19.1 CHARGE CONTROLLERS AND MONITORING SYSTEMS FOR BATTERIES IN PV POWER SYSTEMS

In PV-powered systems, batteries are still the component with the lowest average lifetime. Compared to solar modules, which in principle have an infinite economic lifetime and in many cases offer a guarantee period of 25 years, the lifetime of batteries is much lower. The maximum lifetime found in practice is around 8 to 10 years; in most cases it is in the range of 3 to 6 years and in some cases even lower. The upper limit will be determined by normal ageing; the shorter lifetimes are mostly caused by inappropriate treatment or unsuitable control strategies. This topic is discussed in Chapter 18.

Looking at the battery cost in a typical PV diesel system, one can find that its share of the initial costs is around 15%. Because of repeated replacement of exhausted batteries, this initial share grows to more than 35% or even 50% over the expected 25-year service life of the system. Compared to this, the costs for solar modules and other balance-of-system components become small.

To achieve minimum lifetime costs and satisfying operation of the PV system, equipping the battery with appropriate peripherals is money well spent. Some examples, such as systems to automatically mix the electrolyte to prevent acid stratification or automatic water-topping systems, are explained in Chapter 18. Besides this, the application of appropriate operation modes is a crucial factor.

In this chapter, the technical realisation of the key component, the "charge controller", will be described. Furthermore, a new system to operate long battery strings optimally will be introduced.

19.1.1 Charge Controllers

The fundamental task of a charge controller is to operate the battery within the safe limits defined with respect to overcharging and deep discharging by the battery manufacturer or by the operation mode.

Compared to conventional battery chargers powered by the public grid, the situation is much more complex in PV systems. Here, charging power and energy are limited and depend on the varying insolation and load demand. Well-known charging strategies such as constant-current–constant-voltage charging (CC/CV) or more complex charging strategies, cannot be applied one to one. For example, in PV systems the charging current varies according to the insolation. Nevertheless, the term used is "constant current charging". Also, regular full charging of the battery – which is very important for a long service life – cannot be guaranteed.

Furthermore, very high energy efficiency is crucial for all balance-of-system components in PV systems. Most grid-powered battery chargers offer only unsatisfactory efficiency values.

In the following sections, the fundamental technical concepts of charge controllers [1, 2] as well as the associated control strategies will be explained. In addition, a list of criteria will be given that should be taken into account when developing or selecting charge controllers.