OPTIMIZATION OF STATIC CPV FOR THE CAR-ROOF FOR MAXIMIZING SOLAR RESOURCES INCLUDING THE DIFFSED SUNLIGHT.

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Thanks to the technological advancement of III-V cell technologies and increasing demand for high-efficiency PV system including car-roof PV, the III-V cell application without relying on high concentration and precise trackers becomes realistic. However, the cost of III-V cells relative to Si cells is still high, and the door of the early-entry to the market is still closed.

The static concentrator is effective to save the high-cost III-V cells. However, the acceptance angle is inevitably decreased and thus loses the annual energy yield.

The wide acceptance array of the static concentrators using axially-asymmetrical solid lens was developed. We have succeeded to realize the new concentrators with apparent acceptance angle was larger than the nominal thermodynamic limit by new CAD-CAM friendly design method. The module was prototyped and tested both indoor and outdoor (Figure 1).

The achieved acceptance characteristics were excellent as the static concentrator of as high as 4 x of concentration ratio. However, it was poorer than the designed value. The acceptance angle obtained by the outdoor measurement was poorer, possibly because of the two reasons. One is spectrum mismatching loss by lower sun height. Another is DNI decreases faster than the cosine trend due to the nonlinearly increased turbidity of the air.

For accurate prediction of the annual energy yield and thus designing the practical requirement of the static concentrator module using III-V cells, an innovative design method to the static CPV system was developed on the sloped plane in the south such as a roof-top system on the residential houses. In conclusion, more than 55 degrees of acceptance half angle (50 % of efficiency point) will be required, if it is targeting more than 90 % of usage of the total irradiance.

Figure 1: Indoor and outdoor test of the static concentrator module using 4 x of geometrical concentration ratio and 99 cells connected 33 series x 3 parallel.

Figure 2: Required acceptance half angle not to lose annual irradiance due to the limited acceptance. This curve was calculated by irradiance data in 47 local capitals in Japan.