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News Release

June 15, 2023

Graduate School of Frontier Sciences, The University of Tokyo
Musashino University
Sumitomo Realty & Development Co., Ltd.

Promoting Decarbonization and Achieving Green Transition through Renovations of Detached Houses

Joint Research on Decarbonization Through Renovations by The University of Tokyo, Musashino University, and Sumitomo Realty

Verifying the adoption of ZEH and achievement of life cycle carbon neutrality through renovations

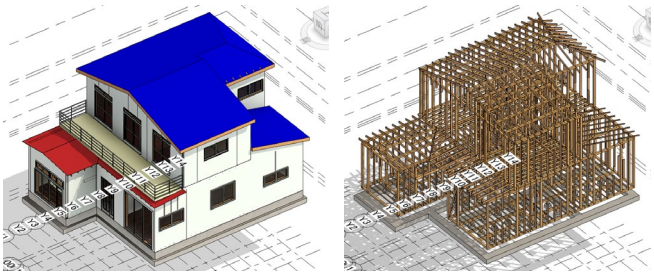
Since December 2021, Professor Tsuyoshi Seike from the Graduate School of Frontier Sciences at The University of Tokyo, Lecturer Takayuki Isobe from the Department of Sustainability Studies at Musashino University, and Sumitomo Realty & Development Co., Ltd. (President: Kojun Nishima) have been conducting joint research, aiming at establishing an environmental evaluation method for the renovations of existing detached houses towards the realization of a decarbonized and circular society.

As an interim target towards carbon neutrality by 2050, the household sector is urgently required to reduce CO_2 emissions by 66% compared to fiscal 2013 by 2030. While discussions on environmental performance measures and government subsidy schemes for newly constructed houses are progressing, little progress has been made in discussion toward promoting energy savings or decarbonization for existing houses, most of which have inferior energy efficiency performance to newly constructed houses.

Following last fiscal year's announcement, we are pleased to announce the verification results on the effects of renovation for extending useful lives of existing detached houses, as well as the adoption of ZEH and achievement of life cycle carbon neutrality through renovations measured using the Building Life Cycle Assessment method*.

* Building Life Cycle Assessment method: A method of evaluating the total environmental impact over the lifespan of a building by considering the environmental load at each stage, from construction and residency to disposal.

Structural frame being reused



BIM 3D Model of a sample house

◆ Key Points of the Research Findings

- **<u>A prototype of a quantitative evaluation tool has been completed for measuring the resource recycling and decarbonization effects of housing renovations.</u>**
- **The research has demonstrated that through renovation, <u>improving insulation and equipment performance as well as installing solar power generation equipment,</u> the adoption of ZEH (Net Zero Energy House) and life cycle carbon neutrality could be achieved without the need for special construction work.**
- **The research has demonstrated that through renovation, which is more resource-saving and low on CO_2 emissions compared to rebuilding, <u>life cycle carbon neutrality could be achieved more rapidly than through rebuilding.</u>**
- **By tracing the past construction cases of "Shinchiku Sokkurisan," which has conducted more than 160,000 renovation projects over the 27 years since 1996, <u>the research confirmed the lifespan extension effects of renovated houses.</u>**

■ Background and Purpose of the Joint Research

For decarbonization in the household sector to achieve carbon neutrality by 2050, effective approaches are needed not only for newly constructed houses but also for existing houses, most of which have inferior energy efficiency. However, there have been few studies quantifying the contribution to decarbonization through the renovation of existing houses, and there has been a strong demand for establishing an environmental evaluation framework for the renovation of existing houses based on scientific methods, from the perspective of policy and system formulation.*

Under such circumstances, the University of Tokyo Graduate School and Musashino University requested research cooperation from Sumitomo Realty, which has a broad-ranging track record from partial to full remodeling. With our full cooperation in performing studies at our worksites and data provision, research began in December 2021.

In this research, under industry-academia collaboration, we aim to develop a method for evaluating the environmental contribution of renovations, which will serve as the basis for a system to promote the decarbonization of existing detached houses, a social issue, and to establish an evaluation framework.

*** Government's Initiatives Towards Decarbonization of Existing Houses (Examples)**

- Three ministries, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport and Tourism, and the Ministry of the Environment, together formulated the approach for energy-saving measures, etc. in housing and buildings towards a decarbonized society. It outlines the national decarbonization policy for buildings and explicitly states the need to develop methods and evaluation techniques for rationally and efficiently assessing energy efficiency performance before and after renovation.
- Government projects were set up to provide subsidies for partial improvements in energy efficiency, such as equipment updates and heat insulation on exterior walls and windows.
- Our project to establish a CO_2 evaluation system for existing detached houses (for renovation) has been selected for a subsidy by the Ministry of Land, Infrastructure, Transport and Tourism's as part of their program to promote innovation in housing production technology.

Since renovating existing houses promotes resource circulation, it has the potential to contribute to decarbonization ➡ **However, little research has been conducted to evaluate the decarbonization effects of renovation, and there are no frameworks for quantifying its contributions** ➡ **It is urgent to establish quantitative methods for evaluating resource circulation and decarbonization effects**

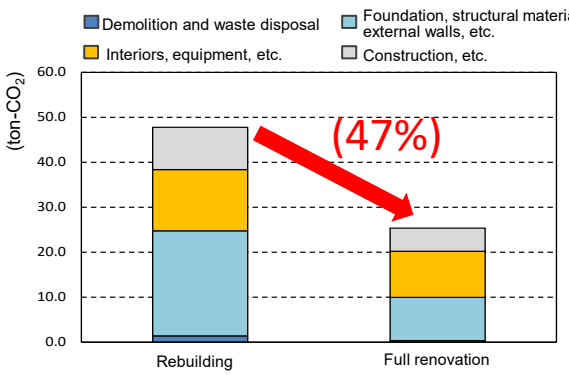
◆ Three-phase Verification of Issues

Phase 1	Verify the CO_2 emissions reduction effects of existing detached house renovations
Phase 2	Verify the building lifespan extension effects of existing detached house renovations
Phase 3	Verify the adoption of ZEH and achievement of life cycle carbon neutrality through existing detached house renovations

Phase 1 (Research findings announced in June 2022)

Comparison of CO_2 emissions from rebuilding and renovation, related to the amount of construction resources and waste disposal from existing detached houses

➡ CO_2 emissions from renovation were 47% lower than emissions from rebuilding

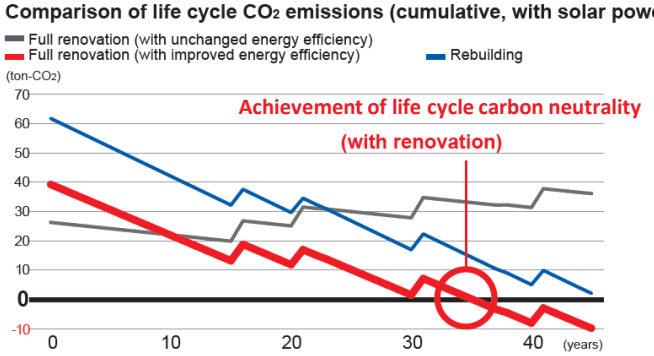


Phase 2 and 3 (Research findings announced in June 2023, details are on the next page)

- **Verify the building lifespan extension effects of existing detached house through renovations**
- **Verify the adoption of ZEH and achievement of life cycle carbon neutrality through renovations**

➡ Life cycle carbon neutrality can be achieved through full renovations (with improved energy efficiency) in roughly 35 years, which is faster than through rebuilding

Comparison of life cycle CO_2 emissions (cumulative, with solar power)



* Measurements performed on houses constructed or renovated by Sumitomo Realty

(Reference: News Release) The University of Tokyo, Musashino University, and Sumitomo Realty Announce the Results of Their Research on Decarbonization Through "Shinchiku Sokkurisan" Building Renovation (June 16, 2022)

■ Life Cycle Carbon Neutrality through Renovations

◆ Structure of Life Cycle Carbon Neutrality

I. CO_2 emissions during renovation work … (1)
(renovation work + demolition work)

II. CO_2 emissions during residency … (2), (3)
(during residency)

III. Life Cycle CO_2 emissions … (4)
(renovation work + demolition work + during residency)

IV. Life Cycle Carbon Neutrality … (5)
(renovation work + demolition work + during residency - power generation effect)

◇ Cases Compared

A) Full Renovation (with unchanged energy efficiency)

The existing house is stripped down to its main frame and renovated into a house equipped with:

- Unchanged level of insulation and energy efficiency
- Approximately 7.5kW solar panels

B) Full Renovation (with improved energy efficiency)

The existing house is stripped down to its main frame and renovated into a house equipped with:

- Grade 4 insulation, energy efficiency equivalent to ZEH
- Approximately 7.5kW solar panels

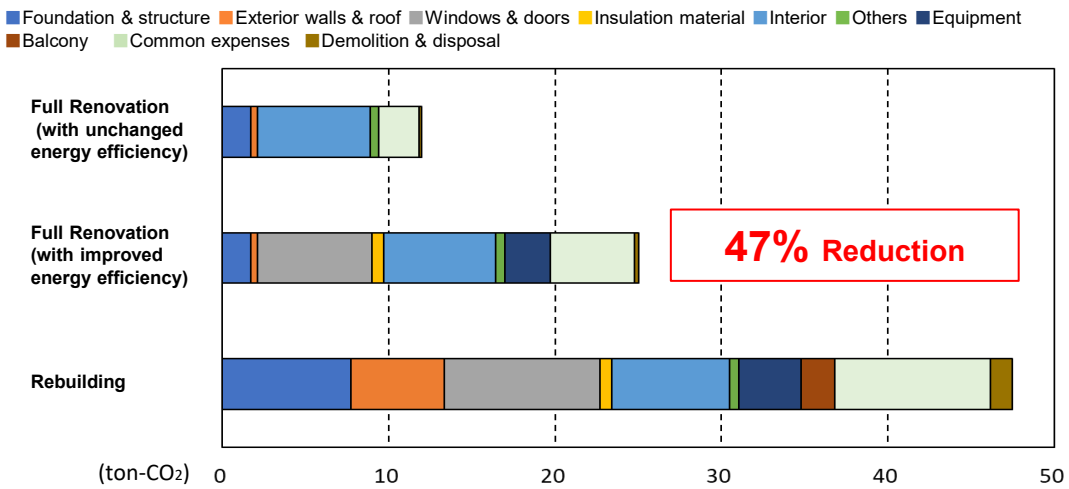
C) Rebuilding

The existing house is dismantled down to an empty lot, and a new house is built equipped with:

- Insulation and energy efficiency equivalent to ZEH
- Approximately 7.5kW solar panels

(1) CO_2 Emissions During Renovation Work (from the FY2021 research results)

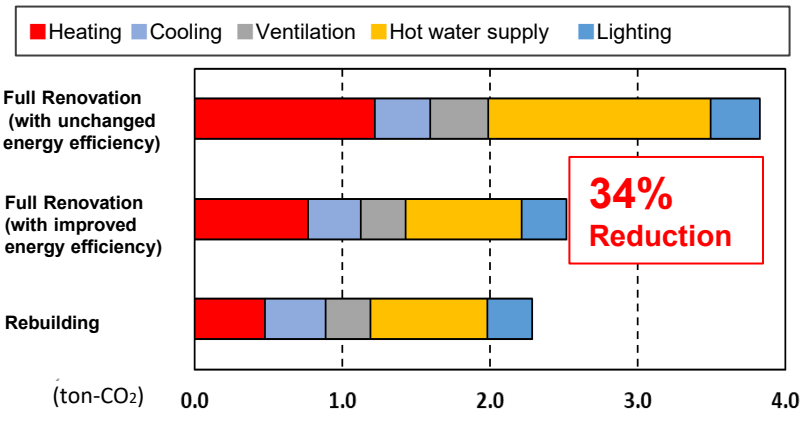
The amount of CO_2 emissions from renovation and demolition work depends on the amount of new materials used and waste generated. Therefore, "Full Renovation (with improved energy efficiency)" emits less CO_2 than "Rebuilding," and even with the addition of energy efficiency improvements equivalent to a newly constructed house such as improved insulation and equipment performance, CO_2 emissions can be reduced by 47%.



(2) CO_2 Emissions During Residency

The amount of CO_2 emissions generated during residency can be significantly reduced by improving insulation and equipment performance.

Compared to "Full Renovation (with unchanged energy efficiency)", "Full Renovation (with improved energy efficiency)" can reduce CO_2 emissions by about 34% by improving energy efficiency to the level of newly constructed house, and affects the CO_2 emissions during residency over the long term.



(3) Extending Useful Lives of Existing Houses through Renovations

By replacing aging components through renovation, the building performance such as seismic resistance improves, and its useful life is extended. When considering the life cycle CO_2 of renovated houses, the extended useful life contributes to the overall reduction of CO_2 emissions.

Through this research, we confirmed that the majority of the houses renovated more than 20 years ago are still standing at present. Of those no longer standing, it is assumed that demolition due to aging is limited, as the samples are in Tokyo where many houses are demolished in the process of urban development such as condominium development.

Study Samples

Out of the 160,000 houses we renovated in the past, 3,702 that underwent full renovation more than 20 years ago were chosen. Of these, nearly 500, which accounts for the total number within the top five wards in Tokyo in terms of construction number, were selected as samples and studied.

◇ **Sampling Conditions**

- **Renovation completed before 2001**
- **Detached house**
- **Fully renovated**
- **The property address can be obtained**

Study Method

The building useful life extension effect was verified following two studies described below:

(i) Document study
(ii) Exterior study

(4) Life cycle CO_2 Emissions

By summing up the emissions from (1) and (2), and comparing the life cycle CO_2 emissions of a house under the premise of (3), "Full Renovation (with unchanged energy efficiency)" which has the least CO_2 emissions at the time of construction, emits the least CO_2 for the first 10 years following the renovation. On the other hand, after 10 years, "Full Renovation (with improved energy efficiency)" which emits less CO_2 at the time of construction than "Rebuilding" and improves insulation performance to the level comparable to a newly constructed house, resulted in emitting the least CO_2.

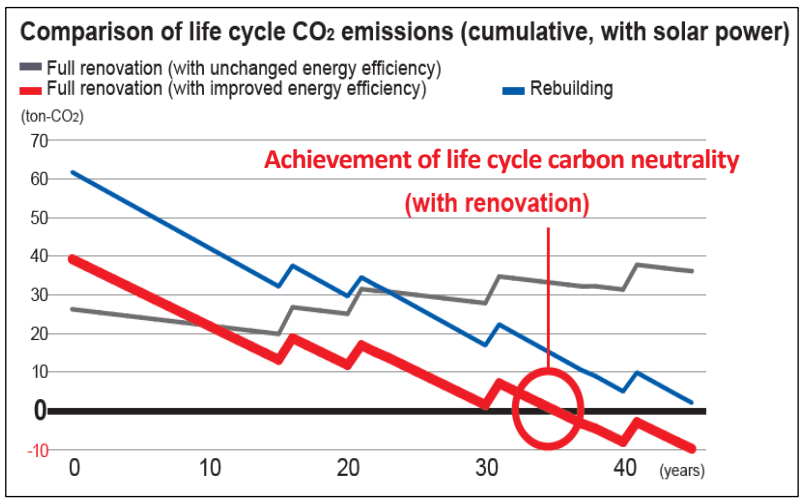
◆ **Comparison of Life Cycle CO_2 Emissions**

(ton-CO_2)	Full Renovation (with improved energy efficiency)	Rebuilding	Full Renovation (with unchanged energy efficiency)
At the time of renovation	25	46	12
10 years	52	72	52
20 years	84	102	98
30 years	117	132	143

(5) Achievement of Life Cycle Carbon Neutrality

When the effect of solar power generation is added to (4), in houses with high energy efficiency, the amount of energy generated is larger than the amount of energy consumed during residency, and the annual CO_2 emissions becomes negative.

As a result, the CO_2 emissions from "Rebuilding" and "Full Renovation (with improved energy efficiency)" decrease, while the CO_2 emissions from "Full Renovation (with unchanged energy efficiency)," which has inferior insulation and energy efficiency, increase over the long term. When all factors are considered, "Full Renovation (with improved energy efficiency)" can achieve life cycle carbon neutrality earlier than the other two.



■ Joint Researchers

Tsuyoshi Seike – Professor, Graduate School of Frontier Sciences at The University of Tokyo

Tsuyoshi Seike graduated from the Department of Architecture in the Faculty of Engineering at The University of Tokyo in 1987. He worked as a Research Associate in the Department of Architecture before joining the Graduate School of Frontier Sciences in 1999.

He engages in research in renovation/demolition technologies, recycling technologies, and environmental evaluation systems, from the viewpoints of building production and the environment.

He is the development leader for CASBEE for Detached Houses, and plays a central role in creating health checklists and resilient house checklists.

His publications include *Sustainable Housing* (editorial supervisor and co-writer), *Creating Facades* (co-writer), and *Rethinking Living Environments - From Smart to Healthy* (co-writer).

Takayuki Isobe – Lecturer, Department of Sustainability Studies in the Faculty of Engineering at Musashino University

Takayuki Isobe received his Doctorate from the Graduate School of Frontier Sciences at The University of Tokyo in 2015. In 2016, he was appointed to the Department of Environmental Systems Sciences in the Faculty of Engineering at Musashino University.

He was appointed to the Department of Sustainability Studies in the Faculty of Engineering at Musashino University from 2023.

His research has focused primarily on environmental evaluation systems that relate to the recycling of construction materials and building life cycle (construction, usage, and disposal) environments.

He served as the director of the LCA Subcommittee within the Research Committee on Global Environment in the Architectural Institute of Japan until March 2023.

He is currently the organizer of the same committee.

Sumitomo Realty & Development

Sumitomo Realty & Development Co., Ltd.

Sumitomo Realty has been working to solve social issues through its business activities under its fundamental mission to "Create even better social assets for the next generation."

Going forward, the Company will further contribute to realizing a sustainable society by creating high-value social assets with environment and social awareness.

◆ Sumitomo Realty's initiatives on ESG and SDGs
https://www.sumitomo-rd.co.jp/english/sustainability/

* The initiatives related to this release contribute to the following SDGs objectives:

Goal 3: Good health and well-being
Goal 7: Affordable and clean energy
Goal 9: Industry, innovation and infrastructure
Goal 11: Sustainable cities and communities
Goal 12: Responsible consumption and production
Goal 13: Climate action
Goal 15: Life on land

<Reference> "Shinchiku Sokkurisan" Remodeling by Sumitomo Realty

In response to the devastating Great Hanshin-Awaji Earthquake of 1995, the Shinchiku Sokkurisan remodeling business was launched with the desire to find a way to renovate detached houses to make them earthquake resistant without the high cost of rebuilding. Based on our concept of providing safe and secure housing, we have established a groundbreaking business model in the industry, offering full remodeling at 50-70% of the price of rebuilding, featuring seismic reinforcement and a fixed price system free of additional costs.

By leaving main structural components intact and utilizing existing materials such as foundations and main frames, we have been able to reduce construction costs, reinforce seismic resistance and thermal insulation, and enhance safety and comfort. We have handled more than 160,000 units (as of the end of March 2023) of such "full remodeling."

Before

During renovation work
(Interior stripped down to its main frame)

After

We are also actively working to further promote decarbonization of existing houses. In December 2021, we began offering **"High-Thermal Insulation Remodeling Plan"** to improve energy-saving of existing houses, and in April 2022, we started offering **"SUMIFU x ENEKARI,"** which enables customers to install solar panels and storage batteries at zero initial cost, together with renovation.

"Shinchiku Sokkurisan" high thermal insulation remodeling and SUMIFU x ENEKARI

Promotion of decarbonization through renovation to safe, secure and energy-efficient housing

In our Shinchiku Sokkurisan remodeling business, in addition to seismic reinforcement for the peace of mind, we promote the extension of the useful life of existing houses by renovating them into environmentally friendly and comfortable houses with excellent energy-saving performance. We have also begun providing the following new services that contribute to the decarbonization of the housing stock of over 50 million units in Japan, which the Japanese government has recognized as an issue.

High Thermal Insulation Remodeling Plan (Began accepting orders in December, 2021)
Remodeling plan available to the entire house or even to individual rooms, ensuring the thermal insulation performance equivalent to the energy conservation standards* for newly-built houses
*Compliant with 2016 energy-saving standards

Shinchiku Sokkurisan and SUMIFU x ENEKARI (Began accepting orders in April, 2022)
Seismic reinforcement (Shinchiku Sokkurisan) for the peace of mind, combining a new solar power generation service (SUMIFU x ENEKARI) which enables installation of solar panels and storage batteries at zero initial cost

We will continue to promote the provision of housing that contributes to the decarbonization with a safe and comfortable living environment.

<Related News Releases>

■Remodeling to Meet Energy Conservation Standards for Newly-Built Houses High Thermal Insulation Remodeling Plan by Shinchiku Sokkurisan Launched Nationwide (December 10, 2021)

■Shinchiku Sokkurisan Remodeling Business to Start Offering SUMIFU x ENEKARI, a Solar Power Generation Service that Delivers Continuous Peace of Mind (April 4, 2022)

<Reference> Initiatives of the "Shinchiku Sokkurisan" Business

Social issues concerning houses in Japan

1. Insufficient earthquake resistance and thermal insulation
2. Environmental impact from waste generated when rebuilding
3. Insufficient thermal insulation causing increased energy consumption

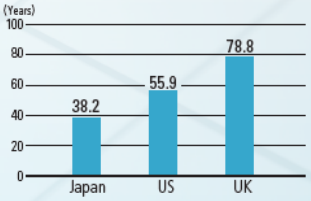
Through the Shinchiku Sokkurisan remodeling

- **Realizing extended useful life**
  Earthquake-proofing and seismic retrofitting
  Revised floor plans to suit lifestyles
- **Reduced environmental impact**
  Reduction of materials used and waste generated
  Installation of solar power generator and reduction of energy consumption by improving thermal insulation performance

Although the penetration rate of earthquake resistant houses in Japan is increasing every year, there are still many housing stocks with low earthquake resistance. In addition, the rebuilding cycle in Japan is short compared with that in Europe and the U.S., and waste from the demolition of houses accounts for a large share of waste discharged by the construction industry. There are growing calls for shifting to a stock-type society by extending the useful life of housing.

Moreover, although discussions have been carried out on various topics for newly constructed detached houses, such as improving their environmental performance toward the realization of carbon neutrality in 2050, little progress has been made toward promoting energy savings or decarbonization for existing houses, which far outnumber new houses (there are currently roughly 50 million existing houses). As such, dealing with existing detached houses, which account for a large percentage of Japanese housing stock, will be essential for Japan's decarbonization.

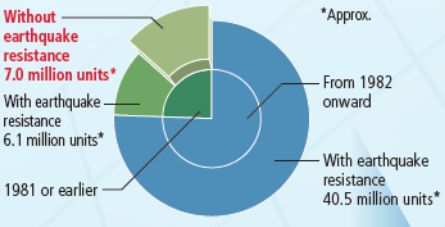
International comparison of the average age of houses



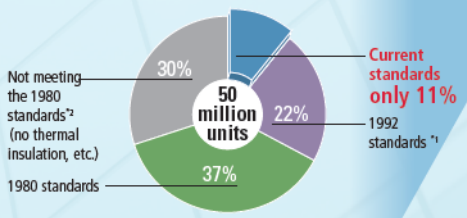
Source: *Housing Economics Data: International Comparison of Average Age of Houses Deregistered (2021)*, Ministry of Land, Infrastructure, Transport and Tourism.

Social issues concerning houses in Japan

1 Earthquake-resistance of housing stock

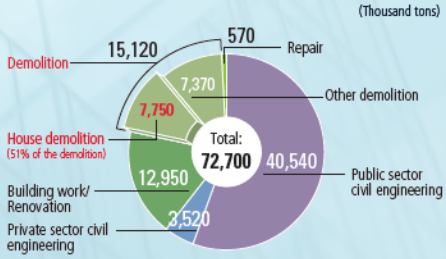


2 Energy-saving standards (thermal insulation performance) of housing stock (about 50 million units)



*1: Standard established in 1992, pursuant to the Act on Rationalizing Energy Use
*2: Standard established in 1980, pursuant to the Act on Rationalizing Energy Use

3 Breakdown of construction waste



Shinchiku Sokkurisan initiatives

1 Extending the useful lives of houses through seismic reinforcement and revision of floor plans

Shinchiku Sokkurisan offers proposals mainly for seismic reinforcement work that meets the government's safety standards, based on earthquake resistance diagnosis. Moreover, in preparation for increasingly severe earthquakes, we have developed a new proprietary method and provide optimal seismic reinforcement and damping plans for houses of all ages.

In addition to functional improvements, we offer solutions reflecting customers' lifestyles such as changes in family structure and aging by layout changes, extensions, downsizing and transforming the house into a two-family house. In this way, we are promoting extended useful lives of houses without rebuilding.

2 Improvement of thermal insulation of existing houses and promotion of installation of solar power generation systems

We began accepting orders for a high thermal insulation remodeling plan that enables existing houses with low thermal insulation performance to achieve a thermal insulation performance equivalent to the energy conservation standards for newly-built houses. This plan is available to the entire house or even to just individual rooms, enabling an increase in the thermal insulation performance only where it is necessary. In addition, we have begun offering "SUMIFU x ENEKARI" to install solar power generation equipment at zero initial cost, together with seismic reinforcement. Through these new services, we will further contribute to the realization of a carbon neutral society by reducing CO_2 emissions from housing.

3 Reduction of environmental load through waste reduction

Shinchiku Sokkurisan remodeling contributes to the reduction of the environmental burden through seismic reinforcement while the principal structural elements of the house are retained, thus minimizing industrial waste discharge, CO_2 emission, and waste of resources, compared to the demolition involved in building a new house.

Release of results of joint research on the decarbonization effect of building renovation

Reducing CO_2 emissions by 47% compared with rebuilding while improving the building performance

With the aim of establishing a new environmental evaluation method for building renovation, we started a joint research with The University of Tokyo and Musashino University in December 2021. The research results found that for detached houses in which full renovation was performed and significantly improved building performance (earthquake resistance, thermal insulation performance, etc.), the reuse of foundations, main frames, etc. dramatically reduced the amount of new materials used compared to rebuilding the entire building, and cut CO_2 emissions by 47%. We will continue this research with the aim of further contributing to decarbonization and realization of a stock-type society.

Sources: 1. *Progress of Earthquake Proofing of Houses (2018)*, Ministry of Land, Infrastructure, Transport and Tourism.
2. *Housing Economics Data: Performance of Housing Stock (Barrier-Free and Energy-Saving) (2021)*, Ministry of Land, Infrastructure, Transport and Tourism.
3. *Status of Industrial Waste Associated with Demolition of Houses (36th Meeting of the Housing and Building Land Committee of the Panel on Infrastructure Development)*, Ministry of Land, Infrastructure, Transport and Tourism.