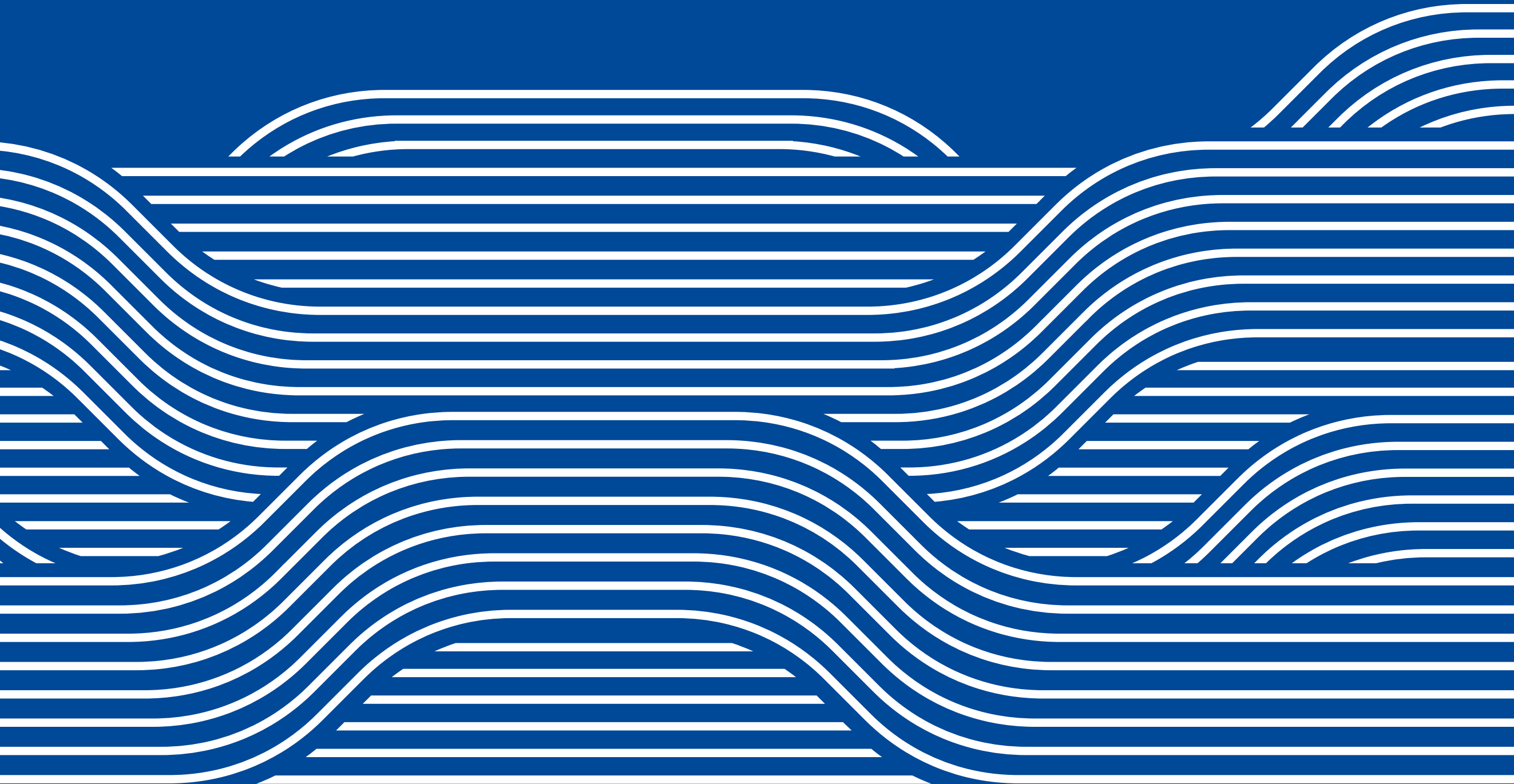


ENVISIONING PARTNERS

IMPACT REPORT

2023

envisioning
partners



Disclaimer

Envisioning Partners ("Envisioning") is an impact venture capital. Envisioning embarked on its new journey in 2021 when the assets and key investment professionals transferred from Yellowdog, a first-generation impact investing firm in Korea. This report contains Envisioning's investment philosophy and strategy, and the stories of major portfolio companies invested in 2022. The impact factors of each company are evaluated at the time of investment.

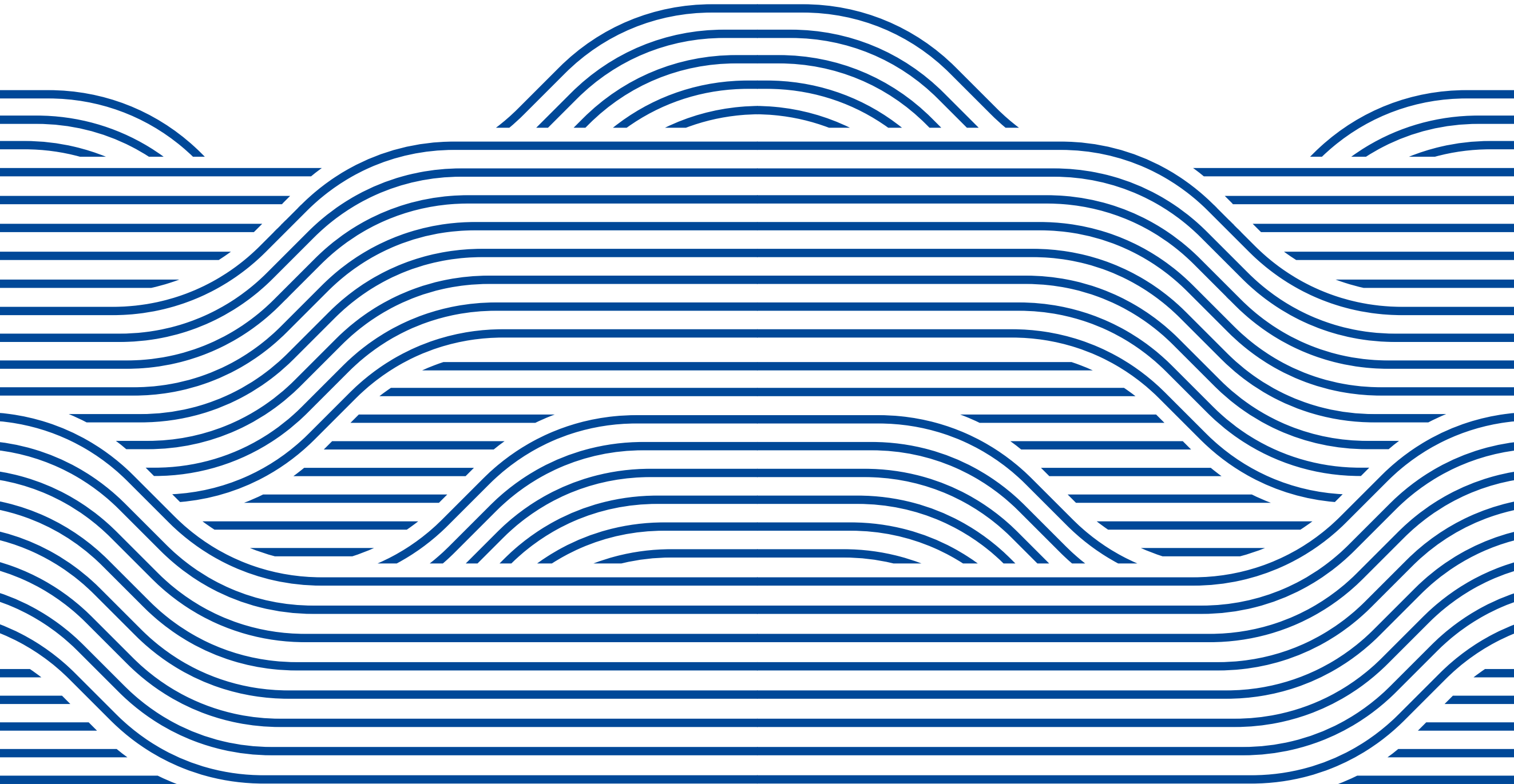


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Starting 2023

After all of the volatility of 2022, as we start the new year, it feels like 2023 will be the first full year of a new era. The global geopolitical and economic paradigm has changed and it feels like we are now living in a world which will be more multipolar and regional, with higher inflation and interest rates, and slower growth in general. It's an eerie sense, like entering into a new section of a rollercoaster ride and how long this will last is hard to tell.

The one constant that will flow over into this new era, we believe, is the urgency and the ever stronger need to slow, and ultimately reverse, the impact of climate change. With the passage of the Inflation Reduction Act in the US last year and similar movements elsewhere, venture investments into climate tech is one area that will undoubtedly increase in 2023.

Envisioning has been prioritizing investments in climate solutions since 2021, focusing on technologies on multiple fronts that will contribute most directly and effectively to the transition to a decarbonized economy. In 2023, we plan to continue our investment pace as we build on our expertise in our core areas of focus within climate technology.

As important as it is for new startups to be formed by driven entrepreneurs that address the many facets of climate change, we think it is perhaps even more crucial for there to be numerous success stories of existing startups effectively scaling up both operationally and in terms of valuations. There needs to be multiple companies that can serve as benchmarks for how climate focused startups can grow to become the next generation of unicorns. In addition, as we stressed in our quarterly newsletter in 2022, this is a time when startups will need to focus on the basics and be highly cash and cash flow focused. This will continue in 2023. We will continue to work with our portfolio companies to ensure that they are best positioned to survive and effectively scale up in the long term.

The task of meeting the global net zero targets seems daunting at times. Let's not, however, reduce the level of our efforts to try to meet these targets just because we are afraid we might not ultimately get there. We hope that everyone starts 2023 with renewed energy and positive spirit as we embark on this new era.

Hyunjoo Je | Yong Hyun Kim

Managing Partners at Envisioning Partners

제해주 · 김용현

MISSION

**We build bridges
connecting the
capital markets
with impact makers.**



We invest in companies where the business model and impact model are closely interlinked.



We refine our own impact investing perspective and strategy and redefine the role of capital for people, community and the environment.

Envisioning Partners 2023

(As of the end of February, 2023. Ratio (%) by investment amount)



* As of FY22 Q4

** Investment in companies that raised follow-on rounds after our initial investment

Envisioning's Investment Thesis and Strategy

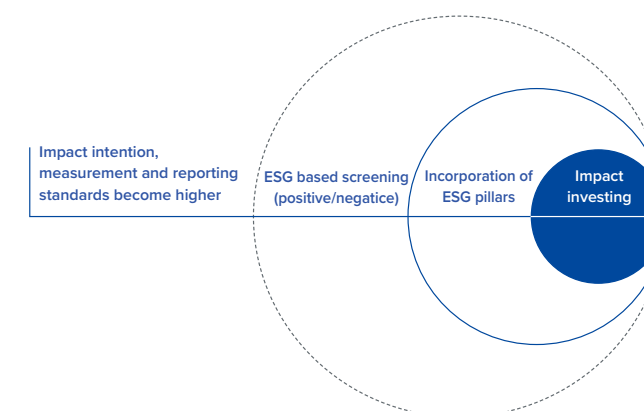
Envisioning Partners (“Envisioning”) is a venture capital firm based in Seoul, with impact investing at the core of its investment philosophy and strategies. We invest in startups that turn major social and environmental challenges of our time into great market opportunities.

Investment Thesis

Environmental, Social and Governance (“ESG”) is a term that has gained the most attention in Korea during the past couple of years, particularly in social and economic sectors. It has become a popular investment criteria in capital markets and has been declared by many companies as their business priority.

In the realm of ESG investing, ESG considerations can be applied in general mainly for positive or negative screening purposes in the selection of companies for inclusion in a portfolio, or more specifically and comprehensively, across investment strategies and decision-making processes to achieve ESG integration.

Impact investing is a type of ESG investing in its most assertive form. Impact investors invest in companies that explicitly tackle social and environmental issues directly as a part of their business activities. The underlying philosophy and strategies at the core of impact investing is to capture market opportunities that bring environmental and social benefits and to inspire better decision making from the diversity and inclusiveness standpoints. The proverbial phrase “attack is the best form of defense” can be aptly applied to describe impact investing. We believe companies that utilize ESG considerations as an opportunity, as opposed to being a cost for the business, are on a path toward long-term success, and impact investing is an apt means to identify and capitalize on the growth of such companies.



The Spectrum of Sustainable Investing
Source: World Economic Forum

Investment
Criteria



Startups with impact creation embedded in their business models

A company’s commercial results and social impact can grow hand in hand when the theory of change triggering impact is integrally interlinked with the company’s business model. We invest in startups that demonstrate high collinearity between business growth potential and social impact.



Startups with innovative solutions to problems

We invest in startups that create significant market opportunities by delivering innovative solutions to major social and environmental problems of our time. Game changers that innovate the market through new technologies and creative business models will be able to scale up the impact.



Business leaders that contribute to the market and our society

We invest in people and teams with exceptional leadership. We believe good entrepreneurship can manifest itself in the products and services of a company, and ultimately has an impact on customers and the society. We invest in business leaders with strong commitments to resolving social issues and who are able to deliver the commitments while growing their businesses.

Investment
Strategies



Through proactive business strategy development as the lead investor, we refine the company’s impact model and support value enhancement

Envisioning aims to ingrain impact models into the DNA of startups and their founders. The early investors of a startup company and their relationship with the founder can determine the way impact models are established in the company. As the lead investor, we focus on Series A and Series B funding rounds with the strategic goal of providing the necessary financing and actively supporting the company’s business growth.



We make investment decisions based on a clearly defined impact perspective and provide post-investment management support

Before making an investment decision, Envisioning conducts an impact relevance test to see if the startup’s business matches the impact areas prioritized by Envisioning, and an impact model test to determine whether there will be sustainable impact creation. Subsequently, Envisioning designs impact assessment and management systems based on a theory of change. After making the investment, Envisioning continues to take an active role in establishing the startup’s impact model and enhancing business value. Our investment professionals specializing in impact assessment and management explore ways to maximize impact values from the moment we start investing in the startup. These professionals are responsible for individual impact assessment and post-investment management, and also for ensuring that the startup’s business activities remain focused on impact creation.

Impact Domains and Portfolio

Envisioning strives to make an impact in the domains of climate change, health and wellness, education and the future of work.

1

Climate Change

Businesses that contribute innovatively to the transition to a decarbonized economy







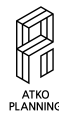











2

Health and Wellness

Businesses that provide healthier eating / lifestyle services or quality healthcare services to a wider range of people











3

Education

Businesses that present innovative educational models and provide access to education across physical and economic barriers, from children to adults






4

The Future of Work

Businesses that enhance the quality and diversity of jobs under the changing paradigms of 'work' and help resolve the gap between supply and demand in the labor market. Lifestyle services reflecting changes in the labor market







* Envisioning invested in GymT, which merged with The 4th Wave and changed its name to Poprika.

** Envisioning invested in Dr. Kitchen, which was acquired and merged with Fresheasy.

Investment in Climate Tech



Climate tech companies
in our portfolio
(by investment amount)

53%

Climate Change
impact domain

1

Energy Transition

Technologies and businesses that accelerate the transition from fossil fuel-based energy sources to low-carbon energy sources, including renewables

2

Industrial Decarbonization and Circular Economy

Technologies and businesses that contribute to building a circular resource model by reducing resource and energy use and increasing recycling rates throughout the entire process of production, distribution, use, and disposal of industrial materials

3

Sustainable Food and Agriculture

Technologies and businesses that contribute to the decarbonization of the existing agri-food value chain while effectively responding to climate change-induced agricultural environmental changes and food shortages

4

Carbon Tech

Technologies and businesses that efficiently remove emitted carbon from the air and further utilizes it as a new resource

5

Climate Change Adaptation

Technologies and businesses that enhance adaptability to the rapidly changing environment caused by climate change

In response to the magnitude and urgency of climate change issues and the role of technology as a solution to address such issues, we have prioritized climate solutions as the most important technology among our impact domains. As climate solutions have, by their nature, strong deep tech properties and are very broad in scope, Envisioning has defined specific areas to focus on within climate technology based on market size, maturity, and internal expertise. Our five focus areas include energy transition, industrial decarbonization and circular economy, sustainable food and agriculture, carbon tech (carbon to value), and climate change adaptation.

Major Portfolio Companies

Energy Transition



Industrial Decarbonization and Circular Economy



Sustainable Food and Agriculture



Carbon Tech



Climate Change Adaptation




Whether to make an investment is determined at ‘impact due diligence’ phase, which entails the following steps.

STEP 01 Impact Relevance Test


We determine whether the potential company’s business can resolve social issues relevant to key impact domains and therefore, directly contribute to achieving corresponding Sustainable Development Goals (“SDGs”) of the UN. If the potential target company engages in a business that falls under one of the key impact domains of Envisioning and directly contributes to at least one of SDGs, we will consider whether to make an investment in the company.

STEP 02 Impact Model Test


We comprehensively test the impact model based on the following three areas:

- 

Mission

Whether the potential target company has clearly defined corporate mission relevant to the social issues it aims to address, proclaimed it and communicated continuously
- 

Strategy

Whether the potential target company’s key elements of business model directly contribute to solving the social issues it aims to address
- 

Governance

Whether the potential target company has the right shareholders and corporate governance structure to sustain its impact orientation

STEP 03 Theory of Change Test and Impact Valuation

In this step, we define the theory of change as it relates to the impact to be brought on by the potential target company, and perform a valuation to quantify the potential impact. During this process, we develop performance indicators that will be used to track impact after making the investment.

Measurement and Assessment of Environmental Impact of Climate Solutions

When it comes to climate change, which is one of Envisioning’s impact domains, we focus our investment on technological solutions that reduce greenhouse gas emissions. Unlike in social impact assessments where we should consider the chain reaction at a social level, environmental impact assessments require a review of direct impact inherent to the relevant technology.

When we consider making an investment into a company under the climate change impact domain, we consider i) the size of impact, ii) scalability, and iii) directness of impact, as individual value assessment criteria. For all climate technology solutions that are ready for a full investment review, we conduct assessments to find out whether they take innovative approaches to meet the “net zero” targets, and how efficient and effective they are in reducing greenhouse emissions.

Assessment Criteria	Key Considerations
Size of impact If the technology is implemented, how effective is it in reducing greenhouse gas emissions?	<ul style="list-style-type: none">· The portion of greenhouse gas emission sources that can benefit from the technology· Greenhouse gas reduction potential of the technology
Scalability How likely is it that the technology will be widely implemented within a short period time?	<ul style="list-style-type: none">· The likelihood that the technology will reach commercially meaningful scale by 2040· Technological and non-technological barriers that need to be overcome, before the technology is utilized at a meaningful scale
Directness of Impact How much does the technology directly contribute to reducing greenhouse gas emissions?	<ul style="list-style-type: none">· The technology’s ability to contribute to greenhouse gas reduction – whether the application of the technology alone can directly contribute to reducing greenhouse gas emissions, or it contributes to decarbonization of industries in general. The technology’s impact is assessed for each case
Alternatives & Risk If an alternative technology is introduced, how likely is it that the technological solution will become obsolete? From the overall value chain perspective, is there a concern that the technological solution might in fact disrupt meeting the net zero targets?	<ul style="list-style-type: none">· Alternative technologies or systems that might render the potential target company’s technology obsolete· The risk that the technology would temporarily reduce greenhouse gas emissions but ultimately delay meeting net zero targets

Disclaimer

In principle, the assessment and measurement of impact are not final and will only be utilized as the basis for objective decision making and actual impact creation. In particular, the conversion of impact into quantitative figures is solely for the purpose of understanding the theory of change and aligning priorities, and is not intended for relative comparison between impact domains.

ESG Inspection and Management Principles

Envisioning Partners is an investment company that has “impact investing” as its investment philosophy and strategy. Envisioning invests in those target companies that simultaneously create financial returns and positive impact by solving environmental and social problems while operating their businesses.

Before making any investment decisions, Envisioning conducts an impact evaluation of each target company and follows the principle of investing only when it is deemed that there is collinearity between business growth and impact creation. Envisioning operates its unique impact management system to assist such target company to maintain its impact orientation after the initial investment during the period when Envisioning is in possession of shares of such target company and even after the liquidation thereof.

Along with this philosophy and strategy, the purpose of establishing this separate “ESG Investment Principle” is as follows. 1) Target companies that want to create positive impacts through business must also be aware of the possibility of negative impacts that may occur in the process of conducting their business. If you ask them to continuously check and improve such possibilities, as an impact investor, one can help the target company build a long-term sustainable business structure. In addition, 2) it can clarify and systematize the principles and methods of decision-making that have been implicitly carried out so far and helps Envisioning strengthen its responsibility to achieve the investment results commensurate with the intended investment goals as an impact investor.

ESG Investment Principles

1. Before the Investment Committee is held, the ESG items of the target company shall be evaluated and the contents of such evaluation shall be reflected in the decision-making process for the investment in question. After carrying out the investment, a mid-to-long term ESG improvement goal shall be established along with the target company and tracked as an essential post-investment management item. Envisioning will transparently share information on the ESG evaluation and the improvements of the target company with key interest parties.
- 1-1. In the case of early/mid-term startups (Series C or before), it is judged that they are in the process of establishing the overall business model and operation method, and the purpose of the ESG evaluation will be to strengthen the startups’ positive impact orientation and ESG from a long-term perspective and helping such target companies gradually achieve the requirements. In the case of items that are determined to have little or no relevance or impact due to the size of the target company, the premise of such an argument shall be specified and the evaluation of such items may be waived. This method 1) prevents management inefficiencies that can occur when all ESG items are applied uniformly to all target companies without considering the type and size of the target company, and 2) establishes a tool with which target companies can use to manage the risks to their actual business that they will face at each growth stage. When the target company reaches the point where it needs to prepare itself to be a listed public company, all ESG items of the target company should be evaluated, and according to the results of the evaluation, it is advised that the target company establish appropriate improvement and implementation plans.
- 1-2. When considering an initial investment in a company with plans to go public within two years, ESG evaluation results shall be reflected in the decision-making process for the investment.
- 1-3. Although the positive impact that can be anticipated from the investment in 1-2 above might be large, if it is determined that there are elements to be improved from an overall ESG perspective, a specific improvement plan for the relevant item must be requested and active implementation should be encouraged, by reflecting special terms and conditions in the investment contract.

- 1-4. The major ESG items of the target companies in which Envisioning possesses shares shall be confirmed again at regular intervals and improvements shall be identified. Such re-confirmation intervals shall be semiannually or annually. As a shareholder, one shall discuss issues with the target company's representatives and members of its leadership team, and, if needed, one shall set them as the agenda for the meetings of the board of directors to find practical measures to improve them.
- 1-5. Major ESG indicators and improvement information for each fund shall be included in the semi-annual business report and shall be regularly shared with investors.
- 1-6. For newly invested companies, the basis for decision-making and the key contents of the impact evaluation shall be included in the annual impact report or shared through other official channels.

ESG Operation and Responsibility

- 2. All investment professionals are responsible for complying with this ESG principle, and the final decision on the establishment and operation of ESG principles at Envisioning's level is determined by the resolution of its board of directors.
- 2-1. One of the managing partners must act as the chief ESG officer in charge of the company-wide ESG implementation, and in the absence of the chief ESG officer, one registered director, designated by the board of directors, will act on behalf of the chief ESG officer regarding these responsibilities. Envisioning will have a separate personnel to support ESG-related operations and communication more smoothly at the practical level.
- 2-2. All investment professionals shall make themselves familiar with the ESG principles and participate in the investment decision-making process by considering such principles. ESG evaluation and monitoring of individual portfolio companies shall be taken care of by the investment professionals who are in charge of each such portfolio company.
- 2-3. When a significant ESG-related issue concerning a portfolio company is discovered, the responsible investment professionals shall immediately share such information with a

partner so that the Envisioning board of directors can promptly address the issue and decide how to respond to the issue going forward. Issues that are deemed important to be quickly shared with investors/LPs at the fund level shall be communicated through channels other than the biannual/quarterly report as needed.

Impact Insight



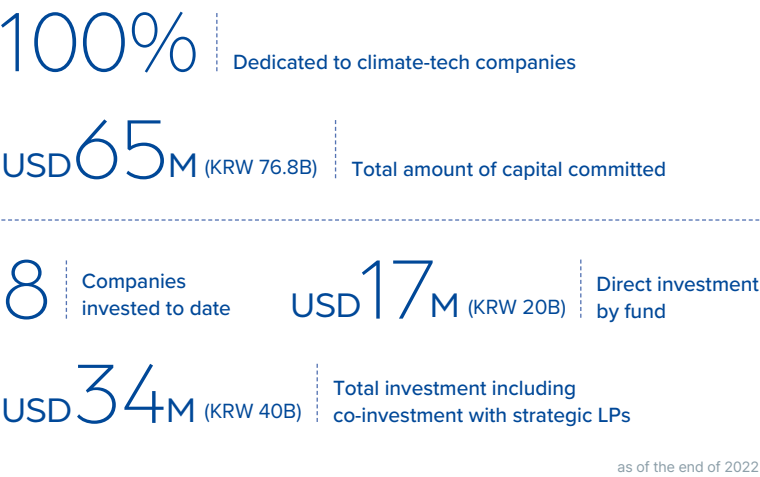
Market Opportunities for Climate Tech and Door to a Decarbonized Society

In our annual impact report at the beginning of 2021, we declared climate change, the greatest threat to humanity, as our top priority investment area. In 2020, when there were signs that the market was finally starting to move in earnest, we made the decision that we needed to focus on climate change at a much faster pace and on a much larger scale than we had done before. This decision led to the launch of the Envisioning Climate Solutions Fund, which invests 100% in climate tech. The KRW 76.8 billion fund is entirely funded by private LPs, mainly strategic investors who consider climate change a priority as both a risk and a new business opportunity. As such, we bring a strategic perspective to each investment which goes beyond financial returns and we work with our LPs to accelerate the growth of our portfolio companies. We aim to contribute to the rapid growth of decarbonization solution startups in Korea, while also actively investing in pioneering technology startups overseas and connecting them to the domestic market to increase our society's readiness for climate action.

As of the end of 2022, the fund has invested a total of KRW 20 billion in eight companies, four of which secured co-investments from our strategic LPs. Including the amount of co-investments, a total of KRW 40 billion has been invested by the fund. Envisioning's climate portfolio includes: H2 (Korea), a global leader in vanadium redox flow battery technology; RECO (Korea), which is revolutionizing the entire waste treatment process; Mango Materials (US), a developer of plastic substitutes by utilizing methane-based PHA technology; and Green Li-ion (Singapore), a direct to cathode battery recycling technology company.

It has only been about 18 months since the fund was launched, but in that time we have seen tremendous momentum build up in the climate tech market. While capital markets have slowed and startup investments have cooled, investments in climate tech, especially early-stage investments, are showing robust growth. In 2022, USD 70 billion was invested in climate

Envisioning Climate Solutions Fund



tech, up 89% year-over-year (HolonIQ)¹. This is remarkable considering it comes at a time when venture capital investment plummeted by 42%. The amount of capital committed to climate tech in 2022 was nearly 35 times higher than a decade ago.

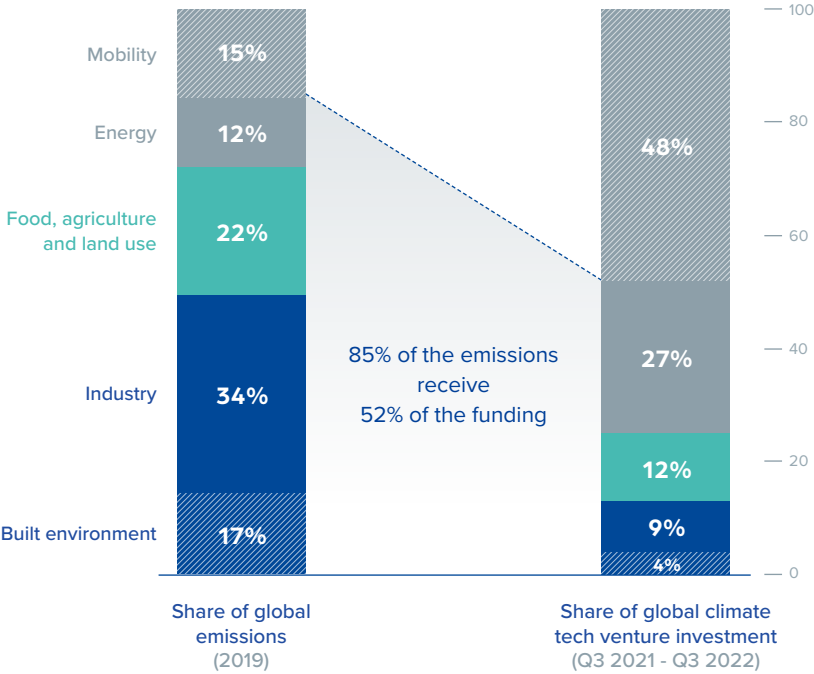
The number of funds investing in climate solutions continues to grow as well. More than 60 new climate tech funds were launched in 2022, a number that hasn't changed significantly from the previous year, but the total assets under management of these new funds has more than doubled². More than 15 funds of USD 50 million or more closed in 2022 alone. Examples include GenZero, a USD 3.6 billion investment platform formed by Temasek to invest in decarbonizing companies, and the USD 3.5 billion BeyondNetZero fund formed by global private equity firm General Atlantic. Specialization within climate tech is also deepening. Rather than referring to a specific sector, climate tech is a broad term for technologies aimed at reducing greenhouse gasses or adapting to climate change, and accordingly, the field is very large. As the consensus on the need for climate tech grows and markets have developed for

¹ "Defying gravity, 2022 Climate Tech VC funding totals \$70.1B, up 89% on 2021", HolonIQ, Climate Tech Intelligence Unit, January 3, 2023.

² Climate Tech VC, PitchBook

specific areas within climate tech, specialized funds are emerging that invest, for example, only in batteries, only in the hydrogen economy, only in food systems, and only in decarbonization technologies. Investing in climate tech will increasingly require a high degree of expertise, as it requires an understanding of the underlying deep tech, a perspective on how the market will evolve, and a sense of the dynamics between the various stakeholders. At Envisioning Partners, we have prioritized specific areas within climate tech to sharpen our domain expertise and are investing in each area with an agile understanding of the rapidly changing market trends.

Share of global emissions and climate tech venture investment by sector



Source: PwC State of Climate Tech Report 2022, PwC analysis of pitchbook data

The passage of the Inflation Reduction Act (IRA) in the US has significantly lowered the threshold for commercialization of climate tech. Of the total USD 790 billion budgeted in the IRA, USD 369 billion will go to green and climate action industries, making it the largest financial investment in US history to address the existential crisis of climate change. In fact, since the passage of the IRA, companies in the renewables, hydrogen, batteries, and carbon to value sectors have been revising their business plans more aggressively. New startups are popping up every day, especially in carbon capture, which had been thought to be a long way from reaching economic viability. There is no better example of the power of bold policy decisions by governments in shaping markets.

The global climate tech market is moving at a rapid pace, and the capital being invested is growing fast, but it is neither large enough nor effective enough to address the magnitude of the problem that we need to solve. Looking at global climate tech venture investment in the 12 months from Q3 2021 to Q3 2022³, 48% of all investments went to the mobility sector, which accounts for only 15% of all greenhouse gas emissions. In other words, only 52% went to all other sectors - energy, food systems, industry, and the built environment - which together account for 85% of emissions. While this is down from nearly two-thirds of investment in mobility over the previous seven years, 48% is still excessively high. This suggests that capital is not being deployed and allocated optimally in terms of its effectiveness.

³ "Overcoming inertia in climate tech investing", PwC, 2022.



However, this analysis is not necessarily a reason to be pessimistic: the trajectory of investments into passenger EV technology and markets within mobility is a preview of the future of many other climate technologies. With the rise of market-creating industry leaders, coupled with tremendous leaps in enabling technologies and favorable regulatory changes, the conditions were ripe for various forms of capital, including venture capital, to pour into the EV market. In 2010, it was far from an accepted premise that EVs would be the future of mobility by 2030; however, few would doubt that now. The fact that half of all investments made into climate tech was made into mobility does not mean that too much was invested into mobility. Rather, it means that the same amount of resources that went into mobility should be invested into all of the other areas of climate tech. And soon they will be, but the pace should be much faster than it was for EVs. Considering that Tesla was founded in 2003, it has taken nearly 20 years for electric vehicles to become a natural part of the near term future. Given the accelerating reality of climate change, we cannot wait 20 years for all the other areas of climate tech to become as obvious as electric vehicles.

To shorten the 20 years to 10 or even 5 years, first, we not only need a large amount of capital, we need a wide variety of different types of capital in order to scale up the climate technologies. More catalytic and patient capital needs to be deployed to help climate tech founders accelerate their journey to reach proof of concept and attract commercial venture capital. Once venture capital inflows have begun, reaching scale-up will require funding from a variety of asset classes, including project financing, facility loans and venture debt, in addition to venture equity investments. This need is particularly more critical in climate tech, a sector that must transform existing industrial infrastructure. Second, the talent pool for climate tech needs to be vastly expanded in terms of both diversity and number. We need more incentives to attract top-level engineering talent to start climate tech startups, and we need to actively communicate the huge market opportunity that will be created when society, as a whole, responds to climate change. We also need more people with a global perspective and deep industry experience. Not only will many climate tech businesses inevitably have to target global markets, but they will also need to work with a range of stakeholders in existing industries to grow. This is why climate tech businesses desperately need veterans with industrial experience.

Third, there is a need for multidisciplinary collaboration, cross-disciplinary research and technology development across academia, industry, policy groups, and governments. It has been estimated that over half of global greenhouse gas emissions could be reduced by commercializing and scaling up technologies that have been already developed. When technologies that exist in academia meet specific applications within climate tech, and when existing industries actively embrace and co-develop these technologies, markets will open faster and the pace of climate action will accelerate. This must be accompanied by an appropriate regulatory and policy environment. In this context, and last but not least, it is absolutely critical that regulatory and policy change is proactively heralded and consistently pursued. In many climate tech fields, the question of whether demand or supply comes first is a

major obstacle. The development of the hydrogen economy, for example, requires investment in reliable green hydrogen supply and delivery infrastructure, but in order for large-scale investment to occur, there must also be a high level of certainty in sufficient demand being there. Given that we have limited time, the right regulatory framework and supportive policies need to be put in place in advance, with the expectation that they will remain in place consistently. Only then can talent and capital be attracted to startups, technology development, and infrastructure deployment, and supply and demand can grow in tandem, across the entire value chain. In the end, a sustainable low-carbon economy will only be built when low-carbon solutions become competitive alternatives in the marketplace. A range of instruments, including penalties and incentives, must be designed and predictably delivered to ensure that the cost of carbon and the cost of the environment are reflected in market prices. Given that climate technologies aim to transform our social infrastructure which have to date been based on fossil fuels, the policies and institutions that define the ground rules of markets and society will need to be rewritten.

All of these challenges seem enormous, but the good news is that the problems and solutions of climate change are fairly well defined, and what we need to do is also relatively clear. The time horizon is short, and regulatory innovation and technology research, entrepreneurship and market development, demand building and supply expansion, all need to happen simultaneously. Only by boldly imagining the future can problems be solved and opportunities seized. Over the next 10 years, we will witness in many climate techs a thunderous opening of the door of opportunity as ambitious leaders emerge, early adopter consumers respond, and regulatory change brings predictability to the marketplace. There will be a clear divide between those who stand at the door of this opportunity and those who don't, and Envisioning is committed to identifying and supporting the exceptional founders who will stand at that door.

We are reminded here of the last paragraph of our 2021 Annual Impact Report, where we declared that addressing climate change is our top priority.

The 2020s will be a time when the climate crisis, which has already begun to take shape, will become increasingly visible, and we will see capital markets, industries, and social systems embrace climate change as a new premise. We hope that more founders will be ambitious about the huge climate market that lies ahead. We also expect governments, regulatory environments, and large corporations with deep pockets to move faster and bolder to transition to a decarbonized economy. At Envisioning, we will do everything we can to be a good partner for climate tech entrepreneurs and act as a catalyst for the decarbonization transition.

In 2023, we will invest with the same aspirations and the same determination.



Investment Portfolio

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Mission Barns: Fat-First Approach Drives Flavor and Expedites Scale for Cultivated Meat

Mission Barns is a food company based in San Francisco, US. Founded in 2018, its mission is to cultivate meat for a more sustainable food system with fewer greenhouse gas emissions, reduced land and water usage, and free from animal harm — all while keeping us safer from animal-borne diseases. Mission Barns combines cultivated animal fat with plant protein to deliver the flavor and juiciness consumers are looking for. The company is creating delicious bacon, meatballs, and sausages, which are ready for market pending regulatory approval.







Founder
Eitan Fischer, CEO

Products and services
Cultivated meat that combines cultivated animal fat and plant protein

Representative	Eitan Fischer	Established	March 2018
Corporate name	Mission Barns	Investment	January 2022
Location	San Francisco, USA	Website	missionbarns.com

Impact Factor

UN SDGs	Impact Model	Theory of Change
 	 MISSION  STRATEGY	<p>Develops cultivated meats to solve the problem of greenhouse gas emissions and water pollution by conventional animal agriculture</p> <p>Contributes to improving the mouthfeel and flavor of plant-based meats currently available in the market, and promoting cultivated meat options to become a reliable food and energy resource</p>

Impact Domain



Social Background and Problem Definition

According to the Good Food Institute, global investments into alternative proteins have grown fivefold from USD 1 billion in 2019 to USD 5 billion in 2021¹. We have witnessed that new startups and existing food companies dived into plant-based options. Combined with the growing interest in healthier and smarter consumption, the impact of climate change also contributed to the changes in the business landscape of the food industry and the steady growth of the alternative meat market.

Under such market trends, improving the consumer experience with better taste and flavor has become the most pressing priority for alternative meat and protein companies. Many alternative protein companies, however, realized that consumers still feel a gap in the taste and flavor when compared to conventional meat. As part of its attempt to bridge the gap, they found that ‘fat’ is crucial to replicate the taste and texture of conventional meat successfully and eventually applied fat to its end products in its ways.



1 “Record \$5 billion invested in alt proteins in 2021”, Good Food Institute Press Release, March 2022.

Mission Barns' Competitive Advantage

Mission Barns grows animal fat, called Mission Fat, from cells without animals and then blends it with plant-based proteins to produce its end products, such as bacon, sausages, or meatballs. Eitan Fischer, CEO and founder, established the company in 2018 after leaving Eat Just, a well-known company for its plant-based eggs and cultivated chicken. He has been paying attention to animal fat in mimicking the taste of meats and tried to deliver sustainability in the production process early on.

A blend of animal fat without animals and plant proteins for sustainability

Most plant-based meat producers use canola oil, coconut oil, or sunflower oil to recreate the fats of conventional meat. The problem is that such vegetable oils have lower melting points than animal fats and end up melting too quickly when cooked. Recent attempts to tackle this issue include the technology to encapsulate vegetable oils to increase the melting temperature, while Mission Barns chose to apply animal fat.

Cell cultivation is Mission Barns' technological path to produce animal fat without animals. The company chose such methods to overcome environmental issues and food safety related to bacteria and viruses, heavy metals, dioxins, trans fats, or antibiotics caused by the conventional animal industry. Furthermore, Mission Barns' cultivated meat products are made with only a single animal input: a starter sample that is taken without harm and fed plant-based nutrients in a cultivator. A single animal sample may produce the same amount of meat as thousands of farm animals.



What captured our attention is that fat cell cultivation is about ten times more efficient than muscle cell cultivation². Hence, Mission Barns strategically takes the cell cultivation to produce fat only and blends it with plant proteins to mimic a muscle-like texture. Additionally, a variety of expensive nutrients such as amino acids are required to grow muscles, which hinders the affordability of such products. In contrast, fat only requires simple and inexpensive nutrients like sugar to grow, which further solidifies the company's strategy to become more price competitive and enables mass production.

Technology and business strategy aiming at rapid scale-up

A rapid scale-up is only possible with secured cell lines, affordable growth factor and media with high performance, and proper bioreactor system designs. Mission Barns exhibited significant progress in all these areas. In particular, the company developed its own growth media to grow cells without fetal bovine serum³ and its proprietary reusable bioreactor customized for high density fat culture.

In 2021, Mission Barns announced a partnership with California-based Silva Sausage. It expanded its pilot production facility in San Francisco and since then has been in active discussions with various food companies and retailers. In addition, its regulatory approval process with the US Food and Drug Administration (FDA) is currently underway.

² Megan Poiniski, "Why Mission Barns believes cultivated fat is the key to better plant-based meat", Food Dive, June 8, 2022.

³ Animal serum, such as fetal bovine serum (FBS), is a component of the culture medium necessary for the general cell culture process.



LumanLab: Digital Therapeutics that Help Early Diagnosis of Developmental Disabilities






LumanLab develops software for diagnosis and treatment of children with developmental disabilities. Developmental disabilities and delays are common diseases experienced by one-fifth of the world's child population. Early diagnosis and treatment can dramatically improve a child's quality of life after they grow up. However, even in countries with a high level of medical infrastructure, access to diagnosis and treatment of the disease is limited. Envisioning made an early investment in the company in February 2022, expecting that their solution could dramatically improve access to treatment for developmental disabilities.



Founder
Jaehyun Lim, CEO

Products and services			
Software for diagnosis and treatment of developmental disabilities			
Representative	Jaehyun Lim	Established	July 2021
Corporate name	LumanLab	Investment	February 2022
Location	Korea	Website	lumanlab.com

Impact Factor

UN SDGs	Impact Model	Theory of Change
 	 MISSION  STRATEGY  GOVERNANCE	<p>Strengthens early diagnosis of developmental disabilities and delays, and improves access to cognitive therapy</p> <p>Provides practical alternatives to help children with developmental disabilities achieve better quality of life as they grow up</p>

Impact Domain



Social Background and Problem Definition

Data-driven digital healthcare solutions that help diagnosis, treatment, and comprehensive health management are rapidly evolving. Through the COVID-19 period, the importance of virtual medical care has been highlighted. In line with this, existing technologies such as artificial intelligence (AI), virtual reality (VR), and chatbots have been actively applied with investments into this field also increasing. Among them, "digital therapeutics" exhibited remarkable growth. Within healthcare software, solutions that have demonstrated clinical effects are defined as digital therapeutics¹. The market was estimated to be worth about USD 4.2 billion in 2021 and is expected to grow more rapidly at an average annual rate of 26.1% by 2030². In Korea, the digital treatment device review and approval guidelines³ were announced in 2020, and the related market is gradually growing.



¹ In 2017, when the U.S. Food and Drug Administration (FDA) approved the drug addiction treatment mobile app 'reSET' developed by Pear Therapeutics, digital therapeutics started to appear in the market. The FDA temporarily permits the distribution of harmless digital treatments during the COVID-19 era, when the need for non-face-to-face treatment has increased. For example, Endeavor (developed by Akili Interactive Labs), which treats attention deficit disorder caused by ADHD, received FDA approval in June 2020, allowing doctors to prescribe it.

² Digital Therapeutics Market Size 2022-2030, Grand View Research

³ Ministry of Food and Drug Safety, August 27, 2020.

Unlike traditional therapies, digital therapeutics do not have toxicity or direct side effects and have significant advantages in cost and accessibility. It also has the advantage of being easy to track and manage diseases as it enables the accumulation of consistent data through continuous patient monitoring. Thanks to this, in addition to chronic diseases, digital therapeutics are helping to treat diseases for which access to treatment has been limited, such as Alzheimer's, Parkinson's, attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and post-traumatic stress disorder (PTSD). Expectations are high that digital therapeutics will be able to offer a meaningful treatment method for various neuropsychiatric diseases.

Within neuropsychiatric diseases, developmental disabilities, revealed from infancy, are fields where the starting point of diagnosis and treatment is directly related to the quality of life after growing up. However, even in Korea, which has a relatively strong public medical infrastructure, treatment access in this area is very limited with more than 90% of children with developmental disabilities or delays not receiving treatment in a timely manner. Currently, around one-fifth of children under the age of 5 worldwide (approximately 53 million) experience developmental disabilities or delays⁴. In the case of the United States, children and adolescents between the ages of 3 and 17 who have been diagnosed with developmental disabilities or delays account for 18%⁵. In Korea, as of 2020, there are 60,000 registered persons with intellectual disabilities and autism spectrum disorders under the age of 19⁶. The above does not include the ADHD-diagnosed population (under the age of 19), which represents about 90,000 individuals⁷.

Absence of appropriate treatment of developmental disabilities can easily result in cognitive decline as the golden window for treatment is when these children are less than 60 months old. It is often difficult for caregivers to discover symptoms of developmental disorders early in infants and toddlers as their language skills are still being developed. In Korea, diagnoses are limited to university hospitals, so accessibility remains significantly low and the limited treatment options post diagnosis is also a challenge that needs to be addressed. In the case of cognitive therapy programs for developmental disabilities, a standardized curriculum does not work well and a personalized 1:1 face-to-face treatment is preferred. Since outpatient treatment is unavoidable and the cost of treatment is high, only 1% of the total can afford such treatment.

⁴ "Developmental disabilities among children younger than 5 years in 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016", *Lancet Global Health* 2018; vol 6: e1100–21

⁵ US Centers for Disease Control and Prevention (CDC)

⁶ Status of persons with disabilities in 2020, Ministry of Health and Welfare, Statistics Korea

⁷ Data submitted by the National Health Insurance Service to the National Assembly. Related Article: Dae-ik Kwon, medical reporter, "Female ADHD patients in their 20s and 30s increased 7-fold in the last 4 years", *Hankook Ilbo*, October 1, 2021.

LumanLab's Competitive Advantage

LumanLab is a startup with the banner of "digital healthcare for infants and toddlers." CEO Jaehyun Lim (M.D., Ph.D.), who majored in brain engineering and medicine, founded the company to reduce medical blind spots by distributing clinically proven digital therapeutics. In particular, the company focuses on early childhood stages, when meaningful data is scarce in the human life cycle, and took developmental disabilities as a starting point, where early diagnosis and treatment solutions are lacking.

Early diagnosis solution to catch the golden time of developmental disability treatment

If you want to recognize a child's suspected developmental delay at home and receive an accurate diagnosis, you will likely wait for six months to two years until the first visit to a domestic university hospital in Korea. It is also burdensome, costing as much as a thousand dollars to go through expert diagnosis.

LumanLab developed Eltern, a digital service that can identify the possibility of developmental delay in children at home using a mobile device. Eltern's AI algorithm determines the key factors of developmental disability and delay by analyzing uploaded videos and user (caregiver) questionnaires. Afterward, it provides 1:1 coaching with experts.

As the solution quickly and easily checks the possibility of the problem at a much lower cost than existing diagnosis methods, more children with such issues will likely receive effective treatment within the "golden time", if widely adopted. Improvements in the diagnosis and treatment environment also lead to a favorable prognosis, substantial improvements to the quality of life for children with developmental disabilities, and reduce high social costs accumulated over time. LumanLab is conducting joint research on diagnosing developmental delay with major domestic medical facilities to advance the early diagnosis algorithm.



Improving access to cognitive therapy by distributing digital therapeutics for home use

After the diagnosis of a developmental disability, ongoing treatment is required. Depending on the symptoms and their severity, drug treatment can be accompanied; however, given that it is in the early stages of infancy, drug treatments should be carefully scrutinized as neurophysiological side effects from drug treatment have significant impact on normal growth. As such, Applied Behavior Analysis (ABA)⁸ is regarded as the most effective treatment method. Still, the percentage of children receiving effective treatment in a timely manner is limited as only a small number of therapists are available at high costs.

LumanLab is currently developing an ABA-based home treatment program for developmental delays. First, the program will present a scale for identifying the cause of behavior and provide a treatment plan. Then, it will help caregivers to record daily behaviors, conduct training, and track the improvement effect.

By distributing accessible digital therapeutics that caregivers can use at home, the company prioritizes creating an environment where consistent treatment is available while providing a service for finding and making reservations for professional therapists. One step further, LumanLab is considering developing remote therapies as well.

LumanLab continues to participate in various clinical trials to diagnose and treat developmental delay. In addition, the company plans to deploy online parental behavior coaching programs that are equivalent to face-to-face treatment and expand its business over the global market.

8

As an analysis method that verifies the entire behavioral process using behavioral analysis procedures, hypothetical behavioral principles are applied to improve specific behaviors. Whether there are changes in behaviors and what factors induce changes are evaluated. Refer to the Korean Society for Educational Evaluation, etc.



Mango Materials: High-Quality Plastic Alternative From Methane Gas






Mango Materials, based in California, US, uses methane gas¹, one of the greenhouse gasses, as a raw material to produce a biodegradable biopolymer (PHA) by fermenting bacteria. Three female environmental engineers who have studied PHA and methane founded the company in 2010 and successfully completed lab-scale and pilot-stage verification. Since 2020, the company has partnered with a sewage treatment plant in Redwood City, California to begin operations of a PHA production facility. Envisioning Partners participated as a co-lead investor in the Series B1 round of Mango Materials in May 2022.



Founder
Molly Morse, CEO

Products and services			
Manufacture of plastic substitutes (biodegradable biopolymers (PHA)) based on methane			
Representative	Molly Morse	Established	July 2010
Corporate name	Mango Materials, Inc.	Investment	May 2022
Location	California, USA	Website	mangomaterials.com

Impact Factor

UN SDGs	Impact Model	Theory of Change
<div> </div>	<div> MISSION</div> <div> STRATEGY</div> <div> GOVERNANCE</div>	<p>Supplying competitive biodegradable materials to replace existing petroleum-based plastics using methane gas which is inevitably generated in industrial facilities as a feedstock</p> <p>Contribute to reducing greenhouse gas emissions and preventing environmental pollution caused by the production and disposal of petroleum-based plastics</p>

¹ Geyer, R., Jambeck, JR, & Law, KL (2017). Production, use, and fate of all plastics ever made. Science advances, 3(7), e1700782

Impact Domain



Social Background and Problem Definition

Globally, more than 300 million tonnes of plastic are thrown away every year. From 1950 to 2015, the accumulated plastic waste amounted to 6.3 billion metric tonnes (MT), of which most (91%) were incinerated, landfilled or flowed into the sea, further contributing to air, soil and ocean pollution. While a number of policies and measures to increase plastics recycling have been developed, recycling rates still remain low at 29% for textiles, 12% for general consumer goods, and only 3%² for packaging, which accounts for the largest share of plastics.

To date, the challenge has been to find materials with as good physical properties and economic feasibility as plastic, leaving two major ways to solve the issue. The first solution is a repetitive recycling solution that reduces plastics production, and the second solution is to develop either plastics that are fully biodegradable by nature or completely new environment-friendly alternatives.



² Geyer, R., Jambeck, J. R., & Law, K. L., "Production, use, and fate of all plastics ever made", Science advances, 2017.

Envisioning Partners invested in a number of companies that will solve the plastic problem through recycling, including a unique technology that upcycles plastic waste into high performance materials (Novolooop, US), a textile solution that completely recycles even blended fabrics (Circ, US), and a highly functional multi-use packaging solution (s.Lab Asia, Korea).

In addition to investing in recycling solutions, Envisioning has been paying attention to the potential of biodegradable plastic substitutes, which are considered as the most achievable alternatives to virgin plastics. Biodegradable plastics (plastic substitutes) have a wide variety of source materials and processing methods, which include natural polymer-based plastics (starch, cellulose, soybean, pulp, etc.), chemical synthetic plastics (PBS, PBAT, etc.), natural synthetic plastics (PLA, TPS, etc.) and microbial synthetic plastics (PHA, PHV, etc.).

However, all these biodegradable materials are faced with two challenges compared to the existing petroleum-based plastics; one is price, and the other is physical properties. In fact, most of the existing biodegradable materials do not decompose under natural conditions, but will only begin to rot when additional factors such as temperature and humidity are satisfied. As more materials are combined to enhance its physical properties, more challenges arise in biodegradation. For example, PLA, mainly produced by lactic acid fermentation, is gaining market share among other biodegradable plastics as it can be mass-produced and is already relatively price competitive. However, it still has to overcome a couple of variables; first, it is not fully biodegradable by nature, and second, its main sources come from food crops such as corn and sugarcane³.

Given the increasing environmental burden caused from plastic use and the urgent need to respond to climate change, if plastics with high biodegradability appear within the price and quality range that can compete with petroleum-based plastics to some extent, its demand is expected to grow rapidly.

3 As one of the greenhouse gasses, the absolute emission is small compared to carbon dioxide, but the emission factor is 21 times higher.

Mango Materials’
Competitive
Advantage

Mango Materials injects methane gas, a major greenhouse gas, into a biodegradable biopolymer that can replace conventional petroleum-based plastics. The unique technology of culturing methanotrophs produces PHA with the best biodegradability among plastic alternative materials.

Dual effect of defense against climate change: development of plastic
alternative materials using a major greenhouse gas as raw material

PHA is classified as an advanced biodegradable biopolymer as it not only decays in soil but also in the ocean. While PHA overcomes the critical limitations of other biodegradable plastics centered around PLA, PHA has also adopted sugarcane or vegetable oil as its main raw material, subjecting itself to limitations on physical properties, economic feasibility, homogeneity in quality and production sustainability.

Classification and Properties of Major Biodegradable Plastics (Plastic Substitutes)

Chemical	PBAT	Characteristics
Chemical Synthetic	PBAT Polybutylene Adipate Terephthalate	<ul style="list-style-type: none">· Petroleum-based raw material· Good flexibility (This feature is one of the reasons why it is often used in combination with PLA.)· Biodegradable in soil
Natural Synthetic	PLA Polylactic Acid	<ul style="list-style-type: none">· Produced by fermenting crops including sugarcane (100% bio material content)· Excellent transparency and widely used in food containers· Currently the most common biodegradable material, has price competitiveness with virgin plastics· Fragile, low heat resistance and low interrupting performance· Low biodegradability (not biodegradable by nature), slow decomposition speed
Microbial Synthetic	PHA Polyhydroxyalkanoate	<ul style="list-style-type: none">· Produced from sugarcane, vegetable oil, bacteria, etc. (100% bio material content)· Applicable to various uses· To date, PHA is the only material which is biodegradable in the ocean as well as in soil· Need to secure price competitiveness



Mango Materials utilizes methane gas as feedstock, which is inevitably generated from household waste or sewage treatment facilities. When methane gas is dissolved in a bioreactor, it reacts with a distinct bacteria and generates PHA polymers in their cells. Based on years of research, the company has built a unique bacteria-based production facility that produces high-efficiency polymers at low operating costs.

By producing (i) fully biodegradable materials that will solve the problem of production and disposal of petroleum-based plastics, and applying (ii) methane gas as feedstock, which must be reduced and is readily available globally⁽³⁾, Mango Materials can achieve the dual effect of defending against climate change. Thanks to its single feedstock source (methane gas), the company succeeded in producing a homogeneous PHA that does not require any pre-treatment or complex quality control.

Premium products that overcome the physical properties of existing biodegradable plastics

It is noteworthy that the company has built an environment-friendly technology and system in their entire process of PHA production. Moreover, they can manufacture PHA in the form of fibers, which is expected to provide an opportunity to expand and disseminate biodegradable plastics in apparel and premium consumer goods, markets that have been traditionally difficult to enter due to its high demands on physical properties.

Mango Materials aims to fundamentally solve the global plastics issue by distributing environmentally friendly options that can compete with existing plastics as quickly as possible. To do so, the company is collaborating with various customers to ramp up its commercialization and also adopting a licensing model.





TissenBioFarm: An Innovative Technology Enabling the Mass Production of Cultivated Meat






TissenBioFarm is a cultivated meat technology company founded in 2021 by CEO Han Wonil with a background in researching artificial organs for medical use. By developing a technology that can produce whole-cut meat, the company presents a novel way to mass culture and mass production, which are vital tasks in the cultivated meat field.



Founder
Wonil Han, CEO

Products and services			
Production of cell cultured meat			
Representative	Wonil Han	Established	November 2021
Corporate name	TissenBioFarm	Investment	May 2022
Location	Korea	Website	tissenbiofarm.com

Impact Factor

UN SDGs	Impact Model	Theory of Change
 	 MISSION  STRATEGY  GOVERNANCE	<p>Development of cultivated meat to solve greenhouse gas emissions and water pollution problems in the livestock industry</p> <p>Developed proprietary technologies and engineering process to overcome the limitations of commercializing cultivated meat by enabling mass production</p> <p>Ultimately contributes to establishing cultivated meat as a reliable food resource</p>

Impact Domain



Social Background and Problem Definition

There are now more than a hundred cultivated meat startups globally with more than 20 new companies emerging annually from 2019 to 2021¹. As a result, market expectations for cultivated meat as a sustainable food resource have risen, resulting in the investment of USD 1.38 billion in 2021 alone. Many players are collaborating with global food companies early on by sharing their expertise in biotechnology and engineering.

Cultivated meat has evolved in many ways over the past decade, both technologically and in its product format. Previously, products were predominantly in the form of processed meats such as hamburger patties or chicken nuggets. Recently, a fat-first approach² has been introduced, dramatically improving the taste and texture of alternative meats by combining cultured fats with plant-based proteins. Additionally, technologies enabling the production of whole-cut cultivated meat have been introduced.



¹ "2021 State of the Industry Report: Cultivated Meat and Seafood", Good Food Institute, April 2022.
² Mission Barns, which cultivates animal fat and blends it with plant protein, is a representative case.

Cell-based meat companies currently face two fundamental challenges. First, they need to prove that cultivated meat has the same original taste and texture as conventional meat in order to position themselves as a reliable alternative. The second challenge is lowering the production costs to reach price parity. These challenges can only be overcome with mass culture and mass production technologies.

Innovation in various parts of the technology is necessary for effectively culturing cells in vitro. The use of scaffolds³ has been considered an essential element of the production process. One of the biggest challenges in current scaffolding structures when producing cultivated meat in a whole-cut form is that cells easily escape from the scaffold or die from lack of oxygen inside the scaffold. To address this issue, companies are trying new production methods that eliminate the scaffold, but there are very few cases where cultivated meat can recreate the thickness of whole-cut steaks.

**TissenBioFarm's
Competitive
Advantage**

TissenBioFarm developed a platform technology that enables the production of whole-cut cultivated meat. Han Wonil, founder and CEO, has a doctorate in interdisciplinary bioengineering and has accumulated extensive experience in researching and developing artificial organs for biomedical applications. He founded the company in 2021, thinking that cultivated meat has the same technological roots as artificial organs; however, the direction of technological innovation must be different in order for it to be commercialized within the food industry. Envisioning Partners invested in the company's pre-Series A round in May 2022.

Culture method optimized for whole-cut meat

Some companies utilize 3D bioprinting technology to produce meats in large chunks. Alternative methods have also appeared such as cell sheet stacking (stacking multiple thin and wide cell sheets to replicate thickness) or forming cells in a ring shape and then combining them. However, these relatively recent technologies have not been able to solve the challenges

3 Scaffolds provide structural support helping cell proliferation and differentiation.

of cell necrosis caused by hypoxia in the process of aggregating cells beyond a certain thickness. Even without cell necrosis, it is difficult to achieve mass production when it takes more than 30 minutes to produce meat of a centimeter's thickness.

TissenBioFarm was started with the idea that cultivated meat should eventually provide the value of "food." Other existing technologies such as scaffold-based culture, cell aggregate utilization, and bioprinting suitable for making individual organs, are not well suited for the food industry that is fundamentally low margin and high volume. TissenBioFarm focuses on breaking through these barriers by paving a new way to produce meat close to its original and desired shape, while overcoming the limitations in efficiency that are currently holding back the industry from being widely adopted.

Securing cultivated meat precursor manufacturing technology that enables mass production

Even though new technologies in cell culture have been demonstrated, strong capabilities in bioengineering are still required to produce food at a mass scale. TissenBioFarm has the ability to i) develop bio-ink suitable for cultivated meat manufacturing and ii) engineering technologies that improve cell viability and texture. These provide a solid basis for producing high-quality, tailored cultivated meat precursors (preceding materials for making cultivated meat). In addition, the company is continuously improving its core element technology while drastically reducing manufacturing costs and time in comparison to existing methods.





KETOS: Completely Automated Solution for Water Quality Measurement and Management

KETOS has developed a fully automated lab-accurate water quality measurement solution for real-time insights that can help build smarter, safer and sustainable industries, cities and farms. It includes innovative hardware capable of monitoring over 30 different parameters in real-time combined with (ii) enterprise grade cloud-based monitoring software.



Founder
Meena Sankaran, CEO

Products and services			
Smart turn-key water quality measurement solution			
Representative	Meena Sankaran	Established	August 2015
Corporate name	KETOS, Inc.	Investment	June 2022
Location	California, USA	Website	ketos.co

Impact Factor

UN SDGs	Impact Model	Theory of Change
 	 MISSION STRATEGY	<p>Measures various water quality metrics in real-time and increases water recycling rate to reduce water consumption</p> <p>Reduces the energy consumption required for water treatment and suppresses the discharge of contaminated water by optimizing water treatment based on the quality measurement results</p>

Impact Domain



Social Background and Problem Definition

As climate change intensifies, clean water will become one of the most precious resources. According to a paper published by Environmental Research in June 2022¹, over the 20 years from 2000 to 2020, more than 500,000 deaths and an excess of USD 2 trillion in economic damage were caused by extreme weather. First, typhoons and prolonged heat waves caused severe damage, followed by floods, droughts, cold waves, and forest fires. As climate change accelerates, and in particular, heat waves and droughts are prolonged, and rainfall and regional concentrations are becoming irregular, adding further complexities to make accurate predictions.

Climate change is expected to significantly increase the frequency of direct disasters and disable the existing methods of food production that our civilization has been relying on. In 2022, heavy rains in the desert or more extreme droughts in traditionally agricultural areas were frequent on all continents. In the monsoonal regions, rainy seasons have



¹ Ben Clarke et al., "Extreme weather impacts of climate change: an attribution perspective," Environmental Research, June 28, 2022. However, this study is based on EM-DAT (The international Disaster Database), adding that the actual damage would have been much more remarkable because of incomplete data reporting from developing countries, including Africa.

gradually shortened, and heavy rainfalls have increased. Rainwater is a crucial resource, but it can only be utilized with accurate forecasts and responses. Since the soil environment that absorbs rainwater differs depending on the climate zone, the damage caused by anomalous rainfall inevitably increases.

About 10% of global greenhouse gas emissions are related to "water"², mostly due to our current methods of water consumption. The amount of energy required to supply and purify water is enormous, particularly in agriculture and livestock farming, household water and wastewater treatment. Additionally, greenhouse gas is accumulated from wastewater that is not adequately treated. For this reason, we need a comprehensive approach to secure a stable water supply and consume water as efficiently as possible in order to respond to climate change.



² "Climate Action Pathway Water," United Nations Framework Convention on Climate Change (UNFCCC), 2020.
The original text cited in the report: "Report on Water and Climate Change: Stop Floating, Start Swimming: Water & Climate Change – Interlinkages & Prospects for Future Action," GIZ, 2020.

KETOS' Competitive Advantage

Based in California, US, KETOS provides a patented system integrating robotics, material sciences, data science, and IoT for a robust real-time water intelligence solution. The solution includes a robotic system capable of self-calibration, a unique capability to detect heavy metals in water like never before, and a system combining sensing modules to measure more than 30 water quality parameters in real time. In addition, it also incorporates enterprise-grade cloud-based monitoring software providing trending, actionable, and predictive insights. Founder Meena Sankaran majored in electrical engineering and accumulated industrial solutions expertise for over 16 years at CISCO and others. With the vision to pass down a stable water supply to future generations, she established KETOS in 2015. Envisioning Partners invested in this company that develops a promising solution for climate adaptation in June 2022.

Automated solution that measures and manages water quality parameters in real-time

Currently, water quality measurement requires a wide range of equipment in order to measure various parameters. The process is very time consuming and continuous monitoring has also been traditionally unavailable as it requires manual labor to be present on site. KETOS' bi-directionally communicating system, in conjunction with real-time water quality monitoring, surpasses traditional water quality monitoring systems by providing greater efficiency, improved accuracy, and reduced labor costs.

KETOS' hardware is an automated system that can perform measurements, flushing, cleaning, and calibration without any manual intervention. Users can access real-time data through mobile and web platforms and remotely set desired water quality thresholds, alert levels, and testing schedules. It is also easy to track relevant metrics for sustainability reporting.

This system is particularly relevant for industries that are water-intensive, such as agriculture, food and beverage, and manufacturing. The implementation of this automated system leads to substantial cost savings for businesses, reduced environmental impact, and responsible use of water resources.

For example, a KETOS agricultural customer operating a vertical farm was previously changing their water around three times a week to regulate the nutrients present in the water. This practice incurred costs amounting to tens of millions of dollars yearly. By utilizing KETOS' real-time monitoring and management system, the customer could optimize their water treatment methods. The outcome was an impressive increase in their water recycling rate, accompanied by a reduction in their water footprint while improving the quality, safety, color, and taste of their food produced.

Scalability of products and adaptability to various industries and regulatory environments

Since its establishment, KETOS has attracted interest from companies in various industries, such as mining, automotive, manufacturing, municipal, and agriculture, where water quality measurement and management are essential to their business operations. In addition to the increasingly stringent water treatment regulations, the scalability of the KETOS solution played a crucial role in establishing its market presence. The hardware developed by KETOS is modular, making it easily installable and keeping the option open for subsequent reconfiguration. Furthermore, the cloud-based software helps customers conveniently change and apply desired testing settings anytime.

In addition, KETOS offers a subscription-based model, making the solution accessible without any upfront CAPEX expenses and only a one-time installation fee. As a result, KETOS rapidly increased its customer base by implementing an agile go-to-market strategy that continuously adapts to changing demands. Its innovative business model transforms behavior in this legacy sector where the ownership of the technology, maintenance, and service lean on the vendor front allowing for more stickiness in the relationship with the customer as a "data as a service" model.





AweXome Ray : High-end Material Technology with Multiple Impact Generation

AweXome Ray developed a unique technology that is able to produce carbon nanotubes (CNTs), a next-generation industrial material, in the form of continuous fibers. Since its establishment in 2018, CEO Se Hoon Gihm, with a Ph.D. in materials science and engineering, has rapidly implemented CNT fibers in materials, components, and equipment units and has expanded its application to a wide range of industries. Envisioning Partners, as the lead investor in the series B round, invested in the company in September 2022.



Founder
Se Hoon Gihm, CEO

Products and services			
Carbon nanotube (CNT) related materials, cold cathode X-ray tubes, air sterilization and purification devices			
Representative	Se Hoon Gihm	Established	July 2018
Corporate name	aweXome Ray	Investment	September 2022
Location	Korea	Website	awexomeray.com (company) airxome.com (air solution)

Impact Factor*

UN SDGs	Impact Model	Theory of Change
<div></div> <div></div>	<div></div> <div>MISSION</div> <div></div> <div>STRATEGY</div> <div></div> <div>GOVERNANCE</div>	<p>Improves indoor air quality by simultaneously eliminating fine dust, bacteria, and virus for a healthier environment</p> <p>Reduces energy consumption in air purification through the advanced filter technology</p> <p>* In this report, the impact model was described specifically for the indoor air quality business of aweXome Ray. However, as the CNT fiber based light sources developed by the company can be utilized in various products, the impact generation at the company level is expected to be much more significant. For example, in terms of material or component, in addition to the currently described SDGs, the solution can also contribute to food preservation (SDG 2, 12) and water purification (SDG 6, 14). Moreover, the solution will likely create additional impact as a climate technology (SDG 13) if it expands its business to the energy sector in the future.</p>

Impact Domain

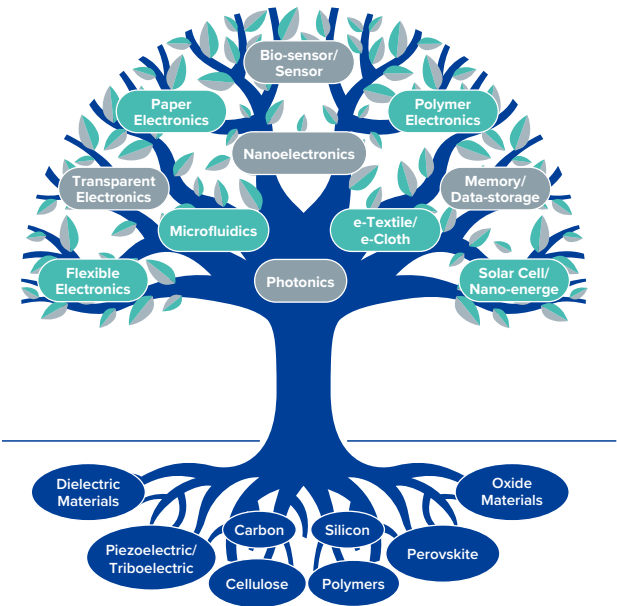


Social Background and Problem Definition

The emergence of innovative solutions results from overlapping various scientific attempts but usually coincides with the emergence of innovative materials. Therefore, developing materials with better properties and economics, and producing them in a way that minimizes environmental impact, has become even more imperative in the climate era.

The core advantage of materials is its wide applicability, in that the same material can be utilized in various areas with different properties. The more diverse its uses, the wider the range of impact a single material can create. Of course, even if excellent material properties are demonstrated, different technological steps must be taken to commercialize them.

'Sketch of the materials' tree¹. The concept that each material technology becomes the root and creates various high-tech products



1 Rodrigo Martins et al., "Materials as activator of future global science and technology challenges", Progress in Natural Science: Materials International 31, 2021.

Graphene, which has been garnering much interest in the industry, appeared in 2004². Theoretically, its tensile strength is hundreds of times higher than that of steel, and its thermal conductivity, flexibility, and optical transmittance are far superior to other materials with such properties. However, seeing that commercialization attempts are only taking place 20 years after the first exfoliation of graphene, one can appreciate how much technical, business, and environmental verification must be supported to utilize a new material.



AweXome Ray's Competitive Advantage

AweXome Ray has developed the technology to produce carbon nanotubes (CNT) in the form of continuous fibers. CNT is a tube-shaped carbon allotrope discovered in 1991, and is considered a next-generation, high-tech material that is one step ahead of graphene³. It has been a long lasting research subject as it contains many revolutionary characteristics such as excellent strength, electrical conductivity, thermal conductivity, and field emission. However, it has only recently reached the level of mass production in the form of "powder." Considering the structural dimension of CNT, its advantages are maximized when produced as "fiber" but reaching production stage has yet been unavailable due to the particularity of its implementation. AweXome Ray successfully developed a unique technology to manufacture CNT in the form of fibers and has further developed their system for mass production.

² Geim, A., Novoselov, K., "The rise of graphene", Nature Mater 6, 2007. For the first time, Russian physicist Andre Konstantin Geim and his successor Sir Konstantin Sergeevich Novoselov isolated graphene as a membrane from graphite. They were recognized for this achievement Nobel Prize in Physics 2010.

³ Iijima, S., "Helical microtubules of graphitic carbon," Nature 354, 1991. Dr. Sumio Iijima of Japan first published in Nature, and since then, CNT research has been conducted for various uses, such as semiconductor devices and next-generation displays.

Securing original technology with high scalability

Based on its original technology, aweXome Ray directly produces i) materials, ii) components, and iii) equipment while increasing the scalability of the technology. The company i) makes CNTs in the form of yarn into industrial materials with various physical properties through processes of braiding and weaving (material business), ii) uses CNT fibers as field emission electrodes for cold cathode X-ray tubes to produce next-generation X-rays that are characterized by ultra-small size, digital operation, low dose, and high resolution (component business), and iii) provides air solution equipment that can simultaneously remove fine dust, germs, and viruses in the air by photoionization through the use of their X-ray tube (equipment business).

AweXome Ray is determined to spearhead innovation throughout the industry by commercializing its original technology with plans to expand their business to industrial and medical imaging fields in the near future. In the long term, they are planning for further expansions into heating elements, winding wires, and solid-state batteries through the mass production of CNT materials.

Excellent business development capabilities to seize market opportunities

AweXome Ray's differentiated business acumen also played a prominent role in quickly introducing its advanced material technology to the market. The company developed AirXome, an indoor air sterilization and purification solution using CNT-based X-rays, and set it as its primary business within two years of its founding. During the COVID-19 pandemic, strong social demands for antibacterial and antiviral products called for new technologies as individuals were increasingly spending more time indoors. Seizing this opportunity, aweXome Ray introduced its technology as a complete equipment unit and raised its awareness in the market through this approach.

In 2022, aweXome Ray signed a contract to develop and supply air solution modules for residential units with KOCOM, a leading home IoT company. In addition to residential use, they are in active discussions with related companies to develop an air solution optimized for transportation, such as subways, ships, and elevators. As the company's first CNT fiber product creates a stable commercial track record, aweXome Ray is gearing up for business expansion to a wider range of applications. The company is already exploring new possibilities of using the cold cathode X-ray tubes in the industrial and medical imaging fields, by conducting technology feasibility assessments with institutions and companies.



Aquafortus, an Innovative Wastewater Zero Liquid Discharge technology enabling carbon neutrality

Aquafortus developed a solvent extraction based wastewater treatment technology, providing Zero Liquid Discharge (ZLD) solutions to a wide range of industrial companies. Compared to conventional thermal ZLD systems, the process is a chemistry based solvent exchange technology, which maximizes energy efficiency and water recovery rates. In 2016, CEO Daryl Briggs and COO Jessica Lam co-founded Aquafortus in New Zealand and has expanded into the US by incorporating a company in Delaware in 2021.

Co-founders



Daryl Briggs, CEO Jessica Lam, COO

Products and services			
Solvent extraction-based wastewater treatment and zero discharge solution			
Representative	Daryl Briggs	Established	Established in 2016 Incorporated in Delaware in August 2021
Corporate name	Aquafortus, Inc.		
Location	Auckland, New Zealand (Headquarters, R&D) /	Investment	October 2022
	Delaware, US (Registered)	Website	aquafortus.com

Impact Factor

UN SDGs	Impact Model	Theory of Change
<div></div> <div></div>	<div></div> <div>MISSION</div> <div></div> <div>STRATEGY</div>	<p>Purifies highly polluted wastewater generated in industrial sites to increase water recovery rates and ultimately reduce water consumption</p> <p>Provides a significantly higher energy efficient system compared to existing technologies, enabling energy savings and net-zero implementation of related industries</p> <p>Contributes to local communities' drinking water supply security by providing a sustainable ZLD solution</p>

Impact Domain



Social Background and Problem Definition

Climate change and water are closely intertwined as climate change is poised to have a direct impact on global water supply scarcity. Conserving clean water and purifying used water for beneficial reuse have proven to be more challenging than many expected due to the fact that most existing water treatment technologies are highly energy intensive, ultimately rendering them unaffordable.

A 2017 UN report found that 80% of the world's industrial and domestic water is discharged without proper treatment¹. In the 'Progress on Wastewater Treatment²' report issued by the UN in 2021, only 32% of wastewater goes through the water treatment process, which still does not guarantee treatment to satisfy safety standards. Furthermore, this figure is limited to 42 countries (18% of the world's population) that provide standardized data on a national level. Considering that aggregating data is complex, the actual adoption of safe water treatment systems of each country varies significantly.



1 "2017 UN World Water Development Report, Wastewater: The Untapped Resource"

2 The report's subtitle is 'Global Status and Acceleration Needs for SDG Indicator 6.3.1'. It was issued to check the implementation status of Sustainable Development Goal (SDG) 6 (Ensuring the availability and sustainable management of water and sanitation for all).

Around 20% of water resources worldwide is used for industrial purposes, and this figure rises to approximately 60% in high-income countries³. As responding to climate change becomes prioritized and environmental regulations get stricter, the demand for energy efficient water treatment technology is rapidly increasing, particularly in industries that require enormous amounts of water, such as agriculture, oil & gas, and mining. The global desalination market was estimated at USD 13.1 billion in 2020 and is projected to grow to USD 28.2 billion by 2029⁴. Among water treatment-related technologies, ZLD solutions is projected to grow to a USD 9.9 billion market by 2027⁵.

Aquafortus' Competitive Advantage

Aquafortus is a solvent extraction based ZLD solutions provider. Unlike conventional ZLD solutions that are extremely energy intensive, Aquafortus utilizes a non-thermal process based on chemical technology to increase wastewater treatment efficiency while reducing environmental impact. Envisioning Partners invested in the company in October 2022.

High energy efficiency resulting in dramatic cost reductions

ZLD technology has been regarded as a solution to reduce water pollution risk by recovering clean water resources from wastewater. However, wide scale adoption has been challenging as the upfront capex and opex required to operate and maintain the facility is very expensive for many industrial sites. Its cost is mainly due to the technical limitations as a thermal solution, which requires high temperature heat. A thermal-based ZLD solution usually boils the wastewater to separate a slurry with less than 15% moisture and a mass of salts in solid form from the water. This process has been proven to be very inefficient as it not

³ Annual Freshwater Withdrawals, Industry (% of Total Freshwater Withdrawal), World Development Indicators, World Bank, May 22, 2022.

⁴ Zero Liquid Discharge Systems Market by System (Conventional, Hybrid), Process (Pretreatment, Filtration, Evaporation & Crystallization), End-Use Industry (Energy & Power, Chemicals & Petrochemicals, Food & Beverages), and Region - Global Forecast to 2027, Markets and Markets, November 2022.

⁵ Water Desalination Market by Type, by End Users, by Applications, and Region, Global Forecast 2019 to 2029, Adroit Market Research, October 2022.



only consumes a lot of energy but also incurs high maintenance costs due to equipment corrosion. As an alternative to this heating method, membrane technology has been introduced; however, membranes are also economically challenged due to high raw material costs, short replacement cycles, and its limited ability to treat wastewater streams of high Total Dissolved Solids (TDS) content⁶.

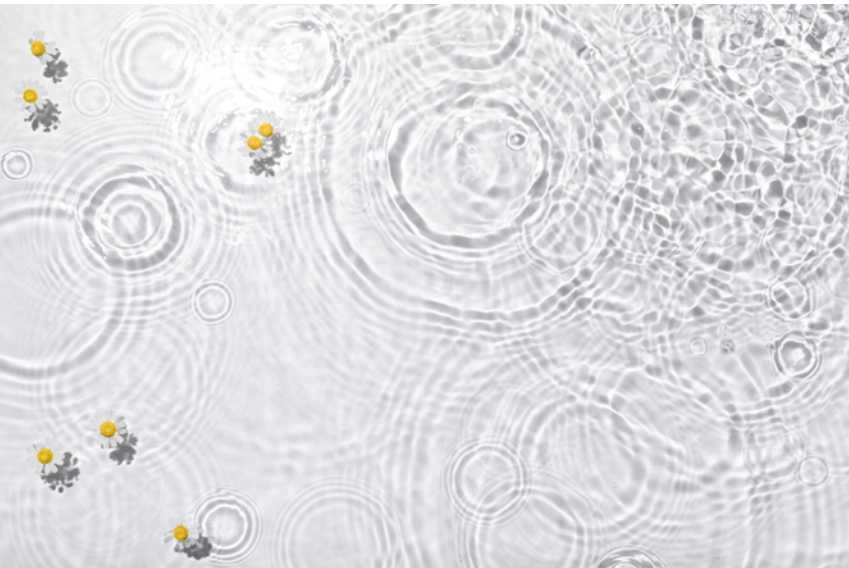
Aquafortus has developed a solvent extraction-based ZLD solution that offers an alternative from conventional thermal-based technologies of low energy efficiency. It efficiently filters pollutants from wastewater through a continuous chemical process consisting of the Absorbent and Regenerant cycles. The solution demonstrates a water recovery rate of 98%, energy savings of 75%, and operating costs savings of up to 60% when compared to thermal-based solutions. In addition, the solution is able to treat a wide range of wastewater streams with a TDS content between 10%~60%⁷.

⁶ Reverse Osmosis solution among membrane technologies can be applied when the TDS is less than 10%, and Membrane Distillation is known to be applicable when the TDS is 10%~30%. However, this is a theoretical range, and the actual TDS level is lower than when applied to real fields. Aquafortus' estimation.

⁷ Total Amount of Dissolved Solids (TDS) refers to the amount of minerals, metals, organic material, and salts dissolved in particular water. It is one of the measurements of the pollution level of wastewater.

New market opportunities by increasing resource recovery rates and securing water supply sources for climate response

Aquafortus does not stop at water treatment and offers a complete solution that maximizes resource recovery. During the solvent extraction process, high value-add metals dissolved in wastewater are recovered, and the water is filtered through the membrane in its final step to recover clean water. This purified water has many beneficial reuse applications, including industrial and agricultural water in nearby areas suffering from severe drought. As Aquafortus’ ZLD system is capable of an almost 100% water recovery rate, it aims to serve as a supplementary source of water supply. In addition to wastewater treatment revenues, Aquafortus creates new market opportunities by generating additional revenue streams from the sale of recovered metals and purified water.



Business expansion into various industries

The growing demand for energy and cost efficient ZLD solutions in various industries is also a rapid growth driver for Aquafortus. For example, in the oil exploration industry, extracting one barrel of oil produces 2 to 8 barrels of wastewater⁸, in which a large portion of oil and gas companies’ operations are centered around wastewater management. Traditionally, US oil and gas companies simply buried their wastewater into the so-called underground disposal wells⁹. However, these wells have been suspected to cause a higher number of earthquakes in the region and potentially contaminate the regional drinking water quality, and as a result, permission to operate these disposal wells have been largely suspended. Additionally, an increasing pressure on oil and gas companies to integrate sustainable and climate positive practices into their operations has also increased the demand for ZLD technologies. Aquafortus plans to enter the market by initially targeting the US oil and gas industry and later expand its footprints to a wider range of industries such as mining, chemicals, and seawater desalination.

8
Ali B, Kumar A., “Life cycle water demand coefficients for crude oil production from five North American locations”, Water Res., October 15, 2017.

9
It is known that there are many cases in which oil wells that are no longer mined are repurposed into waste wells.

Impact Relevance Test

Portfolio	SDGs*	Target
Mission Barns	 	[12.1] Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns with developed countries taking the lead, and taking into account the development and capabilities of developing countries
		[12.A] Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
		[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
LumanLab	 	[3.8] Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
		[4.1] By 2030, ensure that all children complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes
Mango Materials	 	[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
		[12.4] By 2030, achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
		[12.5] By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
Tissen BioFarm	 	[12.1] Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns with developed countries taking the lead, and taking into account the development and capabilities of developing countries
		[12.A] Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
		[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
KETOS	 	[6.4] By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity and reduce populations suffering from water scarcity
		[6.5] By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
		[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
aweXome Ray**	 	[3.9] By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
		[11.6] By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
Aquafortus	 	[6.3] By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
		[6.4] By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
		[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
H2	 	[7.2] By 2030, increase substantially the share of renewable energy in the global energy mix
		[13.1] Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

* SDG indicated in the order of impact magnitude





** AweXome Ray has a unique material technology and while the expected impact area is very broad, this report is only based on the impact created by their air purification solution, the current major product.

Portfolio Interview



H2, a Leader in Large-scale, Long-duration Energy Storage

H2 is the first company in Korea to commercialize vanadium redox flow battery (VRFB), a next-generation technology in the field of large-scale and long-duration energy storage¹. As the share of renewable energy in the total energy mix increases, the demand for energy storage is also increasing. VRFB is one of the most advanced solutions in terms of technology maturity and commercialization performance among the currently available utility-scale and long-duration solutions.

Impact Factor		
Products and services	UN SDGs	Impact Model
Vanadium redox flow battery for long-duration energy storage	 	 MISSION  STRATEGY
Theory of Change		
VRFB, a next-generation technology, implements large-scale and long-duration energy storage, which is essential to increase the share of renewable energy generation in the total power supply		
Contributes to the decarbonization of the power generation sector by replacing gas power generation through VRFB power plants (Gas power generation is being adopted as a substitute power for renewable energy)		
Representative	Shin Han, CEO	
Corporate name	H2	
Established	July 2010	
Investment	Initial investment in July 2021 Follow-on investment in June 2022	
Website	h2aec.com	

¹ Large-scale and long-duration energy storage refers to a system capable of discharging for a long time with a specific output.

Impact Domain



Social Background and Problem Definition

Global carbon emissions have steadily increased by at least 1% per year over the past 30 years. However, in 2020, due to the impact of the Covid-19 pandemic and economic recession, it recorded the most significant decrease in history (4.4%-5.4%), then increased again by 4.9% in 2021, signaling a return to the previous levels before the pandemic². Carbon emissions in the energy sector account for an overwhelming share of approximately 73% of total carbon emissions³.

Currently, the decarbonization transition is underway to replace traditional energy sources with renewable energy as much as possible. To reduce carbon emissions, the proportion of clean energy sources must account for a larger share in the world's power generation mix. By 2050, more than 44% of the world's primary energy sources will come from renewables⁴.

As the share of renewable energy increases, power grid operations are more critical than ever before as renewable energy is an intermittent power supply, resulting in a more challenging balancing of electricity supply and demand. For example, if the demand exceeds supply, power outages occur, and when supply exceeds demand, the frequency of AC electricity goes out of the normal range, leading to the possibility of system failure. As renewable energy sources such as solar and wind power are less predictable and output fluctuations are large, it is difficult to consistently balance the grid. Moreover, as it is impossible in nature to supply the entire electricity demand throughout the entire

² (i) Global Carbon Budget 2021, Global Carbon Project. (ii) "Preliminary 2020 Global Greenhouse Gas Emissions Estimates", Rhodium Group, December 23, 2021. Global carbon emissions have been steadily increasing from 1990 to 2020 but recorded temporary decreases at the time of the dissolution of the Soviet Union in 1991, the global financial crisis in 2008, and the corona pandemic in 2020.

³ A Global Breakdown of Greenhouse Gas Emissions by Sector, Our World in Data, December 15, 2021.

⁴ Figures based on changes in the future energy system (Energy Technology Perspectives, IEA, 2016) predicted the scenario of suppressing rise within 2°C compared to the time of the Industrial Revolution. Under the realization of the 1.5°C scenario re-agreed by the international community, it is estimated that a larger share of renewable energy will be required.

day purely with renewable energy, gas peaker plants, which can start or stop their operations with very short notice, are increasingly used as backup power. However, these peaker plants are very expensive and exacerbates the grid's carbon emissions.

It is clear we need systems that are able to store the generated electricity when supply exceeds demand and for it to be supplied to the grid on short notice when needed in order to adequately utilize a highly variable energy source, such as solar and wind power. Without the development of large-scale, long-duration energy storage, the transition towards a more renewable and efficient energy market is not possible.

While numerous technological innovations continue to be developed in the energy storage industry, there are patterns that a single technology that proves to be superior tends to dominate the entire market. For example, Lithium-ion batteries are the most widely accepted energy storage technology; however, such technology is not suitable for long-duration storage as it is flammable and has technological inefficiencies as duration increases.

Energy storage is in high demand for future grid stability, but technologies must also be equipped with price competitiveness while addressing the current limitations of existing technologies, such as safety issues and a longer discharge period. Among the various attempts in utility-scale and long-duration energy storage, redox flow batteries (RFB) are considered the most advanced technology in terms of maturity as it is currently in the demonstration and adoption phase.



About H2

H2 manufactures vanadium redox flow batteries (VRFB) that use a 'vanadium aqueous solution' as an electrolyte, known for its high technological stability. Since its establishment in 2010, the company has devoted itself to research and development for over ten years, anticipating the increase in the demand for long-duration energy storage. Founder Shin Han and his team are dedicated to provide a technology essential to sustain human life. H2 is the first and only company in Korea to commercialize VRFB technology predicated on its extensive research and development.

Key Milestones

Secured 31MWh track record in the global long-duration energy storage field

Developing the largest VRFB project in California, US, since 2021, with a consortium of domestic public power companies and national research institutes (full-scale commercial operation expected in the second half of 2024)

Acquired UL1973 certification as the world's second stack for flow batteries

Acquired Korea's first new product certification (NEP), an innovative product certification from the Ministry of SMEs and Startups, and Standards of private sectors

Interview with CEO Shin Han, Founder of H2



Increasing the share of renewable energy and improving power generation efficiency are essential conditions for carbon neutrality. Accordingly, the demand for utility-scale, long-duration energy storage is increasing. Among various technologies, why is VRFB attracting attention, and what do you think is the competitive edge of H2's VRFB solution?

VRFB satisfies all four criteria that large-scale power generation companies judge as the top priority when building a power plant:

- 1) Safety (no fire hazards): It is a very important advantage compared to lithium-ion batteries, which have suffered 38 fires since 2017.
- 2) The ease of implementation of large-scale energy storage: In order to replace existing power plants with energy storage, the discharge must be possible for a long period (4 to 12 hours). VRFB can easily increase energy capacity by simply increasing the amount of electrolytes so that it can be developed according to the required discharge period.
- 3) A long lifespan of 20+ years: Power generation companies have long requested battery technologies equivalent to the 20-year level of new and renewable energy. VRFB is the first commercial battery technology to satisfy it.
- 4) Levelized Cost Of Energy (LCOE) competitiveness: Large power generation companies care not only about the initial investment cost but also the total lifetime cost including maintenance cost. VRFB is competitive from a LCOE point of view, thanks to the safety and long lifespan due to its unique chemical properties.



H2's VRFB is based on its proprietary technologies, FLEXMOULE™¹, HYPERDENSITY™², HYPERBOOST™³, and is positioning itself as a leader in the global VRFB industry. Compared to world-class VRFB products, it boasts superior flexibility in energy capacity implementation, 20% higher energy density, and 5% higher energy efficiency⁴.

The most significant achievement last year was the largest VRFB project in California, US. Can you share the current progress and plans for future operation? We are also curious about what this project means to the company and to the energy storage market, respectively.

The US is the most aggressive country in introducing renewable energy and energy storage as a power plant, and California is leading this trend. Therefore, establishing a track record of large-scale power plants in this region gives us a very advantageous position in expanding the market to

¹ FLEXMODULE™: Modularization technology that can flexibly implement output and energy capacity

² HYPERDENSITY™: Technology to increase energy density through the high-performance stack and high-density modular design

³ HYPERBOOST™: Technology to increase energy efficiency through a high-voltage battery

⁴ Energy density is the result of comparing test results from accredited testing institutes, and energy efficiency is based on the company's evaluation standards.

the US and the rest of the world. In that sense, the fact that H2 is building the largest VRFB power plant in the US of 20MWh scale, drew attention from overseas markets, which in turn served as a trigger for the domestic VRFB project to begin in earnest. Since the project started, discussions about building a large-scale VRFB system have been actively conducted in Korea.

The California project that started in late 2021 is currently underway as planned. In the second half of 2023, we will complete installation and begin to operate it; in the second half of 2024, we will start commercial operation. The project is expected to be the first VRFB in the US to operate under the central dispatch system⁵. We expect this case will also serve as an opportunity to promote the introduction of central dispatch VRFB power plants in Korea.

In January 2023, H2 successfully finished its series C fundraising round. It can be seen that the company has entered a stage to achieve significant growth. What are H2's mid to long-term goals, and what are the milestones to achieve them? What is the ultimate vision of the company?

H2 plans to focus on building the nation's first central dispatch VRFB power plant with a capacity of hundreds of MWh. In the first half of this year, a new manufacturing site with annual production capacity of 330MWh is about to be completed. Based on this, H2 goes for a full-scale production and international sales. VRFB is the most effective energy storage in the long-term, and its demand will likely explode as the level of response to climate change increases. The key is to prepare for future demand and increase production capacity preemptively. At the same time, plans to establish a local plant in the US are being materialized to expand overseas business. In addition to the California project, large-scale follow-up projects are also being promoted.

⁵ Operated according to the dispatch order of the power grid operator (e.g., Korea Power Exchange), not the ESS generator. It is a common operating method for large-scale fossil fuel power plants. It is being discussed as a way to solve renewable energy output curtailments.

H2 aims to create a foundation for the effective and stable operation of renewable energy by providing a safe and economical utility-scale, long-duration solution. Ultimately, the company's mission is to replace fossil fuel power plants completely. We are working diligently to become a renowned energy storage company that can play a pivotal role in achieving carbon neutrality by 2050.

When you decided to start a business, it must have been even before the market was formed. How did you remain confident in starting this business? What was the driving force that allowed you to continue building the business when the market was yet to be formed for more than ten years?

As a researcher, when I started my business, I tried to find a place where there was yet to be a market, so there were no dominant players but also an area with very high growth potential. Most of these business items are deep technologies characterized by extremely difficult R&D and commercialization. VRFB met this criteria in many ways.

Since it is an esoteric technology, I expected it would take considerable time to develop. Still, I hoped that the market would open up by the time our development was completed to some extent. However, technology development took much longer than expected, which was our biggest challenge. Fortunately, we successfully completed R&D by receiving investment from VCs who recognized the value of our technology, and luck followed as the market began to form in line with this.

We have been able to develop and commercialize VRFB steadily for more than ten years because we were convinced of the basic premise of the business, that large-scale long-duration energy storage is essential to achieve carbon neutrality. It is a self-evident fact that fossil fuels, currently the primary source of power generation, must be replaced, and the belief that VRFB is the only available technology that can replace it is the foundation of H2.



As a company active in the climate tech field, how do you feel about climate tech-related capital markets and global regulatory changes compared to the past?

The atmosphere in the capital markets dealing with climate tech in the early days of H2 and now is entirely different. Around the time we launched our prototype, there was the Paris Agreement and the world's first carbon-neutral declaration following it, and Korea declared carbon neutrality in 2020. So far, more than 120 countries worldwide have declared carbon neutrality, and the capital markets transition is also in line with this radical trend of climate response. Of the KRW 56.2 billion accumulated investment in H2, 72% (KRW 40.2 billion) was invested over two years, 2021 and 2022. As a company that has addressed climate issues, I felt the change more clearly than anyone else.

Much capital is being invested in climate tech, including long-duration energy storage, led by so-called developed markets such as the US, Europe, and Australia. Regarding this, new systems are being introduced so that essential climate techs can settle in the market. Tax benefits for climate tech brought about by the US Inflation Reduction Act (IRA), California's subsidy that invested USD 380 million in the long-duration energy storage sector, the introduction of a central dispatch energy storage in Jeju Island, Korea⁶ would be representative examples.

Energy storage is an industry receiving a lot of investment and attention worldwide among climate techs. Nevertheless, we understand that there were difficulties you have experienced as a founder of a climate solution company and a founder who deals with hardware technology in Korea. What improvements could be made to the climate startup ecosystem, and do you have any suggestions as a founder?

It will be challenging for new technologies to enter the market, not just in climate tech but in all other areas. However, in the case of climate tech, it is tough to secure absolute economic feasibility, especially in the early stages, so governmental support is critical. Based on the trust that climate tech will show significantly better value in the mid to long term, it is necessary to promote the market entry of early climate technology by taking a policy drive. Through incentives such as tax benefits for introducing climate solutions, the private market, which does not move only for its own sake, should be encouraged to accept climate tech more actively. In the same vein, climate tech companies must have the ability to achieve not only research and development for better solutions but also policy improvement and social awareness shifts.

⁶ Korea's first central dispatch long-duration energy storage case based on Korea's 10th Basic Plan for Electricity Supply and Demand (announced in January 2023).

When starting a business, there are many cases where business items are set first. But we know you set up a mission first, gathered people, and then materialized the business. It can be said that H2 was born with the imagination that linked the vision of solving our society's big problems with the team's outstanding capabilities. Now more than ever, we need imagination from a climate perspective regarding talent, technology, and capital. What advice would you give to potential researchers and prospective entrepreneurs?

A straightforward way to have outstanding achievement is to 'challenge a big problem.' Researchers with potential, or anyone who considers themselves highly competent in any field, are encouraged to tackle even more audacious problems. For example, the biggest problem facing humanity today is climate change. It's a challenging enough task, and it will give you a high sense of accomplishment.

In addition, I hope that outstanding talents will come together and form a team rather than remaining exceptional individuals. The more talented people are gathered, the more likely they will solve the bigger problems. Imagine that we contribute to humanity's achievement beyond that of one individual or group. Isn't this vision attractive?

Envisioning Partners made its first investment in H2 in 2021 and executed a follow-on investment in 2022. What does it mean from the founder's point of view to be invested by an impact investor like Envisioning? Has anything changed since the investment was made?

Envisioning Partners is one of the leading impact investing institutions in Korea. Receiving investment from Envisioning felt like the value of our solutions as innovative and promising climate tech was well recognized. Other venture capitalists also judge whether to invest based on technology and growth potential but do not closely examine social and environmental values. Envisioning's investment is a complex process that must satisfy both social and environmental perspectives as well as financial ones, so it is very meaningful and proud to our members. After Envisioning's investment, several follow-on investments followed from other impact investors and ESG-purposed funds. I credit Envisioning for opening the door.



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Editor Sue Woo | Envisioning Partners

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IMPACT REPORT
2023

