Hitachi, Itoki, and Tokuyama demonstrate upcycling of photovoltaic panel glass directly into office furniture

Low-temperature thermal decomposition and nondestructive evaluation enable reuse of plate glass as building materials and furniture components without crushing, potentially halving CO_2 emissions

Prototype video conferencing booth made from recycled glass recovered from photovoltaic panels (exterior)

Tokyo, September 1, 2025—Hitachi, Ltd. (TSE: 6501, "Hitachi"), Itoki Corporation ("TSE: 7972, Itoki"), and Tokuyama Corporation ("TSE: 4043, Tokuyama") have demonstrated the upcycling[*1] of plate glass recovered from photovoltaic panels—which have traditionally posed disposal challenges—into furniture components as another step toward realizing a circular society. High-quality plate glass was recovered using Tokuyama's low-temperature thermal decomposition, and degradation effects such as cracks[*2] and alkaline elution[*3] were evaluated with Hitachi's nondestructive strength estimation technology to enable direct reuse of the glass. Itoki, meanwhile, created a prototype video conferencing booth that utilizes the unique characteristics of the recovered plate glass, offering new value for recycled materials. This initiative opens the way for the creation of sustainable office and public spaces that are both aesthetically pleasing and environmentally friendly, providing users with a new value experience that fuses social contribution and design. Marking the first time that plate glass recovered from photovoltaic panels has been reused in office furniture without first being crushed,[*4] the initiative is expected to reduce waste and cut CO_2 emissions by up to 50% compared to manufacturing new glass, propelling the creation of sustainable social infrastructure. Looking ahead to commercialization, the three companies will work with partners in office furniture, building materials, and a range of other fields to build supply chains, consider business models, and further standardize quality verification and evaluation technologies so as to accelerate the realization of a carbon-neutral circular economy.

*1 Upcycling: Added-value recycling of products that would otherwise be thrown away; also known as "creative reuse."

*2 Cracks: Minute cracks or dents on the glass surface caused by flying debris hitting a photovoltaic panel.
*3 Alkaline elution: The phenomenon whereby sodium and other alkaline components on the glass surface dissolve when exposed to water or alkaline solutions during long-term outdoor use.
*4 Research by Hitachi, Itoki, and Tokuyama (as of August 2025).

Background and issues

With mass disposal of end-of-life photovoltaic panels expected to increase as of the 2030s—reaching up to 500,000 tons per year in Japan—the European Union and countries around the world are moving preemptively to institute mandatory recycling and strict disposal regulations. As the plate glass used in photovoltaic panels accounts for approximately 60% of their weight, the high-value-added reuse of that glass will be crucial in boosting photovoltaic panel recycling rates. Currently, methods for crushing the glass for use as roadbed material[*5] or glass raw material are being considered. The direct upcycling of plate glass has the potential to create new value, but reusing it without evaluating quality degradation such as the cracks and alkaline elution that occur during long-term outdoor use have presented safety and durability challenges.

To address these challenges, Hitachi, Itoki, and Tokuyama began joint research in September 2024, launching a new initiative to reuse plate glass recovered from photovoltaic panels directly as furniture components.

*5 Roadbed material: Material laid beneath the surface and base layers in road pavement structures to boost road strength, durability, and stability

Features of the technologies and solutions developed to solve the issues

The features of the technologies and solutions developed by the three companies for the safe direct reuse of high-quality plate glass recovered from photovoltaic panels are as follows:

1. Low-temperature thermal decomposition for efficient recovery of high-quality plate glass
Through joint research with the New Energy and Industrial Technology Development Organization (NEDO), Tokuyama has established a technology that uses its unique low-temperature thermal decomposition for high-quality recovery of the plate glass, cells, and interconnectors that make up used photovoltaic panels.[*6] By optimizing the thermal decomposition conditions and treatment process, the company has succeeded in turning the main components into raw materials (open-loop recycling and horizontal recycling). By identifying issues that must be resolved to enable direct recycling of plate glass into products, as well as reflecting these findings in quality control and treatment processes, it will be possible to supply higher-quality components.

*6 Development of a recycling technology for photovoltaic cell modules using low-temperature thermal decomposition (July 2019–March 2025)

2. Nondestructive strength estimation technology that accounts for deterioration factors
Hitachi has developed a technology to estimate the strength of recovered glass. In addition to comprehensive evaluation of the impact on glass strength of cracks and alkaline elution as factors causing glass degradation, the technology also features image processing that determines degradation factors. This enables the recovered glass to be upcycled while ensuring its safety and durability. Hitachi is also pursuing a range of other initiatives, such as the creation of a recycled materials marketplace,[*7] development of upcycling technologies,[*8] and formulation of a grand design at the H-AIST CE Lab.[*9] In conjunction with these activities, Hitachi aims to implement its nondestructive strength estimation technology as One Hitachi, expand its lineup in the recycled

materials marketplace, and help realize a harmonized society in which the environment, happiness, and economic growth are in balance.

*7 "Hitachi and SEKISUI CHEMICAL Completed Proof of Concept for 'Marketplace System for Recycled Materials' Which Accelerate the Use of Recycled Materials," news release, June 5, 2024.
*8 "Development of a Smart Remanufacturing Solution for the Upcycling of Used Products," *Hitachi Review*.
*9 Hitachi-AIST Circular Economy Cooperative Research Laboratory.

3. Creation of a prototype video conferencing booth that leverages the unique characteristics of recycled glass

Itoki has created a prototype video conferencing booth that uses recovered glass, retaining its minute irregularities, as a material to help ensure privacy. Because recovered glass is not particularly thick and comes in uneven sizes, Itoki approached the issue of efficient reuse by laminating the glass for safety and redesigning the panel structure to maintain strength by mixing glass and steel surfaces. Proposing new value for these and other recycled materials also helps in raising awareness of the SDGs.*10 The prototype's tabletop material and sofa upholstery use other upcycled materials that Itoki has been working, as well.

Prototype video conferencing booth that reuses glass recovered from photovoltaic panels (interior)

*10 SDGs: United Nations Sustainable Development Goals

Confirmed effects

By estimating the strength of the recovered glass and processing it into laminated glass, it was confirmed that the glass could be used as a component for office furniture. Furthermore, it was estimated that CO_2 emissions could be reduced by up to 50% compared to manufacturing new glass.*11

*11 The CO_2 emission reduction effect was calculated by comparing the production of new laminated glass with the production of laminated glass using recovered glass. In the case of new production, the process consists of raw material extraction, glass production, interlayer film production, lamination, and the associated transportation. In the case of this initiative, the process comprises glass separation, interlayer film production, lamination, and the associated transportation. The calculation assumes that the transportation distances associated with common processes are the same. This initiative cuts out the CO_2-heavy parts of the manufacturing process related to raw material extraction and glass production, leading to an estimated CO_2 reduction effect of approximately 50%. The emission factors for CO_2 emissions are based primarily on the AIST-IDEA database and the Ministry of the Environment's list of emission factors (in Japanese).

Looking ahead

Going forward, the three companies will work with partners in office furniture, building materials, and a variety of other fields to build supply chains, consider business models, and further standardize quality verification and evaluation technologies so as to meet the needs of the many

customers seeking the development of sustainable products. They will also call for cross-industry co-creation and standardization in an effort to expedite the realization of a sustainable and carbon-neutral circular society and foster recycling in expanded applications.

Some of the initiative's results will be presented at the Mining and Materials Processing Institute of Japan (MMIJ) Fall Meeting 2025, scheduled to be held at Hokkaido University on September 2–4, 2025.

About Hitachi, Ltd.

Through its Social Innovation Business (SIB) that brings together IT, OT(Operational Technology) and products, Hitachi contributes to a harmonized society where the environment, wellbeing, and economic growth are in balance. Hitachi operates globally in four sectors – Digital Systems & Services, Energy, Mobility, and Connective Industries – and the Strategic SIB Business Unit for new growth businesses. With Lumada at its core, Hitachi generates value from integrating data, technology and domain knowledge to solve customer and social challenges. Revenues for FY2024 (ended March 31, 2025) totaled 9,783.3 billion yen, with 618 consolidated subsidiaries and approximately 280,000 employees worldwide. Visit us at http://www.hitachi.com.

About Itoki Corporation

Itoki Corporation was founded in 1890. With a mission statement of "We Design Tomorrow. We Design WORK-Style.," the company supports the creation of a variety of spaces, environments, and places by leveraging its strengths in "Tech × Design based on PEOPLE," including office furniture manufacturing and sales, office space design, work-style consulting, and office data analysis services, as well as furniture for remote work and home study and equipment for public and logistics facilities.

In recent years, the company has made employee engagement a key management indicator and is working to maximize its human capital through a variety of efforts, mainly by investing in its office environments, strengthening internal communication, and promoting diversity, equity, and inclusion. In addition, the company aims to realize its vision of "Vibrant People, Beautiful Planet" by developing environmentally friendly and sustainable products and promoting a circular society, among other efforts.

About Tokuyama Corporation

Tokuyama Corporation was founded in 1918 in Tokuyama (now Shunan), Yamaguchi Prefecture, with the aim of establishing domestic production of soda ash, an area that was at the time dependent on imports. In addition to traditional basic materials such as chemicals and cement, the company is now focusing on the electronic and advanced materials segment, including polycrystalline silicon for semiconductors, and the life science segment, including photochromic materials for eyeglass lenses and dental materials and equipment. Tokuyama is also expanding into eco-business, developing recycling technologies for waste gypsum board and used photovoltaic panels. For more information, please visit the Tokuyama Corporation website at https://www.tokuyama.co.jp/eng.

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