COMILLAS
UNIVERSIDAD PONTIFICIA

Grado en Administración y Dirección de Empresas (ADE) con Mención Internacional (E-4)

The Challenges and Opportunities of a Net-Zero Supply Chain for Amazon.com

Clave: 202119655

MADRID | Mayo 2023

Abstract

This thesis examines the challenges and opportunities associated with achieving net-zero emissions for Amazon's supply chain. Qualitative research methods, including a systematic literature review , experiential reflection as well as semi-structured interviews with key energy and sustainability stakeholders at Amazon, were used to explore this concept in detail. The Climate Pledge, a corporate commitment to achieve net-zero emissions by 2040 and preserve the planet, poses significant challenges for Amazon, such as the accounting and management of carbon data, an immature market for carbon reduction technology, and well stakeholder engagement. This study identifies potential strategies to overcome these challenges while also highlighting various business opportunities, including reputational benefits, a more resilient and robust supply chain, cost savings, improved reputation, and innovation. This research highlights the relevance of Amazon's pursuit of a net-zero emissions supply chain by acknowledging that these prospects go beyond environmental duty and have direct implications for Amazon's overall profitability and competitiveness.

Keywords: Amazon, supply chain, net-zero emissions, sustainability, carbon reduction

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1. Introduction

1.1 Research Background

The transition to net-zero emissions has emerged as a critical issue for businesses around the world, driven by the escalating threat of climate change and rising demand for sustainability. As one of the world's largest corporations, Amazon has recognized the importance of this issue and has set ambitious targets to achieve net-zero emissions by 2040. Given its size and global reach, Amazon's commitment to decarbonizing its supply chain has the potential to drive industry-wide change and foster a more sustainable future.

The supply chain is critical in reducing emissions because it includes the complex processes involved in manufacturing, distributing, and transporting goods. Amazon can not only reduce its environmental impact but also set an example for the industry to follow, by successfully decarbonizing its supply chain. Achieving net-zero emissions across the supply chain not only demonstrates Amazon's commitment to environmental stewardship, but it also encourages innovation in sustainable practices and strengthens the company's reputation as a responsible and forward-thinking corporation. Furthermore, it provides Amazon with a competitive advantage by protecting against potential legal frameworks, meeting consumer demand for environmentally friendly products and services, and mitigating disruptions caused by resource scarcity. By taking on the crucial goal of reaching net-zero emissions throughout its supply chain, Amazon has the potential to influence industry standards, spur systemic change, and open the door for businesses all around the globe to move toward a sustainable future.

As a Business Analyst in the EU RME Energy and Sustainability team during a six-month internship with Amazon, I gained valuable insights into the pivotal role of climate goals in the company's decision-making process, as well as the initiatives in place to achieve these targets. To quantify the effectiveness of these initiatives, I utilized vast amounts of energy data and provided critical

analyses to drive carbon-reducing strategies. Additionally, I had the opportunity to visit eleven Amazon warehouses across Spain and the UK to gain first-hand experience and a better understanding of how one could approach the decarbonization of this unique supply chain.

Motivated by the significance of emission reduction in combatting climate change along with the global magnitude and profound implications of the net-zero transition on business and the economy, this research topic resonates with my academic and personal pursuits. As a student of international business specializing in sustainability, I have been captivated by the complexities and possibilities associated with creating a sustainable future, particularly in the context of greenhouse gas emissions reduction. Therefore, this project gives a unique opportunity for me to learn more about this important subject and actively participate in the continuing conversation about climate action. I want to produce significant findings that shed light on this important subject through the meticulous examination of case studies and insightful conversations with relevant sustainability experts.

Climate strategy will be critical for all companies, both big and small, to adapt to the changing environment and overcome arising challenges while creating value for the business. As stated by Birshan (2022), "There is an opportunity to move from what we might call ‘fatalistic’ to ‘futuristic’ mindsets in terms of the ambition. The opportunity, and the imperative, is to make the net-zero transition a tailwind." This requires companies to adopt a futuristic perspective that sees the transition as a catalyst for growth and innovation. Consequently, this study emphasizes how important it is to work toward net-zero emissions, not only for environmental reasons but also for Amazon's long-term growth and position as a leader in its sector. Through its findings, I hope that this research will contribute to the ongoing progress towards environmentally responsible business strategy and environmentally conscious practices.

1.2 Amazon: Company Background

Amazon is a multinational technology company, and its goal is "to be the most customer-centric company in the world". Amazon was founded by Jeff Bezos in his garage on July 5, 1994 and started as an online bookstore. Today, the company is the world's largest online retailer and focuses on cloud computing, digital broadcasting, and artificial intelligence. Amazon has a strong set of values, consisting of 16 leadership principles, which include, for example, "Think Big", "Frugality" and "Deliver Results". These leadership principles are used endlessly and are the basis for all decisions made at Amazon, whether it is to discuss ideas for new projects or decide on the best approach to solving a problem.

Amazon has 185 fulfilment centres across the world. Other Amazon buildings include cooperate offices, Amazon Fresh shops, and delivery stations. The great size of Amazon's operation brings with it today, great scrutiny around its sustainability strategy. In response to this the company, alongside Global Optimism, founded the Climate Pledge in 2019. (*The Climate Pledge – Amazon Sustainability*, 2023).

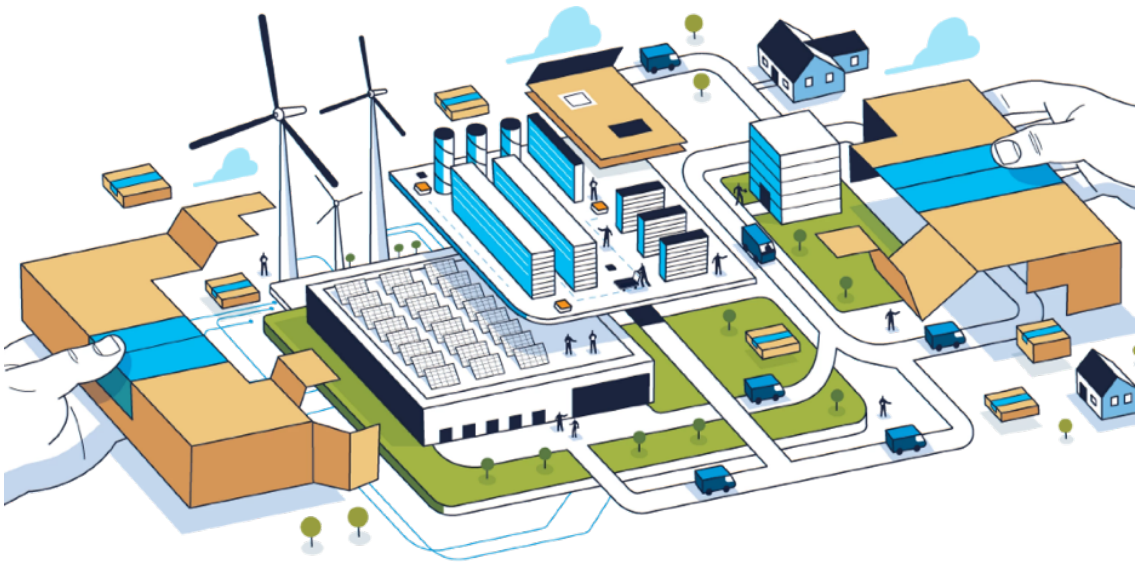

Figure 1. *Amazon´s Sustainable Bond Framework* (Amazon, 2021a)

1.3 Climate Pledge

The Climate Pledge is a commitment to reach net-zero carbon emissions by 2040—10 years ahead of the Paris Agreement. Amazon co-founded The Climate Pledge in 2019 to build a cross-sector community of companies, organizations, individuals, and partners working together to address the climate crisis and solve the challenges of decarbonizing our economy. The climate pledge is currently signed by more than 370 companies including Amazon, SAP, and Microsoft (*The Climate Pledge – Amazon Sustainability*, 2023).

Commitments of the pledge include regular reporting and measurement of greenhouse gas emissions, decarbonization strategies (i.e., renewable energy), and neutralizing any remaining emissions with quantifiable and socially beneficial offsets to achieve net zero annual carbon emissions by 2024.

The purpose of this Climate Pledge is to increase the chance of keeping global warming temperatures below 1.5ºC, with more ambitious targets than those of the Paris Agreement. Failure to do so may result in serious consequences for our planet. For example, according to the IPCC (2021), an extreme heat event that would have occurred once per decade in a climate before human influence would happen 4.1 times a decade at 1.5°C of warming and 5.6 times at 2°C.

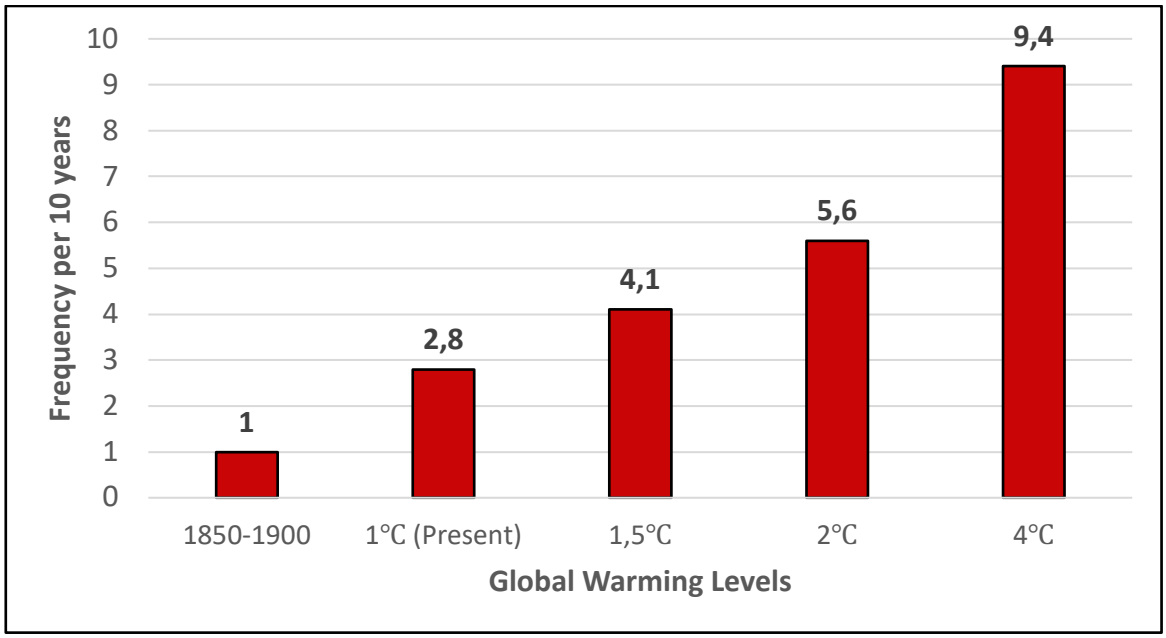

Figure 2. *Frequency of Extreme Temperature Event per 10 years* (IPCC, 2021)

There is no doubt that the signatories of the Climate Pledge (Amazon, SAP, Microsoft, etc.) face an intricate conflict between their constant pursuit of growth and these sustainability commitments outlined above.

2. Objectives and Research Questions

The primary objective of this thesis is to identify and evaluate the challenges and opportunities faced by Amazon.com in its transition to achieving net zero emissions from a supply chain perspective. The following objectives and research questions will serve as a clear framework for the study, guiding the research process and shaping the desired outcomes.

2.1 Objectives

1. *Identify and evaluate the factors impeding progress towards achieving net zero emissions within the Amazon.com supply chain (Challenges).*

This question explores the specific obstacles that Amazon, as a company, may face as it works towards achieving net zero emissions. It aims to identify and understand the potential blockers that may hinder the company's progress in this transition. This is an important area of investigation, as understanding these challenges will be key in developing effective strategies to overcome them and achieve the goal of net zero emissions.

2. *Identify and evaluate the opportunities arising from Amazon's transition to achieving net-zero emissions within its supply chain and assess their potential for driving sustainable growth and competitive advantage.*

As Amazon continues to work towards its goal of achieving net zero emissions, a variety of opportunities may arise for the company. These opportunities could include the ability to attract and retain the growing population of environmentally aware customers, the potential for cost savings through sustainable practices (government support), and the creation of new markets for products and services related to emissions reduction (Crutzen, N., Zvezdov, D., & Schaltegger, S. 2017). Additionally, there may be opportunities for Amazon to form strategic partnerships with other organizations working towards similar goals, further

enhancing the company's sustainability efforts, similar to the strategic partnership between Unilever and Green Century funds which developed sustainable investment options available for customers and an agreement to reduce carbon emissions produced by Unilever's supply chain (Green Century, 2017).

3. *To explore the concept of net zero emissions and its significance in the context of Amazon's sustainability efforts.*

This objective involves delving into the principles and implications of net zero emissions, particularly in relation to Amazon's sustainability strategy. By gaining a deeper understanding of the concept and its relevance, this research will contribute to the academic discourse on net zero emissions and its practical implementation in corporate settings.

4. *To identify and* analyse *the main sources of greenhouse gas emissions in Amazon's operations and supply chain and identify strategies that can effectively reduce these emissions and promote sustainability within the company.*

This objective focuses on the investigation of the primary sources of greenhouse gas emissions within Amazon's operations and supply chain. By conducting a comprehensive analysis, we aim to gain insights into the specific areas that contribute to emissions and understand their magnitude. This knowledge will enable us to develop targeted strategies and initiatives that can effectively mitigate these emissions and promote sustainability throughout the company. Ultimately, this research will provide valuable guidance for Amazon in its journey towards achieving net zero emissions and fostering a more sustainable future.

5. *To contribute to the academic literature on the topic of net zero emissions and its application in the corporate context, with a specific focus on Amazon, leveraging my own first-hand experience.*

By fulfilling these goals, this research will provide Amazon and other large organizations with essential insights that will help them better understand the potential and challenges associated with reaching net zero emissions in their supply chains. Additionally, this study will contribute to the growing body of

knowledge on sustainable supply chain management and support efforts to mitigate climate change internationally.

2.2 Research Questions

The following research questions will act as a guide for this study in order to accomplish these objectives and learn more about the difficulties and chances connected with reaching net zero emissions in Amazon's supply chain:

1. *What are the key challenges faced by Amazon.com in transitioning to a net-zero emissions supply chain?*
2. *What are the potential opportunities for Amazon.com to reduce its carbon footprint within its supply chain?*
3. *What are the main sources of greenhouse gas emissions in Amazon's operations and supply chain, and what strategies could Amazon use to reduce these emissions?*

The previously mentioned research questions will be addressed in this study, which will offer insightful information about the major difficulties, chances, and plans of action facing Amazon as it strives to establish a supply chain with zero emissions.

3. Methodology

3.1 Introduction to Methodology

This study aims to provide a deeper understanding of Amazon's path to net zero emissions by exploring ambiguous ideas, formulating theories, and exploring theories. To achieve this, the study adopts a qualitative research approach, as it is well-suited for answering questions about experience, meaning, and perspective. Qualitative methods allow for the exploration of data that cannot be measured or counted, utilizing techniques such as small-group discussions, semi-structured interviews, in-depth interviews, and text analyses (Hammarberg et al., 2016).

In this research, I will employ a systematic literature review a case study analysis and semi-structured interviews, to gather data and insights. An exhaustive academic literature review will provide valuable support in examining existing knowledge in this field. To comprehend the approach of different companies to net zero emission the case study approach will be utilized. “The case study approach is particularly useful to employ when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context”. (Crowe et al., 2011).

I will use my *End of Internship Reflection* essay, which I completed as part of the internship module at university, along with my weekly diary entries to comprehensively evaluate my learnings during my internship at Amazon and establish insights into the company's approach to the net-zero problem. This essay will be a valuable resource for reflecting on my personal experience at Amazon and analysing the broader context of the organization's net-zero challenge.

Finally, to fill in the gaps, semi-structured interviews will be conducted with key members of Amazon's RME Energy and Sustainability team, including the EU RME Energy Manager, Anthony Hatfield, and the EU Solar Manager, Gabriel Ortiz, as well as with director of BPC Engineers John Gleeson. ‘Building Performance Consulting engineers’ is dedicated to supporting clients in their sustainable transformation towards a net-zero future by optimizing building energy efficiency, reducing carbon emissions, promoting occupant health and wellness. Their expertise and perspectives will contribute significantly to answering the research questions identified.

By employing a qualitative approach, combining a systematic literature and case study review, experiential reflection and semi-structured interviews ,this research seeks to offer valuable insights into Amazon's transition to net zero emissions and contribute to the existing body of knowledge in this area.

3.2 Factors to consider

- Limitations: The study's limited sample size of interviewees, which may restrict the findings' generalizability, is one of its limitations. A chosen selection of members of Amazon's RME Energy and Sustainability team will be interviewed for the project. Even while this team is directly involved in the company's sustainability initiatives, it's possible that their attitudes might not entirely reflect those of other parties in Amazon's supply chain. As a result, the results need to be understood in the context of this small sample.
- Validity: Several sources of data will be used in the study to establish its validity. In addition to conducting interviews, a thorough assessment of the literature will be done to compile the body of knowledge and viewpoints on net zero emissions and sustainable supply chain management. In addition, a case study analysis will be performed to look at actual instances of achieving net zero emissions in supply chains. The study attempts to provide a comprehensive understanding of Amazon's potential and challenges in its transition to net zero emissions by utilizing a variety of data sources. Triangulation of the data will be used to increase the validity of the results. To verify consistency and convergence of the findings across sources, the data gathered from interviews, literature reviews, and case studies will be compared and analysed. The study's findings are more trustworthy and credible as a result of this strategy.
- Reliability: A standardized interviewing methodology will be created for the study's participants in order to guarantee the study's dependability. The interview questions, probing methods, and criteria for data collection will all be described in this protocol. The goal of the study is to reduce any inconsistencies in data collecting and boost the dependability of the results by employing a uniform strategy throughout all interviews. Additionally, member checks will be carried out to assess the accuracy of the data. To make sure that their viewpoints and experiences are appropriately portrayed in the study, participants will have the chance to review the results and offer feedback. This procedure makes it possible to confirm the accuracy of the data and raises the reliability of the research findings.

- Research Reflexivity: It is vital to recognize the possibility of personal biases and conflicts of interest in carrying out this study as a former employee of Amazon. A reflective approach will be used throughout the research process to address this. In order to identify any biases and assumptions that may affect how data is interpreted, critical self-reflection will be used. Throughout the course of the study, transparency and disclosure of any potential biases or conflicts of interest will be upheld. Any arising possible prejudices will be acknowledged and freely discussed. This includes reporting the researcher's previous links to Amazon as well as any other personal relationships that might have an impact on the conduct or outcome of the study. Additionally, participating in regular critical reflection and discussion with colleagues and participants can assist reduce any biases and improve the study's overall rigor. The study strives to respect ethical standards and guarantee the accuracy of the results by encouraging transparency and open dialogue.

3.3 Research Approach

According to (Dubois & Gadde, 2002) here are three ways to do research: deductive, inductive, and abductive. Deductive research tests ideas that already exist, while inductive research creates new ideas from data. Abductive research is different from both and is useful when researchers want to discover new insights, such as novel concepts or relationships between phenomena. Abductive research combines old ideas with new ones from real-world experiences. This can help create new and better ideas.

For this study I will be taking on an abductive research approach with a focus on the “generation of new concepts and development of theoretical models, rather than confirmation of existing theory” (Dubois & Gadde, 2002).

3.4 Research Design and Strategy

A research design can be exploratory, descriptive, or explanatory (Saunders et al., 2019). The exploratory design is flexible and useful when investigating a

situation that may change. The descriptive design aims to create an accurate profile, while the explanatory design aims to show the relationship between variables (Saunders et al., 2019). Due to the rapid advancements being made in the area of sustainability as of now, I used an exploratory research design for this study to allow for potential developments during the investigation.

3.5 Data Collection

For the topic of the challenges and opportunities for Amazon.com in the transition to net zero, I chose to use a qualitative approach to data collection. This is because qualitative research allows for an in-depth exploration of complex issues, which is particularly relevant to this topic as it involves a wide range of environmental, social, and economic factors. Additionally, qualitative research methods, such as interviews, and case studies, allow for quality and detailed data directly from key stakeholders, providing valuable insights into their experiences and perspectives. Through this approach, I was able to gain a comprehensive understanding of the transition to net-zero for the Amazon.com supply chain.

3.5.1 Literature review

Once I had determined my research questions, I began the literature review process. This helped me focus my search by identifying relevant keywords. I used "supply chain," "sustainable," and "net-zero" to narrow down my findings. The DCU library database was a valuable resource throughout this process, providing access to a wide range of scholarly works. I applied filters such as "peer-reviewed" and limited the publication years to after 1990 to ensure the relevance and quality of the sources. While I prioritized highly cited papers, I also explored lower-cited works for niche topics like carbon offsetting. The literature review was crucial to this study's success since it offered a thorough understanding of the subject matter both before and after additional research methods, such interviews, were used. I sought to build a solid knowledge base that would permit the synthesis of important ideas and the development of concepts by studying a wide range of peer-reviewed literature and case studies.

I started by conducting a thorough literature search to find relevant sources in the topic of interest before conducting interviews. I was able to learn a lot about the state of the field's expertise and the most recent developments thanks to this methodical literature search. It assisted me in identifying areas that needed more research and possible research gaps. After the interviews, I went back to the literature review to support and add to the results from the primary research. This iterative method enabled a more thorough investigation and interpretation of the gathered data in the light of prior understanding. I intended to develop a thorough and complex grasp of the research issue by fusing the interview results with the literature review. The results of the interviews and the literature review were combined, creating a triangulation of data that improved the overall validity and dependability of the research findings. I was able to create a thorough study and reach well-informed conclusions by contrasting and analysing the ideas I learned from both sources.

3.5.2 Experiential Reflection

My six-month internship as an Energy and Sustainability Business Analyst at Amazon, provided me with valuable insights into this side of the business. As I was aware from the start of my internship that I wanted to write my thesis on this topic, I created a weekly diary to comprehend different concepts and variables which would later help me to answer some of the key research questions I had in mind. Writing these weekly diary entries also helped me achieve my deliverables in the role and bring value to the team. Some of the important learnings I developed from my time at Amazon which apply to this research include:

a) <u>Industry trends</u>

I became informed about the on-going trends surrounding sustainability, such as:

i. Russia's invasion of Ukraine which led to energy disruption in Europe, creating a strong incentive for investment in renewable energy.
ii. The impact of AI: requires significant energy usage yet it can also contribute to better conservation of natural resources and energy management.

iii. Companies are now looking beyond their traditional business and transforming their supply chains to become carbon negative, which involves paying back the CO2 debt created since the company's creation (Olynec, 2023)

b) Energy Analytics

Whist working as a business analyst I discovered the importance of data in reducing energy consumption. I remember during my first day at Amazon my manager, Anthony Hatfield, told me "*You can't monitor what you can't measure*" (Hatfield, 2023). The energy sector is generating vast amounts of energy production and consumption data and becoming more digitized due to the increasing use of emerging information technologies (Zhou et al., 2016). Through sub metering and granular data, over consumption of electricity, gas and water can be identified and mitigated, improving efficiency whist reducing costs and emissions. However, while working with Amazon's energy data, I observed inconsistency in its quality and completeness. Energy suppliers, often government-owned entities, are not advanced on the data front as they operate in a monopoly, with little demand for innovation. This inconsistency can pose a challenge for Amazon when it comes to carbon accounting.

c) Projects and Initiatives

Attending quarterly sustainability meetings allowed me to understand the strategies in place across the business to reduce Amazon's carbon footprint and promote a greener future for the company. Some of these strategies include:

i. Renewable Energy - Expansion of PV across the roofs of fulfilment centres (Ortiz, 2023),
ii. HVAC Temperature Optimization – this project involves using data analytics and machine learning techniques to optimize the temperature control system within the fulfilment centres. By analysing data from sensors and other sources, the system can adjust the temperature

settings to improve energy efficiency while maintaining a comfortable working environment for employees. This can result in significant cost savings for Amazon in terms of energy consumption, as well as reducing the environmental impact of their operations (Hatfield, 2023).

iii. Shutdown Analysis – A project I worked on which focused on achieving optimal energy efficiency in Amazon buildings during the weekly site shutdowns, through data analysis and best practice implementation.

iv. Gas and Water Leak Detection - Gas and water leaks can result in significant waste of resources and pose safety risks. Amazon has implemented a project that uses machine learning algorithms to identify and prioritize gas and water leaks within its facilities.

Overall, my internship at Amazon provided me with a unique experiential learning opportunity that allowed me to gain insights into the energy and sustainability side of a major corporation. This provided valuable insights that have shaped my thesis research.

3.5.3 Interviews

There are three fundamental types of research interviews: structured, semi structured and unstructured. Semi-structured interviews have a set of main questions to guide the conversation, but also offer room for the interviewer and interviewee to delve deeper into interesting ideas or responses (Britten, 1999). I used semi-structured interviews as a qualitative research method to collect data on the challenges and opportunities for Amazon.com in the transition to net zero. The semi-structured approach allowed me to have a flexible conversation with the interviewees, while still ensuring that the key research questions were addressed. This approach also allowed for the exploration of emerging themes and ideas that may not have been considered in a more structured approach. Using semi-structured interviews, I was able to gain valuable insights and perspectives from individuals within the company who are directly involved in the transition to net zero, which provided a rich and detailed understanding of the topic.

The table below provides information about the interviews that I conducted.

Participant	Role	Date	Duration
Gabriel Ortiz	EU RME Solar Manager Amazon	24/02/2023	60’
Anthony Hatfield	EU RME Energy Manager Amazon	03/03/2023	60’
John Gleeson	Director BPC Engineers	07/02/2023	60’

Figure 11. *Interview Participants*

I selected Gabriel and Anthony for interviews due to my close working relationship with them throughout my internship with Amazon as well as their knowledge of the company and experience in the industry of energy and sustainability.

I chose Anthony as an interviewee for my thesis due to his impressive background as an experienced manager of energy and carbon. His expertise in operational energy management, business communication, and energy cost and consumption reduction made him a valuable resource. Anthony's background includes serving as the Energy Program Manager in the Reliability, Maintenance & Engineering (RME) team at Amazon, where he contributes to the company's efforts in reducing energy costs and global carbon emissions. At Amazon, he is responsible for driving energy and carbon reductions, as well as implementing innovative technologies to meet the company's energy and carbon targets.

Before joining Amazon, Anthony served as a Senior Energy Manager at Rolls-Royce, where he managed and delivered the 2030 zero-carbon target across global facilities and operations. His responsibilities included the delivery of normalized energy and water consumption reduction targets, development and execution of a 5-year capital plan that featured future technologies and renewables, and the implementation of low carbon and renewable technologies. Anthony was also responsible for global energy project management, global utility budget management, utility contract management, and carbon compliance.

Gabriel Ortiz is a Solar Program Manager at Amazon, who possesses a vast amount of experience in the renewable energy sector. His notable accomplishments include leading the implementation of the first utility-scale PV

plant with ancillary service capabilities in Chile and being recognized for his innovative work in renewables integration. I chose to interview Gabriel for my thesis on Amazon's challenges and opportunities in transitioning to net zero, due to his expertise in renewable energy and his specific experience with utility-scale PV plant implementation and grid integration. Renewable energy plays a critical role in decarbonizing the supply chain, and I believed that Gabriel's knowledge and experience would be invaluable in exploring further its role in the transition to net zero.

One of the key areas that Gabriel is particularly knowledgeable about is contract management, which is a crucial aspect of Amazon's transition to net zero. Effective contract management ensures that Amazon can access renewable energy at scale while providing price certainty and risk mitigation. Gabriel's expertise in this area can help identify the most suitable contracts and ensure that they meet Amazon's unique needs.

In addition, Gabriel's experience in carbon compliance can also prove to be valuable. As part of its transition to net zero, Amazon needs to ensure that its emissions are in line with the Paris Agreement's objectives. Gabriel's knowledge can help identify and implement carbon reduction strategies, as well as ensure that the company meets regulatory requirements.

Finally, I chose to interview John Gleeson, director of BCP Engineers for my thesis focused on the net-zero transition because of his extensive experience and expertise in decarbonization, sustainability certification of buildings and installing energy-efficient solutions for various major consultancy projects worldwide.

John was able to provide me with great insights into carbon reduction methods, along with the challenges that may arise during their implementation. This knowledge had a wider scope as John’s interpretations are taken from a diverse range of projects across different buildings and supply chains. However, he provided various valuable observations which I was later able to link and apply directly to the case of Amazon. For example, John highlighted to me the importance of carbon offsetting for achieving Net-Zero as well as the big

challenge of carbon accounting, preventing organisations from establishing a carbon baseline.

The interviews with Anthony, Gabriel, and John have greatly contributed to understanding Amazon's net-zero transition. Their expertise in renewable energy, carbon reduction strategies, and sustainability certification of buildings, have highlighted the critical role that these areas play in achieving Amazon's goal. Anthony, Gabriel, and John are exceptional candidates for exploring Amazon's challenges and opportunities in transitioning to net zero.

All participants in the study provided their consent for audio recording of the interviews, which I then transcribed.

4. Structure of the study

This section will elaborate on the different components of the study, including the theoretical framework, scope of the phenomenon of interest, synthesis of the research, questions already answered and those unsolved, as well as the results and conclusions.

The theoretical framework (Section 5) serves as the foundation for this study, providing a conceptual lens through which the research is conducted. In relation to the subject of net-zero emissions in Amazon's supply chain, it includes a variety of current theories, concepts, and models. By referencing these frameworks, the study seeks to gain a deeper comprehension of the subject and offer insights into the obstacles and opportunities that Amazon must overcome in order to meet its sustainability objectives. The decarbonization of Amazon's supply chain is the phenomenon of interest, and the scope of this phenomenon is outlined in Section 5.1. By highlighting obstacles and opportunities of decarbonizing the supply chain of Amazon.com, the study fills the research gap. The study ensures a focused and realistic analysis of the subject matter by defining the scope. The synthesis of the research (Section 5.2) involves integrating and analysing the existing literature, studies, and data related to net-zero emissions in supply chains, with a particular focus on Amazon. This synthesis aims to identify the current state of

knowledge, highlight the gaps and limitations in existing research, and provide a comprehensive overview of the field. It involves a systematic review of relevant academic articles, reports, and industry publications to ensure a rigorous and evidence-based analysis.

This synthesis is divided into two parts:

5.2.1: Established Concepts and Literature Review: This section provides a thorough understanding of the research topic as well as the current knowledge gathered from scholarly literature.

5.2.2: Addressing Research Gaps and Exploring New Aspects: This section of the study focuses on addressing knowledge gaps and looking into areas that need more research. In order to generate new insights and viewpoints, I draw on my own personal experience at Amazon as well as the transcripts from the interviews carried out.

By organizing the theoretical framework in this manner, the study makes use of already-known information while also attempting to increase comprehension.

Moving on to the results (Section 6), the study presents the study's findings. Section 6.1 identifies the key barriers, obstacles, and complexities impeding Amazon's progress toward its sustainability goals. In addition, Section 6.2 focuses on the opportunities for Amazon.com in the net-zero emissions transition. Finally, Section 7 summarizes the key findings, implications, and recommendations derived from the research. It provides a comprehensive overview of the study's contributions to the understanding of net-zero emissions in Amazon's supply chain and offers insights for both academic and practical stakeholders.

5. Theoretical Framework

5.1 Scope: Phenomenon of Interest

Achieving net zero emissions is an urgent and critical issue in the face of climate change. Large corporations like Amazon have a pivotal role in achieving global climate goals, as they are major contributors to greenhouse gas emissions.

Amazon has publicly committed to achieving net-zero carbon emissions by 2040, making it one of the largest and most influential corporations in the world to do so (The Climate Pledge – Amazon Sustainability, 2023). Among Amazon's five primary divisions, its e-commerce sector, Amazon.com, significantly contributes to the company's greenhouse gas emissions. Most of these emissions from the e-commerce sector of the business, are produced during the supply chain process, delivering the product from the supplier to the customer. According to Bove and Swartz (2016) “The typical consumer company’s supply chain creates far greater social and environmental costs than its own operations, accounting for more than 80 percent of greenhouse-gas emissions and more than 90 percent of the impact on air, land, water, biodiversity, and geological resources”. Therefore, due to its significance in relation to net zero emissions, this thesis will focus on the e-commerce sector, from a supply chain perspective.

The current literature lacks in-depth research on the challenges and opportunities faced by large supply chain operations, particularly Amazon, in achieving net zero emissions. Existing studies have mainly focused on reducing carbon emissions without fully exploring the potential obstacles and advantages of doing so. Additionally, while some research has examined the sustainability of supply chain management, many fail to consider the intricate nature and magnitude of Amazon's operations. Therefore, the current research gap involves identifying the challenges and opportunities Amazon encounters as it transitions to net zero emissions from a supply chain perspective.

To address this gap, my research aims to identify and evaluate the factors that can impede or enable progress towards achieving net zero emissions within the Amazon.com supply chain. By leveraging my experience within the company and consulting key Amazon stakeholders in sustainability roles, I aim to offer new perspectives and insights on this topic. The research will also examine the role of analytics in identifying, measuring, and managing carbon reduction initiatives in Amazon's supply chain, which will be a crucial focus. By offering new perspectives and insights on this critical topic, my research will contribute to a better understanding of the challenges and opportunities faced by large

corporations like Amazon in transitioning to net zero emission and contribute to the global effort to mitigate climate change.

The process of evaluating the environmental impact of supply chains is commonly performed using a widely recognized method known as Lifecycle Assessment (Laínez, 2008). I will use this method to help identify the challenges and opportunities for Amazon in terms of reducing emissions. Furthermore, I will utilize sustainability frameworks, such as The Triple Bottom Line theory, to evaluate the sustainability performance of Amazon in terms of three dimensions: social, environmental, and economic. Applying this theory to the concept of achieving net zero emissions for Amazon's supply chain can provide a comprehensive approach to understanding the challenges and opportunities involved.

5.2. Synthesis

This part of the theoretical framework will focus on the questions that have been answered already and the problems that remain unsolved.

5.2.1 Established Concepts and Literature Review

1. *From what disciplines has "decarbonizing the supply chain" been studied? How is the topic been approached in each case?*

In recent years, there has been a significant surge in both academic and corporate attention towards sustainable and green supply chain management, as demonstrated by a growing body of research (Lyon & Maxwell, 2011). After an extensive literature review and examination of key words, I identified the four main academic disciplines from which this area has been studied (Appendix A).

1) Environmental science
2) Operations Management
3) Economics and Finance
4) Engineering

I selected the most important academic papers from each topic based on their relevance to the topic under consideration and their citation count. I then classified them into the four academic fields mentioned above. The categorization of the literature into disciplines allows for a comprehensive understanding of the approaches to studying supply chain decarbonization (See Appendix 1). This structured framework enabled me to investigate the topic from a variety of perspectives and gain insights from various fields. The categorization of literature in environmental science, operations management, economics and finance, and engineering reveals a diverse range of strategies and best practices. Each discipline brings a distinct perspective to a multidimensional understanding of supply chain decarbonization.

I have mapped these 4 disciplines onto a graph which distinguishes their approach by two concepts.

1) Corporate Strategy
2) Sustainability Awareness

I chose corporate strategy and sustainability awareness as key concepts in categorizing the literature because of their direct relevance to this thesis on decarbonizing the supply chain of Amazon.com. When it comes to net-zero, both financial considerations and environmental impact are critical factors that drive decision-making and shape strategies related to sustainability and carbon reduction in supply chains.

Corporate strategy explains how businesses strategically incorporate decarbonization efforts into their business strategies. I gained a valuable understanding of decision-making processes and considerations in pursuing decarbonization goals by studying the disciplines operations management and economics and finance. Businesses must consider the financial implications of adopting sustainable practices because they operate within economic frameworks. Cost considerations, return on investment, and financial viability are all important factors in decision-making. I hope to capture the economic drivers, challenges, and opportunities associated with supply chain decarbonization by including financial considerations as an axis.

On the other hand the focus of sustainability awareness is on the environmental consciousness and long-term sustainability aspect of supply chain decarbonization. By including environmental impact as a key axis, I hope to highlight the motivations, strategies, and actions taken by various disciplines to mitigate the environmental consequences of supply chain operations.

This study benefits from categorizing the disciplines into a graph based on corporate strategy and sustainability awareness. It depicts the alignment and emphasis of each discipline, assisting in understanding their perspectives. The graph allows for comparison, identifying similarities and differences in approaches. It also identifies gaps and areas of overlap, encourages interdisciplinary collaboration, and identifies research opportunities.

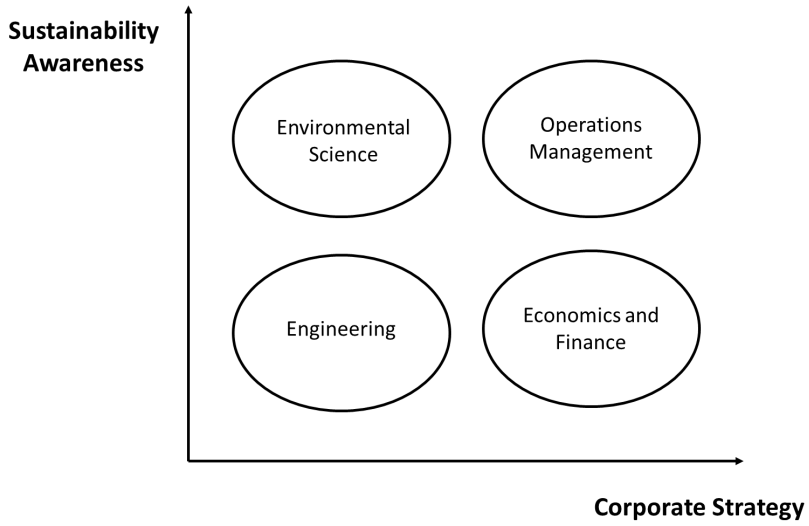

Figure 3. Disciplinary Matrix

1) Environmental science

Literature reviews and studies from this discipline often emphasize the ecological aspect of supply chain management while downplaying the financial and business-related aspects. For example, Hervani et al. (2005) define green supply chain management as the incorporation of environmental considerations into supply chain management, recognizing the impact and relationships between supply chain management and the natural environment. This approach is

motivated by an environmentally conscious mindset and may also stem from a desire for competitiveness within organizations. Overall, environmental science brings a valuable perspective to the study of sustainable supply chain management by emphasizing its impact on the planet and its species.

2) Operations management

Studies from the discipline of operations management have also contributed to the understanding of sustainable and green supply chain management. From the operations management discipline, one central concept that is often applied which helps operationalize sustainability, is the triple bottom line approach (Elkington, 2013). This approach emphasizes the importance of meeting minimum performance requirements in all three dimensions - environmental, economic, and social - to achieve sustainability in supply chain management. An example of a study from the operations management discipline using this approach is “Supply chain channel coordination with triple bottom line approach” (Biswas et al., 2018). This paper suggests a way to divide environmental and social responsibilities in decentralized supply chains and show that they affect supply chain decisions. Socially responsible suppliers can help coordinate the supply chain.

In addition to the triple bottom line approach, operations management research has also explored a range of other strategies for decarbonizing the supply chain. For example, studies have examined the adoption of circular economy models. An article by Lopes de Sousa Jabbour et al. (2019) explores how adopting circular economy business models affects decision-making in operations management, including product design, production planning, and logistics. It suggests ways in which operations managers can adapt and develop new skills to meet emerging demands. Overall, studies from the operations management discipline have contributed significantly to the understanding of sustainable and green supply chain management, with concepts such as the triple bottom line approach and circular economy models being explored as strategies for achieving sustainability, efficiency and cost reduction.

3) Economics and finance

Decarbonizing the supply chain has also been studied from the financial discipline, with a particular focus on the popular concept of Sustainable supply chain finance (SSCF). SSCF offers a viable solution for attaining sustainable development goals by prioritizing profit-seeking enhancements with a heightened focus on ecological awareness (Blome et al., 2020). It is an innovative managerial practice dedicated to release cash flow pressure and improve operational efficiency in supply chain, which has drawn increasing attentions from academia and industry" (Wei & Dou, 2023). According to the Global Head of Core Trade for JPMorgan Chase and Co (2023), Natasha Condon, "Supply chain finance can be used to create a financial incentive for a supplier to commit to a sustainability policy".

While the primary focus of SSCF is sustainability, it is important to note that SSCF is still a financial tool that must be profitable in order to be sustainable, that is why I placed it on the bottom right of the matrix in figure 3.

4) Engineering

From an engineering perspective, there has been a focus on developing **technology**, to reduce emissions in the supply chain. Some of this technology includes blockchain technology, electric vehicles and artificial intelligence.

There has been a particular emphasis on blockchain technology. According to (Saberi et al., 2019) Supply chains must meet sustainability standards, and blockchain technology can help by improving transparency, security, and process integrity. Blockchain is a decentralized database that reduces the need for middlemen and enables accurate and trustworthy records of product movements. This enhances consumer confidence in companies' sustainability practices.

The transportation industry alone is responsible for 27 percent of all greenhouse gas emissions. (Patel et al., 2021) Electric vehicles (EVs) are proposed as a mode of freight transportation as they have several benefits such as producing zero carbon dioxide emissions, being accessible to charge, having tax and financial benefits, and producing almost no noise pollution (Patel et al., 2022)

Engineers are also developing artificial intelligence to decarbonise the supply chain. According to PwC (2019), the application of AI levers could reduce worldwide greenhouse gas (GHG) emissions by 4% in 2030, an amount equivalent to 2.4 Gt CO2e - equivalent to the 2030 annual emissions of Australia, Canada and Japan combined.

2. *How are emissions categorized? Which category of emissions represents the majority throughout the supply chain?*

According to the Greenhouse Gas Protocol (GHG Protocol, n.d.) carbon emissions are classified into three categories.

Scope 1 emissions refer to the direct emissions that arise from sources that the organization controls or owns. These may include emissions from combustion of fossil fuels in manufacturing processes, emissions from transportation of products by the company's own fleet of vehicles, and emissions from on-site waste disposal. Scope 2 emissions, on the other hand, are indirect emissions that are generated from the production of purchased electricity, heating, cooling, or steam consumed by the organization. These emissions result from the generation of energy by external sources that are supplied to the organization. (Olatunji et al., 2019).

To lower Scope 1 and Scope 2 emissions, “retailers could seek to improve the energy efficiency of stores with LEDs; more efficient heating, ventilation, and air-conditioning (HVAC) motors; heat pumps; on-site solar-power generation; and battery energy storage. They might also decarbonize their owned transportation fleet by upgrading to zero-emissions vehicles (for example, those that run on batteries or fuel cells)” (Bhargava et al., 2022).

Finally, Scope 3 emissions include all other indirect emissions that are generated throughout an organization's value chain, including emissions resulting from employee commuting, business travel, supply chain activities, and the use of the organization's products and services by consumers. These emissions may be

challenging to identify and quantify, as they occur outside the organization's direct control (Plan A Academy, 2022). These emissions, which occur outside of an organization's direct control, frequently account for the majority of its greenhouse gas footprint (Gezgin et al., 2017). According to the CDP's 2022 report, approximately 75% of emissions in many industries are caused by upstream or downstream activities (CDP, 2022). Addressing scope 3 emissions is critical for businesses to meet their climate change commitments and participate in the Race to Zero initiative, allowing customer-facing sectors to drive rapid decarbonization across the economy (Boston Consulting Group, 2021). Collaboration with suppliers is critical, it involves sharing best practices, revising procurement standards, and procuring renewable energy collectively (Enel North America, 2023). Identifying and quantifying scope 3 emissions presents challenges, but addressing them is essential for credible sustainability efforts and broader decarbonization across the value chain.

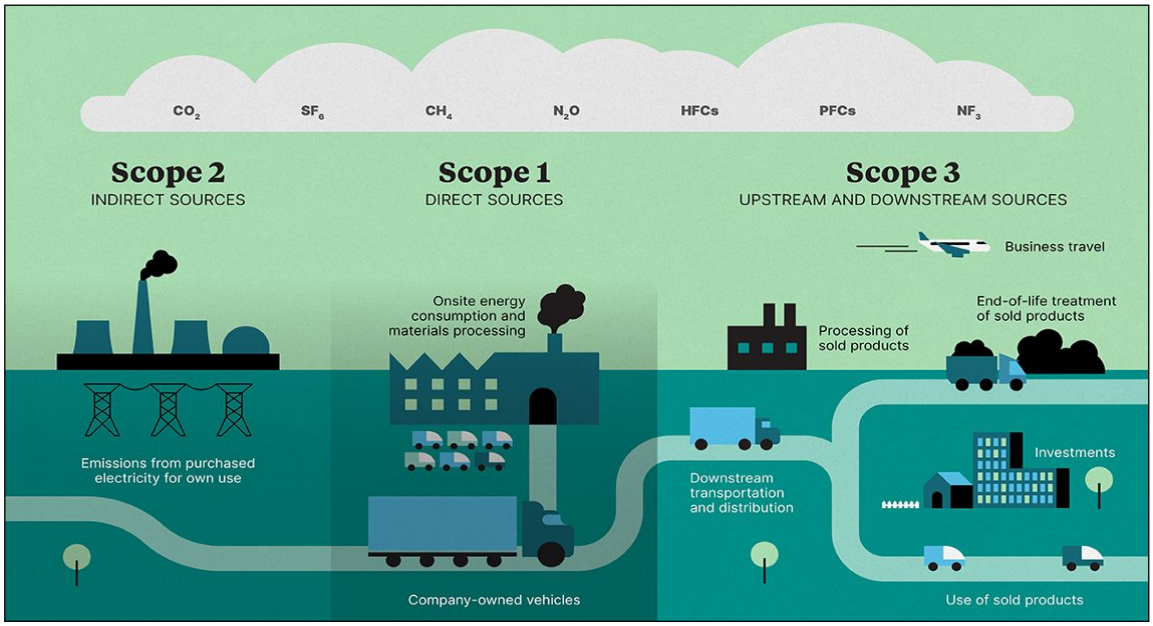

Figure 4 . *There's no low-carbon future without cutting Scope 3 emissions.* (Oliver Wyman Forum, 2021)

3. What is Amazon's current carbon footprint and how has it changed over time?

Amazon's direct operations (Scope 1) emissions, which include emissions from fossil fuels and refrigerants, have increased from 5.76 (million metric tons of carbon dioxide equivalent) in 2019 to 12.11 (million metric tons of carbon dioxide

equivalent) in 2021, a 26% increase from 2020. This was due to an increase in the company's operations during the Covid-19 pandemic. Where the company saw a growth in annual revenue of 21.7% in 2021 (Macrotrends, 2023).

Emissions from purchased electricity (Scope 2) have decreased from 5.50 (million metric tons of carbon dioxide equivalent) in 2019 to 4.07 (million metric tons of carbon dioxide equivalent) in 2021, a 23% decrease year over year. This is mainly due to Amazon's increased use of renewable energy sources for its operations.

Emissions from indirect sources (Scope 3), which include corporate purchases, Amazon-branded product emissions, capital goods, and other indirect emissions, have increased from 39.91 (million metric tons of carbon dioxide equivalent) in 2019 to 55.36 (million metric tons of carbon dioxide equivalent) in 2021, a 21% increase year over year. This suggests that Amazon's supply chain emissions have increased, due to an increase in the company's overall sales during the pandemic in 2021 (Amazon 2021).

However, despite this increase in supply chain emissions, Amazon's carbon intensity, measured in grams of carbon dioxide equivalent per dollar of gross merchandise sales, has decreased from 122.8 in 2019 to 100.8 in 2021, a decline of 1.9% year over year, as highlighted in the table below. This suggests that the company has been able to reduce its carbon emissions per dollar of sales.

Carbon Intensity (grams of carbon dioxide equivalent per dollar of gross merchandise sales)	**2019**	**2020**	**2021**	**YOY%**
	122.8	**102.7**	**100.8**	**-0.019**

Emission Category (million metric tons of carbon dioxide equivalent)	**2019**	**2020**	**2021**	**YOY%**
Emissions from Direct Operations (Scope 1)	5.76	9.62	12.11	26%
Fossil fuels	5.57	9.37	11.89	27%
Refrigerants	0.19	0.25	0.22	-12%
Emissions from Purchased Electricity (Scope 2)	5.5	5.27	4.07	-23%
Emissions from Indirect Sources (Scope 3)	39.91	45.75	55.36	21%
Corporate purchases and Amazon-branded product emissions	15.41	16.7	19.09	14%
Capital goods (e.g. building construction, servers and other hardware, etc.)	8.01	10.52	15.37	46%
Other indirect emissions (e.g. third-party transportation, packaging, etc.)	12.44	15.77	18	14%
Lifecycle emissions from customer trips to Amazon's physical stores	4.05	2.77	2.91	5%
Amazon's Total Footprint	**51.17**	**60.64**	**71.54**	**18%**

Figure 9. *Our Carbon Footprint* (Amazon, 2021b)

4. What are the key drivers / motives behind supply chain decarbonization?

I. Cost savings

Initiatives for supply chain decarbonization have both environmental and financial benefits. Organizations can gain cost savings and operational efficiency through improving energy efficiency, optimizing transportation routes, and minimizing waste. These activities help to optimize resources, streamline operations, and boost market competitiveness (Okereke, 2007). Many multinational corporations have successfully used sustainable practices to generate financial rewards and long-term value. For example, Unilever saved €1.2 billion of cost due to sustainable sourcing, eco-efficiencies at factories (Business Today, 2021).

II. Legislation

Regulatory and policy pressures are key drivers of supply chain decarbonization, as evidenced by the existence of many climate change laws around the world. According to Eskander Shaikh and Fankhauser (2020), approximately 1,800 climate change laws are in place around the world. More than half of these laws contain provisions concerning energy supply, specifically the promotion of renewable energy sources These regulations establish targets, impose emission reduction requirements, and create reporting frameworks, compelling businesses to prioritize sustainable practices and reduce their carbon footprint throughout the supply chain. More than half of these laws, for example, include provisions relating to energy supply, particularly the promotion of renewable energy sources (Eskander Shaikh & Fankhauser, 2020). Compliance with these regulations, as well as the desire to avoid penalties and reputational damage, are powerful motivators for organizations to pursue decarbonization efforts aggressively.

III. Resilience or risk mitigation

Companies are driven by a desire to protect themselves against potential risk or commercial loss that may arise from inactivity on climate change; in other words, the perception of risk from physical damages connected with climate change is a major element affecting corporate climate strategy. They understand that inaction on climate change can expose them to a variety of risks, including reputational damage, operational disruptions, and supply chain disruptions. The perception of risk resulting from the physical effects of climate change, such as extreme

weather events, sea-level rise, and resource scarcity, has a significant impact on their corporate climate strategies. (Skjaerseth & Skodvin, 2003).

IV: Stakeholder Pressure

“Stakeholders are increasingly pressing companies to integrate environmental and social issues into their business operations due to the detrimental impacts of globalization, such as environmental and social problems, among others” (Haleem et al., 2022). These stakeholders include competitors, governments, communities, non-governmental organizations (NGOs) (González-Benito & González-Benito, 2006). As a result, organizations are setting decarbonization goals and actively looking for ways to positively impact the environment and society (Enel North America, 2023). Companies hope to improve their reputation, mitigate risks, and align with changing societal expectations by responding to stakeholder pressure, ultimately driving the adoption of sustainable management practices and the pursuit of decarbonization goals.

5. What strategies can be used for achieving emissions reduction in the supply chain?

1) Strategies for Achieving Emissions Reduction in the Supply Chain.

There are various factors which drive the reduction of carbon emissions being produced in supply chains. Based on my study of the topic, some of these include collaboration and engagement, efficient transportation and energy efficiency.

I. Stakeholder collaboration and engagement

Collaboration and engagement are essential to achieving sustainable supply chains, according to Zsidisin and Siferd (2001). The process of transitioning to carbon neutrality requires ongoing communication and education with supply chain stakeholders, particularly in the initial stage, which can be more challenging due to a "lack of awareness" and "resistant mindset (Zhang et al., 2022). “Engaging suppliers and customers on carbon management reduces vulnerability to climate-related risks and increases resilience and adaptability in supply chains” (Lintukangas et al., 2022).

Most greenhouse gas emissions attributed to companies occur beyond their own operational boundaries, resulting from the activities of their suppliers operating within the supply chain, those of which are Scope 3 emissions. (Tidy et al., 2016) It is often difficult for the focal company to engage the supplier, however in the case of a company the size and magnitude of Amazon there is exceptions, powerful buyers can serve as role models and set standards, thereby extending their suppliers' engagement in sustainability efforts (Amaeshi et al., 2008). Strategies employed by companies to engage their suppliers include sharing technologies, monitoring performance, and providing incentives (Bove & Swartz, 2016). A notable example is Walmart's efforts to work with thousands of Chinese suppliers to improve energy efficiency, resulting in an average reduction of 10% in energy consumption (Gezgin et al., 2017). The Amazon Supply Chain Standards require suppliers to comply with environmental laws and regulations, minimize adverse impacts on the environment, continuously improve energy efficiency and reduce greenhouse gas emissions, obtain necessary environmental permits, manage hazardous substances, and implement effective resource management practices. The standards also encourage suppliers to prevent pollution, conserve resources, manage water and solid waste, treat air emissions, and address environmental justice issues (Amazon, 2022).

On the other hand, engaging customers in carbon management often is based on a customer's commitment to their relationship with the focal company (Patrucco et al., 2020). From the focal company's (Amazon) perspective transparency and collaboration are key in achieving consumer engagement to decarbonize the supply chain. Companies can provide their emissions figures to customers to demonstrate their commitment to addressing climate change and encourage customers to reduce their own emissions by choosing more sustainable products. This type of information transfer can also help to build trust and loyalty with customers who value sustainability and environmental responsibility. (Dahlmann & Roehrich, 2019). For example, a study shows that including sustainability messaging in a restaurant menu could increase diners' choice of vegetarian dishes by between 35 and 100 percent. "Changes to menu

messaging can increase sales of climate-friendly food," (World Resources Institute, 2022)

II. Waste reduction

Packaging plays a crucial role in the daily lives of many consumers, serving as a key facilitator in various aspects of the retail experience. It not only assists in guiding the consumer's purchasing decision journey while shopping in-store but also enables brand owners to establish cost-effective delivery systems. Furthermore, it helps to minimize product breakage and food waste throughout the value chain while satisfying the consumer's desire for convenience (Feber et al., 2020). However, it produces a significant amount of waste for e-commerce businesses like Amazon. According to a study by Oceana (2021) "analysed e-commerce packaging data and found that Amazon generated 599 million pounds of plastic packaging waste in 2020. This is a 29% increase of Oceana's 2019 estimate of 465 million pounds. The report also found that Amazon's estimated plastic packaging waste, in the form of air pillows alone, would circle the Earth more than 600 times." This ultimately leads to massive greenhouse gas emissions and ocean pollution (Liu et al., 2021). Approximately 46% of global plastic waste is believed to originate from packaging (You et al., 2021).

Circular supply chain management aims to achieve a zero-waste approach by minimizing waste generation and maximizing waste value recovery (Farooque et al., 2019). According to the Circularity Gap Report 2021 (Circle Economy, 2021), implementing a circular economy model has the potential to reduce global emissions by 39%. Within a circular supply chain, reuse and recycling practices play a critical role in reducing emissions embedded in end-of-life products and materials. Amazon must prioritize these practices as part of their efforts to decarbonize their supply chain and contribute to global emission reductions. Despite the growing emphasis on circularity, the European Union has made little progress in reducing plastic packaging waste over the last decade, as illustrated in the graph below. This highlights the importance of collaborative efforts and creative solutions to effectively address this issue.

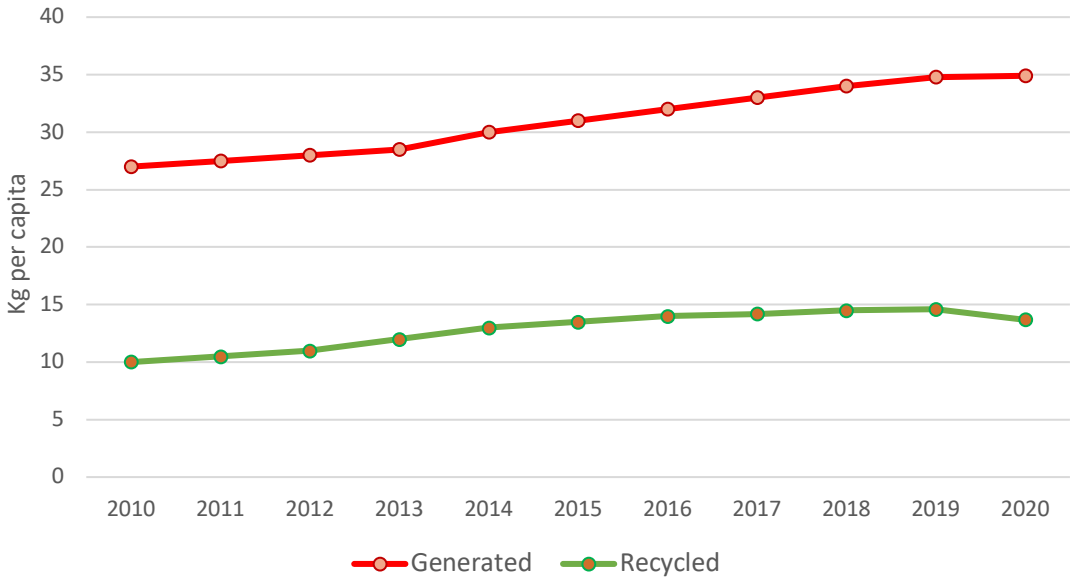

Figure 5 . *Plastic packaging Waste in the EU (2010-2020)* (Eurostat, 2022)

III. Efficient Transportation

According to the International Energy Agency (IEA n.d.) "transport has the highest reliance on fossil fuels of any sector and accounted for 37% of CO2 emissions from end-use sectors in 2021", producing nearly 7.7Gt CO2. To reach the emissions target of less than 6 Gt by 2030 in the transport sector, as set out by the Net Zero Scenario, there must be a reduction of approximately 20%. This reduction can be achieved through a variety of methods, including the rapid adoption of electric vehicles, implementation of operational and technical energy efficiency measures, widespread use of low-carbon fuels - particularly in the maritime and aviation sub-sectors, and the promotion of alternative, lower carbon transportation options through policy incentives. (International Energy Agency (IEA) n.d.)

The proposed closed-loop supply chain model integrates transport mode selection and closed-loop logistics to minimize total cost and reduce environmental impact. The model considers optimal facility locations, operation unit flows, and transportation modes while accounting for capacity constraints, customer demand, and recycling rates. Transportation mode selection is crucial due to its significant impact on air pollution, contributing approximately 14% of

total global emissions. The model considers various transportation modes, such as air, sea, road, and rail, based on factors such as cost, transit time, and environmental performance. Financial and environmental considerations, as well as time window constraints, are used to select the optimal transport mode. This model pays special attention to the CO2 emissions resulting from freight transportation and aims to reduce the environmental impact of the entire supply chain (Mohajeri & Fallah, 2014).

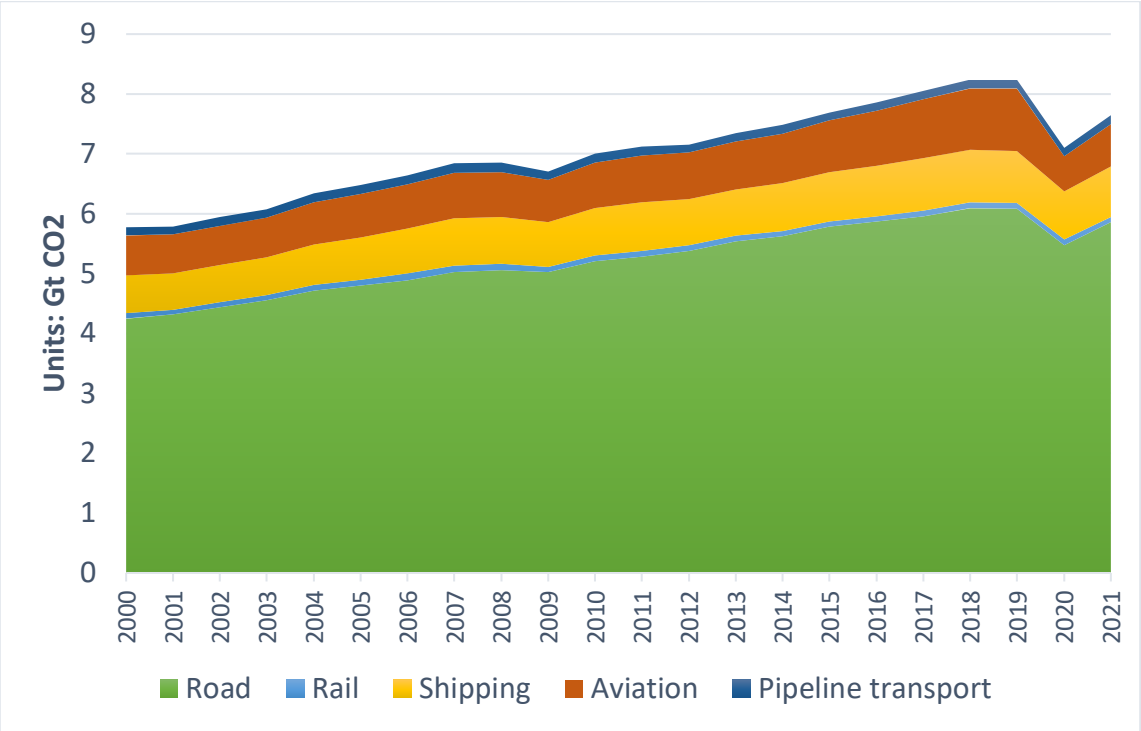

Figure 6. *Global CO2 emissions from transport by sub-sector* (International Energy Agency (IEA) n.d.)

IV. Renewable energy

In recent times, there has been significant attention given to Renewable Energy Sources (RESs) as potential solutions to mitigate the anticipated shortfall in energy supply and demand, as highlighted by reference (Sahebi et al., 2022)

The U.S. Energy Information Administration (2017) explains that renewable energy sources regenerate, unlike fossil fuels, which are finite. The recent Russian invasion of Ukraine has exposed the economic and security vulnerabilities of dependence on non-renewable energy sources, as pointed out by Hosseini (2022). Renewable energy systems like wind and solar have reached a cost-competitive level, making a future with reduced carbon emissions possible (Kinley, 2017). Renewable energy is increasingly recognized as a key factor in decarbonizing the supply chain. However, despite advances in renewables, energy demands exceed the amount of renewable power generated Hosseini (2022).

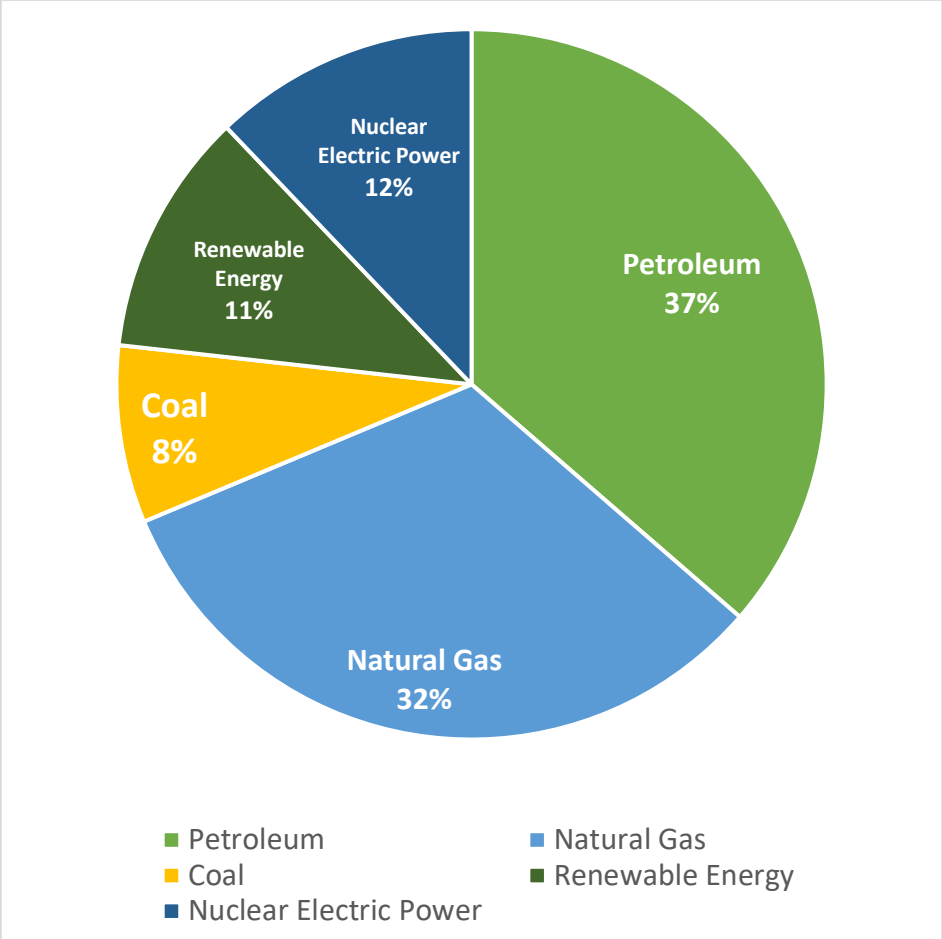

Figure 7. *U.S. energy consumption by energy source 2021* (U.S. Energy Information Administration, 2022)

V. Carbon offsetting

Carbon offsetting has become a popular strategy for companies to reduce their carbon footprint in supply chains. Carbon offsetting involves investing in projects that reduce or remove greenhouse gas emissions to compensate for the emissions produced elsewhere. These projects can include renewable energy, forest conservation, and energy efficiency improvements. The idea is that by investing in such projects, companies can offset the emissions they produce, making their overall carbon footprint neutral or even negative. (Tsai, 2020).

The voluntary market for carbon credits has grown significantly in recent years, and demand for them is expected to continue rising as efforts to decarbonize the global economy increase. (Christopher Blaufelder et al., 2021) estimates that by 2030, annual global demand for carbon credits could reach up to 1.5 to 2.0 gigatons of carbon dioxide and up to 7 to 13 $GtCO_2$ by 2050. Purchasing carbon credits is a way for companies to address emissions they are unable to eliminate, and the market for voluntary carbon credits is important because it directs private financing to climate-action projects that would not otherwise get off the ground (Christopher Blaufelder et al., 2021)

Carbon offsetting can be a useful tool for companies that are unable to eliminate their carbon emissions. However, it is important to note that carbon offsetting should not be the only strategy employed to achieve decarbonization in supply chains. Instead, it should be used in combination with other strategies such as energy efficiency, waste reduction, and collaboration with suppliers and customers (Tsai, 2020).

The challenges facing the carbon credit market are significant and complex. While there is potential for the market to grow significantly in the coming years, there are several obstacles that must be overcome to realize this potential. These include the need to ramp up the development of carbon credit projects at an unprecedented rate, the concentration of potential supply in a small number of countries, the risks associated with these projects, and the challenge of verifying the quality of credits and defining their co-benefits. In addition to these challenges, the market also faces issues related to low liquidity, scarce financing,

inadequate risk-management services, and limited data availability (Christopher Blaufelder et al., 2021; Gleeson, 2023).

Addressing these challenges will require a concerted effort from all stakeholders in the carbon credit market, including governments, investors, project developers, and carbon credit buyers. By working together to address these issues and build a more robust and efficient market, it may be possible to realize the full potential of carbon credits as a tool for addressing climate change.

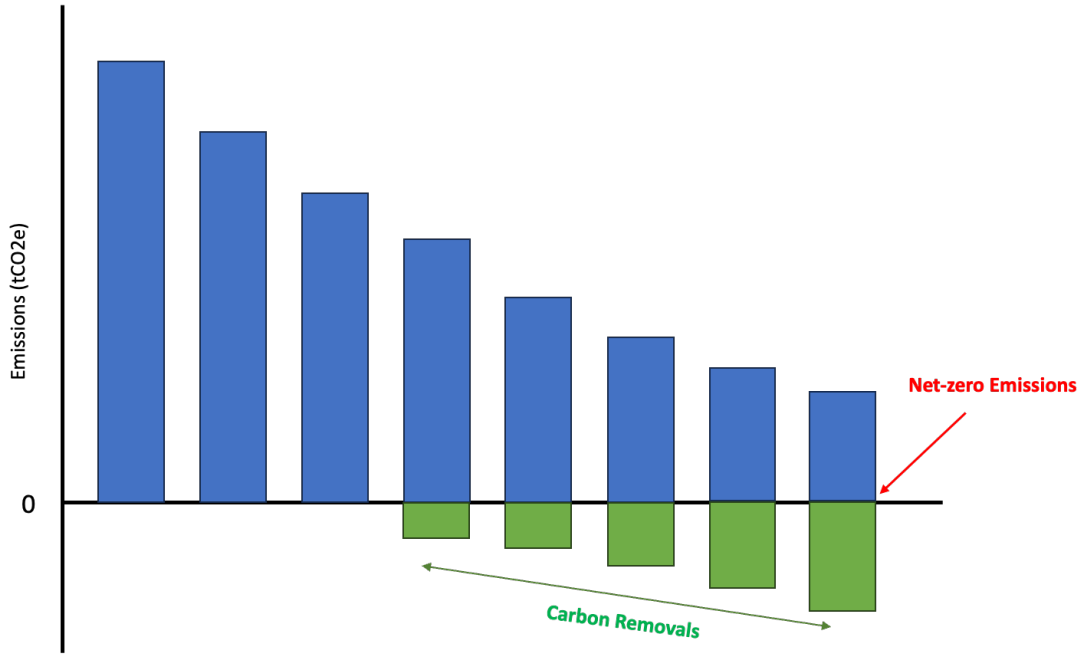

Figure 8. *Carbon Offsetting* (EcoAct, 2022)

5. *What are the main initiatives has Amazon taken to reduce its carbon footprint so far?*

According to the Amazon (2021) some of the key initiatives are as follows.

I. “Powering our operations with 100% renewable energy by 2025”.

Shifting to renewable energy is among the most impactful ways to swiftly decrease emissions. Amazon, as the largest corporate purchaser of renewable energy globally, plans to power its operations with 100% renewable energy by 2025, five years earlier than their original goal of 2030. Amazon is currently on

track to reach its renewable energy goals, with “401 projects globally, including 164 wind farms and solar farms, and 237 rooftop solar projects on Amazon facilities. Once operational, Amazon’s global renewable energy projects are expected to generate 56,881 gigawatt-hours (GWh) of clean energy each year.” (Amazon, 2023)

II. “Developing more-sustainable transportation infrastructure”.

“We plan to make half of our shipments net-zero carbon by 2030, and to do that, we are creating a worldwide fleet of zero-emission vehicles. Right now, the vehicles and charging infrastructure don’t exist at the scale needed to serve customers. We need the supply to increase dramatically. We have ordered 100,000 electric vehicles (EVs) from Rivian, and thousands more from manufacturers such as Mercedes-Benz, Stellantis, and Mahindra Electric” (Amazon, 2023).

III. “Constructing more sustainable buildings”

“Businesses also face the challenge of removing carbon emissions from new building construction. Via The Climate Pledge Fund, Amazon has invested in CarbonCure Technologies, which enables concrete producers to make the same high-quality concrete with a lower carbon footprint, and Brimstone Energy, which seeks to make cement carbon neutral through a process focused on calcium silicate rocks, which have no embedded CO2, as well as magnesium species, which passively absorb CO2. Amazon is lowering the carbon footprint of our buildings by using CarbonCure’s systems and Brimstone Energy cement in some new construction, including in Amazon’s second headquarters in Virginia (HQ2)” (Amazon, 2023).

IV. “Decarbonizing the supply chain”.

Amazon is working to improve the granularity and transparency of data in order to decarbonize the supply chain. “We already work with organizations and regulatory bodies around the globe to promote transparent and comparable climate reporting. One example of this is through our partnership with the We

Mean Business Coalition, a group of non-profits focused on accelerating the transition to a net-zero economy" (Amazon, 2021b).

5.2.2 Research Gaps and Unexplored Aspects

1. *Analysing the Unique Elements of Amazon's Supply Chain: A First-Hand Perspective*

From my own experience visiting Amazon fulfilment centres across Spain and the UK , as well as interviews with Amazon energy managers to clarify my understandings, I have been able to distinguish the factors which make the Amazon supply chain unique from the rest. Some of these key distinguishers include:

I. Heavy investment in technology and logistics infrastructure to offer a wide range of products, fast and reliable delivery, and easy returns.
II. Innovative supply chain practices such as data analytics, just-in-time inventory management, and robotics and automation to improve efficiency and reduce costs.
III. Large network of fulfilment centres and transportation assets to optimize delivery routes and minimize shipping times.
IV. Use of renewable energy sources and energy-efficient practices to reduce carbon emissions and energy consumption.
V. Extreme delivery locations
    a. Himalayas by motorbike, at an elevation of more than 11,000 feet.
    b. Amazon delivers on Mackinac Island by horseback, where motor vehicles have been banned for more than 120 years.
    c. Tauplitz Mountain Village on skis.

The below visual provides a simplified explanation to the *´Fulfilment by Amazon´* supply chain.

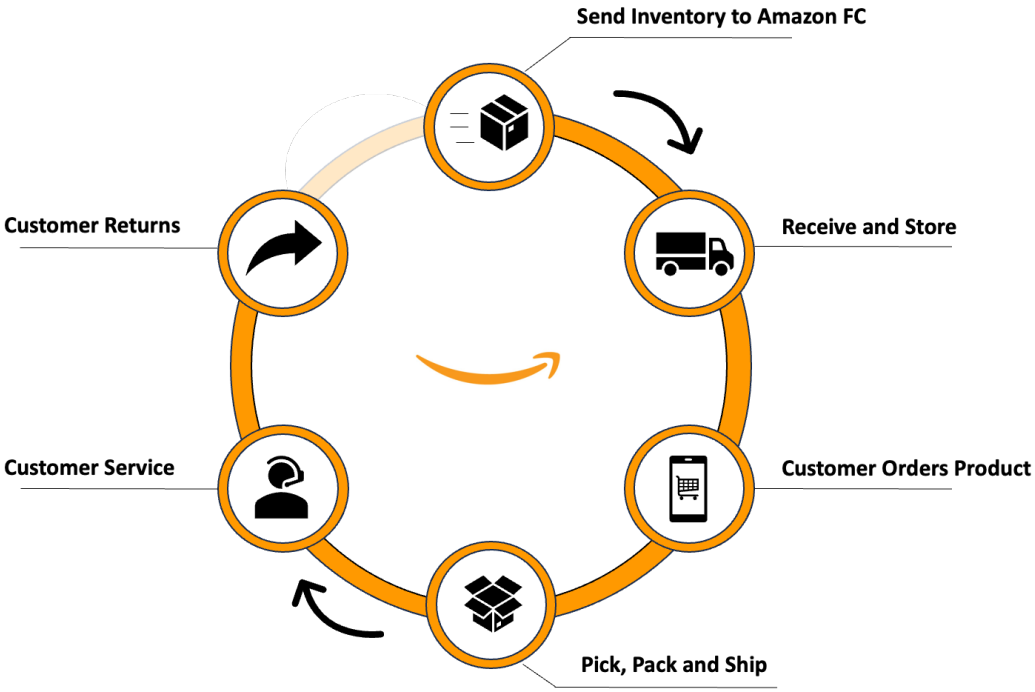

Figure 10. *How Does Amazon Supply Chain Work in 2022?* (Patrucco et al., 2020)

2. *The role of energy efficiency in supply chain decarbonization*

Improving energy efficiency is a critical component of supply chain decarbonization, providing benefits such as reduced emissions, increased energy security, and cost savings, in return for little for no capital expenditure (European Commission, 2010). However, energy efficiency has been overlooked in supply chain management, even at large corporations such as Amazon (Halldorsson & Kovacs, 2010). Whilst, a business analyst at Amazon, I focused on key energy efficiency projects, such as the “Shutdown Analysis”, which aimed at optimizing energy efficiency during the shutdowns of fulfilment centres. There is a huge potential for carbon reduction and economic savings through these initiatives, for example, Shell (2005) reports that energy efficiency measures taken in its refineries in 2005 resulted in an annual savings of about $60 million. However, energy efficiency initiatives are frequently overshadowed by other sustainability projects that appear more exciting and promise quicker results, giving the impression that energy efficiency is a sort of “old hat” (Hatfield, 2023).

A comprehensive framework integrating energy efficiency into logistics and supply chain management is required to fully realize its potential. More research is required to maximize the benefits of energy efficiency and promote its widespread adoption (Halldorsson & Kovacs, 2010).

3. *What is the internal perception of energy and sustainability within Amazon?*

I personally observed that directors and senior management at Amazon prioritize sustainability and energy efficiency projects. However, during my visits to fulfilment centres, I found that some site managers were hesitant to incorporate sustainable best practices due to concerns about operational impact. Overcoming this requires a collective effort to prioritize sustainability efforts across all levels of the organization.

RME Energy Manager Anthony Hatfield described sustainability to be seen as “important across all the different functions at Amazon, from procurement and finance to logistics”. He also noted the operational scorecards, include sustainability topics. The sustainability topics covered in these scorecards can vary depending on the site and location, but they generally include energy and water usage, waste reduction, greenhouse gas emissions, and sustainable sourcing. Amazon tracks progress on these metrics over time, comparing current performance to previous periods and setting targets for future improvements. Finally, Hatfield described the internal perception of energy to be a great lever to pull when to reduce costs. Each building type has a sustainability department.

During my interview with RME Solar Manager, Gabriel Ortiz, I was interested to discover how the emphasis on renewable energy and energy efficiency has grown dramatically since the war between Russia and Ukraine. Ortiz (2023) mentioned how before the war, energy was at Amazon, and other multinational companies, more of an afterthought, that would be highlighted when the bills came in and not so much beforehand. Since the war, plans for renewable energy at Amazon have accelerated as there is now a “reduced bureaucracy for rooftop PV installation allowing for quicker expansion” (See Appendix C).

4. *How has Amazon's internal sustainability strategy evolved over time and what factors have driven these changes?*

What were internal company targets, became global fixed targets following the Paris Agreement. Even more so when Amazon developed the climate pledge. Those companies that did not sign up to the climate pledge, were questioned as to why not, and it became crucial to be part of the club.

7 years ago, the 2040/2050 goals seemed distant, but the timeline has since become closer, and further advancements are required. Amazon's energy strategy has always been focused on reducing carbon emissions and has a direct link to cost savings. However, during the COVID-19 pandemic, the carbon reduction strategy was paused due to increased demand and activity. More recently with the energy crisis and the decline in activity post Covid there has been a serious need for cost reduction, reducing energy consumption then became a top priority for Amazon. Amazon's internal sustainability strategy has been driven by financial factors, resiliency concerns, global targets, and changing timelines. (Hatfield, 2023)

5. *What are the broader societal implications of Amazon's net zero goal, particularly in relation to climate change and sustainability?*

The retail industry's wide scope and impact give it a unique ability to promote sustainability and influence society. Amazon, as a leading retail company, has the potential to drive significant change towards sustainability not only within the industry but also across other sectors due to its broad reach and global presence (Sullivan & Gouldson, 2016).

Amazon's net zero goal has far-reaching societal implications, particularly in relation to climate change and sustainability. Here are some of the broader implications of this goal as outlined by Hatfield (2023):

I. Setting a standard for other organizations: Amazon's net zero goal can inspire other companies to set similar targets and take concrete actions to reduce their carbon footprint. By leading the way, Amazon can encourage

other companies to follow suit, thereby creating a ripple effect that can help address the urgent issue of climate change.

II. Driving international improvement: As a global company, Amazon's net zero goal can have a significant impact on the international community's efforts to combat climate change. By demonstrating that achieving carbon neutrality is feasible, Amazon can inspire other countries to set similar targets and take concrete actions to reduce their carbon emissions.

III. Demonstrating new technology, mechanisms, and processes to achieve the target: As a technology-driven company, Amazon can showcase new technologies and mechanisms that can help achieve its net zero goal. By investing in innovative solutions, Amazon can demonstrate the potential for technology to help solve some of the world's most pressing environmental challenges.

IV. Driving local, national, and international air quality, carbon reduction, waste management improvements: Amazon's net zero goal can have a significant impact on local, national, and international efforts to improve air quality, reduce carbon emissions, and manage waste. By taking concrete actions to achieve its goal, Amazon can help create a cleaner and healthier environment for people around the world.

V. Inter-generational equity: By reducing its carbon footprint and mitigating the impacts of climate change, Amazon can help create a more sustainable future for future generations, ensuring inter-generational equity.

VI. Creating new job opportunities: Amazon's net zero goal can create new job opportunities in the green economy. By investing in renewable energy and sustainable infrastructure, Amazon can contribute to economic growth and development while also reducing its carbon footprint.

6. Results

This section presents the findings of a study that explores the challenges and opportunities faced by Amazon.com in achieving "net zero emissions" by 2040.

The results are derived from the research methods highlighted in the previous section ***Error! Reference source not found.,*** guided by the theoretical framework developed in section *This* section will elaborate on the different components of the study, including the theoretical framework, scope of the phenomenon of interest, synthesis of the research, questions already answered and those unsolved, as well as the results and conclusions.

The theoretical framework (Section 5) serves as the foundation for this study, providing a conceptual lens through which the research is conducted. In relation to the subject of net-zero emissions in Amazon's supply chain, it includes a variety of current theories, concepts, and models. By referencing these frameworks, the study seeks to gain a deeper comprehension of the subject and offer insights into the obstacles and opportunities that Amazon must overcome in order to meet its sustainability objectives. The decarbonization of Amazon's supply chain is the phenomenon of interest, and the scope of this phenomenon is outlined in Section 5.1. By highlighting obstacles and opportunities of decarbonizing the supply chain of Amazon.com, the study fills the research gap. The study ensures a focused and realistic analysis of the subject matter by defining the scope. The synthesis of the research (Section 5.2) involves integrating and analysing the existing literature, studies, and data related to net-zero emissions in supply chains, with a particular focus on Amazon. This synthesis aims to identify the current state of knowledge, highlight the gaps and limitations in existing research, and provide a comprehensive overview of the field. It involves a systematic review of relevant academic articles, reports, and industry publications to ensure a rigorous and evidence-based analysis.

This synthesis is divided into two parts:

5.2.1: Established Concepts and Literature Review: This section provides a thorough understanding of the research topic as well as the current knowledge gathered from scholarly literature.

5.2.2: Addressing Research Gaps and Exploring New Aspects: This section of the study focuses on addressing knowledge gaps and looking into areas that need more research. In order to generate new insights and viewpoints, I draw on

my own personal experience at Amazon as well as the transcripts from the interviews carried out.

By organizing the theoretical framework in this manner, the study makes use of already-known information while also attempting to increase comprehension.

Moving on to the results (Section 6), the study presents the study's findings. Section 6.1 identifies the key barriers, obstacles, and complexities impeding Amazon's progress toward its sustainability goals. In addition, Section 6.2 focuses on the opportunities for Amazon.com in the net-zero emissions transition. Finally, Section 7 summarizes the key findings, implications, and recommendations derived from the research. It provides a comprehensive overview of the study's contributions to the understanding of net-zero emissions in Amazon's supply chain and offers insights for both academic and practical stakeholders.

5. Theoretical Framework. The findings identify three noteworthy challenges and three promising opportunities that emerged from the research.

6.1 Challenges to Achieving Net-Zero Emissions in Amazon's Supply Chain

1. Accounting and Management of Carbon Data

One of the most significant obstacles Amazon will encounter is data management. In order to comprehend the origins of emissions, establish a true carbon baseline, and spot prospects for improvement. According to Gleeson (2023) carbon baselining is an important step in corporate sustainability and is often a prerequisite for participation in carbon offset programs or for reporting on carbon emissions to stakeholders such as investors, customers, and regulatory bodies. Amazon Energy Manager (Hatfield, 2023), highlighted that “there is an overwhelming amount of data available, and it is important to have a centralized platform to effectively utilize and analyse the data.” (See Appendix B)

One of the primary challenges is ensuring that energy data is precise and comprehensive. Energy data can be difficult to gather, verify, and centralize because it comes from various sources and can be presented in various formats. Amazon must work to improve the accuracy, granularity and completeness of this data. Internal monitoring systems, such as Building Management Systems (BMS), still require fine-tuning to ensure accuracy and enable the implementation of sustainability initiatives within Amazon (Hatfield, 2023). “While having the right people and data is crucial, there is currently an abundance of data and there could be even more, with gas and water data. It needs to be better organized and streamlined” (See Appendix B).

Another challenge in data management is ensuring that data is easily accessible and usable for relevant stakeholders. Amazon must develop tools and processes to ensure that supply chain managers and sustainability teams can readily access data. While internal data visualization tools like AWS Quicksight are improving, there is currently no comprehensive energy platform for internal stakeholders at Amazon due to incomplete energy data from the grid, I discovered this during my time at Amazon.

Accurate data collection and accounting for scope 3 emissions also poses a substantial problem for Amazon in addition to data management issues. Scope 3 emissions accounted for 77% of Amazon’s overall climate impact in 2021, compared to direct scope 1 (17%) and indirect scope 2 emissions (6%).

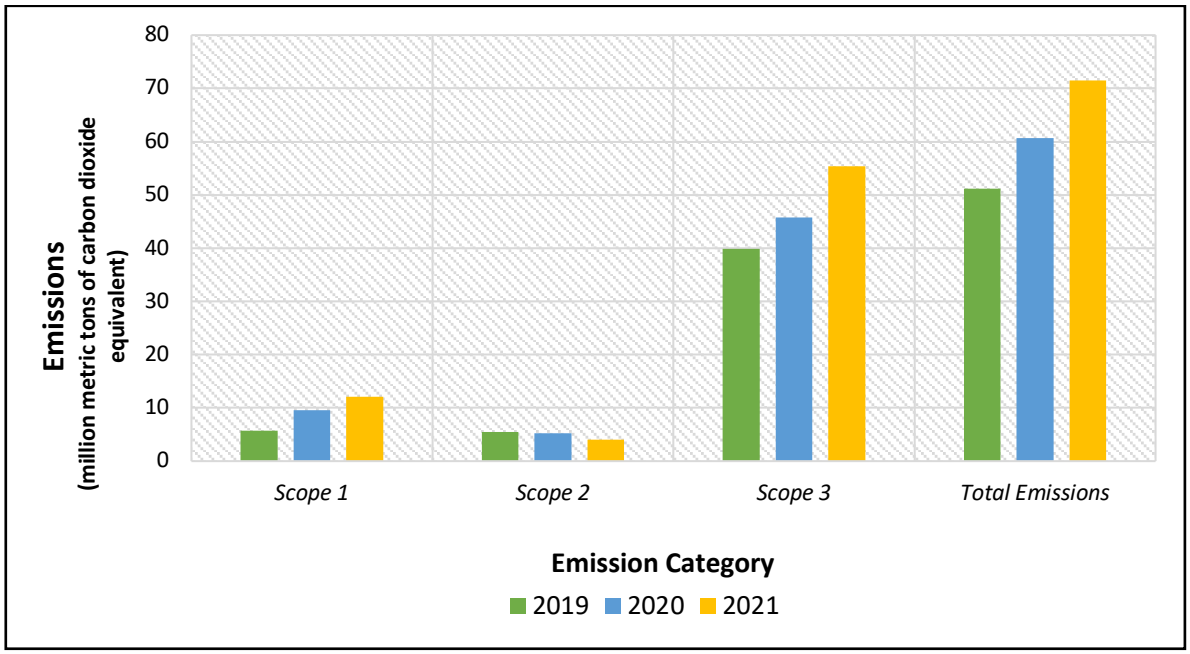

Figure 11. *Amazon´s Carbon Footprint* (Amazon, 2021b)

This poses a significant obstacle for Amazon in decarbonizing these scope 3 emissions, which equated to 55.36 million metric tons of carbon dioxide equivalent in 2021. Gleeson (2023) highlighted that many suppliers do not have the necessary tools or resources to measure and report their emissions accurately, therefore they often estimate emissions using secondary data sources, which might result in inaccurate and incomplete data. According to Peter Spiller (2021), “Many suppliers don’t properly understand their own Scope 1 and 2 emissions, let alone those of second-tier suppliers and beyond. And even when estimates are available, different companies use different industry averages, factors, and assumptions.”

In conclusion, the challenge of accurately collecting, accounting for, and centralizing emissions data is a pressing issue for companies like Amazon that have large and complex supply chains. By addressing these challenges, Amazon can take significant strides towards decarbonizing its supply chain and mitigating its climate impact.

2. Stakeholder Engagement towards Sustainable Practices

As highlighted in theThis section will elaborate on the different components of the study, including the theoretical framework, scope of the phenomenon of interest,

synthesis of the research, questions already answered and those unsolved, as well as the results and conclusions.

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5. Theoretical Framework, collaboration with suppliers and customers is one of the key drivers of decarbonization in the supply chain. The company must engage with both customers and suppliers to promote sustainable practices and reduce scope 3 emissions. However, engaging these stakeholders is no easy feat.

Amazon has already implemented "Amazon Supply Chain Standards" (Amazon, 2022) for suppliers, but further engagement is needed to reduce emissions. Amazon can use its position as a buyer to encourage sustainability through incentives, engagement, and communication. Collaborating with suppliers requires building stronger relationships, providing tools to measure emissions, and incentivizing sustainable practices. These efforts demand significant resources, and success is not guaranteed. Amazon, as a focal company, has the ability to lead carbon neutrality initiatives in the supply chain. Amazon can overcome supplier resistance and promote sustainable practices by strategically partnering with like-minded businesses and driving the implementation of consistent sustainability strategies. This coordinated approach promotes knowledge sharing and identifies emission reduction opportunities. Amazon's proactive involvement and leadership are critical to achieving carbon neutrality throughout the supply chain (Zhang et al., 2022)

Engaging customers in sustainable practices is equally challenging. While Amazon can offer more sustainable options, customers may prioritize

convenience and cost over sustainability. Promoting sustainability in marketing may also require a different approach than traditional advertising, further complicating the task (Gleeson, 2023).

Furthermore, according to Hatfield (2023) sustained engagement from internal and external stakeholders is vital to achieving decarbonization goals. Upskilling employees, reporting carbon-adjusted earnings per share, and introducing reporting and incentive systems that reward innovative carbon-reduction work can drive significant benefits. However, these efforts require significant communication and change management, and the pace is slower, spanning years rather than quarters, which may lead to falling momentum and rising fatigue (See Appendix B)

In short, stakeholder engagement is a complex and ongoing challenge for Amazon in the transition to net-zero emissions, but it is a critical component of a comprehensive sustainability strategy that can have significant positive impacts on the environment and the company's reputation.

3. Challenges of Carbon-Reduction Technology

The difficulty of developing carbon-reduction technology creates significant obstacles for Amazon's move toward net zero. While technology advancements are necessary to achieve net-zero emissions, their costs and technical viability are often unknown, making it challenging to make long-term plans. Technology for reducing carbon emissions, like carbon capture, renewable energy, and energy-efficient transportation, calls for significant infrastructure and R&D investments, which can put a burden on available financial resources.

As Amazon copes with the ongoing layoffs of employees, the company's leadership principle "Frugality" has become a critical factor in decision-making. “Amazon is undergoing the largest layoffs in company history after it went on a hiring spree during the Covid pandemic. The company’s global workforce swelled to more than 1.6 million by the end of 2021, up from 798,000 in the fourth quarter of 2019” (Palmer, 2023). With limited resources, Amazon must find ways to

maintain its customer-centric culture while also investing in carbon reduction technology.

More specifically Ortiz (2023) explains how “integrating renewable energy sources such as solar power requires significant changes in distribution networks”, such as digitalization investments, in order to improve system performance through centralization and take advantage of the flexibility provided by small, distributed assets. This requires “significant investment in energy storage technologies… today batteries are expensive , however by 2030 they will be much more competitive” (Ortiz, 2023). Additionally, some of these investments may have a “longer payback period which can make them less attractive… from a financial standpoint within the company… a result, they may not always have access to the resources they require to thrive.” (See Appendix C).

Amazon must collaborate closely with public authorities and other private businesses to further technological advancement and work together on R&D projects. Amazon must devise effective strategies to overcome these challenges if it hopes to achieve its ambitious goal of attaining net-zero emissions across its supply chain by 2040.

4. Global Infrastructure Gaps

The lack of infrastructure globally in terms of EV charging points, PV availability, and renewable energy grids poses a significant challenge for Amazon in creating a net zero supply chain. Ortiz (2023) highlighted that “even if Amazon invests in electric vehicles and renewable energy sources, it may not be able to fully utilize them without adequate infrastructure” (See Appendix C) . This lack of infrastructure is particularly challenging in developing countries, where the infrastructure is not yet established, making it difficult for Amazon to source sustainable energy and operate electric vehicles. The need to work with governments, energy providers, and other stakeholders to help build the necessary infrastructure for decarbonizing its supply chain globally is crucial. Additionally, the cost of renewable energy is higher than that of fossil fuels in some countries, which may pose a challenge for Amazon in the short term. (Ortiz,

2023). However, as renewable energy technology continues to improve and economies of scale are achieved, the cost gap between renewable energy and fossil fuels is expected to decrease, making it more cost-effective for Amazon to transition to a sustainable supply chain. Therefore, addressing the global infrastructure gaps is essential for Amazon to achieve its goal of creating a net zero supply chain-

6.2 Opportunities for Amazon.com in the Net-Zero Emissions Transition

Amazon.com is a leading multinational technology company that has recently announced its commitment to achieving net-zero carbon emissions by 2040. Through identified four potential opportunities that could arise during its transition to a net-zero supply chain. This article will explore each of these opportunities in detail and explain how they could benefit Amazon in the long run.

1. Cost Savings

The transition to a net-zero supply chain presents a multitude of opportunities for Amazon, including significant cost savings. Amazon can achieve this by investing in renewable energy, energy-efficient buildings, and electric vehicles. According to Hatfield (2023) , by investing in renewable energy, energy-efficient buildings, and electric vehicles, Amazon can reduce its energy costs over time and minimize its exposure to volatile fossil fuel prices, resulting in substantial cost savings in the long term (See Appendix B).

Amazon has already taken several initiatives to reduce its carbon footprint, those highlighted by Ortiz (2023) include the installation of solar panels on the roofs of its warehouses and parking lots, as well as the implementation of electric delivery vehicles. These efforts have helped the company to decrease its carbon emissions whilst also cutting costs. Going forward, there are opportunities for Amazon to further reduce its carbon footprint and long-term costs by implementing electric trucks as well as electric delivery vans (See Appendix C).

Many of these initiatives require a significant initial investment before benefitting from the savings in the longer term, however these “set-up costs” are following a downward trend thanks to government incentives, policy changes and developments in technology. Over the past 40 years, solar power has become significantly cheaper, with the cost of large solar power projects decreasing by 85% in the last decade alone. As a result, solar power has become more cost-effective than using fossil fuels in certain regions. Additionally, the installation cost of solar power has gone down by 81% during this period (Helveston et al., 2022). The competitive production of solar power in China, thanks to the "free flow of capital and talent," has made it more economically feasible for global supply chains (Green, 2019).

Transitioning to electric delivery vans is already proving to be a cost-effective solution, with electric vehicles now being three to six times cheaper to drive than traditional, fossil-fuel-powered cars in the US (Lambert, 2022). Overall, transitioning to a net-zero supply chain presents a significant opportunity for Amazon to achieve long-term cost savings through sustainable practices, such as investing in renewable energy, energy-efficient buildings, and electric vehicles, while also positioning itself as a leader in the green economy and reducing its carbon footprint.

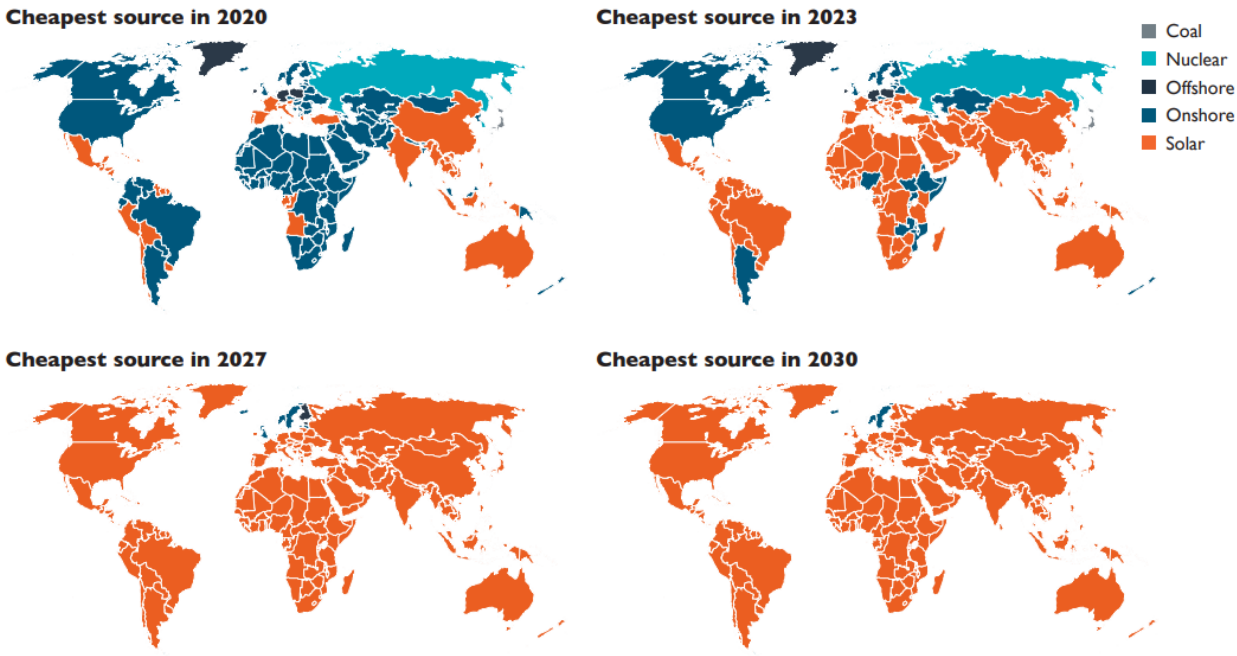

Figure 12 . *Predicted cost of renewables worldwide* (Mercure, 2022)

2. Improved Supply Chain Resilience

Transitioning to a net-zero supply chain can also improve supply chain resilience by reducing the reliance on fossil fuels, mitigating climate-related risks, and increasing supplier transparency and collaboration. By reducing the reliance on fossil fuels, Amazon can protect itself from market forces such as volatility in fossil fuel prices and geopolitical risks (Hatfield, 2023)

By transitioning to renewable energy sources, Amazon can reduce its dependence on foreign oil and gas supplies, achieve greater energy security and enhance long-term resilience by reducing carbon emissions and regulatory compliance requirements (Genovese et al., 2017). The recent Russian invasion of Ukraine has highlighted the economic and security vulnerabilities of dependence on non-renewable energy sources, further emphasizing the need for businesses to transition to sustainable energy sources (Hosseini, 2022).

Furthermore, Amazon can mitigate climate-related risks by implementing sustainable practices across its supply chain. Climate change poses significant risks to global supply chains, including extreme weather events, resource

scarcity, and supply chain disruptions. By implementing sustainable practices across its supply chain, Amazon can reduce its carbon footprint and contribute to mitigating climate change. This can also help the company adapt to the changing climate and reduce its exposure to climate-related risks (Davis et al., 2021).

Increased supplier transparency and collaboration can also enhance supply chain resilience. By working closely with suppliers to identify and address sustainability issues, Amazon can ensure that its suppliers are operating in a sustainable manner and reduce the risk of supply chain disruptions. This can also lead to better supplier relationships and improved supply chain performance (Lintukangas et al., 2022).

In conclusion, transitioning to a net-zero supply chain not only benefits the environment but also provides a range of economic and strategic advantages. By reducing reliance on fossil fuels, mitigating climate-related risks, and promoting supplier transparency and collaboration, Amazon can achieve greater energy security, enhance supply chain resilience, and contribute to a sustainable future.

3. Positive Reputation

Optimizing the supply chain for Net Zero not only increases efficiency and reduces costs, but also improves customer service and enhances reputation among consumers who have rising expectations for sustainable business. It also wins support from investors who increasingly demand strong environmental, social, and corporate governance. As companies that prioritize sustainability are often viewed more positively by stakeholders, including customers, employees, investors, and regulators, achieving net-zero emissions can enhance Amazon's reputation as a responsible corporate citizen and improve brand loyalty. This, in turn, can lead to increased customer loyalty and employee satisfaction (Gleeson, 2023; PwC, 2023)

For example Anthony Hatfield (2023) explains how “achieving Net Zero emissions can attract the right people, particularly younger talent”. A positive

reputation can also improve investor confidence, which can lead to more significant investment opportunities and lower costs of capital. (See Appendix B).

Moreover, Amazon's net-zero goal can make it a role model for other organizations. By leading the way, Amazon can inspire other companies to set similar targets and take concrete actions to reduce their carbon footprint (See Appendix B). This can create a ripple effect that can help address the urgent issue of climate change (Hatfield, 2023).

By committing to a net-zero supply chain, Amazon has the opportunity to not only make a positive impact on the environment but also establish itself as a socially responsible company. This can lead to a positive reputation that can set Amazon apart from its competitors, attract top talent, and create new business opportunities.

4. Innovation

According to Thakker and Bakshi (2023), efforts to combat climate change and prevent material waste are driving innovation in technology, supply chains, and policy, aimed at reducing greenhouse gas emissions. Transitioning to a net-zero supply chain presents an opportunity for Amazon to develop new products and services, collaborate with suppliers on new solutions, and create new revenue streams.

For example, Gabriel Ortiz (2023), EU RME Solar Manager, suggests the idea that Amazon could potentially “transition into a data and electron/energy company, becoming a Purchase Power Producer (PPP)”. embracing the energy aspect of its business which would involve storing renewable energy being produced from Amazon locations using batteries and distributing it to third parties, like suppliers. This approach would help Amazon's suppliers reduce their carbon footprint, achieve their sustainability goals, and promote the use of renewable energy, ultimately contributing to Amazon's overarching objective of achieving net-zero emissions throughout its supply chain (See Appendix C).

Furthermore, Amazon could utilize its technological expertise to develop new algorithms that optimize delivery routes to minimize emissions and create software that enables customers to track their carbon footprint (Hatfield, 2023).

Companies that lead decarbonization efforts are likely to gain a competitive advantage over those that do not. By achieving net-zero emissions, Amazon can showcase its commitment to sustainability and attract more environmentally conscious customers and investors. In conclusion, transitioning to a net-zero supply chain not only reduces costs, improves operational efficiency, and enhances reputation, but it also promotes innovation.

7. Conclusion

In conclusion, the transition to a net-zero supply chain is a necessary and critical step towards a sustainable future, and it is imperative for companies like Amazon to take bold action in addressing the urgent issue of climate change. Through this thesis, I have explored the challenges and opportunities associated with transitioning to a net-zero supply chain and identified several sustainable practices that Amazon can implement to achieve long-term cost savings, improve supply chain resilience, and enhance its reputation as a responsible corporate citizen.

I discovered the significant opportunities for Amazon that may arise in this transition. Firstly, investing in renewable energy, energy-efficient buildings, and electric vehicles can lead to significant cost savings and reduce Amazon's exposure to volatile fossil fuel prices. Secondly, supply chain resilience is critical in mitigating climate-related risks and reducing reliance on fossil fuels. By transitioning to renewable energy sources, Amazon can enhance its energy security, reduce dependence on foreign oil and gas, and increase long-term resilience by cutting carbon emissions and regulatory compliance requirements. Thirdly, increased supplier transparency and collaboration can ensure that suppliers are operating in a sustainable manner, which can reduce the risk of supply chain disruptions.

The implications of these findings are vast. Transitioning to a net-zero supply chain not only increases efficiency and reduces costs but also improves customer service and enhances reputation among consumers who have rising expectations for sustainable business practices. Achieving net-zero emissions can enhance Amazon's reputation as a responsible corporate citizen and improve brand loyalty, leading to increased customer loyalty and employee satisfaction. Moreover, Amazon's net-zero goal can inspire other companies to set similar targets and take concrete actions to reduce their carbon footprint.

The research also identified four major challenges that Amazon and other companies face in their journey towards decarbonizing their supply chains: data management, stakeholder engagement, and carbon-reduction technology. These challenges require cross-functional collaboration and sustained effort, but the benefits of transitioning to a net-zero supply chain far outweigh the costs.

Overall, this thesis highlights the importance of transitioning to a net-zero supply chain, not just as a corporate responsibility, but also as a business opportunity for Amazon. By implementing sustainable practices and investing in renewable energy, Amazon can achieve long-term cost savings, improve supply chain resilience, and enhance its reputation as a responsible corporate citizen. As the world's largest online retailer, Amazon has a significant role to play in addressing climate change and inspiring other companies to take similar actions.

The findings of this research suggest that the solutions Amazon develops could serve as a model for other companies seeking to decarbonize their supply chains. By sharing best practices, promoting transparency, and engaging stakeholders, companies can work towards a common goal of reducing their carbon footprint and mitigating their impact on the environment. The transition to a net-zero carbon economy requires collaboration, innovation, and sustained effort from companies across all sectors.

In conclusion, this thesis project has highlighted the challenges and opportunities that companies like Amazon face in transitioning to a net-zero supply chain. By embracing the challenges and opportunities presented by the transition to a net-

zero supply chain, Amazon can create a better world for current and future generations.

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9. Appendix

9.1 Appendix A

Field of study	References	Citations
Operations Management	Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. C. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. Omega, 66(Part B), 344-357.	1204
Operations Management	Biswas, Raj, A., & Srivastava, S. K. (2018). Supply chain channel coordination with triple bottom line approach. Transportation Research. Part E, Logistics and Transportation Review, 115, 213–226.	105
Operations Management	Bove, A., & Swartz, S. (2016). Starting at the Source: Sustainability in Supply Chains. McKinsey on Sustainability and Resource Productivity, 4, 36-43.	76
Operations Management	Dahlmann, & Roehrich, J. K. (2019). Sustainable supply chain management and partner engagement to manage climate change information. Business Strategy and the Environment, 28(8), 1632–1647.	72
Operations Management	Patrucco, A. S., Moretto, A., Luzzini, D., & Glas, A. H. (2020). Obtaining supplier commitment: Antecedents and performance outcomes. International Journal of Production Economics, 220, 107449.	39

Environmental Science	Elkington, J. (2013). Enter the triple bottom line. In The triple bottom line: Does it all add up? (pp. 1-16). Routledge.	3034
Environmental Science	Zsidisin, G. A., & Siferd, S. P. (2001). Environmental purchasing: A framework for theory development. European Journal of Purchasing and Supply Management, 7, 61-73.	995
Environmental Science	Halldorsson, & Kovacs, G. (2010). The sustainable agenda and energy efficiency: Logistics solutions and supply chains in times of climate change. International Journal of Physical Distribution & Logistics Management, 40(1/2), 5–13.	271
Environmental Science	Kinley, R. (2017). Climate change after Paris: from turning point to transformation. Climate Policy, 17(1), 9-15.	166
Environmental Science	Davis, K. F., Downs, S., & Gephart, J. A. (2021). Towards food supply chain resilience to environmental shocks. Nature Food, 2(1), 54-65.	149
Environmental Science	Liu, Liu, W., Walker, T. R., Adams, M., & Zhao, J. (2021). How does the global plastic waste trade contribute to environmental benefits: Implication for reductions of greenhouse gas emissions? Journal of Environmental Management, 287, 112283–. https://doi.org/10.1016/j.jenvman.2021.112283	29
Engineering	Lopes de Sousa Jabbour, Rojas Luiz, J. V., Rojas Luiz, O., Jabbour, C. J. C., Ndubisi, N. O., Caldeira de Oliveira, J. H., & Junior, F. H. (2019). Circular economy business models and operations management. Journal of Cleaner Production, 235, 1525–1539.	277

Engineering	Mohajeri, & Fallah, M. (2014). Closed-Loop Supply Chain Models with Considering the Environmental Impact. TheScientificWorld, 2014, 852529–23.	19
Engineering	Laínez, J. M., Bojarski, A., Espuña, A., & Puigjaner, L. (2008). Mapping environmental issues within supply chains: a LCA based approach. In Computer aided chemical engineering (Vol. 25, pp. 1131-1136). Elsevier.Lambert, F. (2022, March 22). Electric cars are now three to six times cheaper to drive in the US as gas prices rise. Electrek. https://electrek.co/2022/03/22/electric-cars-now-three-to-six-times-cheaper-drive-us-gas-prices-rise/	18
Engineering	Tsai. (2020). Carbon Emission Reduction—Carbon Tax, Carbon Trading, and Carbon Offset. Energies (Basel), 13(22), 6128–. https://doi.org/10.3390/en13226128	16
Engineering	Helveston, He, G., & Davidson, M. R. (2022). Quantifying the cost savings of global solar photovoltaic supply chains. Nature (London), 612(7938), 83–87. https://doi.org/10.1038/s41586-022-05316-6	13
Economics and finance	Lyon, T. P., & Maxwell, J. W. (2011). Greenwash: Corporate environmental disclosure under threat of audit. Journal of Economics & Management Strategy, 20(1), 3-41.	1330
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Economics and finance	F., Blome, C., Sun, H., Yang, Y., & Zhi, B. (2020). Towards an integrated conceptual framework of supply chain finance: An information processing perspective. International Journal of Production Economics,219,18–30	130
Economics and finance	Hosseini, S. E. (2022). Transition away from fossil fuels toward renewables: Lessons from Russia-Ukraine crisis. *Future Energy*, *1*(1), 2-5.	48

9.2 Appendix B

These responses are not an exact transcript, but rather condensed notes from the interview.

1. Interview with Anthony Hatfield – Energy and Sustainability Manager at Amazon

I. How has Amazon's internal sustainability strategy evolved over time and what factors have driven these changes?

Anthony: The energy strategy was and always has been focused on reducing carbon. There is certainly a direct link to cost savings. Over the last few years, with Covid, Amazon got busier and busier, and that carbon reduction strategy was paused. However, with the energy crisis war, it became a number one priority to reduce energy consumption for two main reasons. Firstly, financials - cost reduction became a key focus due to massive growth during Covid, followed by a decline in activity post-Covid and pressure for cost reduction. Secondly, resiliency - maintaining electricity across the fulfillment centers (FCs). Following the Paris Agreement, internal company targets became global fixed targets. It became crucial to be part of the climate pledge club.

II. *How is sustainability seen across the company? Including teams not directly involved with the issue?*

Anthony: Sustainability is important across all different functions within the company. It is seen as a crucial topic by procurement, finance, and logistics teams. The scorecards for sites include sustainability topics. Energy has always been seen as a great lever to pull to reduce costs. At Rolls Royce, for example, reducing energy consumption was seen as a quick way to reduce costs.

III. *How does Amazon measure and monitor its energy consumption and emissions?*

Anthony: Everything related to energy at Amazon is data driven. Energy is measured through data, global targets, third-party audits, and waste audits.

IV. *What is the role of innovation in Amazon's sustainability strategy, and how is the company leveraging new technologies and processes to reduce energy usage and emissions?*

Anthony: Innovation is a core principle at Amazon and plays a key role in the sustainability strategy. For example, the AWS monitron is used to access the vibration and temperature of assets. Additionally, external technologies are leveraged.

V. *What is the role of the BMS?*

Anthony: The Building Management System (BMS) at Amazon does everything the company needs it to do, setting up and running FCs. However, it is not fine-tuned and needs to be corrected in order to take full advantage of sustainability initiatives through the technology.

VI. *Can you describe any initiatives or programs that Amazon has implemented to reduce energy usage or promote sustainability?*

Anthony: Amazon has implemented optimization techniques, best practices, and a project tracker to deliver sustainability goals.

VII. *What challenges does Amazon face in achieving Net Zero emissions?*

Anthony: Finance is a significant challenge. If possible, Amazon would change dock doors for more efficient ones, convert all gas systems to electric, and put

solar on every single building. Improving insulation around dock doors, installing sensors, and upgrading dock door lighting are also challenges due to financial constraints. Third-party solar Power Purchase Agreements (PPAs) and energy-as-a-service models could help overcome financial barriers.

VIII. What opportunities may arise for Amazon from achieving Net Zero emissions?

Anthony: Achieving Net Zero emissions can attract the right people, particularly younger talent. It also serves as a role model for customers, promoting technology and Power Purchase Agreements (PPAs). Additionally, it protects Amazon from market forces and reliance on the grid. Cost savings, by investing in renewable energy, energy-efficient buildings, and electric vehicles, Amazon can reduce its energy costs over time and minimize its exposure to volatile fossil fuel prices, resulting in substantial cost savings in the long term.

IX. What are the benefits of energy analytics for achieving Net Zero, and how can companies effectively implement energy analytics programs?

Anthony: You can't monitor what you can't measure. Energy analytics help set and achieve targets by providing a baseline and identifying areas for improvement. However, that there is an overwhelming amount of data available, and it is important to have a centralized platform to effectively utilize and analyse the data. While having the right people and data is crucial, there is currently an abundance of data and there could be even more, with gas and water data. It needs to be better organized and streamlined.

9.3 Appendix C

2. Interview with Gabriel Ortiz – Solar Manager at Amazon

I. What role do renewable energy sources play in Amazon's energy strategy, and how does the company plan to increase the use of renewables in the future?

Gabriel: Currently, Amazon primarily acts as a purchaser of renewable energy rather than a producer. Amazon is currently a data company at the core. However, I see the potential for a future transition into a data and electron/energy company, becoming a Purchase Power Producer (PPP). As Amazon continues to automate its operations, there is a significant opportunity to embrace the energy part of the business and develop a strategic plan to increase the use of renewables. The idea is to connect renewable energy sources, such as wind and PV farms, virtually and create a unique power plant that can distribute energy. This approach goes beyond what can be produced on Amazon's rooftops alone. By involving third-party renewable energy providers, Amazon can benefit from improved reputation and cost savings. However, internally, there is some perceived risk associated with making the shift to producing our own energy. Amazon has experienced rapid growth by purchasing the energy it needs, so there may be skepticism regarding the need for change in a system that has always worked efficiently. The energy industry itself has been seen as lacking innovation, further dampening the perception of significant opportunities in this sector.

Energy can often be an after-thought in multinational companies, the bill comes in and its paid. This is changing as energy costs are rising and effective strategy is crucial. Renewable energy initiatives often have a longer payback period which can make them less attractive, compared to other projects, from a financial standpoint within the company. As a result, they may not always have access to the resources they require to thrive.

II. *How do you see the future of solar energy evolving in the context of Amazon's net-zero goals and the broader push toward renewable energy sources?*

Gabriel: As the prices keep going down, solar is the cheapest source of energy in most parts of the world, and it will be the cheapest by 2030. As prices keep dropping and efficiency keeps going up, we will put photovoltaic (PV) systems wherever the sun shines. Currently, we have electric vans, but there is also an aim to have electric trucks soon. Batteries are not as competitive at the

moment, but they will be by 2030. In the past, we were building solar projects, partially to send a signal of sustainability, but now we are focusing on building PV systems to scale up and reap the benefits of the technology.

III. *Finally, what are some of the key trends or developments in the solar energy industry that you think Amazon should be paying attention to as they work to reduce their carbon footprint?*

Gabriel: Some key trends and developments in the solar energy industry include new benefits for producing energy after the war, as we further realized we cannot depend on finite sources, reducing the time needed for rooftop installations, and removing remuneration barriers, which leads to more revenues for energy generators. Since the war there is reduced bureaucracy for rooftop PV installation allowing for quicker expansion.

IV. *Can you provide examples of successful solar energy projects that Amazon has implemented.*

Gabriel: Some examples of successful solar energy projects that Amazon has implemented include rooftop and carpark PV installations, as well as the use of electric vans.

V. *There has been growing attention around hydrogen as a renewable energy source, what are your thoughts on this approach as a driver in supply chain decarbonization?*

Gabriel: Hydrogen will have a business case for specific industries (cement), but it may not be suitable for everything. In the case of Amazon, we find hydrogen to be less feasible for our operations. pipe turbines tanks will be a stranded asset. Owners will lose out otherwise. They want to make money and are advertising this as the next big thing in the energy world.

VI. *What are some of the key benefits that Amazon can expect from implementing solar energy solutions, beyond just reducing carbon emissions?*

Gabriel: As we introduce electric trucks, there will be significant reductions in diesel costs. This is the same for PV; more PV installations mean lower costs for electricity from the grid. Implementing solar energy solutions will result in huge long-term savings as solar power becomes increasingly accessible.

VII. What are the main challenges Amazon has faced in implementing solar energy solutions?

Integrating renewable energy sources such as solar power requires significant changes in distribution networks. Batteries, not so competitive but they will be 2030, difficulty storing energy. Infrastructure, even if Amazon invests in electric vehicles and renewable energy sources, it may not be able to fully utilize them without adequate infrastructure.

9.4 Appendix D

3. Interview with John Gleeson – Director at Building Performance Consulting Engineers

Transcript not disclosed upon request from interviewee

I. *As a director of Building Performance Consulting Engineers, what opportunities do you believe can arise from decarbonizing the supply chain? How can these opportunities contribute to driving sustainable growth and competitive advantage?*

II. *What are the main barriers or obstacles that companies face whilst seeking to decarbonize their supply chain?*

III. *What are the main sources of greenhouse gases within the standard supply chain? How can these be reduced?*

IV. *What are the limitations of using carbon offsetting as a supply chain decarbonization approach?*

V. *Explain the importance of carbon baselining for carbon reduction? What are the limitations of carbon accounting as of today?*

VI. *What role, do collaboration and partnerships play in enabling sustainable transformations and reaching net-zero emissions in firms' supply chains? How can companies effectively engage stakeholders in order to encourage collective action and sustainability?*

VII. *Given the constantly changing landscape of sustainability and the growing urgency to address climate change, what trends or advances do you see arising in the fields of net-zero emissions and sustainable supply chains?*