A Circuit-Based Approach to Simulate the Characteristics of a Silicon Photovoltaic Module With Aging

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Résumé en anglais	The aging of photovoltaic modules results inevitably in a decrease of their efficiency all through their lifetime utilization. An approach to simulate the evolution of electrical characteristics of a photovoltaic module with aging is presented. The photovoltaic module is modeled by an equivalent electrical circuit whose components have time-dependent characteristics determined under accelerated tests. By entering sun irradiance and temperature, I–V and P–V curves as well as efficiency evolution can be simulated over years assuming equivalent time. The methodology is applied for the case of a monocrystalline photovoltaic module modeled by a one-diode circuit and aging laws are determined with experimental results of damp heat (DH) tests 85 °C/85% RH performed by Hulkoff (2009, “Usage of Highly Accelerated Stress Test (HAST) in Solar Module Aging Procedures,” M.S. thesis, Chalmers University of Technology, Göteborg, Sweden). A power degradation rate of 0.53%/yr is found. A parametric study shows that the rundown of optical transmittance of the upper layers with aging has the most important impact by reducing the initial efficiency by 11.5% over a 25-year exposure contrary to electrical degradations which cause a decrease of 1.85% of the initial efficiency.
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