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**Scaling Sustainable Start-ups:
Barriers and Enablers in Financing in Europe**

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Abstract

This thesis examines barriers and enablers of scaling sustainable start-ups in Europe across regulation, financing, and talent. Building on a structured literature review and 15 semi-structured interviews with founders, venture capitalists, and sustainable industry experts, it shows how regulation in form of administrative burdens and policy volatility slow market adoption, while well-designed policies can create demand niches. Findings also reveal a persistent funding gap and the need for blended finance mechanisms. Finally, purpose attracts talent, but retention depends on mission execution and clear people structures. It derives actionable implications for founders to enable resilient growth during the scaling phase.

Keywords: *Sustainable start-ups, venture scaling, scale-up barriers, scale-up enablers, regulatory barriers, policy uncertainty, public grants and subsidies, scale-up funding gap, impact investing, talent attraction and purpose-driven motivation*

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List of Abbreviations

AI	Artificial Intelligence
CSR	Corporate Social Responsibility
EIB	European Investment Bank
ESG	Environmental, Social and Governance
EU	European Union
GHRM	Green Human Resource Management
HR	Human Resources
OECD	Organisation for Economic Co-operation and Development
SME	Small and Medium-sized Enterprise
TBL	Triple Bottom Line
VC	Venture Capital

1 Introduction

Start-ups have become crucial actors in Europe's green transition, particularly sustainability-oriented ventures that embed environmental and social objectives into their business models (Hirschfeld 2025). Although these firms carry significant potential to drive decarbonisation and structural change across energy and mobility sectors, many struggle to overcome the scaling gap, which is the transition from early-stage experimentation to broad market adoption (Ahmed 2025). Understanding what enables sustainable start-ups to scale, and what barriers inhibit that process, is therefore essential for strengthening Europe's capacity to meet its climate and innovation ambitions. Sustainable start-ups are understood here as ventures that embed environmental and/or social objectives into their core business model, beyond compliance (Hockerts and Wüstenhagen 2010).

The initial motivation for this thesis emerged from the case of Enpal, one of Europe's fastest-growing green-tech ventures. Founded in 2017, Enpal introduced a no-upfront-cost rental model for residential solar systems and later expanded into heat pumps and integrated home-energy services. This business model, combined with strong demand for decentralised renewable energy solutions, enabled exceptionally rapid growth. In 2023, the company secured more than €5 billion in financing commitments and pioneered Europe's first green asset-backed securitisation for residential solar portfolios (McKinsey & Company 2022; Radke n.d.; Schmitz-Normann 2022). Enpal also raised more than €200 million in additional growth funding in 2023, underlining how innovative financing structures can enable rapid scaling in hardware-based green ventures (Tech Funding News 2023).

At the same time, Enpal's trajectory surfaced critical tensions and risks associated with rapid scaling. Media reporting documented customer dissatisfaction, operational backlogs, and strains within partner networks (Stern 2023). More seriously, investigative reports raised allegations of precarious working conditions among subcontracted labour, revealing how fast organisational expansion can challenge internal sustainability, governance practices, and ethical

standards. These contradictions, rapid green-tech expansion on one hand, and organisational or social frictions on the other, indicate that scaling extends beyond growth and involves a tension between external scale enablers and internal organisational sustainability. For more detailed information on Enpal, please see Appendix A.

Prior research has explored elements of sustainable entrepreneurship, noting that start-ups dedicated to environmental and social goals are essential for introducing new sustainable pathways within economies (Lee et al. 2025). Systematic reviews highlight gaps in understanding external actors and government support in sustainable start-up ecosystems, suggesting that integrative perspectives on regulatory, financing, and talent barriers remain underdeveloped. To address this gap, this thesis examines regulatory conditions, financing structures, and talent attraction in depth by identifying the key barriers and enablers that shape scaling trajectories for sustainable ventures in Europe.

Empirically, this study draws on 15 semi-structured interviews with founders, investors, and industry experts across Europe. Using Mayring's (2000) qualitative content analysis, the research systematically codes and interprets interview data to identify recurring patterns and underlying mechanisms reported by practitioners. It then translates these insights into actionable implications for resilient growth during scaling. The findings show that scaling barriers for sustainable start-ups are largely structural and arise from the interaction of regulation, financing, and talent dynamics. In the regulatory domain, administrative complexity and policy instability emerge as the most significant barriers, slowing market adoption and increasing uncertainty, while stable and coherent policy frameworks act as key enablers by creating predictable demand conditions. In financing, the analysis reveals a persistent mismatch between asset-heavy sustainable business models and traditional venture capital instruments, leading to liquidity constraints during scaling. Blended financing models and strong credibility signalling toward investors are identified as central mechanisms for overcoming this gap. Regarding talent attraction, sustainable start-ups benefit from strong mission alignment and

purpose-driven motivation, which supports recruitment despite limited financial resources. However, retention is constrained by organisational capacity and underdeveloped people structures, often reflected in limited role clarity, inconsistent onboarding, and unclear ownership of people-related responsibilities. Overall, the research highlights that successful sustainable scaling requires aligned regulatory stability, suitable financing structures, and proactive organisational governance.

2 Literature Review Protocol

This thesis employs a literature review protocol to ensure transparency, replicability and the conceptual rigor in examining how sustainability oriented start-ups scale. The review follows a structure of inclusion and exclusion criteria, focusing on peer-reviewed and high quality academic literature, as well as grey literature. Eligible studies examined ventures that comply with the Triple Bottom Line (TBL) and discussed scaling or growth processes. The searches were conducted across renowned academic databases, e.g., Elsevier, Google Scholar, SSRN and Research Gate, using combinations of terms such as “sustainable start-ups”, “green venture scaling” and “growth barriers”.

A two-stage screening process ensured that quality and consistency was maintained. Titles and abstracts were first reviewed for eligibility, followed by a full-text assessment. Further, data extraction captured study characteristics, contexts, methodologies and identified scaling barriers and enablers. For further insight into the proceedings for the literature review, please refer to the complete Literature Review Protocol in the Appendix B.

3 Literature Review

The following literature review is structured by clarifying the conceptual foundations of sustainable start-ups, their scaling pathways and the core structural factors that shape their growth. Building on this, it synthesises the main barriers and enablers identified in the literature, before organising these insights around the three core thematic blocks of this thesis: policies

and regulation, financing and funding, and talent attraction and culture. This structure allows for a detailed examination of the existing academic discourse on the challenges and enablers for sustainable start-ups as they scale.

3.1 Conceptual Foundations

The subsequent analysis of barriers and opportunities requires a clear understanding of the foundational concepts. Therefore, this section defines the key terminology of sustainable start-ups and explores the specific scaling pathways and growth models relevant to these ventures.

3.1.1 Terminology of Sustainable Start-ups

A sustainable start-up is generally defined as a new venture that embeds social and environmental objectives alongside financial goals from its inception. Such ventures are often described as “born-sustainable” for pursuing a triple bottom line, i.e. creating economic, social, and environmental value, as a core mission (Carle and Rayna 2024; Martins de Souza 2024, Puglieri, and de Francisco 2024). In the literature, closely related terms such as green start-ups and social enterprises are sometimes used, but with narrower emphases: green start-ups focus primarily on ecological innovation, while social enterprises prioritize social value creation. In contrast, sustainable start-ups explicitly integrate both environmental and social objectives alongside economic viability from the outset, positioning them as distinct within the broader family of mission-driven ventures (Hockerts and Wüstenhagen 2010; Tiba, van Rijnsoever, and Hekkert 2021). For the purpose of this thesis, sustainable start-ups are understood as early-growth ventures that integrate environmental and social objectives alongside financial viability as explicit, measurable components of the business model. Ventures that frame sustainability only as peripheral Corporate Social Responsibility (CSR) activity or post hoc reporting, without material implications for value creation, product design, or strategic decision-making, are not treated as sustainable start-ups within this conceptual scope.

3.1.2 Scaling Pathways and Growth Models in Start-ups

Scaling in start-ups refers to the deliberate process of increasing reach, output, or impact through efficient resource leverage, typically by replicating a validated model or expanding operations without proportional increases in cost (Palmié et al. 2023). It implies not just growth, but efficient and systematized growth, where outputs such as revenue or customer reach increase faster than inputs like labor or capital.

For start-ups rooted in the TBL, integrating economic, environmental, and social objectives, scaling is understood as amplifying mission-aligned impact while achieving operational growth. The goal is not merely to become larger or more profitable, but to extend the venture's ability to deliver sustainable value across all three dimensions in tandem (Hultberg and Pal 2023). In contrast to conventional scaling logics that prioritize rapid financial expansion and efficiency as primary success criteria, TBL scaling requires that growth trajectories preserve or deepen environmental integrity and social contribution alongside economic performance. This requires designing scale-up strategies that maintain environmental integrity and social contribution as the firm expands. Accordingly, impact measurement becomes a core element: TBL scaling is evaluated not only by traditional KPIs but also by the reach and depth of ecological and social outcomes (Panigrahi, Nikou, and Calabretta 2025).

This logic shifts the purpose and mechanisms of scaling. While conventional ventures typically optimize for financial acceleration, TBL start-ups align growth decisions with sustainability performance. Strategic scaling may involve multi-stakeholder partnerships, open business models, or localized adaptations that favor mission fidelity over speed (Shepherd and Patzelt 2022). Thus, scaling becomes a process of extending impact infrastructure, expanding what works without diluting the sustainability ethos. The result is a form of organizational scaling where the venture's footprint and values grow in parallel.

3.1.3 Core Factors Influencing Scaling Processes in Sustainable Start-ups

Building on the definitions of sustainable start-ups and their scaling logic, this thesis understands the scaling process of sustainability-focused ventures as being shaped by a specific set of structural frictions. Sustainable ventures often attempt to correct environmental or social market failures and therefore depend more strongly on public policy, long-lived assets and specialised skills than conventional digital start-ups (Bergset and Fichter 2015; Vermunt et al. 2019). In the academic and policy debate, these characteristics consistently concentrate barriers and opportunities into three interdependent domains: the institutional framework, access to finance and human capital. These domains also mirror the main clusters of challenges identified in recent work on European scale-ups and in the Enpal case discussed above.

First, regulatory and policy interfaces are central because many sustainable business models only become commercially viable once externalities are priced, standards defined or public procurement schemes implemented. Empirical studies on circular and green business models show that regulatory complexity and fragmented policy regimes constitute major external barriers to implementation (Vermunt et al. 2019). Conversely, coherent long-term policies, for instance carbon pricing or green public procurement, can create privileged market niches and accelerate diffusion.

Second, financing emerges as a distinct domain because many climate and sustainability solutions are asset-heavy and require substantial up-front investment in physical infrastructure, pilot plants or hardware (McKinsey & Company 2024). This capital intensity is poorly aligned with traditional venture capital models that evolved around software, contributing to a “scale-up gap” in growth-stage funding for innovative firms in Europe (European Investment Bank 2024). Policy and market reports further describe a “missing middle” in climate-tech financing between early-stage venture rounds and large infrastructure capital (Barclays 2024).

Third, talent attraction and culture form the human-capital pillar of the sustainable scaling challenge. Sustainable ventures require teams that combine entrepreneurial and commercial

competences with domain-specific “green skills”. Yet global labour market data indicate that such skills remain in short supply relative to demand (LinkedIn Economic Graph Research Institute 2023). At the same time, strong sustainability and purpose profiles in companies are increasingly cited by executives as a way to recruit and retain talent (Deloitte 2024).

3.1.4 Start-up Funding

In order to get a better understanding of how financing plays an essential role in the growth scaling of start-ups, the following part will give a brief overview of the funding landscape with regards to funding types, funding barriers and challenges but also opportunities and enablers for start-up scaling.

3.1.4.1 Definition of Funding

In the context of entrepreneurial growth, funding refers to the provision and allocation of financial resources required to initiate, operate and expand a venture (Bessant and Tidd 2015). It encompasses not only the external injections of capital, such as equity investments, accrual or grants, but also makes use of the internal resources deployed by founders to sustain business activities (Mansouri and Momtaz 2022). Funding represents a core resource composition process that enables start-ups to mobilize and deploy capital in seizing opportunities and making use of the competitive advantage (Barney 1991).

For start-ups, in their early stages, funding typically covers product development, market entry and validation. However, in the scaling phase, characterized by market expansion, operational replication, and internationalization, the funding function evolves to include larger capital volumes, structured financing rounds, investor governance and exit strategies (Vyas 2025). For sustainable start-ups following the TBL approach, ventures that integrate environmental and social objectives with financial goals, the definition of funding extends beyond monetary inflows to encompass alignment with mission-driven objectives, stakeholder values and longer-term sustainability horizons (Mukherjee, Owen, et al. 2024). These firms often require patient capital that accommodates longer payback periods and higher technological or market uncertainty (Skala-Gosk et al. 2025)

Thus, funding for sustainable ventures can be understood as the strategic alignment of capital type and structure in regards to the venture's developmental stage, sustainability mission and

ecosystem context. It is not merely a transactional exchange but a process linking financial, social, and institutional dimensions that collectively determine the growth potential.

3.1.4.2 Types of Funding

The typology of funding for start-ups generally includes equity-based and debt-based forms, though sustainable ventures frequently rely on more diversified sources (Miglo 2022). Equity funding involves exchanging ownership for capital through investors such as angels or venture capitalists, while debt funding relies on borrowed capital repaid with interest (L. Zhang, Zhang, and Guo 2019). Sustainable start-ups, facing high uncertainty and capital intensity, often complement these traditional sources with public grants, crowdfunding, and hybrid mechanisms (Gai et al. 2025) Mukherjee, Griffiths, et al. 2024).

At the earliest stages, founders frequently rely on bootstrapping, drawing on personal savings or reinvesting early revenues to maintain autonomy (Brinckmann, Salomo, and Gemuenden 2011). As ventures mature, angel investors provide early equity capital, often combined with mentorship and industry expertise. Angel networks, particularly those with an impact orientation, play a pivotal role in bridging the early financing gap for sustainability-oriented entrepreneurs (Lange, Rezepa, and Zatrochová 2024)

For firms seeking to scale, venture capital (VC) represents a major source of growth financing. VC firms contribute not only capital but also strategic resources such as governance, legitimacy and market access (Gompers and Lerner). However, traditional VC funds often prioritise short-term returns and may not align with sustainability-oriented business models (Mukherjee, Owen, et al. 2024). To address this gap, impact venture capital has emerged, focusing on “double bottom line” performance, financial and social/environmental returns. These funds tend to offer longer investment horizons and greater tolerance for risk in sectors such as renewable energy, circular economy or social innovation (Agrawal and Hockerts 2021; Jeffers et al. 2024)

Debt financing, such as bank loans or convertible debt, becomes more viable as ventures

demonstrate stable revenue streams. However, early-stage sustainable start-ups frequently face challenges in accessing credit due to lack of collateral and uncertain profitability (OECD 2023). In response, green loans and sustainability-linked bonds are gaining prominence as alternative instruments, particularly in Europe, where financial institutions are expanding Environmental, Social and Governance (ESG) focused lending portfolios (European Investment Bank 2025). Additionally, public grants and subsidies play a crucial role, particularly in supporting R&D and commercialization of sustainable enterprises. Government-backed programmes, such as the EU's Horizon Europe initiative, de-risk innovation by funding early-stage experimentation and prototype development (European Commission n.d.). Crowdfunding also provides mission-driven capital from individual supporters, allowing sustainable start-ups to communicate their impact narratives directly to socially conscious investors (Cholakova and Clarysse 2015). Finally, blended finance models, combining concessional public funding with private investment, have gained attention as mechanisms to attract commercial capital to high-impact but higher-risk ventures (European Investment Bank 2024).

In sum, sustainable start-ups typically pursue a hybrid capital structure that evolves with growth, combining grants, equity, debt, and impact investment to balance risk, mission alignment, and scale objectives.

3.2.2.3 Funding Challenges in the Scaling Context for Sustainable Start-ups

Despite increasing awareness and policy support, sustainable start-ups face distinctive funding challenges during the scaling phase (Lee et al. 2025). A core difficulty is the perceived high risk associated with unproven technologies, immature markets and complex regulatory environments (Mukherjee, Owen, et al. 2024). Investors often view sustainability-oriented business models as uncertain due to longer commercialization timelines and limited historical benchmarks (Rizzitello, Piazza, and Perrone 2025). This contributes to the so-called “valley of death”, the funding gap between early-stage grants and large-scale private investment

(European Investment Bank 2024).

Another challenge arises from misaligned investor expectations. Conventional venture investors seek rapid growth and exit opportunities, while sustainable start-ups often prioritise long-term impact over short-term profitability (van den Heuvel and Popp 2023; Y. Zhang et al. 2021). The resulting tension between financial return and impact objectives constrains access to mainstream VC funding (Lih, Sjöström, and Wennberg). This can lead to these ventures having to rely more heavily on public grants or impact-focused investors, which can limit scalability due to smaller capital pools (Dechezleprêtre and Kelly 2025)

Information asymmetry further compounds the problem. Many sustainable start-ups lack standardized impact measurement frameworks or credible ESG metrics, making it difficult for investors to assess risk-adjusted returns (Boiardi 2020). Duve and Marx 2025 note that insufficient transparency and the absence of common reporting standards hinder investor confidence. Moreover, ecosystem immaturity, particularly in emerging markets, limits access to experienced intermediaries who can connect sustainable entrepreneurs with capital providers (Vyas 2025).

Even alternative channels such as crowdfunding face limitations. Empirical studies show that sustainable ventures often attract fewer backers compared to conventional start-ups, partly because their social missions require more elaborate communication to demonstrate value (Calic and Mosakowski 2016). Hence, credibility, transparency and trust-building become decisive success factors in attracting non-traditional funding sources.

Finally, macro-institutional barriers, such as regulatory uncertainty, slow permitting processes and inconsistent green finance taxonomies, discourage large-scale investment in sustainable start-ups (European Commission 2025b). The European Investment Bank highlights that despite progress in green finance regulation, market fragmentation and lack of cross-border investment vehicles continue to constrain funding flows to innovative sustainable ventures.

3.2.2.4 Funding Strategy and Enablers for Scaling Sustainable Start-ups

To address these challenges, both entrepreneurs and policymakers have developed strategic responses and enabling mechanisms. First, mission-aligned investment has emerged as a critical enabler. Start-ups that secure investors sharing their sustainability ethos are better positioned to obtain patient capital and strategic support (Skala-Gosk et al. 2025). Establishing relational trust and clear communication of impact metrics fosters long-term investor partnerships and mitigates misalignment risks.

Second, investment readiness is crucial. Sustainable start-ups that develop credible financial forecasts, measurable impact indicators, and scalable business models are more likely to attract growth-stage capital (Vyas 2025). Entrepreneurial training, mentorship, and accelerators focused on sustainability can enhance readiness and bridge knowledge gaps between founders and financiers (Duve and Marx 2025).

Third, ecosystem development acts as a major enabler. Mature ecosystems, comprising impact investors, accelerators, research institutions and public agencies, reduce transaction costs and create shared standards for evaluating sustainability ventures (Elf et al. 2025; Ziakis, Vlachopoulou, and Petridis 2022) (Bamini et al. 2025). In Europe, public-private partnerships and innovation hubs have been instrumental in connecting sustainable entrepreneurs with specialized funds and corporate partners.

Fourth, blended and innovative finance mechanisms offer structural solutions. By combining public funding, to de-risk innovation, with private capital, to scale impact, blended finance frameworks mobilize larger funding volumes for sustainable enterprises (Cormann and Staur 2025). Similarly, instruments such as revenue-based financing, impact-linked loans, and green venture debt provide flexible alternatives to equity dilution while tying financial returns to social or environmental performance (UNDP 2024).

Lastly, policy and institutional support remain essential enablers. Governments can catalyse

private investment by offering tax incentives, guarantee schemes, and procurement programs for sustainable innovations. Regulatory clarity on ESG standards and sustainable finance taxonomies further strengthens investor confidence (European Commission 2025b). Collectively, these enablers suggest that scaling sustainable start-ups requires a multi-level strategy integrating entrepreneurial capabilities, ecosystem maturity, and supportive institutional frameworks.

4 Research Gap

The preceding literature review reveals that while the scaling of sustainable start-ups has gained scholarly attention, most studies focus on early-stage entrepreneurship rather than the growth and expansion phases. Existing research offers fragmented insights into specific dimensions such as regulatory frameworks (Edler and Fagerberg 2017), funding mechanisms (Mukherjee, Owen, et al. 2024), or talent acquisition (Estrin et al., 2016), yet seldom explores how these factors interact to shape scaling trajectories. This fragmentation limits theoretical understanding of how sustainable ventures transition from small-scale operations to impactful, growth-oriented enterprises.

This study therefore addresses the research gap by examining how the convergence of regulatory barriers, funding constraints, and talent acquisition challenges affect the scaling process of sustainable start-ups. Understanding these interdependencies is essential to identifying the strategic enablers that allow ventures to grow without compromising their sustainability missions.

Therefore, the study is guided by the research questions:

1. **Financing:** What financing and funding barriers constrain the ability of sustainable start-ups to scale, and which financial strategies or investment models enable successful growth?

These questions provide the analytical foundation for the thesis's empirical investigation and the development of a conceptual framework that links structural barriers, responses, and ecosystem conditions influencing sustainable start-up growth.

5 Methodology

The following section outlines the methodological foundations of the study. It details the research design, data collection and analysis procedures, as well as the strategies used to ensure transparency and trustworthiness of the findings.

5.1 Research Design

This study centers on individuals' subjective perceptions as well as experiences and behaviors, which makes a qualitative research design appropriate and defensible (Baur and Blasius 2014).

To address the research questions, the approach of the study is exploratory, we seek to surface which barriers hinder or drive scaling, what counts as key success factors, and how regulation/policies, funding, and talent attraction jointly shape the scaling of sustainable start-ups.

To ensure validity, the research process is designed to be transparent, traceable, and well documented. Therefore we maintain a clear audit trail so that procedures and interpretations are comprehensible and replicable.

Methodologically, an extensive literature review is combined with semi-structured interviews to obtain in-depth perspectives from founders of sustainable start-ups, venture capital investors, and industry experts. This dual concept allows to contrast and integrate practitioner insights with theoretical findings, strengthening the credibility and richness of the analysis. The integrated design is used to connect empirical findings with the literature and to derive grounded implications for how sustainable ventures can navigate regulatory contexts, financing conditions, and talent dynamics when scaling sustainable ventures.

5.2 Sampling Strategy

For this study, a purposive sampling is used to capture diverse, experience-based perspectives on scaling sustainable start-ups. The sample comprises 15 semi-structured interviews: eleven founders or C-level persons of sustainable ventures, two venture capitals investors from Germany and Portugal who actively invest in this domain, and two industry experts in sustainability consulting. By combining founder, investor, and practitioner perspectives, the sample supports triangulation and a multifaceted analysis of the research question.

The founders operate across core climate- and energy-related sub-segments, including

renewables and storage to building decarbonization, energy software/analytics, carbon and climate solutions, and utility-facing offerings, covering stages from early commercial traction to active scaling. An anonymized overview by venture profile, stage, and sub-segment is provided in Appendix C.

Participants were recruited via our professional network and targeted LinkedIn outreach. Selection was based solely on domain expertise and relevance to the research questions, and it was not sampled on gender or other demographic characteristics. To minimize bias and protect participants, all identifiers were anonymized, responses are treated as confidential, and evidence is reported in aggregate. To further mitigate selection bias, we defined inclusion criteria, provided in Appendix D, and applied them consistently across recruitment.

The greatest strength of this sample is its close alignment with the purpose of the research question, because through exploratory interviews with actors directly involved in scaling sustainable ventures, we gain deep, practical insights. Given the high information value of expert informants and the focused scope, the resulting small but well-targeted sample is appropriate and valid for an in-depth qualitative exploration.

5.3 Data Collection

A total of 15 semi-structured interviews were conducted, each lasting approximately 45 to 60 minutes. Two interview guides were developed in advance, one tailored to founders and operations/growth managers of sustainable start-ups and another for venture capital investors and consultants in the sustainability sector. In preparation, an exploratory conversation was held with an early employee of a sustainable start-up who had experienced scaling processes firsthand. Insights from this discussion, particularly regarding typical challenges across the three thematic areas, and the findings from the literature review informed the development and refinement of both interview guides. Both guides, found in Appendix E and F, employed open-ended questions with targeted sub-questions to enable deeper understanding where relevant.

The question sets were organized into blocks covering growth drivers, challenges, and barriers, followed by focused sections on regulatory and policies, funding, and talent attraction.

The guide was pilot-tested with an experienced industry professional to assess clarity and validity. Based on the feedback, wording and sequencing were refined to improve flow and depth. After the refinements, interviews were conducted by a two-person research team with one interview partner at a time. The majority of interviews were conducted in English, and only a small portion in German, which were then translated into English on a one-to-one basis.

All interviews were run via Microsoft Teams in a time period of two weeks. With informed consent and a guarantee of anonymity, sessions were recorded and subsequently transcribed using AI transcription tools (such like Otter.ai and Microsoft Teams), ensuring accurate and confidential documentation for analysis.

5.4 Analysis of Data

The analysis of the collected data is based on the qualitative content analysis following Mayring's (2000) approach, combining both inductive and deductive category development, and the transcripts of the interviews serve as the foundation for the subsequent coding process. First, a category system is developed deductively from the existing literature on scaling strategies in sustainability-focused and traditional ventures. On this basis, a codebook is created that specifies main categories, subcategories, and explicit coding rules that are based on our previous theory research. This codebook supports a structured and replicable coding process and ensure coherence in data interpretation. It also serves as a reference point throughout the analytical process to maintain coding reliability across different interviews. By clearly defining how data segments are assigned to categories, the codebook, found in Appendix G, contributes to methodological rigor and enhances the validity of the findings.

At the same time, an inductive approach is applied to identify emerging themes from the interview data itself, allowing for the extension and iterative refinement of categories as new

insights surface. It ensures that both expected and unexpected patterns are captured, providing a comprehensive and nuanced understanding of our collected data.

The coding and analysis is conducted using the software MAXQDA, which facilitates the organization, visualization, and systematic interpretation of qualitative data. An in-depth overview of the analysis process can be found in Appendix H. Additionally, Excel is used to produce a clear and compact summary of the coding matrix, and an overview table of the individual findings is included in the Appendix I, J and K.

6 Interview Findings

The preceding chapter established the methodological framework for this analysis, detailing the selection of fifteen sustainable start-ups and the application of Mayring's qualitative content analysis. This chapter transitions from methodology to empirical findings, presenting a systematic analysis of the barriers and enablers for sustainable start-ups.

6.5 Thematic Findings: Financing and Funding related Barriers and Enablers

This chapter moves from methodology to empirical findings for the financing and funding dimension, presenting the analysis of how capital access, financial instruments and policy-related funding conditions shape the scaling trajectories of these ventures. The analysis is structured around eight core categories: *Ecosystem Capital Constraints*, *Instrument & Structuring Fit*, *Investor Trust & Signaling*, *Internal Readiness & Governance*, *Return, Exit & Risk Expectations*, *Public Policy & Blended Support*, and *International Finance Friction*. These categories were developed deductively from the literature and operationalised through a detailed codebook. Moreover, several more nuanced patterns (e.g., grant-heavy models, sector-specific investor biases) emerged inductively within these overarching themes.

The central objective of this analysis is to move beyond individual fundraising narratives to identify systemic trends and recurring configurations in German and European financing environment for sustainable start-ups. The application of predefined coding rules to this dataset reveals a financing landscape that is both enabling and constraining, as the following findings show. While external capital is confirmed as a critical precondition for scaling in capital-intensive climate markets, the data overwhelmingly highlight three interlinked bottlenecks. First, the structural undercapitalisation of hardware-intensive ventures. Secondly, the misalignment between standard venture instruments and asset-heavy business models, and lastly, a high degree of dependency on, and exposure to, public policy and subsidy design. The following sections detail these findings.

6.5.1 Ecosystem Capital Constraints

A central finding concerns the presence of *structural capital constraints* within the financing ecosystem for sustainable and hardware-intensive ventures. Across interviews, founders consistently highlighted that funding for such business models remains comparatively scarce, especially when contrasted with digital, software or AI-based ventures. In the heat pump

segment, it was observed that “many VCs are still unsure about the heat pump market because of negative experiences with other start-ups” (Int_6), illustrating how sector-specific failures in the past continue to shape current investment behaviour. Investor-side perspectives confirm this view. Limited partners allocate only a “small slice” of their portfolios to sustainability-focused funds and instead “prioritise high-growth digital segments” (Int_1). Founders in energy hardware, heat pump installation and related sectors repeatedly described a *narrow and specialised investor pool* with limited appetite for long-horizon, capital-intensive projects. As one founder summarised, “in hot sectors like AI, money gets thrown around; in our sector it’s trickier” (Int_6). Taken together, these accounts suggest that the observed funding shortage does not primarily reflect firm-level inadequacies, but rather *systemic ecosystem-level constraints*. The composition and preferences of investors and LPs create a structural imbalance that reduces available funding options, stretches fundraising cycles and may ultimately inhibit the scaling speed of hardware-centric sustainable ventures (Int_1, Int_3, Int_6).

6.5.2 Instrument and Structuring Fit

A second prominent theme relates to the *fit between financing instruments and the capital needs* of sustainable ventures. Several founders reported that conventional start-up instruments, particularly pure equity rounds, are poorly suited to cover working-capital requirements, inventory build-up or upfront hardware manufacturing and installation costs. One interviewee explained that “pure equity would be too dilutive and too slow” to fund their asset-heavy scaling model (Int_5). In response to these constraints, ventures that achieved more rapid scaling typically deployed *hybrid financing models*, integrating equity with debt facilities, leasing structures, asset-backed lending, or grant co-financing. For example, a interviewee described how they “packaged hardware and financed it through a partner bank” in order to manage capital intensity and smooth cash flows (Int_3). Others emphasised the role of specialised debt providers or credit lines to pre-finance meters, heat pumps or related hardware (Int_9, Int_10).

In contrast, ventures without access to such tailored instruments experienced constrained expansion and higher liquidity risk, despite strong demand (Int_9, Int_11, Int_12). These patterns suggest that *instrument and structuring fit functions as a necessary enabling condition*. When financing structures do not mirror the operational realities of hardware or installation models, scaling becomes structurally limited.

6.5.3 Investor Trust and Signaling

Across the dataset, *investor trust emerged as a central determinant of fundraising outcomes*. Interviewees repeatedly emphasised the importance of credibility-enhancing signals, including demonstrable market traction, reputable institutional investors, prior entrepreneurial experience, sector-specific domain expertise among backers and clear evidence of governance quality. As one founder put it, “once we had proven traction, angels came inbound because they understood the product” (Int_6). Interviewees also described how specific signals, such as a co-founder’s previous successful exit, substantially reduced investor hesitation: “that track record brought credibility” (Int_10). Conversely, ventures without strong signaling foundations, particularly those in highly regulated or technically complex markets, reported heightened skepticism. One founder commented that “investors don’t know how to evaluate this sector, so they look for strong references and governance signals” (Int_9, Int_11). The evidence therefore supports the interpretation that *signaling mechanisms operate as central risk-mitigation tools*, enabling investors to better evaluate ventures in domains characterized by technological, regulatory and execution uncertainty.

6.5.4 Internal Readiness and Governance

Although ecosystem-level constraints are dominant, several interviews emphasised the importance of *internal organisational readiness* in enabling funding access. In particular, founders of software-driven or capital-efficient ventures stressed the need for “structured financial planning and transparent forecasting” when engaging with investors (Int_5). Another

interviewee highlighted that investors increasingly expect “clean financials and clear milestone logic” as prerequisites for follow-on rounds (Int_7, Int_14).

Such practices, ranging from disciplined cash management and milestone-driven roadmaps to rigorous reporting systems, were described as necessary conditions for building investor confidence (Int_5, Int_7). However, hardware-oriented start-ups cautioned that internal governance, while important, cannot fully offset sector-wide skepticism or policy-related uncertainty. As one founder stated, “governance matters, but the bigger issue is the market and policy uncertainty” (Int_4). Overall, internal readiness emerges as *a contributory but not decisive factor*. It enables successful fundraising but does not guarantee it in the face of structural ecosystem barriers in sustainable hardware markets.

6.5.5 Return, Exit, and Risk Expectations

A recurring challenge across multiple interviews concerns the *misalignment between investor expectations and the economic characteristics of sustainable hardware ventures*. Investors frequently prioritise short payback periods, scalable digital models, global expansion potential and clearly defined exit routes. Many sustainable ventures, however, operate in markets shaped by slower scaling dynamics, regulatory dependencies and long-term asset cycles. Interviewees reported that investors routinely inquire whether the business model could operate independently of public subsidies, reflecting concerns about policy-driven risk and long-term revenue stability (Int_15). As one founder noted, “investors always ask whether we can operate without subsidies in the future” (Int_4). Another founder expressed deliberate hesitation toward VC financing, citing pressure to pursue growth milestones that “don’t fit hardware scaling” (Int_10). These accounts indicate that *return and risk expectations remain largely calibrated toward digital venture norms*, creating an additional layer of friction for climate hardware models whose economics deviate from those expectations.

6.5.6 Public Policy and Blended Support

Public policy emerged as a central, *multidimensional determinant* of financing conditions for sustainable start-ups, exerting a structural influence on both market behaviour and investor decision-making. Across the cases, four distinct, yet interrelated, policy effects became visible. First, market activation played a decisive role, particularly in segments such as heat pumps and building electrification, where demand-side subsidies were repeatedly described as indispensable for initial customer adoption. As one founder noted, “heat pumps are government-funded, which is a huge accelerator” (Int_6), also highlighted by Int_14. These incentives did not merely support an uptake as they functioned as a primary demand generator in otherwise cost-intensive and risk-sensitive markets. Second, interviewees consistently highlighted policy volatility, emphasising that fluctuating political debates and anticipated reforms triggered pronounced oscillations in customer behaviour. Periods of accelerated purchasing, driven by the expectation of imminent policy changes, were followed by phases of hesitation once public discussions cast doubt on funding continuity. Several founders reported that “customers became uncertain about the future of funding, especially after recent political discussions” (Int_6, Int_11, Int_12), illustrating the destabilising effect of anticipated or contested regulatory adjustments.

A third mechanism concerned subsidy dependency and its perception by investors. Investors commonly questioned whether start-ups could operate and scale independently of policy support. While founders acknowledged that subsidies were essential during early market formation, many simultaneously stressed strategic efforts to develop revenue models resilient to policy changes. As one interviewee summarised, “investors ask all the time how we plan to operate without governmental funding” (Int_6). Dependency therefore became both a financing concern and a signalling challenge that shaped investor confidence and valuation expectations. Finally, complementary public funding, including grants, blended finance instruments, and dedicated programmes from institutions such as KfW, was described as filling structural

financing gaps, particularly for capital-intensive or impact-driven technologies that struggle to attract sufficient private investment. As one expert put it, “public programs from KfW matter because private capital alone cannot fill the gap” (Int_2). These instruments provided not only financial resources but also legitimacy signals that helped de-risk early-stage ventures and attract subsequent private capital.

6.5.7 International Finance Friction

Only a subset of interviews provided evidence of *international finance friction*, primarily in ventures operating across multiple jurisdictions or engaging foreign investors. These cases highlighted issues such as investor hesitation toward less familiar legal or fiscal environments and the complexity of restructuring corporate entities for international fundraising. One interviewee described “flipping a German entity into a US structure” as “expensive and time-consuming” (Int_1, also Int_4), illustrating how legal and tax considerations can materially affect financing strategies. Although not universally experienced, such challenges demonstrate that *jurisdictional structure can influence access to capital*, particularly for internationally oriented climate ventures.

7 Discussion

This chapter discusses the empirical findings in light of existing research and reflects on their implications for theory and practice. Further, it highlights the overall contribution of the study and prepares the ground for the subsequent sections on integration, implications, and limitations.

In this section, the key findings of the study are systematically related to the concepts and debates introduced in the literature review. The aim is to show where the results confirm, refine, or challenge existing theoretical perspectives on the scaling of sustainable start-ups. Additionally, specific propositions are derived throughout the discussion and a comprehensive list including further extended propositions can be found in Appendix L.

7.1.1 Start-up Financing

The interview analysis largely reinforces core academic arguments on the financing environment for sustainable start-ups but simultaneously extends them in important ways. The strongest empirical validation concerns the literature's claim that structural undercapitalisation is a defining constraint for sustainable ventures, especially hardware-intensive ventures. Interviewees consistently described limited investor appetite not as a temporary market fluctuation but as a persistent ecosystem feature. This confirms existing literature arguing that investor preferences skew toward asset-light, rapid-scaling models, leaving sustainable and climate hardware ventures competing for a disproportionately small share of available capital. In line with the literature, the interviews clearly show that this capital scarcity restricts the availability of large follow-on rounds and slows scaling trajectories independent of firm-specific performance. These findings support proposition 1: *Sustainable start-ups face persistent structural undercapitalisation driven by investor bias, resulting in a pronounced "valley of death" between early-stage financing and growth-stage capital.*

Similarly, the data substantiates the well-established assertion that conventional venture capital

instruments are ill-suited for capital-intensive climate technologies. Across interviews, founders emphasised that standard equity rounds fail to meet the liquidity, working-capital, and asset-financing needs inherent to sustainability based models. This aligns closely with academic discussions around instrument misfit. The necessity of blended financing structures, integrating a mixture of equity, debt, grants, and public funding, receives strong empirical support, reinforcing the argument that sustainable ventures (especially hardware intensive) require financing architectures fundamentally different from those of conventional (software) ventures. Therefore the findings lead to *proposition 2: Conventional VC instruments are insufficient to meet the liquidity and working-capital requirements of sustainable hardware ventures, making blended financing architectures a necessary condition for scaling.*

Beyond confirming theoretical expectations, the empirical findings sharpen existing concepts by adding concrete operational detail. Whereas the literature tends to describe signaling and credibility as generic factors in entrepreneurial finance, interview evidence shows that in climate and hardware these mechanisms become disproportionately central. Investors' unfamiliarity with long-horizon technologies amplifies reliance on proxies such as endorsements by reputable funds, proven founder track records, or demonstrable unit economics. Signaling, therefore, emerges not as a peripheral contributor but as a primary filtering mechanism in high-uncertainty climate markets. This discovery leads to *proposition 3: In high-uncertainty markets, credibility signals function as primary filtering mechanisms in investment decisions and significantly influence access to growth capital.*

The data also deepens the understanding of public policy's role in financing. While the literature positions subsidies and grants as supportive financial tools, the interview findings underscore a more foundational reality. For many sustainable ventures, public policy is not merely supportive but constitutive of their financing model. Public programmes often provide the only available risk-absorbing capital capable of unlocking private financing. This reframes the function of policy from a complementary funding source to a precondition for market entry and

scaling. Conversely, certain insights challenge dominant narratives in the financing literature. While academic work commonly frames policy-induced volatility as a uniformly negative factor that deters investors, the interviews reveal a more complex dynamic. Several founders argued that policy turbulence can, under certain conditions, serve as a competitive filter. Ventures with strong operational agility and diversified financing architectures reported using regulatory shifts to outpace slower incumbents, transforming what the literature labels as “instability” into a strategic advantage. This suggests that flexibility in capital structuring can partially offset policy risk, introducing a counterpoint to more deterministic theoretical positions.

Finally, the role of administrative friction in financing processes. While bureaucracy is often discussed in relation to regulatory burden, the interview data highlight its direct financial implications that delayed subsidy confirmations extend sales-to-cash cycles, complicate forecasting, and heighten investor concerns about liquidity management. Additionally, the findings introduce the mechanism of financing paralysis, whereby political debate, not regulatory change itself, creates psychological uncertainty among investors and customers, freezing purchasing and investment decisions irrespective of financial incentives. These dynamics show that capital allocation in sustainable markets is influenced not only by structural financial parameters but also by narrative and perception-driven factors.

7.6 Sector-specific and Perspective Nuances

Across the sample, regulatory burden is perceived as a shared challenge, but its mechanisms are clearly sector-specific. In the heat-pump and residential decarbonisation cluster, bureaucracy becomes an operational bottleneck: start-ups act as an administrative buffer between complex subsidy schemes and private households and are highly exposed to politicised debates that trigger “wait-and-see” behaviour and abrupt demand shocks. For solar ventures and hardware manufacturers, regulatory instability primarily appears as investment risk, with

memories of policy reversals and divergent technical standards constraining scale-up decisions. By contrast, for CleanTech software enablers, regulatory complexity more often turns into a product opportunity, as these firms monetise their ability to codify and update changing rules faster than incumbents. In deep-impact niches such as carbon removal, regulation is constitutive of the market itself, creating the underlying demand for negative-emission services.

Financing and funding challenges are likewise universal but underpinned by different mechanisms across sectors. For heat-pump, retrofit and residential decarbonisation ventures, financing frictions manifest primarily in working-capital intensity and exposure to subsidy-driven demand volatility. Firms must pre-finance equipment and installation capacity while absorbing cash-flow shocks created by political debates and shifting incentive schemes. Solar ventures and hardware manufacturers instead face constraints rooted in long-term investor risk perception. Historical policy reversals and cross-national technical divergence create a persistent credibility burden that suppresses appetite for asset-heavy climate hardware, making structured instruments such as debt facilities, asset-backed mechanisms and bank partnerships disproportionately important for unlocking scale. CleanTech software ventures operate under different financial dynamics, where capital is generally more accessible and equity often suitable, while the challenge shifts toward differentiation in crowded VC markets rather than structural funding scarcity. Deep-impact niches such as carbon removal rely on policy-anchored financing architectures, advance market commitments, certification frameworks and early corporate offtakes because public and quasi-public mechanisms effectively constitute the revenue model. These sectoral contrasts are mirrored by diverging perspectives. Investor-side experts frame financing constraints in terms of portfolio allocation and risk-return logic, whereas founders emphasise operational frictions, including delayed sales-to-cash conversion, administrative overhead for subsidy processes and the continuous need to translate climate impact into narratives legible to mainstream capital.

The core mechanisms of talent attraction and culture appear largely sector-independent, yet

some nuances emerge. Climate- and energy-related ventures, particularly hardware- and service-intensive models such as heat-pump installation, energy services and carbon removal, benefit from a highly tangible impact narrative, which helps them attract very committed and often highly qualified candidates. At the same time, they report above-average workload intensity, non-9-to-5 expectations and related retention tensions, alongside explicit efforts to increase gender diversity in traditionally male-dominated fields. By contrast, digital/software and ESG advisory ventures place greater emphasis on employer branding, online channels and reputation to communicate purpose and differentiate themselves in competitive labour markets, while flexible work arrangements and a modern, low-hierarchy culture are treated almost as standard offerings. Expert interviews from advisory backgrounds tend to foreground these systemic branding and signalling mechanisms, whereas founder interviews, especially in climate and energy, focus more on the everyday realities of mission execution, operational strain and the risks of mis-hiring in high-growth settings.

7.7 Implications for Scaling Sustainable Start-ups

With our findings, we seek to contribute to theory development in the emerging literature on scaling sustainable ventures and to offer practitioners concrete guidance on how regulatory conditions, funding structures, and talent attraction can be leveraged as growth drivers. In the following, we translate the identified mechanisms into actionable implications for founders and teams of sustainable start-ups.

Given the structural financing constraints identified, sustainable start-ups, especially hardware-intensive climate ventures, should adopt several strategic measures to strengthen their scaling prospects. First, ventures should build blended financing strategies early, combining equity with debt facilities, leasing arrangements, guarantees or asset-backed instruments to match capital intensity and reduce dependence on dilutive equity rounds. Establishing relationships with specialised climate lenders and structured-finance partners can help secure these

instruments before liquidity pressure arises.

Second, start-ups should actively strengthen credibility and signaling, as investor decisions in uncertain climate hardware markets depend heavily on early legitimacy. Transparent governance, rigorous financial reporting, demonstrable traction, and reputable co-investors or advisors can materially reduce perceived risk and accelerate access to capital.

Third, ventures operating in policy-dependent markets should institutionalise policy-risk management, including scenario planning for subsidy adjustments, diversification across regulatory environments, and flexible pricing or operational models. These practices help buffer “policy cliffs” and stabilise revenue patterns.

Given the substantial liquidity impact of administrative friction, start-ups should professionalise subsidy and compliance processes, for example through dedicated internal roles, digital documentation workflows or partnerships with external service providers. Reducing sales-to-cash delays strengthens both liquidity and investor confidence.

Finally, financing strategies should be aligned with the underlying business model: software-based sustainability ventures can focus on rapid validation and VC-driven growth, whereas hardware ventures benefit from developing finance-ready operational structures, inventory systems, asset registries, and cash-flow models, that facilitate access to debt and structured capital.

By following these concrete suggestions, founders of sustainable start-ups can turn many of the barriers identified in this study into enablers of growth and begin to systematically overcome them.

8 Limitations

While the preceding discussion has outlined this study’s main contributions, it is equally important to acknowledge the boundaries within which these insights hold. The following section therefore reflects critically on the methodological choices and empirical scope of the

research by outlining key limitations.

8.1 Methodological Limitations

This study applies a qualitative, exploratory research design, which constitutes both a methodological strength and a limitation. The strength lies in the depth and richness of the insights generated through 15 semi-structured interviews with founders, investors, and experts directly involved in scaling sustainable start-ups. The purposive sample is thus highly aligned with the research aim and provides substantial information value, enabling a detailed understanding of regulatory, funding, and talent-related dynamics. However, the qualitative design also limits the generalisability of the findings. The insights represent subjective experiences of a specific sample rather than statistically representative patterns, meaning that observed relationships cannot be interpreted as causal or universally applicable.

The sample size, which is common and acceptable for qualitative inquiry, allows for thematic saturation within the scope of the research, yet it necessarily restricts the breadth of perspectives captured. As recruitment partly relied on professional networks, the sample may be affected by selection bias. Although inclusion criteria were consistently applied and identities anonymised, personal contacts may have influenced who agreed to participate and may have skewed the distribution of sectors, growth stages or founder backgrounds.

Furthermore, interview-based research involves potential recall bias and social desirability bias. Founders may emphasise external barriers over internal shortcomings, investors may downplay structural financing issues, and experts may generalise from their own consulting experience. Finally, while the semi-structured format allowed for depth, time constraints during interviews limited the ability to probe in greater detail on certain topics, or example, intra-organisational HR practices or cross-country regulatory deviations.

Overall, the design yields strong exploratory insights but limits causal claims and broader generalisation.

8.2 Transferability and Boundary Conditions

The transferability of the findings is shaped by several contextual boundaries. First, the empirical material is grounded predominantly in German and Portuguese sustainable start-ups, complemented by a small number of experts operating in European markets. These national contexts share EU-level frameworks but differ in regulatory implementation speed, administrative structures, and funding landscapes. As such, the findings may not fully apply to other European ecosystems, particularly those with more mature clean-tech markets (e.g., the Nordics) or less developed regulatory infrastructures.

Second, the sample focuses primarily on sustainable firms within energy, climate, and resource-efficiency domains. While many insights, such as bureaucracy, policy instability, or purpose-driven talent attraction, are broadly relevant across green sectors, other findings (e.g., heavy dependence on subsidies, hardware capital intensity, regulatory permitting bottlenecks) may be more specific to climate-tech and deep-tech segments. Sectors with lower capital intensity or less regulatory exposure may face different scaling dynamics.

Third, the study examines ventures between seed and Series B stages. Scaling challenges in later maturity phases (e.g., international expansion, large-scale manufacturing, corporate governance complexity) lie outside the boundary of this analysis. The results therefore transfer most strongly to ventures that are in early scaling but not yet large incumbents.

Finally, as the data capture a time-specific institutional context, shifts in regulation, subsidy regimes, and investor sentiment may change these patterns over time, limiting longitudinal transferability. Given the research question, a broader scope was not required. These boundaries should be considered when applying the findings to other contexts and provide a basis for future research.

9 Future Research

Future research can address the above limitations in several ways. First, quantitative studies using larger, cross-country samples could test the patterns identified in this thesis and examine the statistical significance and causal relationships among regulatory conditions, funding structures, talent dynamics, and scaling outcomes. While this thesis provides the groundwork by analysing each dimension in detail, a next step would be to test how their interaction jointly shapes scaling outcomes. This requires translating the mechanisms observed here into explicit, testable hypotheses. Such hypotheses could be examined through survey-based designs and multivariate analysis and, ideally, embedded in mixed-methods research that combines quantitative data with follow-up interviews or case studies to preserve contextual depth.

Second, replication studies across additional industries, such as circular economy, consumer goods, mobility, or social enterprises, could identify sector-specific differences in scaling conditions and test whether the mechanisms observed here hold beyond climate-tech domains. Comparative sector studies that systematically contrast, for example, energy and infrastructure ventures with consumer-product start-ups would help disentangle which barriers are structural (e.g., bureaucracy, policy volatility) and which are tied to particular asset structures or business models (e.g., hardware capital intensity versus brand- and supply-chain-driven models in consumer goods).

Third, comparative geographical studies could investigate how different institutional and ecosystem configurations shape scaling trajectories. Cross-country designs that include, for example, Nordic countries, other EU member states, and non-European ecosystems would allow researchers to assess how variation in policy stability, financial markets, and labour markets affects the relative importance of regulatory, funding, and talent-related barriers.

Fourth, longitudinal research following start-ups over several years would capture how regulatory changes, investor climates, and organisational cultures evolve over time. Such designs could trace scaling trajectories from seed to later growth stages, illuminate how firms

transition from subsidy-dependent to more autonomous business models, and examine how purpose-driven cultures, HR practices, and governance structures change as ventures grow.

Finally, future qualitative work could broaden the sampling frame by including founders without prior ties to the research team and expanding recruitment to more countries and ecosystems. Together, these approaches would increase contextual diversity and improve the robustness and generalisability of the findings.

10 Conclusion

This thesis set out to examine the enablers and barriers to the scaling of sustainable start-ups in Europe, focusing on three core domains regulation and policy, financing and funding, and talent attraction. Building on the literature review and fifteen semi-structured expert interviews, the research reveals that sustainable start-up scaling is not primarily constrained by the entrepreneurial capabilities of founders, but by systemic conditions embedded in Europe's institutional, financial, and labour-market architectures. The analysis therefore positions scaling not as a linear process that ventures can achieve independently but as a structurally mediated trajectory shaped by market design, political signals, resource availability, and the organisational capacity to navigate these complexities.

10.1 Summary of Key Insights

Financing proved to be a systemic bottleneck, links to answering *Research Question 2*. Interviews strongly confirmed the structural mismatch between available funding instruments and the capital requirements of sustainable technologies. Conventional equity alone rarely supports scalable growth. Instead, successful ventures rely on blended financing architectures combining equity, debt, and public funding. Credibility and signaling were identified as central for attracting investment in policy-exposed sectors, while bureaucratic delays and subsidy-related administrative burdens directly created liquidity constraints. This confirms that financing challenges for sustainable start-ups are not episodic but structurally embedded in the

European innovation ecosystem.

Taken together, the findings emphasise that scaling sustainable start-ups requires navigating a highly interdependent system: regulation influences investor incentives and labour dynamics; financing determines organisational readiness and resilience; and talent enables execution within volatile regulatory and market environments.

10.2 Contribution to Theory and Praxis

The thesis contributes to academic discourse by advancing a systemic, multi-dimensional understanding of sustainable start-up scaling. Empirically, the study enriches scaling research by identifying mechanisms that are understudied in current literature, including politically induced demand paralysis, subsidy-driven market distortions, credibility thresholds, and the centrality of internal organisational sustainability. The thesis therefore provides a more nuanced explanation of how sustainable start-ups can overcome barriers in these three core aspects and use them as growth drivers.

For practice, the findings offer actionable implications. Start-ups benefit from adopting blended financing strategies, establishing simple but clear people structures strengthening governance and signaling, as well as institutionalising policy-risk management. Investors gain insight into the structural drivers of risk in climate markets, clarifying why conventional evaluation logics may underestimate the potential of sustainable technologies. Policymakers are encouraged to improve regulatory execution, reduce administrative burdens, and align funding instruments with the temporal and capital needs of sustainability innovations. In addition, founders should convert purpose into a credible employee value proposition and sustaining culture during rapid scaling to secure scarce talent.

10.3 Closing Remarks

Europe's capacity to meet its climate objectives depends on whether its entrepreneurial ecosystems can support the ventures capable of delivering sustainable innovation at scale. This

thesis has shown that sustainable start-up scaling is not primarily constrained by a lack of innovation or entrepreneurial ambition, but by structural conditions that shape how ventures grow, secure capital, attract talent, and navigate policy environments. Strengthening these conditions, through coherent regulation, tailored financing mechanisms, and organisational capacity building, is therefore essential for realising the transformative potential of sustainable start-ups. Clarifying the systemic nature of scaling barriers and enablers, this thesis contributes to a more integrated understanding of what it takes for sustainable start-ups to progress from early promise to long-term societal impact. As Europe enters a decisive decade for climate action, fostering environments in which such ventures can scale reliably, responsibly, and resiliently is both an economic imperative and a societal necessity.

11 References

- Agência para a Modernização Administrativa (AMA). 2023. *Relatório de Atividades e Plano de Atividades 2023*. Lisbon.
- Agrawal, Anirudh, and Kai Hockerts. 2021. Impact Investing: Review and Research Agenda. *Journal of Small Business and Entrepreneurship* 33 (2). Taylor and Francis Ltd.:153–181. doi:10.1080/08276331.2018.1551457.
- Ahmed, Murtada. 2025. European Startup Ecosystem: Gaps, Improvement Trends, and Economic Impact. *Proceedings of the International Conference on Business Excellence* 19 (1). Walter de Gruyter GmbH:4994–5005. doi:10.2478/picbe-2025-0382.
- Bamini, J, Sudheer Choudari, Anu Jossy Joy, Namita Chawla, Bhanu Priya Yabaluri, Shiv Shankar Das, and Ranjit Singh. 2025. *The Role of Entrepreneurial Ecosystems in Supporting Startup Growth and Innovation*. *Journal of Information Systems Engineering and Management*. Vol. 2025. <https://www.jisem-journal.com/>.
- Barclays. 2024. *Scaling Growth-Stage Climate Tech Companies: Policy Recommendations for the UK*. London. <https://home.barclays/content/dam/home-barclays/documents/citizenship/Sustainability/2024-Climate-Tech-Report-FINAL.pdf>.
- Barney, Jay. 1991. “Firm Resources and Sustained Competitive Advantage.” *Journal of Management* 17 (1): 99–120. doi: 10.1177/014920639101700108.
- Bastos, Manoel, Gomes Neto, Lucas Emmanuel, Nascimento Silva, Rebeca Da, Rocha Grangeiro, Catherine Esnard, and Rebeca Da Rocha. 2024. Hurdles and Opportunities for Women Career in Startups. doi:10.12712/rpca.v14i2.41290.
- Baur, Nina, and Jürgen Blasius. 2014. *Handbuch Methoden Der Empirischen Sozialforschung*. Wiesbaden: Springer Fachmedien Wiesbaden GmbH.
- Bellucci, Andrea, Gianluca Gucciardi, and Daniel Nepelski. 2025. Public Grants Beneficiaries and Venture Capital-Backed Firms: A Tale of Two Funding Strategies. *Journal of Technology Transfer* 50 (5). Springer:2262–2305. doi:10.1007/s10961-024-10180-9.

- Berger, Marius, and Hanna Hottenrott. 2021. Start-up Subsidies and the Sources of Venture Capital. *Journal of Business Venturing Insights* 16 (November). Elsevier Inc. doi:10.1016/j.jbvi.2021.e00272.
- Bergset, Linda, and Klaus Fichter. 2015. Green Start-Ups – A New Typology for Sustainable Entrepreneurship and Innovation Research. *Journal of Innovation Management* 3 (3):118–144. doi:10.24840/2183-0606_003.003_0009.
- Bessant, John, and Joe Tidd. 2015. *The Innovation Imperative*. www.innovation-portal.info.
- BMWK. 2024. *Bundesbericht Energieforschung 2024 – Forschungsförderung Für Die Energiewende*. Berlin. <https://www.bundeswirtschaftsministerium.de/Redaktion/DE/Publikationen/Energie/240716-bundesbericht-energieforschung-2024.pdf>.
- Boiardi, Priscilla. 2020. Measuring and Managing the Impact of Sustainable Investments—A Two Axes Mapping.
- Brinckmann, Jan, Soeren Salomo, and Hans Georg Gemuenden. 2011. Financial Management Competence of Founding Teams and Growth of New Technology-Based Firms. *Entrepreneurship: Theory and Practice* 35 (2):217–243. doi:10.1111/j.1540-6520.2009.00362.x.
- Brush, Candida, Linda F. Edelman, Tatiana Manolova, and Friederike Welter. 2019. A Gendered Look at Entrepreneurship Ecosystems. *Small Business Economics* 53 (2). Springer New York LLC:393–408. doi:10.1007/s11187-018-9992-9.
- Calic, Goran, and Elaine Mosakowski. 2016. Kicking Off Social Entrepreneurship: How A Sustainability Orientation Influences Crowdfunding Success. *Journal of Management Studies* 53 (5). Blackwell Publishing Ltd:738–767. doi:10.1111/joms.12201.
- Carle, Alice, and Thierry Rayna. 2024. Where to Start? Exploring How Sustainable Startups Integrate Sustainability Impact Assessment within Their Entrepreneurial Process. *Journal of Management and Organization* 30 (1). Cambridge University Press:148–164.

doi:10.1017/jmo.2023.46.

Cholakova, Magdalena, and Bart Clarysse. 2015. Does the Possibility to Make Equity Investments in Crowdfunding Projects Crowd Out Reward-Based Investments? *Entrepreneurship: Theory and Practice* 39 (1). SAGE Publications Ltd:145–172. doi:10.1111/ETAP.12139.

Cormann, Mathias, and Carsten Staur. 2025. *OECD DAC Blended Finance Guidance 2025. Best Practices in Development Co-Operation*. doi:10.1787/e4a13d2c-en.

Cornelli, Giulio, Jon Frost, Leonardo Gambacorta, and Ouarda Merrouche. 2023. *Climate Tech 2.0: Social Efficiency versus Private Returns*. www.bis.org.

Council of the European Union. 2024. Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 Laying down Harmonised Rules on Artificial Intelligence and Amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act). <http://data.europa.eu/eli/reg/2024/1689/oj>.

Dechezleprêtre, Antoine, and Petra Kelly. 2025. *Venture Capital, Innovation and Business Success in Cleantech Startups*. OECD Science, Technology and Industry Working Papers. doi:10.1787/ba73f647-en.

Deloitte. 2024. *CxO Sustainability Report: Signs of a Shift in Business Climate Action*. London. <https://www.deloitte.com/cn/en/about/press-room/cxo-sustainability-report.html>.

Dhingra, Naina, Andrew Samo, Bill Schaninger, and Matt Schrimper. 2021. Help Your Employees Find Purpose—or Watch Them Leave. *McKinsey & Company*, December. <https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/help-your-employees-find-purpose-or-watch-them-leave>.

Duve, Munyaradzi, and Benjamin Marx. 2025. Exploring Sustainability in Startups: A Systematic PRISMA Review. *Sustainability (Switzerland)*. Multidisciplinary Digital

- Publishing Institute (MDPI). doi:10.3390/su17146475.
- Edler, Jakob, and Jan Fagerberg. 2017. Innovation Policy: What, Why, and How. *Oxford Review of Economic Policy* 33 (1):2–23. doi:10.1093/oxrep/grx001.
- European Banking Federation. 2025. *Increasing Bankability of Transition & the Clean Industrial Deal*. <https://www.ebf.eu/wp-content/uploads/2025/09/Increasing-bankability-of-transition-the-Clean-Industrial-Deal.pdf>.
- European Commission. 2016. The User Guide to the SME Definition. Brussels. <https://publications.europa.eu/en/publication-detail/-/publication/79c0ce87-f4dc-11e6-8a35-01aa75ed71a1>.
- European Commission. 2025a. *The EU Startup and Scaleup Strategy: Choose Europe to Start and Scale*. Brussels.
- European Commission. n.d. “Horizon Europe.” Research and innovation, European Commission. https://research-and-innovation.ec.europa.eu/funding/fundingopportunities/funding-programmes-and-open-calls/horizon-europe_en
- European Commission. 2025b. Investment Barriers to Sustainable Finance: How to Enable the Transition in G20 Economies. In . doi:10.2765/50647.
- European Economic Committee. 2025. Opinion of the European Economic and Social Committee on the Competitiveness of the EU’s Small and Medium-Sized Enterprises in Light of New Administrative Burdens/Obligations. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024AE3549>.
- European Investment Bank. 2023. Investment Barriers in the European Union 2023: A Report by the European Investment Bank Group. doi:10.2867/364809.
- European Investment Bank. 2024. The Scale-Up Gap: Financial Market Constraints Holding Back Innovative Firms in the European Union. EIB Thematic Studies. Luxembourg. doi:10.2867/382579.

- European Investment Bank. 2025. Sustainability Report 2024. Luxembourg: European Investment Bank. <https://doi.org/10.2867/4824393>.
- European Parliament, and Council of European Union. 2021. Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 Establishing the Framework for Achieving Climate Neutrality and Amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (European Climate Law). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119>.
- Gai, Lorenzo, Carmelo Algeri, Federica Ielasi, and Maria Manganiello. 2025. Sustainability-Oriented Equity Crowdfunding: The Role of Proponents, Investors, and Sustainable Development. *Sustainability (Switzerland)* 17 (5). Multidisciplinary Digital Publishing Institute (MDPI). doi:10.3390/su17052188.
- Gompers, Paul, and Josh Lerner. 2001. The Venture Capital Revolution. *Journal of Economic Perspectives* 15 (2): 145–168. <https://doi.org/10.1257/jep.15.2.145>
- Hirschfeld, Alexander, Gilde, Jannis, and Walk, Vanusch. 2025. *Deutscher Startup Monitor 2025*. Berlin: Bundesverband Deutsche Startups e.V. www.startupverband.de.
- Hockerts, Kai, and Rolf Wüstenhagen. 2010. Greening Goliaths versus Emerging Davids — Theorizing about the Role of Incumbents and New Entrants in Sustainable Entrepreneurship. *Journal of Business Venturing* 25 (5). Elsevier:481–492. doi:10.1016/J.JBUSVENT.2009.07.005.
- Hopkins, Matthew M, and Yin Li. 2020. Financing Energy Innovation: The Need for New Intermediaries in Clean Energy. *Sustainability* 12 (24). MDPI:10440. doi:10.3390/su122410440.
- Hultberg, Emelie, and Rudrajeet Pal. 2023. Exploring Scalability from a Triple Bottom Line Perspective: Challenges and Strategic Resources for Fashion Resale. *Circular Economy and Sustainability* 3 (4). Springer Nature:2201–2231. doi:10.1007/s43615-023-00267-0.
- Jeffers, Jessica, Tianshu Lyu, Kelly Posenau, Shawn Cole, Shaun Davies, Peter Dunbar,

- Michael Ewens, Arpit Gupta, Wendy Hu, Arthur Korteweg, et al. 2024. *The Risk and Return of Impact Investing Funds*. <https://impactfinanceresearchconsortium.org/>.
- Kanitz, Shaleen, Lucia Daub, and Deniz Sebik. 2024. The Importance of People Sustainability. *BearingPoint Insights*. <https://www.bearingpoint.com/de-de/publikationen-and-events/publikationen/the-importance-of-people-sustainability/>.
- Lange, Jürgen, Stefan Rezepa, and Monika Zatrochová. 2024. The Role of Business Angels in the Early-Stage Financing of Startups: A Systematic Literature Review. *Administrative Sciences*. Multidisciplinary Digital Publishing Institute (MDPI). doi:10.3390/admsci14100247.
- Lee, Kijun, Taewoo Roh, Junggeun Kim, Sieun Park, and Yunjae Bae. 2025. Unpacking Sustainability in Start-Ups: A Systematic Review and Research Agenda. *Discover Sustainability*. Springer Nature. doi:10.1007/s43621-025-01070-7.
- Lema, Rasmus, Xiaolan Fu, and Roberta Rabellotti. 2020. Green Windows of Opportunity: Latecomer Development in the Age of Transformation toward Sustainability. *Industrial and Corporate Change* 29 (5). Oxford University Press:1193–1209. doi:10.1093/icc/dtaa044.
- Lih, Jia Yu, and Wenjing Deng. 2024. Financial and Social Tensions in Impact Venture Capital: Insights from Sensemaking. Stockholm, Sweden
- Mansouri, Sasan, and Paul P. Momtaz. 2022. Financing Sustainable Entrepreneurship: ESG Measurement, Valuation, and Performance. *Journal of Business Venturing* 37 (6). Elsevier Inc. doi:10.1016/j.jbusvent.2022.106258.
- Martins de Souza, Adriano, Fabio Neves Puglieri, and Antonio Carlos de Francisco. 2024. Competitive Advantages of Sustainable Startups: Systematic Literature Review and Future Research Directions. *Sustainability (Switzerland)*. Multidisciplinary Digital Publishing Institute (MDPI). doi:10.3390/su16177665.
- Mayring, Philipp. 2000. *Qualitative Content Analysis*. <http://www.zuma->

mannheim.de/research/en/methods/textanalysis/.

McKinsey & Company. 2022. From Vision to Green-Tech Unicorn: Lessons from Enpal.

<https://www.mckinsey.com/capabilities/tech-and-ai/our-insights/from-vision-to-green-tech-unicorn-lessons-from-enpal>

McKinsey & Company. 2024. A Different High-Growth Story: The Unique Challenges of

Climate Tech. *McKinsey Quarterly*. <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/a-different-high-growth-story-the-unique-challenges-of-climate-tech>.

Mukherjee, Abhishek, Paul Griffiths, Paresha Sinha, and Sahil Deol. 2024. Finance for

Sustainability: A Systematic Review on Crowdfunding for Renewable Energy Projects. *Review of Financial Economics* 42 (4). John Wiley and Sons Inc:467–490. doi:10.1002/rfe.1211.

Mukherjee, Abhishek, Robyn Owen, Jonathan M. Scott, and Fergus Lyon. 2024. Financing

Green Innovation Startups: A Systematic Literature Review on Early-Stage SME Funding. *Venture Capital*. Routledge. doi:10.1080/13691066.2024.2410730.

OECD. 2022. *OECD Reviews of Innovation Policy: Germany 2022: Building Agility for*

Successful Transitions. OECD Reviews of Innovation Policy. Paris: OECD Publishing. doi:10.1787/50b32331-en.

OECD. 2023. *Financing SMEs for Sustainability – Financial Institution Strategies and*

Approaches. Vol. 46. OECD SME and Entrepreneurship Papers. doi:10.1787/b3fe3647-en.

OECD. 2025. *The Green Transition of SMEs and Entrepreneurship in Portugal*. OECD Studies

on SMEs and Entrepreneurship. Paris: OECD Publishing. doi:10.1787/36e668f2-en.

Palmié, Maximilian, Vinit Parida, Anna Mader, and Joakim Wincent. 2023. Clarifying the

Scaling Concept: A Review, Definition, and Measure of Scaling Performance and an Elaborate Agenda for Future Research. *Journal of Business Research* 158 (March).

Elsevier:113630. doi:10.1016/J.JBUSRES.2022.113630.

Panigrahi, Anshuman, Shahrokh Nikou, and Giulia Calabretta. 2025. The Sustainability Scale-up Framework: A Tool to Design Scale-up Strategies for Sustainable Businesses. *Sustainable Production and Consumption* 59 (October). Elsevier:375–392. doi:10.1016/J.SPC.2025.08.021.

Pardo-del-Val, Manuela, Elvira Cerver-Romero, Juan Francisco Martinez-Perez, and Antonia Mohedano-Suanes. 2025. From Startup to Scaleup: Public Policies for Emerging Entrepreneurial Ecosystems. *Journal of the Knowledge Economy* 16 (2). Springer:7874–7907. doi:10.1007/s13132-024-02175-6.

Polzin, Friedemann, Florian Egli, Bjarne Steffen, and Tobias S. Schmidt. 2019. How Do Policies Mobilize Private Finance for Renewable Energy?—A Systematic Review with an Investor Perspective. *Applied Energy* 236 (February). Elsevier:1249–1268. doi:10.1016/J.APENERGY.2018.11.098.

Radke, Boris. n.d.. *Enpal Surpasses €5 Billion in Financing Commitments for Renewable Energy*. <https://www.corporate.enpal.com/pressemitteilungen/enpal-surpasses-eu5-billion-in-financing-commitments-for-renewable-energy>

Rizzitello, Eleonora, Mariangela Piazza, and Giovanni Perrone. 2025. Unlocking Green Startup Investments: How Environmental Policy Pressures Drive Venture Capital Funding Decisions. *Technological Forecasting and Social Change* 217 (August). Elsevier Inc. doi:10.1016/j.techfore.2025.124158.

Rosso, Brent D, Kathryn H Dekas, and Amy Wrzesniewski. 2010. On the Meaning of Work: A Theoretical Integration and Review. *Research in Organizational Behavior* 30:91–127. doi:10.1016/j.riob.2010.09.001.

Sánchez-Limón, Mónica, Pedro Severino-González, Guipsy Rebolledo-Aburto, Jairo Dote-Pardo, and Ian Scott-Kinney. 2025. Female Entrepreneurship and Sustainability: Behavioral Insights and Sustainable Development Goals. *Sustainable Futures*. Elsevier

- Ltd. doi:10.1016/j.sftr.2025.100695.
- Sandström, Christian. 2023. From Green Deals to Green Bubbles: Time to Question Brussels as an Entrepreneurial State. *Future Europe Journal*, no. 3. European Liberal Forum:8.
- Santoleri, Pietro, and Emanuele Russo. 2025. Spurring Subsidy Entrepreneurs. *Research Policy* 54 (1):105128. doi:doi.org/10.1016/j.respol.2024.105128.
- Schmitz-Normann, Rüdiger. 2022. *Start-Ups “Green, Affordable, Independent. And Cool.” Data Protection Principles*. <https://www.kfw.de/stories/economy/start-ups/enpal>
- Shepherd, Dean A, and Holger Patzelt. 2022. A Call for Research on the Scaling of Organizations and the Scaling of Social Impact. *Entrepreneurship Theory and Practice* 46 (2):255–268. doi:10.1177/1042258720950599.
- Skala-Gosk, Agnieszka, Hubert Dyba, Milena Gołofit-Stawińska, Bartłomiej Gładysz, and Tim van Erp. 2025. Financing and Business Model Archetypes as Predictors of Early Survival in European Sustainable Startups. *Sustainability (Switzerland)* 17 (21). Multidisciplinary Digital Publishing Institute (MDPI). doi:10.3390/su17219618.
- Spigel, Ben. 2017. The Relational Organization of Entrepreneurial Ecosystems. *Entrepreneurship Theory and Practice* 41 (1):49–72. doi:10.1111/etap.12167.
- Startup Portugal. 2025. *Startup & Entrepreneurial Ecosystem Report 2025*. Lisbon. <https://startupportugal.com/startup-entrepreneurial-ecosystem-report-2025/>.
- Stern. 2023. Enpal: Solar-Start-up verärgert Kunden und Netzbetreiber. <https://www.stern.de/wirtschaft/enpal--solar-start-up-veraergert-kunden-und-netzbetreiber-33853172.html>
- Tech Funding News. 2023. German Solar Unicorn Enpal Raises €215M from Tesla Backer and More. <https://techfundingnews.com/solar-unicorn-enpal-raises-e215m-from-tesla-backer-and-others-to-expand-beyond-germany/>
- Tiba, Sarah, Frank J. van Rijnsoever, and Marko P. Hekkert. 2021. Sustainability Startups and Where to Find Them: Investigating the Share of Sustainability Startups across

- Entrepreneurial Ecosystems and the Causal Drivers of Differences. *Journal of Cleaner Production* 306 (July). Elsevier:127054. doi:10.1016/J.JCLEPRO.2021.127054.
- UNDP. 2024. *Feasibility Study on Sustainability-Linked Financing Final Report*. www.id.undp.org.
- van den Heuvel, Matthias, and David Popp. 2023. The Role of Venture Capital and Governments in Clean Energy: Lessons from the First Cleantech Bubble. *Energy Economics* 124 (August). Elsevier B.V. doi:10.1016/j.eneco.2023.106877.
- Vermunt, D A, S O Negro, P A Verweij, D V Kuppens, and M P Hekkert. 2019. Exploring Barriers to Implementing Different Circular Business Models. *Journal of Cleaner Production* 222:891–902. doi:10.1016/j.jclepro.2019.03.052.
- Vyas, Rohit. 2025. *Challenges of Scaling Startups: A Critical Review of Existing Literature*. doi:10.2139/ssrn.5111938.
- Zhang, Ling, Sheng Zhang, and Yingyuan Guo. 2019. The Effects of Equity Financing and Debt Financing on Technological Innovation: Evidence from Developed Countries. *Baltic Journal of Management* 14 (4). Emerald Group Holdings Ltd.:698–715. doi:10.1108/BJM-01-2019-0011.
- Zhang, Ye, Harrison Hong, Wei Jiang, Daniel Metzger, Charlotte Ostergaard, David Reeb, Jan Starmans, Per Strömberg, Johan Sulaeman, Jack Willis, et al. 2021. *Fundraising Barriers for ESG Startups: Experimental Evidence*. <https://ssrn.com/abstract=3959117>.
- Ziakis, Christos, Maro Vlachopoulou, and Konstantinos Petridis. 2022. Start-Up Ecosystem (StUpEco): A Conceptual Framework and Empirical Research. *Journal of Open Innovation: Technology, Market, and Complexity* 8 (1). Multidisciplinary Digital Publishing Institute (MDPI). doi:10.3390/joitmc8010035.

12 Appendix

Appendix A: Case Study Enpal

Founded in Berlin in 2017, Enpal pioneered an innovative “solar-as-a-service” business model that enables homeowners to install photovoltaic systems without upfront investment. Rather than purchasing solar panels, customers lease a comprehensive energy package, including photovoltaic panels, battery storage, electric vehicle chargers, and digital energy management systems, for a fixed monthly fee (McKinsey & Company 2022). This subscription covers installation, maintenance, insurance, and, after a typical contract period of 20 years, the option to acquire ownership of the system for a symbolic price of €1 (Enpal 2021; McKinsey & Company 2022). By bundling all technical, financial, and operational components into a single service, Enpal transformed rooftop solar into a unique solution and substantially lowered the financial and procedural barriers that had previously constrained residential adoption.

This service-based model proved particularly effective in the German context, where high electricity prices and growing climate awareness intersect with demand for decentralised energy solutions. As Enpal’s CEO Mario Kohle has described, the company’s ambition was to make solar adoption a “no-brainer,” comparable to how financing models accelerated automobile ownership (European Investment Bank n.d.; McKinsey & Company 2022). Customers avoid the typical €20,000 – €40,000 upfront cost associated with residential solar-plus-storage systems, instead paying monthly fees that are often offset by savings on electricity and fuel expenses. This innovation unlocked significant latent demand and enabled rapid expansion. By 2024, Enpal had deployed more than 500,000 distributed energy devices, including solar panels, batteries, and heat pumps, adding approximately 3 GW of installed renewable capacity and reducing CO₂ emissions by around one million tonnes annually in Germany (Radke n.d.). These figures underscore Enpal’s growing relevance as a private-sector contributor to household-level decarbonisation.

Enpal's growth has been facilitated by a broadly favourable regulatory and policy environment, although not without constraints. Germany's long-standing support for renewable energy, including feed-in tariffs under the Renewable Energy Act, fostered market demand and public acceptance of residential solar systems. Importantly, Enpal developed its model without relying on direct installation subsidies, demonstrating that private financing mechanisms can drive large-scale adoption. The company explicitly frames its financing platform as enabling widespread renewable energy uptake "without government subsidies, driving Europe's energy transition" (Enpal 2024). Nevertheless, regulatory frameworks continue to shape operational outcomes. In 2023, for instance, a temporary German subsidy for combining photovoltaic systems with EV chargers was exhausted within 24 hours, revealing the volatility of short-term incentive schemes. Additionally, delays in grid connection approvals have, in some cases, prevented customers from receiving feed-in revenues and even resulted in penalties under legacy regulations. One documented case involved an €80 fine under outdated EEG provisions, which Enpal argued conflicted with newer EU regulatory principles (Gerber 2024). Such incidents highlight the frictions that can arise when rapidly scaling private-sector models encounter slow-moving administrative and regulatory systems.

A central pillar of Enpal's scaling strategy is its sophisticated financing architecture. The company pioneered large-scale asset-backed financing for residential solar portfolios by bundling long-term customer contracts into special-purpose vehicles (SPVs) that are financed by banks and institutional investors (Schmitz-Normann 2022). Through this structure, Enpal sells the cash flows from 20-year lease or loan agreements, allowing upfront installation costs to be refinanced externally. This approach effectively converts thousands of individual rooftop installations into a stable, investable asset class. By late 2024, Enpal had secured more than €5 billion in debt financing commitments (Enpal 2024). A key milestone was the issuance of Europe's first public residential solar asset-backed securitisation, a €240 million bond backed by approximately 8,500 rooftop systems (Nelthorpe 2024). The participation of the European

Investment Bank as an anchor investor further underscored the financial credibility of distributed clean-energy assets. Alongside structured debt financing, Enpal attracted significant venture capital, including a €150 million investment from the SoftBank Vision Fund in 2021 that elevated the company to unicorn status (Lunden 2021). Additional backing from climate-focused investors, such as Princeville Climate, enhanced both capital access and strategic legitimacy. However, it is Enpal's financial engineering, aggregating small-scale household assets into institutional-grade portfolios, that fundamentally enabled its rapid expansion by aligning the interests of homeowners, financiers, and capital markets.

Despite its growth and environmental impact, Enpal's rapid scaling exposed notable organisational and governance challenges. Media reports and customer feedback increasingly pointed to service quality issues, particularly in post-installation support and grid registration processes. Customers reported delayed system activation, missed feed-in payments, and limited responsiveness following Enpal's transition from local phone support to an app-based ticketing system (Nestler 2025). By late 2024, German technology media observed that reliability could be an issue when customers relied on Enpal to manage all aspects of the installation and operation (Gerber 2024). These challenges suggest that internal processes and digital infrastructure lagged behind the company's rapid sales growth. Labour practices emerged as an even more contentious issue. As Enpal expanded, it shifted from reliance on external installers toward building an in-house installation workforce exceeding 1,000 employees (Schmitz-Normann 2022). This transition intensified coordination challenges and strained relationships with local installation partners. In 2025, investigative reporting by Manager Magazin alleged excessive working hours, precarious contracts, and exploitative recruitment practices involving foreign electricians, particularly from Latin America. The report characterised some arrangements as resembling "modern slavery", citing training and relocation costs that allegedly bound workers to the company (Pöppel Arbeitsrecht). Enpal categorically rejected these claims, asserting compliance with labour standards and above-average compensation

level. Nonetheless, the controversy triggered broader public debate about labour conditions, governance, and social responsibility in fast-scaling green-tech firms. Earlier legal disputes, including a 2024 court case concerning unpaid sales commissions during leave periods, further reinforced concerns regarding organisational oversight (Pöppel Arbeitsrecht)

Overall, Enpal's case illustrates the complex dynamics of scaling sustainable business models. While the company demonstrates how innovation in business models and finance can accelerate renewable energy adoption at scale, its experience also reveals how organisational strain, regulatory friction, and social risks can emerge when growth outpaces internal capacity.

Appendix B: Detailed literature review protocol

This section provides a detailed description of the literature review protocol that was employed to guide the collection, selection and synthesis of scholarly and practitioner knowledge on the scaling of sustainable start-ups. The protocol was developed to ensure that the review process was systematic, transparent and replicable, providing a structured foundation for the integrative framework.

The literature review was designed to answer three core research questions.

1. **Regulation:** How do regulatory frameworks, policy instruments, and administrative processes influence the scaling of sustainable start-ups, and what regulatory barriers or enablers are most critical for their growth?
2. **Financing:** What financing and funding barriers constrain the ability of sustainable start-ups to scale and which financial strategies or investment models enable successful growth?
3. **Talent Attraction:** How do sustainable start-ups attract and retain talent during the scaling phase and what cultural factors enable or hinder talent-driven growth?

Together, these questions serve to map the current state of knowledge, uncovering conceptual and empirical gaps and form the foundation for developing the integrative framework presented in subsequent chapters.

The review was constructed by specific geographical and conceptual parameters. From the published literature, the analysis aims to consider literature from 2010 onwards (with minor exceptions), ensuring that the analysis reflects contemporary developments in sustainable entrepreneurship and venture scaling. The expectation may differ in definitions or theoretical concepts. The review adopted a global scope but prioritised studies from European and comparable economic contexts to ensure relevance to the research setting. Eligible materials included peer-reviewed journal articles, high-quality conference papers, master and doctoral

dissertations and practitioner or industry reports (grey literature) that provided empirical or case-based evidence on the growth or scaling of sustainable start-ups. For languages, English and German-language publications were included. The focus was limited to ventures with a clear sustainability, environmental or climate-related orientation. Studies that addressed only the earliest stages of entrepreneurship, such as ideation or market entry, without discussing growth or scaling were excluded.

A structured search strategy was employed to identify relevant studies. The primary databases consulted were SSRN, Scopus, Google Scholar, Research Gate, IEEE Elserv and selected policy or industry repositories, such as OECD, European Commission, European Investment Bank and Green Start-up Monitor. The search strings combined multiple keywords and Boolean operators to capture variations in terminology. Core terms included “sustainable start-up,” “green start-up,” “scaling sustainable venture,” “growth challenges sustainable start-up,” “scaling climate ventures,” and “scaling renewable energy start-up.” These were complemented with synonyms and related terms such as “scaling”, “growth”, “expansion”, “barriers”, “enablers”, “challenges”, and “hurdles”. The boolean logic (AND/OR) was applied to ensure comprehensive coverage. In addition to database searches, reference lists of relevant publications were examined to identify additional sources (“backward search”), and forward citation tracking was conducted to locate more recent works. Grey literature searches included reports from climate-tech accelerators, incubators, government and non-governmental organisations, and European or national green start-up initiatives.

To maintain consistency and transparency in the inclusion of materials, a set of predefined inclusion and exclusion criteria was applied. Studies were included if they focused on sustainability-oriented ventures, presented empirical evidence, whether qualitative, quantitative, or mixed-methods, on scaling-related barriers, enablers or strategies. Furthermore, theoretical and conceptual works were also part of the inclusion. Excluded were purely studies limited to early start-up phases without attention to scaling or growth, and publications in

languages outside the review scope. In cases of duplicate studies reporting the same data, the most comprehensive version was retained.

The selection process followed a two-stage screening procedure. In the first stage, two reviewers independently assessed titles and abstracts using the established inclusion and exclusion criteria. In the second stage, the full-text of each article that passed the initial screening was reviewed to confirm eligibility. Disagreements between reviewers were resolved through discussion and where necessary, a third team member acted as an adjudicator.

Overall, this protocol ensures that the literature review is systematic, transparent and reproducible. By clearly documenting search strategies, screening criteria, and synthesis methods, the review establishes a robust basis for analysing the structural conditions that shape the scaling trajectories of sustainable start-ups. The insights derived through this process directly support the development of the thesis's integrative framework and provide the necessary theoretical grounding for interpreting the empirical findings.

Appendix C: Overview of the descriptive data of the interview partners

Classification	Position	Industry	Verticals	Location	Model	Funding Stage	Total Funding	Last Funding Round	Nr. of Employees	Founding Year
Int_1: VC Investor 1	VC Investor	Cybersecurity	-	Lisbon, Portugal	B2B2I	-	-	-	-	-
Int_2: Industry Expert 1	CEO	ESG & Financial Advisory	-	Stuttgart, Germany	B2B	-	-	-	-	-
Int_3: Start-up 1	Operations Manager	Electrical Equipment	CleanTech, SaaS	Cologne, Germany	B2B/B2C	Early stage VC	\$ 12.6 Million	7 January 2025	51-200	2023
Int_4: Start-up 2	Business Development Manager	Business productivity software	CleanTech, SaaS, A rtificial Intelligence & Machine Learning	Berlin, Germany	B2B	Early stage VC	\$ 9.4 Million	31December 2024	11-50	2023
Int_5: Start-up 3	Venture Development Manager	Alternative Energy Equipment	CleanTech, Manufa cturing	Berlin, Germany	B2C	Early stage VC	\$ 40 Million	7 April 2025	200+	2017
Int_6: Start-up 4	Finance Manager	Heat Pump Installation Services	CleanTech, Climate Tech	Munich, Germany	B2C	Seed Funding	N/A	13 June 2025	11-50	2023
Int_7: Start-up 5	Founder & CEO	Carbon Removal	-	Munich, Germany	B2B	x	x	X	3	2023
Int_8: Start-up 6	Co-Founder	Business/Productivit y Software	CleanTech	Funchal, Portugal	B2B	Accelerator /incubator	\$ 7.73 Million	1 January 2025	11-50	2022
Int_9: Start-up 7	Chief of Staff	Energy Services (Energy Storage/ energy equipment	Climate Tech	Hamburg, Germany	B2B	Early stage VC (Series C)	\$ 615 Million	28 July 2025	200+	2021
Int_10: Start-up 8	Founder & CEO	Heat Pump Installation Services	Clean Tech	Cologne, Germany	B2C	-	-	-	11-50	2023
Int_11: Start-up 9	Head of Project Management	Heat Pump Installation Services	Climate Tech	Cologne, Germany	B2C	Seed Funding	\$ 7.66 Million	28 October 2024	51-200	2022
Int_12: Start-up 10	Founder & CEO	Decarbonisation and heating Services	CleanTech, Climate Tech	Berlin, Germany	B2C	Seed Funding	N/A	N/A	11-50	2020
Int_13: Start-up 11	Founder & COO	Solar storage systems	Climate Tech	Munich, Germany	B2C	Accelerator /incubator	N/A	N/A	51-200	2018
Int_14: Industry Expert 2	Senior Consultant	ESG Advisory	-	Hamburg, Germany	B2B	-	-	-	-	-
Int_15: VC Investor 2	VC Investor	Impact Investing	-	Munich, Germany	B2B2I	-	-	-	-	-

Appendix D: Selection and inclusion criteria for sustainable start-ups

General Criteria

- Firm age: Founded within the last 10 years
- Firm size / stage: Seed, Series A or B (ideally > 10 employees, showing scaling activity)
- Geography: Europe-based (to ensure interview accessibility & comparability)
- Willingness: **C-level person**, open to a 45 – 60 min interview in English or German

Special Sustainable Start-up Criteria

- Mission: Explicit triple bottom line orientation (profit, people, planet)
- Sustainability as a founding principle (by embedding ecological and social objectives alongside economic goals in its business model)
- For example, value propositions:
 - Consumer Goods: eco-materials, circular economy, ethical sourcing, reduced footprint
 - SaaS: solutions for ESG reporting, carbon tracking, resource efficiency, or social impact
 - Energy: renewable energy tech, green energy storage, sustainable grids, efficiency innovations
- Certifications / legitimacy signals: Preferably B Corp, Fairtrade, organic, eco-labels, ISO standards, or sustainability awards (not mandatory)
- Stakeholders: Engaged with NGOs, impact investors, or sustainability-focused accelerators/incubators

Additional (Optional) Criteria

- Team size: 10 – 100 employees (too small = no scaling yet, too big = more established than a start-up)
- Market traction: Product/service already launched, with early scaling signals (revenue growth, retail/industry partnerships, internationalization, or strong user base)

Appendix E: Semi-structured interview guide for sustainable start-ups

Introduction

Thank participant, explain purpose, ensure anonymity/confidentiality.

“We are studying what are the key challenges and opportunities sustainability-focused (purpose-driven) start-ups face when scaling?. We’re interested in your personal experiences and views. There are no right or wrong answers. Every information will be confidential and anonymous.”

Warm-up: “Could you briefly introduce yourself, your current role, and a bit about your company/organization?”

Block 1 - General questions on scaling

A - Definition of scaling

“How do you personally define “scaling” in your context?”

Do you see scaling mainly as growth in revenue, number of employees, geographical expansion, or impact?

How does your definition of scaling differ from “survival” or “normal growth”?

Has your understanding of scaling changed since founding? If yes, how?

“Looking back on your growth journey:”

Which stages of scaling would you distinguish?

Were there turning points where the dynamics changed significantly?

“In general, what have been the biggest challenges you have faced during scaling, regardless of the specific domain?”

B - Growth drivers

“What were the main drivers of your venture’s growth so far?”

What role did capital access (VC, impact investors, public funding) play?

How important were networks and partnerships (accelerators, corporate collaborations, supply chain relationships)?

Did customer demand or market trends significantly accelerate your scaling?

How did your team and internal capabilities influence scaling (skills, leadership, culture)?

Were there external enablers (policies, technology, ecosystem support) that supported your growth?

C - Barriers & Challenges

“What have been the biggest barriers or challenges in your scaling journey?”

Did you face resource constraints (financial, human, technological)?

How did regulation or compliance impact your ability to grow?

Were there competitive pressures that limited your expansion?

Have you experienced legitimacy challenges (convincing investors, customers, regulators)?

Did internal organizational challenges (e.g., managing a larger team, processes, culture) emerge?

Can you give an example of a critical moment or turning point where barriers threatened your scaling?

D - Prioritization of scaling goals

“How did you prioritize between different scaling goals (e.g., speed, profitability, market share, impact)?”

Did you ever have to trade off speed for stability (e.g., slower growth, but stronger foundations)?

How do you balance short-term financial performance vs. long-term strategic goals?

How do you reconcile impact goals vs. profit goals?

Who or what influenced your prioritization (e.g., investors, board, customers, mission)?

Has your prioritization shifted over time? Why?

Block 2 – Financing / Funding

“What role has financing played in your growth strategy?”

Which sources of funding have you used (equity, venture capital, public funding, business

angels, impact investors)?

Which of these have been most helpful or most difficult to access?

“What challenges have you encountered when raising capital?”

Have investors seen your sustainability mission as an advantage or more as a risk?

Do you perceive differences compared to conventional start-ups (e.g., return expectations, investor patience)?

“Have funding programs or specific impact investment mechanisms supported your growth?”

To what extent do you depend on such programs?

What happens when funding programs expire or conditions change?

Block 3 – Regulations / Policies

“How have governmental regulations and bureaucratic requirements affected your growth?”

Did you experience hurdles with permits, certifications, or compliance processes?

What kind of costs or delays did this create?

“Are there regulatory frameworks that have positively supported your growth?”

For example, funding programs, political initiatives, networks, or clusters?

How important is the institutional environment in Germany/Europe for your development?

“When thinking about international expansion:”

Have you experienced regulatory differences across markets that influenced your scaling strategy?

Block 4 – Talent Attraction

“How do you attract talent to your start-up?”

What role does your mission or purpose play in recruitment?

Which channels or strategies do you use to find new employees?

“What challenges do you face in retaining employees?”

Are factors such as limited salaries, high workload, or missing structures an issue?

“How do you perceive your attractiveness to female talent?”

Do you actively work towards building diverse teams?

How does inclusivity factor into your talent strategy?

“What role do legitimacy signals (e.g., certifications, partnerships, impact stories) play for you?”

Do you actively use them for employer branding?

How do applicants and stakeholders respond to them?

Block 5 – Context Information

Firm Age: When was your start-up founded?

Firm Size & Team Size: How many employees do you currently have?

Geography: In which markets/regions are you active?

Industry Sector: Which sector do you specifically operate in (e.g., energy, circular economy, mobility)?

Mission: How would you summarize your mission in one sentence?

Certifications: Do you hold any certifications or standards (e.g., B Corp, ISO, Fair Trade)?

Stakeholders: Who are your main stakeholders (customers, investors, partners, community)?

Market Traction: How would you describe your current market traction (e.g., revenue growth, customer numbers, partnerships)?

Block 6 - Closing

“If you could share one key lesson from your scaling experience, what would it be?”

“Is there anything important about scaling that we haven’t asked but you think we should know?”

Appendix F: Semi-structured interview guide for industry experts

Research question: What are the key challenges and opportunities sustainability-focused (purpose-driven) start-ups face when scaling?

Introduction

Thank participant, explain purpose, ensure anonymity/confidentiality.

“We are studying what are the key challenges and opportunities sustainability-focused (purpose-driven) start-ups face when scaling?. We’re interested in your personal experiences and views. There are no right or wrong answers. Every information will be confidential and anonymous.”

Warm-up: “Could you briefly introduce yourself, your current role, and your experience with start-ups?”

Block 1 - General questions on scaling

A - Definition of scaling

“From your perspective, what are the biggest challenges sustainable start-ups face when scaling?”

“What drivers or enablers do you see most often (e.g., networks, policy, investor support, customer demand)?”

“In your view, what are the most critical growth drivers for sustainability ventures?”

Capital access, networks, partnerships, customer demand, policies, or talent?

Which of these factors tend to make the biggest difference in practice?

B - Growth drivers

“What were the main drivers of your venture’s growth so far?”

What role did capital access (VC, impact investors, public funding) play?

How important were networks and partnerships (accelerators, corporate collaborations, supply chain relationships)?

Did customer demand or market trends significantly accelerate your scaling?

How did your team and internal capabilities influence scaling (skills, leadership, culture)?

Were there external enablers (policies, technology, ecosystem support) that supported your growth?

C - Barriers & Challenges

“What have been the biggest barriers or challenges in your scaling journey?”

Did you face resource constraints (financial, human, technological)?

How did regulation or compliance impact your ability to grow?

Were there competitive pressures that limited your expansion?

Have you experienced legitimacy challenges (convincing investors, customers, regulators)?

Did internal organizational challenges (e.g., managing a larger team, processes, culture) emerge?

Can you give an example of a critical moment or turning point where barriers threatened your scaling?

D - Prioritization of scaling goals

“How did you prioritize between different scaling goals (e.g., speed, profitability, market share, impact)?”

Did you ever have to trade off speed for stability (e.g., slower growth, but stronger foundations)?

How do you balance short-term financial performance vs. long-term strategic goals?

How do you reconcile impact goals vs. profit goals?

Who or what influenced your prioritization (e.g., investors, board, customers, mission)?

Has your prioritization shifted over time? Why?

Block 2 – Financing / Funding

“What role has financing played in your growth strategy?”

Which sources of funding have you used (equity, venture capital, public funding, business angels, impact investors)?

Which of these have been most helpful or most difficult to access?

“What challenges have you encountered when raising capital?”

Have investors seen your sustainability mission as an advantage or more as a risk?

Do you perceive differences compared to conventional start-ups (e.g., return expectations, investor patience)?

“Have funding programs or specific impact investment mechanisms supported your growth?”

To what extent do you depend on such programs?

What happens when funding programs expire or conditions change?

Block 3 – Regulations / Policies

“How have governmental regulations and bureaucratic requirements affected your growth?”

Did you experience hurdles with permits, certifications, or compliance processes?

What kind of costs or delays did this create?

“Are there regulatory frameworks that have positively supported your growth?”

For example, funding programs, political initiatives, networks, or clusters?

How important is the institutional environment in Germany/Europe for your development?

“When thinking about international expansion:”

Have you experienced regulatory differences across markets that influenced your scaling strategy?

Block 4 – Talent Attraction

“How do you attract talent to your start-up?”

What role does your mission or purpose play in recruitment?

Which channels or strategies do you use to find new employees?

“What challenges do you face in retaining employees?”

Are factors such as limited salaries, high workload, or missing structures an issue?

“How do you perceive your attractiveness to female talent?”

Do you actively work towards building diverse teams?

How does inclusivity factor into your talent strategy?

“What role do legitimacy signals (e.g., certifications, partnerships, impact stories) play for you?”

Do you actively use them for employer branding?

How do applicants and stakeholders respond to them?

Block 5 – Just for Industry Experts (Investors, Accelerator Managers, Consultants, etc.)

(only for experts)

“From your perspective, what are the main differences in how sustainability-oriented and conventional start-ups scale?”

“How do you assess the risks and opportunities of investing in sustainability-focused ventures compared to traditional ones?”

“What criteria make a sustainable start-up attractive for funding or support?”

“Have you observed changes in the ecosystem over the past years that affect how sustainable ventures scale?”

“What advice would you give to sustainable start-ups looking to overcome scaling barriers?”

Block 5 – Context Information

Firm Age: When was your start-up founded?

Firm Size & Team Size: How many employees do you currently have?

Geography: In which markets/regions are you active?

Industry Sector: Which sector do you specifically operate in (e.g., energy, circular economy, mobility)?

Mission: How would you summarize your mission in one sentence?

Certifications: Do you hold any certifications or standards (e.g., B Corp, ISO, Fair Trade)?

Stakeholders: Who are your main stakeholders (customers, investors, partners, community)?

Market Traction: How would you describe your current market traction (e.g., revenue growth, customer numbers, partnerships)?

Closing

“If you could share one key lesson from your scaling experience, what would it be?”

“Is there anything important about scaling that we haven’t asked but you think we should know?”

Appendix G: Codebook for the data analysis

Main category	Subcategory	Definiton	Anchor example	When to include	When to exclude
Funding & financing	Ecosystem Capital Constraints	Structural shortage of investors or LPs willing to back sustainable, hardware-intensive or long-horizon startups.	“LPs who explicitly want to invest in sustainable start-ups are not many... creates a no man’s land.”	Include statements in which founders explicitly attribute financing challenges to external ecosystem limitations such as a small or specialised investor pool, lack of sector-specific capital, insufficient institutional investors with sustainability mandates, or overall scarcity of large-ticket funding available for sustainable ventures.	Exclude statements where funding challenges arise from internal factors (e.g., poor readiness, unclear metrics) or from general risk perceptions that do not specifically relate to the structural depth or composition of the funding ecosystem.
	Instrument & Structuring Fit	Mismatch between funding instrument (equity, debt, grants) and startup's capital needs or model.	“We obtained credit lines to refinance inventory... packaged heat pumps and sold them to a bank.”	Include passages in which entrepreneurs emphasise that the financial instruments available, equity, debt, grants, or hybrids, are unsuitable or misaligned with their asset intensity, cash-flow profile, business model, or stage of growth, leading to friction or limiting scale.	Exclude statements where the difficulty is not due to instrument design (e.g., investor scepticism, regulatory barriers) but instead due to availability of capital, internal shortcomings, or policy-induced uncertainty.
	Investor Trust & Signaling	Ability to create investor confidence through impact measurement, strong networks, accelerators, or	“Y Combinator gave us exposure... and helped us close our seed round.”	Include statements where founders describe how credibility markers, such as reputable investors, accelerators,	Exclude mentions of networks, accelerators, or partnerships that support operations or strategy but are

		credible signals.		certifications, governance signals, or impact validation, affect investor trust, reduce perceived risk, or unlock access to capital.	not directly linked to improving investor perceptions or signalling mechanisms.
	Internal Readiness & Governance	Quality of financial planning, reporting, internal governance and transparency required for funding access.	“Preparing clean financials across many small subsidiaries has been demanding.”	Include segments where founders link fundraising success or difficulty to the company’s internal preparedness, such as quality of financial reporting, forecasting, impact measurement, compliance structures, or overall governance maturity.	Exclude statements referring to external investor misunderstandings, market uncertainty, or sector-wide challenges unless the founder attributes the cause directly to internal processes or organisational readiness.
	Return, Exit & Risk Expectations	Investor expectations for exit pathways, risk horizons, and the tension between impact and financial return.	“Investors still need a path to returns and plausible exits.”	Include passages where founders explicitly discuss mismatches between investor expectations (e.g., fast returns, clear exit pathways, risk tolerance) and the venture’s sustainability-driven, capital-intensive, or long-horizon business model, thereby affecting financing.	Exclude statements that discuss profitability, margins, or business performance without reference to investor expectations for returns, exit routes, or perceived risk.

Appendix H: In-depth overview of the analysis process

After transcription, all interviews were imported into MAXQDA for systematic analysis. First, a hierarchical code system was developed and refined in an iterative process. All relevant text segments were coded line by line, and the emerging codes were continuously checked for overlap, redundancies and unclear boundaries. Rare or ambiguous codes were merged or removed, and code definitions were documented in code memos to ensure consistency in their application.

Once the full data set had been coded, an initial descriptive overview was generated using MAXQDA's visual tools. In particular, the Code-Matrix-Browser was used to examine the distribution of codes across interviews and document groups (e.g. different stakeholder types such as sustainable start-ups and industry experts). This step helped to identify frequently occurring themes as well as more case-specific aspects. On this basis, a subset of central codes was selected for more in-depth analysis.

For these central codes, the Summary Grid function was used to condense the material. For each interview and code combination, short, standardised summaries were written that captured the core content of the underlying coded segments without re-quoting the full-text. These cell-level summaries were then used to produce higher-level code summaries, in which the main patterns, recurring themes and variations across cases were described for each code. In parallel, brief document summaries were created for selected interviews to retain a case-oriented perspective on the material.

Subsequently, cross-case and cross-group comparisons were carried out, drawing on the code summaries, document summaries and matrix views. This allowed similarities and differences between interviews and respondent groups to be identified and described in a structured way.. Finally, relevant outputs from MAXQDA (e.g. matrices, summaries) were exported and, where appropriate, complemented by simple overviews in spreadsheet format (Excel) to support transparent reporting of the analysis in the results chapter.

Appendix J: Overview of interview findings – Start-up funding

Main categories	Findings
Ecosystem Capital Constraints	- Growth-stage capital for sustainable hardware ventures remains structurally scarce compared to digital sectors - LPs allocate only a small portfolio share to sustainability funds, limiting fund capacity for capital-intensive ventures - Narrow investor pools increase fundraising cycles and reduce scaling speed
Instrument & Structuring Fit	- Traditional equity rounds often fail to match the working-capital and asset-heavy requirements of hardware models - Pure equity financing is viewed as too dilutive and too slow for capital-intensive scaling - Debt facilities, leasing structures, and asset-backed financing are essential to smooth cash-flow - Ventures without access to tailored hybrid instruments face slower growth and higher liquidity risk
Investor Trust & Signaling	- Investors rely on signalling mechanisms to evaluate markets with technological and regulatory uncertainty - Credibility markers accelerate follow-on funding - Trust-building is essential for unlocking later-stage, larger-ticket financing
Internal Readiness & Governance	- Structured financial planning, transparent forecasting and milestone logic are prerequisites for investor engagement - Clean reporting systems and disciplined cash management enhance credibility in fundraising conversations - Strong governance cannot fully offset external frictions but acts as a necessary baseline - Investment readiness functions as an enabling but not decisive condition in capital-intensive markets.
Return, Exit & Risk Expectations	- Grants lower customer barriers but often introduce administrative delays that slow the sales-to-cash cycle - Dependency on public funding increases vulnerability to political shifts and sudden eligibility changes - Blended finance is viewed as a critical enabler for de-risking larger rounds - Clear, stable policy frameworks directly influence investor confidence and capital mobilisation.
International Finance Friction	- Cross-border fundraising is hindered by fragmented legal, accounting and tax frameworks across Europe - Investors prefer familiar regulatory environments, reducing willingness to finance ventures abroad - Administrative complexity of multi-jurisdiction financing increases legal spend and slows deal cycles

Appendix L: Propositions from the findings:

Building on the exploratory analysis, a set of propositions can be derived that integrate the three core dimensions examined in this thesis, regulatory conditions, start-up funding and talent attraction. These propositions translate the observed qualitative mechanisms into testable statements that can guide future, more systematic and comparative research designs.

Financing and funding

Proposition 1: Sustainable start-ups face persistent structural undercapitalisation driven by investor bias, resulting in a pronounced “valley of death” between early-stage financing and growth-stage capital.

Proposition 2: Conventional VC instruments are insufficient to meet the liquidity and working-capital requirements of sustainable hardware ventures, making blended financing architectures a necessary condition for scaling.

Proposition 3: In high-uncertainty markets, credibility signals function as primary filtering mechanisms in investment decisions and significantly influence access to growth capital.

Propositions 4: Public funding instruments and subsidies are not merely supportive but often constitutive of sustainable start-ups’ financing models, as they provide essential risk-absorbing capital that enables private investment.

Proposition 5: Administrative delays and political uncertainty can induce financing paralysis by extending sales-to-cash cycles and suppressing investment decisions, even in the absence of formal regulatory change.

Appendix M: Declaration of AI Usage

During the preparation of this work, we used ChatGPT, Perplexity, and Grammarly to improve readability and language, as well as to enhance the coherence and structure of our arguments. After using these tools, we carefully reviewed, revised, and edited all proposed content, and we take full responsibility for the final version of the thesis.