Long-term Outdoor Study of Organic Photovoltaics for Building Integration

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Abstract

Organic photovoltaics (OPV) has attracted tremendous attention as a promising alternative to silicon wafer-based technologies for building integration. While significant progress has been achieved on the power conversion efficiency of OPV technologies, their field stability is rarely studied. This work investigates the field performance and reliability of a large-area OPV module designed for BIPV application in the tropical region of Singapore for 4.5 years. The device suffered more than 14% degradation in power at the standard testing conditions from the initial performance, largely due to losses in fill factor (-12% relative). During the monitoring period, it exhibited comparable performance to more conventional silicon PV technologies, with an average specific energy yield of about 4 kWh/kWp/day and an average performance ratio of 0.96. Excellent performance at low light conditions was also observed. However, its field performance was heavily impacted by soiling, which typically led to a 5 to 10% loss in the current output after several months. Further, the device's outdoor performance also showed a three-stage degradation process, including (1) an initial slow degradation in the first two years (about -1%/year), (2) a stable period with negligible performance loss from year 2 to year 3.5 and (3) a rapid degradation in the last year (about -5%/year).

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