THE CURRENT LANDSCAPE FOR CLIMATE TECH STARTUPS
— INSIGHTS FROM THE GLOBAL CLEANTECH 100 LIST —

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SUMMARY

- Climate tech startups have become popular investment targets amid growing attention to the impact of climate change, with investments flowing into the energy, resources, and environment industries in particular, as well as into a variety of other areas.
- Investment in such emerging enterprises has seen two booms and a lull. Despite the fluctuating interest, climate tech is expected to remain a major investment theme as long as climate change continues to be a global concern.
- However, it is important to recognize that even for major companies, investment risk is inherent in (1) the financial environment, (2) changes in industry structure, and (3) the difficulty in corporate management.

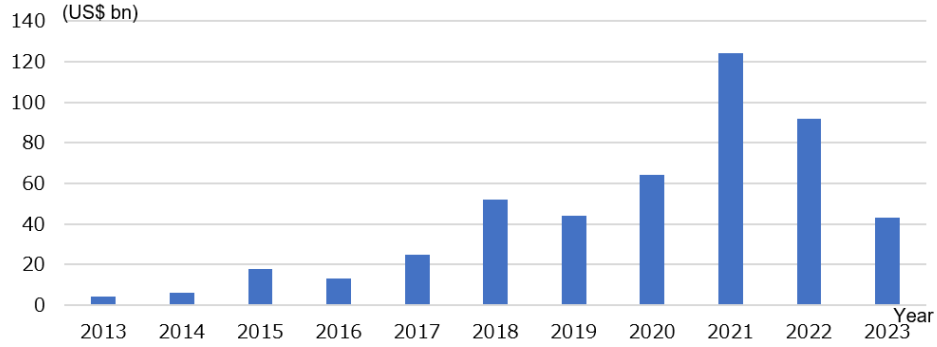
Climate tech is defined as technologies that are explicitly focused on reducing GHG emissions, or addressing the impacts of global warming[1]. As concern about climate change grows, climate tech has become a hot investment topic, especially for investments by venture capital firms. This report describes the current situation for climate tech startups based on trends at the companies selected for the Global Cleantech 100, a list of leading emerging climate tech enterprises.

1. CLIMATE TECH STARTUPS & VENTURE INVESTMENTS

1-1. Overview

After the Paris Agreement was concluded in 2015, the amount of investment in climate tech startups grew owing to heightened interest in climate change solutions (Figure 1). Subsequently, investment peaked in 2021 and then began to decline against the backdrop of deteriorating financial conditions and other factors but remained above the pre-COVID-19 (2019) level at approximately US$43 billion in 2023 (nine months). (For details, see section 1-2. Two Investment Booms.)

Figure 1: Investment in climate tech startups



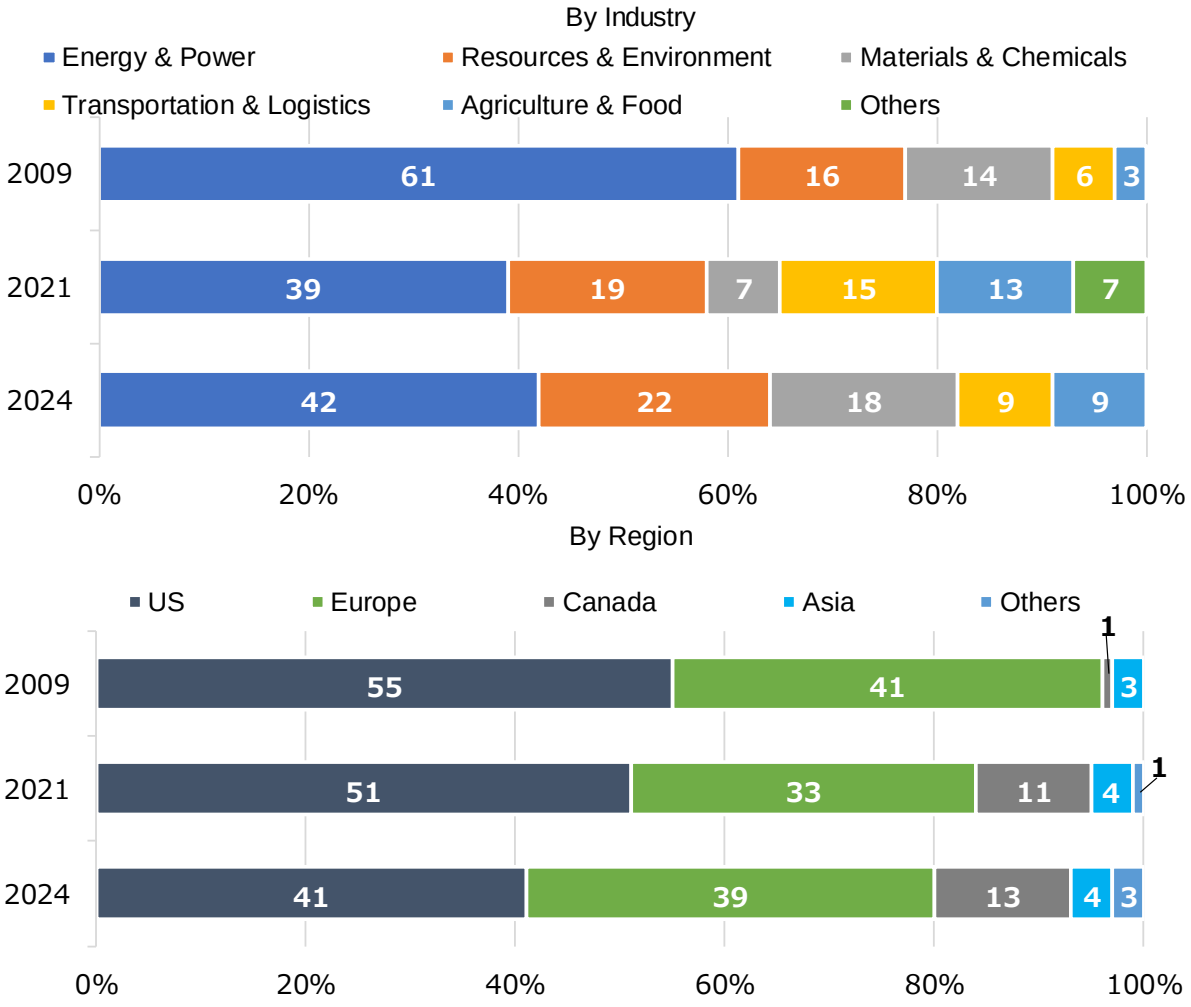
Note: Value for 2023 is the cumulative total through 3Q.
Source: Compiled by MGSSI based on PwC Japan, "State of Climate Tech 2023" (in Japanese)

The Global Cleantech 100 list shows that investments

[1] PwC Japan, "State of Climate Tech 2021" (Japanese edition) (accessed February 6, 2024, same for all other references hereafter)

are concentrated in the energy industry, where technological innovation is directly linked to GHG emissions reduction, in North America, where the venture investment market is flourishing, and in Europe, where climate change regulations are being formulated. In addition, greater diversification has been seen in recent years, with the energy industry along with the resources and environment sectors attracting more investment, reflecting the focus on carbon capture, utilization, and storage (CCUS) and other technologies. In terms of regions, Asia and other regions now account for a larger share of the total (Figure 2).

Figure 2: Distribution of leading climate tech startups (Global Cleantech 100 list)



Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list

The companies that have been inducted into the Global Cleantech 100 Hall of Fame[2] multiple times are mainly from North America and Europe (Figure 3).

[2] Companies that have appeared on the Global Cleantech 100 list seven times are inducted into the Cleantech Group's Hall of Fame. Once a company is inducted into the Hall of Fame, it will not be selected for the Global Cleantech 100 list thereafter.

Figure 3: Leading climate tech startups (Global Cleantech 100 Hall of Fame companies)

	Company	Country	Establishment	Overview	Note
Energy & Power	Enbala Power Networks	Canada	2003	Provides demand-side energy management services	Acquisition completed
	TENDRIL	US	2004	Provides energy service management (ESM) solutions, cloud-based to deliver personalized energy services	Merger completed
	DIGITAL LUMENS	US	2008	Developed intelligent lighting for industrial facilities that reduces light energy use and provides control and reporting functionality	Acquisition completed
	Skeleton Technologies	Germany	2009	Manufactures graphene-based ultracapacitors	-
	Sunfire	Germany	2010	Provides energy conversion technologies such as renewable synthetic fuels based on solid oxide fuel cells and solid oxide electrolyzers	-
	AutoGrid Systems	US	2011	Provides software for public utilities to better integrate distributed energy resources	-
	tado	Germany	2011	Develops a smart thermostat and SaaS platform that allows users to control their home heating and cooling systems from their smartphones	-
Resources & Environment	Organica Water	Hungary	1998	Delivers biological wastewater treatment plants for urban and residential settings	-
	Ostara Nutrient Recovery Technologies	Canada	2005	Provides a solution to recover phosphorus and nitrogen from agricultural runoff and convert them into slow-release fertilizer	-
	CarbonCure Technologies	Canada	2007	Develops permanent carbon removal technology for concrete manufacturing	-
	MineSense Technologies	Canada	2008	Develops excavator sensor technology to capture ore in mine waste and provide real-time analysis during mining	-
Materials & Chemicals	Kebony	Norway	1997	Manufactures and sells sustainable hardwoods made from sustainably sourced and processed conifers	-
	Avantium	Netherlands	2000	Develops processes to convert biomass into bio-based materials and fuels	Listed
	LanzaTech	US	2005	Develops carbon capture and reuse technologies for converting abundant waste and low-cost resources into low-carbon fuels and chemicals	-
	GaN Systems	Canada	2008	Develops gallium nitride (GaN) semiconductors for more efficient electronics	Acquisition completed
Agriculture & Food	Vestaron	US	2005	Develops biological pesticides using natural peptides to replace conventional chemical pesticides	-
Transportation & Logistics	Proterra	US	2004	Develops zero-emission battery-electric buses to help fleet operators eliminate dependence on fossil fuels and reduce costs	-
	ChargePoint	US	2007	Provides EV charging solutions	Listed

Note: North American companies are shaded blue and European companies are shaded orange.
Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list

Climate tech emerging enterprises are characterized by the fact that (1) many of them originate from research institutes and (2) they require a longer period of time to scale up compared to startups in other fields such as IT. To begin with, in climate change mitigation, there are many measures and targets that cannot be achieved with existing technologies alone, including carbon neutrality, and the development and practical application of new technologies is essential. For this reason, many companies have their beginnings in universities and other research institutions. In addition, due to the nature of the climate change issue, many companies target infrastructure such as electric power and other systems. Infrastructure requires a high level of safety and strength, so development takes time, and a sufficient period is needed from the start of construction to completion.

1-2. Two investment booms

Investment in climate tech startups has seen the following two booms.

1-2-1. First boom from around 2010 driven by venture capital (VC) investment firms

The 2006 release of a documentary about the threat of climate change, “An Inconvenient Truth,” drew attention to the topic and, as a result, interest in environmental issues grew around the world. After his victory in the 2008 US presidential election, President Barack Obama launched energy-centered economic policies (under what

some dubbed the Green New Deal), and that led to an influx of capital into environmental conservation-oriented industries. At that time, VC investment increased for solar and other renewable energy generation-related projects.

However, investment in climate tech has declined sharply for reasons that include (1) a renewed focus on gas-fired power generation in the wake of the shale gas revolution, (2) intensifying price competition with China in solar power generation equipment, and (3) the difficulty of achieving balance between the time required from technology development to profitability and the return on investment within a VC fund's operational period (10 years)[3].

1-2-2. Second boom from 2020 fueled by corporate venture capital (CVC) and angel investor funding

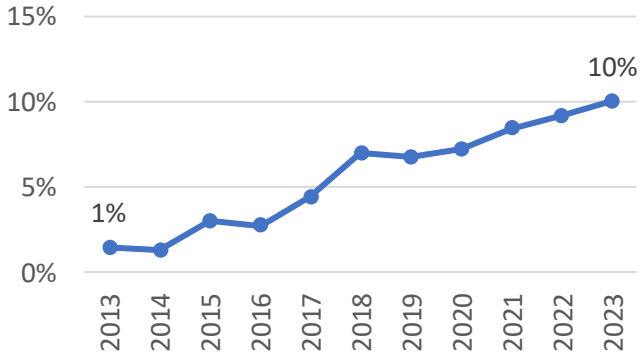
Climate change concerns have been increasing globally since the Paris Agreement, leading to a rise in climate tech investments. Furthermore, since the second half of 2020, investment has grown sharply, boosted by large-scale monetary easing. Investment trends include: (1) a widening in the range of target industries to include not only the energy sector but also transportation and food, and (2) a widening in funding sources to include not only VCs but also CVCs and angel investor funds that are not restricted by a set investment period.

As of 2021, it was expected that this would be more than a temporary boom due to the diversification of investment targets and funding sources, but the impact of the deterioration in the fund procurement environment due to financial tightening from 2022 onwards was felt in the climate tech sector as well, and the amount of investment began to decline.

1-3. Future prospects

After 2022, the tide of ultra-low interest rates has turned in response to high inflation in the US and Europe, but the timing of the projected rate cuts is not clear, and the outlook for startup funding is uncertain. However, the share of investments in climate tech as a percentage of total investments has continued to rise even as the total amount of investments has fluctuated (Figure 4), and investors are paying more attention to this area. Climate tech will remain one of the main investment themes, at least as long as there is continued policy support for climate action.

Figure 4: Climate tech investments as a percentage of total venture capital investments



Note: Value for 2023 is the cumulative total through 3Q.
Source: Compiled by MGSSI based on PwC Japan's "State of Climate Tech 2023 (in Japanese)

1-4. Initiatives by major *sogo shosha*

In light of this increased focus on climate action and its future expansion, many investors are considering investing in and collaborating with climate tech startups. Similarly, *sogo shosha* (general trading companies) that invest in various businesses are moving forward with efforts to form alliances, make investments and acquisitions, and provide support (Figure 5).

[3] MIT Energy Initiative, "Venture Capital and Cleantech: The Wrong Model for Clean Energy Innovation"

Figure 5: Major *sogo shoha's* investments in climate tech startups (examples)

Month/year	Company	Overview
Dec. 2023	Mitsui & Co.	Invests in a US startup investment fund (including climate tech startups) with The Norinchukin Bank, Mitsubishi Pencil, and Nitto Denko
May. 2023	Mitsubishi Corp.	Forms a fund with Mitsubishi UFJ Bank and PPE to primarily target climate tech-related companies
May. 2023	Sumitomo Corp.	Together with SCSK, establishes a second CVC fund in the US to invest in companies with climate tech and quantum computing technology
May. 2023	Itochu Corp.	Invests in Veloce Energy, a US manufacturer of energy storage systems and power distribution equipment, and enters into a strategic business alliance
Jun. 2021	Mitsubishi Corp.	In collaboration with Nippon Yusen, launches a program to support and nurture startups that contribute to the realization of a low-carbon, decarbonized society

Source: Compiled by MGSSI based on press releases and information on the websites of each company

2. RISKS OF CLIMATE TECH VENTURE INVESTMENTS AS OBSERVED FROM TRENDS FOR "GRADUATES"

2-1. Considering the risks of climate tech venture investments: Focus on "graduates"

Even though climate tech is a leading investment theme, investing in the first place is fraught with risk. Given this, what risks should interested parties be aware of when considering an investment? To help understand the risks, this chapter traces the paths of companies that have gone through IPOs and M&As, referred to as "graduates" in this report. Investors who want to avoid risk will choose companies that are highly regarded by the market as investment targets, so it can be assumed that they will target companies that were selected for the aforementioned Global Cleantech 100 and "graduated" during one of the two investment boom periods (1st round: January 2009 to December 2012; 2nd round: October 2020 to December 2021) (Figures 6 and 7).

By reviewing the post-graduation trend of graduates, three risks can be pointed out: (1) deterioration of the financial environment, (2) changes in the industry structure due to technological innovation and other factors, and (3) the difficulty in managing emerging enterprises.

Figure 6: Companies that conducted IPOs after inclusion in the Global Cleantech 100 list

	Company	Country	Industry (Note 1)	Time of IPO	SPAC (Note 2)	Overview
1st investment boom (Note 3)	A123 Systems	US	Energy	2009/9	-	Developed advanced lithium-ion batteries and battery systems
	Tesla Motors	US	Transportation & logistics	2010/6	-	Develops and sells EVs
	Amyris Biotechnologies	US	Energy	2011/1	-	Developed a synthetic biology platform for the production of fuels and chemicals
	Gevo	US	Energy	2011/2	-	Produces biobutanol from starch-based feedstock
	Zipcar	US	Transportation & logistics	2011/4	-	Provided car sharing services
	Solazyme	US	Energy	2011/5	-	Developed an algae-based fermentation process to produce biofuels and biochemicals
	Enphase Energy	US	Energy	2012/4	-	Provides microinverters and solar energy management systems
2nd investment boom (Note 3)	Fisker	US	Transportation & logistics	2020/10	O	Manufactures plug-in hybrid and solar-powered luxury vehicles
	ChargePoint	US	Transportation & logistics	2020/12	O	Provides EV charging solutions
	Desctop Metal	US	Manufacturing support	2020/12	O	Provides 3D printing solutions for metal and carbon fiber
	C3.ai	US	Energy	2020/12	-	Provides AI and IoT solutions
	Farmers Edge	Canada	Agriculture & food	2021/3	-	Provides data solutions for farms
	NUVVE	US	Transportation & logistics	2021/3	O	Develops technologies for EV recharging, and storing and reselling unused electricity
	View	US	Energy	2021/3	O	Develops energy-saving glass technology for architectural applications
	Stem	US	Energy	2021/4	O	Develops software for energy storage, power usage, and grid operation
	Innoviz Technologies	Israel	Transportation & logistics	2021/4	O	Develops the LiDAR technology for self-driving
	Proterra	US	Transportation & logistics	2021/6	O	Develops zero-emission battery-electric buses
	Microvast	US	Energy	2021/7	O	Manufactures battery systems for EV and large power grid applications
	EVgo	US	Transportation & logistics	2021/7	O	Supplies quick charging stations for EVs
	Volta Charging	US	Transportation & logistics	2021/8	O	Supplies free charging stations for EVs
	otonomo	Israel	Transportation & logistics	2021/8	O	Developed software for real-time data exchange between automated vehicles, etc.
	Joby Aviation	US	Transportation & logistics	2021/8	O	Provided electric aircraft systems
	Li-Cycle	US	Energy	2021/8	O	Provides lithium resource recovery services and supplies lithium-ion battery materials
	Benson Hill	US	Agriculture & food	2021/9	O	Develops synthetic biotechnology platform for crop and food development
	Lilium	Germany	Transportation & logistics	2021/9	O	Develops battery-powered aircraft
	Energy Storage Systems	US	Energy	2021/10	O	Develops energy storage technology using iron
	Solid Power	US	Energy	2021/12	O	Develops all solid-state rechargeable batteries for the EV and mobile power markets
	Planet	US	Environmental technology	2021/12	O	Established a network of observational satellites that provide open source information on global climate change

Note 1: Based on the Cleantech Group's Global Cleantech 100 list. Shading indicates energy or transportation & logistics industries, which have a large number of companies on the list.

Note 2: Refers to listing using a special purpose acquisition company (SPAC) (SPAC listing).

Note 3: The first boom period was from January 2009 to December 2012, and the second boom period was from October 2020 to December 2021.

Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list

Figure 7: Companies involved in M&As after inclusion in the Global Cleantech 100 list

	Company	Country	Industry (Note 1)	Details	Time of event	Buyer	Merger, withdrawal complete
1st investment boom (Note 2)	Solel Solar Systems	Israel	Energy	Solar power generation	2009/10	Siemens	○
	SunEdison	US	Energy	Solar power generation	2009/11	MEMC	○
	Concentrix Solar	Germany	Energy	Solar power generation	2009/12	Soitec	○
	Cpower	US	Energy	Power adjustment (demand response)	2010/9	Constellation Energy	
	Inge	Germany	Resources & environment	Ultrafiltration membranes for water treatment applications	2011/4	BASF	○
	Landis+Gyr	Switzerland	Energy	Smart meters	2011/5	Toshiba	○
	QuantaSol	UK	Energy	Concentrator photovoltaics (CPV)	2011/7	JDSU	
	eMeter	US	Energy	Smart meters	2011/12	Siemens	
	SmartSynch	US	Energy	Software development (smart meters)	2012/2	Itron	
	Marine Current Turbines	UK	Energy	Development of undersea tidal stream turbines	2012/2	Siemens	○
2nd investment boom (Note 2)	Enbala Power Networks	Canada	Energy	Demand-side energy management	2020/10	Generac	
	Advanced Microgrid Solutions	US	Energy	Software development (distributed energy)	2020/11	FLUENCE	
	SolarCentury	US	Energy	Solar power generation	2021/1	Statkraft	
	Next Kraftwerke	Germany	Energy	Virtual power plant operation	2021/2	Shell	
	Varentec	US	Energy	Development of digital power electronics	2021/2	sentient energy	
	ubitricity	Germany	Energy	Mobile metering technology for EV smart charging	2021/2	Shell	
	ONZO	UK	Energy	Big data analytics	2021/5	geo	
	electriphi	US	Transportation & logistics	Software development (EV energy management)	2021/6	Ford	
	Anesco	UK	Energy	Energy efficiency support	2021/6	Aksiom	
	Novomer	US	Materials & chemicals	Polymer production using CO2	2021/7	danimer	
	Open Energi	UK	Energy	AI software development (distributed energy)	2021/7	bp	
	ViriCiti	Netherlands	Transportation & logistics	Vehicle management services	2021/8	ChargePoint	
	Aqwise	Israel	Resources & environment	Water treatment services	2021/8	GES water	
	ecobee	Canada	Energy	Smart thermostats	2021/11	Generac Power Systems	
	Opus One Solutions	Canada	Energy	Software engineering and solutions for EVs, renewable generation, and energy storage	2021/12	GE Digital	
	envelio	Germany	Energy	Software development for electric power companies	2021/12	E.ON	
	AMPLY Power	US	Transportation & logistics	EV charging-related services	2021/12	bp	

Note 1: Based on the Cleantech Group's Global Cleantech 100 list. Shading indicates energy or transportation & logistics industries, which have a large number of companies on the list.

Note 2: The first boom period was from January 2009 to December 2012, and the second boom period was from October 2020 to December 2021.

Note 3: Two acquisitions by funds (SiC Processing and agri.capital) have been excluded.

Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list

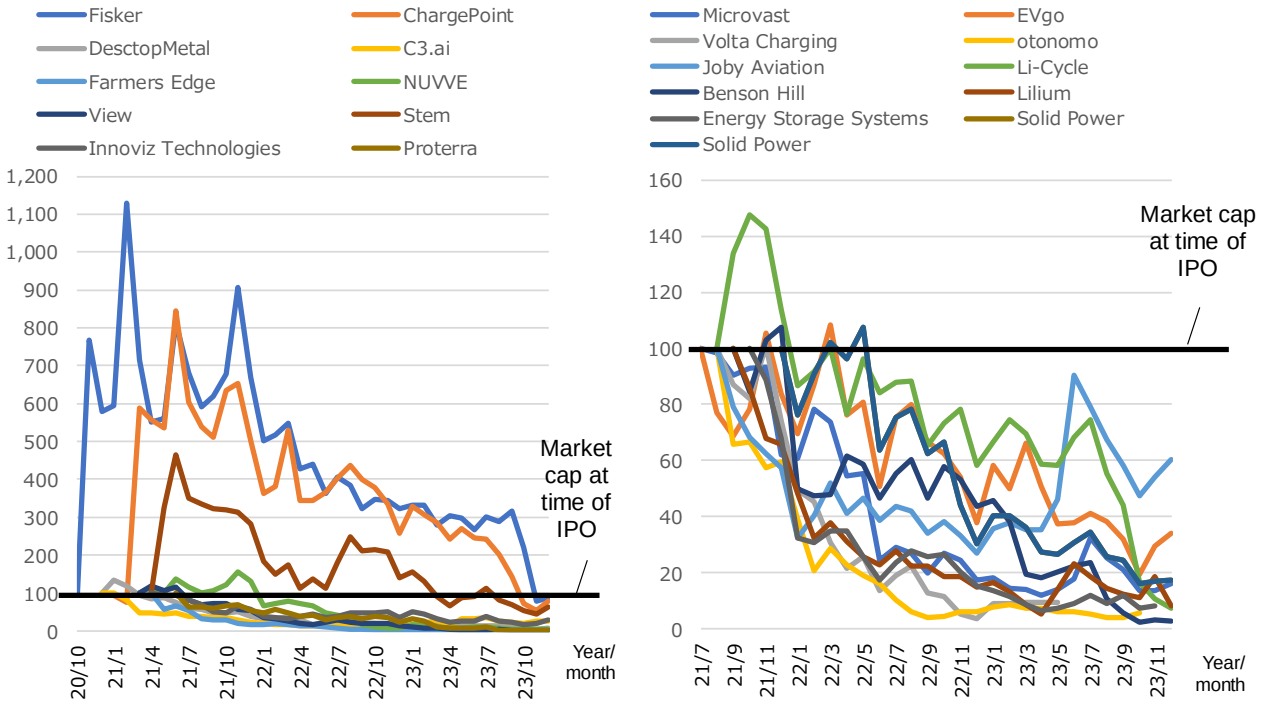
2-2. Risk (1): Deterioration of the financial environment (IPOs during 2nd boom)

First, let's look at the post-listing market capitalization of graduates who conducted IPOs during the most recent boom period (October 2020 to December 2021). As of December 31, 2023, the respective market capitalizations of 10 companies that listed their shares before June 2021, shown on the left side of Figure 8, and the 11 companies that listed after July 2021, shown on the right side, were all below that at the time of listing. In addition to the tightening of monetary policy, the rising trend of listing through special purpose acquisition companies (SPACs)[4] has been pointed out as a reason for the decline in investment in venture startups across all industries after 2022. Companies that go through the SPAC listing process undergo a different listing screening process and meet with different market expectations than companies that go through the conventional process. However,

[4] Listing using a Special Purpose Acquisition Company (SPAC). A SPAC is a paper company formed for the sole purpose of merging with or acquiring a privately held company. After listing, the company raises funds from the stock market to make the acquisition. Private companies can go public by merging with a SPAC. For companies seeking to go public, the ability to raise funds more quickly than with an IPO, which is subject to a rigorous screening process, has been an advantage, and the number of IPOs using SPACs has increased.

given the sluggish post-listing growth of all graduates, including those that went public without using SPACs, it can be said that the impact of the deterioration in the financial environment cannot be overlooked, and that the impact of listing through SPACs is not the only reason.

Figure 8: Changes in market capitalization after IPO (market capitalization at the end of the month in which the IPO was conducted = 100, indexed as the end-of-month value)



Note: Volta Charging and otonomo (both shown at right) were no longer publicly traded companies as of December 31, 2023 after the former was acquired by Shell and the latter ceased to exist due to a merger.

Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list and Bloomberg data

2-3. Risk (2): Change in industry structure (M&As)

A look at the graduates that were involved in M&As during the first boom period (January 2009-December 2012) shows that 6 of the 10 companies exited businesses that were newly established or strengthened through acquisitions. Three of them are photovoltaic power generation projects, but in the background, it was the shale gas revolution that ended the first boom, intensified price competition, and led to other changes in the industry structure. Even if a company is considered to be strong before an acquisition, there is a risk that the value of the business may change suddenly due to changes in the industry structure.

Among M&As during the second boom period, unlike the first boom period, when activities were concentrated in the electric power industry, companies in diverse industries, such as mobility and chemicals, emerged. Ford acquired electriphi for the purpose of building a charging network for its EVs and partnered with a number of other companies in pursuing its EV business strategy[5]. This suggests risk can be mitigated to some degree if a company is willing to draw up its own strategy in anticipation of changes in the industry structure.

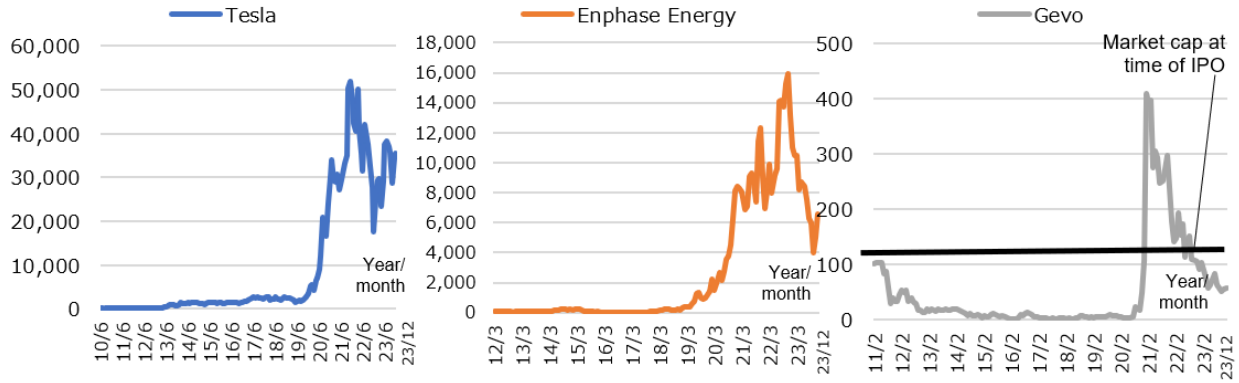
[5] Nihon Keizai Shimbun, May 13, 2022, "Analysis of the alliance relationship chart, Ford's investment strategy for future vehicles in the US" (in Japanese)

Sogo shosha have been quick to venture into areas within their existing businesses that are expected to grow as a consequence of climate change measures, and in areas where GHG emission reduction measures are required. The companies are making these moves in anticipation of changes in the industry structure, as did Ford.

2-4. Risk (3): Difficulty in managing startups (IPOs during the 1st boom)

Of the seven graduates that achieved IPOs during the first boom period, only three (Tesla Motors (now Tesla), Enphase Energy, and Gevo) were still in business as of December 31, 2023, and of these, only two (Tesla and Enphase Energy) have a market capitalization higher than that when they went public (Figure 9). This suggests the considerable degree of difficulty in growing a startup after listing, and investment risk is inherent in this regard.

Figure 9: Changes in market capitalization after IPO (market capitalization at the end of the month in which the IPO was conducted = 100, indexed as the end-of-month value)



Source: Compiled by MGSSI based on the Cleantech Group's Global Cleantech 100 list and Bloomberg data

3. IN CONCLUSION

Investment in climate tech startups has gone through two booms and a lull, but like climate change, it is a topic that remains a focus of attention around the world. At the same time, even for leading companies, risks are inherent in (1) the financial environment, (2) changes in industry structure, and (3) the difficulty of corporate management. If investors make an investment by just following trends, they may face unexpected hardships when they recover their investments.

Climate tech startups will be one of the options for investment and business alliances for *sogo shosha* and other companies that need to change their business models amid the changing landscape brought by climate change countermeasures. However, while recognizing the aforementioned risks, a company should also consider synergies with its existing business activities so that the investment will be an indispensable piece of the strategy for the company's future.