AI-Driven Growth in Climate Tech Startups: The Perspective of Startups & Venture Capitalist in Scaling Climate Solutions

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Abstract

This thesis examines how artificial intelligence (AI) is driving growth and investment in climate technology startups. It explores how AI influences the investment criteria of venture capitalists (VCs) and how startups perceive the role of AI in scaling business operations and securing funding. Within the context of current climate challenges and EU frameworks, such as the European Green Deal, AI is proving to be an enabler of efficiency, innovation and scalability. The qualitative study is based on semi-structured interviews with VCs and climate tech startups. The results show that VCs tend to favor startups that authentically integrate AI, while startups highlight the importance of AI for streamlining processes and optimizing resources. However, challenges such as data quality issues, integration complexity and high energy consumption continue to limit the adoption of AI. Despite these limitations, the thesis concludes as AI provides a strategic advantage and a key driver for innovation in climate tech, enabling startups to address the challenges of climate change while navigating a shifting investment environment. The findings help to understand the transformative potential of AI in supporting sustainable growth and advancing climate innovation in this rapidly evolving sector.

Title: AI-Driven Growth in Climate Tech Startups: The Perspective of Startups & Venture Capitalist in Scaling Climate Solutions

Keywords: Artificial Intelligence, Climate Technologies, European Union, Growth, Scaling, Startups, Startup Ecosystem, Venture Capitalist

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Resumo

Esta tese analisa a forma como a inteligência artificial (IA) está a impulsionar o crescimento e o investimento em startups de tecnologia climática. Explora a forma como a IA influência os critérios de investimento dos investidores de capital de risco (VC) e como as startups percepcionam o papel da IA na expansão das operações comerciais e na obtenção de financiamento. No contexto dos actuais desafios climáticos e dos quadros da UE, como o Pacto Ecológico Europeu, a IA está a revelar-se um facilitador da eficiência, da inovação e da escalabilidade. O estudo qualitativo baseia-se em entrevistas semi-estruturadas com investidores de capital de risco e startups de tecnologia climática. Os resultados mostram que os capitalistas de risco tendem a favorecer as startups que integram a IA de forma autêntica, enquanto as startups sublinham a importância da IA para a racionalização de processos e otimização de recursos. No entanto, desafios como os problemas de qualidade dos dados, a complexidade da integração e o elevado consumo de energia continuam a limitar a adoção da IA. Apesar destas limitações, a tese conclui que a IA proporciona uma vantagem estratégica e um fator-chave para a inovação na tecnologia climática, permitindo que as startups enfrentem os desafios das alterações climáticas enquanto navegam num ambiente de investimento em mudança. As conclusões ajudam a compreender o potencial transformador da IA no apoio ao crescimento sustentável e no avanço da inovação climática neste sector em rápida evolução.

Título: Crescimento impulsionado pela IA em startups de tecnologia climática: A perspetiva das empresas em fase de arranque e dos investidores de capital de risco na expansão das soluções climáticas

Palavras-chave: Inteligência Artificial, Tecnologias Climáticas, União Europeia, Crescimento, Escala, Startups, Ecossistema de Startups, Capitalista de Risco

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List of Abbreviations

AI	Artificial Intelligence
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon Capture & Storage
DAC	Direct Air Capture
DL	Deep Learning
EU	European Union
GM	Gioia Method
IP	Interview Partner
ML	Machine Learning
VC	Venture Capitalist
VPP	Virtual Power Plant

1 Introduction

The intersection of artificial intelligence (AI) and climate technology represents a transformative area in addressing one of the most pressing global challenges: climate change. The accelerating climate crisis presents risks to ecosystems, economies and societies. In the European Union, frameworks such as the European Green Deal aim to address these challenges by setting targets, including achieving net zero emissions by 2050 and promoting sustainable economic growth (European Parliament, 2023; Panarello & Gatto, 2023). To achieve these goals, scalable, efficient and innovative solutions are required, which are increasingly recognized by founders and venture capitalists for overcoming climate change through innovation.

AI is increasingly being used across industries, with climate technology being one area of application. The wide range of possible applications ranges from data analysis to modelling and resource optimization, enabling solutions to address pressing environmental challenges (Nost & Colven, 2022). For instance, some of the AI-driven models improve the efficiency of renewable energy systems and support carbon capture technologies that enable a more accurate and effective approach to climate change (Chen et al., 2023). In recent years, AI attracted strong interest from venture capitalist. In Q2 2024, AI startups accounted for 18% of European VC funding (Dealroom.co, 2024b), while in the U.S., AI startups represented 29% of total VC investment in the first half of 2024 (Grabow, 2024). These numbers suggest the strong appeal of AI-driven innovations within the startup's ecosystem.

However, despite the promising opportunities, there are considerable gaps in understanding how the integration of AI impacts the growth and funding of climate tech startups. There is limited research on the motivations and decision criteria of venture capitalists for AI-driven climate tech investments and how startups effectively use AI to scale their operations.

This thesis addresses these gaps by exploring how AI is driving the growth and scalability of climate solutions, focusing on the perspectives of startups and VCs. It examines how climate technologies are promoted and used and what role AI plays in scaling these innovations. Qualitative methods based on interviews with startups and VCs were conducted to answer two main research questions: (1) How does the integration of AI in climate tech startups influence the investment criteria and decisions of VCs? (2) How do climate tech startups perceive the role of AI in scaling their operations and attracting funding? The findings provide insights into the role of AI in driving innovation and attracting investment in the climate tech sector.

1.1 Structure of Thesis

This thesis consists of six main chapters. Beginning with chapter 2, which includes a comprehensive literature review focusing on startup ecosystems, climate tech innovation and AI applications. Chapter 3 outlines the qualitative research methodology, including the data collection and analysis techniques, applied. Followed by chapter 4 presenting the findings of the interviews with startups and VCs. In chapter 5, the findings are discussed and related to the existing literature as well as the theoretical contributions and managerial implications are described. Finally, chapter 6 highlights key findings, the limitations of the study and provides recommendations for future research in this emerging field.

2 Literature Review

2.1 Startup Ecosystem

The original term "ecosystem" comes from biology and refers to the complex network of interactions between living organisms and their environment. The concept of an ecosystem was first introduced to the world of business in the late 1990s to describe the environment in which enterprises operate (Baron & Harima, 2019). In a business context, an ecosystem includes all relevant stakeholders and resources that can impact a company's success or failure, forming a network of diverse players that influence and support one another (Bala Subrahmanya, 2022; Baron & Harima, 2019). The primary objective of this ecosystem is to promote innovation, value creation and growth of startups (Baron & Harima, 2019). Participants in such an ecosystem include not only founders and VCs, but also the incubators and accelerators, government, universities and other companies (Bala Subrahmanya, 2022; Ziakis et al., 2022). To obtain a better overview, the different ecosystem stakeholders are presented in appendix A).

The literature provides various classifications of startup ecosystems, but one way to categorize ecosystems is by the level of maturity of the ecosystem ranging from early-stage to well-established (Baron & Harima, 2019). Another possible classification is based on geographic location, known locations are for example the Silicon Valley or Berlin (Skawińska & Zalewski, 2020). Additionally, ecosystems can be segmented by industry, the categorization applied in this thesis. In this case, the focus of the ecosystem is on a specific sector, such as sustainability or climate tech startups (Skawińska & Zalewski, 2020; Spender et al., 2017).

2.1.1 Startups & Their Stages

A startup is a young (< 10 years), small company characterized by innovative and novel solutions. At its core, startups focus on developing products, services, or business models that meet market needs and help them stand out from competitors (Handoko & Tjaturpriono, 2023). According to the Europe Startup Monitor Report from 2019/2020, the average startup consists of 6.4 employees, including both full-time and part-time staff (Bormans et al., 2020). Most startups are created by a founding team, typically composed of two or three founders (Bormans et al., 2020). Additionally, a key feature of startups is the pursuit of a scalable and repeatable business model (Battistella et al., 2017). Repeatability in the sense that hypotheses about customer interactions with the product or service can be continuously tested and refined and the results incorporated into the development process. While scalability refers to the ability to meet market demand by producing the required quantity of the product or service after testing it successfully (Hiroshi Usirono et al., 2024).

Startups are defined by their high growth potential, as they aim to expand rapidly and increase their market share revolutionize traditional markets as well as the management practices of larger companies (Jeong et al., 2020; Singh & Mungila Hillemane, 2023). Their flexibility and agility allow them to quickly adapt to changing market conditions and drive innovation in their respective industries (Kohler, 2016; Skawińska & Zalewski, 2020). Moreover, alongside new innovations, they can create new needs and demand that have not yet existed for the consumer (Hiroshi Usirono et al., 2024). At the same time, they are often marked by limited resources, both financial and personnel-related and have a higher degree of uncertainty then established companies (Picken, 2017b).

A startup goes through several stages, which Picken (2017b) categorizes into the startup phase (also known as early-stage phase), the transition phase, and the scale-up phase. During the early-stage phase, the young company, often consisting of two to three founders or a small team, primarily focuses on the development and validation of the business idea (Handoko & Tjaturpriono, 2023). A key characteristic of this early phase is the focus on achieving product-market fit, which confirms that the product or service meets the needs of the target customer group (Eisenmann et al., 2017). The transition phase begins with market entry, focusing on refining the product or service to establish a strong foundation for scaling (Picken, 2017b). As the company attracts its first customers, the need for additional resources and new skills increases and the challenges for the founding team become more complex (Picken, 2017b).

In the scale-up phase, the focus shifts towards exponential growth, achieving economies of scale, and securing a competitive position (Picken, 2017b). As the company expands, hierarchical structures and formalized management processes become increasingly important (Picken, 2017a).

2.1.2 Venture Capitalist

Venture capitalists (VCs) are companies that specialize in financing young and new startups or companies with high growth potential, providing them with venture capital (Wang, 2023). In this context, VCs are involved in a variety of functions. First, they evaluate and identify promising startups, offering them venture capital to support their development and growth (Wang, 2023). They support startups by using their expertise and networks to recruit talent, grow their business, help develop their products or services and build strategic partnerships. (Spender et al., 2017; Wang, 2023). The support or funding from VCs often extends over several years, as they typically follow medium- to long-term investment strategies before planning their exit (Wang, 2023).

The focus of their investment varies based on several factors. For instance, some firms concentrate on early-stage companies, particularly in seed or Series A funding, where the investment risk is higher (Cohen et al., 2019). Additionally, some VCs focus on investing in companies with a strong impact, whether the goals of the startup are social, economic, or a combination of both (Wurth et al., 2022). Other VCs focus on startups in the growth phase or within specific industries, like Fintech or AI technologies (Knight et al., 2020; Wang, 2023).

2.1.3 Growth & Scaling

Growth and scaling are two main aspects for startups. A company's growth includes the expansion and development of its operations, resources and market presence over time and serves as a key indicator of its progress and market viability (Bass et al., 2024). Scaling, on the other hand, refers to how fast and efficiently a company can grow (Bass et al., 2024). A scalable business model enables a company to replicate its operations and services to meet growing demand without increasing operational capacity. For startups especially, having a scalable business model is essential to remain competitive and achieve long-term success (Cavallo et al., 2024; Morton & Iglesias Ruiz, 2024).

For startups, the main objectives are innovation and expansion, whereas growth and scaling are essential elements. While growth primarily enables startups to expand their resources and capabilities (Cavallo et al., 2024), scaling facilitates them to fully promote this growth and gain market share rapidly. Scaling is especially important for technology-based startups, as they often benefit from network effects, where the value of a product or service increases according to the number of users (Cavallo et al., 2024; Sanasi et al., 2023; Teixeira et al., 2021).

Growth and scaling are essential objectives for startups, but they are set in a broader context of urgent environmental challenges. This research focuses on climate tech startups using their scalable business models not only for commercial success, but to drive meaningful climate solutions. Therefore, the following chapter focus on the role of startups as key innovators in addressing climate change.

2.2 The Role of Startups in Climate Solutions

Part of this thesis is the focus on the climate crisis and the innovations and technologies related to it. The next section focuses on the climate situation in the European Union (EU) and explores sectors where new climate-related technologies are emerging.

2.2.1 Climate Regulations European Union

The climate situation represents a global challenge that affects all European regions and causes forest fires, flooding, extreme heat, rising sea levels and ecosystem disruption. These impacts are reducing the ability of forests and agricultural land to capture and store carbon (European Parliament, 2023; Kurze, 2020). In response, the EU has set climate targets in line with the 2015 Paris Agreement, including restricting the temperature rise to 1.5°C, reducing greenhouse gas emissions and introducing carbon pricing to address the main drivers of global warming (European Parliament, 2023).

To reach these goals, the EU has launched initiatives such as the "European Green Deal", which aims to achieve a climate-neutral economy by 2050 (Panarello & Gatto, 2023). The Green Deal focuses on transforming the energy sector, decarbonizing the industry, introducing carbon pricing and promoting carbon capture and storage, among other measures (Federal Ministry for Economic Affairs and Climate Protection, 2024; Panarello & Gatto, 2023).

Moreover, the EU introduced the Carbon Border Adjustment Mechanism (CBAM) in 2023. This instrument aims to reduce CO_2 emissions and mitigate the risk of relocating carbon-intensive production to countries with less stringent climate regulations (European Parliament, 2023). CBAM is part of the EU's broader efforts to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, a key objective of the Green Deal (European Parliament, 2023; Kurze, 2020). Initially, CBAM applies to imports from energy-intensive sectors such as cement, iron and steel, aluminum, chemical fertilizers and power generation (Pan & Liu, 2024).

Under this system, importers must purchase carbon emission allowances to offset the CO_2 emissions associated with their imported goods. This mechanism is intended to prevent companies from relocating their production to countries with lower environmental standards to avoid EU carbon prices (Pan & Liu, 2024).

Besides the systems and implementations mentioned above, there are several other measures introduced by the EU. A comprehensive discussion of all initiatives would exceed the scope of this paper, therefore the focus remains on these initiatives mentioned.

2.2.2 Innovation & Technology in Climate Tech

The mentioned EU regulations encourage the demand for climate-friendly systems, solutions and support innovation as well as technological progress in areas like energy, energy efficiency and circular economy (Horbach & Rammer, 2025). The literature highlights that climate issues can only be effectively addressed through innovation and new technologies. Green innovation plays a crucial role in reducing environmental impact and promoting a more sustainable economy (Sarkodie et al., 2023; Tao, 2024). In literature, the term "climate tech" is defined as technology that is designed to address the effects of climate change, reduce greenhouse gas emissions, increase energy efficiency and drive green development (Ahmad et al., 2024; Aibar-Guzmán et al., 2023). Climate tech can be both high-tech and low-tech solutions, which can be new energy-saving techniques, carbon capture technologies, pollution control and waste management (Aibar-Guzmán et al., 2023). As climate tech includes a range of technologies in companies, the following paragraphs describe some of them in more detail using examples to provide a better overview.

In recent years, an increasing number of startups have emerged to address various climate challenges. Technologies have been developed to promote the expansion and integration of renewable energy sources, like solar, wind and water to reduce dependence on fossil fuels (Sarkodie et al., 2023). One example of renewable energy is the German company trawa, which helps companies of all sizes to generate electricity from solar and wind power plants using an innovative solution that helps to decarbonize one of the largest sources of emissions, electricity consumption, while reducing dependence on energy-intensive fuels (Future Energy Services GmbH, 2023).

Furthermore, numerous technologies have been created to enhance energy efficiency to lower consumption and reduce emissions (Sarkodie et al., 2023). One example is Enter, a Berlin-based company focused on energy consulting and renovation to optimize energy efficiency of residential buildings and support Germany's energy transition. Enter provides sustainable renovation solutions, such as insulation, heat pumps, and solar thermal systems, to help property owners create climate-neutral living spaces (baupal GmbH, 2021).

Other climate solutions include carbon capture and storage (CCS) technologies, which capture or store CO_2 emissions from industrial facilities and store them permanently, thereby reducing greenhouse gas emissions into the atmosphere (Khoyashov et al., 2024). An example of this is Phlair, founded in 2022, which developed a Direct Air Capture (DAC) system to remove CO_2 directly from the air. This CO_2 can then be either stored permanently or used as a raw material for carbon-negative chemicals, helping governments, companies, and individuals to achieve net-zero emissions faster (Phlair GmbH, n.d.).

The technologies mentioned provide a brief overview of the many innovations that have been developed in recent years to mitigate climate change. Moreover, the companies mentioned represent only a small part of the technologies available and are only intended to give a better understanding in the context of this work.

2.3 Artificial Intelligence and the Role in Climate Startups

2.3.1 Artificial Intelligence

Artificial intelligence (AI) describes a field of computer science that focuses on the development of systems able to perform tasks that normally require human intelligence (Okada et al., 2023). AI can be found in different forms, for example as software in online search engines or as a component in devices like cars (Okada et al., 2023). One of the applications of AI is machine learning (ML), where the software independently learns by recognizing patterns or rules from large datasets based on statistical analysis, without requiring explicit programming from the developer (Nordgren, 2023). Deep learning (DL) is a form of ML that uses artificial neural networks to process data in a similar way to the human brain (Bini, 2018). In contrast to traditional machine learning, DL can process raw data and extract its own features without any human input. For instance, DL algorithms can learn to recognize and differentiate faces in images without the need for predefined features such as “nose” or “eyes” (Bini, 2018). The ability of DL to independently extract complex features makes it particularly valuable for climate prediction, from modeling temperature trends to forecasting extreme weather events (Chen et al., 2023). Another form of AI is generative AI, which includes large language models like ChatGPT. Generative AI can create entirely new content, such as generating text, images and music (García-Peñalvo & Vázquez-Ingelmo, 2023).

In recent years, the introduction of AI has impacted various sectors, promoting efficiency, productivity, and innovation. For example, in the climate and energy sector, AI has contributed to enhancing climate models, advancing new technologies, and supporting climate financing (Chen et al., 2023; Zhao et al., 2024). AI is not only used as a direct technology, but also as part of managerial decision-making processes. The use of AI facilitates faster analysis of data sets, improving management decision-making (Korzynski et al., 2023).

Since the application of AI in business models and companies is increasing, the EU adopted the AI Act in 2024. A regulatory framework that aims to balance the protection of individuals rights with the support of innovation and competitiveness in the AI sector in Europe (Cancela-Outeda, 2024). The EU AI Act introduced direct communication for startups to promote innovation. With improved access to supercomputers, data collection support, funding incentives and regulatory roadmaps startups can develop, test and validate innovative AI systems overseen by authorities (European Commission, 2024).

2.3.2 AI Applications in Climate Tech

Several innovations and technologies aimed towards slowing or mitigating climate change have already been discussed in this paper. An additional focus in this context is the integration of AI into climate solutions, which will be examined in the following section.

As described, AI is already deployed across various sectors and has influenced multiple industries. AI is used to track emissions across different sectors and improve processes for emission reduction. One of the important applications of AI in climate tech is emissions tracking, where AI monitors greenhouse gas emissions in different industries, identifies emission hotspots and evaluates mitigation efforts (Cowls et al., 2023; Olawade et al., 2024). Chen et al. (2023) show that AI-supported systems can increase the accuracy of emissions data and support compliance with environmental regulations. The use of smart networks and energy management systems which optimize energy consumption can reduce energy losses by up to 50%. These technologies contribute to achieving climate targets by helping companies and other stakeholders to measure and manage their environmental impact more precisely (Chen et al., 2023).

In the energy sector, AI already plays a role in enhancing efficiency and accurately calculating energy demand (Cowls et al., 2023). AI algorithms optimize the use of renewable energy sources by integrating wind and solar energy systems (Tao, 2024). Moreover, AI can be used to determine optimal locations for solar power plants, precisely control the alignment of solar panels and detect potential faults in wind turbines at an early stage (Chen et al., 2023).

Another application of AI is in analyzing large datasets to improve climate model accuracy, enabling better forecasting of temperature trends and the identification of climate patterns (Coeckelbergh & Sætra, 2023). Sources highlight AI's role in industrial production, optimizing manufacturing processes, reducing energy and material waste, and supporting sustainable practices (Verendel, 2023). AI models also predict temperatures, rainfall, and extreme weather, extending their applications beyond climate prediction. According to Cowls et al. (2023), AI algorithms that process large amounts of environmental data enable early identification of climate risks and support preventive measures to minimize damage from extreme climate events.

AI in climate tech presents promising opportunities to advance climate goals, however its challenges also need to be considered. AI, particularly DL, requires high volume of energy to process training of large datasets (Perucica & Andjelkovic, 2022). The increasing demand for computing power has led to the expansion of data centers, which consume large amounts of energy and contribute to global CO_2 emissions (Perucica & Andjelkovic, 2022). Cowls et al. (2023) highlight that AI-powered data centers account for approximately 1% of global greenhouse gas emissions, posing a contradiction to AI's potential benefits for climate action. This underlines the need for careful consideration of scaling AI-based solutions while managing their environmental impact. Furthermore, large scale AI implementation requires high computing resources, which can increase emissions if the underlying infrastructure is based on non-renewable energy sources (Cowls et al., 2023).

2.4 Investment Trends in AI & Climate Tech

2.4.1 Current Investments Trends

This section explores the investment behavior of VCs globally, in the United States (US) and in Europe to gain a better understanding of current VC investments trends in general, with AI and in the climate sector to provide a basis for the qualitative research to follow.

In the third quarter of 2024, global VC financing reached USD 66.5 billion, representing a decline of 16% from the previous quarter (Q2) and 15% from the same quarter last year (Teare, 2024). AI leads globally as the top investment sector, followed by healthcare and biotech, with investments in AI showing an increase from last year (Teare, 2024). An EY report on US investment trends indicates that 37% of investments in Q2 2024 were directed toward AI-related companies (Grabow, 2024).

A comparison of global and US investment and European investment trends shows that in general, European investments have increased in 2024. Between the first and second quarters, investments increased by 14% (KPMG, 2024). Also in Europe, investments in AI are among the highest. The Dealroom Q2 Report identifies industrial technology, generative AI as the top segments (figure 1) (Dealroom.co, 2024b).

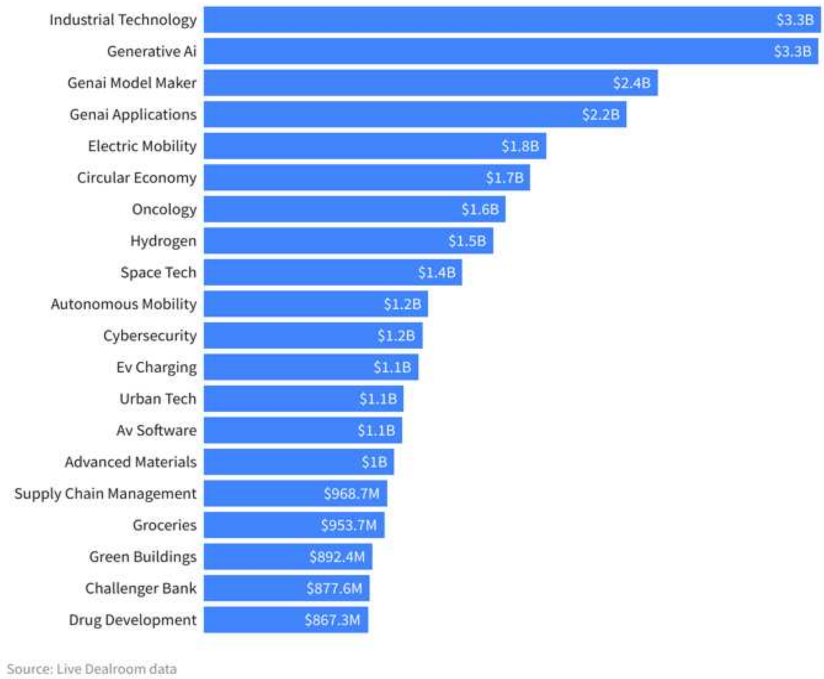

Figure 1: Europe's leading Segments by VC Investment (Dealroom.co, 2024b)

Literature studies underscore the growth of AI driven by its capacity to transform industries and autonomously generate content (Siddik et al., 2024). This is reflected in European AI investment trends, where AI funding has increased by ten times in the last ten years (Dealroom.co, 2024a). Leading AI investment sectors in Europe include financial technology, drug discovery, robotics and security (Dealroom.co, 2024a). The distribution of funding for AI investments shows the United Kingdom, France and Germany as the three leading European countries for AI investments (Dealroom.co, 2024a).

Climate tech investment is an integral component of global investment behavior, with funding reaching USD 87.5 billion in 2021, a rise from the previous year (Aibar-Guzmán et al., 2023). Compared to the AI investment trends outlined above, climate tech holds particular importance in Europe, where the energy sector attracts the highest amount of investment in both 2023 and 2024 (Dealroom.co, 2024b). In contrast, energy investments in the US decline overall in Q2 2024 (Grabow, 2024). This prominent European trend may be attributed to EU regulations aimed at promoting climate technologies and advancing efforts to mitigate climate change.

The combination of AI and climate technology has created a unique investment environment where technological innovation meets environmental sustainability. Surana et al. (2023) state that companies are increasingly investing money in climate tech startups that use AI for climate modelling, resource optimization and energy management. Such investments are of crucial importance for corporate sustainability strategies (Surana et al., 2023). Corporate investments focus on climate tech startups at a later stage of development. Companies like Shell and Alphabet are investing financial resources in technologies that are about to be launched on the market, including sustainable aviation fuels and electric vehicles (Surana et al., 2023). Surana et al. (2023) point out that this strategic focus aims to accelerate commercial feasibility and broad adoption.

As both AI and climate tech solutions are still relatively new, there is limited discussion in the literature about the various investments and trends. For this reason, the following section describes further investment opportunities as well as the challenges that stand in the way of promoting innovations in the field of AI and climate tech.

2.4.2 Opportunities & Challenges for Investment in AI and Climate Tech

As previously discussed, there is a strong trend in AI investment both globally and within Europe. Although various EU regulations create a demand for climate innovations and technologies, AI-driven climate tech is not yet among the top-listed investment areas.

In a US study, Cornelli et al. (2023) observed that private investors are increasingly investing in sectors supported by the government. These insights could be transferred to the European market, as the EU is setting clear signals and creating appropriate framework conditions through regulations such as the European Green Deal as well as ambitious climate targets for the coming years. These political measures could open new investment opportunities for private investors, especially in the climate technologies sector.

As briefly mentioned in section 2.3.1, AI integration has already transformed processes and technologies across various sectors. In the climate sector, AI enhances energy demand forecasting accuracy (Olawade et al., 2024) and supports agriculture by monitoring weather, soil moisture and plant health, delivering useful insights and data (Rashid & Kausik, 2024). Its integration into climate technologies has also driven advancements and adoption, particularly in the transportation and energy sectors. Verendel (2023) shows a high volume of AI-enabled patents in these sectors, indicating potential for further growth and resource optimization to reduce emissions. AI offers additional opportunities to advance climate technologies. Deep learning techniques can improve climate models by analyzing large datasets, identifying trends, assessing risks, and informing policymakers and stakeholders about potential scenarios (Olawade et al., 2024). Moreover, AI-powered emissions control systems can identify hotspots, monitor CO_2 emissions over time, and evaluate the effectiveness of mitigation strategies (Olawade et al., 2024).

Besides the potential opportunities, there are challenges for AI-based climate solutions. As mentioned, the use of AI itself requires a high level of energy consumption, which is why there is a constant discussion in the literature as to whether AI can contribute to solving climate problems. Furthermore, many climate tech solutions require high investments and generate considerable operating costs, which can discourage both startups and investors. For example, data analysis for climate models and the implementation of AI-based solutions are very complex and require specific knowledge, increasing implementation costs (Akter et al., 2021; Herman, 2023).

Another challenge comes from the commercialization of climate tech, as it is often difficult to scale and requires complex technical and industrial processes, which can potentially hinder investors (Kulkov, 2023). In addition, investors are interested in knowing when their investment will be profitable. Many climate solutions take a long time to develop and to become profitable, which increases the time it takes for investors to generate profits and their financial risk (Kulkov, 2023). Besides VC, AI startups often face high development costs and long time-to-market, thereby increasing the risk of investing in this area. The financial requirements for the research and development of AI companies are high, making it a challenge to scale, especially for investors aiming for short-term returns (Kaggwa et al., 2023).

2.5 Gaps in Literature

This research explores the intersection of startup ecosystems, climate technologies and AI, with a specific focus on VC investment. The initial chapters provide a comprehensive literature review on key concepts, including the role of stakeholders within startup ecosystems, the distinct growth and scaling stages of startups, and the dynamics of funding.

The literature review highlights the growing importance of AI in climate technology, with applications ranging from emissions monitoring and energy optimization to climate modelling and industrial processes. Despite its potential, challenges such as energy consumption, high implementation costs and scalability stand in the way of broader application. Research shows that there is growing interest in AI and climate tech individually, but limited exploration of their combined potential. Both are relatively new innovations and there is limited literature addressing their intersection, particularly in the context of VC and their motivations and expectations for investing in AI-related climate tech. Moreover, there is limited research on why AI is not yet widely used in climate technology as well as the challenges and opportunities this integration could present.

Chen et al. (2023) identify several critical areas where AI has potential but requires further exploration. For example, the effective implementation of AI in carbon capture and storage is essential to achieving sustainability goals and carbon neutrality. However, challenges in applying AI to this field and the need for further research and development remain considerable barriers to realizing its full potential. Similarly, in the context of weather forecasting, the authors mention that the accuracy of AI predictions improves with increasing data availability, but not enough attention is paid to how greater accuracy and timeliness can reduce weather-related disasters and improve land use efficiency (Chen et al., 2023). Further, Chen et al. (2023) discuss the potential of AI applications to lower energy consumption and emissions when designing and retrofitting buildings. AI algorithms can optimize building systems while maintaining the comfort of occupants, however, further innovation and research is required to fully realize these benefits.

Lastly, despite there being literature on individual players in the ecosystem, there is limited literature on how these players collectively influence the growth of climate tech startups using AI. This indicates unexplored potential for growth and innovation in this area.

Based on the above-mentioned gaps in the literature, the following research questions are identified:

(1) How does the integration of AI in climate tech startups influence the investment criteria and decisions of VCs?
(2) How do climate tech startups perceive the role of AI in scaling their operations and attracting funding?

3 Methodology

This research explores how AI is driving the growth of climate tech startups and improving their ability to secure funding. It examines the challenges and opportunities in implementing AI and attracting VC investment. This chapter outlines the research methodology and describes the research approach, data collection methods, sample selection and data analysis process to understand the dynamic relationship between VCs and startups in climate tech and AI.

3.1 Research Design

This study follows a qualitative research design, which allows for a detailed and in-depth understanding of complex topics (Lutz & Hill, 2009). It focuses on the deeper exploration of the experiences, perspectives, and meanings that individuals or small groups attach to particular topics (Alshenqeeti, 2014). In qualitative research, different data collection techniques can be applied, such as interviews, focus groups and observations (Hamilton & Finley, 2019). Considering that both climate tech and AI are relatively new fields and have gained particular attention in recent years, in this context the qualitative research approach seems especially suitable. The use of interviews provides a deeper understanding of the two stakeholder groups, offering detailed insights into experiences, opinions, and motivations of the participants (Alshenqeeti, 2014).

3.2 Data Collection

Interviews are part of the qualitative research design and provide direct insight into the respondent's experiences and perspectives. The flexibility of interview formats, such as semi-structured interviews, applied in this research, allows researchers to address pre-defined topics as well as emerging, unexpected topics (Adhabi & Anozie, 2017). Semi-structured interviews are structured using a predefined questionnaire that is systematically organized around specific topics. Depending on the progress of the interview, additional questions can be introduced to explore certain topics in more depth (Qu & Dumay, 2011). This approach allows researchers to discover underlying aspects of behavior, and is characterized by its flexibility, accessibility and simplicity (Qu & Dumay, 2011). As part of this research, an interview guide for VCs as well as one for startups was created to address the specific needs of the respective stakeholders more directly.

To address the research questions and gain a comprehensive understanding of two of the startup ecosystem stakeholders, both startups and VC were interviewed. A purposive sampling method was employed. Compared to random sampling, this approach selects participants based on their expertise and relevance to the research questions, ensuring the most insightful contributions (Hamilton & Finley, 2019). Moreover, with the support of the initial interview partners, additional VCs and climate tech startups were recruited for interviews, whereby the snowball technique was applied (Naderifar et al., 2017).

The interviews were held online via Microsoft Teams, with the participants giving their consent to be recorded. A total of 17 interviews were conducted, lasting between 18 and 45 minutes on average. Most of the interviews were done in German, as most of the participants were from German-speaking countries. A total of 7 VCs specializing in climate tech and general investment areas, as well as 10 startups in the climate tech sector, were interviewed (figure 2).

Interview Partner	Ecosystem Stakeholder	Focus Area	Position
1	Venture Capitalist	Impact & Climate Tech Fund	Senior Associate Analyst
2	Venture Capitalist	DeepTech with Climate Fund	Senior Associate Analyst
3	Venture Capitalist	Climate Deep Tech Fund	Investment Associate
4	Venture Capitalist	Climate Deep Tech Fund	Founder Associate
5	Venture Capitalist	Impact & Climate Tech Fund	Analyst
6	Venture Capitalist	Tech Fund	Platform Analyst Intern
7	Venture Capitalist	Impact Fund	Investment Associate
8	Startup	Energy Management	Commercial Strategy Manager
9	Startup	Renewable Enery	Associate Director Operations & Growth
10	Startup	Energy Management	Co-Founder
11	Startup	Carbon Capture/Storage	Head of Sales
12	Startup	Renewable Enery	Founder Associate
13	Startup	Waste Management	Founder Associate
14	Startup	Carbon Capture/Storage	Founder Associate
15	Startup	Carbon Capture/Storage	Sales & Marketing
16	Startup	Renewable Enery	Working Student CRO Office
17	Startup	Carbon Capture/Storage	Founder Associate

Figure 2: Overview Interview Partner VCs & Startups with their Focus Area and Position

VC specializing in tech, with a focus on climate tech and AI were specifically approached to provide insights into trends and their perspectives on these emerging fields. Simultaneously, startups primarily operating within the climate tech sector were interviewed, including some who already use AI-based solutions, such as machine learning, within their technologies. This dual focus aimed to gain a well-rounded understanding of the market dynamics and the opportunities that AI and climate tech present from the perspectives of both investors and startups.

3.3 Data Analysis

The following section outlines the analytical approach used for qualitative research with semi-structured interviews applied in this study. The Gioia Method (GM) serves as the chosen analytical framework, offering a systematic approach to qualitative data analysis. The GM aims to ensure accurate research while exploring the potential for new insights through inductive research methods. (Magnani & Gioia, 2023). The foundation of GM is grounded theory, based on the systematic data collection and analysis to guarantee the credibility of the interpretation of the findings (Gioia et al., 2013).

The methodological process of data coding and analysis in the GM includes the data collection, the three main steps and the final visualization of the data structure (figure 3). The first involves the creation of 1st-order concepts, which aim to capture the perspectives of informants, in this case, the interview participants. This step is described as "informant-based," as it uses the statements and terminology of the interviewees without interpretation (Magnani & Gioia, 2023). The next step involves the development of 2nd-order themes, referred to as "researcher-based," which abstract and synthesize findings from the 1st-order concepts into overarching themes. At this stage, researchers begin to incorporate theoretical perspectives into the analysis. The final step entails further refining the 2nd-order themes to identify higher-level dimensions, a process referred to as aggregate dimensions (Magnani & Gioia, 2023). However, it is important to mention that the data from startups and VCs were analyzed separately. The analysis process was performed for each stakeholder group and visualized accordingly. Since most of the interviews were conducted in German, some quotes were translated into English to provide a more fluent and coherent text. Besides, data saturation was achieved during the interview process as additional interviews consistently repeated existing themes, with no new insights or patterns emerging (Saunders et al., 2018).

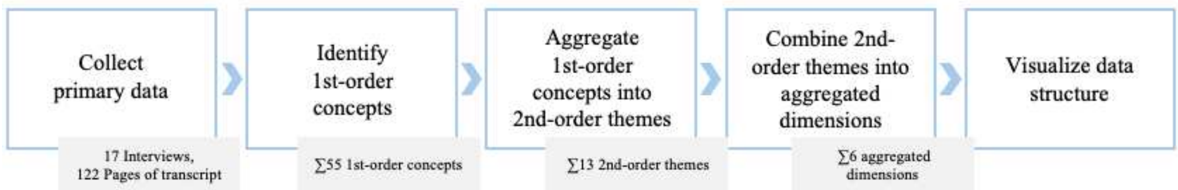

Figure 3: Data Analysis Process based on Gioia (Magnani & Gioia, 2023) incl. the achieved quantity

4 Findings

This section presents the main findings of the qualitative data analysis. The structure of the presentation follows the approach of the GM, as previously outlined. The findings from the stakeholder groups are initially described separately, starting with the results from the venture capitalists (4.1, 4.2, 4.3) (Appendix B), followed by the outcomes of the startup interviews (4.4, 4.5, 4.6) (Appendix C). Moreover, the term interview partner is shortened to "IP" in the following chapter.

4.1 AI as a Driver for Growth & Innovation in Climate Tech

This first aggregated dimension examines the role of AI in driving growth, efficiency and innovation in the climate tech sector (figure 4). The results show how AI improves operational scalability, accelerates research breakthroughs and supports the development of innovative solutions in areas such as renewable energy and climate change mitigation.

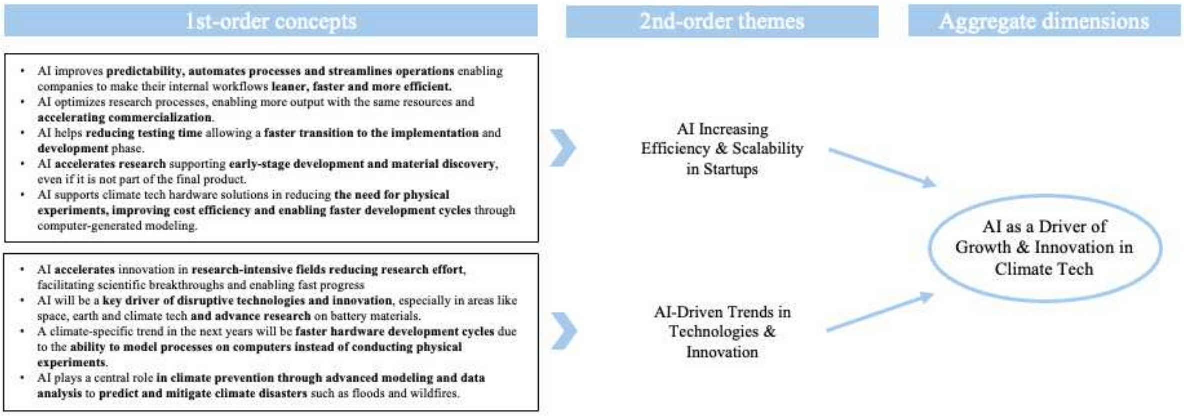

Figure 4: Data Structure first VC Aggregate Dimension

4.1.1 AI Increasing Efficiency & Scalability in Startups

The findings highlight the role of AI in enhancing efficiency and scalability in climate tech. By improving predictability, automating processes, and streamlining operations, AI enables companies to manage internal workflows more effectively. IP5) explains, "*Startups are going to need to adapt and to start leveraging AI so that they can improve their processes somehow or improve their software*".

In various interviews, VCs highlighted how AI optimizes research processes allowing to achieve more results with the same resources and accelerate commercialization. Additionally, the ability to reduce testing time, which allows for a faster transition to the implementation and development phase. One VC remarked: "*New materials are being researched at an incredible speed*" (IP2). Another mentions:

> *"The work that you can do [...] that's of course a game changer because it allows to be much quicker and much leaner at analyzing things that before were not possible"* (IP3).

The scalability provided by AI was highlighted, with several IPs explaining how automation and AI-driven processes allow companies to achieve similar results becoming leaner and with fewer employees. IP7) states:

> *"You can automate many things right from the start with foundation models or the various other products that are currently being built on top. This means you can reach a similar product with significantly fewer employees".*

Another observation is that efficiency increases through AI are highlighted as critical to maintaining competitiveness in the climate tech sector, whereby IP1) generally pointed out the role of AI: "*AI brings such strong efficiency increases in the climate tech sector that whoever gets left behind here will have a very, very hard time"*.

4.1.2 AI-Driven Trends in Technologies & Innovation

AI was highlighted by the IPs as a key driver of innovation and emerging trends in climate tech. It was stated that AI reduces research effort, drives science progress and advances in material development, *"AI can shorten research cycles, making the process faster and more efficient"* (IP4). In addition, this VC highlights that *"most startups we invest in are based on scientific breakthroughs and have long development cycles"* (IP4), suggesting the role of AI in addressing these challenges.

Moreover, AI is seen as a driving force for deep-tech, hardware technologies and breakthrough innovations in areas such as space, earth and other climate technologies. IP5) mentioned:

> *"The most radical and breakthrough technologies will be across sectors of space tech and earth tech, and AI is going to be the leverage they use to build these technologies"*.

Further, he underlines that AI contributes to *"more deep-tech and hardcore technologies"* (IP5). In climate tech, AI's ability to accelerate testing, such as for "*new membranes for electrolyzers",* was highlighted (IP4).

Another key area is AI's role in climate prevention and disaster mitigation. By using advanced modeling and data analysis, "*AI can play a strong role, with many startups focusing on floods, wildfires, and so on"* (IP4).

4.2 Navigating AI Integration in Climate Tech Startups

The next aggregated dimension presents findings on the challenges and strategies approaches for integrating AI in climate tech startups (figure 5). Interviewees highlighted the barriers startups face, like data quality and infrastructure, as well as the importance of a clear AI roadmap to drive efficiency and growth in this dynamic sector.

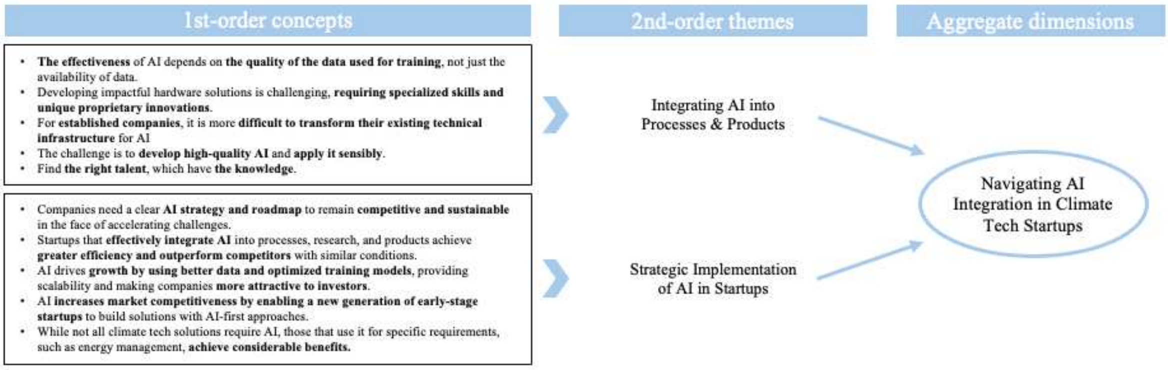

Figure 5: Data Structure second VC Aggregate Dimension

4.2.1 Integrating AI into Processes & Products

The integration of AI in climate tech startups presents several challenges identified by the IPs. A central challenge many companies face when implementing AI in their processes or products is *"to develop good AI and apply it sensibly"* (IP1). In this context, the efficiency of AI depends on the quality of the data used for training, rather than merely on the availability of data. *"The problem is often not whether you have data, but whether the quality of the data is good enough to build meaningful models or predictions"* (IP2). It was mentioned that: *"AI [is] only as good as the data you feed it. If you have bad data, even the best model won't help"* (IP2).

Another challenge described was the integration of AI into existing technological processes for companies that have already been in existence for several years. One VC notes: *"If you've been building a company for five to ten years, it's hard to make your entire tech infrastructure AI-ready now"* (IP7). In contrast, startups which have operated with AI since the beginning experienced less challenges in this regard (e.g IP7).

One additional challenge is the recruitment of qualified professionals with expertise in AI, particularly for startups. As one VC mentions, finding highly skilled professionals in this field is both challenging and costly (IP2). Additionally, the fast pace of AI development was highlighted as a persistent challenge *"you also have different levels of challenges, including the fact that things are accelerating all the time"* (IP1).

4.2.2 Strategic implementation of AI in Startups

A further highlight was the need for a clear AI strategy and roadmap to keep companies competitive and sustainable in the dynamic climate tech landscape. IP1) states:

> *"every company needs an AI roadmap and an AI strategy. Otherwise, as a large company, you won't be able to work sustainably".*

Startups that effectively integrate AI into their processes, research, and products were described as achieving considerable advantages. IP4) highlights how such integration leads to improved efficiency and performance:

> *"The best startups are those that strongly integrate AI, whether in internal processes, research, or the product itself. If two startups have the same conditions, the one with well-integrated AI will always outperform the other".*

In this context, it was mentioned that the best startups focus not only on AI but also on strong product ideas and execution (e.g. IP4).

Besides, AI is further described as a driver of growth using better data and optimized training models, which enhance scalability which make startups more attractive to investors. Additionally, AI was described to increase market competitiveness by enabling the rise of early-stage startups with AI-first approaches and called *"a new generation of competitors"* (IP7).

Expanding on this, not all climate tech solutions rely on AI, but those that strategically apply it to specific needs, such as energy management, demonstrate advantages. IP4) explains:

> *"The hype around investing in AI startups will fade, and it will shift to areas like energy management startups. The best ones will be those that use AI effectively".*

4.3 Development of VC Strategies

The last aggregate dimension from the VC interviews examines AI's role in investor decision-making and funding trends within climate tech (figure 6). The findings highlight the importance of meaningful AI integration for investment appeal, the evolving funding landscape, and the increasing interest in AI-driven hardware solutions.

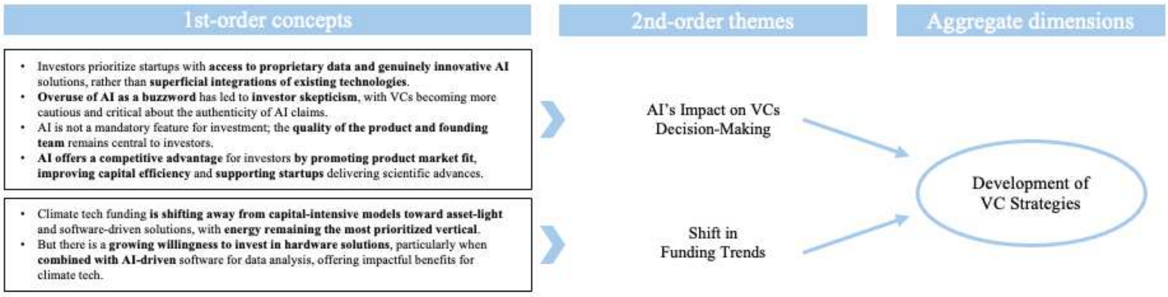

Figure 6: Data Structure third VC Aggregate Dimension

4.3.1 AI's Impact on VCs Decision-Making

The role of AI in investor decision-making was an important topic in the interviews, with VCs highlighting both its benefits and challenges. While AI was identified as a factor that can increase attractiveness of a startup, only if it is implemented in a meaningful way. In this regard, IP4) referred to the preference for startups offering proprietary data and authentic self-developed AI solutions over those with superficial integrations of existing technologies: *"This whole AI buzzword is becoming negatively connoted, leading some VCs to be more cautious and try to move away from simple ChatGPT integrations toward startups that build their own models and deeply integrate AI into their products*". Another point is the overuse of AI as a buzzword which has led to growing skepticism among investors. IP3) explains: *"I think it has led to a lot of noise, with companies claiming they have AI as a solution, but simply building a backend stack on ChatGPT does not mean you've developed a model yourself"*. This skepticism is leading investors to be more cautious about AI claims and instead focus on startups with meaningful and authentic AI applications.

While AI can provide startups with a competitive edge, it was not seen as a mandatory feature for investment. The quality of the product and the founding team remain the most critical factors for investors. One VC stated:

> *"I never heard of a startup being rejected because they didn't use AI [...] there are many other reasons, much more related to the founding team [...] whether they are experienced or so"* (IP6).

IP3) added: *"For the product itself, no, it's not why we invest. You need to have an amazing product without AI"*.

AI's potential to enhance scalability and efficiency was highlighted as an attractive feature for investors to grow a startup. IP1) mentions:

"If you talk about hockey-stick growth, it's hardly possible nowadays without AI. There will always be someone using AI, making them more attractive to investors in the same segment".

However, the same IP clarifies that while AI-driven scalability is exciting, it is not the only pathway to success "*scalability can come from AI, in which case it's exciting for us, but it can also come from other things that aren't necessarily AI and are just simpler automation, and that's just as good for us"* (IP1).

Following on this, the value of AI for investors extends beyond scalability. It is also recognized for its role in driving growth by shortening the time between research and market launch, improving capital efficiency and enabling scientific breakthroughs. As IP4 points out:

"We should always invest in the best startups, and those will be the ones that leverage AI most effectively, whether it's in internal processes, research, or the product itself. The potential is enormous to achieve more with the same input".

4.3.2 Shift in Funding Trends

The funding landscape in climate tech is undergoing a transformation, as described by the VCs. Energy remains the most prioritized vertical in climate tech, continuing to attract investment due to its broad potential for new renewable solutions. IP3) explains:

"the most invested climate tech vertical is energy. And it's always the one that has been getting more attention".

While the energy sector continues to dominate, there is a clear shift in investment preferences away from capital-intensive deep-tech models towards asset-light and software-driven solutions. One VC observes:

"There is still deep-tech funding for climate and capital-intensive models, but much, much less than before. Now, it is much more about asset-light models, software models" (IP1).

This reflects a general trend among investors, particularly early-stage VC, who are increasingly attracted to business models that offer a fast route to profitability and a low capital investment. IP1) also explains:

"The entire funding landscape has changed a bit. Investors, especially early-stage VCs, are looking for models with a quick path to profitability and low capex, basically, low-investment models".

Despite the shift towards software-driven models, there is an emerging trend towards increased interest in hardware investments, particularly when combined with AI-driven software for data analysis. Hardware solutions that integrate AI offer advantages for climate tech. IP7) described: *"We are seeing an increasing willingness to invest in hardware, something we haven't seen for ages"*. This willingness suggests that investors are beginning to recognize the potential of hardware solutions when combined with advanced software technologies to address critical climate issues.

4.4 AI for Growth, Scalability & Operational Excellence

The first aggregated startups dimension focuses on AI as a key factor for growth, scalability and operational excellence in climate tech startups (figure 7). Thereby, the results show how AI increases efficiency, drives innovation and supports market trends, making it an essential operational tool for startups to remain competitive.

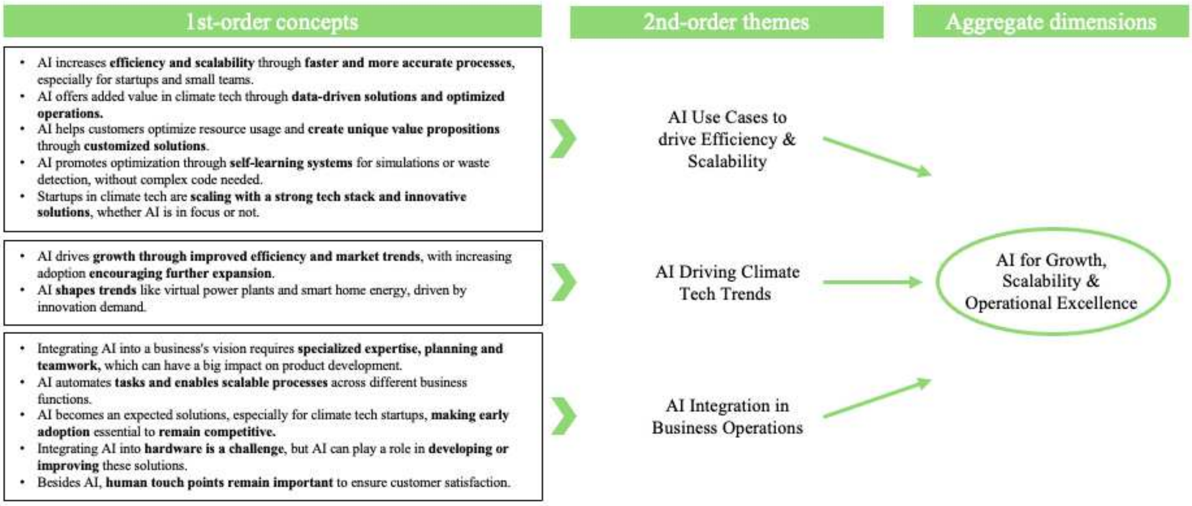

Figure 7: Data Structure first Climate Tech Startups Aggregate Dimension

4.4.1 AI Use Cases to drive Efficiency & Scalability

The findings highlight that AI serves as a key driver for efficiency and scalability in climate tech startups by improving operational processes and enabling innovative solutions. Throughout all interview partner mentioned AI's ability to streamline workflows, automate tasks, and facilitate scalability across various business functions. For instance, IP 8) stated, *"AI is super important because it takes so much off our hands",* underscoring the reduction in workload achieved through AI-driven tools.

Various startups mentioned that AI often forms the key component of their solutions by enabling data-driven approaches. IP16) highlights: "*Our USP is essentially based on the AI that* *we also develop"*, allowing the company to offer unique value propositions. Expanding on this, they explained how their AI enables them to consistently offer customers the cheapest and cleanest electricity, highlighting the role of AI in creating measurable benefit for consumers. Besides, AI enhances customer-facing solutions by enabling resource optimization and delivering unique value. One Startup partner shared how its AI system allows customers to become active participants in the energy market without relying on traditional energy providers:

> *"Through AI, it is [...] possible for the customer to [...] participate in the energy market themselves and no longer depend on [...] an energy provider, because they effectively become the energy provider"* (IP9).

Moreover, AI-powered Virtual Power Plants (VPP) were described as innovative way where these systems represent *"a major milestone because [...] if we do it right, the customer can [...] earn money with us and doesn't have to spend any"* (IP9).

AI's ability to support scalability was another highlighted point. Different startups described AI as crucial for managing complex tasks and processes that would otherwise be unfeasible. IP15) points out:

> "*For it to scale and keep [...] the asset specificity, you have to mix and match [...] things that otherwise without these tools you will not be able to"*.

Moreover, the adaptability of AI also applies to its self-learning capabilities by optimizing simulations and detecting inefficiencies, described by IP17): *"You have to simulate how the forest will develop and for that, we work with a lot of data that flows into the machine learning algorithms"*.

These various applications indicate AI's ability to address complex operational challenges in climate tech through its adaptive and data-driven methods. While AI is of central relevance for most startups, the results mention that the success depends on the underlying technological infrastructure. In this context IP13) mentioned the importance of a strong tech stack: *"I believe, and I see this specifically in our case, that if the tech stack of a company is not good, it cannot scale well"*. Furthermore, it is highlighted that while AI drives scalability, non-AI solutions are still competitive if they offer robust innovation: *"I don't think that startups working with AI scale better than others with a really good idea that doesn't use AI"* (IP13).

4.4.2 AI Driving Climate Tech Trends

The emerging trends in climate tech are increasingly influenced by AI, which most interview partners described as a key driver of innovation and market growth. Thereby, AI not only supports operational improvements, but actively shapes technological advances in the industry. One startup described AI as an "accelerator for the market, for growth" and underlines its role in enabling more efficient solutions and encouraging the expansion of the sector (IP9).

As AI adoption grows, its influence on market trends is becoming more pronounced. IP9) highlighted how the increasing acceptance of AI creates a positive feedback loop of growth and innovation "*The faster AI grows, the more acceptance it gains, which leads climate tech to use it more and this brings additional factors into play"* (IP9).

Specific trends, such as the rise of VPP, indicate the impact AI has. In solar energy, one participant predicted: *"In the solar sector, I believe many will jump on the virtual power plant solution"* (IP9). Furthermore, IP17) remarked the growing excitement around AI, saying: "*There is currently a certain hype, but also a wave of innovation coming from AI, and naturally, there is a certain demand on the climate tech side"*. Another expressed optimism about the potential of AI and climate tech to grow, saying: "*I definitely see the possibilities as good because I believe that the market volume will grow significantly"* (IP13).

4.4.3 AI Integration in Business Operations

The integration of AI into business operations emerged as a critical topic as interviewees highlighted its growing importance in startups. Several startups explained that AI is no longer optional and must be considered in modern businesses. This is underlined by the statement of IP8):

> *"You always have to [...] consider everything, and I think that will remain. Whether you base your business model on AI, support it or choose not to, you have to consider it".*

Building on this, the same interviewee predicted that AI will become indispensable in business within the next ten years, leaving no way around it (e.g. IP8). Additionally, IP17) mentions: *"when we use software today, we almost expect it to have some kind of AI component",* which indicates that AI tools are increasingly expected in business solutions.

Startups are using AI in various areas of their business. For example, language models were mentioned for their strong impact in areas like sales, marketing campaigns and general operations: *"Whether in sales, writing proposals, creating marketing campaigns or simply in the* *operational side of the business, language models are very helpful"* (IP11). This integration of AI enables startups to scale their processes and remain competitive in a demanding market. As one startup stated: *"The impact of AI on a company and the scalability of processes is incredible that I don't think you can keep up with conventional methods"* (IP8).

Although AI is widely used in operational processes, integration with hardware solutions in in climate tech is a challenge. IP9) explained: *"Climate tech is very much tied to hardware solutions, and making the connection is, I believe, not so easy"*. They further mentioned: *"because hardware is so solution-driven, it's the most challenging part for AI and climate tech*" (IP9). Another IP highlighted AI's potential to drive or even create hardware solutions, saying: *"AI could or will perhaps become very relevant in defining or inventing a hardware component"* (IP12). Moreover, alongside the challenges of integrating AI with hardware solutions in climate tech, IP9) mentioned the need to balance technology with human interaction: *"Our customers still need a lot of human touchpoints to feel happy and cared for",* reinforcing the ongoing relevance of human relationships along with AI-driven automation.

4.5 Market Growth in Climate Tech

This aggregated dimension highlights market growth drivers in climate tech, focusing on AI attracting funding, startup differentiation and the impact of regulatory and market trends (figure 8). The findings show how AI has become a key factor in securing investment, alongside the EU's regulatory framework and focus on sustainability.

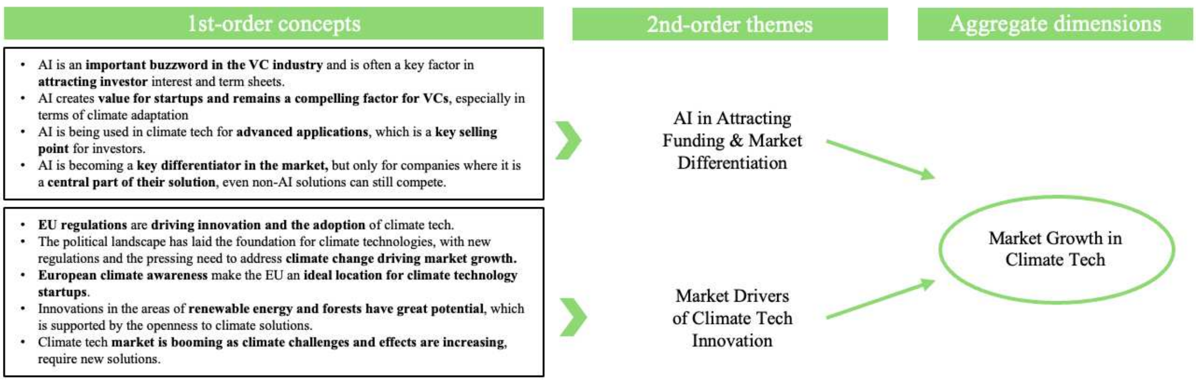

Figure 8: Data Structure second Climate Tech Startups Aggregate Dimension

4.5.1 AI in Attracting Funding & Market Differentiation

The role of AI in raising funding and differentiating climate tech startups emerged as a common theme in the interviews. Startups highlighted that AI has become a key factor for VCs and is an important keyword in the industry. IP8) noted:

"In VC, it's still one of the biggest keywords. It means that if you're not doing anything with AI in certain cases, even in climate tech, it's difficult".

IP12) talked about how the rise of tools like ChatGPT has further increased the appeal of AI:

"When we raised our pre-seed round, ChatGPT was just popular. I think everyone was scrambling for the AI tag and were excited to see it in the pitch deck".

However, the value proposition of AI goes beyond the hype, as participants pointed out that it can be powerful in attracting investors. Although AI is not essential for every business model, its presence can increase the attractiveness of a startup for VCs. In this context, IP17) mentioned:

"Our company or business model would also work without AI and VCs would probably still invest. But it is definitely a factor that strengthens the whole package".

Another startup added: *"One of the most selling points for all the VCs that offered us term sheets was this AI part that we are trying to develop for the future"* (IP15).

Furthermore, specific AI applications, such as its role in climate adaptation or technologies like VPP, were highlighted as key selling points. IP9) saying: "*On the investor side, I think VPP is a key argument, a key selling point for investors"*. However, startups emphasized that while AI can be a crucial differentiator, its impact depends on meaningful integration into a startup's solution:

"Throwing the word AI around doesn't work anymore. Only the right startups, where AI is truly a core element, will benefit from being called an AI startup" (IP12).

4.5.2 Market Drivers of Climate Tech Innovation

The growth of climate tech startups is not only driven by investors, but also through a combination of the regulatory framework, increasing climate awareness and the urgent need for sustainable solutions. IP11) highlights: *"The market will massively boom, not only because climate challenges are becoming more urgent, but also because additional regulations are being introduced"*. This was further supported by IP17): *"The foundations for climate tech and combating climate change were clearly set in the past, so this is now where the development is taking shape"*. Moreover, Europe's strong focus on sustainability and climate awareness makes it a leading center for startups in climate tech:

"In Europe, climate awareness is higher than, for example, in America or China. I believe Europe is an even better location for climate tech startups compared to other countries" (IP9).

Certain climate tech sectors, such as renewable energy and forestry, were highlighted as important emerging opportunities. As IP10) said: *"Renewable energy or innovative technologies in forestry can bring huge benefits"*, while another mentions the openness to new ideas: *"Overall, we see a great openness to technologies and climate technologies"* (IP12).

4.6 Balancing AI Implementation in Climate Tech

This last aggregated dimension addresses the main challenges that climate tech startups face in adopting AI and possible approaches to overcome them (figure 9). The findings highlight the constant need for system refinement, the data quality and the energy consumption of AI technologies. Further, the outcomes show the need for employee training and expertise across different business functions to fully integrate AI into operations.

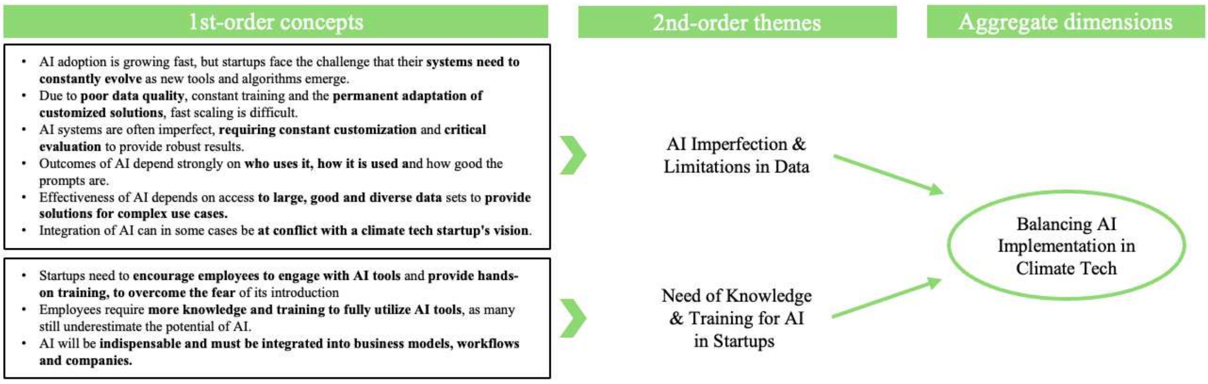

Figure 9: Data Structure third Climate Tech Startups Aggregate Dimension

4.6.1 AI Imperfection & Limitations in Data

The adoption of AI in climate tech brings several complex challenges that startups need to overcome to realize its full potential. During the interviews, it emerged the need for constant development, as a main challenge. IP8) explained:

"You don't go and launch your AI and suddenly it changes the whole world, [...]. So, you always have this level of imperfection that you have to deal with".

This is suggesting that these evolving systems require continuous updates as new tools and algorithms emerge, making their integration a persistent challenge for startups. Moreover, IP8) highlighted the need to critically assess and improve existing AI systems:

"You have to face the challenge that not everything is perfect. AI has to grow and adapt with you."

This indicates the need for AI solutions to keep in line with organizational as well as technological developments. Despite these efforts, AI-generated results are not exempt from errors. As IP8) continued: "*Sometimes our AI co-pilot's answers are still wrong or inaccurate*", showing the importance of further improving and overseeing AI systems to reduce errors and increase their reliability.

Another challenge is the low data quality and accessibility to develop robust AI applications. IP8) mentions:

"AI could already have a much greater impact, even in the climate tech sector, but the data quality is still super poor. If you input bad data, you get bad results, and ultimately, there's no benefit".

In addition, the extent of individual adaptations required was mentioned as a challenge. IP13) explained: *"Every plant has different requirements, so we can't just sell the same product every time, we have to retrain the AI for each customer."* This demonstrates the need for individualized approaches complicates scaling efforts and increases the time required for implementation.

Besides, the energy demand of technologies such as large language models represent a challenge for sustainability efforts. IP8) pointed out: *"The energy consumption of data centers will increase [..] in the coming years"*. This challenge poses a potential conflict between the integration of AI and the goals of a climate tech startups. As IP17) remarked: "*That is a difficult point because, in climate tech, it can sometimes run counter to the vision of the startup"*. This statement demonstrates the difficulties that climate tech startups face in implementing AI as they need to ensure that their application is sustainable and in line with core values.

4.6.2 Need of Knowledge & Training for AI in Startups

In this section, the findings show that knowledge and training are essential for the effective adoption of AI in startups. Several IPs pointed out that employees often lack a comprehensive understanding of the potential of AI, making training important. One startup explained that in smaller startups, it is particularly important to encourage employees to engage with AI tools, saying: *"Especially as a smaller startup [..], I think you have to encourage your employees to engage with it and use it"* (IP12). Based on that, they also added that "*there also needs to be appropriate teaching, like a kind of 'how-to' for employees"* (IP12), indicating the combined need for support and training guidelines to encourage effective AI integration. The effectiveness of AI tools was described as highly dependent on the expertise of the user and the way AI is applied *“it depends so much on who uses it, how they use it, and how it’s prompted”* (IP8). This connection between the user's skills and AI performance further highlights the importance of user-specific training.

Another startup highlighted the importance of skilled teams mentioning: *“Without the idea, knowledge, and amazing people on our team who dedicate hours to figuring out how to use AI in the backend of our tool, we wouldn’t be where we are today”* (IP15), showing the role of expertise in optimizing the AI potential of startups. The integration of domain-specific knowledge with technical expertise was identified as a challenge, particularly in industries like climate tech. IP15) further explained: *“You need someone specialized in asset knowledge, climate change topics, and climate science to understand the weather effects, to train a model, and then coordinate between our climate circle and tech circle”,* suggesting the need of understanding specific use cases along technical skills.

5 Discussion

This study explores the role of AI-driven growth in shaping the development of climate tech startups, focusing on perspectives from key ecosystem stakeholders, including VCs and climate tech startups. It examines how AI integration influences investment decisions, scalability as well as operational efficiency. The findings reveal that AI is widely perceived as a key driver of growth and innovation within the climate tech sector, enabling a better scalability, improved operational processes and the development of innovative solutions (figure 10).

In this context, two research questions were of central importance for this thesis. *(1) How does the integration of AI in climate tech startups influence the investment criteria and decisions of VCs?* The findings show that VCs prefer authentic and meaningful AI integration. Startups can use AI to optimize processes, streamline products and build similar products with less employees (e.g. IP7). Despite the current hype around AI, VCs recognize the real potential to drive innovation, increase efficiency and make startups more attractive to investors by advancing research and operations. This is consistent with the findings from the literature, which underline the high level of investment, with AI becoming one of the main investment sectors worldwide (Dealroom.co, 2024a; Teare, 2024). It is important to mention here that the primary objective, especially within climate tech, is still to mitigate climate change. Therefore, climate solutions that are not based on AI but effectively address critical problems are not necessarily excluded from getting funding.

(2) How do climate tech startups perceive the role of AI in scaling their operations and attracting funding? The findings for climate tech startups highlight their strong awareness of the immense opportunities AI offers, enabling them to achieve their goals more quickly and cost-effectively in both daily operations and technology development. This improved efficiency allows startups to operate leaner, improve productivity and remain competitive, which aligns with studies highlighting AI as a key focus of current investment trends (Dealroom.co, 2024a; Knight et al., 2020). At the same time, startups acknowledge the challenges of AI's rapid advancements, points out the need for continuous employee training to fully utilize the potential of AI in their companies (e.g. IP8, IP15).

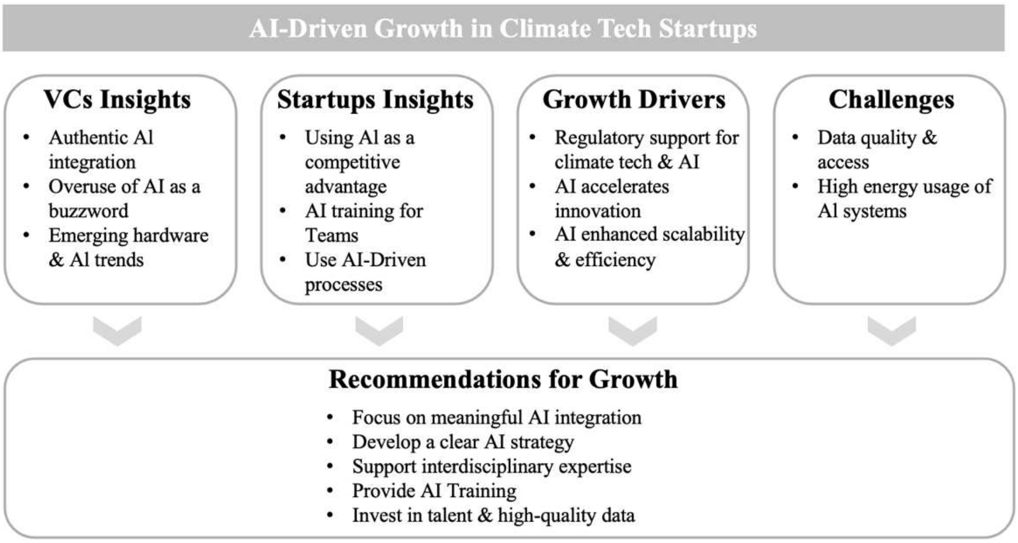

Figure 10: Overview Findings of this Thesis

Based on the research the next section explores the broader implications of the findings in more detail. It examines how these findings contribute to existing theories, while addressing new topics and challenges in integrating AI into climate tech startups.

5.1 Interpretation & Theoretical Contributions

Driving Innovation & Scale Through AI

The literature on startup ecosystems highlights the importance of innovation, agility, and stakeholder collaboration to drive growth and scalability (Bala Subrahmanya, 2022; Baron & Harima, 2019). This thesis builds on these insights by demonstrating how AI acts as a central driver connecting these ecosystem elements, particularly in climate tech startups. AI enhances operational efficiency, accelerates innovation cycles, and optimizes resource allocation, aligning with prior research on its role in improving decision-making and scalability (Cavallo et al., 2024; Korzynski et al., 2023). IPs from VCs and startups (e.g., IP3, IP7, IP11) confirmed AI's contribution to scaling operations and creating unique value propositions, reinforcing existing literature on the role of AI in driving competitive advantage and addressing emerging market needs (Jeong et al., 2020; Kohler, 2016).

The findings demonstrate that AI streamlines operations, enhances testing processes, and accelerates product-market fit. VCs (e.g. IP4, IP5) pointed out that AI improves prototyping, shortens testing times and enables climate tech companies to efficiently develop solutions like material science and energy management tools, which accelerates the overall development of the startup. This aligns with previous literature, which considers innovation, agility and collaboration to be essential in the transition and development of a startup (Picken, 2017b; Singh & Mungila Hillemane, 2023). The results presented expand the understanding by showing the potential of AI to address complex challenges in the climate sector, and its essential role in overcoming barriers to scale and improving efficiency.

Venture Capital & Funding Dynamics for Startups

VCs are interested in startups that integrate meaningful AI into their existing solutions and provide scalability, efficiency and differentiation. Several VCs (e.g. IP4, IP7), prefer companies that authentically incorporate AI into products and processes, highlighting value of a true AI application (Cowls et al., 2023; Knight et al., 2020). Moreover IPs (e.g. IP3, IP4, IP7) pointed out a growing skepticism towards superficial AI implementations, for example the use of generic tools like ChatGPT not adding value on their own. Instead, startups should build their own AI and integrate it into their products, processes and services.

In addition, this research identifies a growing interest in hardware solutions combined with AI (IP7), question the earlier tendencies towards asset-light models due to their scalability and lower risk (Kulkov, 2023; Morton & Iglesias Ruiz, 2024). This shift points to the increasing acceptance towards the potential of hardware combined with advanced analytics to deliver measurable climate solutions and more efficient scaling options, making it an attractive investment.

Regulatory incentives, such as the European Green Deal, are further influencing VC behavior by creating demand for compliance-driven innovation (European Parliament, 2023; Pan & Liu, 2024). Startups using AI for their climate tech solutions, like emissions monitoring and others, are closely related to these trends and are positioning themselves as attractive candidates for funding in an increasingly competitive investment landscape (Dealroom.co, 2024b; Horbach & Rammer, 2025).

Overcoming Limitations & Advancing the Use of AI

While the potential of AI in climate tech is generally recognized, certain challenges limit its effective implementation. One highlighted challenge is data quality, as low-quality or inconsistent datasets reduce the reliability of AI models. Both VCs and startups (IP2, IP8) stressed the importance of high-quality, context-specific data for accurate environmental analyses. This aligns with Cowls et al. (2023) but extends the discussion by highlighting the increased complexity for climate tech startup, where reliable data is essential for applications like emissions forecasting and energy optimization.

In addition, another challenge is the tension between the energy consumption of AI and sustainability goals of climate tech. Especially startups (IP8, IP17) expressed concerns about the carbon footprint of AI-driven data centers, which is also discussed within the literature (Perucica & Andjelkovic, 2022). This highlights the need for sustainable AI practices, for example the use of renewable energy to power AI infrastructure, an area that has been under-explored in previous research.

Additionally, VCs and startups (e.g. IP3, IP4, IP12) mentioned skepticism about the overuse of AI as a buzzword and again highlight the importance of meaningful applications, e.g., custom AI models adapted into processes like climate mitigation and energy management. This criticism is in line with Cowls et al. (2023), who warns about the superficial AI integrations which tend to detract from its value.

5.2 Managerial Implications

For climate tech startups, a clear and well-defined AI strategy is a key differentiator and a powerful selling point for VCs (e.g., IP4, IP8, IP9). Rather than simply using "AI" as a buzzword in pitch decks or websites, startups should prioritize high-quality data, robust models, and specialized teams combining technical, climate-specific, and business expertise. This approach helps them to address complex market challenges, accelerate innovation, attract investors through meaningful differentiation, and scale effectively in a competitive environment (e.g., IP2, IP4, IP12, IP15).

From the VC perspective, the findings provide guidance on evaluating AI-driven climate tech startups. Investors should look beyond the "AI" label and evaluate the authenticity of model development, the quality of underlying data and the strategic integration of AI into product roadmaps (e.g., IP4, IP7). By focusing on the depth and substance of AI applications, VCs can better identify startups capable of achieving sustainable competitive advantages. Further, they can encourage portfolio companies to explore specific AI solutions directly applicable to their technologies, ensuring both climate impact and financial returns are maximized.

At the management level, startups should bring AI experts together with climate scientists, engineers, and operations specialists to ensure continuous improvement and adapt to rapidly changing policies and markets. Similarly, VCs can provide targeted support by offering access to AI mentors, preferred partnerships with data providers, and comprehensive training. Both stakeholders should also ensure AI training across all business areas, including solutions and daily operations, to improve workflows and drive advancements at every level of the organization.

6 Conclusion

This thesis explores the role of AI in driving growth and scalability in climate technology startups, focusing on the perspectives of startups and VCs. The findings show how AI increases operational efficiency, accelerates innovation and improves the ability of startups to attract investment. The findings highlight AI as a transformative tool that helps startups overcome market challenges, develops breakthrough solutions, drives innovation in climate technology and drives growth.

The qualitative methodology used in this study involved semi-structured interviews with 17 startup ecosystem participants. This approach allowed a detailed exploration of the perspectives and experiences of both startups and VCs. Using the Gioia Method ensured systematic analysis and the identification of key themes. The findings show that AI has the potential to accelerate innovation and growth in the climate sector, even if its implementation is associated with challenges such as data quality, integration complexity, sustainability compromises and fast progress.

Besides these valuable insights, it is important to recognize the limitations present in this study. The sample, which focuses primarily on stakeholders from German-speaking countries, may not fully reflect the broader European or global landscape of AI-driven climate tech startups. Moreover, the reliance on qualitative data limits the generalizability of the results. As both AI and climate tech are still evolving, the findings may of course change as the sector develops.

Since the study focuses primarily on strategic and operational aspects of AI implementation, it does not address the technical details or environmental costs of AI adoption.

To build on these findings, future research could examine the intersection of AI and climate tech on an international or global scale. Quantitative studies could confirm the trends identified earlier and provide more complete insights into the financial performance and scalability of AI-driven startups. Additionally, longer-term studies could monitor the evolution of AI integration over time, in response to regulatory changes and technological advances. Further, more in-depth investigation of sustainable AI practices, like reducing the energy consumption of AI applications through data centers powered by renewable energy, would be critical to address important environmental concerns. To fully realize the potential of AI in addressing climate change and advancing climate solutions, continuous research is essential to follow this fast-paced movement of AI. As this research highlights, AI is evolving rapidly, and *"the potential is immense, because climate change is the most pressing issue of our generation, the use of AI is particularly important in achieving better goals"* (IP4).

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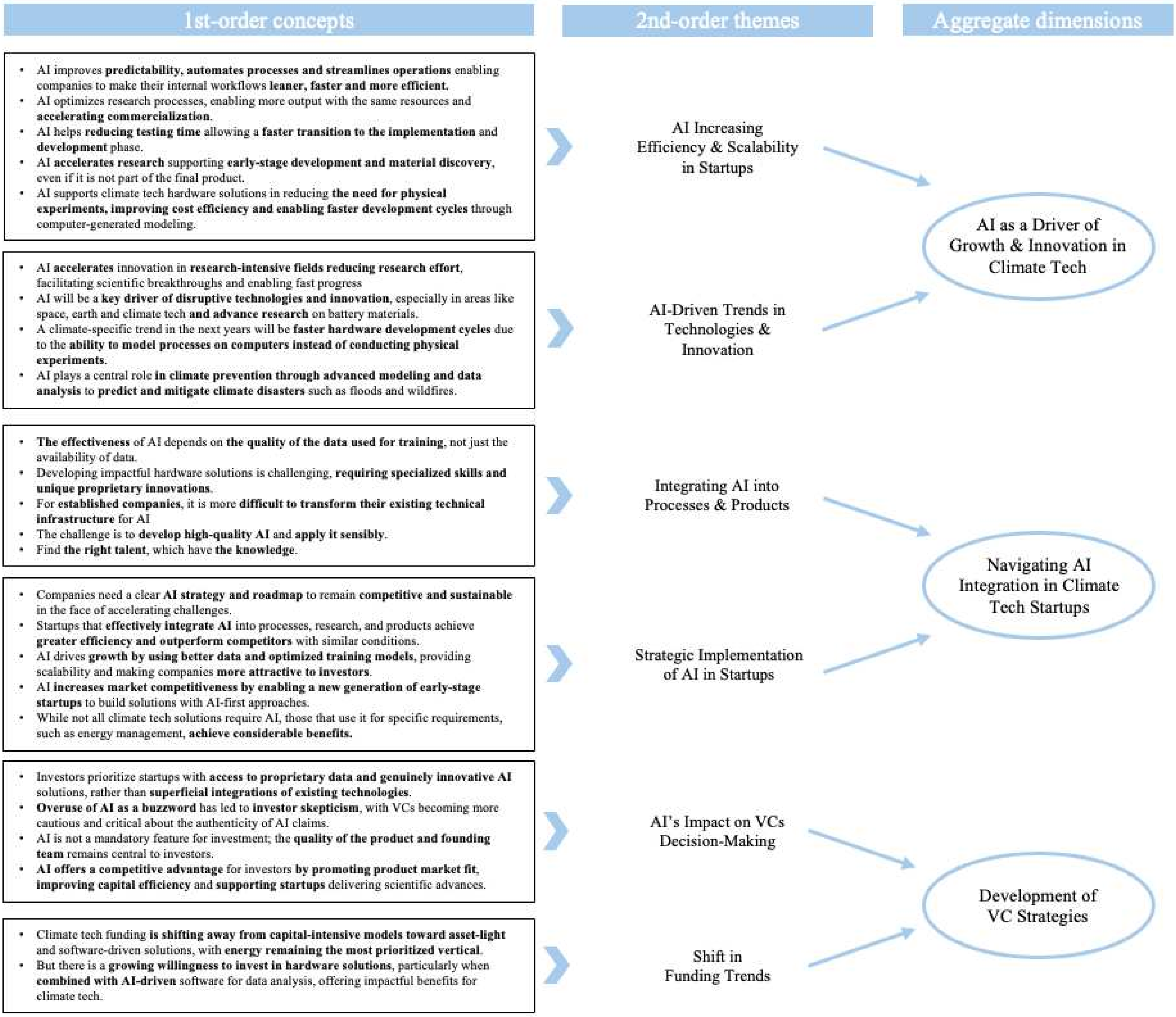
Appendix

Appendix A): Stakeholders and Their Role in the Ecosystem

	Startup Ecosystem Stakeholders	Role in the Ecosystem
1	Startup	A startup is a young company in the early stages of its development, characterized by a focus on innovation, high growth potential, and scalability. Startups are typically defined by technology-intensive business models, a significant level of risk, and a strong reliance on external funding (Battistella 2017, Skawińska & Zalewski, 2020).
2	Venture Capitalist (VCs), angel investors, corporate funding	Investors providing startups with the relevant financial capital or funding in order to drive the starups business and growth (Ziakis et al., 2022).
3	Incubators and Accelerators	These programs aid early-stage startups, with incubators offering long-term support like office space and mentoring, while accelerators focus on short-term, intensive preparation for investment or market entry (Ziakis et al., 2022).
4	Government	Promoting high-risk areas that the private sector avoids, removing bureaucratic barriers, destigmatizing failure and creating a conducive legal framework. (Ziakis et al., 2022).
5	Universities	Fostering knowledge transfer directly and indirectly through entrepreneurship education and promoting related research (Ziakis et al., 2022).
6	Other companies	Experienced entrepreneurs, industry experts, and advisors can provide startups with valuable guidance and support. This assistance often takes the form of personalized mentoring, workshops, and training programs (Ziakis et al., 2022).

Appendix B): VC Gioia Method Overview



Appendix C): Climate Tech Startups Gioia Method Overview

1st-order concepts	2nd-order themes	Aggregate dimensions
• AI increases **efficiency and scalability** through **faster and more accurate processes**, especially for startups and small teams. • AI offers added value in climate tech through **data-driven solutions and optimized operations.** • AI helps customers optimize resource usage and **create unique value propositions** through **customized solutions**. • AI promotes optimization through **self-learning systems** for simulations or waste detection, without complex code needed. • Startups in climate tech are **scaling with a strong tech stack and innovative solutions**, whether AI is in focus or not.	AI Use Cases to drive Efficiency & Scalability	AI for Growth, Scalability & Operational Excellence
• AI drives **growth through improved efficiency and market trends**, with increasing adoption **encouraging further expansion.** • AI **shapes trends** like virtual power plants and smart home energy, driven by innovation demand.	AI Driving Climate Tech Trends	AI for Growth, Scalability & Operational Excellence
• Integrating AI into a business's vision requires **specialized expertise, planning and teamwork,** which can have a big impact on product development. • AI automates **tasks and enables scalable processes** across different business functions. • AI becomes an expected solutions, especially for climate tech startups, **making early adoption** essential to **remain competitive.** • Integrating AI into **hardware is a challenge**, but AI can play a role in **developing or improving** these solutions. • Besides AI, **human touch points remain important** to ensure customer satisfaction.	AI Integration in Business Operations	AI for Growth, Scalability & Operational Excellence
• AI is an **important buzzword in the VC industry** and is often a key factor in **attracting investor** interest and term sheets. • AI creates **value for startups and remains a compelling factor for VCs**, especially in terms of climate adaptation • AI is being used in climate tech for **advanced applications**, which is a **key selling point** for investors. • AI is becoming a **key differentiator in the market,** but only for companies where it is a **central part of their solution**, even non-AI solutions can still compete.	AI in Attracting Funding & Market Differentiation	Market Growth in Climate Tech
• **EU regulations** are **driving innovation and the adoption** of climate tech. • The political landscape has laid the foundation for climate technologies, with new regulations and the pressing need to address **climate change driving market growth.** • **European climate awareness** make the EU an **ideal location for climate technology startups.** • Innovations in the areas of **renewable energy and forests have great potential**, which is supported by the openness to climate solutions. • Climate tech **market is booming as climate challenges and effects are increasing**, require new solutions.	Market Drivers of Climate Tech Innovation	Market Growth in Climate Tech
• AI adoption is growing fast, but startups face the challenge that their **systems need to constantly evolve** as new tools and algorithms emerge. • Due to **poor data quality**, constant training and the **permanent adaptation of customized solutions**, fast scaling is difficult. • AI systems are often imperfect, **requiring constant customization** and **critical evaluation** to provide robust results. • Outcomes of AI depend strongly on **who uses it, how it is used** and how good the prompts are. • Effectiveness of AI depends on access **to large, good and diverse data** sets to **provide solutions for complex use cases.** • Integration of AI can in some cases be **at conflict with a climate tech startup's vision.**	AI Imperfection & Limitations in Data	Balancing AI Implementation in Climate Tech
• Startups need to **encourage employees to engage with AI tools** and **provide hands-on training, to overcome the fear** of its introduction • Employees require **more knowledge and training to fully utilize AI tools**, as many still underestimate the potential of AI. • AI will be **indispensable and must be integrated into business models, workflows and companies.**	Need of Knowledge & Training for AI in Startups	Balancing AI Implementation in Climate Tech