Investigating the Roles, Influencing Mechanisms, and Outcomes of Private Equity and Venture Capital on Companies in High-Tech Renewable Energy Sectors

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Abstract. Along with many environmental issues arising, such as climate change and extreme weather disasters, there has been a gradual increase in recognizing the importance of promoting green practices. Venture capital investors evaluate significantly more the environmental impacts of the business, and what the company has done to have a positive impact not only socially, but also on sustainability. Therefore, today, when analyzing a firm, the Environmental, Social, and Governmental (ESG) framework is considered in-depth. In this paper, the mechanisms behind PE/VC investment in renewable clean energy sector startups will be investigated. In addition, the influencing mechanisms, factors considered by PE/VC investors, and the characteristics of successful clean energy startups will be covered. Investors will then be able to make more informed decisions about prospects, potential growth, and development of this industry, while also examining why certain startups are successful as opposed to the countless others that collapse, aligning with the high-risk return balance of such an industry that has relatively greater levels of risk than others.

Keywords: Private equity; Venture capital; Energy transition; Green finance, Renewable energy startups.

1. Introduction

1.1. Background

Private equity (PE) and venture capital (VC) play a crucial role in allowing startup companies to survive through their early stages of development by providing them capital. With ongoing concerns about climate change and environmental issues, governments and large corporations have all shifted their focus toward renewable energy sources as for energy consumption. Startups in energy sectors often tend to have a substantial failure rate due to obstacles creating high barriers to entry, such as significant capital costs, elaborate siting and transmission (i.e., wind and solar energy sources have decentralized systems requiring larger areas), etc – according to the International Energy Agency (IEA), 80% of clean energy startups in 2010 that have secured their seed funding failed to attain their investors' expectations. The role of PE VC, especially under such high-risk circumstances, is therefore meaningful and worth studying, as venture investments are associated with specific risk-return profiles. Despite the likelihood of failure for startup companies entering renewable energy sectors, once successful, the rewards earned in return are also extremely significant for having chosen to tolerate such risks. Studying the relationship between PE VC investments and renewable energy sectors also offers important policy insights. Studying whether PE VC investments positively impact the development of clean energies can have implications for policymakers and regulators who seek to promote eco-friendly practices and businesses, further encouraging more sustainable development and innovation.

1.2. Related research: literature review

Heuvel and Popp studied why venture capital (VC) investments in clean energy technologies have often failed. Researchers analyzed 150,000 US startups from 2000 to 2021 via Crunchbase data, identifying the weak demand and lower potential returns of cleantech as factors accounting for the lack of investments in it, compared to other areas. Contrary to assumptions, financial constraints aren't

the main issue. Results show that although public funding attracts VC investment, success rates remain limited; stimulating demand is key to clean energy progress [1].

Bürer and Wüstenhagen explored renewable energy policy effectiveness through the lens of private investors in cleantech firms. The methodology consisted of surveying 60 investment professionals from PE/VC funds in Europe and North America, encompassing quantitative ranking and qualitative interviews, assessing policy impact on stimulating their interest in innovative clean energy technologies. Findings reveal that feed-in tariffs are perceived as the most effective policy, especially among European-based investors with substantial clean energy exposure [2].

Inchauspe et al. studied the excess returns in the renewable energy sector for the WilderHill New Energy Global Innovation Index which lists renewable energy firms, further used as a benchmark. Researchers employed a multi-factor asset pricing model with time-varying coefficients, investigating the impact of energy prices and stock market indices as explanatory factors. Results indicate significant influence by the MSCI World index and technology stocks, while the effect of oil prices, though increasing since 2007, remains lower [3].

Polzin and Sanders utilized standard scenarios to analyze the European alignment of financing sources for renewable energy, energy efficiency, and grid investments. Researchers matched available funding with demands, further identifying a surplus of funds available. However, institutional investors and lenders remain cautious due to potential policy disruptions. Polzin and Sanders underscore the need for additional VC and household investments to support early-stage cleantech projects. Researchers developed a finance matrix outlining various available investment sources and their roles in the energy transition process [4].

Petkova et al. explored how reputation shapes decision-making under ambiguity. Researchers found that a firm's reputation encourages both risky strategies to meet higher aspirations and risk reduction to maintain consistent performance. Analyzing the U.S. VC investments in clean energy from 1990 to 2008, results show how reputable firms invest in the cleantech sector but employ risk reduction extensively, influenced by sector legitimacy and reputation interactions [5].

Islam et al. investigated the utilization of signals by early-stage startups in emerging sectors, with a specific focus on esteemed government research grants within the U.S. clean energy domain. Researchers employed a framework investing the roles such signals play when obtaining government-issued research funds. The results demonstrate that startups receiving these grants have a 12% higher likelihood of attaining subsequent venture capital funding, particularly if they have fewer patents. This underscores the strategic importance of leveraging signaling through public agencies for startups navigating transitions across their organizational life cycles within emerging industries [6].

Cumming et al. studied unique aspects of cleantech VC investment, differing from conventional VC due to its high capital intensity and technology risks. Researchers investigated countervailing factors influencing cleantech investment. The use of a global dataset analysis of 31 countries from 1996 to 2010 reveals that oil prices and media coverage significantly drive cleantech venture capital deals, further impacting legal, governance, and cultural variables [7].

Gaddy et al. investigated the relationship between cleantech and VC, a market where $25 billion was invested from 2006 to 2011. The study examines risk and return patterns in cleantech, comparing them to medical and software technology investments, by using a comprehensive account to date of the cleantech VC boom and bust. Results suggest that cleantech presented high risks and low VC returns, with "deep technology" being the least profitable [8].

Hegeman and Sørheim explored the reasons behind CVC investments in cleantech startups, by analyzing 26 cases of established companies investing in Norwegian startups from 1999 until 2012. Contrary to existing assumptions, there is a diverse set of CVC investors, including small and medium enterprises. Results reveal multifaceted motivations, such as companies' drive to enhance corporate greening and competitiveness. Such factors contribute to increased sustainable practices, and understanding CVC's role in promoting green initiatives [9].

Kolte et al. addressed the escalating threat of climate change and the rising significance of clean energy (CE) solutions. CVCs are playing an increasingly crucial role in funding CE innovations.

Focusing on the Asia-Pacific (APAC) region, the research employs a quantitative approach, analyzing data from institutional databases. It aims to clarify the profiles and strategic intentions of CVCs active in the CE sector, offering insights into their roles, innovation impact, and growing presence in APAC. Results reveal that CVC leaned towards external innovations to gradually integrate new technologies [10].

1.3. Objective

This paper will examine the influencing mechanisms of PE/VC on the renewable energy technology sector: the roles they play and the impacted created on such firms. Specifically, the investigation will be done about the characteristics and nature of companies in the renewable energy sector in different sub-sectors as it is a relatively broad topic, in addition to the product types and components of renewable energy that these companies aim at innovating. Moreover, the important factors that private equity and venture capital investors will be analyzed, centering around the ones specific to this industry sector, as it is known for offering an extreme balance of high risk and return, with this section ultimately closing off by a holistic recount and evaluation of a PE/VC case-study on a company operating in the industry.

Following an analysis of the relationship between private equity/ venture capital and startup companies in the renewable energy industry, solutions, strategies, prospects and insights will be provided. This incorporates an explanation of why startup companies in this specific sector are typically difficult to succeed and become established, while also suggesting the main factors creating such collapses. Finally, further prospects for these businesses will be introduced, such as whether investors should excavate the value of businesses working on niche areas of this industry that constitute renewable energy, rather than evaluating and generalizing the sector altogether.

2. Functions, Roles, Influencing Mechanisms and Effects of Pe/Vc on the Renewable Energy Sector

PE/VC plays an important role in technological development through the use of renewable energy. First, because renewable energy is a new area relative to more traditional production of energy sources such as oil and natural gas, it has a long industry chain that has yet to be developed. In contrast, conventional means of yielding energy already offer a saturated market that restricts any possible new entry to succeed or finding potential sites to derive such material. On the other hand, despite the financial barrier to building renewable energy due to extensive R&D (Research & Development), the sector has the potential to be gradually filled as the benefits it can bring are substantial to the entire economy, just as the significant advantages it will be capable of providing to the environment and humanity. Therefore, investment in new energy will be chained with the development of a series of industrial chains including management, sales, and more. The essence that differs PE/VC investment in this specific industry compared to others lies in the level of risk associated with the business, and the chances for investors to gain a high return on investment as opposed to unquestionable possibilities of failure. Though it is important to realize the core nature of private equity/ venture capital in that such investors seek to tolerate high risks while obtaining a high return, the effects of the new energy industry are especially prominent. Another effect of new energy is the internationalization of investment, as the technology and capital in international circulation is easier than the conventional industry; the latter has caused instability in the provision of energy because of international trade disputes that have continually appeared. The role of PE/VC has been crucial in economies such as the United States, where the funding of startup companies can contribute to transformative research results in the market. Often, when R&D of renewable energy is funded by the government which is restricted to budgets, venture capital investors play the role of filling in gaps by providing financial support, with a certain return on the money subsidized.

2.1. Segment Areas Developed by Startups and Their Characteristics

Startups often have the qualities of scalability, technology, a global approach, youth, and low initial costs [11]. Scalability and technology characteristics are especially crucial for energy startups as opposed to ones in other divisions of the industry market. Technology is at the core of innovation, on top of the traditional sources of energy. It is more importantly the key to being competitive in the industry, as more advanced technology implies a greater potential of staying ahead. Scalability, in addition to a global approach, are essential trait for success for new energy startups, since a narrow and small target audience won't be sufficiently promising for making a profit and gaining a return on such high-risk investment.

Products and service segments offered by new energy startups vary. They work on solutions from not only the production of clean energy (solar, wind, nuclear, etc), but also narrow down to power control hardware, real-time production and demand forecasts, multi-rotor wind turbines, geothermal systems, energy efficiency (green buildings, heating and cooling), energy storage, green hydrogen, heat pumps, and more. The general process of implementing a new energy project includes locating a site, securing financing, conducting environmental reviews, finding buyers for the power, obtaining permits, and communicating with local stakeholders [12].

2.2. Factors That PE/VC Evaluate When Considering Startups in the New Energy Sector

As opposed to startups in other industries, venture capital investors will pay close attention to thoroughly analyzing the startup’s team, their technical skills and competence, due to facing exceptionally great risks of failure, though this balances out with the outstanding returns given the success of such firms. They focus on evaluating whether the company will be able to expand and establish strong market power in the industry, as well as whether the team and people involved are knowledgeable enough, whether they’ve specialized in this area before, or their level of experience working in this sector. Moreover, the technological aspect is unquestionably decisive because the firm innovation in terms of profession and skills should be advanced at an international scale.

2.3. Case Study (Function, Effect, and Return of PE/VC)

There have been countless surging startups entering the renewable clean energy industry, though the number of firms that haven't succeeded in growing should be acknowledged. However, numerous startups have done well based on historical records, becoming established and continually growing. Therefore, it is important to study the cases of firms that have overcome the difficulties and barriers to succeed in this sector, to provide constructive insights for future startups and clean energy innovation that could boost more efficient development of technology.

One company that has a meaningful history is called Enpal, a German startup company founded in 2017, which now has over 10,000 installations established [13]. It makes use of a battery product in addition to its photovoltaic (PV) systems, which are gradually supported and adopted to a greater extent by German consumers. Enpal, as a relatively young startup company, has disrupted the green energy market by making homes smarter, as many homeowners are catching on to the trend of leasing solar systems on their rooftops right after the systems' popularity has spread in the US.

The upsurge of this energy startup was not without challenges. Germany, being one of the European countries with the highest electricity prices, has had difficulties keeping the prices of solar expansion low. Despite its government's promise to ensure that the energy transition would only cost an additional dollar per month, records show the opposite: 'The Düsseldorf Institute for Competition Economics estimates that the cost of energy transition for the average household has been closer to $42 a month'. However, despite these uncertainties and financial drawbacks, as technological advances are made in the field, solar energy is also gradually becoming more affordable to the average household in the country enabling them to make the transition and adopting more environment-friendly energy sources. Enpal's business model is designed to democratize solar energy [14]. They don't only sell out their systems, but most importantly, 'take care of service and maintenance (solar-as-a-service).

To date, Enpal has raised around $360 million in equity, with another $406 million in debt, and has been profitable since 2022, reaching 415 million euros in revenue [15]. It closed its round D series with 200 million euros in equity. This case study presents a typical example that funds itself using venture debt financing. According to explodingtopics.com, Enpal's five-year search growth has been in an exploding status of 8200% as of July 2023, with the company's headquarters located in Berlin, Germany. This company has a goal of first expanding its customer base in its home market, then spreading to new areas after building a solid basis. The startup was funded by SoftBank, with a recent valuation of 2.2 billion euros, analyzed as of January 2023 [16]. Though the company has rival competitors such as Soltec Power Holding, ib vogt, and more, the company is still very young and has massive space for growth. According to CrunchBase, the company has gone through 14 rounds of financing, with a total of 34 investors (12 lead investors).

Such success would have to be attributed to insights and exceptionally efficient operations management for the startup to overcome the risks of bankruptcies, given the sector they're operating in. A 2022 interview with Enpal's CEO and founder, conducted by McKinsey & Company, provides the key insights that have been essential in establishing the company's success, the main ones being the following [17]. First, the company took a gradual approach to making sales, so that the business could try out the best ways suitable for it to function and become accepted by more people. For instance, this means that the company started by 'proving that customers would buy solar installations online without a direct sales contact or ever visiting a store', explains Mario Kohle, the CEO and co-founder of Enpal. Another key takeaway is that the team was exceptionally strong, as it aimed to 'hire the very best people and give them room to do their jobs'. The specific benchmark for recruiting is mainly based on two factors – an individual's passion for their work and its purpose, in addition to being the best expert at what they do. Hence, people who had a vision that corroborated with the startup Enpal were attracted to work for the firm as they were able to see its potential and prospects. Moreover, Kohle's prior entrepreneurship experience has allowed him to reflect on mistakes, and avoid them throughout his journey building Enpal. In addition, staying innovative is key to becoming competitive in terms of product differentiation: the company, 'wanting to be the center of energy and mobility in the home, developed an operating system and app', which elevates the product and service's consumer experience to another higher level.

3. Problems of renewable energy startups and their prospects

3.1. Problems of renewable energy startups and corresponding solutions

There are many issues underlying the reason why most startups entering the clean energy industry have extremely low chances of succeeding. Factors contributing to such failures include a lack of expertise in the startup team, where knowledgeable employees are necessary in both financial and environmental/ technological areas. This is because renewable energy startups have rigorous requirements in dealing with the high-risk investment financials associated with the business, while also demanding highly professional research & development to ensure the product and/ or service provided is innovative and differentiable to already existing alternatives. There are also other significant challenges [18] faced by companies in this sector. Along with other financial activities engaging in the trend of moving to a decentralized operating system, the energy transition follows it as the industry seeks to become more spread out. Solutions to ensuring greater network stability are crucial in keeping the services operating and continually steady from a long-run perspective. Additionally, one of the primary obstacles faced by new energy startups remains the difficulty of persuading PE/VC investors to fund projects, as there is a greater supply of relevant prospective companies than the funding capable of being provided by the market. Regulatory challenges also play an inhibitory role in ensuring the day-to-day operation of startups, and any unfavorable policy has the potential of claiming bankruptcy for startups since they usually cannot resist such unavoidable troubles. Finally, many common problems faced by inexperienced entrepreneurs attempting to enter

any industry are just as challenging for new energy startup founders: ineffective management or the failure of R&D can easily hit and end the business.

In order to overcome such challenges for renewable energy startups, recruitment can be done with more precaution, such as prioritizing quality over quantity. A few people who are experts in clean energy technology and others who are experienced and specialized in dealing with venture capital investment and other financials will be more strategic than increasing the employee size, and paying the wages, though without producing desired outcomes nor working efficiently. To attract investors, startups can shift their focus on making technological improvements and innovation to become precursors in the sector, which is crucial in ensuring less risk for the investors' money devoted to growing business and seeking return.

3.2. Prospects

As mentioned previously, the renewable energy sector is relatively new compared to conventional approaches in retrieving energy and hence suggests significant space for growth. The market still allows for the filling in of gaps and is currently distant from attaining a saturated state. It is now going through an integration period, which may end when entries start becoming excessive. As the products and services offered constantly develop and innovate, there will always be better options emerging that can facilitate the transition of energy in households at a greater scale, with a common aim of improving environmental conditions worldwide. Prospective PE/VC investors can focus on specific divisions constituting the concept of green energy and its transition, rather than broadly examining the industry as a whole (e.g., batteries).

Nevertheless, from the investor’s perspective, a comprehensive evaluation must be conducted with comparison to determine which industry would be able to bring more appealing returns. Other more popular industries such as biotech or ICT (Information and Communication Technology), especially along with the exponential growth of artificial intelligence, appear more profitable now [19]. They seem more attractive to venture capital investors in comparison, as this sector has comparatively more hope in successful R&D while also producing more revolutionary outcomes for humanity, and therefore, higher returns. Hence, the scope of available PE/VC investments for new energy startups isn’t without threat when analyzed at the industry level of the entire market.

4. Conclusion

Characteristics that venture capital investors consider when deciding whether to invest in this field include the level of skills and competence possessed, the potential of expansion and market power at the international level, the strength of the individuals constituting the startup team, and whether the firm's technology is sufficiently innovative and advanced to be competitive enough. Moreover, according to Bloomberg, a total $358 billion investment has been injected into the renewable energy sector as of 2023. The biggest portion of clean energy that has been invested in remains solar energy, which can be reasonably explained by the extensive research done and the technology produced making the segment already well-established, mature, and implemented on a bigger scale. Evidence of successful new energy startups, such as Enpal, indicates that as of today, no other type of clean energy can surpass the potential and growth of solar energy in the industry.

The prospects of the individual renewable energy sector are promising, though its attractiveness to PE/VC investors should be reassessed. The upsurge of other more technological industries with incredibly high growth potential risks that funds will be less abundant as the innovative energy industry might seem of weaker appeal to investors who seek to put more emphasis and value on startups that enter more trending, popular market sectors.

Overall, however, PE/VC investors still play an extremely crucial role in boosting renewable energy entrances due to their high-risk tolerance nature. They play a key role in making renewable energy startups possible so that innovators can further develop and improve society's technology and the world's environment through a gradual clean energy transition.

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