ESTIMATION OF THE ECONOMICAL VALUE OF A SECOND LIFE EV BATTERY: CASE STUDY

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Overview

In renewable energy power plant, the instant production usually does not correspond to the demands in terms of energy. Hence the need of an energy storage system [1] to store the energy produced during low-demand hours and distribute it during high-demand hours in order to alleviate the load on the grid. That is called peak-shaving [2].

In term of power and energy, electric vehicles (EV) batteries seem suitable for this application [3]. The battery degrades over time, that is called the battery aging. Their performances are decreasing and they become of lower interest for an EV application. These batteries are currently being recycled or simply discarded after use [4]. However, they can still be used in other application. The question is whether or not it is economically relevant to use these batteries in second life for a peak-shaving application.

The objective of this paper is to estimate the economic value of the second life EV battery and to compare it to a new battery for the same application. A simple case is studied. Different technical aspects are taken into account such as the battery aging and its impact on the efficiency the total energy that it can deliver and the remaining use time. All of the above vary through ageing. There is a need to quantify these differences with a precise technical model. After which the eco

nomic value will be assessed using an economical model.

Methods

In order to conduct the techno-economic study, two models are combined. On one hand, a technical model of the Renault Zoe (2018) is built to estimate the battery aging and its consequences. On the other hand, an economical model is built to estimate the value of the second life battery and compare it to a new battery, the value depends on key parameters that are obtained by the technical model.

The model of the Renault Zoe is structured using to the EMR formalism (Energetic Macroscopic Representation formalism) [5]. This model allows an assessment of the state of health (SoH) of the battery, that represents the battery aging. In first life, the WLTP cycle is considered to be performed twice a day for three days before recharging the battery. This cycle is used to assess the consumption of cars, it lasts 30 minutes and around 23 km.

The economic model takes into account the value of the equivalent new battery for the same application, the operation and maintenance costs, the cost of make-up electricity, energy delivered through the remaining life of the battery and the round-trip efficiency of the battery. Most of those parameters differs from first to second life battery. The costs are compared using the levelized cost of storage (LCOS). The study also takes into account the social cost of carbon (SCC). That allows an assessment of the benefits of using a second life battery.

Results

The model is used to represent an average driver usage. The swap to a second life usage is realized when the battery SoH reaches 80%, which is about 10 years of daily usage from the studied scenario with the Renault Zoe. The results are presented in Figure 1. The second life usage continues until the SoH reaches 70%, after that the battery behaviour becomes faster and can be unsafe (electrolyte leakage…) [6]. In this scenario, the battery has a total lifetime of 13 years. During the second life (3 years), the battery executes around 716 Full Equivalent Cycles (FEC) for a total of 24.5 MWh of transferred energy.

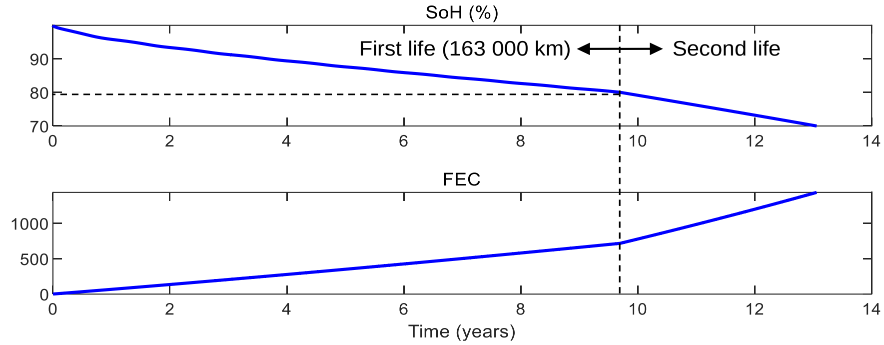

Figure 1 SoH and FEC evolution with a first life of 9.7 years

We can observe that the battery aging is faster during the second life. That is because the exchange of energy per day is higher for the battery in second life in the considered scenario.

According to some studies [7], [8], the usage of second life batteries is not worth compared to buying a new battery for the same purpose. In most of those studies, the battery characteristics are considered constant regardless of the application. However, that is not the case in reality, due to ageing, the battery parameters change through its lifetime, and some characteristics such as its efficiency differs depending on the application and the current involved. Due to that, the use of a technical model linked to an economic one allows a realistic estimation of the economical value of batteries.

Conclusions

The value of a second life battery is heavily dependant on the application in which it is used. It also depends on the timing involved and the different additional values that it takes into account like user willingness to pay for additional driving range or governmental subsidies. For the case studied in this paper, the usage of a second life battery does not seem relevant economically speaking due to the high decrease in new battery prices over time. However, that could be different for other applications or driver behaviour.

Merging technical and economic models represents a good opportunity to study the economical interest of certain projects using realistic values. It is also useful to forecast when the battery will die and how to delay or accelerate that time. The use of a technical model coupled with an economic one allows an assessment of costs closer to the reality than a model based exclusively on theorical values.

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