Durability of On-board Battery for Electric Vehicle

SOCE Error

- **There are differences between SOCE and SOH, meaning that new calculation methods need to be developed.**

➢ $SOCE_{measured}$=$UBE_{measured}$/$UBE_{certified}$

1 $$UBE_{measured} = UBE_{measured,nc} - \Delta E_{REESS,CC_{ave}}$$

2 $$UBE_{measured,nc} = \sum_{i=1}^{n} \Delta E_{REESS,i}$$

3 $$\Delta E_{REESS,i} = \frac{1}{3600} \times \int_{t_0}^{t_{end}} U(t)_{REESS,i} \times I(t)_{REESS,i}\, dt$$

4 $$\Delta E_{REESS.CC,ave} = \sum_{i=1}^{n} \Delta E_{REESS,avg,i,CC}$$

5 $$\Delta E_{REESS,avg,i,CC} = \frac{1}{3600} \times \frac{1}{t_{end,CC} - t_{start,CC}} \times \int_{t_{start,CC}}^{t_{end,CC}} \int_{t_{start,CC}}^{t_{end,CC}} U_{REESS,i}(t) \times I_{REESS,i}(t) dt\, dt$$

SOCE Error

- The simplified test method of $UBE_{measured}$

$$UBE_{measured} = Q * SOHC * \left(\int_{SOCL}^{SOCH} Uocv * dSOC + \int_{SOCL}^{SOCH} Iref * Rcell * SOHR * dSOC\right)$$

  - Q: Certified Battery Capacity
  - **SOHC**: State of Health – Capacity (affected by consistency and ageing of battery)
  - **SOCH:** State of Charge - High (affected by the increased resistance after battery ages)
  - **SOCL**: final SOC when the UBE test ends (affected by the initial power performance and DCR increase of battery)
  - $dSOC$**:** Change of SOC (affected by accuracy of SOC)
  - U_{ocv}: OCV curve (the curve will shift after ageing)
  - Iref: Current under WLTP at the beginning of life
  - **Rcell:** Resistance under WLTP at the beginning of life (affected by the change of temperature and consistency of battery during the test procedures)
  - **SOHR**: State of Charge – Resistance (the proportion of which the battery resistance increased)

Calculation Error

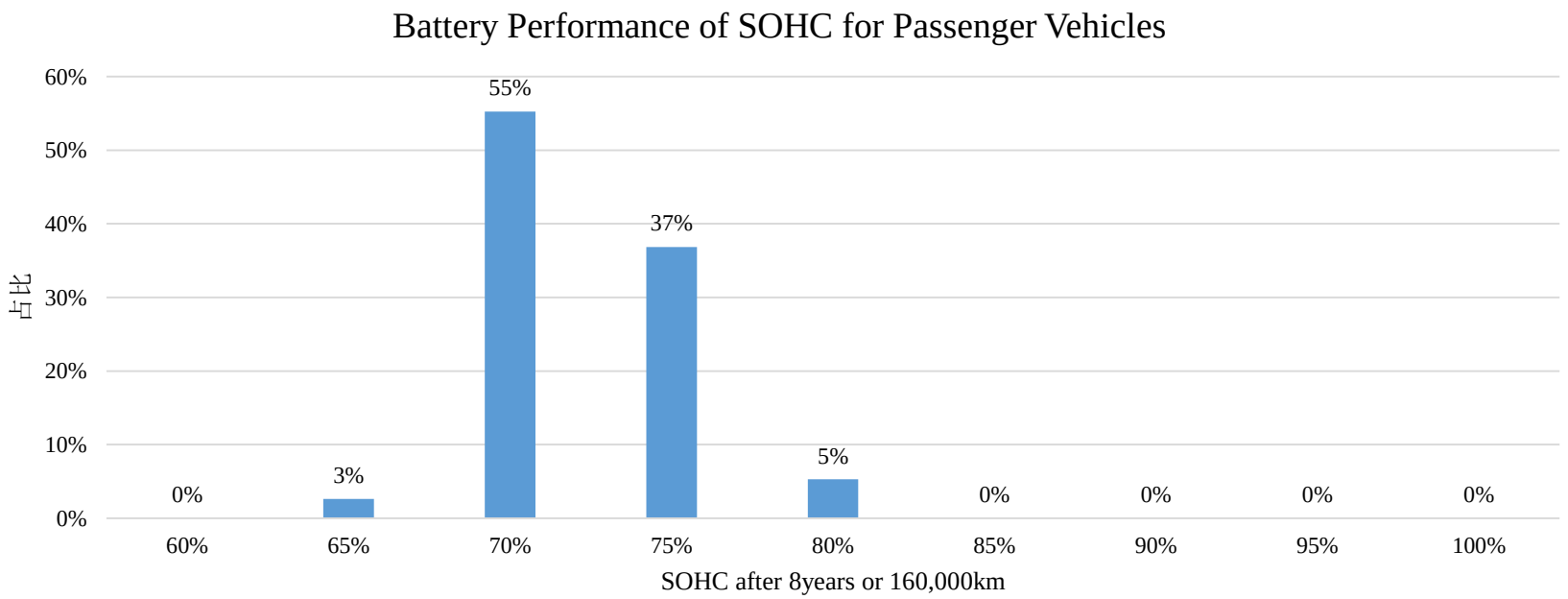
- SOHC: Accuracy 3%~5%
- SOC: Accuracy 3%~5%
- Uocv: Accuracy ~1%
- Rcell: 10%
- SOHR: 5%~10%
- $UBE_{certified}$difference between certified and actual values

Estimated SOCE Error

- SOCE: > 5%

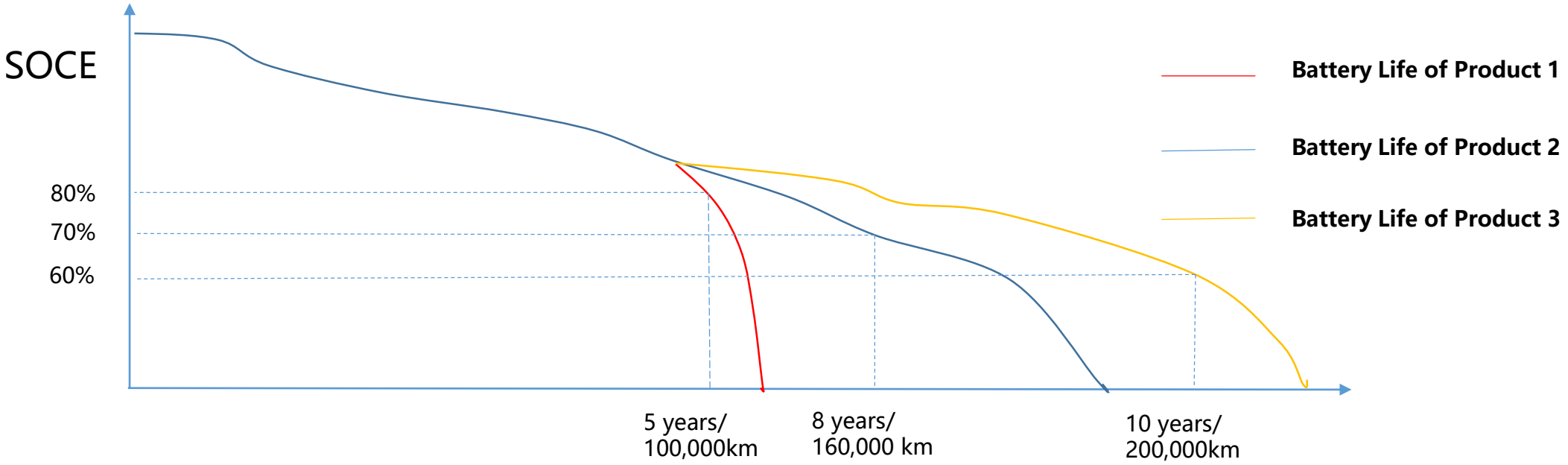
MPR-SOCE

- The most common approach in the industry is to measure SOH in terms of capacity. The expected SOHC of most batteries is 70% when they reach 8 years or 160,000km, which is different from the SOCE requirement. In general, SOCE is lower than SOHC.
- Since SOCE is calculated through data read, there is deviation between the data read and the actual value of battery energy. Considering all the possible errors, SOCE might not be able to reflect the most exact SOH of the battery.



MPR-Lifetime

- The battery life depends largely on the cost and application requirements of vehicles. Only some of the vehicles are in need of applications that could satisfy the 8 years or 160,000km requirement. It is not necessary to set MPR for products that have exceeded their designed battery life.
- The main purpose of N1 category vehicles is carrying goods. The power consumption, driving range and frequency of discharge of N1 category are quite different from vehicles under the M category. Besides, the actual battery life would be designed based on different requirements for mileage. It is necessary to set different mileage requirements for N1 category vehicles.



Summary

- It is important to study and figure out a more accurate way of reflecting on the actual vehicle durability, meaning that more data needs to be collected and analyzed for SOCE accuracy verification.

- It is important to take into consideration the actual requirements for different vehicle application scenarios and battery life when setting the age- and driving range-based requirements.

- It is important to consider the possible calculation error of SOCE/SOCR when setting the MPR.

Thank you for your attention.