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Suitability of Equity Funding Options for Cleantech Startups

Literature Review

Erik Hellman

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Author Erik Hellman

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Thesis supervisor Assistant Professor Fabian Fagerholm

Thesis advisor Doctoral Researcher David Wunder

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Abstract

Cleantech startups are essential for providing new green technologies mitigating the effects of climate change. Still, cleantech startups face challenges in attracting funding due to industry specific characteristics. The different forms of funding are not just essential for providing capital, they can also support the growth of the startup and therefore the commercialization of green technologies. However, to which degree these forms of funding, particularly equity funding, are suitable for supporting cleantech startups remains unexplored in research.

The objective of this thesis is to understand the suitability of different equity funding options for cleantech startups. This is achieved through a literature review as well as a discussion regarding the findings. The research questions are: (1) What are the defining characteristics of cleantech startups? (2) What is the suitability of different equity funding options for meeting the defining characteristics of cleantech startups? The research methods consist of utilizing search engines and databases to obtain relevant academic articles, reports and market studies.

The key results, concerning both research questions, are the following. (1) Cleantech startups are defined by the following characteristics: driving environmental benefits in addition to seeking profit, a high capital intensity, long development time horizons, being challenged by incumbents, need for specialized investor knowledge, volatile markets and a challenging commercialization. (2) BAs, particularly green BAs, are suitable for cleantech startups due to industry expertise and the ability to serve as an intermediary between investors. Crowdfunding is relatively suitable for cleantech startups by valuing sustainability efforts and helping in showing viability of products, however, crowdfunding provides less additional value adding activities. IVC is suitable by providing sufficient capital and value adding activities, however, IVC typically is unsuitable for longer development time frames. Green CVC is particularly suitable through long term strategic goals and when complementary interests are pursued. GVC is somewhat suitable by valuing societal benefits, however, industry expertise may be lacking.

Keywords Equity Funding, Cleantech Startups, BA, Crowdfunding, IVC, CVC, GVC

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Författare Erik Hellman

Titel Lämpligheten av aktiefinansieringsalternativ för tillväxtföretag inom miljöteknik

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Sammandrag

Tillväxtföretag inom miljöteknik är nödvändiga för att minska verkningarna av klimatförändringen. På grund av industrispecifika karaktärsdrag står dessa tillväxtföretag dock inför utmaningar med att säkra finansiering. Olika finansieringsalternativ är nödvändiga för att stödja tillväxten av gröna teknologier. Till vilken grad olika alternativ av aktiefinansiering lämpar sig för tillväxtföretag inom miljöteknik är dock en obesvarad fråga inom forskning.

Syftet med denna avhandling är att förstå lämpligheten av olika aktiefinansieringsalternativ för tillväxtföretag inom miljöteknik. Detta görs genom en litteraturstudie samt en diskussion gällande resultaten. Forskningsfrågorna är följande: (1) Vilka är typiska karaktärsdrag för tillväxtföretag inom miljöteknik? (2) Hur väl lämpar sig olika aktiefinansieringsalternativ för att bemöta de typiska karaktärsdragen för tillväxtföretag inom miljöteknik? Forskningsmetoderna innefattar användandet av sökmotorer och databaser för att erhålla relevanta artiklar, rapporter och marknadsundersökningar inom ämnet.

Huvudresultaten för bägge forskningsfrågorna är följande: (1) Tillväxtföretag inom miljöteknik kännetecknas av följande karaktärsdrag: miljömål utöver vinstsökande, en hög kapitalintensitet, långa tidshorisonter för utveckling, utmanade av marknadsledare, krav på specialiserade investerare, volatila marknader samt en utmanande kommersialisering. (2) Gröna affärsänglar lämpar sig väl för dessa tillväxtföretag på grund av industriexpertis och förmågan att fungera som mellanhand till andra investerare. Gräsrotsfinansiering lämpar sig relativt bra trots att stödmekanismera är begränsade. Privat riskkapital lämpar sig väl under kortare investeringscykler på grund av stödmekanismer. Grönt korporativt riskkapital lämpar sig speciellt bra för dessa tillväxtföretag på grund av långsiktiga strategiska målsättningar för investeringarna. Statligt riskkapital lämpar någorlunda väl, men expertis inom miljöteknikindustrin kan saknas.

Nyckelord Aktiefinansiering, tillväxtföretag, miljöteknik, affärsänglar, gräsrotsfinansiering, privat riskkapital, korporativt riskkapital, statligt riskkapital

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1 Introduction

Startups play an important role in providing new technologies for solving global environmental challenges. Particularly clean technology (cleantech) startups are in a key role, as these are focused on solving environmental problems through new technologies (Mukherjee et al., 2024). These cleantech startups are important as current technologies are not enough to address global environmental challenges, such as reaching net zero (Botelho et al., 2023). New technologies are therefore needed. Cleantech startups, however, require funding to commercialize their environmental technologies on a global scale. New technologies providing more efficient energy production or less pollution might for example never reach the general market and make an impact without sufficient funding. The funding provided for cleantech startups is therefore essential for mitigating the effects of climate change as well as other environmental challenges (IPCC, 2022).

Still, a funding gap persists for cleantech startups, which may hinder these future environmental technologies from reaching the general market (Mukherjee et al., 2024). This gap can lead to challenges for startups in obtaining the necessary funding needed to commercialize. In addition, the constantly evolving landscape of different funding options may also lead to uncertainty for cleantech startups. This uncertainty may stem from a lack of understanding regarding which forms of funding are most suitable for a cleantech startup. The thesis is conducted to address this uncertainty and specifically concentrates on equity funding. The problem is addressed by matching the characteristics of different equity funding options with the characteristics of cleantech startups. Through this, insights are provided for which equity funding options are suitable for supporting cleantech startups in commercializing environmental technologies. As the funding gap causes limited availability of funding for cleantech startups, choosing suitable forms of funding becomes more important.

Previous research has been conducted on funding options for cleantech startups. Particularly Mukherjee et al. (2024) introduce different funding options broadly for cleantech Small and Medium-sized Enterprises (SMEs) and their challenges related to funding. de Lange (2017) also discusses how investors perceive and invest in startups with a sustainability focus. Still, O’Reilly et al. (2025) emphasize the need for further research on how equity funding impacts the performance of cleantech startups. Therefore, a gap in the research seems to exist regarding which forms of funding, particularly equity funding, are most suitable for cleantech startups.

This thesis is a literature review. The thesis aims to provide concrete insights for cleantech startups seeking equity funding. The goal is to clarify which forms of equity funding match best with the characteristics of cleantech startups. The suitability is determined by examining the characteristics, benefits, and drawbacks of these different forms of funding in the context of cleantech startups. Understanding this is important as cleantech startups can face problems in attracting funding, due to inherent characteristics (de Lange, 2017). The thesis addresses this problem by examining which funding options can best respond to these characteristics and therefore the suitability of these funding options for cleantech startups.

Given this background, the thesis aims to answer the following questions:

1. What are the defining characteristics of cleantech startups?
2. What is the suitability of different equity funding options for meeting the defining characteristics of cleantech startups?

The literature is comprised of academic articles, reports, and market studies. The articles used were extracted from the database Scopus. The following keywords were used to obtain articles in the area: "cleantech", "clean-tech", "climate-tech", "green", "climate tech", "environmental" combined with "entfin", "funding", "financing", "finance" or "business angels", "crowdfunding", "VC", "IVC", "CVC", "GVC", "venture capital". Among the equity funding options available the emphasis is on business angels (BAs), crowdfunding and venture capital (VC), as previous research on equity funding options for startups has primarily centered around these (Drover et al., 2017; O'Reilly et al., 2025). Tracking references and citations in available articles was additionally utilized to obtain further articles. Here, academic articles were extracted from literature reviews encompassing sustainable entrepreneurship and cleantech more generally.

The structure of the thesis begins with an introduction to cleantech startups in Chapter 2. Key terminology and definitions are first compared and explored. Next, defining characteristics of cleantech startups are identified, in line with the first research question. Additionally, challenges related to funding stemming from these characteristics are discussed. Chapter 3 first provides an overview of equity funding for cleantech startups. Based on this, different equity funding options are examined in the context of cleantech startups to answer the second research question. For each funding option general characteristics as well as benefits and drawbacks are identified. The equity funding options discussed are the following: BAs, crowdfunding, and VC. VC is divided into three parts: independent VC (IVC), corporate venture capital (CVC), and government venture capital (GVC). Chapter 4 then further discusses the suitability of these funding options, particularly for meeting the characteristics of cleantech startups. Finally, Chapter 5 concludes the key findings to the research questions. Limitations of the study and implications for further research are also outlined.

2 Cleantech Startups

The following section discusses cleantech startups as part of the broader area of sustainable entrepreneurship. Following this, cleantech as well as cleantech startups are defined by comparing existing definitions, and the importance of these startups is outlined. Next, the defining characteristics of these cleantech startups are discussed. The challenges in attracting funding caused by these characteristics are also examined.

2.1 Definition of Cleantech Startups

Cleantech startups can be viewed as a subcategory of sustainable entrepreneurship. Entrepreneurship concerns creating a new business whereas a startup achieves this, particularly through innovation and rapid growth (Ratten, 2023). Sustainable entrepreneurship goes beyond financial value capturing and profit-seeking. Sustainable entrepreneurship is defined as entrepreneurial activities aimed at business opportunities rooted in market failures negatively impacting sustainability (Dean & McMullen, 2007). This means addressing non-financial Environmental Social and Governmental (ESG) goals in addition to being profit-seeking (Mansouri & Momtaz, 2022). Tiba et al. (2021) further see sustainable entrepreneurship as profit-seeking startups with innovative solutions aimed at addressing the challenges defined under the 17 Sustainable Development Goals (SDGs) created by the United Nations. Anand et al. (2021) argue that sustainable entrepreneurship is characterized by a reduced negative impact on the environment as well as core business activities largely influenced by socio-environmental values. This means that the startup delivers both societal value and firm value (de Lange, 2017; Manigart & Khosravi, 2024). Some definitions, however, see sustainable entrepreneurship as non-profit organizations solely delivering societal value (Tiba et al., 2021).

Cleantech startups are profit-seeking entities under sustainable entrepreneurship, particularly targeting the environmental aspect. This relationship is depicted in Figure 1. The exact definitions for cleantech varies to some extent. Mukherjee et al. (2024) define cleantech as a variety of initiatives, technologies, and business models, which aim to reduce environmental impact. Reducing environmental impact includes activities such as minimizing emissions, using energy sources more efficiently, and avoiding waste. The different areas that cleantech startups consists of based on this definition are further illustrated in Figure 1. Cumming et al. (2016) argue that cleantech consists of technologies increasing energy efficiency and, additionally, that these also include areas such as information technology and green chemistry. Bento et al. (2019) on the contrary define cleantech as either initiatives focused on installations of energy plants or as products, which enable saving energy for the consumer. Here, a broader definition of cleantech will be used, in line with Mukherjee et al. (2024). Cleantech is defined as focusing on energy-efficient and environmentally positive technologies, thus encompassing the different subcategories presented in Figure 1. Moreover, cleantech startups pursue these technologies through rapid growth.

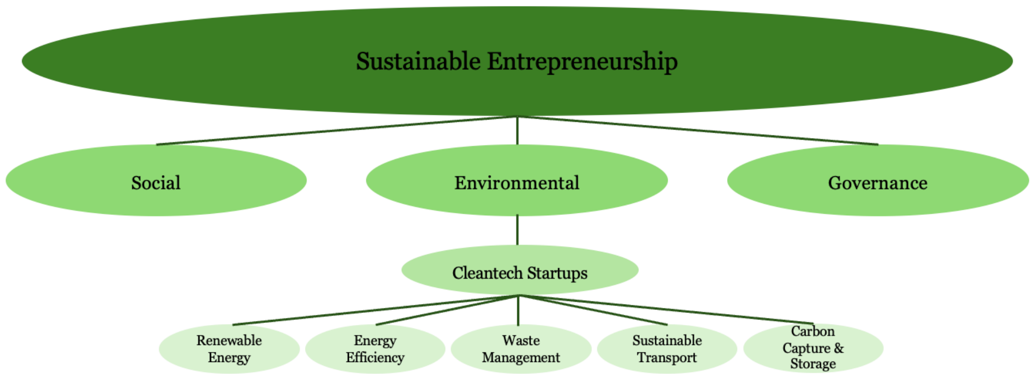

Figure 1. Cleantech startups in the context of sustainable entrepreneurship as well as the subcategories of cleantech startups. Adapted from Mukherjee et al. (2024).

As cleantech has a positive impact on the environment, cleantech startups are essential for achieving future sustainability and climate change mitigation targets. Achieving this change is enabled by the disruptive technologies of cleantech startups, which are pivotal for reducing the global carbon footprint (Owen, 2023). These novel technologies, particularly in the energy sector, are important as current alternative energy solutions, such as wind and solar power, are alone not enough to mitigate the effects of climate change (Bento et al., 2019; Gaddy et al., 2017). Cleantech startups as well as investors are therefore increasingly embracing these sustainability objectives (Manigart & Khosravi, 2024). Still, cleantech startups face problems in receiving funding, particularly in the early stages (Bento et al., 2019; Owen, 2023). The funding gap these startups face is caused by the inherent characteristics of cleantech startups.

2.2 Characteristics of Cleantech Startups

Cleantech startups are characterized by having a positive impact on the environment, which can lead to challenges from a business perspective. Eccles et al. (2014) argue that established companies with a high sustainability focus financially outperform companies, without similar policies, in the long run. Still, emerging startups might on the contrary face challenges from a sustainability focus. Cleantech startups can therefore be distinguished by restricted routes to financial success as environmental sustainability targets pose limitations on how revenue is generated (Mansouri & Momtaz, 2022). Meeting these targets in addition to seeking profit can stretch resources and therefore make these additional goals controversial (de Lange, 2017). Furthermore, entrepreneurs and investors are generally unable to fully capture the financial benefits from their environmental efforts (Cumming et al., 2016; Mansouri & Momtaz, 2022). Here, these benefits often positively affect the public more than the entrepreneur. All of society therefore benefits from the positive impact of cleantech (Cumming et al., 2016). These positive impacts are observable in for example water resources, the atmosphere, and the air. As a result, the end user can therefore not be charged for the environmental value created. Still, Eccles et al. (2014) argue that companies financially benefit from generating this public value, as this for example leads to a better perception among customers and employees.

The disruptive nature of cleantech startups further creates distinct characteristics, including high funding requirements and long development time horizons. These characteristics can in turn cause challenges in attracting investors. As one characteristic is a high capital intensity, cleantech startups require high initial investments, which leads to fewer interested investors (Cumming et al., 2016). The long time horizons of investments into cleantech additionally make these less attractive for private investors in comparison to shorter horizon sector investments (Owen, 2023). Shorter horizon investments, such as investments into software startups, can be more attractive due to faster payback times. Furthermore, the longer development timeframe results in cleantech startups typically facing the “The Valley of Death”. This is a challenging stage between the R&D phase and the commercialization phase (Hecht, 2023; O’Reilly et al., 2025). “The Valley of Death” is more evident in cleantech than with other disruptive new technologies due to the high funding requirements and regulatory risks, in addition to longer development timeframes (O’Reilly et al., 2025). This stage can lead to a lack of funding and eventually even bankruptcy. Therefore, this challenge of commercializing R&D is a further characteristic.

The characteristics of cleantech startups also cause challenges related to market factors. Cleantech startups typically create new markets or are deployed in newly emerged markets, in the same way as other disruptive startups (Siefkes et al., 2025). This can be perceived as unfavourably risky among investors. Investors considering cleantech startups as an investment may further lack an understanding of the sustainability-specific aspects and the complex technologies behind the product or service (Cumming et al., 2016; Siefkes et al., 2025). This therefore creates information asymmetries prior to the investment. The potentially limited expertise is also especially evident in the energy sector of cleantech startups and leads to a lack of understanding among investors regarding the market potential (Cumming et al., 2017). Specialized investor knowledge is therefore needed to support cleantech startups. Another characteristic is the volatile market of cleantech investments, which is for example influenced by the price of oil (Cumming et al., 2016). The market uncertainty has its roots in the boom and bust of the cleantech bubble in 2010 (Gaddy et al., 2017). Between 2000 and 2010 the investments into cleantech grew rapidly on a global scale from around 1% to around 10% (Cumming et al., 2016). After this rapid period of growth, the share of investments in cleantech saw a rapid decline until 2014 (Gaddy et al., 2017). This led to unpredictability regarding the cleantech market.

The characteristic of unpredictability in the cleantech market is also influenced by government regulations and policies (Cumming et al., 2016). The volatility partly stems from government policies and regulations being able to both hinder or increase funding for cleantech startups (Ghosh & Nanda, 2010). Here, the shorter regulatory cycles of governments in comparison to the longer development time horizons of cleantech startups can especially lead to volatility. For example, regulations might change every four years as governments change, whereas a cleantech startup might exist for a lifetime of eight years. This creates uncertainty for investors as the regulations concerning cleantech startups might evolve. Therefore, government regulations and policies can reduce these obstacles for cleantech startups primarily through long-term and stable policies (O'Reilly et al., 2025). This enables a better business environment for both cleantech startups as well as investors (Ambrois et al., 2025; Cumming et al., 2016). Here, countries with sustainable policies provide a better environment for cleantech startups through different forms of cost savings, which in turn can attract investors (de Lange, 2017).

Cleantech startups are further characterized by potentially facing challenges related to incumbents, which can result in poor exit opportunities (Ghosh & Nanda, 2010). Cleantech startups may be challenged by the incumbents in the energy industry, as energy companies, particularly those producing oil and gas, may be unlikely to support cleantech startups (Cumming et al., 2016). Although startups face this problem across industries, this phenomenon is more evident in the cleantech sector (Bocken, 2015). A large part of competing incumbents produce a commodity, energy, which means less pressure to adapt to new technologies (Ghosh & Nanda, 2010). The lack of support from incumbents may further pose an existential risk for these cleantech startups as this also results in poor exit opportunities (Cumming et al., 2016). Moreover, when investments are made by these incumbents into cleantech these may solely be superficial greenwashing efforts in order to please the public rather than finding alternative energy solutions for the future (Cherry & Sneirson, 2010; Ghosh & Nanda, 2010). Still, Cohen et al. (2020) argue the contrary, claiming that energy-producing incumbents generate high-quality green innovations, which support the sector of alternative energies as a whole.

The characteristics of cleantech startups, summarized in Table 1, are perceived in various ways among investors. Some investors view these as unprofitable while others are willing to compromise. de Lange (2017) argues that a sustainable mission and business model reliant on sustainability leads to investors perceiving the investment as unfavourable. On the contrary, Siefkes et al. (2025) claim that cleantech startups are becoming increasingly interesting for investors and that the perception of cleantech startups being risky investments is changing. Ambrois et al. (2025) support this, stating that investors are increasingly willing to look beyond the inherent risk of the sector and focus on the opportunities. This is, however, only if the startup is expected to grow rapidly. Many equity funding options particularly expect this rapid growth from cleantech startups for the investment to be profitable (Drover et al., 2017).

Table 1. Characteristics for cleantech startups.

	Key Observations	Literature
General Characteristics of Cleantech Startups	- Embracing environmental goals in addition to profit-seeking.	Mansouri & Momtaz (2022), Mukherjee et al. (2024)
	- Delivers both societal and firm value.	Cumming et al. (2016), de Lange (2017), Manigart & Khosravi (2024)
	- Unable to capture full economical benefits of environmental value creation.	Mansouri & Momtaz (2022), de Lange (2017), Cumming et al. (2016)
	- Focused on energy efficient and environmentally positive technologies.	Mukherjee et al. (2024)
Characteristics of Cleantech Startups Causing Funding Challenges	-Sustainability focused business model can be perceived as both risky and interesting.	de Lange (2017), Siefkes et al. (2025), Ambrois et al. (2025)
	- High capital intensity requiring high initial investments.	Cumming et al. (2016)
	- Long development time horizons.	Owen (2023), Ghosh & Nanda (2010)
	- Can be challenged by incumbents, leading to challenging exit opportunities.	Ghosh & Nanda (2010), Cumming et al. (2016), Cherry & Sneirson (2010)
	- Need for specialized knowledge among investors.	Siefkes et al. (2025), Cumming et al. (2016)
	- Volatile market of cleantech investments partly due to regulations and policies.	Cumming et al. (2016), Gaddy et al. (2017)
	- Hard to commercialize initial research due to disruptive technology.	O’Reilly et al. (2025)

3 Equity Funding Options for Cleantech Startups

The following section begins with a general overview of equity funding for cleantech startups, discussing general similarities and differences. The primary equity funding options for cleantech startups are additionally outlined. Each equity funding option is then examined in more detail in the following order: BAs, crowdfunding, IVC, CVC, and GVC. The order for these funding options is based on the order in which these funding options typically become relevant in the lifecycle of a cleantech startup, as Chapter 3.1 discusses. BAs and crowdfunding are first discussed as these are more relevant in earlier stages, whereas the different forms of VC are typically more active towards later stages. The characteristics of each funding option are further discussed. Additionally, benefits and drawbacks are addressed from a cleantech startup perspective. This in turn provides implications for the suitability of each funding option for cleantech startups.

3.1 Overview of Cleantech Startup Equity Funding

Startup equity investors trade capital for a share of ownership in a startup (Drover et al., 2017). This allows startups to avoid raising debt. Equity funding options are characterized by taking a significant risk but also gaining a potentially high financial reward. The different forms of equity funding are all further typically characterized by determining success through the exit (Deias & Magrini, 2023). This refers to the event when the shares of ownership are sold, with the target of generating a high return. Drover et al. (2017) view the primary forms of equity funding for startups as different forms of VC, BAs, crowdfunding, and accelerators. O'Reilly et al. (2025) highlight that in the context of cleantech startups, the primary equity funding options are IVC, CVC, GVC, BAs, and crowdfunding. These different forms of equity funding play an important role in the context of cleantech startups. O'Reilly et al. (2025) found that over their entire lifecycle, 61% of cleantech startups raise equity funding, which highlights the importance of this form of funding for cleantech startups.

These different equity funding options vary in the stage of funding provided and the funding amount (Drover et al., 2017). The difference between the five primary equity funding options for cleantech startups in terms of funding stage and funding amount can be seen in Figure 2. Here, Figure 2 illustrates how the different funding options are active throughout the lifecycle of a cleantech startup. First, BAs are individuals, typically with an entrepreneurial background themselves, investing personal capital into entrepreneurial ventures (Drover et al., 2017). As Figure 2 illustrates this typically occurs in earlier stages for cleantech startups when capital requirements are lower. Crowdfunding refers to a multitude of individuals, each investing a small amount in a startup, likewise in the initial stages (Bento et al., 2019). CVC concerns established corporations investing in the equity of startups, usually in the early or mid stages (Drover et al., 2017). These investments typically pursue long-term strategic goals and can provide significant funding amounts. GVC are funds managed by fully governmentally owned companies, which can provide significant funding from early and mid-stages onwards, similarly to CVC (Grilli & Murtinu, 2014). IVC refers to professional investors typically investing in later stages with high funding requirements (Ghosh & Nanda, 2010). This can, however, also be done in mid stages or even earlier stages. IVCs target potential high-growth startups with substantial technology risk. The three forms of VC can be active throughout all the stages of a cleantech startup, as Figure 2 illustrates (Hegeman & Sørheim, 2021). However, these investors typically invest after BAs and crowdfunding. Figure 2 additionally illustrates funding options, including private equity (PE) and debt, which become relevant in later stages once the startup phase is passed for the cleantech startup.

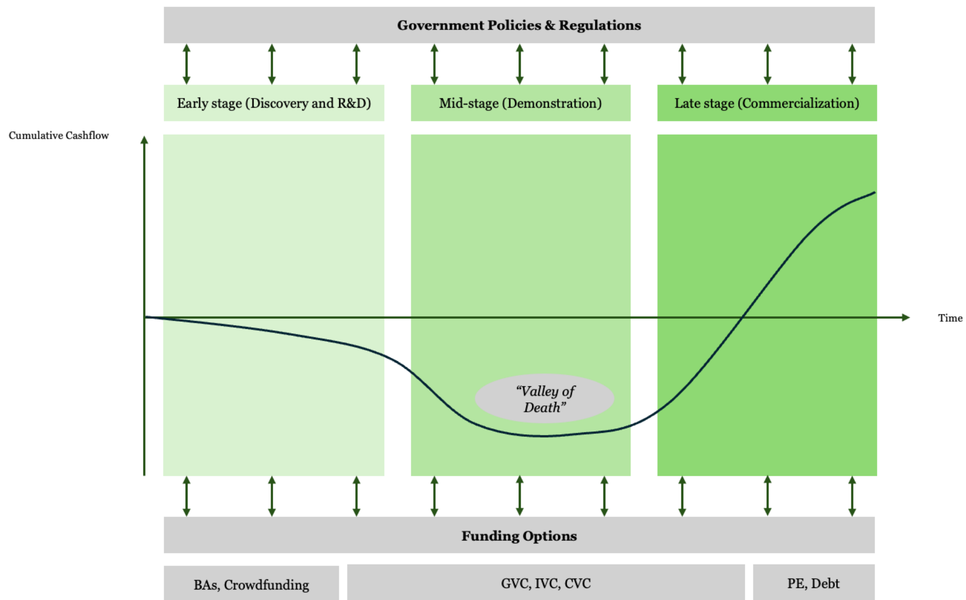

Figure 2. Funding options throughout the lifecycle of cleantech startups. Adapted from Hegeman and Sørheim (2021).

Equity funding options further differ in strategic objectives, geographic area, and degree of involvement after having provided funding (Drover et al., 2017). The strategic objectives can involve varying emphasis on financial and societal outcomes (Klein et al., 2019). Moreover, the additional involvement after funding may include for example mentoring and access to networks (Bocken, 2015). Equity funding options also differ in terms of how accessible each funding option is for startups (Klein et al., 2019). These areas cause variations between the funding options in the context of cleantech startups. Through individually examining each equity funding option in the context of cleantech startups the suitability can be understood.

3.2 Business Angels

BAs are characterized by seeking ventures to apply their expertise in and pursuing this in a less formal way (Drover et al., 2017). This means, for example, focusing less on contracts and due diligence before investing. The startups benefit from these investors as they apply their expertise throughout the lifecycle, for example by serving as a board member (Siefkes et al., 2025). BAs invest their personal capital and are further not bound by the interests of outside shareholders (Botelho et al., 2023). This in turn leads to greater independence and even investments beyond solely financial return (Botelho et al., 2023; Siefkes et al., 2025). BAs make these investments based on a combination of altruistic, hedonistic, and economic motivations (Botelho et al., 2023).

BAs with existing knowledge in the cleantech sector provide additional benefits for cleantech startups, through for example sharing best practise information and helping attract additional funding. Specifically "green angels" are more likely to value the long-term environmental benefits as opposed to short-term financial gains (Siefkes et al., 2025). These green BAs possess a track record of investing in previous cleantech startups. Furthermore, green BAs bring sustainability value to the startup after the initial investment through strategic advice. This includes advice on for example supplier selection as well as sustainability monitoring and reporting best practises (Siefkes et al., 2025). This industry knowledge of green BAs has additional benefits. Green BAs can serve as intermediaries between cleantech entrepreneurs and traditional investors by understanding the perspectives of both sides (Bergset, 2015). Having green BAs early on might therefore help attract additional funding. The expertise of BAs in specific fields as investors can also lead to a better understanding of the advanced technologies developed by cleantech startups (Siefkes et al., 2025). This might therefore increase the likelihood of these BAs investing. In the context of cleantech startups Botelho et al. (2023) even argue that BAs are the primary source of funding enabling cleantech startups to find a market. Finding this market is enabled by the expertise of BAs.

BAs also exhibit drawbacks in the context of cleantech startups, caused by the heterogeneity of these investors. Although many BAs investing in cleantech startups are driven by altruistic reasons Botelho et al. (2023) found that this is not the sole driver. Economic drivers play an equally important role, emphasizing that cleantech startups should adopt this point of view in their pitches. Furthermore, this group of investors is comparatively heterogeneous (Siefkes et al., 2025). This means that the interests, motivations, activity, and competence in the context of sustainability vary greatly among these BAs. Consequently, the impact and value added to the startup by the BAs also greatly varies (Siefkes et al., 2025). One such difference within this group can be seen with "green angels" and "light green angels" (Botelho et al., 2023). Here, light green angels, similarly to green angels, invest in cleantech startups but pursue financial returns instead of additional environmental motivations.

3.3 Crowdfunding

Crowdfunding is typically conducted through the internet and can be viewed as an "open call" for funding, both as donations or in exchange for some financial or non-financial benefits (Schwienbacher & Larralde, 2010). An example of a novel form of crowdfunding is Initial Coin Offerings (ICOs), which emerged through digitalization (Manigart & Khosravi, 2024). These are a form of blockchain-based token crowdfunding. The benefits these crowdfunders receive are typically equity shares, future products, a share of the profits, or voting rights to support the purpose of the startup (Bento et al., 2019). Therefore, crowdfunding cannot always strictly be classified as a form of equity funding if the benefits are not tied to equity ownership. Still, the incentives for these investments can be seen as aimed at economic value, a guaranteed output of the startup, or personal utility for the individual investor.

General benefits of crowdfunding, beyond the context of cleantech, are rooted in crowdfunders, who ground investment decisions on values over financial return. Crowdfunders typically base investment decisions on core values, such as environmental goals, as opposed to business plans and collateral (Lehner, 2016). This can be seen in the context of cleantech startups, where crowdfunders increasingly invest despite these startups financially underperforming within a year compared to non-sustainability-focused startups (Mansouri & Momtaz, 2022). Bento et al. (2019) show that crowdfunders, investing specifically into cleantech, take a higher risk, which is not reflected in the reward received from this. Bento et al. (2019) further argue that this is partly explained by altruism. More generally, sustainable entrepreneurship achieves higher initial valuations in comparison to conventional entrepreneurship in crowdfunding campaigns (Mansouri & Momtaz, 2022). Crowdfunders typically invest smaller amounts, which enables partly substituting financial performance for societal value in this previously described way (Cumming et al., 2017).

Cleantech startups can further benefit from crowdfunders by attracting additional investors. By attracting additional investors crowdfunding can be beneficial for cleantech startups beyond solely accumulating funding (Mollick, 2014). This is particularly the case when the crowdfunders through their investments signal a demand for a given product or solution (Mollick, 2014). These crowdfunding investments also serve as a method for validating the idea and business plan of the startup (Gerber et al., 2012). Investments made by these crowdfunders may then attract other investors, such as VCs, as these investors view the startup as less risky by having demonstrated demand and validity (Bocken, 2015). As crowdfunding can open the door to additional investors, it is a particularly useful funding option in the initial stages characterized by limited funding options (Bento et al., 2019; Schwienbacher & Larralde, 2010).

Cleantech startups also benefit from the large group of investing individuals in crowdfunding. As crowdfunding is conducted through a large group of individuals, the ownership is scattered if the crowdfunders receive equity (Gerber et al., 2012). This allows the startup to maintain control. Furthermore, crowdfunders are typically actively engaged in the venture or project, bringing potential insights to the startup (Schwienbacher & Larralde, 2010). The crowdfunders are as mentioned often potential customers, which therefore allows cleantech startups to expand awareness among customers in their crowdfunding campaigns (Gerber et al., 2012). The above-mentioned benefits have allowed crowdfunding investments to grow at a rapid pace, rooting this as a promising future funding option for cleantech startups (Cumming et al., 2017). Still, crowdfunding has its challenges in the context of cleantech startups.

The key drawbacks of crowdfunding in the context of cleantech startups stem from the unprofessional nature of the investors. First, crowdfunding typically raises a low amount of capital in comparison to professional investors (Schwienbacher & Larralde, 2010). These low funding amounts are a downside for crowdfunding in the context of the typically capital-intensive cleantech startups. Crowdfunders accepting lower returns for cleantech investments can also be caused by bounded rationality as opposed to the previously mentioned altruism (Bento et al., 2019). Information asymmetry prior to the investment might further be higher among crowdfunders compared to other investors as these crowdfunders are not specialists in the cleantech industry (Schwienbacher & Larralde, 2010). Additionally, as the crowdfunders are a scattered group of investors without specialist knowledge, they are unable to provide expertise or networks as with other forms of funding (Bocken, 2015). Crowdfunders therefore lack an active role in the operations or decision-making of startups (Bento et al., 2019).

Market factors also cause challenges in crowdfunding investments. Crowdfunding campaigns for cleantech startups are e.g. impacted by oil prices with lower prices resulting in a decrease in investments into cleantech startups (Cumming et al., 2017). Furthermore, the success of crowdfunding campaigns varies depending on the country, with lower success in countries with high levels of individualism. These factors can cause challenges for obtaining crowdfunding in individualistic countries as well as during times with low oil prices. Finally, despite the above-mentioned challenges it is worth noting that crowdfunding, in the context of cleantech, remains quite unexplored. Only a few research articles (Bento et al., 2019; Cumming et al., 2017; Lehner, 2016; Mansouri & Momtaz, 2022) have been published in this context, which creates some uncertainty regarding the suitability of the funding option.

3.4 Independent Venture Capital

IVCs typically invest in already growing companies in later investment stages as a way of mitigating the high risk (Ambrois et al., 2025). IVCs can, however, also invest during R&D, early commercialization, or scale-up stages (Ghosh & Nanda, 2010). The high risk of these investments leads to a potentially high reward for the investors. The high reward is typically achieved through a trade sale or initial public offering (IPO) (Owen, 2023). IVC investments, in comparison to other forms of equity funding options, conventionally lead to higher levels of innovation and a more rapid commercialization for a startup (Dutta & Folta, 2016). This is partly possible due to the following IVC characteristics: enabling the adoption of network effects, creating new market segments for new technologies, and increasing demand through brand marketing (Ambrois et al., 2025). Additionally, IVCs provide business coaching and network support (Bocken, 2015). The network support can consist of for example customers, suppliers, and lawyers. All of these factors help to remove obstacles in the way of the success of the startup (Ghosh & Nanda, 2010).

IVCs can be a beneficial option for cleantech startups in later stages with short timeframes due to the industry knowledge these IVCs possess. Ambrois et al. (2025) argue that IVCs positively impact the growth rate of cleantech startups, surpassing non-IVC-backed cleantech startups, particularly in the short term. This growth rate was found to be most evident on a shorter time horizon of 3 years after the initial IVC investment. Furthermore, IVCs provide a supporting effect by offering industry knowledge and expertise, which particularly aids in turning the startup into revenue-producing (Wüstenhagen & Teppo, 2006). This comes from niched abilities of IVCs to understand a certain area of cleantech startups, such as the energy sector (Ambrois et al., 2025). The expertise enables these IVCs to understand emerging technologies and markets. Moreover, this allows the cleantech startup to enter a completely new technology market in a short time successfully (Owen, 2023). These synergies between cleantech startups and IVC can also be seen in the market for IVC investments in cleantech startups, showing promising signs of growth (Gaddy et al., 2017). For example, the IVC deals made into cleantech startups in Europe tripled from 2015 to 2023 (Ladwig, 2025)

Cleantech startups still face funding challenges related to IVCs as these can find cleantech startups as unsuitable investments. Factors, that may lead to IVCs viewing cleantech startups as unsuitable, are the capital-intensiveness as well as market growth uncertainties of cleantech more generally. IVCs typically avoid capital-intensive sectors, which is particularly characteristic of cleantech startups during development and scaling (Cumming et al., 2016; Gaddy et al., 2017). Additionally, the risk is higher and remains for much longer in cleantech investments compared to IVC investments in other industries (Ghosh & Nanda, 2010). Evaluating the market growth opportunities in this context is additionally more difficult for IVCs, which increases the risk (Cumming et al., 2016). Deep technology (deeptech) startups within the context of cleantech possess a particularly high risk for IVCs as these technologies, such as hardware, materials, or chemistries, require the largest amounts of funding but yield the lowest profits (Gaddy et al., 2017). These factors might lead to IVCs turning down investments in cleantech startups.

The longer development cycles of cleantech startups can also cause post-investment challenges with IVC funding due to misalignment between time frames. Here, IVCs can be unsuitable for startups due to their short-term investment mindsets, potentially expecting payback periods of 2-3 years (Bocken, 2015). This clashes with the long-term development timeframes of cleantech startups. Particularly cleantech startups with project-based business models, such as biogas plants or windfarms, have proven to financially perform poorly for IVC investments due to the longer timeframe (Ambrois et al., 2025). This became evident during the VC cleantech bubble between 2005 and 2010. The underperformance was due to a longer timeframe in comparison to traditional IVC investments caused by extensive planning and preparation stages. Gaddy et al. (2017) further argue that cleantech startups focused on materials and hardware require longer development cycles than the 3–5-year cycles typically expected by IVCs. According to Gaddy et al. (2017) this further makes IVCs unsuitable for cleantech startups. IVCs typically also need proof of commercial viability to invest in future investment rounds (Ghosh & Nanda, 2010). This is a challenge for cleantech startups as proving the commercial viability is protracted due to the longer timeframe.

3.5 Corporate Venture Capital

CVC is conducted on the side of the core business activities of the corporations and generally invested with long-term strategic goals for the investment (Drover et al., 2017). These strategic goals include increasing industry knowledge, gaining access to innovations and customer segments as well as providing capital. From the corporate perspective, CVC provides a viable alternative to mergers and acquisitions (M&A) when uncertainty is high, such as with the cleantech market (Drover et al., 2017). CVC investments into cleantech startups can therefore help companies with green opportunities and responsiveness, as these generally offer more strategic value as opposed to merely providing capital (Hegeman & Sørheim, 2021).

CVC is generally beneficial for both the startup and investing enterprise when these two parts pursue complementary interests and are not competitors (Dushnitsky & Shaver, 2009). In this case, the collaboration becomes more fruitful, and interaction as well as sharing of information increases. Here, CVC can additionally provide industry contacts and expertise on top of capital (Huang & Madhavan, 2021). Drover et al. (2017) agree that the collaboration aspect is a strength of CVC from a startup perspective. Furthermore, the complementary assets CVC provides increase innovation and growth for the startup (Drover et al., 2017). Wunder and Maula (2024) support this is in the context of cleantech, arguing that “green CVC” facilitates green innovation for the startup after the investment. Here, green CVC refers to CVCs with a parent company already engaged in green technologies. Non-green CVCs, on the contrary, show no evidence of supporting cleantech startups in this way.

In addition to complementary benefits, CVC can be beneficial for cleantech startups as CVC investments can seek strategic long-term benefits over short-term financial returns (Hegeman & Sørheim, 2021). However, the motivations for these investments differ between smaller and larger firms. CVC investments into cleantech startups may not be advantageous financially, but despite this both larger enterprises and SMEs possess various incentives for investing CVC (Hegeman & Sørheim, 2021). Allen and Hevert (2007) even argue that the majority of different subunits of a firm engaged in CVC typically experience substantial negative returns. On the contrary, Huang and Madhavan (2021) argue that CVC investments generally are financially beneficial for the investing corporation, although the extent of this varies. Nevertheless, these investments are made regardless, as the strategic value for the whole firm is in focus (Allen & Hevert, 2007). Here, CVC investments from larger enterprises have the incentive to become greener (Hegeman & Sørheim, 2021). These enterprises hold the underlying assumption that cleantech will become financially viable in the future. Therefore, these enterprises assume that exposure through investments will be beneficial in the long run. Hegeman and Sørheim (2021) further argue that SMEs on the other hand are more likely to undertake these CVC investments to increase revenue and enhance business development. SMEs therefore focus less on green opportunities and are even unaware of the specific risks related to the investment.

Non-green CVC causes drawbacks for cleantech startups, as this might come from adverse incumbents (Cumming et al., 2016). The sector of cleantech is characterized by certain incumbents unwilling to invest in cleantech startups, which might cause challenges for cleantech startups seeking CVC funding. Therefore it is important to make the distinction between green and non-green incumbents investing CVC (Wunder & Maula, 2024). The distinction is important as non-green CVC has a negative impact on green innovations after the investment. Gaddy et al. (2017) also argue that companies with the potential to acquire cleantech startups are likely to be more risk-averse and focused on revenue, which is in line with the goals of non-green CVC. These incumbents are more cautious compared to for example established medical and software companies making acquisitions in their respective sectors.

3.6 Government Venture Capital

GVCs are funds where a government provides the capital for investing (Grilli & Murtinu, 2014). The capital can then be invested into startups through for example direct investments or co-financing (Mukherjee et al., 2024). These investments target startups with a positive impact on society, typically in their early stages (Grilli & Murtinu, 2014). Furthermore, GVC is often focused on sectors experiencing a funding gap (Colombo et al., 2016). An example of this is GVC investing in economically underdeveloped regions without an established IVC ecosystem. GVC traditionally seeks to drive the growth of the IVC investments to the sectors with funding gaps, which is referred to as “crowding-in” (Leleux & Surlemont, 2003). Here, the GVC investment into a startup can signal growth potential to IVCs. On the contrary, GVC can also lead to “crowding-out”, which refers to driving away

IVC investments from a sector. Colombo et al. (2016) further emphasize that GVC can pursue investments benefiting the whole society with limited financial returns. This means that the GVC can act more patiently in terms of the exit and prioritize the societal value-adding activities. Moreover, GVC prioritizes these activities by using fewer contract mechanisms focused on financial outcomes, in comparison to IVC (Grilli & Murtinu, 2014).

In the context of cleantech, GVC is likely to grow and become more common as this form of funding helps tackle the funding gap cleantech startups typically face (Owen, 2023). Additionally, GVC supports the private market for cleantech IVC investments through this. GVC can particularly support the sector by cofinancing cleantech startups with IVC, which reduces the risk for the cleantech IVC. This form of cofinancing is brought up by multiple sources as a key solution for driving the success of cleantech startups (Cumming et al., 2016; Hegeman & Sørheim, 2021; IPCC, 2022; Mukherjee et al., 2024).

GVC is further beneficial for driving green innovation in the invested cleantech startups through characteristics differing from IVC and CVC (Li et al., 2024). One such characteristic supporting cleantech startups is a sufficient fund size, which enables the fund to provide significant investments (Owen, 2023). GVC is also characterized by the ability to provide long-term investments extending beyond 10 years. Additionally, GVC can choose to target investments to markets experiencing funding gaps and thus bridge the funding gap for cleantech startups (Li et al., 2024). Li et al. (2024) further found that through GVC, cleantech startups can see an increase in green patents and alleviated financial constraints. Given these varying characteristics, Owen (2023) argue that the role of GVC is becoming increasingly important in early-stage funding, for example as this could help attract more private investments.

GVC is, however, a constantly emerging form of cleantech funding, which creates challenges for startups related to benefitting from and obtaining funding (Owen, 2023). First, GVCs are more likely to lack the expertise and support mechanisms needed to grow the startup in comparison to IVC (Colombo et al., 2016). This lack of coaching leads to underperformance and a lack of efficiency. Owen (2023) further highlight that GVCs still typically put relatively little emphasis on funding for early-stage cleantech startups, as this funding is targeted towards larger projects. Additionally, the benefits provided by the GVCs are smaller for startups in comparison to these larger projects (Li et al., 2024). Still, GVC is constantly growing and can be expected to overcome these challenges and play an increasingly important role for cleantech startups in the future (Owen, 2023). Li et al. (2024) support this arguing that the positive effects of GVC on cleantech startups outweigh the drawbacks.

4 Discussion

Throughout the different equity funding options certain characteristics are reoccurring in the context of cleantech startups. One such reoccurring characteristic is the valuation of non-financial environmental benefits of cleantech startups. The equity funding investors value this to a varying degree, with crowdfunding and GVC putting the most emphasis on this and IVC the least. de Lange (2017) still argues that cleantech investors base their decisions on actual or expected financial returns. This holds true for the different equity funding options as financial viability is required from all funding options, although environmental benefits are appreciated. Regardless of the funding option, cleantech startups should therefore emphasize the business case over sustainability benefits when seeking funding (Bocken, 2015).

The heterogeneity of the investors as well as market volatility are additionally returning themes. The heterogeneity within a certain type of investors can be seen in terms of the degree to which societal benefits are valued. One example of this is “green angels” and “light green angels”, as discussed by Botelho et al. (2023). Due to this heterogeneity, different investors must be approached in different ways. A further reoccurring phenomenon among the equity funding options discussed is the market volatility of the investments. This again emphasizes the need for stable regulations and policies to create an attractive funding environment, as discussed in Chapter 2.2. Despite reoccurring similarities, the funding options exhibit varying characteristics. These characteristics result in varying degrees of suitability of the five primary funding options for cleantech startups.

BAs seem particularly well-suited for cleantech startups, particularly green BAs investing in the initial stages. This stems from expertise and interest in the cleantech sector. As mentioned, these green BAs provide information on industry best practises and work as a bridge to other investors (Siefkes et al., 2025). Green BAs therefore particularly address the need for cleantech startups related to having investors providing specialized knowledge. The industry knowledge can additionally help startups with commercializing initial research and bridging the gap to incumbents. Having a skilled BA as an investor early on might thus be valuable primarily due to the expertise provided. Still, the previously mentioned heterogeneity of BAs is a challenge addressed by Botelho et al. (2023).

These green BAs might further be more prone to view the sustainability mission of a cleantech startup as valuable. This addresses the challenge related to a sustainability-focused business model. Here, BAs are not constrained by outside stakeholders, which might play a part in enabling this.

Additionally, this might equip BAs with a tolerance for the long-term development cycle of cleantech startups. The funding provided by BAs might, on the contrary, not be sufficient for a cleantech startup in the long term, which emphasizes the need for additional funding. As BAs are individual investors the threshold might be too high to invest beyond initial stages in the capital-intensive sector of cleantech startups.

Crowdfunding could serve as an additional funding option, as this option shows relatively promising suitability in the context of cleantech startups. Still, crowdfunding has its drawbacks. The market of crowdfunding is, as stated, quite young but still shows promising signs as a form of funding for cleantech startups. As crowdfunders can ground investment decisions on values over financial viability (Lehner, 2016) this makes it suitable for cleantech startups with environmental goals in addition to seeking profit. This might facilitate easier access to crowdfunding for a cleantech startup, although the amounts received are likely to be relatively small. A benefit of crowdfunding is additionally maintaining control (Gerber et al., 2012). However, this is likely not relevant if the whole lifecycle of the cleantech startup is considered. As cleantech startups are capital-intensive, other equity funding options are most likely essential during some part of this lifecycle to commercialize. Therefore, the control might still be lost to some degree eventually.

Although crowdfunding provides capital, a cleantech startup will not necessarily benefit after the investment. As crowdfunders lack industry expertise crowdfunding fails to address the characteristics concerning the need for specialized investors, commercialization, and bridging the gap to incumbents. Crowdfunding can still help attract additional investors after the investment by showing demand for a given product or solution (Mollick, 2014). This could, however, be argued to not always be applicable as the interest of crowdfunders might come from the environmental benefits of the startup as opposed to the viability of the product. Furthermore, if the product is not sold directly to consumers this benefit is likely to not be evident as the crowdfunders receive no product for their investment. Therefore, crowdfunding may not always attract additional investors after the investment.

IVC can on the contrary be argued as suitable for cleantech startups, particularly in later stages, due to potential specialized knowledge in the cleantech sector. This expertise enables additional value-adding activities, including the adoption of network effects, coaching, creating new market segments, and increasing demand (Ambrois et al., 2025). Through these traits, IVCs can help cleantech startups overcome the challenges of commercialization and the need for specialized knowledge among investors.

Additionally, IVCs are likely to be able to provide sufficient funding amounts, which in turn addresses the challenge of capital-intensity among cleantech startups. Furthermore, IVCs might bridge the gap between incumbents and cleantech startups, thus facilitating exit opportunities. This could be argued as the expertise of IVCs could enable support and guidance, steering the startup in a direction leading up to a merger or acquisition. Still, IVCs drive a clearer focus on financial viability over sustainability targets and are affected by the volatile market.

The primary downsides of IVCs in the literature further seem to be various reasons for why IVCs might perceive cleantech startups as unsuitable investments. These reasons are primarily the capital-intensiveness (Cumming et al., 2016) and longer development timeframes of the startups (Gaddy et al., 2017). It is worth noting that this likely affects the investment decision itself rather than the suitability after the investment. As the IVC market is showing positive signs of growth (Ladwig, 2025) IVCs could still be seen as increasingly willing to overlook these downsides. One post-investment risk could, however, be caused by losing the IVCs during later funding rounds due to a prolonged timeframe. Therefore, seeking IVC in later commercialization stages could potentially be preferred as the longer development time frames appear unsuitable for IVC. This is to keep the investment cycles of IVCs shorter, in line with the typical expectations of IVCs. Alternatively, IVCs could also be suitable in earlier stages if the IVC is particularly focused on cleantech startups and willing to sit through longer development cycles.

CVC can also be argued as suitable for cleantech startups as CVCs are likely to have long-term strategic goals for the investment. This creates an advantage over the typically short-term focused IVC. Through this, CVC can potentially overlook the challenges of cleantech startups related to a restricted ability to generate profit due to environmental targets. This strategic approach of CVC can also enable suitability for the long-term development nature and capital-intensity of cleantech startups. Having long-term strategic goals for the CVC investment can further make the investors less concerned about market volatility. The previously discussed benefits of IVC, such as expertise, coaching, and access to a network, are also likely to apply for CVC. As CVC comes from the incumbents in the sector, this can further address the challenge related to incumbents for cleantech startups. However, to benefit from these characteristics a distinction between green and non-green CVC must be made.

CVC from larger enterprises, primarily green CVC, is particularly suitable for cleantech startups. The suitability becomes evident in situations where the cleantech startup and investing enterprise pursue complementary interests.

This is as green CVC increases innovation, growth (Drover et al., 2017), and information sharing (Dushnitsky & Shaver, 2009) for the cleantech startup. Non-green CVC on the contrary seems to be unsuitable for cleantech startups. This form of CVC is likely not able to provide the previously mentioned additional benefits and might only seek financial returns over long-term strategic value.

GVC further seems relatively suitable for cleantech startups, arguably most so in the earlier stages. This is as GVC might attract and crowd in additional IVC after the investment. For example, Owen (2023) highlights this, emphasizing that the earlier stages are most suitable for seeking GVC from the perspective of a cleantech startup. GVC could also be argued as suitable in the initial stages as GVC can take a greater financial risk as the interest of GVC is more targeted towards the environmental benefits provided by the startup. This could make GVC tolerable for the characteristics of high capital-intensity and long development cycles. However, GVC lacks the same level of expertise as IVC or CVC. This could potentially lead to obstacles in meeting the needs for specialized knowledge among investors and overall support for commercialization. As the research on GVC remains somewhat limited the impact GVC has on bridging the gap to incumbents as well as to what extent GVC is affected by market volatility remains uncertain.

The suitability as well as characteristics of the different equity funding options discussed are summarized in Table 2. Table 2 outlines the differences and similarities between equity funding options in the context of cleantech startups. The characteristics are divided into general characteristics and characteristics specific to the cleantech startup context. Moreover, suitability is examined through general suitability for cleantech startups as well as through which funding stage is most suitable for the funding option in the cleantech startup context.

Table 2. Characteristics and suitability of equity funding options for cleantech startups.

	General Characteristics	Characteristics in Cleantech Startup Context	Suitability for Cleantech Startups	Suitability for Cleantech Startup Funding Stage
BA	- Typically have entrepreneurial background - Invest in early stages - Seek ventures to apply their personal expertise	- Can help attract additional funding - Green BAs are likely to value long term benefits and have industry knowledge - Not bound by interests of outside shareholders - Heterogenous group, different reasons for investing	- Green Bas are likely to be suitable in initial stages due to expertise	- Suitable in initial stages for implementing cleantech best-practises and helping attract additional funding
Crowdfunding	- The crowdfunders can be actively engaged - Done through the internet - Typically invested in early stages - Startup maintaining control - Potentially attracts other investors and expands awareness	- Investment decisions based on core values and valuation of non-financial benefits - Raises relatively low amount of capital - Crowdfunders are not experts in the cleantech industry - Crowdfunding campaigns influenced by a countries level of individualism	- Crowdfunding seems relatively suitable for cleantech startups, however, additional value-adding activities are limited	- Suitable in early stages for proving viability of products and limited amounts of capital
IVC	- Invests in startups with high growth potential, typically in later stages - The end goal of the investment is a trade sale or IPO	- Positively impacts the growth rate in the short term - Potential niched cleantech industry knowledge, enabling entering new markets, innovation and fast commercialization - Usuitable for project-based cleantech business models - Potentially unwilling to invest in cleantech startups due to capital-intensity, market volatility and uncertain exit opportunities	- IVC can be argued as suitable for cleantech startups due to potential specialized cleantech knowledge	- More suitable in later stages of the cleantech startup lifecycle, when the innovation can be commercialized in a shorter time frame
CVC	- CVC is often invested in early or mid-stages - Investments made on the side of core business activities - Long-term strategic goals for the investments - An alternative to R&D for innovating - Growth and innovation increases from pursuing complementary interests	- Larger enterprises are willing to prioritize long-term strategic benefits over financial value - Green CVC facilitates innovation while non-green CVC has a negative impact - Adverse incumbents might cause challenges in receiving funding	- CVC, particularly green CVC, seems suitable for cleantech startups by having long-term strategic goals for the investment	- Can be suitable from early- to mid-stages onwards due to long-term strategic goals
GVC	- Government provides capital - Focused in sectors experiencing a funding gap - Can "crowd-in" or "crowd-out" other investors - Can pursue investments benefiting the whole society with limited financial returns	- Can attract IVC by reducing the risk through co-financing - Can provide sufficient amounts of funding over longer time periods - Cleantech startups can see an increase in green patents and alleviated financial constraints - Lacks expertise and support mechanisms - Little emphasis on funding for early-stage cleantech startups	- GVC seems relatively suitable by providing sufficient funding, however, additional value-adding activities are limited	- Suitable in initial stages for providing larger amounts of funding

The general suitability of each equity funding option outlined in Table 2 can through the discussion be determined on a more detailed level. This concerns the suitability of the different equity funding options in addressing the defining characteristics of cleantech startups. Table 3 visualizes the degree of this suitability. Here, the rightmost column illustrates the overall suitability, as the other characteristics all impact how suitable each option is for supporting commercialization. As mentioned, the heterogeneity among funding options is further worth considering. The table is based on to which degree each funding option can provide support in the best scenarios, however, this suitability varies depending on the context. For example, CVC might therefore not always be the most suitable option across various situations.

Table 3. Suitability of equity funding options for meeting the defining characteristics of cleantech startups.

	Acceptance of sustainability focused business model	Tolerance for high capital intensity	Suitability for long development time horizons	Ability to bridge gap to adverse incumbents	Industry expertise addressing need for specialized knowledge	Unaffected by volatile cleantech market	Overall support for commercial izing the technology
BAs	Medium	Low	Medium	Medium	High	Can't say / Not Mentioned	Medium
Crowdfunding	High	Low	Can't say / Not Mentioned	Low	Low	Can't say / Not Mentioned	Low
IVC	Low	High	Low	Medium	High	Low	High
CVC	Medium	High	High	High	High	High	High
GVC	High	High	High	Can't say / Not Mentioned	Low	Can't say / Not Mentioned	Medium

Can't say / Not Mentioned   Low   Medium   High

As Table 3 presents the equity funding options show commonalities and distinctions across the defining characteristics of cleantech startups. In terms of providing sufficient funding the VC options all display a high ability for this, whereas crowdfunding and BAs are likely to provide significantly smaller amounts. CVC and GVC also both show suitability for long-term development cycles, particularly in comparison to IVC with lower suitability. CVC further seems to be the only option with the potential of efficiently addressing the challenges caused by incumbents. IVC and BAs, however, also display a relatively promising suitability regarding this. The funding options also differ in terms of industry expertise. IVC, CVC, and BAs are more likely to have the highest industry expertise, while crowdfunding and GVC generally have significantly lower industry expertise. The level of acceptance for the volatile market remains unexplored in research, at least for BAs, crowdfunding, and GVC. CVC can, however, endure this particularly well, whereas IVC is more sensitive. Overall, the suitability seems the highest for IVC and CVC. Crowdfunding, on the contrary, seems to have the overall lowest suitability.

5 Conclusion

This thesis explored the suitability of different equity funding options for cleantech startups. The objective was to offer practical insights for cleantech startups seeking equity funding. The insights aimed to particularly address which funding options support the commercialization of environmental technologies through additional value-adding activities beyond strictly capital. This was achieved by first defining and outlining the characteristics of cleantech startups. The literature, related to the five primary equity funding options in the context of cleantech startups, was next examined. Based on this, the suitability of each funding option was discussed, particularly in meeting the characteristics of cleantech startups. This thesis contributes to existing research by discussing the impact different equity funding options have on cleantech startups, thus exploring an unanswered question in the field (O'Reilly et al., 2025).

The results provide insights into the characteristics of cleantech startups and the suitability of five different equity funding options for cleantech startups. The characteristics of cleantech startups answer the first research question and can be summarized into seven primary characteristics. These are driving environmental benefits in addition to seeking profit, a high capital intensity, long development time horizons, being challenged by incumbents, a need for specialized investor knowledge, volatile markets, and an overall challenging commercialization. Notably, these characteristics are linked and may even overlap. For example, a challenging commercialization can be caused by one or multiple of the other characteristics. Moreover, these characteristics cause varying degrees of obstacles to securing funding.

The suitability of the different equity funding options was further compared and outlined, particularly in the context of addressing the characteristics of cleantech startups. For the second research question regarding suitability, the following was concluded. Particularly green BAs seem suitable for cleantech startups in the early stages due to additional expertise provided. This expertise also helps bridge the gap to other investors. Crowdfunding on the contrary seems to lack the ability to provide additional value-adding activities, which implies a lower suitability. Crowdfunding can, however, be suitable for validating products or business ideas. This can particularly be utilized in earlier stages with lower capital requirements. IVC seems suitable in later commercialization stages due to industry knowledge, however, mid- or early stages might also be suitable if the IVCs are specialized in cleantech. Taking on IVC in later stages still seems particularly suitable as IVC tends to put most emphasis on financial viability over the short term. Green CVC seems particularly suitable in early or mid-stages due to long-term goals of investments and expertise, which match well with the characteristics of cleantech startups. Here the benefits include increased innovation and support functions. These benefits are, however, likely accessed only in situations where green CVCs pursue complementary interests with a cleantech startup. GVC seems relatively suitable due to compatibility with long development time horizons and environmental targets, however, the expertise might be lacking. Still, GVC can potentially provide significant funding amounts.

The thesis also provides general implications for cleantech startups, related to considerations beyond equity funding options. First, as Chapter 2.2 discusses, government policies play a key role in supporting the growth of cleantech startups throughout the lifecycle of the startup. While a cleantech startup should consider the differences in suitability between funding options it is further equally important to lobby for stable regulations and policies. The literature also implies the need for cleantech startups to emphasize financial viability to investors over environmental benefits (Chen et al., 2009; de Lange, 2017). The extent to which environmental benefits are valued still varies between funding options due to the heterogeneity between investors. Nevertheless, a solid business plan and financial viability are still required from all funding options discussed.

Limitations regarding the literature used must be considered when interpreting and utilizing these results. First, the academic literature on funding for cleantech startups is biased towards the private sector, most evidently on VC, with a majority of articles taking this perspective (Mukherjee et al., 2024). Within the literature on the private sector, much less has, for example, been written on crowdfunding and BAs in the context of cleantech startups. It is further worth noting that the area of cleantech startups is constantly evolving and thus results in older research might need to be revised. For example, Gaddy et al. (2017) argue that incumbent companies acquiring cleantech startups tend to be risk-averse and focus primarily on the potential profits instead of growth. Cherry and Sneirson (2010) emphasize that investments into cleantech made by incumbents may be made only for greenwashing purposes. On the contrary, Hegeman and Sørheim (2021) as well as Wunder and Maula (2024) argue that large enterprises invest in and acquire cleantech startups to become greener. These viewpoints highlight the change in perspectives over time.

It is further worth noting that cleantech startups might have specific requirements as well as limited options when choosing between funding options. This implies that no single option is always most suitable across all scenarios. These limited options could primarily be caused by the funding gap for cleantech startups. In contrast, the differing requirements are caused by variations in the capital-intensity of the technologies developed as well as the time frame of the development cycle (Gaddy et al., 2017). For example, materials, chemicals, and hardware are more capital-intensive and require longer development cycles than software solutions related to energy. It is therefore important to remember that the suitability outlined in this thesis concerns cleantech startups as well as funding options on a broader level. The suitability might therefore vary by observing subcategories of cleantech startups, with additional specific requirements. Likewise, the suitability might vary between subcategories of the equity funding options. Furthermore, cleantech startups might not be able to cherry-pick between funding options. The key goal of a startup seeking funding is most likely the capital provided, while additional benefits and synergies are secondary goals. Therefore, all funding options can be argued as suitable for a cleantech startup to some extent by providing capital. The additional value-adding activities as well as willingness to invest, however, vary between different funding options.

The thesis is also limited by the sample of articles used, which provides implications for further research. A more comprehensive view could be obtained by deeper examining each equity funding option separately as well as by examining other funding options beyond equity. The suitability of funding options beyond equity is therefore an area worth further researching. For example, government grants and subsidies could be considered. This would provide a more holistic view of the funding landscape of cleantech startups. Different funding options to explore in addition could also include currently emerging novel forms, such as digital tokens and incubators, as these forms of funding are increasingly growing (Manigart & Khosravi, 2024). Moreover, geographic limitations in further research could additionally provide a more comprehensive view of certain areas by for example examining specific countries.

Further research could additionally extend beyond the suitability of individual funding options. How these options work together and enable growth and synergies between cleantech startups could particularly be studied. Here, the research could address the interactions between investors, such as if conflicts arise for a cleantech startup by having too many investors or investors of varying types. This could be relevant as co-investments are becoming increasingly important in the context of cleantech startups (Siefkes et al., 2025). Taking this holistic perspective could address how the funding environment jointly can meet the funding gap of cleantech startups. Research could further expand on the suitability of different funding options by studying the accessibility of the funding options. Although a funding option might seem particularly suitable due to its additional value-adding activities, cleantech startups might not benefit from it if the market for such funding is limited.

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