Sekisui Heim Smart Houses: Latest technology trends

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1. Introduction

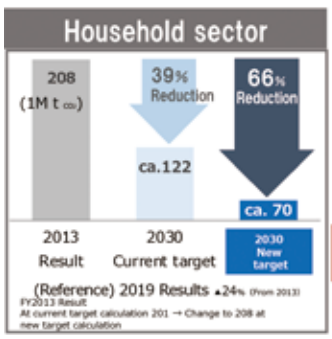
As of November 9, 2021, 144 countries, including Japan, have pledged to achieve carbon neutrality by 2050. In April 2021, Japan declared that it would aim to "reduce its greenhouse gas emissions by 46% in 2030 compared to the level in 2013 and continue its efforts to meet the lofty goal of cutting its emission by 50%" at the meeting of Japan's Global Warming Prevention Headquarters, as well as at the 2021 Leaders' Summit on Climate. In particular, the target set for the household sector is the highest among all sectors at about 66% (Figure 1). Energy-saving measures in the household sector include improving insulation performance, improving the efficiency of equipment through the Top Runner Program, and providing information on energy-saving equipment and energy-saving measures. Japan is also promoting the construction of net zero energy buildings (ZEB) and net zero energy houses (ZEH), which are designed to reduce the annual primary energy consumption to net zero through the use of solar power and other renewable energy sources. In addition to energy conservation through solar power generation and high thermal insulation, the government is also urging captive consumption through the introduction of storage batteries, electric vehicles (EVs), and heat pump water heaters to improve grid stability and resilience for renewable energy, which fluctuates depending on the weather, and provide added value to residents (according to the Sixth Strategic Energy Plan (Draft) announced on July 21, 2021).

2. Sekisui Heim Deployment Achievements

Given this situation, Sekisui Chemical has placed priority on the resolution of environmental and other social issues and the establishment of a solid management foundation as the drivers of future business growth through its Sekisui Heim brand of houses, promoting ESG management by balancing customer value and business value. To achieve a balance between economic efficiency and environmental friendliness, the company has been proactively proposing the use of photovoltaic power generation systems (hereafter referred to as "PV") in its houses since 1997. In 2012, it launched the "Smart Heim" house equipped with PV, home energy management system (HEMS), and household storage battery. Further, in 2018, it adopted the ZEH standard as the standard specification for its houses. In particular, 『ZEH』 (ZEH with square brackets), which ranks highest in terms of environmental contribution among its ZEH lineup, has been the most popular among house owners (Figure 2).

Sekisui Chemical has been promoting the use of renewable energy in detached houses for 25 years, providing a total of more than 229,000 PV houses*1 since 1997 (Figure 3). The total installed PV capacity has reached more than 1.25 M kW*2, with a total annual power generation equivalent to the annual electrical energy consumption*3 of municipalities with a population of 500,000 (e.g., Tottori Prefecture and Hachioji City, Tokyo). This has resulted to reduction in CO_2 emissions by approximately

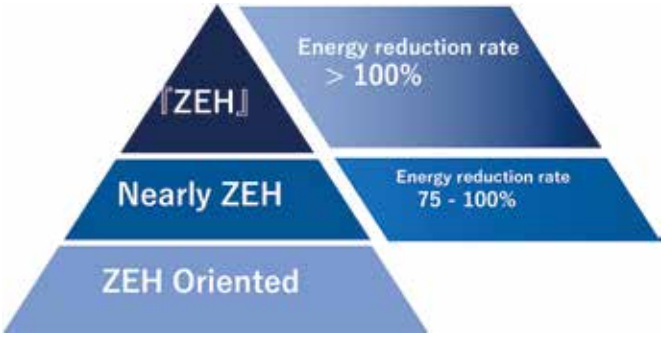
Figure 1: CO_2 reduction targets in the household sector
Reference: "Plan for Global Warming Countermeasures" (Draft) published July 26, 2021



(Reference) Sectoral CO_2 emissions reduction targets

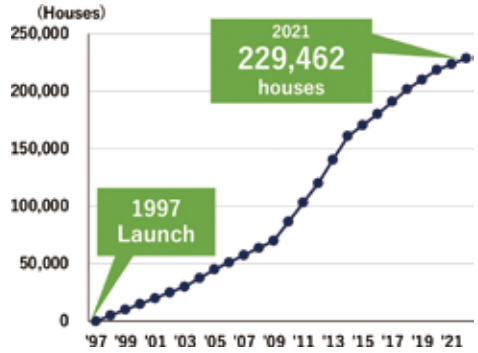
Unit [1M t CO2]	FY2013 Results	FY2030 Targets	Reduction rate
Industrial sector	463	ca. 290	ca. 37%
Service sector	238	ca. 120	ca. 50%
Household sector	208	ca. 70	ca. 66%
Transport sector	224	ca. 140	ca. 38%

Figure 2: ZEH categories

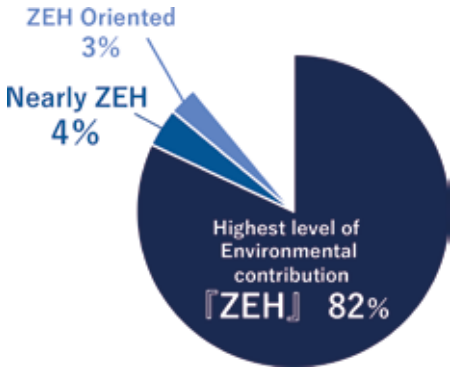


*1 Number of PV houses sold, including new and renovated units, as of the end of March 2022 (based on our research).
*2 Total installed PV capacity for all PV contracts, including new and renovated units, up to FY2021 (based on our research).
*3 Electrical energy consumption was calculated from the national average in the "Household Energy Consumption (FY17)" report by the Ministry of the Environment. (Energy consumption does not include gas or kerosene usage.)

■ Figure 3: Cumulative number of Sekisui Heim houses equipped with PV



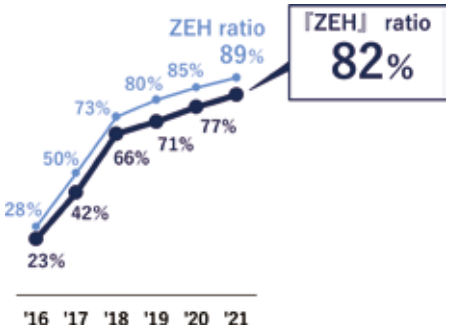
■ Figure 5: Sekisui Heim ZEH deployment record (FY2021)



386,000 tons per year*4, which is equivalent to CO_2 absorption by approximately 27 million cedar trees*5 and to afforestation of more than 31,000 hectares of land, an area similar to the artificial forest area in Tokyo (ca. 35,000 hectares)*6.

Along with the uptake of PV, early on, we have focused on the spread and promotion of ZEH. Performance equivalent to the highest rating (ZEH level) for the thermal insulation performance rating and primary energy consumption rating, which were newly established in April 2022 under the Housing Performance Indication System, has been incorporated as part of the standard specifications of Sekisui Heim houses in 2018*7. Recognizing at the outset the growing need for energy conservation in the future, we have continued to propose ZEH to our customers. In particular, we are focusing on the promotion of 『ZEH』, which ranks highest in the ZEH series in terms of environmental contribution, setting a record high of 82%*8 deployment ratio for 『ZEH』 in FY2021. The overall deployment ratio for ZEH*9 was 89% (Figures 4 and 5).

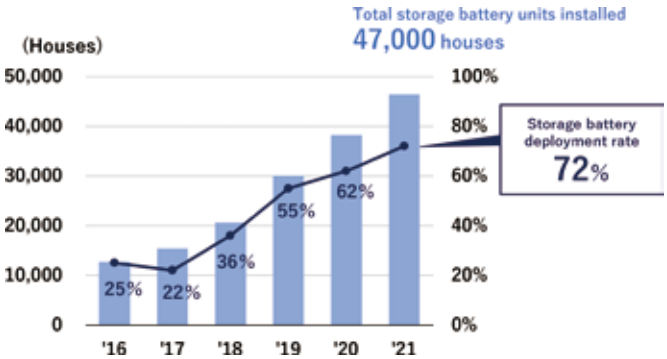
■ Figure 4: Trends in Sekisui Heim ZEH deployment ratios



『ZEH』 is designed to reduce primary energy consumption by 100% or higher than the standard primary energy consumption*7, in addition to use of PV and other renewable energy sources, whereas "Nearly ZEH" is designed to reduce primary energy consumption by 75% or higher, and "ZEH Oriented" by 20% or higher, excluding use of renewable energy.

Also, we are actively working to develop and popularize "energy self-sufficient houses"*10 equipped with storage batteries in response to rising energy prices and supply instability, as well as to enable resilience against frequent natural disasters. The storage battery deployment ratio in sales of newly built detached houses increased for the fourth consecutive year, reaching 72% in fiscal 2021 at 47,000 houses in total*11 (Figure 6). Going forward, we will continue to promote the uptake of "energy self-sufficient houses" along with 『ZEH』.

■ Figure 6: Trends in storage battery deployment ratio and total installed units



*4 Our calculation was based on the installed PV capacity for all PV contracts, including new and renovated units, up to FY2021.
*5 Our calculation for cedar tree conversion was based on data from the Kanto Regional Forest Office.
*6 The artificial forest area in Tokyo was based on the Natural and Artificial Forest Ratios by Prefecture (as of March 31, 2017) published by the Forestry Agency (MAFF).
*7 Standard specifications were refined to meet the national ZEH external standard UA value of 0.6 or less (Regions 4 to 7). Depending on the plan, this may not be achieved if the openings are too large.
*8 『ZEH』 deployment ratio was aggregated based on the ZEH Builder reporting method.
*9 In addition to 『ZEH』, ZEH includes Nearly ZEH and ZEH Oriented models. ZEH deployment ratio was aggregated based on ZEH Builder reporting method.
*10 Not all the electricity can be supplied. There is still a need to purchase power from a utility company.
*11 This deployment ratio represents the contract-based deployment ratio for storage batteries (including V-to-H) from April 2021 to March 2022, and the cumulative number is the total number of houses sold, including new and renovated units, as of the end of March 2022 (based on our research).

3. Project with the Ministry of the Environment

The Ministry of the Environment implemented a project on "Development and Demonstration of Technologies Promoting CO_2 Emission Control Measures" in FY2021 (name changed to "Development and Demonstration of Carbon Neutral Technologies through Regional Co-Creation and Cross-Sectoral Collaboration" in FY2022), with priority theme (1) "Development, demonstration, and cost reduction of energy self-sufficient decarbonized housing modules for dealing with worsening disasters and infectious diseases." Under this project, the "Development and Demonstration of Energy Self-Sufficient Housing Units" Technology Development and Demonstration Theme presented by Sekisui Chemical Housing Company in collaboration with Nichicon Corporation, the Central Research Institute of Electric Power Industry (CRIEPI), and the University of Tokyo Institute of Industrial Science (IIS) was adopted by the Ministry of the Environment in April 2021 (Figure 7). As the representative business operator of this project, we started technological development together with the three collaborators in June 2021. With the "New Smart Power Station FR GREENMODEL" (hereinafter, "New Green Model") launched in October, we conducted evaluation and verification through test house users to further enhance and spread this technology for promoting energy self-sufficiency. Test houses based on the "New Green Model" released in October 2021 were also equipped with high-capacity PV, e-PocketGREEN (Tribrid Energy Storage System), HEMS, and ventilation and air conditioning systems for all rooms. Test house users have started to move in to the "New Green Model" houses from around April 2022. We have collected electricity data via HEMS starting with users that have already moved in and will interview and survey them after they have actually lived in the houses.

Achieving a decarbonized society by 2050 entails the active utilization of clean PV power and the promotion of an energy self-sufficient*10 lifestyle that avoids the purchase of electricity as much as possible. In this project, we will acquire and analyze data on the amount of electricity used in real life and determine how much reduction in CO_2 emissions can be achieved using houses equipped with high-capacity PV and with the high-capacity storage battery "e-PocketGREEN," which were developed to achieve this lifestyle. e-PocketGREEN has a storage capacity of 12 kWh, which is about twice the capacity of conventional storage batteries*12. It also enables high output (4 kVA) even in the event of a power outage. It uses a power conditioner with a Tribrid specification that enables linkage with the V-to-H system so that the combined use of EV further increases the power storage capacity. In both normal times and during power outages, power generated by the high-capacity PV can be stored and consumed independently (Figure 8). In addition, both the storage battery

Figure 8: Menu of systems installed at test houses and items for evaluation and demonstration

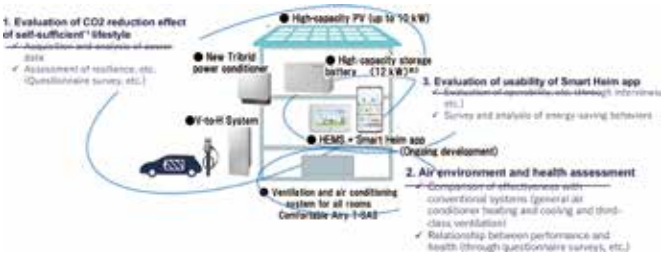
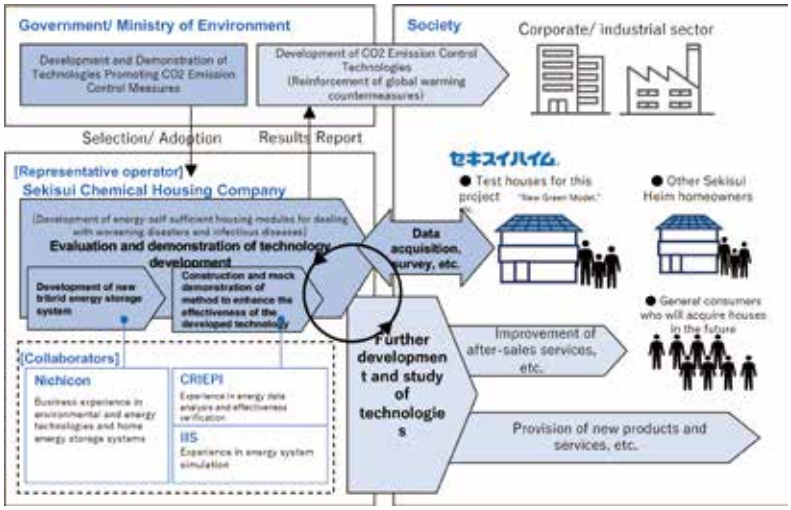


Figure 7: Evaluation and demonstration flow in the project and vision for future deployment



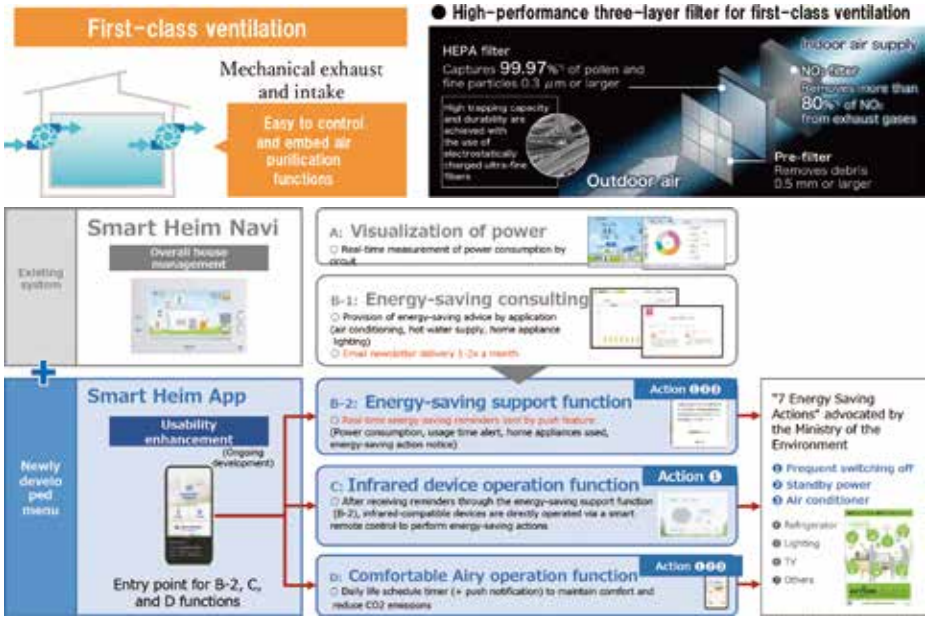
*12 Calculated from the storage capacity of the battery with the highest shipment volume, based on the "Net Zero Energy House Support Project Research Conference 2020" conducted by the Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI). Storage battery capacity of 12 kWh is the catalog value and is different from the actual usable capacity.

and power conditioner can be installed at high places to prevent damage from flooding. The V-to-H system enables saving space by separating the V-to-H stand and the V-to-H pod that connects to the EV, making it easy to install the equipment in parking spaces. We will also collect feedback from the test house users and evaluate the resilience and convenience of installing these systems.

To realize a high-quality indoor environment, which is indispensable for living in the new normal, in June 2021, we developed the "Comfortable Airy T-SAS" ventilation and air conditioning system that provides the three functions of ventilation, air conditioning, and dust purification for all rooms. For the second layer of the high-performance three-layer filter, we used a HEPA filter that can capture 99.97% of pollen and fine particles 0.3 μm or larger*13 on a first-class ventilation system for stably performing both exhaust and intake mechanically. For the air-conditioning filter installed in the indoor air intake vent, we used an antiviral filter*14 that uses the antivirus processing agent Viru-taker™. In this project, with the technical cooperation of the National Institute of Advanced Industrial Science and Technology (AIST), we will verify the effectiveness of indoor air purification and thermal performance using these advanced technologies in comparison with generic systems (air conditioner heating and cooling and third-class ventilation) through actual measurements (Figure 9). We will also evaluate and verify the relationship between health and performance through user surveys and interviews.

To encourage energy-saving actions and reduce CO_2 emissions in daily life, we have standard-installed HEMS (Smart Heim Navi) to approximately 66,000 houses to date. In addition to analyzing the electricity usage data of these HEMS-equipped houses and providing energy-saving consulting services tailored to each house, we also included remote control and voice control functions for household equipment (lighting, EcoCute system, air conditioning, etc.), further enhancing daily life convenience and reinforcing awareness on energy-saving behaviors. To reduce CO_2 emissions by further improving the convenience of HEMS, we will develop a new application for smartphones. We will create an "integrated user interface" to control home equipment and appliances and verify its usability. Initially, we will pre-release the application to owners of Sekisui Heim houses already equipped with HEMS to investigate and analyze energy-saving behavior during the winter (heating period). We will then improve the application from the results of the analysis. Next, we will also verify the operation of the system during the summer (cooling period) through questionnaires and interviews, including test house users. Further, we will improve and re-evaluate the application to enhance the integrated user interface.

Figure 9: High-performance ventilation system and integrated user interface configuration diagram



*13 Pollen particle size was assumed to be 10 μm or larger, based on collection rate measurement results for atmospheric dust between 0.3 and 0.5 μm (based on research by Toray Industries, Ltd.). The value shows the initial performance of the filter at the time of delivery. It may be lower depending on the customer's environment and other usage conditions. The filter needs to be replaced (for a fee) once every five years (guide) to ensure performance. The value may be lower depending on the customer's environment and other usage conditions. It is not intended to treat or improve hay fever or respiratory diseases.

*14 Tested on the basis of JIS standards (JIS L 1922:2016 (ISO 1818184) for suppression of viruses attached to the filter. The filter is not effective against all viruses. It is not intended to cure, improve, or prevent disease. Also, the antiviral function for air passing through the filter has not been tested.

4. Latest Sekisui Heim Smart House

In anticipation of the risk of power outages due to frequent natural disasters, since 2012, Sekisui Chemical has been proactively proposing energy-self-sufficient houses*10, which are equipped with storage batteries and are aimed at enabling a lifestyle that avoids the purchase of electricity as much as possible. In 2021, we launched the New Green Model, the latest smart power station house model equipped with the newly developed high-capacity storage battery e-PocketGREEN*15 and can supply approximately 73% of annual electricity consumption (equivalent to 260 days)*16 with clean PV that does not emit CO_2 during power generation. In addition, we opened GREENMODEL Park showrooms in 20 locations nationwide where customers can have a hands-on experience of eco-friendly living in full-size homes, strengthening our proposal capability for energy-self-sufficient homes (equipped with storage batteries). We recently made proposals in anticipation of the risk of rising energy prices due to geopolitical factors. As a result, we were able to convince many customers of the importance of balancing environmental contribution and economic efficiency and having a reliable energy supply in times of disaster*17. This led to a significant increase in the number of GREENMODEL houses ordered in the second half of fiscal 2021 to 280%*18 compared to the previous year. Consequently, the storage battery deployment ratio in sales of newly built detached houses increased for the fourth consecutive year to a record high of 72%. We have installed storage batteries to a total of more than 47,000 houses since 2012.

5. Conclusion

As a leading sustainable housing company, we are committed to contributing to the reduction of environmental impact through the further promotion of 『ZEH』 and energy self-sufficient houses*2 (equipped with storage batteries). The smart house market, however, is still at an early stage of development and penetration. The nationwide penetration rate of ZEH in Japan is only 20% in 2020, both for custom-built and built-for-sale houses (calculated from the Sustainable open Innovation Initiative (SII) "Net Zero Energy House Demonstration Project Research Conference 2021" presentation material), pointing to an urgent need to increase penetration. Further, since this is only for the new detached house market, there is a need to also promote the penetration of ZEH in the new housing complex and housing stock markets. Also, collaboration and advancement of IoT devices centered on HEMS will also be crucial in the evolution of environment-friendly housing. This includes the automation of energy control, UI-based operation of home appliances and equipment, advancement of display systems, and the provision of data utilization businesses and services. Industry-wide co-creation to drive this evolution and penetration is needed to maximize the advantages for homeowners early on and accelerate the speed of penetration, both for new and existing houses.

References

[1] Press Release: Start of demonstration of the latest Sekisui Heim "Smart & Resilient" Technology, October 29, 2021, Sekisui Chemical Co., Ltd.

[2] Press Release: 『ZEH』, which ranks highest in terms of environmental contribution in the ZEH series of newly built detached houses, reaches a new record high of 82% deployment ratio in FY2021, April 25, 2022, Sekisui Chemical Co., Ltd.

*15 e-PocketGREEN was jointly developed with Nichicon Corporation.

*16 [Calculation conditions] Building site: Nagoya; Power contract: Chubu Electric Power Co., Inc.; fully electrified; PV capacity, 9.72 kW; storage battery capacity, 12 kWh (green mode), air conditioning system in all rooms (Comfortable Airy (1st floor); EcoCute system; total floor area: 121 m2, UA value: 0.54; electricity usage: calculated based on HEMS data in an actual house. This value may not be reached depending on the environment and other usage conditions.

*17 Electricity can be used even in the event of a power outage only if the amount of PV power generated or the remaining charge of the storage battery exceeds the usage or output volume. Some equipment may not be available depending on the weather, season, usage volume, and simultaneous usage (output) volume. Electricity cannot be used if the storage battery is empty.

*18 Ratio of the number of GREENMODEL house contracts in 2H FY2020 and 2H FY2021 (based on our research).