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Issue 10

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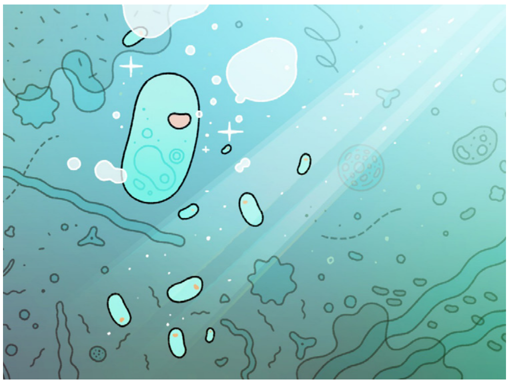

The Amazing Bacteria That “Eats” CO_2

Eco-friendly plastics that reduce CO — it’s happening!
Carbon neutrality is the future.

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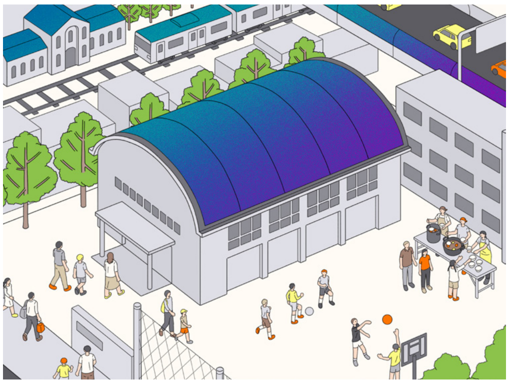

Thin. Light. Flexible. The Amazing Future of Solar Power: Perovskite!

Future Solar Panels at the Osaka-Kansai Expo Gateway: “Perovskite” We spoke with Mr. Futoshi Uewaki, President of Sekisui Solar Film Co., Ltd., about its potential.

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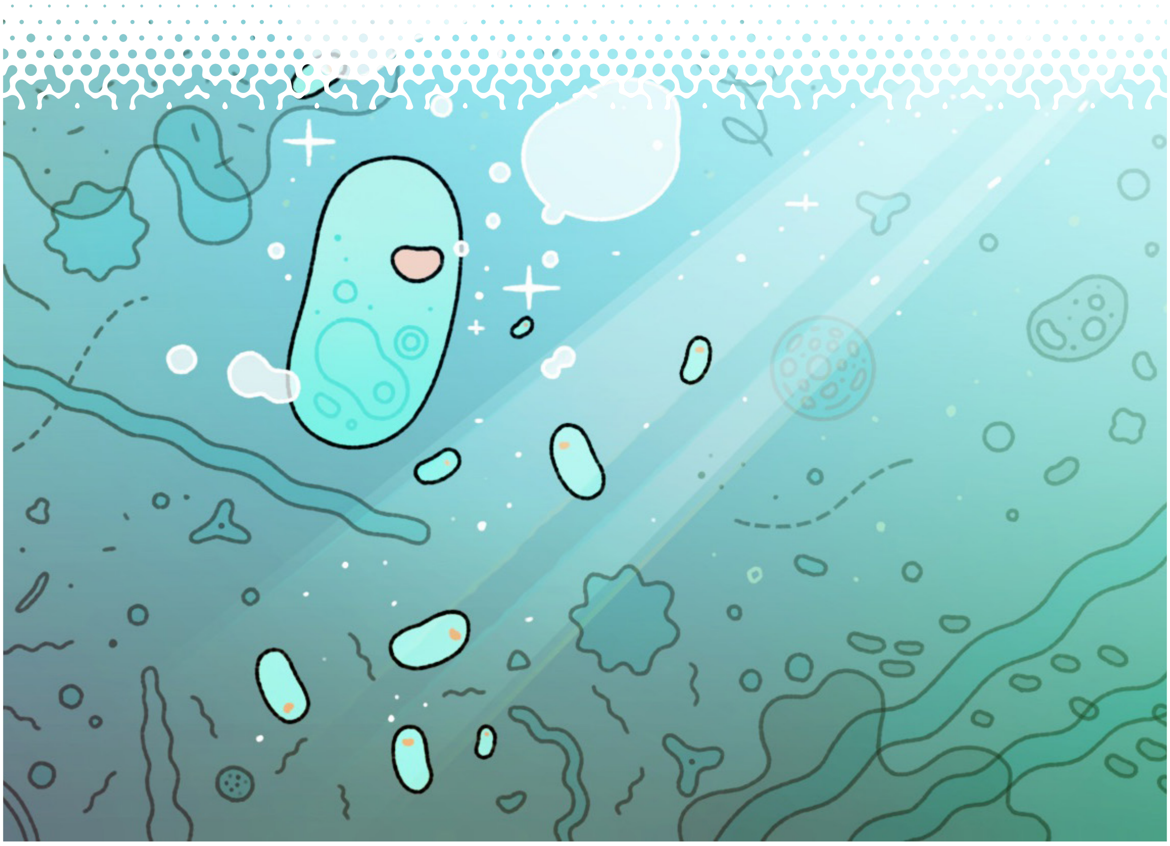
The Amazing Bacteria That "Eats" CO_2



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Among the many challenges facing the world in the 21st century, climate change is undoubt-edly one of the most urgent. A major contributor to this issue is the release of greenhouse gases, such as CO , produced by human activities.The key to solving this lies in remarkable new technologies designed to reduce CO in the atmosphere.

One standout innovation comes from Kaneka Corporation, a leading Japanese chemical manufacturer and a partner in the Japan Pavilion's exhibit. Their breakthrough involves cultivating special microorganisms that rapidly consume CO and use it as a nutrient to e ciently produce biodegradable plastic — an eco-friendly alternative to conventional plastics.Even if this biodegradable plastic were to end up in the ocean, marine microor-ganisms would naturally break it down, returning it safely to the environment.A solution that cuts CO , creates sustainable plastic, and supports marine ecosystems — this innovation feels like a triple win for humanity.

To learn more about the science behind this remarkable technology, we spoke with Dr. Shunsuke Sato, Director of Kaneka's CO Innovation Laboratory.

How CO_2 Turns into Biodegradable Plastic

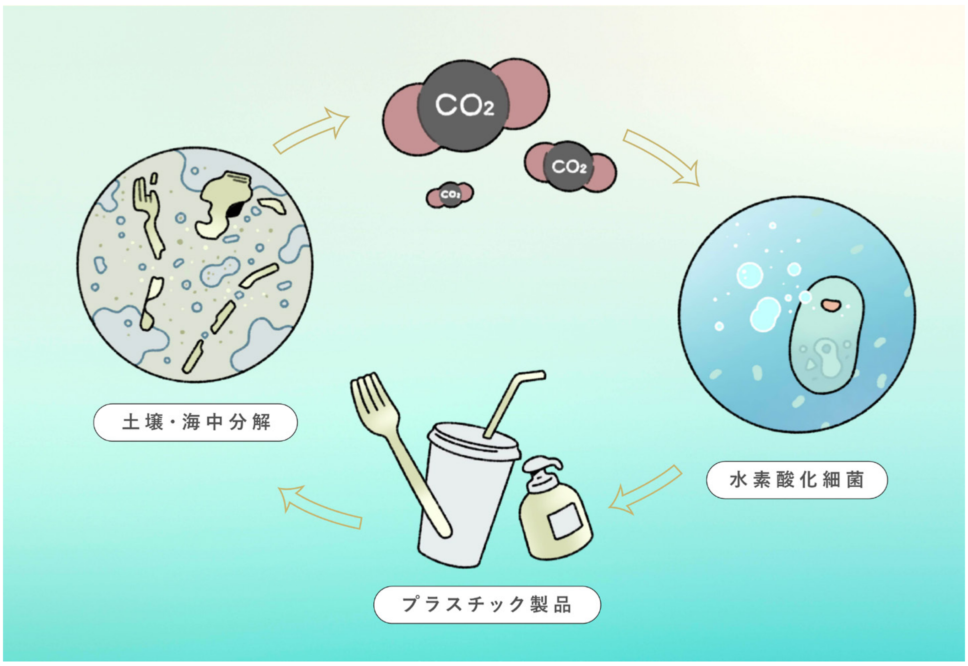
The microorganism at the heart of Kaneka's groundbreaking, triple-bene t technology is called hydrogen-oxidizing bacteria. To understand how this process works, we asked Dr. Shunsuke Sato, Director of Kaneka's CO Innovation Laboratory, explained it in simple terms.

Sato In fact, hydrogen-oxidizing bacteria have existed since the very beginning of life on Earth. These microorganisms are naturally found in environments like soil and oceans. When provided with hydrogen, oxygen, and CO , these bacteria consume them, using the energy produced by oxidizing hydrogen to convert CO into organic matter, which they store within their cells. Essentially, the bacteria store CO in a way similar to how humans store fat. Our research focuses on cultivating these bacteria to e ciently convert CO into what we call Kaneka Biodegradable Biopolymer Green Planet (commonly known as "Green Planet"). We then extract this material and industrialize it for practical use.

It was Sato who developed the groundbreaking technology that gave the hydrogen-oxidizing bacteria — microorganisms abundant in our everyday environment — the ability to produce Green Planet.

Sato In our daily lives, we generally dispose of waste properly in trash bins. Yet, despite this, an estimated 8 million tons of plastic still end up in the oceans each year*. This means that, inevitably, some plastics unintentionally escape into the environment. Since this accumulation is now causing serious problems, I believe that future plastics must be designed with the ability to biodegrade naturally if they end up in the environment. Without such innovation, we may eventually face a future where continuing to use plastic becomes unsustainable.

*Ministry of Enviornment: https://www.env.go.jp/policy/hakusyo/r01/html/hj19010301.html



Biodegradable Plastic Development: From Plant Oils to Innovation

The question arises: why did Kaneka embark on this research in the rst place?

Sato Kaneka began its research in the early 1990s, a time when plastic waste was primarily disposed of in land lls rather than being incinerated. The growing concern back then was the risk of land lls reaching capacity and the resulting soil contamination. While CO emissions were not yet widely recognized as a major issue, Kaneka started developing biodegradable plastic as a solution for plastic waste — a material designed to break down naturally in the soil through microbial action. In the early 2000s, advancements in waste incineration technology improved the ability to safely burn plastic waste, which temporarily reduced interest in biodegradable plastics. Meanwhile, concerns about climate change emerged as rising atmospheric CO levels gained attention. This shift led to increased research into biomass plastics — sustainable alternatives made from renewable resources rather than petroleum. More recently, however, the alarming issue of microplastic pollution in oceans has reignited global interest in biodegradable plastics — particularly those capable of decomposing even in marine environments.

Kaneka is currently supplying straws and disposable cutlery made from Green Planet, a biodegradable plastic derived from plant oils, to convenience stores and cafes. Chances are, some of the plastic products you use every day are already made from biodegradable materials.

The Current Status of CO_2-Based Biodegradable Plastic Development

Sato At the same time, the issue of global warming caused by CO gained increasing attention. We had already anticipated the possibility of shifting from plant oil to CO as a raw material during our development of biodegradable plastic. This was because the supply of plant oil is inherently limited. Since 2023, with support from the New Energy and Industrial Technology Development Organization (NEDO), we have o cially launched full-scale research into new microorganisms and manufacturing processes that can directly use CO as a raw material to produce Green Planet.

The seemingly too-good-to-be-true idea of creating biodegradable plastic from CO has now started to move toward reality. Currently, research and development are reportedly progressing smoothly.

Sato Hydrogen-oxidizing bacteria can absorb CO far more e ciently than plants through photosynthesis. This is because photosynthesis relies on sunlight, meaning plants can only absorb CO across the total surface area exposed to light. In contrast, hydrogen-oxidizing bacteria use hydrogen as their energy source. Since hydrogen dissolves in water, these bacteria can absorb CO throughout the entire volume of the water, not just across a at surface. Additionally, while plants only perform photosynthesis during daylight hours, hydrogen-oxidizing bacteria can operate day and night. Currently, we are scaling up our bacterial cultivation system. By March 2025, we plan to launch a demonstration experiment using a 200-liter cultivation tank. Progress so far has been in line with the original blueprint we envisioned at the start of development. Our ultimate goal is to conduct a large-scale demonstration using a 100,000-liter commercial-scale cultivation tank. After establishing a demonstration plant by the 2030 scal year, we aim to introduce Green Planet products to the market. Alongside scaling up the cultivation process, we are also working to further enhance the bacteria's capabilities to improve e ciency and performance.

If this technology is successfully implemented in society, it will not only make a signi cant contribution to mitigating global warming but also serve as a valuable step toward achieving carbon recycling.

A Promising Vision of a Bright Future with CO_2 Circulation

At the Japan Pavilion at the upcoming Osaka-Kansai Expo, Kaneka's innovative process — where hydrogen-oxidizing bacteria absorb CO , oxygen, and hydrogen to produce Green Planet — will be showcased through an easy-to-understand CG animation in the Farm Area. In addition, visitors will see tableware made from Green Planet, designed by the pavilion's General Producer/Designer, Oki Sato. Moving on to the Plant Area, visitors will witness how this Green Planet tableware breaks down in seawater through microbial action. As the material decomposes, it returns to CO and water, visually illustrating the complete cycle of CO circulation — a powerful reminder of the interconnectedness of nature and sustainable innovation.

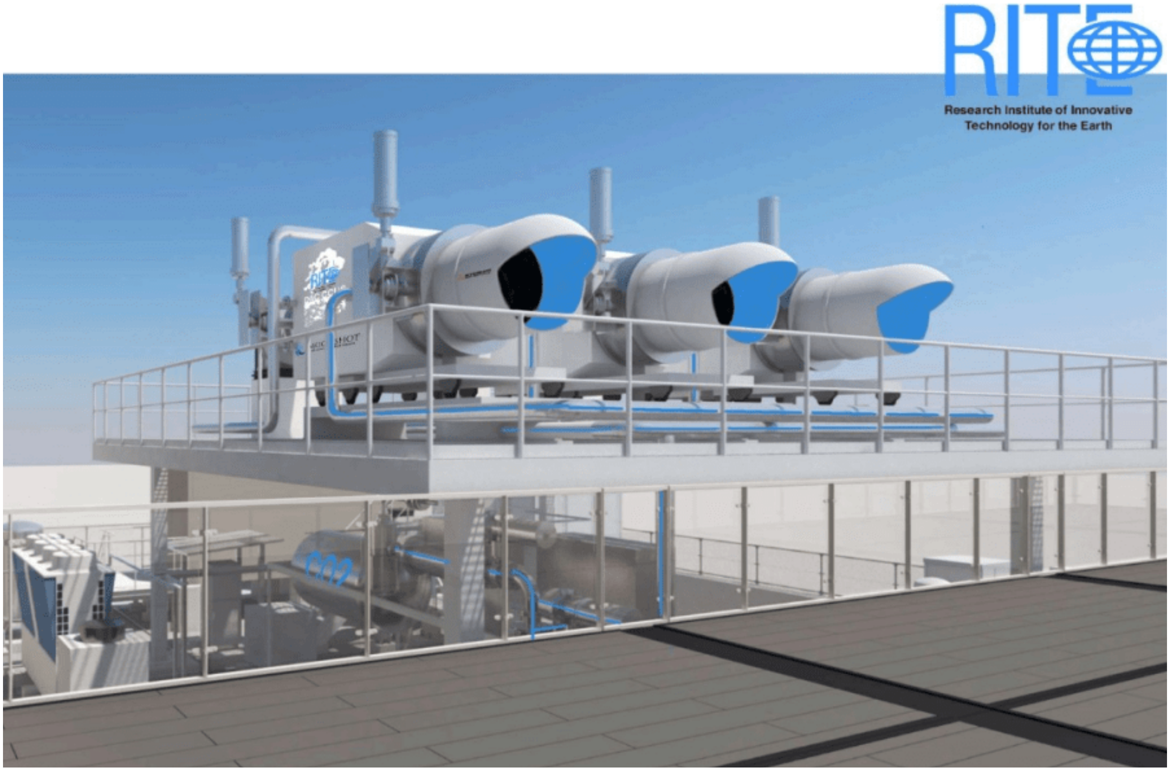
CO from the biogas plant is concentrated, stored in gas cylinders, and symbolically transported through a tunnel. On the right, biodegradable tableware made from CO decomposes naturally after use.

A Showcase of Cutting-Edge CO_2 Reduction Technology

At the Osaka-Kansai Expo, in addition to Kaneka's hydrogen-oxidizing bacteria project, various other cutting-edge technologies aimed at reducing CO will also be showcased. Let's take a closer look at some of these innovative solutions.

Eco-Friendly Concrete by Ando Hazama: An interactive exhibit showcasing the future of sustainable cities made possible by eco-conscious concrete. Benches are also crafted from the same material.

First, let's look at eco-friendly concrete, a material that has already begun to see practical use. Traditional concrete is made from cement, gravel, sand, and water. However, cement production generates a signi cant amount of CO during the manufacturing process. To address this, eco-friendly concrete replaces part of the cement with special materials that absorb CO or with industrial by-products, successfully reducing CO emissions. At the Osaka-Kansai Expo, visitors will nd structures such as a dome (by Kajima, Takenaka Cor - poration, and others) and benches (by Ando Hazama) made from this innovative concrete.



CO_2 Removal by RITE: An exhibit showcasing the DAC (Direct Air Capture) device, which lowers atmospheric CO_2 levels by extracting CO_2 directly from the air. (Image courtesy of RITE - Research Institute of Innovative Technology for the Earth)

Next, let's look at Direct Air Capture (DAC) — a technology that directly absorbs CO_2 from the air. While various countries are actively developing this technology, what makes DAC particularly noteworthy is its ability to recover large amounts of CO_2 that has already been released and accumulated in the atmosphere. Although rising CO_2 levels are a major driver of climate change, CO_2 only makes up about 0.04% of the air we breathe. At present, DAC is considered the only technology capable of efficiently capturing this low-concentration CO_2 dispersed across Earth's atmosphere. Another advantage of DAC is its efficient operation in limited spaces and with minimal water usage. In fact, several DAC plants are already in operation overseas. At the Osaka-Kansai Expo, the research institute RITE will install and operate a DAC demonstration plant as part of its "Forest of the Future" exhibit. Visitors will have the opportunity to join guided tours showcasing this innovative technology in action.

The captured CO_2 will be utilized in several ways: Converted into methane at a methanation plant for use in kitchens at the reception hall, transformed into dry ice for practical applications, and by 2030, integrated into the production of biodegradable plastics, eco-friendly concrete, biojet fuel, and polycarbonate materials. Addressing CO_2 as a valuable resource rather than simply a harmful pollutant is key to achieving meaningful solutions. By strategically incorporating CO_2 into a sustainable cycle, we can turn this environmental challenge into an opportunity for innovation.

For example, a promising future could see DAC-captured CO_2 transformed by hydrogen-oxidizing bacteria into biodegradable plastics — an exciting collaboration that's no longer just a distant dream.

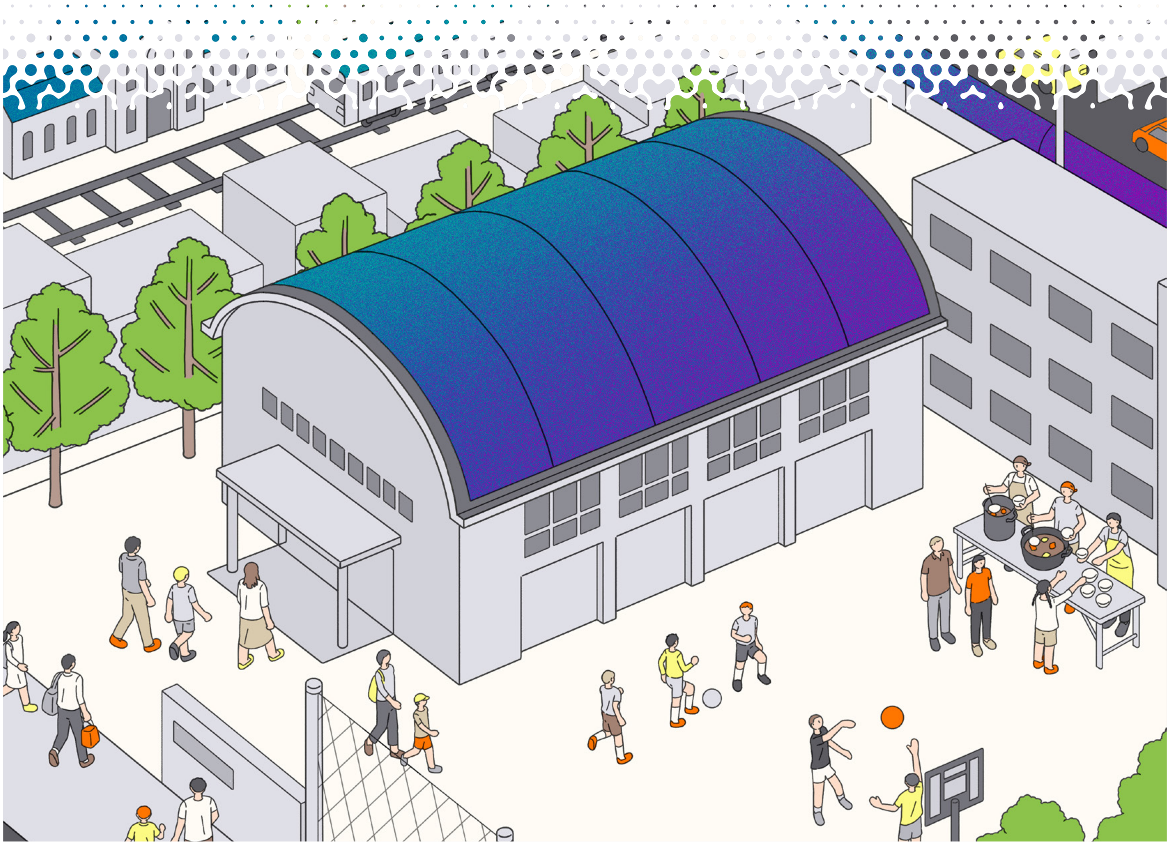
Iida Group Holdings × Osaka Metropolitan University Exhibit: A visual and engaging display that explains the mechanism of artificial photosynthesis and how it differs from natural photosynthesis, designed for both children and adults to enjoy. (Image courtesy of Iida Group Holdings Co., Ltd.)

In addition, the Iida Group Holdings × Osaka Metropolitan University Joint Pavilion, a standout example of industry-academia collaboration, will showcase their jointly developed artificial photosynthesis technology, designed to promote energy self-sufficiency in homes. The Osaka-Kansai Expo serves as a showcase for cutting-edge CO_2 reduction technologies, offering a glimpse into Japan's current efforts to achieve carbon neutrality by 2050, the ultimate goal set by the Paris Agreement.

To conclude, let's once again hear from Dr. Sato of Kaneka.

Sato I have children myself, and I really hope that many young people and children will visit. While it may be difficult to envision a hopeful future in today's social climate, we are presenting a vision of a brighter tomorrow — one grounded in science and technology. By experiencing a future shaped by various cycles that coexist with our planet's environment, I believe visitors will be able to discover a sense of hope and optimism.

Thin. Light. Flexible. The Amazing Future of Solar Power: Perovskite!



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The solar panels you often see on the roofs of homes and apartment buildings are a famil-iar sight. In fact, when measured by land area, Japan ranks as the leading country among major nations in terms of solar panel installations.

However, to achieve GX (Green Transformation) — the shift from a fossil fuel-dependent society to one centered on clean energy — further innovation in solar power technology is essential.

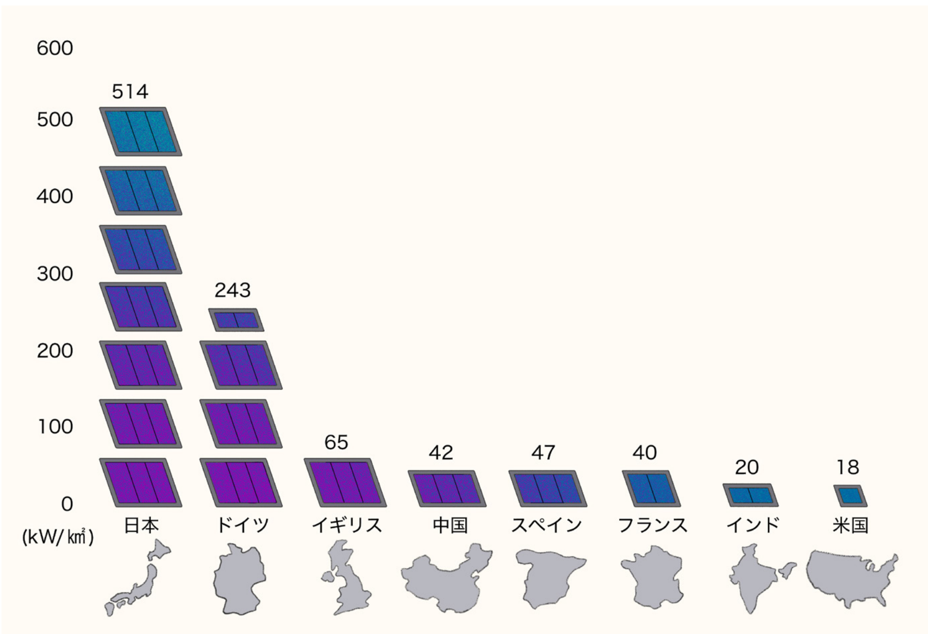
Enter the perovskite solar cell — a revolutionary advancement that promises to be lighter, thinner, and more adaptable to various surfaces while also reducing environmental impact.

This remarkable technology has the potential to overcome multiple challenges, paving the way for a brighter future in solar power. In this article, we'll delve into the potential of perovskite solar cells and the fascinating story behind their development.

What Are Perovskite Solar Cells, the Solar Panels of the Future?

As the global push for renewable energy gains momentum, Japan's Ministry of Economy, Trade and Industry (METI) has set a target for renewables to account for 40–50% of the country's energy mix by 2040. Among these renewable sources, solar power is expected to play a major role.

Japan is already a leader in solar power adoption among developed nations. Despite its relatively limited land area, proactive policies have successfully promoted the widespread installation of solar panels. As a result, Japan boasts the highest solar panel capacity per unit of at land area among major countries — more than double that of Germany, a country renowned for its commitment to renewable energy.



Solar Power Capacity per Unit of Flat Land Area (Source: Agency for Natural Resources and Energy, "Solar Power Policy Trends," May 29, 2024)

In Japan, where about 70% of the land is mountainous, the installation of traditional solar panels faces several challenges. The most signi cant issue is site limitations. Traditional panels are heavy — weighing around 15 to 20 kg per panel for residential use — and require at surfaces for installation, making it di cult to secure suitable locations.

Additionally, the growing frequency of natural disasters poses another concern. Traditional panels are vulnerable to damage from typhoons and earthquakes, and installations on steep slopes risk being destroyed by landslides. Environmental concerns also come into play. Traditional panels require a signi cant amount of energy during manufacturing and generate considerable CO emissions when disposed of.

A promising solution to these challenges lies in the lm-type perovskite solar cell (hereafter referred to as perovskite) — a revolutionary technology that is just 1mm thin, lightweight, and exible. This exibility allows perovskite cells to be installed in locations previously considered unsuitable for solar panels. Additionally, while traditional silicon-based pan-els require temperatures exceeding 1000°C during manufacturing, perovskite cells can be produced at temperatures below 150°C, signi cantly reducing energy consumption during production.

A 250m-long perovskite solar power system will be installed at the bus terminal, the gate-way to the Osaka-Kansai Expo. This will be the world’s largest perovskite installation as of 2025, o ering visitors a rsthand look at the future of solar power.

A 1mm Film Shaping the Future of Energy

What makes the perovskite solar cells installed at the gateway to the Osaka-Kansai Expo so remarkable? To explore the background and groundbreaking innovation behind this technology, we spoke with Mr. Futoshi Kamiwaki, President of Sekisui Solar Film Co., Ltd., the company responsible for its development.

— At the Osaka-Kansai Expo, the perovskite solar cells developed by your company will be installed on the roof of the bus terminal. I understand this will be the world's largest installation of its kind, correct?

Kamiwaki The Osaka-Kansai Expo presents a crucial opportunity to showcase Japan's innovative future technologies to the world. At the same time, it serves as a platform to demonstrate how perovskite solar cells can contribute to climate change mitigation and CO reduction, while also highlighting their unique potential for installation on curved surfaces and other challenging locations. Japan's technology is currently leading the world in perovskite solar cell devel- opment. To showcase the achievements of this ongoing innovation, our company has dedicated signi cant e ort to the installation at the Osaka-Kansai Expo.

— What are the key features of the perovskite solar cells developed by your company?

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— What are the key features of the perovskite solar cells developed by your company?

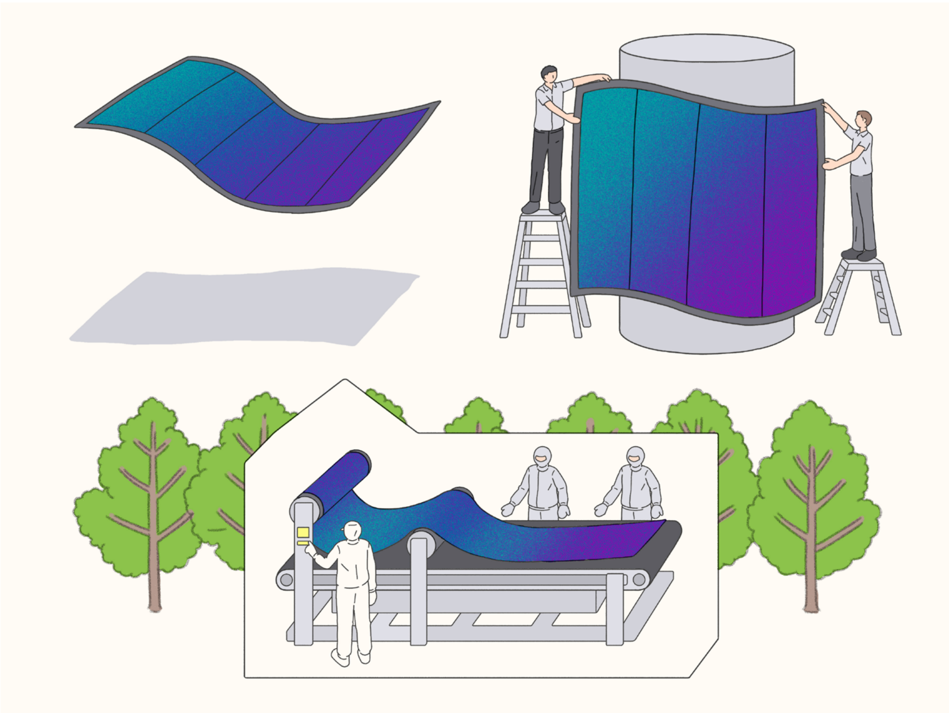
Kamiwaki Our perovskite solar cells have three key features that set them apart from traditional solar panels:

1. Lightweight Design:
Our perovskite cells are approximately one-tenth the weight of conventional solar panels. This signi cant reduction in weight allows installation in locations that were previously unsuitable due to load restrictions, such as gymnasium roofs or older buildings.

2. Flexibility:
Unlike rigid traditional panels, our perovskite cells are exible, enabling in- stallation on curved surfaces. For instance, at the Osaka-Kansai Expo, the perovskite system is designed to follow the curved roof of the bus terminal. We are also conducting demonstration tests in various locations, including soundproof walls along Shinkansen tracks.

3. Thin Pro le:
Our perovskite cells are just 1mm thick. This slim pro le allows seamless inte-
gration into walls and building materials without compromising aesthetics, making solar power adoption possible without disrupting design.

While traditional solar panels achieve an energy conversion e ciency of around 20%, our perovskite cells currently achieve about 15%. However, we expect to reach comparable e ciency levels in the near future.



Features of Perovskite Solar Cells
Weight: Approximately one-tenth of traditional panels, Installation Flexibility: High (suitable for curved surfaces),
CO Emissions During Production: Signi cantly lower than traditional panels

Locally Sourced Materials, Japanese Innovation: “Local Production for Local Consumption” Energy

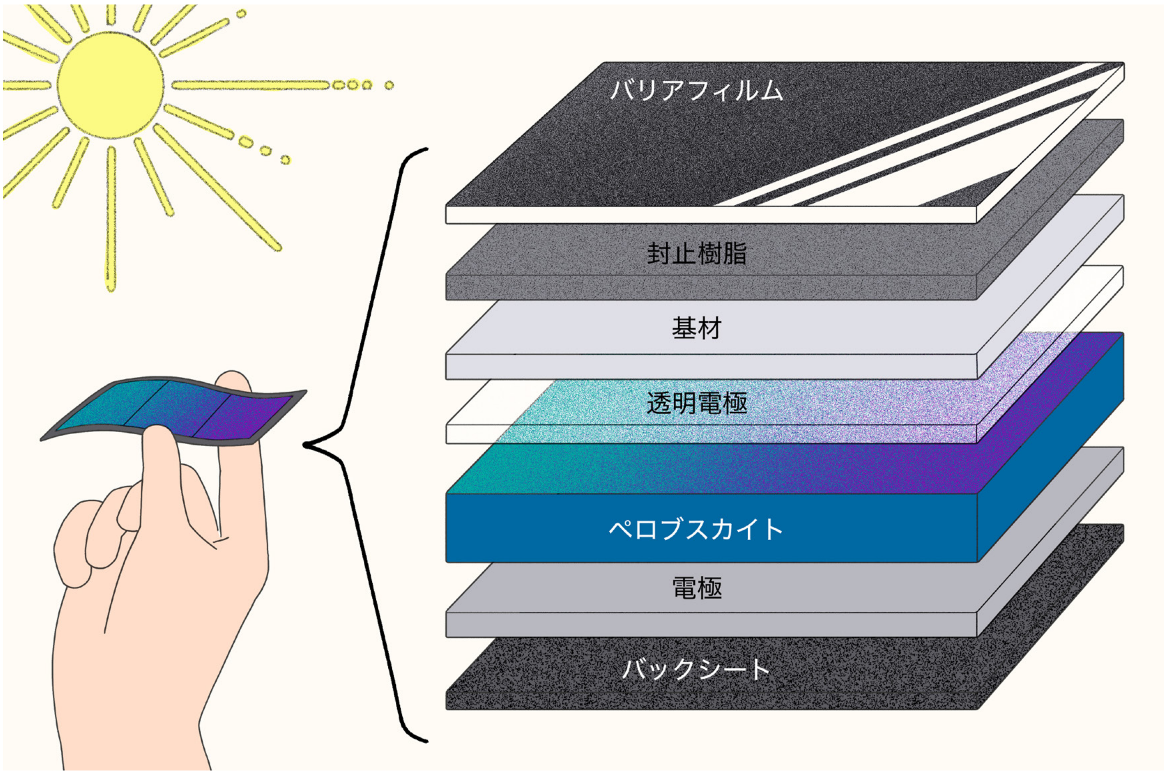
— What enabled your company to successfully develop perovskite solar cells?

Kamiwaki We began development about 12 years ago. Even back then, perovskite was gaining attention as a promising next-generation solar cell technology, but no company had yet achieved mass production. Recognizing that our com-
pany’s technical strengths could play a key role, we decided to take on the challenge of development.

— What kind of technology is used in the development of perovskite solar cells?

Kamiwaki We utilized technologies developed through our experience with liquid crystal displays, such as lm encapsulation (a technique that seals and protects semiconductors without gaps), precise coating on thin lms, and plastic molding techniques. By combining these technologies, we believed we could make perovskite solar cells practical for real-world use.

The result is a 1mm-thick lm-type solar cell composed of multiple layers — a product that embodies the expertise and innovations we have cultivated over the years.



— What materials are used to create perovskite solar cells?

Kamiwaki One of the main raw materials used is iodine, which can be sourced domesti-cally in Japan. This iodine is extracted from brine pumped from underground. Most of Japan's iodine is collected in Chiba Prefecture, ensuring a stable and reliable domestic supply — a signi cant advantage in production.

— So, the main raw material can be sourced domestically?

Kamiwaki In fact, Japan accounts for approximately 30% of the world's iodine produc-tion, making it the second-largest producer globally. Sourcing raw materials domestically is extremely important from the perspective of energy security and economic security. This is not just about material procurement — it also contributes to building a stable production system that leverages Japan's technological expertise.

On the other hand, the primary raw material for traditional solar cells, silicon, is almost entirely dependent on imports from China. As a result, China has gained a competitive edge in the global market through large-scale production supported by low-cost materials, leaving Japan struggling to compete. In contrast, perovskite solar cells o er a competitive advantage as their raw materials can be sourced domestically. Additionally, the manufacturing process for perovskite does not require the high-temperature treatments typical of silicon solar cell production, signi cantly reducing energy consumption and CO emissions.

Pioneering World-First Technology to Achieve GX

— What was the most challenging aspect of the development process?

Kamiwaki The biggest challenge was improving durability. Perovskite is prone to degradation from moisture and light, so we focused heavily on developing lm encapsulation technology. This allowed us to create a system that e ectively blocks moisture and prevents light-induced deterioration. Currently, our perovskite cells have achieved a durability of approximately 10 years after installation. However, this is still a work in progress. We are continuing our e orts to extend the lifespan to 20 years, comparable to traditional solar panels.

We are also focusing on expanding the lm width used in production from the current 30 cm to 1 meter. If achieved, this will mark a world- rst technological breakthrough.

— Are there specific technical challenges involved in increasing the film size?

Kamiwaki The challenge isn't simply about increasing the size itself — the real di culty lies in maintaining quality as the lm size grows.
During the manufacturing process, the raw materials must be applied to the lm in a uniform layer. Any inconsistencies or unevenness can signi cantly reduce the power generation e ciency. As the lm size increases, achieving this level of precision and consistency becomes much more di cult.

— I had imagined layering panel-like materials, but it sounds like the materials are actually applied in a coating process?

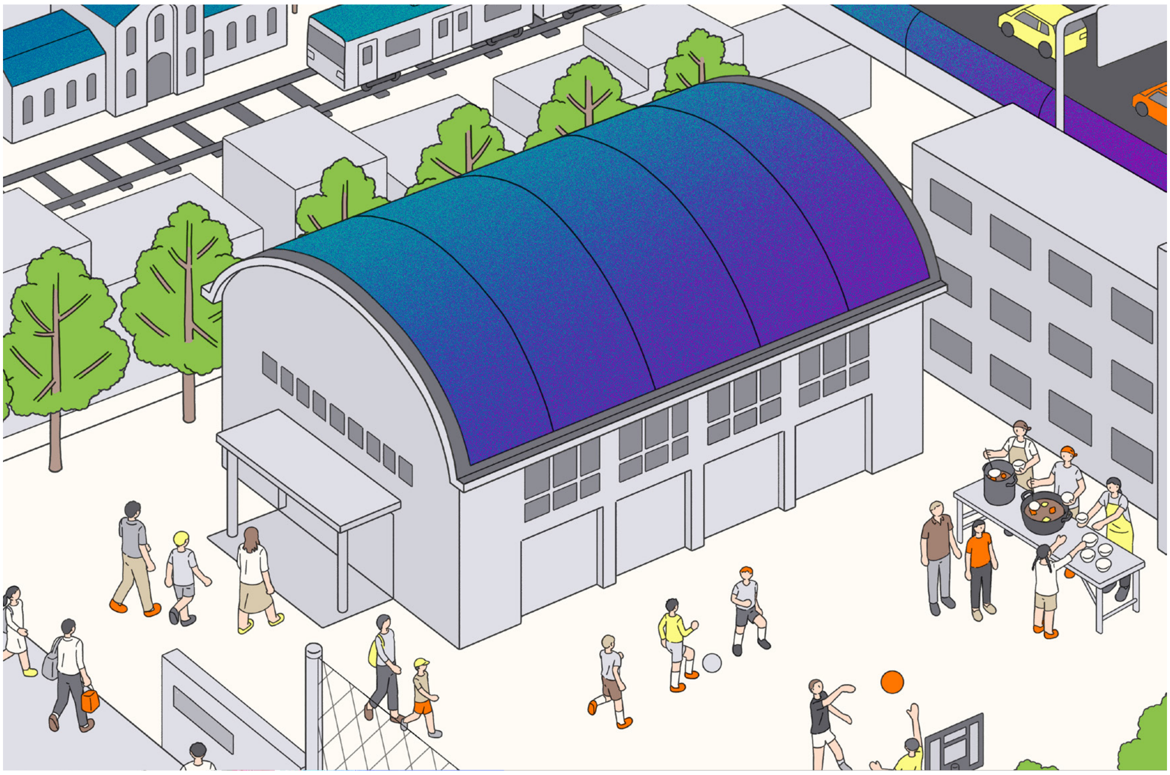
Kamiwaki It's a unique and highly complex technology, but if successful, it is expected to signi cantly reduce both manufacturing and installation costs. Achieving this would be a major step forward in promoting the widespread adoption of perovskite solar cells, and we are committed to making it happen.

— When can we expect to see perovskite solar cells integrated into our daily lives as mass production advances?

Kamiwaki We are currently conducting demonstration tests in various environments, such as sewage treatment plant covers, cruise terminal pillars, and Shinkansen soundproof walls. Through these tests, we've learned that to fully utilize the bene ts of perovskite's lightweight and thin design, minimizing installation e ort is crucial. Ensuring ease of installation will be a key factor in promoting its widespread adoption.

Looking ahead, we plan to begin shipping in scal year 2025 and commence full-scale mass production at our Sakai plant in 2027. The plant will initially produce at a 100-megawatt scale, with plans to expand to 1 gigawatt by 2030.

As for implementation, we aim to start with public facilities such as gymnasi-ums in elementary and junior high schools and disaster prevention facilities. Gymnasiums, in particular, have traditionally faced challenges with solar panel installation due to weight limitations. However, since these spaces often serve as evacuation shelters during disasters, we believe our technology can make a signi cant contribution in enhancing their functionality and resilience.



Futoshi Kamiwaki

Born in 1960, Kamiwaki joined Sekisui Chemical Co., Ltd. in 1983. In 2011, he was appointed Executive O cer and General Manager of the Housing Company's Planning and Administration Department. In 2015, he became Managing Executive O cer and General Manag-er of the Housing Company's Product Development Department. Since 2020, he has served as Director and Senior Managing Exec-utive O cer, overseeing the Corporate Strategy Department, ESG Management Promotion Department, Digital Transformation Promo-tion Department, and New Business Development Department.