Photovoltaics for Vehicles -Similarities and Differences from Standard PV or Car Components

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1. Introduction

Considering the recent development and success of EVs (electric vehicles) and PHVs (plug-in hybrid vehicles), let us think about a solar engine car. Photovoltaic (PV) technologies will be game-changing in the automobile industry. It may be a dream now, but it is worth challenging.

Photovoltaics for vehicles are PV but also a car component. The requirement as a car component is different. The value of the product directly related to the solar resource is also different. The purpose of this presentation is to clarify differences and similarities, specifically in the following four points;

- Power and energy of photovoltaic on vehicles
- Differences in curved (typically 3D curved) modules common to PV for vehicles and standard flat modules
- Difference and similarities of PV standards (IEC) and Car-component standards (ISO and JAS)
- Process of 3D curved modules

2. Power and energy of photovoltaic on vehicles

Unlike standard PV systems, PV on vehicles is often shaded by shading surrounding objects. As a result, solar irradiance varies much wider among streets rather than climate zones and latitudes. The prediction of solar irradiance is much more complex. However, it can be calculated by statistical modeling of the distribution of shading objects.

The impact of partial shading is also complicated, including self-shading and shading by small objects like columns of street signs and overhead power cables. The partial shadow also moves by the movement of vehicles. For the energy rating, it is essential to predict the impact of these partial and dynamic shading. The modeling of the partial shading, typically 3D distribution surface depending on grazing angle and the size of the partial shading, is on the way, but we have the confidence to complete it.

3. Differences in curved (typically 3D curved) modules common to PV for vehicles and standard flat modules

The impact of the curved surface is more significant and complex than we may think. It is summarized in Fig. 1. For reproducible measurement, a typical solar simulator (uniform in 2D surface) may not be sufficient and require 5D uniformity (uniform in 3D space + 2D angles). An international round-robin project is going on (Fig. 2).

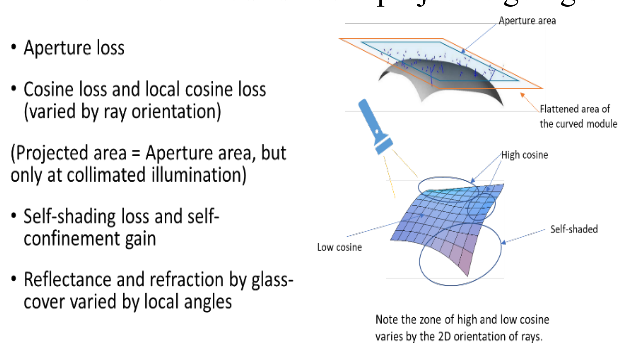

Fig. 1 Difference in the curved modules

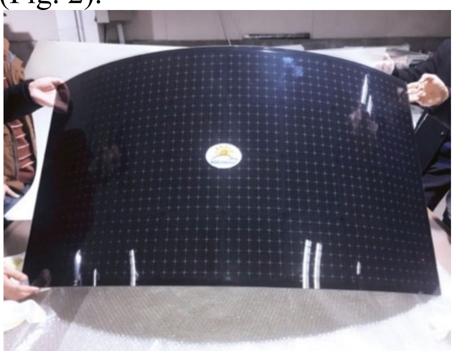

Fig. 2 A round-robin module made by AGG Energy, China

4. Difference and similarities of PV standards (IEC) and Car-component standards (ISO and JAS)

We are investigating the difference and similarities between PV standards and car-component standards. It looks PV modules that pass the PV standards may also pass the car-component standards. However, several tests are not required for PV, and we need to consider such car-specific requirements.

5. Process of 3D curved modules

The typical shape of the car-roof is a 3D curved surface, implying that it cannot be covered by planes. We need an innovative lamination process to avoid buckling cemented to an undevelopable curved surface. These new technologies are reviewed in the presentation. Also, we discuss the required curvature based on the statistical analysis of the curved surface of the commercial vehicles.

Biography:

Kenji Araki is a Distinguished Professor at University of Miyazaki (Japan), IEC TC82 WG7 convenor, IEA PVPS Task-17 (PV in mobility) expert, presiding three VIPV international web meetings, and currently working for modeling and measuring 3D solar irradiance onto the 3D curved car body, power and energy of VIPV in streets, and standardization on VIPV.