This example is just to illustrate the importance of an integrated system planning and design. Powerful tools are necessary and available [42]. The battery is the component with the highest cost share in autonomous power supply systems. Other than in photovoltaics, cost reductions on battery investment costs will be small within the next few years as lead acid batteries are already a commercial product today with a market of more than 10 billion euro per year in the different applications. Cost reductions can occur from improved lifetimes and optimised operation strategies. These figures also show that little tolerance for higher battery costs is given. This is important for the estimation of the market entry of other or new storage technologies. Higher specific costs per kilowatt hour of energy supply and significantly lower efficiency than that achieved today with lead acid batteries will hardly be accepted by a commercial market.

18.7 CONCLUSION

Even though there is a wide range of possible solutions for storage in autonomous power supply systems, the economic boundary conditions focus all solutions on lead acid batteries. This will not change significantly for some years. Their electrical properties are very good. Nevertheless, they have a bad reputation among system designers and operators, which is mainly due to the fact that batteries have a limited lifetime. Owing to their electrochemical nature, they have very complex operation and ageing patterns. Technically speaking, batteries have several time constants. Rapid levelling out of microcycles occurs in the millisecond range, diffusion processes in the seconds and minutes range, state of charge in the hour and day range and ageing effects in the day, month and year range. Batteries have a memory with regard to operation conditions. Faults in the operation can often hardly be repaired, but might show their negative impact much later. Further, currently no method exists that allows a determination of the state of health of the battery within minutes. Nevertheless, it is most likely that lead acid batteries will be the leading storage technologies in autonomous power supply systems for many years to come. This will be especially true if the still available improvements in the lead acid technology concerning lifetime in autonomous power supply systems can be realised.

Mainly lithium batteries have enormous growth rates in the portable market segment. Today, it is difficult to forecast the costs for larger units in terms of capacity for lithium batteries – actual forecasts expect costs in the range of 150 €/kWh and from the technical parameters the lithium batteries are most suited to autonomous power supply systems.

Double-layer capacitors will have their market in applications with very high power demands in the range of a few seconds or less and most probably in combination with an electrochemical battery.

In general, a battery is considered to be “used up” when it has less than 80% of the rated capacity guaranteed by the manufacturer. Nevertheless, this usually does not mean that the battery is completely non-functional. From field experience, it is well known that batteries can be used easily down to 50% of the rated capacity. However, the users must be aware that the days of autonomy are reduced according to the capacity loss and the power available from the battery is reduced due to ageing.