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Does venture capital investment in the clean tech Start-ups promote Sustainable development: A Review

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Abstract

Cleantech venture capital is that capital that focuses on environmental protection. Green futures are ensured through sustainable Startups that focus on the commercialization of clean tech ventures. This study is based on a holistic overview of the literature relating to cleantech Start-ups. The research article provides five main thematic groups such as policy initiatives for cleantech venture capital, venture capital as an effective source of finance, Impact of venture capital on cleantech Start-ups and challenges and problems faced by Cleantech Start-ups, Clean-tech, and sustainable development. This study broadens the scope of corporate venture capital research. The result shows that the Policy attitude and practices of the Government play an important role in solving barriers to clean Tech and different types of Start-ups are promoted by venture capitalists. It is evidenced that cleantech Start-up may attract venture capital. Some studies argue that due to the high investment risk in cleantech, venture capital captures less attention than conventional technology Startups.

Key Words:

Venture Capital, Cleantech Start-ups, Sustainable development

Introduction:

In recent years, human-induced changes have brought many hazards to the Environmental Ecosystem of a Country. So, most companies in India drive their attention to developing green technologies start-ups in India and they have a prominent role in the climate clean-up fight. At present, the Research found that real Environmental innovators are limited. Green

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strategy Start-ups are facilitators of sustainable development. Innovative start-ups concentrate on more Environment-friendly technology such as the use of a renewable source of Energy. Globally, renewable energy is rapidly becoming more popular due to the rapid depletion of natural resources, population growth, and urbanization. Sustainable products and solutions are in high demand as a result of this circumstance. With the advancement of science, technology, and innovation clean tech Start-up provide solutions to many problems such as improving efficiency and productivity. It consists of a wide range of services including renewable energy such as wind power, biomass, solar power, hydropower, and biofuels. (Cumming et.al.2016). Energy, transportation, water, and materials are covered under cleantech (Pernick &wilder 2007). Almost 70% of clean-tech funding belongs to energy-efficient technologies including wind power, and solar power. biomass, hydropower, biofuels. (PWC,2015). Energy security issues, climate change, fossil fuel depletion, new technologies, and environmentally conscious consumers are powerful forces shaping the renewable energy sector, which is the largest segment of cleantech (Sadorsky, 2011).

Cleantech start-ups are those focused on protecting the Environment by using clean Energy and Environment-friendly solutions. Many of the start-ups in India use innovations that are prerequisites for Industrial advancement and to bring progress in the Economic development of a nation. Environmental start-ups, a combination of business and technology aim to create positive change across the global level. There are several environmental start-ups in India that try to reduce problems like converting plastic waste to renewable energy. Cleantech start-ups are a subset of innovative technology-based start-ups. A cleantech start-up that offers any product, process, or service that uses limited resources and creates less waste than a conventional system. Green Building, Green transportation, Solar, Wind, and Biofuel are examples of technologies using clean tech start-ups. In cleantech, technology is used to improve reusing and sustainable energy sources, green construction, electric vehicles, and lighting. Technology and business models are developed by clean tech start-ups for the installation and financing of cost-effective low-carbon and resource-efficient solutions. Cleantech firms are technology-oriented organizations that produce and/or commercialize many products, service, or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than conventional offerings (Pernick and Wilder 2007, Georgeson et al. 2014).

Sustainable development is possible through renewable energy. There can be seen progress in the energy sector. There is an intimate connection between renewable energy and sustainable

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development. Hydropower, biomass, geothermal energy, wind, and solar are renewable energy sources. Many renewable energy Start-ups are emerging in Kerala and the number of venture capital investments is increasing day by day in these sectors. Sustainable development is possible through renewable energy. There can be seen progress in the energy sector. There is an intimate connection between renewable energy and sustainable development. Hydropower, biomass, geothermal energy, wind, and solar are renewable energy sources. Many renewable energy Start-ups are emerging in Kerala and the number of venture capital investments is increasing day by day in these sectors. The development of a country depends on sustainable industrialization with innovation. Dynamic environment, international trade, and promotion of technologies are possible through innovation. Innovation is an inevitable part of cleantech Start-ups. Climate change is a global challenge for all countries. So nowadays importance of climate tech start-ups is emerging. It provides correct innovative solutions that decrease environmental problems. Such type of start-ups is emerging in Kerala.

Policy initiatives for venture Capital investment in Clean-tech:

Venture capital investments have been showing a positive trend towards clean tech since 2015. Venture capital has been considered the most important source of finance for cleantech Start-ups. Policymakers have identified the role of venture capital in promoting innovation (Premus 1986, Federal Reserve System 1958). For promoting the development of new green funds, government intervention and implementation of environmental policies are essential. (Randjelovic et al. 2003). Policymakers promote those innovations that convert traditional industries into revolutionary ones. The Government of every country has been showing interest in promoting and supporting clean tech Industries. Government interventions and policy promotions to support the cleantech industry are needed nowadays. (Borghesi et al.2015). Every public has the right to access environmental resources (Baumol and Oates 1988; van der Ploeg and Babenberg 1994). Every Government has the responsibility to protect, restore, and conserve the ecosystem, natural resources, and environment that facilitate sustainable development. International contexts such as the Kyoto Protocol, Montreal Protocol, and EU Emissions trading scheme affect the strategies of clean tech firms. (Carraro and Siniscalco 1992). Venture capital investment is promoted by Government and Environmental policies and they are able to evaluate the success of companies. (Yuk-Shee,1983; Tyebjee and Bruno,1984; Amit et al;1998) Quantity of renewable energy

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produced by firms is affected by the regulations and policies of the Government. The impact of R&D in green tech ventures is positive (Criscuolo and Menon,2015). Institutional venture capital prefers to invest in developed companies Government should be able to promote institutional investment that focuses on reducing greenhouse gas emissions. (Mazzucato 2011). Australia implemented successful initiatives in clean tech in the name of the Australian Innovation Investment Fund to promote cleantech venture capital and strengthening of Economy. Direct Government intervention is visible in Australia rather than policy initiatives. Agency problems, Moral hazard, and Adverse selection is the reason for the market failure of entrepreneurial finance. (Colombo et al. (2016). Government involvement in Greentech Start-up is a very high way (Doblinger et al; 2019), especially in the commercialization stage, and formulation of policies including the carbon credit market. (Bento et al; 2020; Marcus et al; 2013). Public policymakers have been interested in promoting innovation through venture capitalists. (Premus1986, Federal Reserve System 1958). Government support loan guarantees to venture capital-backed startups. (Andrew' Hargadon and Martin 'Kenne,2011). New ventures have been focusing on bringing innovations and new technologies to market. (Schumpeter;1934, Baumli;2010) A recent study in the US noted that Job creation and the high growth rate of firms in the USA occurred from the concept of Schumpeterian ventures. (Stangler and Litan,2009; Stangler and Kedrosky,2010). Venture capitalists act as an agent for supporting and promoting clean tech Startups. Public policy promotes incremental innovations rather than cleantech start-ups.

Venture Capital as an effective source of finance for cleantech Start-ups:

Nowadays venture capital has been recognized as a revolutionary investment in areas of clean energy, biotech, etc Previous research papers identified that shortage in innovation finance such as venture capital (Polzin and Sanders 2020). Several academic research contribute to the concept of cleantech Start-ups. Several interesting studies are there regarding collaboration and partnership (Meyskens and Casrud 2013; Hansen 2014,) foreign market entry strategies (Steinz et al.2016), venture capital investment (Gidici and Roosenboom 2004), and how to raise capital through crowdfunding. Cleantech Start-ups have been considered as solutions to many environmental problems (Noailly and Smeets,2015). The reason for attracting venture capital into cleantech is the consequences of national and international policies (Cricuolo and Menon,2015), innovations in the clean energy sector, hindrances to promoting clean tech financing including industry, locations,

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geography;(Chapple et al;2010; Chen et al;2010; Knight,2010), Organisational levers (Hegeman and Soherim,2021), Motivation and attitude of investors (Bocken,2015; Hoenig and Henkel,2015). At the beginning of the century, venture capital investments showed remarkable progress, especially in clean energy. During 2005-2008, the share of venture capital investments had been an increasing trend and while evaluating returns from these investments it showed a negative result. Investors lost more than half of the money invested in clean tech Start-ups between 2006 and 2011. (Gaddy et al;2017) Private investors are very much attracted to cleantech firms due to employment opportunities and high growth potential. (Burtis et al.2004). Nowadays huge amount of money is invested in clean tech Start-ups due to public support. This interest in clean tech Start-ups further necessitated venture capital study (Gaddy et al;2017; Nanda et al.;2015). The goal of venture capital is to achieve a 20% return or more over 10 years. (Zider 1998). Value-added services are provided by cleantech through venture capital. (Barry et al;1990; Hellmann and puri,2002). Signalling effects have been created through services such as Mentoring. Coaching, Investment bankers (Megginson and Weiss,1991). The geographical area of investors also supports early-stage investments. (Griffith, Yam, and Subramaniam 2007). Silicon Valley venture capitalist is also making a competitive advantage in cleantech investment. Population in Silicon Valley consists of different professionals from various sectors and they have shown a keen interest in developing an ecosystem for cleantech venture investments. There is evidence from academic literature that innovative technologies are promoted by venture capital. (Barry et al;1990; Hellmann and puri,2002). Market failure of the cleantech industry largely depends on its nature of Industry. Although a funding gap exists in clean tech it is important to analyze the drivers of venture capital investments in clean energy Startups. A higher amount of capital is needed for cleantech and these demands are not fully accomplished by traditional finance providers. (Marc cowling, Weixi Liu). Commercialization of innovations through risk capital is ensured by venture capital. (GinsbergandMarcus,2018; BjorgumandSohreim,2015;Wiistenhagenand Teppo,2006), An important problem faced by ventures is the low risk-return ratio. Traditional venture capital model is not apt due to the high risk and capital demand for early cleantech ventures. (Gaddy et al;2017; La Tour et al;2020). Venture capital activities vary from country to country. There are so many research publications about it. (Zacharakis et al;2007, Li and Zahra,2012 Chachine et al;2012, Cumming,2014).Venture capital is restricted from conducting deals due to the “Valley of Death”. (Grubb 2004; Burer and Wustenhagen 2009). Investors' role is to predict market viability and to formulate strategies rather than developing new technology. More accurate

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returns are predictable from venture capital companies' investors' attention has been going to more mature companies rather than technology. The consequence of these is a decrease in investment opportunities and, an increase in risk disinclination of investors. (Ghosh and Nanda,2010; Chassot et al;2014; Polzin,2017). There is a chance of failure of investments made in hardware materials, chemicals, and processes leading to loss of cash, and consequently venture capital reduces investments in these assets. Cleantech software ensures a return to investors. (Gaddy et al.2017). Research and development subsidies for Greentech are negatively affected by its entry. Cojoianu et al. (2020). There are decreasing financing opportunities in the case of cleantech due to high capital intensity in many phases of development. (Wustenhageri and Teppo,2006; Burer and Wustenhagen,2009).

Impact of venture capital finance on the profitability of clean tech Projects:

Venture capitalists wisely select firms for investment due to high-risk involvement (Florida; Kenney;1988, Gompers and Lerner 2001, Kaplan and Stromberg 2004). Venture capital companies have a vision (Burg &Kenney 2000). Venture capitalists are not passive investors they help a firm to formulate an overall strategy, help the management team, and monitor the growth of a firm. (Florida and Kenney 1988, Gorman and Sahlman 1989, Gompers and Lerner 1995). Post-investment monitoring of firms is also evaluated by venture capital companies. (Kaplan and Stomberg,2003; Lerner,1995; Sahlman,1990). Successful and value-oriented venture capital firms ensure a network of contacts to firms. (Hsu,2006; Lindsey,2008Market features and Country have an effect on venture capital investments. (Cumming et al.2016). Payback period of venture capital investments in clean tech is longer than typical investments. Those Entrepreneurs who run green businesses have easy access to venture capital funding (Mrkajic et al. (2017). A number of funders and environmental orientation are crucial in determining the probability of success. (Horisch and Tenner (2020). Research and development are the first stage in cleantech Start-ups followed by the presentation of technology including product conception to prototype model. During the first stage sources of funds include own capital, friends and family, and Government subsidy. In addition to these early-stage financing is also offered by angel investors. (Landstrom and Mason 2016). Business has been developed and market viability has been reached in the Commercialization stage. Start-ups can find funds from its own returns at this stage. In this stage product would be able to attract venture capital companies and private equity firms. Every Start-up prepares for the challenging market situation because production costs are

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high and the market penetration rate is very low. (Balachandra et al; 2010). There are differences in investing in clean tech and high-tech Start-ups. Environmental innovations and green aspects are promoted by clean tech Start-ups. (Beisse and Runnings ;2005). From the past literature, it was noted that investors are given more value to sustainability. Value creation leads to financial return. (DeLangeand Valliere,2020). Ghosh & Nanda (2010) point out that in biotechnology and information technology, for example, venture capitalists can sell their investments to incumbent firms. Rapid growth and high returns for young companies are ensured through early-stage funding provided by venture capitalists. (Metrick and Yasuda,2020). To increase clean energy investments, the New York Green Bank leverages private capital. (Popp,2020). Seasonable venture capitalists have been providing valuable advice to start-up firms. They help the firm to raise subsequent funding to grow. In the case of biotechnology startups, venture capital helped those firms negotiate contracts with large pharmaceutical firms and use R&D limited partnerships. (Kenney 1986). To ensure private funding in early-stage technology validation models needs to be supported by public funds. (Grueneich, D.M Electr.J 2015). venture capital model can be regarded as the best model because it works closely with such economically driven start-ups and the Government also recognized venture capital's role in the commercialization of cleantech startups. In the case of cleantech VC, however, the incumbent firms are in many cases large companies focused on, or large users of, fossil fuels and therefore, unlikely to be interested in buying an upstart cleantech company. Together these differences make cleantech VC investments different from more traditional VC investments in biotechnology and information technology where the accrual of benefits is clearer, capital intensity is lower and the overall risks are lower.

Venture capital financing provides a solution to various societal problems. (Andrew' Hargadon and Martin 'Kenne,2011). Venture capital firms give great attention and care in selecting firms for investment due to high risk and uncertainty (Florida and Kenney 1988; Gompers and Lerner;2001, Kaplan and Stromberg 2004;) Previous studies reveal that venture capitalists spend 160 hours making their investment decisions. (Tyebjee and Bruno,1984). Venture capitalists deeply screen those firms that have high technology and market viability. (Andrew' Hargadon and Martin 'Kenne,2011). The diligence process compels the entrepreneurs to sharpen their business plans and technology according to market needs and trends. Firm transmission phase is determined by the vision of both venture capitalists and Entrepreneurs. (Burg and Kenney;2000). A firm need to change its business plan frequently

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before it receives fund. (Gompers 1995). Digital and modular cleantech start-ups show remarkable progress in achieving early-stage capital compared to capital capital-intensive hardware sector. (Bumpus and Comello,2017) Like Gaddy et al. (2017). There is a venture capital funding gap in clean tech start-ups due to a lack of product differentiation (Nanda et al.;2015) low demand for green tech products (Baumol; et al.; Noailly et al.;2021) and low scope for outsized returns. (Hargadon and Kenney,2012). So, the Government should take adequate steps to bridge the funding gap in these sectors. Early-stage public funding may help Start-ups to attract series A funding. But those Start-up that receive public funding and Series A funding may not have a chance of long-term survival compared to those firms that receive only Series A funding. Moreover, Previous studies argue that huge public investment has a low impact on cleantech Start-up business success. (Howell,2017; Goldstein et al.;2020). Carbon pricing stimulates demand for clean tech products so the Government should implement those policies.

Challenges faced by Cleantech Start-ups

The boom-and-bust cycle occurred during 2005-2013 drawing the attention of policymakers to invest in green tech products. During this period venture capital investment in clean tech went tripled. (David Popp and Matthias van den Heuvel 2011). But investment in clean tech start-ups from the period between 2006 to 2011, less than half of the over $25 billion investment returned back to investors. (Gaddy et al.2017). As a result, venture capital investment in clean tech Shrivelled. Similarly, 1,50,000 US-based Start-ups that were active between 2000 and 2020 that received venture capital had failed. (Heuvel and Popp 2021). There are multiple causes of poor failure of venture capital investment in clean tech firms (Hargadon and Kenney 2012, Nanda et al 2015). High capital intensive and very low progress towards scaling up resulted in to unattractive long payback period. (Migendt et al 2017). Failure to earn outsized return is another problem faced by clean tech Start-ups and many renewable energy Start-ups fails to differentiate their product from energy produced by non-renewable sources. More risk is another problem faced by clean tech Start-ups due to volatility in international markets and unstable public policies. (Noailly et.al 2021). There is much difference between clean tech venture capital investment and typical investment. Greater technology risks, scalability and high capital intensive are risks associated with cleantech venture capital and its benefits available to society (Douglas Cumming, Irene Henriques, Perry Sadorisky 2016)Cleantech venture capital investment differs from the

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typical venture capital investment in that it tends to be very capital intensive and faces greater technology risks associated with the functioning of the technology, scalability, and exit requirements than the typical venture capital investment. Moreover, unlike the typical venture capital investment, the benefits arising from cleantech cannot be totally captured by the venture capitalist as many of its benefits accrue to society via reduced environmental degradation and better health and quality of life outcomes. The public good nature of cleantech relates to the fact that the benefits of the product or service (clean air, clean water, carbon mitigation) are not depleted by an additional user and for which it is generally difficult or impossible to exclude people from its benefits, even if they are unwilling to pay for them. In contrast, a private good is characterized by both excludability (that is, someone who does not pay for it can be kept from enjoying it) and non-renewability (a commodity is used up when someone consumes it). As a result, a socially efficient equilibrium or outcome cannot be reached via the market and the cleantech good or service in question will be undersupplied (Teece, 1986, McWilliams and Siegel, 2001). Ghosh & Nanda (2010) present a framework describing how cleantech VC investments differ from more traditional VC investments by comparing clean energy sub-sectors according to their capital intensity, risk, and exit requirements (i.e., a venture capitalist's ability to exit the venture via sale or merger and acquisition)

Cleantech and sustainable development:

The year 2030 is the deadline set by UNO for achieving sustainable development goals. Continuous efforts have been taken to reduce the effect of climate change, remove carbon dioxide, implement renewable energy, etc Traditional sources of funds and public funds are not adequate to meet the fund requirements of cleantech start-ups. Venture capital plays an important role in filling the funding gap of venture capital companies. Sustainable development goals mainly focus on energy, climate, and innovation. An investment of $5 trillion will be needed every year to gain a net zero goal by 2020. An alternative source of finance, finance from private, is needed to address issues relating to climate change. (UNFCCC). After the effect of the Paris climate change conference venture capital investment in clean tech Startups has been increasing. (Gaddy et al;2017). Venture capitalists are investing in sustainable Start-ups that have to focus on reducing carbon emissions in order to avoid the impact of climate change (Bocken,2015). Global well-being of society and future generations' welfare is ensured through financial instruments that have invested in clean technology. (Diefendorf,2000). To promote a new sustainable business structure public funds

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are not sufficient. (Halme and Korpela,2014; Khattak et al;2021). Financial, Social, and Environmental goals are strategies of investment firms for sustainability. (Antarciuc et al;2018; Bocken,2015). To reduce the effect of global warming, the world needs to increase investments in low-carbon electricity technologies amounts to $2.3 trillion every year. (Inter-Governmental panel on climate change, special report 2022). But only $75 billion invested up to 2021 in energy transition sectors. There is a severe funding gap in clean technologies (Polzin and Sanders 2020). Nowadays a boom is experienced in the venture capital industry due to the climate crisis and support on the part of the public. A $1 trillion worth of cleantech start-ups would be in high positions when we evaluate every 1000 Startups. (Clifford 2021) Start-ups focus on technological development and follow several ways to investment. (Siegel et al;2003; Balachandra et al; 2010; Zahra and Nielsen,2002).

Conclusion:

The emergence of cleantech is based on the assumption that economic development and productivity are ensured through the protection of the environment. Political factors and Market-related factors assure the growth of cleantech (Caprotti 2020). In some studies, we can see a huge amount of capital flowing into cleantech. Based on some reviews it can be concluded that cleantech also faces barriers to private investment due to the reason the electricity generation by clean tech depends on the local environment and the market is also decentralized. It affects the global market also. Policy, attitude, and practices of Government also play an important role in solving barriers to clean Tech. Capital intensity is the main problem faced by cleantech in terms of utility cost and technology risk. Moreover, Ecosystems in many countries are not monopolized for cleantech. Regional niche markets have been developed for specific technologies such as wind technologies, battery technologies, and geothermal technologies. Venture capital investments that are decentralized in these niche markets will have positive and negative impacts both for policymakers and firms. For cleantech innovation both the market and technology, the Government has an equal role but it is not appropriate alone to finance hardware of the future low carbon economy. For early-stage venture capital investment, there is a need for strong venture capital. Each location has specific characteristics in terms of a particular technology. Market failures and uncertain payoffs are the main barriers. Technology risk and lack of price for carbon are the main risks in early-stage cleantech (Acemoglu et.al 2009). A direct pricing mechanism is a solution to address this rather than competition between price and technology

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policy instruments. (Porter and Linde 1995; Newell, Jaffe, and Stavins 1999). The paper concludes that the Government should strengthen the cleantech policy initiative to tackle many challenges faced by cleantech Start-ups.

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