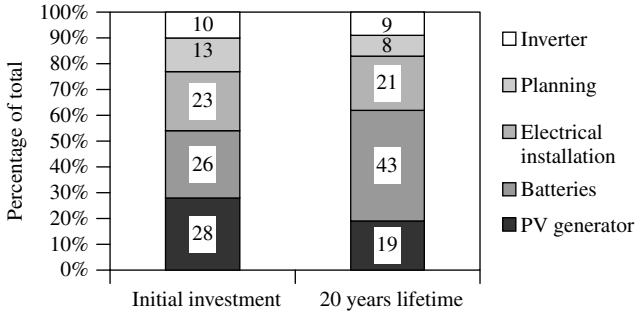

Figure 1.13 Breakdown of costs of a stand-alone PV installation with an optimum size storage. Differences in the initial investment and the life cycle investment are due to replacement of batteries during the 20 year life

We can see that in this case the PV modules represent approximately a quarter of the cost, while the cost of the batteries exceed that of the PV modules, especially when their periodic replacement over 20 years is included. This makes a very important and little appreciated point: even if we could make PV modules for free, the life cycle cost of the stand-alone system in Figure 1.13 would only be reduced by 25%! Clearly, batteries must be examined more closely. It is fortunate that many important applications do not require battery storage and therefore are free from this major cost burden.

Batteries are in most cases the lead-acid type. While automobile batteries are optimized for providing strong current for a short period to start the car, the ideal batteries for PV systems are so-called "deep cycle" batteries that can yield a large fraction of their charge (deep discharge cycle) and must operate with high efficiency and long duration. Yet, many PV applications use standard "shallow discharge" auto batteries due to their ubiquitous availability and lower initial cost (due to massive worldwide markets and applications) to the detriment of the long-term PV system cost. Some of the modern batteries such as those based on lithium ion or lithium polymer used in laptop computers or mobile phones could be used in solar applications but they are too expensive and are not significantly better than properly managed lead-acid batteries. This is studied in detail in Chapter 18. As said before, the relatively high cost of the batteries is further increased when we consider the costs over the PV system's life cycle since the batteries have to be replaced every four to eight years due to their relatively short lifetime. Therefore, good maintenance procedures to increase the battery lifetime are important but not always applied. Alternative methods of storage exist but they will not replace lead-acid battery, at least, not in the next ten years.

The battery charge controller is essential for the long life of the battery. It is an electronic device that prevents overcharging and excessive discharging, both of which can dramatically shorten the battery's life. In large systems, equilibration of the battery charging (so that all battery cells charge equally) should also be incorporated. In hybrid systems, which combine photovoltaics and a diesel or wind generator, the control unit must connect and disconnect the different generators according to a plan. Also, loads can be categorized, so that in case of low battery charge and low PV output, some loads can be disconnected while some essential ones are maintained active.