

A Simple Model for Solar Panel Efficiency

Authors : Stefano M. Spagocci

Abstract : The efficiency of photovoltaic panels can be calculated with such software packages as RETScreen that allow design engineers to take financial as well as technical considerations into account. RETScreen is interfaced with meteorological databases, so that efficiency calculations can be realistically carried out. The author has recently contributed to the development of solar modules with accumulation capability and an embedded water purifier, aimed at off-grid users such as users in developing countries. The software packages examined do not allow to take ancillary equipment into account, hence the decision to implement a technical and financial model of the system. The author realized that, rather than re-implementing the quite sophisticated model of RETScreen - a mathematical description of which is anyway not publicly available - it was possible to drastically simplify it, including the meteorological factors which, in RETScreen, are presented in a numerical form. The day-by-day efficiency of a photovoltaic solar panel was parametrized by the product of factors expressing, respectively, daytime duration, solar right ascension motion, solar declination motion, cloudiness, temperature. For the sun-motion-dependent factors, positional astronomy formulae, simplified by the author, were employed. Meteorology-dependent factors were fitted by simple trigonometric functions, employing numerical data supplied by RETScreen. The accuracy of our model was tested by comparing it to the predictions of RETScreen; the accuracy obtained was 11%. In conclusion, our study resulted in a model that can be easily implemented in a spreadsheet - thus being easily manageable by non-specialist personnel - or in more sophisticated software packages. The model was used in a number of design exercises, concerning photovoltaic solar panels and ancillary equipment like the above-mentioned water purifier.

Keywords : clean energy, energy engineering, mathematical modelling, photovoltaic panels, solar energy

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