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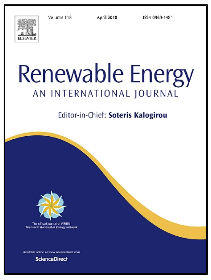

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Energy and economic losses caused by dust on residential photovoltaic (PV) systems deployed in different climate areas

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Abstract

Results of the study revealed that when dust impinged on the surface of the PV modules, monthly maximum power output of a 1.5 kWp system in Perth, Australia and a 50 Wp system in Nusa Tenggara Timur (NTT), Indonesia decreased, on average, by about 4.5% and 8%, respectively. Economic modelling showed that, the cost of production per kWh lost due to dust exhibited by these systems were A$ 0.26/kWh and A$ 0.15/kWh, respectively. Comparison of the cost of energy losses and maintenance revealed that, the Perth system would require manual cleaning in October while the system in NTT would require cleaning in August and October. Although the saving in production losses is not economically significant, this cleaning schedule was recommended, particularly for small systems in NTT since the extra output can have a significant effect on the quality of life in remote villages. The key finding was that higher dust de-rating factors and more cleaning activity may be more appropriate for PV systems deployed in tropical climate areas than that in temperate climate regions. It is recommended that PV system Standards that use the 5% performance de-rating factor due to soiling are reviewed and consideration given to climate-dependent de-rating factors.

Keywords: dust, PV performance, economic losses, maintenance cost, solar home systems

Nomenclature

A$	Australian dollar
C_M	cost of materials applied for cleaning the PV system (A$)
C_{MA}	maintenance cost activity (A$)
C_O	cost of producing or buying electricity from other sources (A$/Wh).
C_{PL}	cost of production losses (A$)
C_{WF}	cost of workforce (A$)
DCF	dust correction factor
E_L	energy losses caused by dust (Wh)
E_{PV}	daily energy produced by the PV system (Wh)
$E_{PV,c}$	energy produced by the PV system in clean condition (Wh)
$E_{PV,d}$	energy produced by the PV system in dusty condition (Wh)
f_{cable}	de-rating factor for DC cable (%)
f_{dirt}	de-rating factor for dirt/soiling (%)
f_{man}	de-rating factor for manufacturing tolerance (%)
f_{temp}	temperature de-rating factor (%)
H_{tilt}	daily solar irradiation on the tilted plane, (Wh/m^2)
L_T	load capacity over a period T e.g. monthly (Wh)
N	number of modules in the PV system
P_{max}	maximum output power of the PV module (W)