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Analysis on Technologies and Costs for Achieving Decarbonization in Households in Japan

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Background

- Japan aims to be carbon-neutral by 2050, which requires firm decarbonization in the building sector particularly where it is relatively easy to reduce direct emissions by electrification.
- In addition to technological developments and price reductions by manufacturers of building materials and appliances, it is important to enable consumers to make informed choices to reduce emissions in order to achieve the social implementation of the measures required for decarbonization.
- In particular, quantifying the additional costs of decarbonization and the future costs and benefits of energy savings could encourage early adoption of the measures.

Purpose

- Organize any technologies needed to decarbonize Japanese households and calculate the emission reductions by measures.
- Develop multiple scenarios and quantify the additional investment required to implement the measures and the costs and benefits received from implementing the measures.

Methodology

- Compared the following 2 cases and calculate CO_2 emission reductions, energy consumption reductions and costs and benefits by energy savings from 2025 to 2050:
  - **BaU case**: conventional technologies are installed in a three-person household in Tokyo;
  - **CM case** : countermeasures are installed to the fullest extent possible in a three-person household in Tokyo
- Developed the following 4 scenarios and conducted sensitivity analysis:
  - **(I) Base scenario**: living in a newly built single-family house from 2025;
  - **(II-i) Renovation scenario**: living in an existing single-family house; although the grade of the installed thermal insulations are low, in 2025 only the windows will be renovated with high insulation grade;
  - **(II-ii) High fuel costs scenario** : living in a newly built single-family house from 2025, with rising fuel costs, about 1.5 times higher than from 2019;
  - **(II-iii) Apartment scenario**: living in an apartment building, without installation of solar panels and battery storages due to lack of space.
- Assumed to install technologies except for battery storages from 2025 on a 20-year loan and install battery storages from 2035 on a 10-year loan. In addition, set the lifetime on each technologies to be replaced where reached.

Assumptions of each case

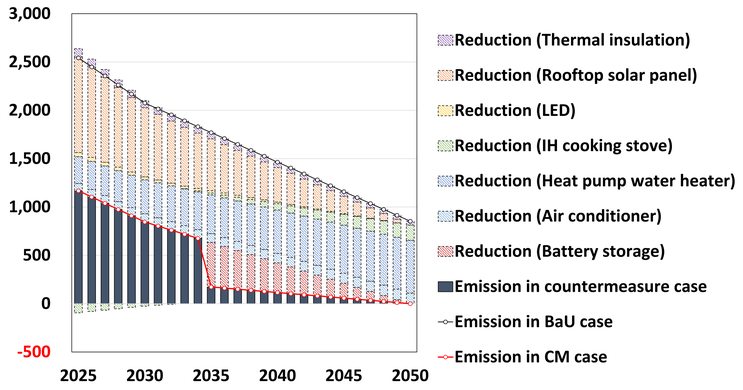
Case	Item	Device	Lifetime [year]	Initial cost [thou. JPY /household]
BaU	Space heating	Gas space heater	14	19
	Hot water	Gas water heater	12	75
	Cooking	Gas cooking stove	10	60
	Lighting	Fluorescent lamp	3	10
	Thermal insulation	Grade 4 in Japan's regulation (not meeting the ZEH standard)	-	1,575
	Solar panel	-	-	-
	Battery storage	-	-	-
CM	Space heating	Air conditioner	14	54
	Hot water	Heat pump water heater	12	175
	Cooking	IH cooking stove	10	75
	Lighting	LED	10	32
	Thermal insulation	Grade 6 in Japan's regulation (meeting the ZEH standard)	-	2,360
	Solar panel	5kW rooftop solar panel	26	1,970
	Battery storage	10kWh battery storage	16	2,380

* Other assumptions are common to BaU case and CM case.

Result

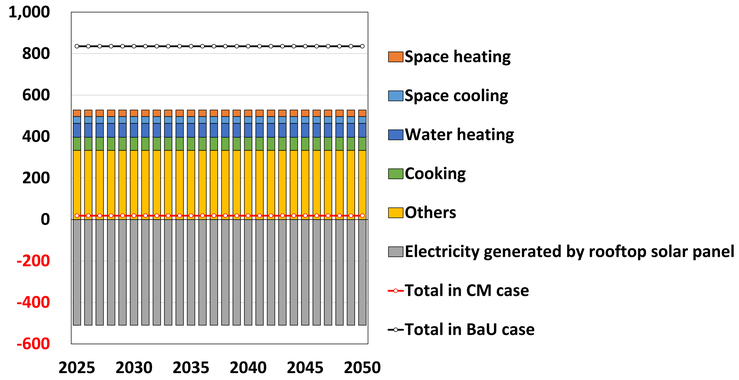
- Comparing to BaU case, CM case will reduce total CO_2 emissions by 76%.
- Solar panels and heat pump water heaters will be the main contributors to emission reductions.
- In particular, the emission reduction of solar panels is greater in the near term, when the emission factor of grid electricity is higher, than in the future. Therefore, the earlier the measures are installed, the more effective the emission reductions will be.

Annual CO2 emission in a household in Base scenario [Unit: kg CO_2]



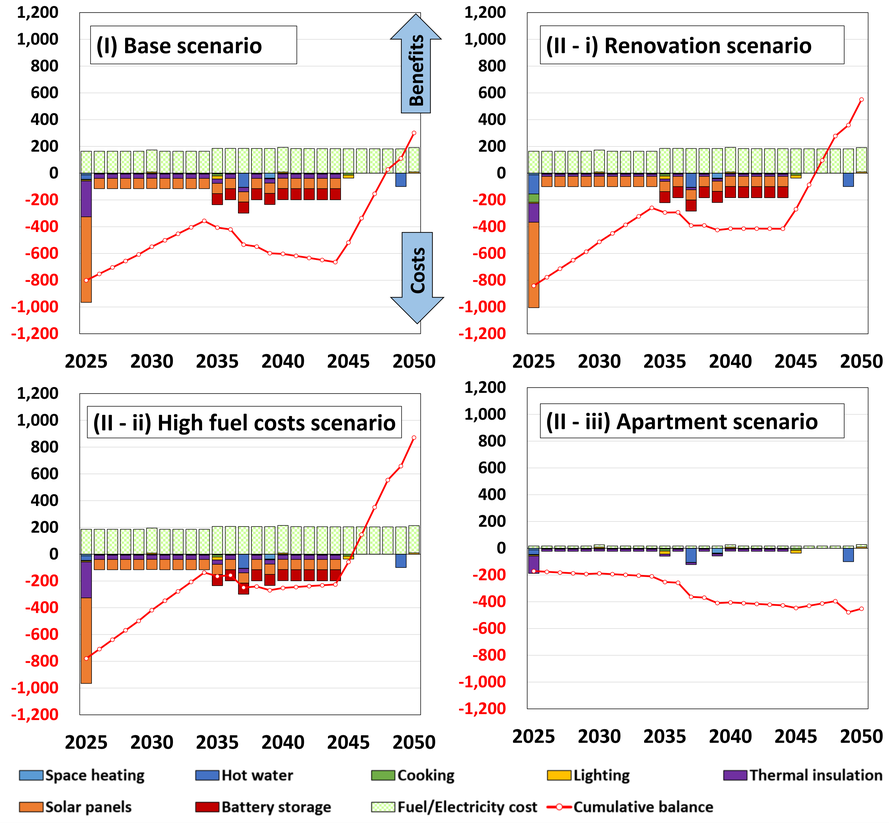
- Total annual energy consumption will be 835 kgoe in BaU case and 19 kgoe in CM case, where the implementation of the measures drastically reduce energy consumption.
- Solar panels will be the main contributor to the reduction in energy consumption, generating 98% of the energy consumption in CM case.

Annual energy consumption in Base scenario [Unit: ktoe]



- In the three single-family house scenarios, the cumulative balances of costs and benefits by 2050 are;
  - (I) Base scenario: 301 thousand yen, 7% ROI;
  - (II-i) Renovation scenario: 551 thousand yen, 14% ROI;
  - (II-ii) High fuel costs scenario: 871 thousand yen, 20% ROI.
- Decarbonization investments will be recouped by 2050 in all three scenarios but the investments will pay off after 2045, more than 20 years after the measures are installed.
- In (II-iii) Apartment scenario for apartment building, the cumulative balance of costs and benefits by 2050 is -451 thousand yen, -50% ROI.
- Households living in apartment buildings will not recoup the decarbonization investment, which highlights the difficulty of implementing decarbonization measures in apartment buildings.

Costs and benefits of decarbonization per household [Unit: thousand JPY]



Conclusion

- We analyzed the technologies needed for decarbonization, their emission reductions and the additional investment and costs and benefits of implementing the measures, per household in Japan.
- In particular, solar panels and heat pump water heaters will contribute to emission reductions.
- Household living in a single-family house could recoup the investment in decarbonization, but it will take at least 20 years after installation of the measures. It is important to encourage consumers to install measures at an early stage such as by providing subsidies for the installation of the measures or regulating the sales of appliances using conventional fossil fuels.
- It is difficult to recoup decarbonization investments in apartment buildings due to more restrictions than single-family house such as not being able to install solar panels and battery storages.
- At the next step, we will use the results of this analysis to estimate emissions in the whole Japanese residential sector, taking into account differences in the potential to install the measures in different regions or more detailed differences in building types.

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