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# Energy reduction effect by thermal insulation promotions in Shiga Prefecture

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## Introduction

- ✓ Shiga's targets of the GHG emission reductions (compare to FY2013)
  Total : FY2030=50%, FY2050= net "Zero"
  Household sector : FY2030=67%, FY2050=100%
- ✓ Drastic reduction countermeasures for dwelling in household sector:
  - ・Electrification (+ with low/de-carbon electricity), Energy saving behavior
  - ・Improvement of **thermal insulation performance**
    → Energy consumption for air conditioning = 21– 23 % (2018–2020)
  - ・ZEH(zero energy house) + Energy efficiency equipments

## Objectives

- Develop the dwelling stock model with considering insulation reform
- Analyze the effects of energy-saving policies for dwelling towards the realization of the net zero $CO_2$ society:
- Target: Shiga prefecture, Periods: 1970–2050

## Flamework of dwelling stock model

<Definition : Available dwelling stock>

Available dwelling: Dwellings that have possibility of consuming energy (=of living in)

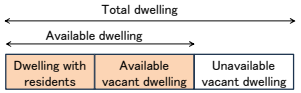


Fig.1 Target dwelling

<Classification>

Type: detached house(DTH), apartment(APT)
Structure: wooden, non-wooden
Construction age: pre-1970, 10 years intervals thereafter (1971–1980,,,,,2041–2050)
Energy saving level: Lv2 – Lv6
(based on energy efficiency standard for building)

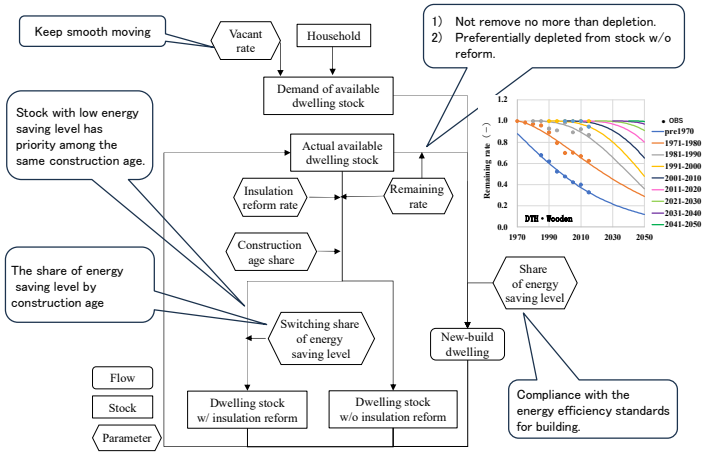


Fig.2 Structure of dwelling stock model

Table1 : Definition of energy saving level

| Energy saving level | Final energy consumption 2020 | 2030 | 2040 onwards | Definition and memo |
|---|---|---|---|---|
| Lv6 | 0.36 | 0.26 | 0.16 | Equivalent or higher to primary energy consumption index = grade 6 (ZEH standard, -20% [compared to grade 4]). With a solar panel. |
| Lv5 | 0.89 | 0.77 | 0.74 | Equivalent to primary energy consumption = -10 — -20% [compared to grade 4]. Almost equivalent to guided standards, top runner house, certified low-carbon house, etc. Without a solar panel. |
| Lv4 | 1.00 | 0.95 | 0.90 | Current regulatory level (after 2025) =Primary energy consumption = grade 4 = Energy saving standard of 2016. Without a solar panel. |
| Lv3 | 1.10 | 1.05 | 1.00 | Equivalent to energy efficiency standard of 1992. Without a solar panel. |
| Lv2 | 1.25 | 1.20 | 1.15 | Equivalent to energy efficiency standard of 1980. Without a solar panel. |

* Changes by periods include guided standards and improvements in equipment efficiency. Between the years are linearly interpolated.
* Lv6 assumes self-consumption of all solar power generation.

## Scenario

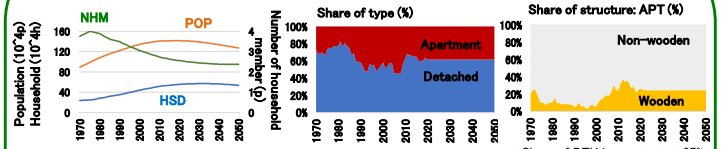


Fig.3 Basic input of scenario

* Share of DTH is constant at 87% for wooden after 2025

<Characteristics by construction age and introduction of countermeasures>

| Construction age | Characteristics and countermeasures |
|---|---|
| Pre 1970 ～1980 | Both the levels of earthquake resistance and energy saving are low. Encourage withdrawal from the available dwelling stock after 60 years of construction. Some dwellings with strong frameworks would be reformed while leaving a part of the structure intact. But since this is a major renovation equivalent to new-build, it would be treated as a "reconstruction as new -build" and the energy saving level is comply with the energy efficiency standard for building as the construction year. |
| 1981 ～2000 | Earthquake resistance level meets the 1981 standard, but not the 2000 standard. Since the energy saving level is below the current energy efficiency standard (insulation performance = grade 4), insulation reform is recommended. |
| 2001 ～2020 | Earthquake resistance level meets the 2000 standard. The share of dwelling which meets the energy efficiency standard (insulation performance = grade 4) is slightly high. The share of dwelling with a solar panel is increasing. Reforms such as improvements of thermal insulation performance and extension of lifetime are encouraged. |
| 2021 onwards | The compliance rate of energy efficiency standard and the share of ZEH become drastically high in accordance with the revision of the law of the energy efficiency standard for building. There are many high-quality dwellings which are easy to maintain, manage and reform (ex. A long-life quality housing). Reforms such as improvements of thermal insulation performance and extension of lifetime are promoted. |

## Setting case

| Case | New-build dwelling | Existing dwelling |
|---|---|---|
| "Stagnation"<br>Introduction of countermeasures for both new-built and existing dwelling is slow. | Regulation of high energy efficiency standard is delayed. Comply with 2025 = grade4. At least Lv5 [insulation grade = ZEH]) is in 2035 for DTH, in 2040 for APT. | Insulation reform rate is trend level (0.5% to whole stock in 2018). Removing low-quality dwelling is in slow progress. Dwelling with around 30 years is volume zone for insulation reform. |
| "NEW-EXS"<br>Introduction of countermeasures for both new-built and existing dwelling is proceeded | Regulation of high energy efficiency standard is conducted. Comply with 2025 = grade4. At least Lv5 [insulation grade = ZEH]) is in 2030 for DTH, in 2035 for almost APT (small potion is remaining by 2040) | Insulation reform rate is 4–6 times compared to the trend level. Removing old low-quality dwelling is proceeded. Partly insulation reform (only windows, ceiling, floor, or their combination) is dominant and energy saving level is upgrade by 1or 2 levels. Whole reform is same as new-build dwelling. |

## Results

### 1) Countermeasure for existing dwelling is essential

Even in NEW-EXS case, the share of available dwelling stock built after 2021 to available dwelling stocks is only 44%. For improving the quality of the whole stock, implementing countermeasures for existing stock is important.

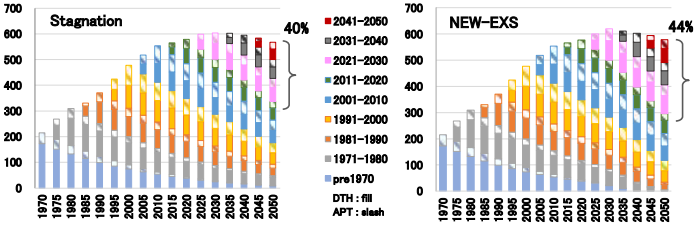


Fig.4 Available dwelling stock (1000n)

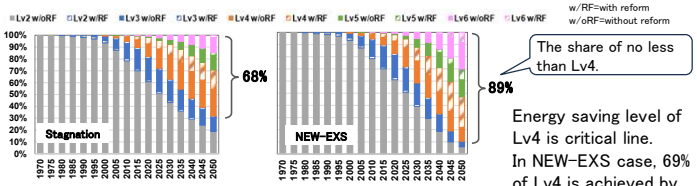


Fig.5 Share of energy saving level of available dwelling stock(%)

Energy saving level of Lv4 is critical line. In NEW-EXS case, 69% of Lv4 is achieved by insulation reform.

### 2) Intensive promotion based on trajectory is effective

.It is desirable to intensify the introduction of countermeasures by taking the opportunity to reform for the earthquake resistance by 2030 and to remove low-quality dwelling around 2040.

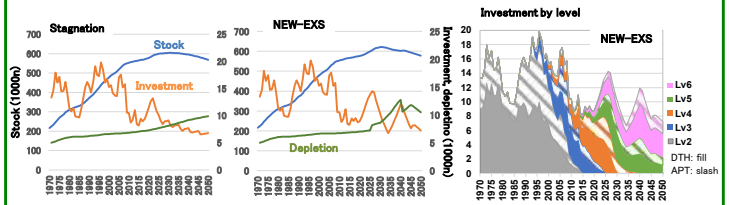


Fig.6 Stock, investment, depletion and investment by energy saving level

### 3) Hard countermeasure (improvement of insulation) is not enough

Energy reduction potential only by improvement of insulation and equipment efficiency is very small. Immediate switching to the de-carbon energy (electricity or e-methane?) is required especially for cumulative $CO_2$ reduction.

< NEW-EXS case in 2050>

| | |
|---|---|
| The stock average of final energy consumption level (w/o PV) | 0.81 |
| The reduction rate of cumulative energy consumption after 2021 (compared to Stagnation) | 5.5% |

## Future Task

- **More detailed classification:** The characteristics of energy consumption is affected by household type. Towards 2050–2060, the impact of this factor would be very important. Dwelling is classified in more detail ; the number of household member (single, 2 or more persons) and the age of householder (less than 65 years old or 65 years old or more).
- **Cumulative $CO_2$:** To achieve the net-zero $CO_2$ society, it is essential not only to achieve the reduction target of single "target year", but also to achieve the carbon budget (=cumulative $CO_2$) by the target year. Consider change of energy mix (mainly electrification) in household sector including change of emission factor of electricity, diffusion of a solar panel and ratio of its self-consumption.

**Reference:** Most of the contents is base on the following: Reina KAWASE and Mamoru ICHISE: Consideration of net zero policies based on available dwelling stock by energy saving level, Japanese Journal of JSCE, 2023. (in press).
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