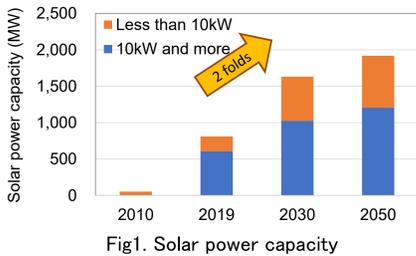


Projection of waste generation of solar panels: Shiga Prefecture

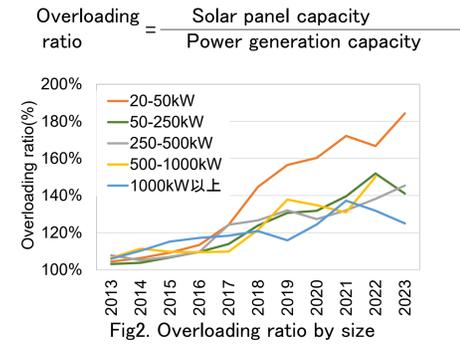


Introduction

- Solar power occupies **83%** of renewable energy potential.
- The 2030 target for "solar power" in the net zero plan is **double** that in 2019.



- Many facilities are overloading.
- Total average of overloading ratio is **143%**



Objectives

- Estimates the future amount of waste generation of solar panel waste generation in Shiga Prefecture until 2060.
- Check the amount of the peak and the year of waste generation of solar panel.
- The sensitivity analysis of the effects of the following factors;
 - with/without consideration of time related deterioration → difference of required power generation capacity (panel capacity)
 - the average lifetime between 20 - 30 years

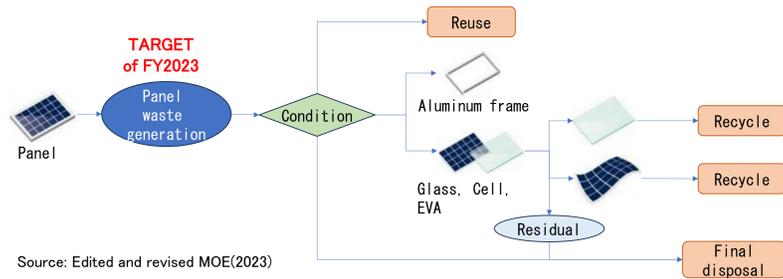


Fig 3. Flow of solar panel waste

Model: Waste generation of solar panel

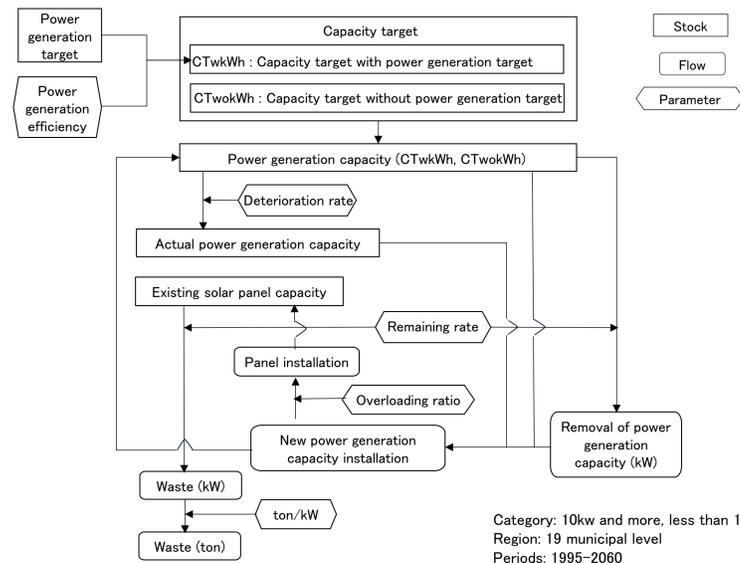


Fig 4. Calculation flow of waste generation of solar panel

Solar power generation facility has aging deterioration. Due to the installation year composition of the facility stock, the power generation output based on the apparent installed capacity differs from the actual power generation output. So, based on the target of the net zero plan (MW or kWh), required capacity is different.

Setting sensitivity analysis

- Factors affecting panel removal has large uncertainty.
- Sensitivity analysis is conducted by the difference of average lifetime of panels.
- Remaining rate is defined by Weibull function.

Table 1. Factors affecting panel removal and setting cases for the sensitivity analysis

Item	Less than 10kW	10kW and more
FIT (Feed In Tariff) scheme	10 years	20 years
System guarantee	20-25 years	
Reasons of panel removal	Replace cycle of power conditioner	
	Land use contract	Lifetime of building or houses
	Profitability of the business	
	House: Roof maintenance (painting, re-roofing; 10-50 years by kinds)	
Average lifetime of panel	Base case: 50%: 20 years	Case 20: 50%: 25 years
	Case 30: 20 years	30 years

- The plan doesn't have the target beyond 2050, so target in 2060 is set as same in 2050.
- The future overloading ratio is assumed to be constant at 143% for 10kW and more, 102% for less than 10kW.

Results

<Base case>

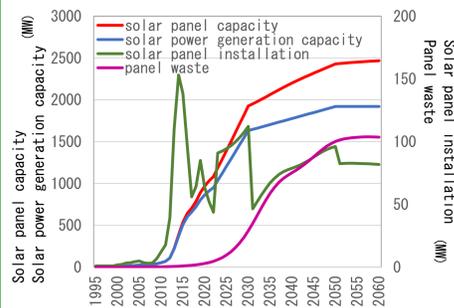


Fig 5. Major indicators of base case

- The solar power generation output capacity is the target of net zero plan (CTwokWh). Solar panel capacity is much more than it because of overloading.
- The target in 2030 is very high. So the installation of power generation capacity needs to continue to be more than double the current level, up until 2030.
- During 2030-2050, the panel waste and panel installation is almost at the same level.

<Solar power capacity>

- The actual power generation output capacity relative to the target capacity of the plan will decrease by 5-7% during 2030-2060.
- To compensate for the decrease in power generation output caused by deterioration, more capacity of solar panel installation is required.
- Required power generation output capacity is 1.9 GW in 2040, and 2.1GW in 2050 and 2060. Taking overloading into account, the solar panel capacity (CTwokWh) in 2035 and 2060 would be 2.2 GW and 2.6GW, respectively.

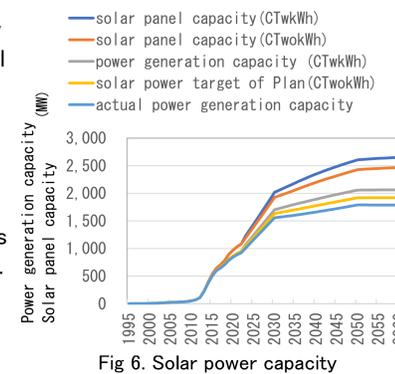


Fig 6. Solar power capacity

Results

<Waste generation>

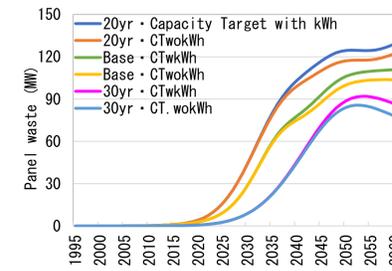


Fig 7. Panel waste generation (kW)

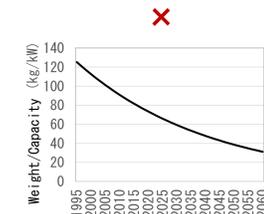


Fig 8. Weight-capacity ratio

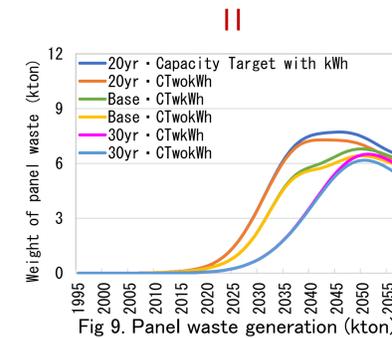


Fig 9. Panel waste generation (kton)

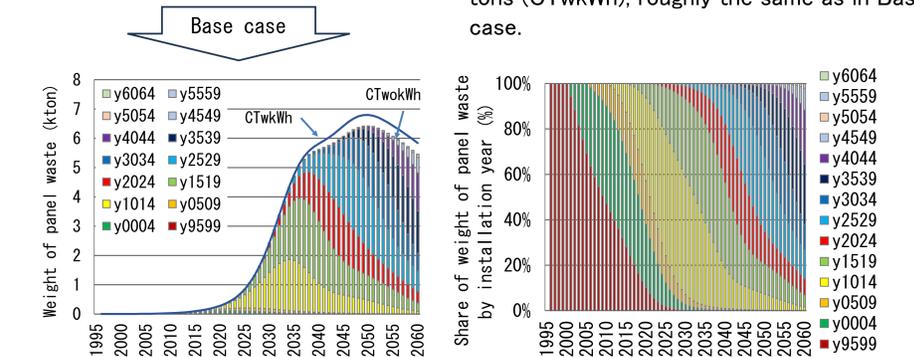


Fig 10. Weight of panel waste by installation year

- In Base case, panel waste generation starts to rapidly increase from 2025-2030. After around 2045, the increase will slow down. The Base case doesn't have no clear peak, and will remain flat or increase slightly until 2060.
- In Case20, the panel updates are fast, so the amount of panel waste generation is large. In Case30, panel waste starts to increase slowly, and has the peak of about 90MW in the early 2050s.
- Due to technology innovation, the ratio drastically decrease.
- The weight-capacity ratio is referred to IEA-PVPS(2016).
- The weight of panel waste is highly sensitive to assumption of the ratio.
- The amount of panel waste generation in unit of weight(kton), the years of the peak differ slightly, but the shapes are roughly the same in all cases.
- In Base case and Case20, the weights of panel waste is gradual between 6,000-7,000 during 2035-2050. The peak is about 7,000 ton for Base case, and 8,000 ton for Case20.
- In Case30, the year when the weight of panel waste exceeds 1,000 tons and begin to rapidly increase is delayed by about seven years compared to Base case, but the peak amounts are 6,200 tons (CTwokWh) and 6,500 tons (CTwokWh), roughly the same as in Base case.
- The increase in weight of panel waste up to 2045 is due to the a large amount of panels introduced up to 2029.
- Since newer panels are lighter, the weight of panel waste (kton) decreases even though the panel waste (kW) increases.

Future Task

- Required recycling facility size:** In order to avoid a shortage of final disposal sites and for effective use of resources, it is necessary to recycle the increasing amount of solar panel waste. In order for a panel to be recycled, it needs to be brought to a recycling facility in a recyclable condition. Investigate the flow of used panels and identify the required recycling facility size.
- Available solar power generation:** This study founded the power generation output loss of solar power facility stock by deterioration. The climate change causes changes in solar radiation and temperature. Increase in solar radiation becomes the factors of both increase and decrease in solar power generation. Temperature rise is the factor of decrease through rise in the panel temperature. Examine the available solar power generation with considering all these factors.

Reference: Reina KAWASE and Yuko KANAMORI: Sensitivity Analysis on Future Generation of Photovoltaic Panel Waste in Shiga Prefecture. (Japanese Journal of JSCE, in press).

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