

Progress in Eco-Housing: Cooperation of Solar Power Generation, Storage, and Water Heating

Kazutoshi Fujihira



The Inagi Eco-House, planned by the Institute of Environmentology and built at the end of 2013, achieved extremely high energy self-sufficiency through solar power generation and thorough energy saving. In February 2025, more than eleven years after its completion, storage batteries were installed, and the water heater was replaced. This renovation has aimed to enhance emergency preparedness, promote further energy saving, and contribute to leveling electricity supply and demand, by utilizing solar power generation, storage batteries, and the new water heater.

Fujihira K. Progress in Eco-Housing: Cooperation of Solar Power Generation, Storage, and Water Heating. April 2025. Institute of Environmentology.

<https://www.kankyogaku.com/docs/progress-in-ecohousing-english.pdf>

Institute of Environmentology: <https://www.kankyogaku.com/en/>

Inagi Eco-House: <https://www.kankyogaku.com/en/ecohouse.html>

Installation of storage batteries

Two lithium-ion batteries, with a total storage capacity of 13.4 kWh, were installed in the Inagi Eco-House. The storage batteries were set indoors. The storage-related devices, namely a power conditioner and two converters, were mounted on the exterior wall. In the event of a power failure, stored electricity can be automatically supplied to all apparatus in the house. The storage batteries were also linked to the solar power generation system and the commercial power grid.



Storage batteries



Related devices: Power conditioner (left) & Converters for storage batteries

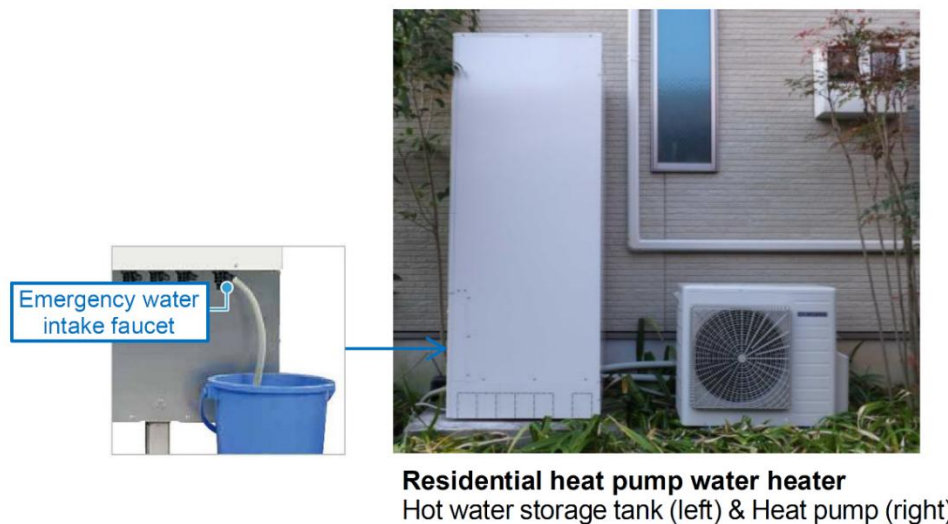
Water heater replacement

The Inagi Eco-House uses a “residential heat pump water heater,” nicknamed an “Eco-Cute” in Japan. This water-heating system comprises a heat pump and a hot water storage tank. Heat pump water heaters use electricity to transfer existing heat from one place to another instead of generating heat directly; therefore, they are highly energy-efficient.

The replacement of the water heater has brought two changes. First, the newly installed model is more energy-efficient than the originally installed one. Additionally, the time of day when the water is heated was changed from late at night to primarily during the daytime. In the past, residential heat pump water heaters were designed to heat water at night to use inexpensive late-night electricity. In contrast, recent models are equipped with a “solar power generation linkage function,” which allows them to use electricity generated during the daytime for water heating. Therefore, when the new model was installed, it was set to heat water mainly during the daytime.

Cooperation of solar power generation, storage, and water heating

The utilization of the solar power generation system, storage batteries, and new water heater further enhanced the house’s sustainability performance in three ways: (1) improvement of emergency preparedness, (2) enhancement of energy-saving performance, and (3) contribution to leveling electricity supply and demand.



(1) Improvement of emergency preparedness

The use and coordination of solar power generation, storage, and a heat pump water heater will ensure a stable energy and water supply even in emergencies, such as in the case of disasters. Concerning energy, the house was already equipped with solar power generation, providing an alternative electricity source in the event of power outages. However, it was unable to cope with outages during the night. The installed storage batteries have enabled the house to secure emergency power all day and night.

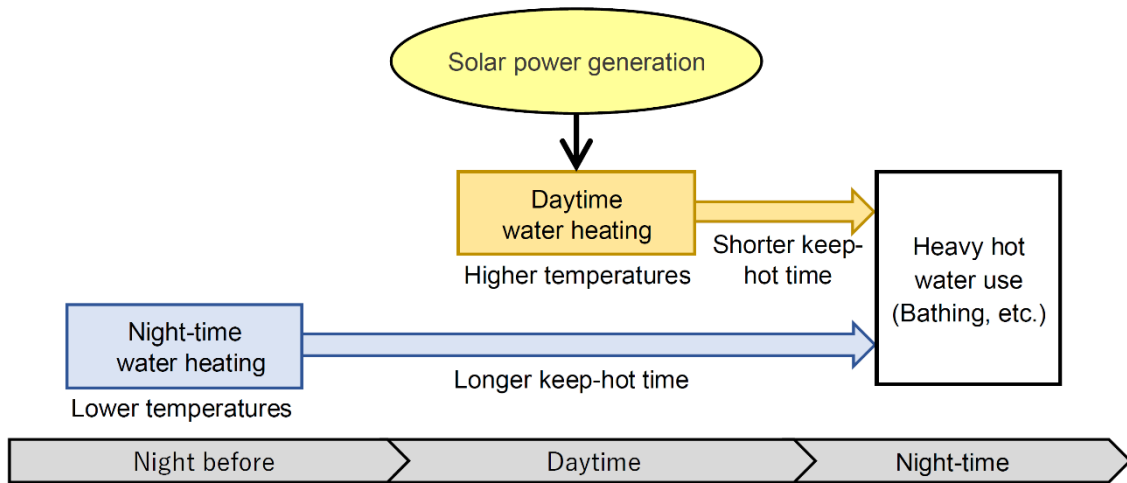
On the other hand, the heat pump water heater is helpful in case of water cutoffs. The hot water storage tank provides an emergency water intake faucet for a water supply suspension.

(2) Enhancement of energy-saving performance

The replacement of the water heater made a significant contribution to energy conservation. Heat pump water heaters are known for their high energy efficiency, but the replacement has further enhanced this efficiency. The first reason is technological progress in the water heater industry. The newly installed model has improved energy efficiency by approximately 17% compared to the one originally installed.

Another energy-saving factor is that the water heating time has been shifted from midnight to mainly daytime. Since air and water temperatures are higher during the daytime than at night, heating water during the daytime can lead to energy conservation. In addition, heavy hot water use, such as bathing, generally occurs in the evening. If water is heated during the daytime, the time to keep water hot can be shortened.

Furthermore, if the water is heated during the day, electricity generated by solar power can be used. In other words, by linking with solar power generation, water can be heated using only renewable energy.



Comparison between daytime water heating and night-time water heating

(3) Contribution to leveling electricity supply and demand

Fundamentally, maintaining a balance between electricity supply and demand is crucial. However, some factors can cause sudden fluctuations in the balance between the two. One such factor is a rapid increase in solar power generation, the supply of which fluctuates greatly depending on the time and weather. For example, a sharp rise in solar power generation during periods of low demand can lead to an imbalance between supply and demand.

Cooperation with storage and daytime water heating can help balance the supply and demand of electricity. With storage batteries, electricity generated by solar power can be stored during periods of low demand and used during periods of high demand. Moreover, if electricity from solar power is used for water heating during low-demand hours, the amount of electricity supplied to the power grid can be reduced.

In April 2025, the Tokyo Metropolitan Government began mandating that major housing manufacturers install solar power generation systems in newly built detached houses. As electricity generated by solar power is expected to continue increasing, the widespread use of storage batteries and daytime water heating will become even more significant. The “cooperation of solar power generation, storage, and daytime water heating” is also aimed at responding to such changes in social conditions.