ESTIMATING THE POTENTIAL FOR PV INSTALLATION IN NON-RESIDENTIAL BUILDINGS IN JAPAN

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Overview

Nowadays, governments and companies are moving towards achieving a zero-emission society. Although the potential installation of photovoltaics (PV) in non-residential buildings in Japan has been calculated in several existing studies such as by The Ministry of Economy, Trade, and Industry (METI) and The Ministry of Environment (MOE), the reported values vary greatly among them. Firstly we examined calculation methodologies employed in the studies. Then we modeled procedures for calculating annual power generation commonly applied to the buildings. Finally, we executed the calculations by assuming that PV systems are installed on the roofs and the sidewalls in several dozens of real non-residential buildings. Moreover, we quantitatively clarified the degree of impacts on the calculated results on annual power generation by changing the parameters in the model.

Methods

In the first step, we focused on the non-residential buildings ready for zero-emission (denoted as "ZEB Ready" hereafter), which are not required to install additional renewable energy equipment. Then, ZEB Ready are chosen from those registered in ZEB Leading Owners, whose installation performance charts are disclosed and unequipped with both PV and solar heat collectors. The number of chosen ZEB Ready was 66.

In the second step, we defined various cases with predetermined different tilt angles (θ) and azimuth angles (ψ) referred from the existing studies (i.e., hereafter denoted as METI, MOE, The New Energy and Industrial Technology Development Organization (NEDO) - Mizuho Information & Research Institute (NEDO-MIRI), and NEDO - Photovoltaic Power Generation Technology Research Association (NEDO-PVTEC)).

In the third step, we calculated the annual power generation in the respective ZEB Ready for each case. For all the cases based on METI, MOE, and NEDO-MIRI, the total floor area was multiplied by the installation factor (Z), output per area (W), solar radiation (H_{Am}), and total design coefficient (K). While for the case based on NEDO-PVTEC in which assumed squared-roof of the ZEB Ready, the total floor divided by the predetermined number of floors is set equal to the roof area. Then, we multiply the length of one side of the roof, the number of floors, and the floor height altogether, to obtain the sidewall area. Moreover, the installable area was obtained by multiplying the roof area and sidewall area with respective specific factors in the studies. Finally, the annual power generation was obtained by multiplying the installable area with the power generation per unit area (Q). Here, Z and Q was defined as the ratio of the installable area to the total floor area and the ratio of the annual power generation to the installable area, respectively. H_{Am} was calculated using the MONthly mean SOLAr radiation data throughout Japan (MONSOLA)-20. The annual power generation was calculated based on JIS C8907 (i.e., the estimation method of generating electric energy by PV power system). Notably, these parameters were given different values for each case depending on the corresponding conditions in the existing studies.

In the last step, we obtained how much the annual power generation of each case differs from those in the reference case with default parameter settings by varying the parameter settings one by one. From the obtained rates of changes in the variations, we determined sensitive parameters to the results as the important ones in estimating the annual power generation and assessed respective calculation methodologies in the existing studies.

Results

The annual power generation shows descending order from NEDO-MIRI, METI, NEDO-PVTEC, and MOE, depending on parameter settings in θ and ψ. Caveating that the number of calculated ZEB Ready from NEDO-PVTEC is smaller by 10 than all the other studies, due to exclusions of irregular buildings.

Regarding the (in)sensitive parameters, Z and W were identified as sensitive with the largest rate of change, while H_{Am} depending on ψ were found insensitive.

Conclusions

Through our assessment exercises, we found that the degree of elaborations differed largely among the studies. Following major differences among the different calculations, methodologies were identified - inclusions of the effect of the number of floors to Z, distinctions of roofs and sidewalls, and inclusions of both H_{Am} and the monthly average temperature at each location depending on the studies.

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