

# The voltage asymmetry of batteries discharge in the off-grid solar systems

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## Abstract

Off-grid solar systems in spite of elements such as photovoltaic panels, inverters and charge regulators always consist of energy battery. At present the cheapest solution of energy storage is an battery made using technology Pb. To obtain the necessary parameters for the rate of battery charging, depth of discharge, the kind of work - now rarely an electrolyte in liquid form (ACID) is used in batteries of that type. The most common solution for use in low temperatures is AGM technology, and to provide the possibility of reversible depth of discharge (deep cycle) - technology GEL. Batteries in both of those technologies are mostly produced for a voltage of 12 V – at present it is a production standard. In order to obtain higher voltages, batteries are connected in series, to achieve greater capacity, parallel connections are used. Modern off-grid solar systems are rarely designed for a voltage of 12 V, the need of the use of booster voltage converter lowers the efficiency of the system. Therefore, solutions based on a 24 V battery (2 serially connected 12 V batteries) such as SMA, Victron, Steca are dedicated to solar systems. Systems with four 48 V batteries, for example Effekta can be also found. The paper presents the real study of the absence of balancing battery strings. It is displayed as a scatter in the battery voltage in the serial strings. Researches made in real systems show how the size of the load and the choice of applied batteries, a type of charging, and even the length of the applied cables linking battery systems is essential for non-uniform distribution of voltage. Researches have been conducted on new batteries and the ones after a few years of usage. Researches have been carried out on batteries of the same type and capacity, but with varying degrees of wear, and combined into a single serial system. Effective ways of balancing of lead solar cells available on the market have been presented.