from the PV generator the fuel cell takes the oxygen from the air and the hydrogen from the tank to produce electrical power.

This concept allows operating the system with very high reliability with respect to the power supply throughout the year without any conventional fuel. The shift of energy from the summer to the winter is beneficial, as, otherwise, in Central Europe a larger PV generator or motor generator would be required to fulfil the energy requirements during winter. Numerous other systems of this type for different applications have been developed and installed by R&D projects within the last decade (e.g. [39–41]).

18.6 INVESTMENT AND LIFETIME COST CONSIDERATIONS

While designing an autonomous power supply system, it is essential to face the lifetime costs rather than looking only into the initial investment costs. The battery has major impacts on the system design, system operation and overall costs.

- The battery causes a considerable part of the initial investment costs.
- The size of the battery influences significantly the solar fraction of the power supply system.
- Typically, more than two-thirds of the energy flow in an autonomous power supply system goes across the storage system. Therefore, the battery acts as an important consumer of electrical energy due to its efficiency of less than 100%.
- The battery voltage influences the selection of the electronic components or vice versa.
- The battery is subject to ageing. Ageing depends very much on the operating conditions of the battery. Operating conditions depend on system sizing and control strategy.
- The lifetime of the battery determines the running costs through the replacement investment.
- The battery needs regular maintenance.
- Depending on the type of the battery, the different requirements of the battery room have to be considered. The requirements are defined in the standards.

These facts are valid for all battery technologies. For the system design, the characteristics of the chosen battery technology must be taken into account. For the following considerations, only lead acid batteries are taken into account.

Investment costs for lead acid batteries depend very much on the technology and the quality of the battery. Typical costs for end users are in the range of 75 to 250 €/kWh. Lifetimes are – depending on the operation conditions – 3 to 8 years. Depending on the sizing of the system (days of autonomy) and the lifetime, the battery will be subjected to 100 to 1000 capacity throughputs. This results in electricity costs of 0.20 to 0.75 €/kWh dedicated to the storage unit. Additional costs occur for the peripherals, the charge controllers res. chargers and maintenance.

Lead acid batteries need maintenance once or twice a year to check the cell connectors, to measure all cell or block voltages to identify weak cells, to clean the tops of the batteries to avoid creeping currents between the poles, to refill water for flooded batteries