The objective of this thesis is to introduce a mathematical model for photovoltaic module based on manufacturing datasheet, ambient temperature and solar irradiation. This mathematical model of PV module is derived from its single diode equivalent electrical circuit using bond graph methodology. The developed model is employed to develop a new method allowing the identification of PV module's five parameters without going through iterative process. Where, all the parameters of the photovoltaic module are given as a function of both ambient temperature and measured solar irradiation. To prove the accuracy of the proposed model, comparisons are done at standard test conditions as well as at random climate conditions using experimental data. Moreover, the different representations of the PV module's single diode equivalent electrical circuit been used in modeling the PV systems, namely: five-parameter model, four-parameter model, and ideal model, can be employed in the energy analysis of photovoltaic module. These equivalent circuits are used for different purposes according to the objective, for instance, the ideal model is still used in many applications particularly power system analysis and water pumping. The accuracies of the three different representations of single-diode equivalent electrical circuit of photovoltaic module are done through the calculation of the absolute relative error of the maximum output power and its corresponding voltage and current at standard test conditions as well as at random climate conditions using experimental data too