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A preliminary study for determining photovoltaic panel for a smart photovoltaic blind considering usability and constructability issues

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Abstract

Many countries have implemented PV systems in buildings to solve environmental pollution and energy shortage issues. A smart photovoltaic blind (SPB) reduces indoor energy consumption with a shading device and substitutes energy consumption through a PV system. This study aims to determine a PV technique, which can be implemented in the development of the SPB as an initial step. Toward this end, usability issues (i.e., efficiency, shading effect, and harmful effect) and constructability issues (i.e., size and weight) were reviewed. Results demonstrated that the second PV technique (i.e., a-Si and CIGS) can be applied to the SPB.

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Keywords: Smart photovoltaic blind; Amorphous silicon; Copper indium gallium selenide

1. Introduction

Global environmental pollution and energy shortage are considered to be urgent issues that need resolution. [1-4]. The building sector accounts for about 40% of the global resources and energy consumption in global economic activities, and much effort is being made to reduce energy consumption [5]. To solve these issues, the South Korean government has established various policies. First, it

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established the '4th Renewable Energy Penetration Plan', which expanded among NREs the ratio of the PV generation ratio from 2.7% (2015) to 4.1% (2030) [6-8]. However, the substitution of energy consumption from the existing rooftop PV system is limited [9]. Accordingly, it is essential to introduce and expand the PV system installed on the building envelops, not just on the rooftops. Second, the government established the 'Act on the promotion of green buildings', which makes it compulsory to install shading devices in public buildings (office buildings and education facilities) whose total floor area is over 3,000m^2 with outer walls that have windows or are made in glass [10].

The smart photovoltaic blind (SPB) combines three functions: electricity generation, automatic control, and real time monitoring and management. The SPB can satisfy both the shading function of the window blind and the electricity generation of a PV system. However, there is a lack of previous research on determining the PV technique applicable to the SPB. Therefore, this study aims to determine PV techniques applicable to the SPB in the initial stage of SPB development considering usability and constructability issues.

Nomenclature

a-Si	Amorphous silicon
CdTe	Cadmium telluride
CIGS	Copper-indium-gallium-selenide
Mono-si	Mono-crystalline silicon
NRE	New and renewable energy
Poly-Si	Poly crystalline silicon
PV	Photovoltaic
SPB	Smart photovoltaic blind

2. Various issues in developing a smart photovoltaic blind

Commercially available PV techniques can be generally categorized into two generations: (i) First generation PV technique (i.e., mono-crystalline silicon (mono-si) and poly-crystalline silicon (poly-Si)); and (ii) Second generation PV technique (amorphous silicon (a-Si), copper-indium-gallium-selenide (CIGS), and cadmium telluride (CdTe) thin-film) [11-13]. To determine the PV techniques applicable to the SPB, this study considered usability issues and constructability issues.

2.1. Usability issues for developing smart photovoltaic blind

Table 1 shows the usability issue (i.e., efficiency, shading effect, and toxic material) of PV panels. First, compared to the first generation PV technique (i.e., mono-si: 14.5% and poly-si: 14.0%), the second generation PV technique (a-Si: 5.8%, CIGS: 10.5%, and CdTe: 9.9%) is less efficient. However, compared to the first generation PV technique, the second generation PV technique uses an thin film PV technique, which improves the applicability of the PV system [14, 15]. Second, compared to the second