EV Battery Durability GTR

UNECE EVE #43

February 3-4, 2021

ALLIANCE
FOR AUTOMOTIVE
INNOVATION

Data Analysis

- Current Datasets
  - Warranty
  - TEMA Model
  - Geotab
- Next Steps
- Recommendations

Warranty Analysis

- Warranties are a contract between the customer and the manufacturer based on technical, commercial, and competitive analysis.
  - Customers can compare warranties and make the decision most appropriate for their circumstance

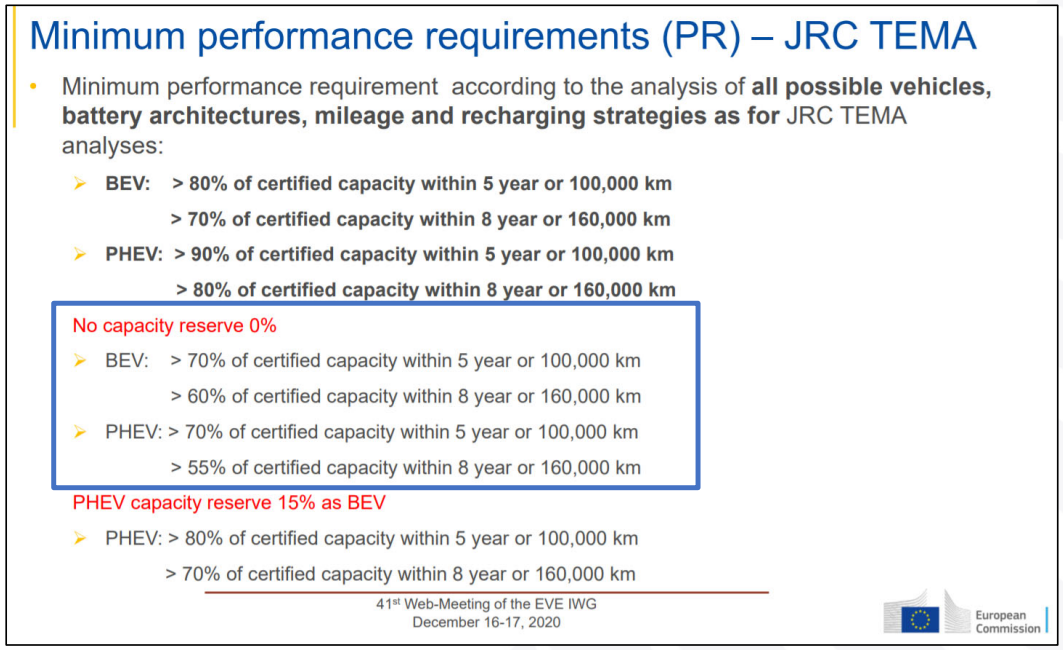
- Warranties provide customers assurance that their product will function within a given timeframe
  - It is not intended to be used to set performance requirements for the fleet

PEV Battery Warranties – US Market (* = Europe)

		Warranty against failure:		Includes
Manufacturer	Model	Years	km	degradation?
Audi	e-tron	8	160,000	NO
BMW	i3	8	160,000	70%
Chevrolet	Bolt	8	160,000	60%
Fiat	500e	8	160,000	NO
Hyundai	Ioniq, Kona	10	160,000	NO
Jaguar	i-Pace	8	160,000	70%
Kia	Niro EV	7*	150,000*	70%
Lexus	UX300e	10*	1,000,000*	70%
Mercedes	B-Class Elec drive	8	160,000	70%
Nissan	Leaf 40, 60	10	160,000	~75%
Porsche	Taycan Turbo	8	160,000	70%
Tesla	Model 3, Y	8	160-190k	70%
Tesla	Model S, X	8	240,000	70%
Volkswagen	e-Golf	8	160,000	70%

TEMA Analysis

- TEMA model assumed high-capacity reserve in its analysis
- Reserve should not be included in MPR development. This is a theoretical value in the model, which leaves no margin for implementation and engineering.
- Reserve should be eliminated to allow for engineering tolerances

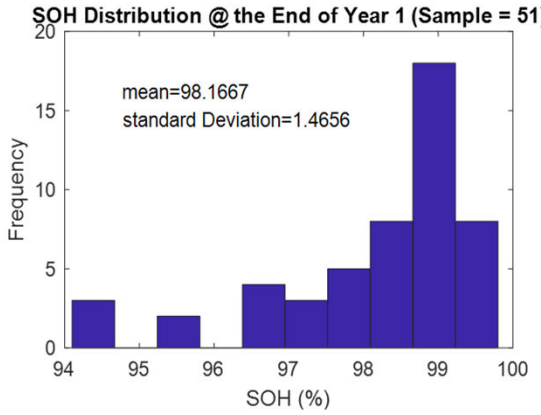


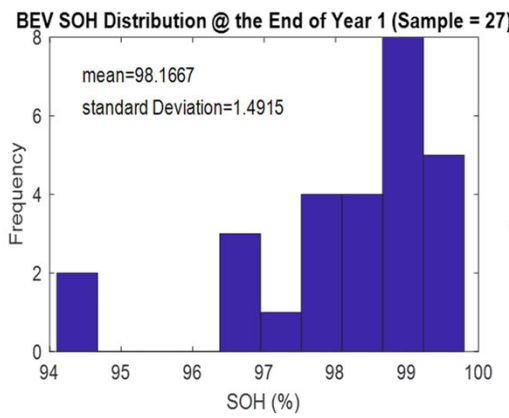
Geotab: Raw Data from EV SOH Database

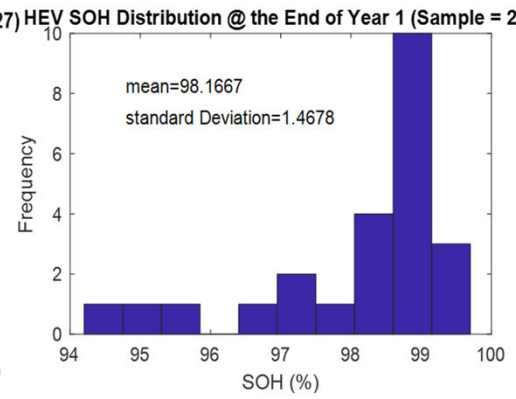
- Number of vehicle models used in this study – 21
- Number of vehicle models with different model year (sample size) – 51
- All 51 have either the end of year 2 or the end of 1 year + 8 month data.
- For those that have 1 year + 8 month data, the end of year 2 was extrapolated by using 1 year 4 month and 1 year 8 month data (They are deemed as “actual” or “raw” data in this study).
- Only year 1 and year 2 data were used to estimate 5-year and 8-year SOH (in order to provide an acceptable sample size).

Geotab: Raw Data Plots – SOH Distribution

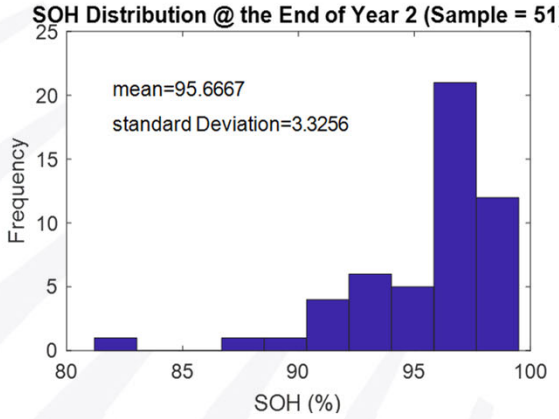
Year 1

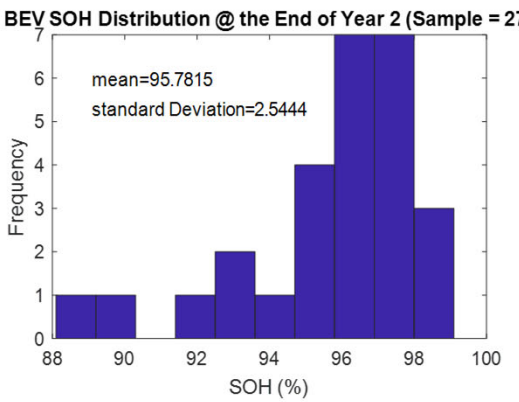


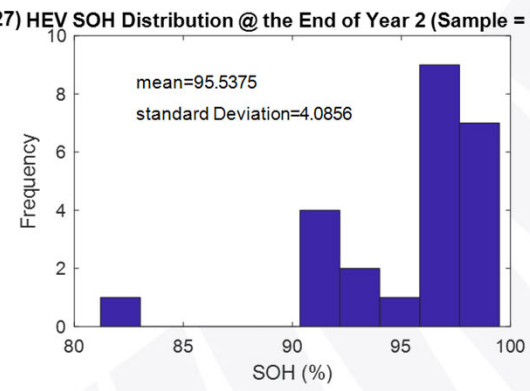




Year 2



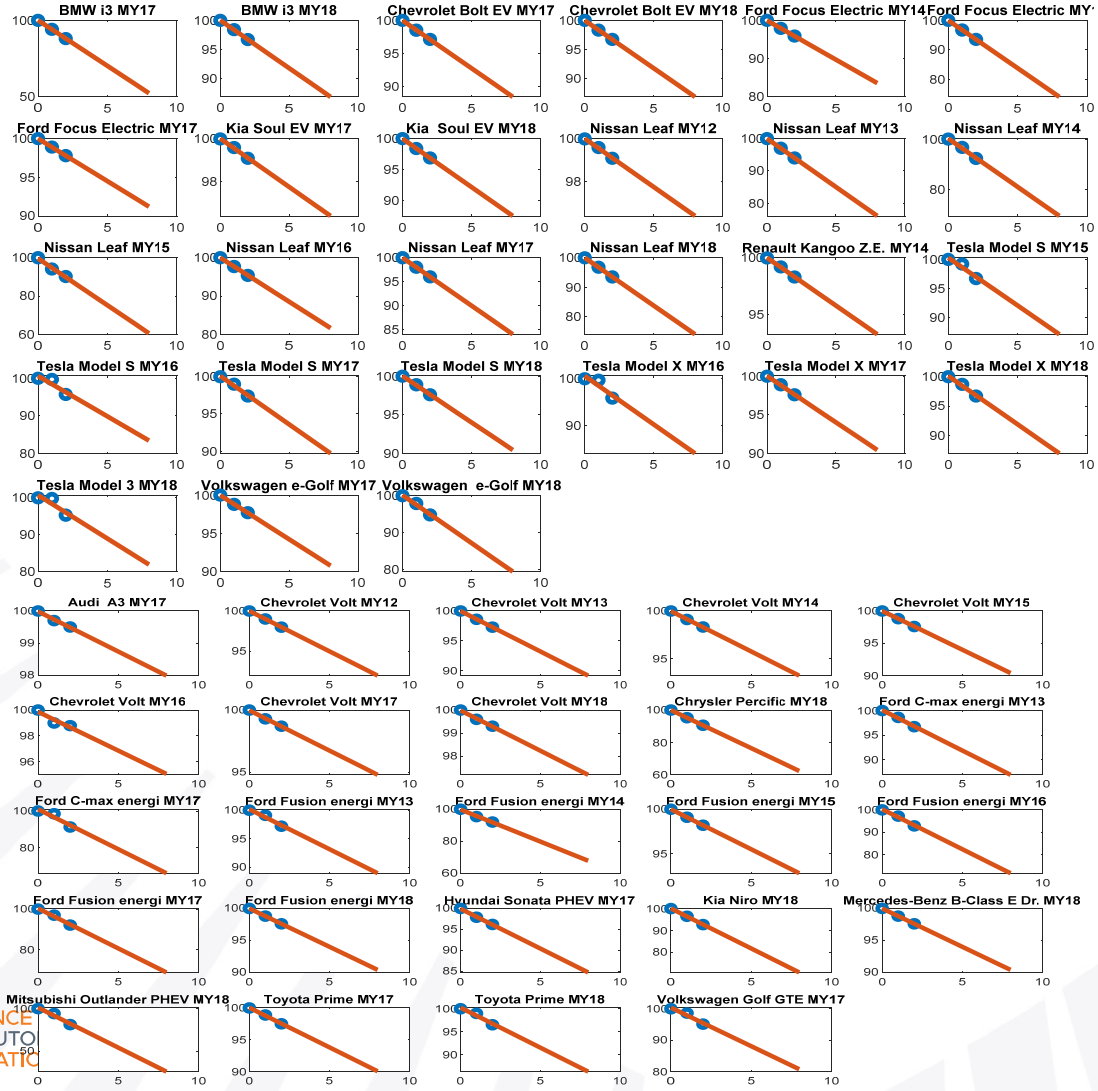




The term “HEV” and “PHEV” are being used interchangeably

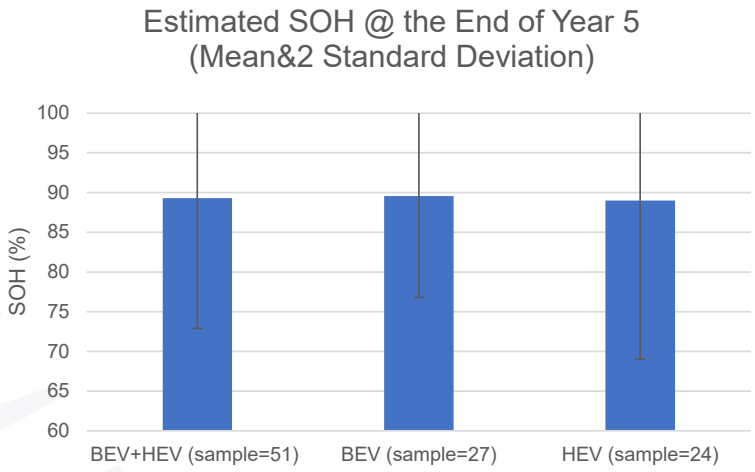
ALLIANCE FOR AUTOMOTIVE INNOVATION

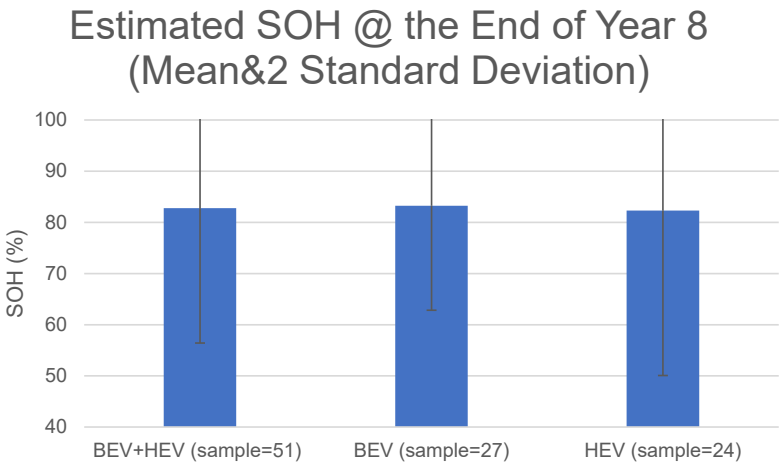
Geotab: Method for Estimation - Linear Regression

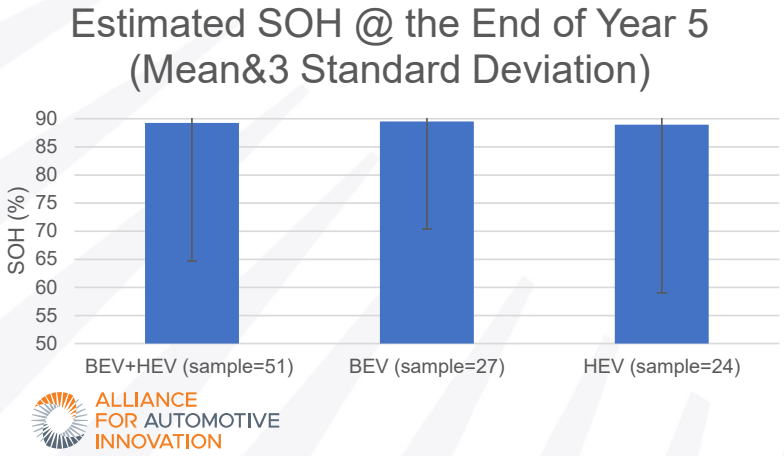


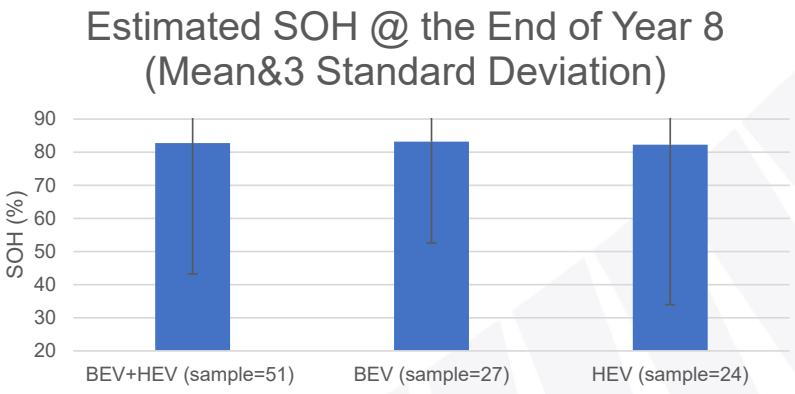
- Point (0 @ 100%) was used for all the vehicles.
- The line was obtained by using 3 data points.
- Year 5 and year 8 estimations are determined from the line for each individual vehicle.

Geotab: Fleet Mean and Two/Three Standard Deviation Range for year 5 and Year 8



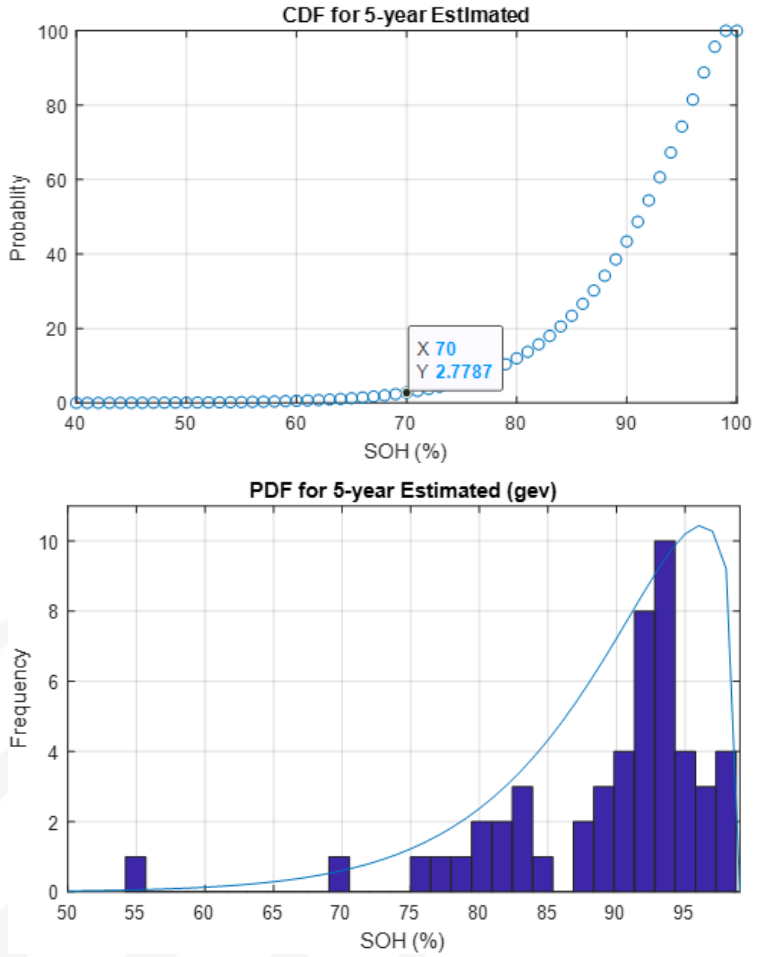






ALLIANCE FOR AUTOMOTIVE INNOVATION

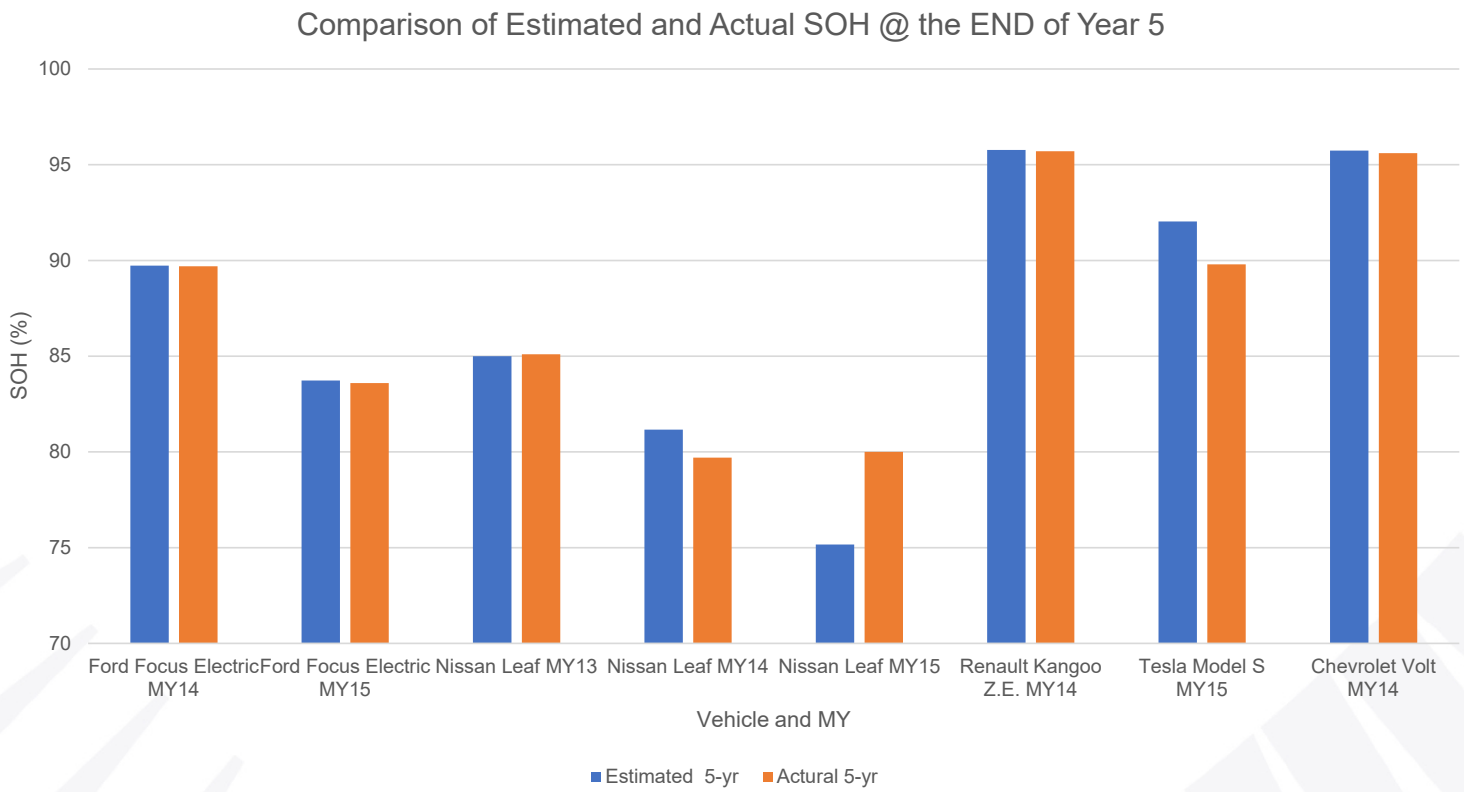
Geotab: Probability Estimates



- 5-year probability that ~3% of population is at or below 70%SOH.

ALLIANCE FOR AUTOMOTIVE INNOVATION

Geotab: Comparison of Estimated and Actual SOH for Year 5



- The two sets of results are very close for almost all the available data.

ALLIANCE FOR AUTOMOTIVE INNOVATION

Geotab: Limitations & Open Questions

- The prediction for the fleet may not be accurate due to limited vehicle models used in this analysis (probably the data from less than 1/3 vehicle models around the world have been available in Geotab database).

- More data points to use for the regression will improve the estimations. There are only 3 data points used for the regression for each vehicle in this study.

- Open Questions:
  - How does Geotab access vehicle data? Is it through an aftermarket OBDII port device?
  - How is the data accessed being interpreted to provide SOH?
  - Is Geotab attempting to calculate their own SOH using data on remaining capacity and state of charge?
    - There may be problems with how those values are developed and used within the vehicle CAN system
    - Geotab data likely doesn't account for the SOH accuracy issues that automakers are struggling with as they compare SOH calculation results with actual battery capacity values
  - It is unlikely that Geotab has any actual measured data on battery capacity to go with the data they took from the OBDII CAN bus
    - CAN bus numbers can look really clean, with no indication of just how much of an approximation they are.

- Data Specific Questions:
  - Vehicle SOH vs Time
  - Vehicle location
  - Mileage per year
  - Charge data
  - Ambient temperature data – average, max/min

Data Conclusions and Recommendations

Open questions on available datasets need to be addressed

- JRC response to TEMA questions from industry to be reviewed
- Deep dive analysis with Geotab – in process

Current data analysis

- TEMA model without battery reserve indicates a MPR level of 70% at 5 years / 100,000 km
- The Geotab linear regression analysis for 5 years indicates that 70% SOH is attainable, and that a higher SOH value cannot currently be supported by the data.
  - No significant difference in total degradation between BEV and PHEV.
  - Moving to a MPR higher than 70% will begin to filter out a large number of vehicles – at 80% MPR closer to 15% of all vehicles will fail the target.

Potential impact of basing MPR on current datasets

- Vehicles become less affordable
- Increased battery size/weight
- Innovations, such as V2G/V2B, could be hindered
- Customer dissatisfied by the requirement to replace battery that is meeting customer needs

Recommended next steps:

- Use phase 1 to collect data and establish an MPR representative of a large dataset on the most up-to-date vehicles. EVE IWG should identify exactly what data should be collected in phase 1.
- If phase 1 data collection is not agreeable, establish a Phase 1 MPR based on fleet average and introduce a backstop concept in Phase 2