### *19.1.1.1 Self-regulating PV systems*

In small systems, such as house-number illumination or power supplies for measurement systems, a charge controller can be avoided in special cases.

This is, for example, true for NiCd batteries, when the current provided by the PV module is lower than the continuous charging current accepted by the battery. Also, such "self-regulating" systems have been used in the past for systems in the 50-W range such as light buoys.

In these systems illustrated in Figure 19.1, only a series diode is needed to block reverse currents from flowing into the module at night. To prevent overcharging of the battery, specially tailored PV modules with, for example, 30 crystalline-silicon cells will be used for 12-V lead acid batteries. With this low number of cells, the operating point will move into the steeply sloping part of the module's $I-V$ curve when the battery is fully charged.

To make this kind of system operate reliably, the load profile as well as the insolation and temperature at the place of operation must be known accurately. Because cheap and reliable charge controllers are available today in the market, such "self-regulating" systems should be avoided.

In all cases, deep-discharge protection according to Section 19.1.1.6 should be implemented.

### *19.1.1.2 Linear charge controllers*

When PV applications commenced, the well-known principles of conventional linear charge controllers were adapted to photovoltaics. These principles do not take advantage of the special properties of solar cells, for example, that they are infinitely tolerant to short circuits. Therefore, the initial linear charge controllers have been replaced by the switching charge controllers described below.

Meanwhile, novel integrated voltage controllers have appeared in the market, which make the principle of linear charge controllers a reasonable option in the power range up to about 50 W like in Solar Home Systems (SHS).

In a linear charge controller, the charging current will be adjusted by a final controlling element that acts continuously and is located either in series or in parallel with

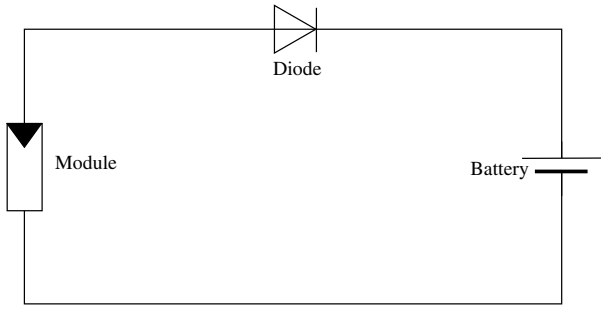


**Figure 19.1** "Self-regulating" PV system without a charge controller