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Energy Collected and Delivered by PV Modules

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20.1 INTRODUCTION

This chapter deals with two different questions: “How much solar radiation reaches the surface of a photovoltaic (PV) collector?” and “What is the conversion efficiency of this solar radiation into electricity?” Both questions are analysed from the PV-system designer’s point of view, whose ultimate interests, depending on the type of application, are the determination of the PV collector surface needed to provide a certain required service, and the estimation of the average electricity yield from a certain PV array.

The input information available for the PV designer is usually restricted to the 12 monthly mean values of global horizontal irradiation, that characterise the solar climate of the location, and to the electrical characteristics of the PV modules under Standard Test Conditions (STC), as provided by its manufacturers. This chapter contains a whole set of procedures applicable to most PV engineering practical problems using only this input information. In particular, models to predict the long-term evolution of the solar radiation incident over any arbitrarily oriented surface, and also models to anticipate the electricity output of PV arrays operating in other than STC are described. Looking for practical usefulness, the chapter is, as far as possible, self-contained and the formulae are presented in such a way, that they can be applied directly to practical problems, even if sometimes empirical or cumbersome expressions have to be introduced. Some examples intended to clarify the proper use of the formulae have also been included.

The two above-mentioned questions intrinsically differ in nature. The random character of the solar radiation over the Earth implies that answers to the first question are never more than future predictions, unavoidably associated with a degree of uncertainty (even if very good past solar radiation data are available). This uncertainty is more than is commonly assumed, and represents a serious limit to the accuracy (or, more strictly, to