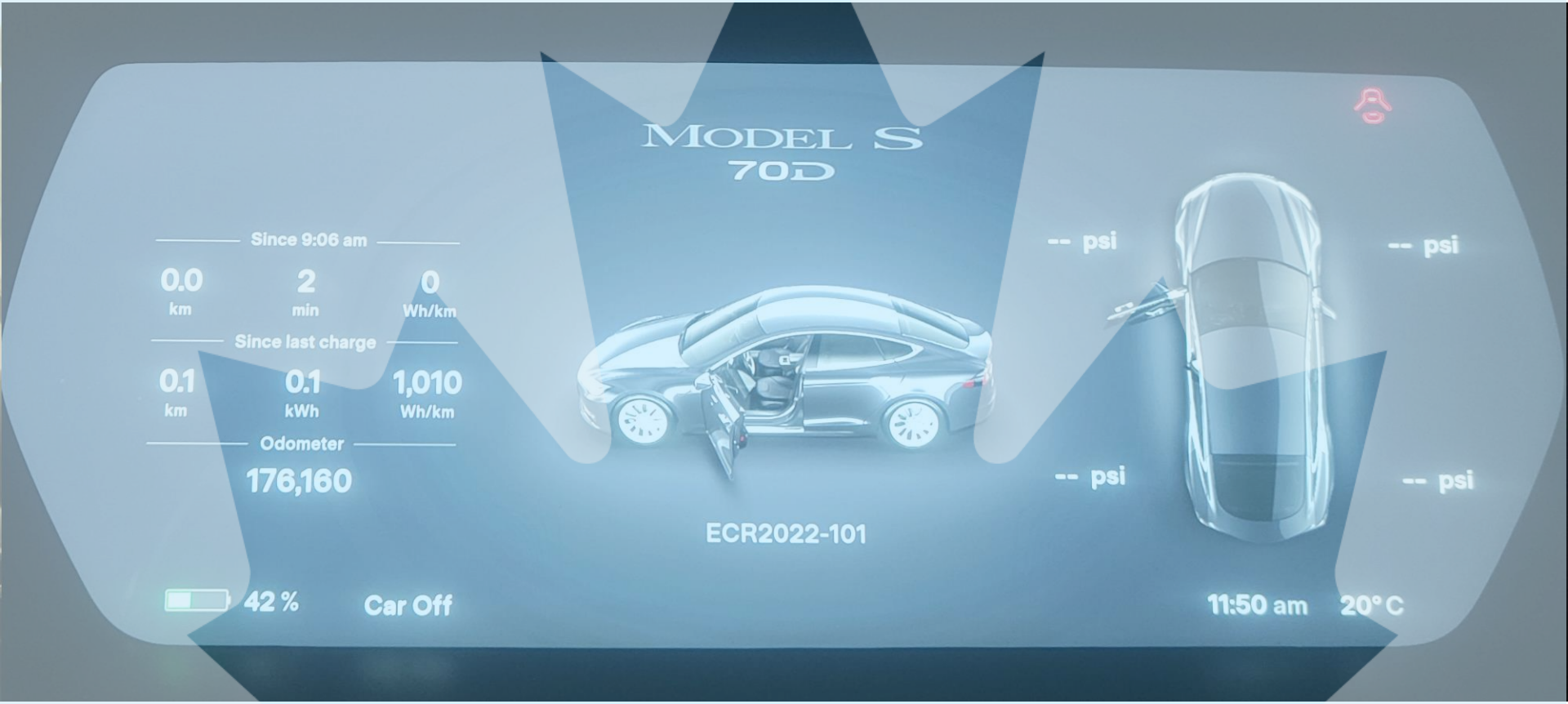
Low vs High Mileage Tesla S



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Reason for Study

- It is extremely rare to have the opportunity to test identical vehicles of the same vintage with vastly different mileages
- This testing will reveal the impact of mileage accumulation on battery degradation, SEPARATE from calendar aging effects
- This testing will also add to the very small in-lab dataset of combined mileage and calendar aging battery degradation effects

Limitations

- The history of the low mileage vehicle (LMV) is well known, as it has been owned by ECCC since 2016 when it was purchased new
- The history of the high mileage vehicle (HMV) is NOT known, so its first 7 years could have been spent in sweltering temperatures, ice cold climates, left at 100% charge, or rarely charged above 20%.
- Its unknown history can impact the results of this study

Use of Data and Findings

- UNECE EVE Working Group
- Publication in EVS38
- Datasets available for regulatory and policy model validation and input data

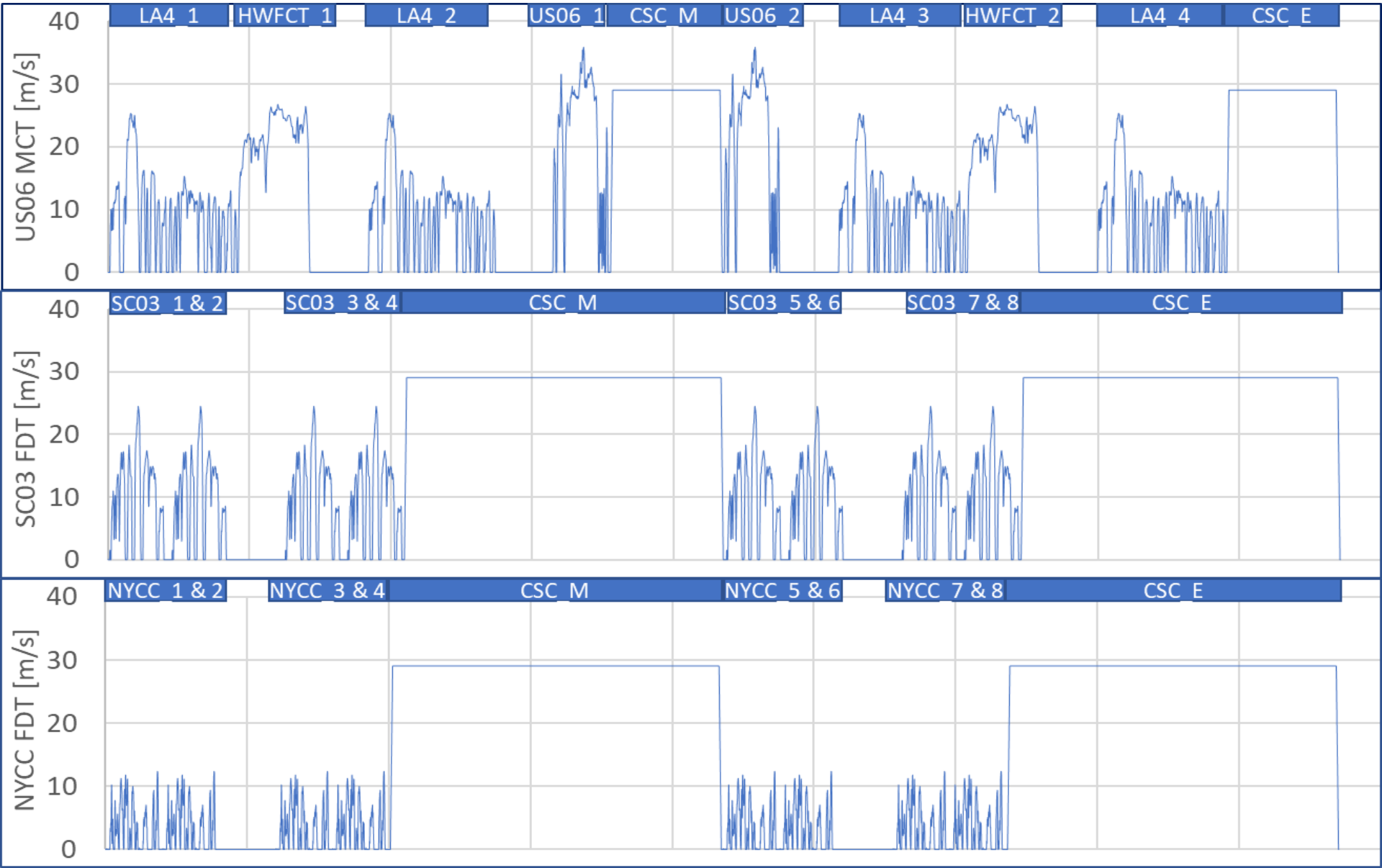
Program Design

- Acquire a high mileage (>160,000km) Tesla Model S of the same vintage and trim to the 2016 Tesla Model S 70D owned by ECCC (bought new 7 years ago)
- Subject these two vehicles to identical test sequences that capture its energy consumption and full useable battery energy
- Calculate and present the differences in the measured energy and range metrics

Test Matrix

Start Odo [km]	End Odo [km]	Test Specimen	-7°C		25°C		35°C
			US06 MCT	NYCC FDT	US06 MCT	NYCC FDT	SC03 FDT
14,013	21,553	LMV	3	3	3	3	3
176,200	184,386	HMV	3	3	5	2	4

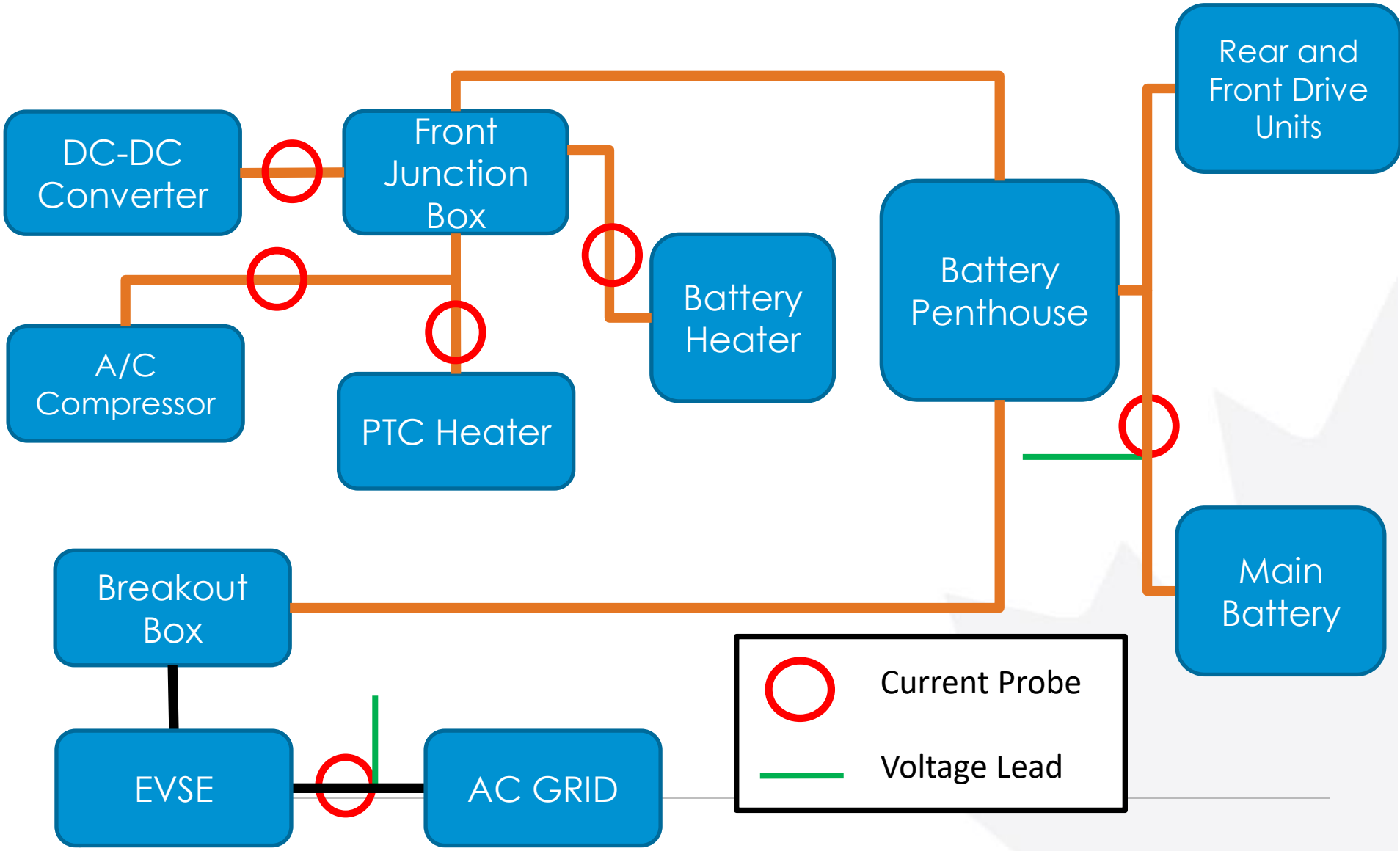
Test Sequences



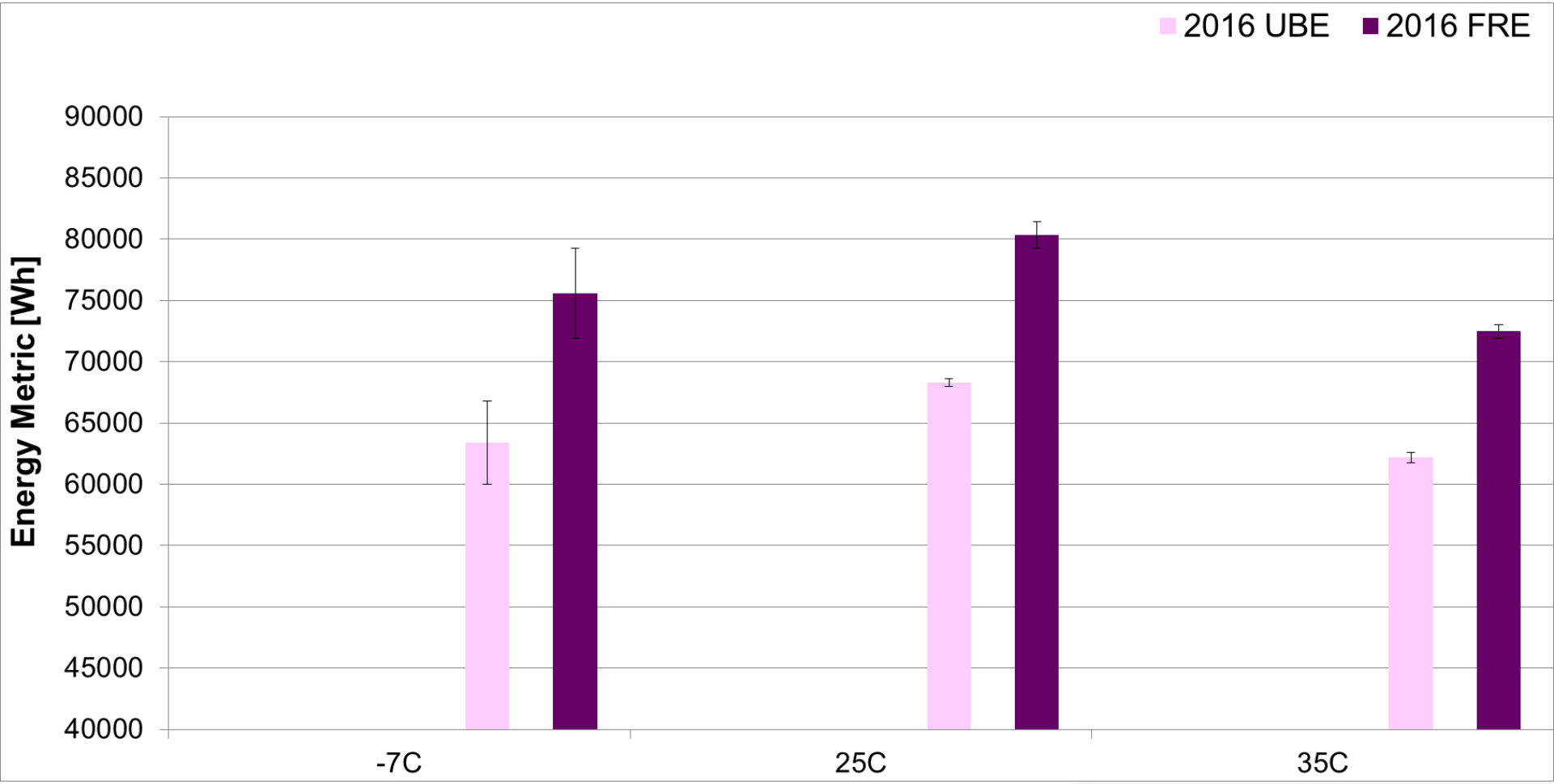
Test Conditions

- No accessories used during 25°C tests
- During 35°C and -7°C tests, 22°C heat setting was used, with automatic fan
- Variable speed fan used to cool the radiator
- All testing was done on a 4-wheel chassis dynamometer
- Augmented braking on the chassis dyno was disabled to allow for full regenerative braking potential to be utilized
- All driver ADAS features were disabled

Instrumentation



Comparing Energy Metrics



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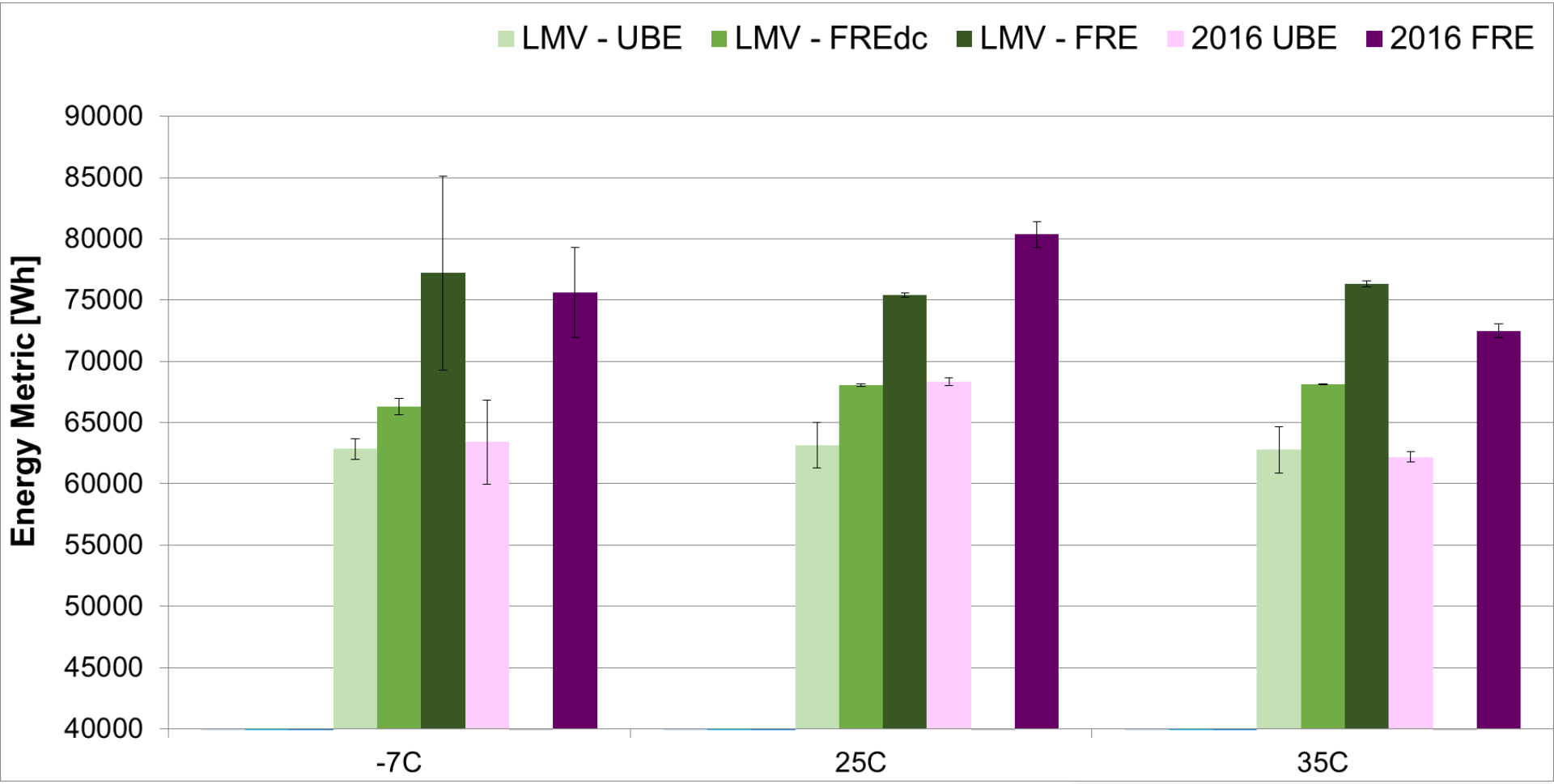
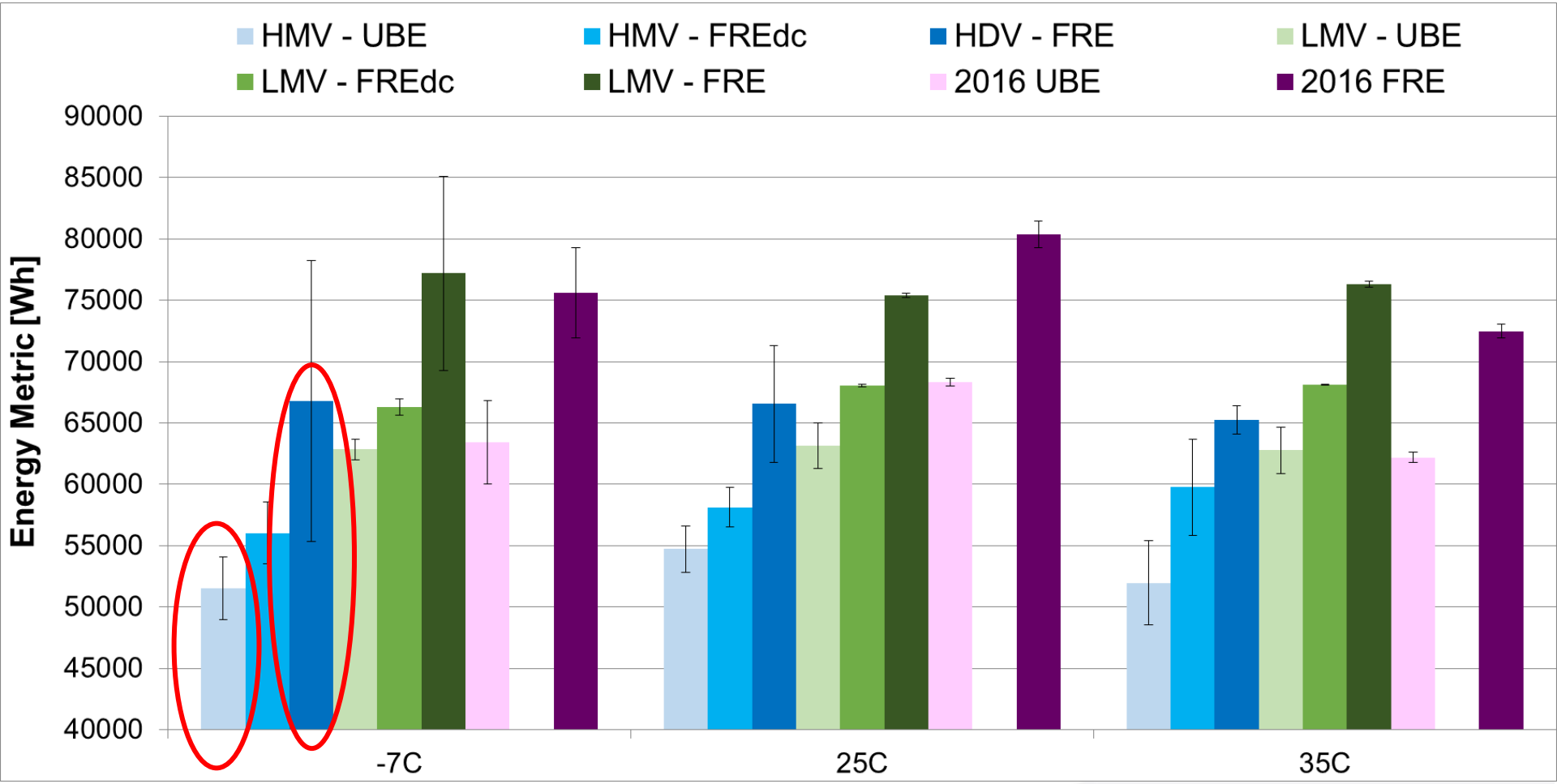


Comparing Energy Metrics



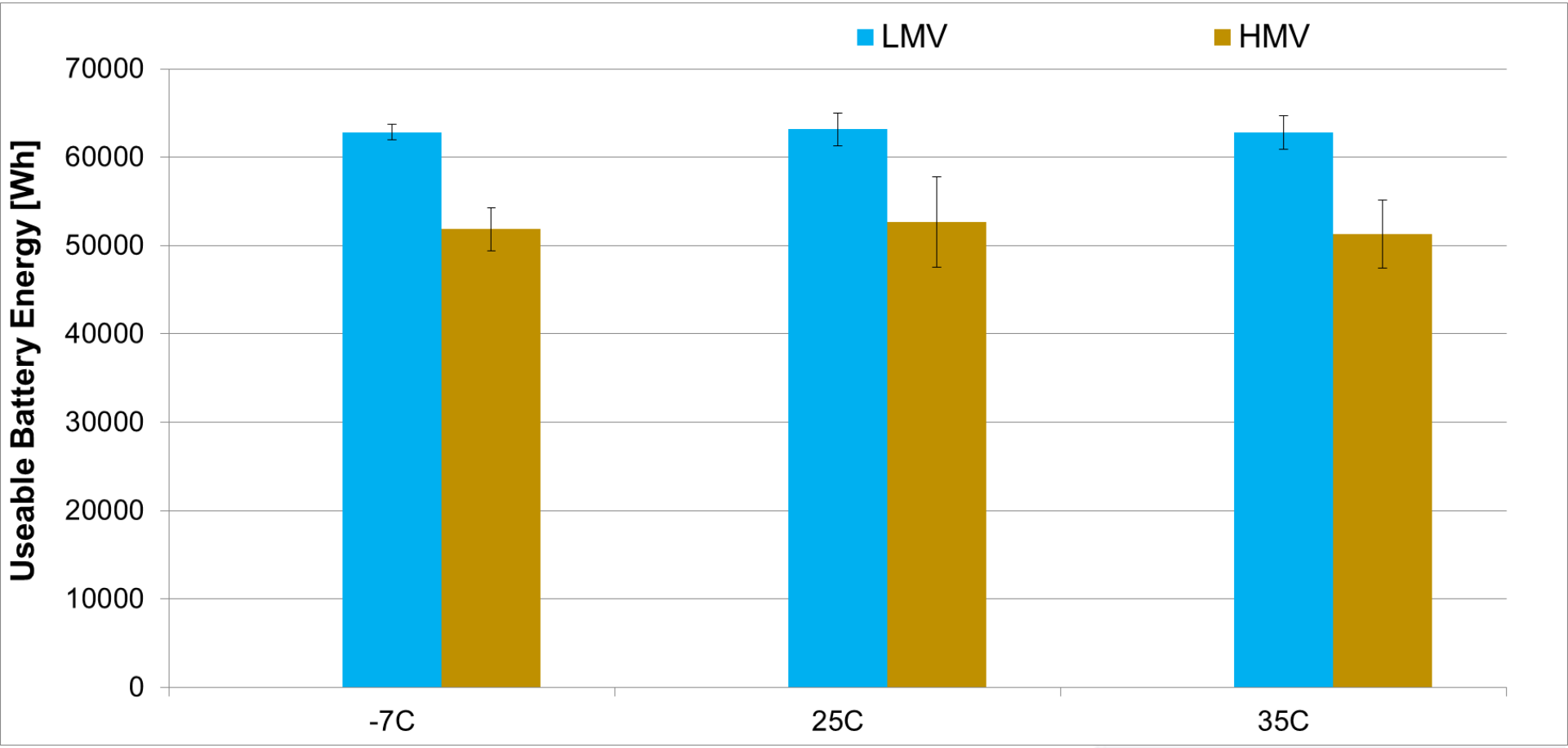
Energy Loss between AC Grid and Battery Discharge

Vehicle	-7°C	25°C	35°C
LMV in 2016	16%	15%	14%
LMV in 2023	19%	16%	18%
HMV in 2023	23%	18%	20%

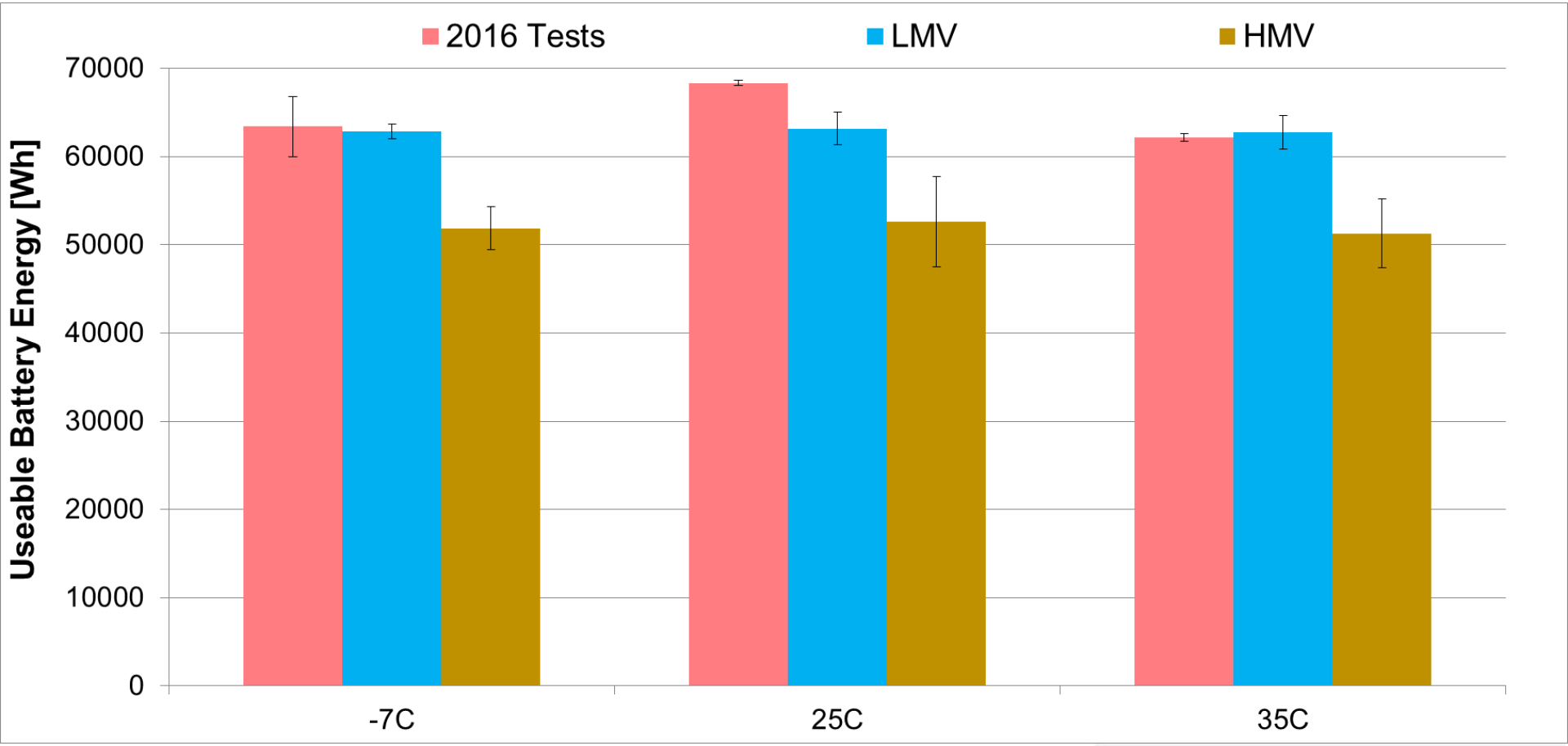
Why? Perhaps:

1. The HMV OBC converts AC level 2 energy to DC battery energy less efficiently than the LMV
2. The HMV battery isn't able to discharge as much of the charge energy it's received as the LMV

Glimpse at UBE



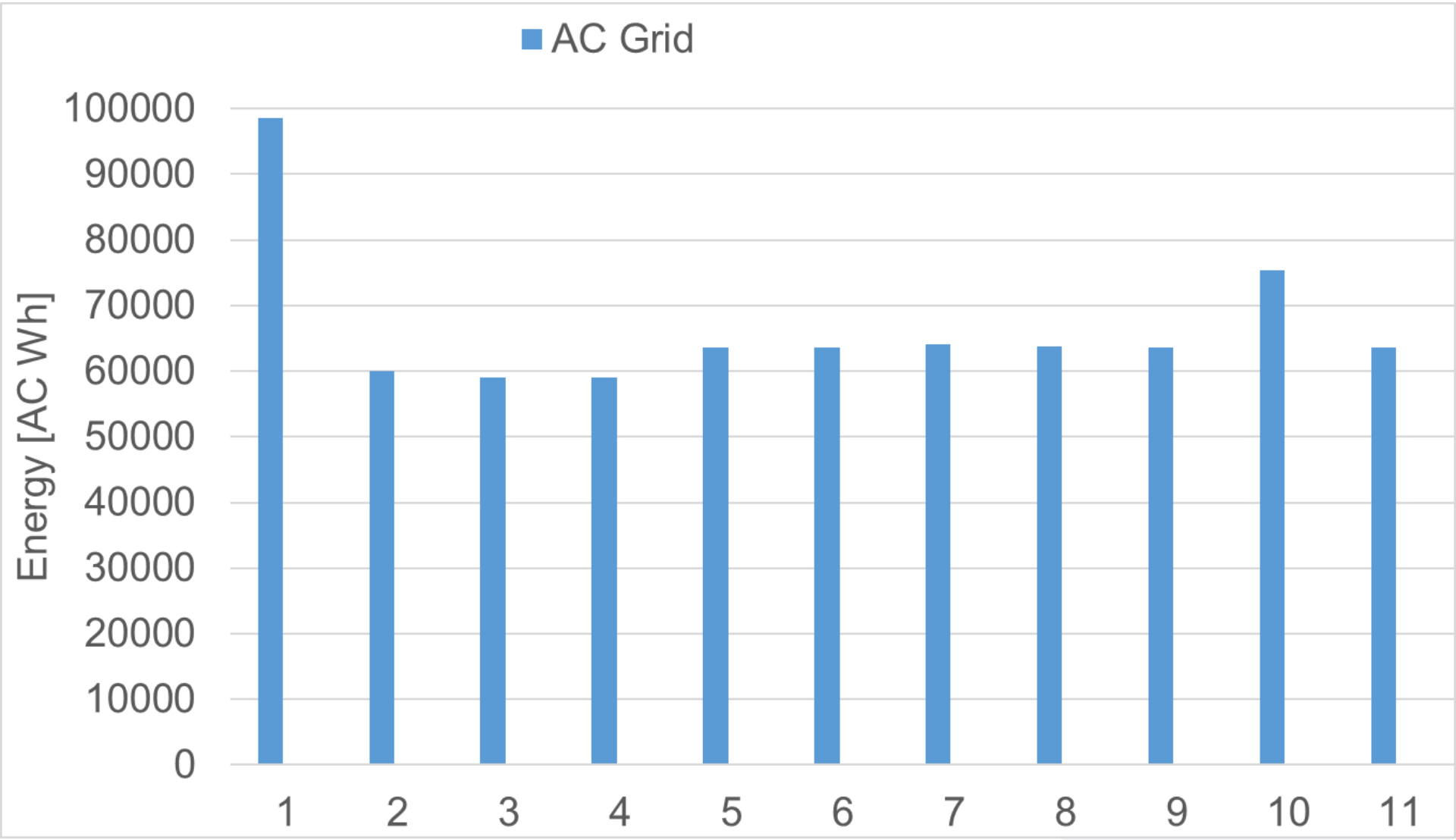
Glimpse at UBE



Comparing Energy Metrics

Loss of UBE from 2016 Testing			
Test Vehicle	-7°C	25°C	35°C
LMV	1%	8%	-1%
HMV	19%	20%	20%

Closer Look at Charging



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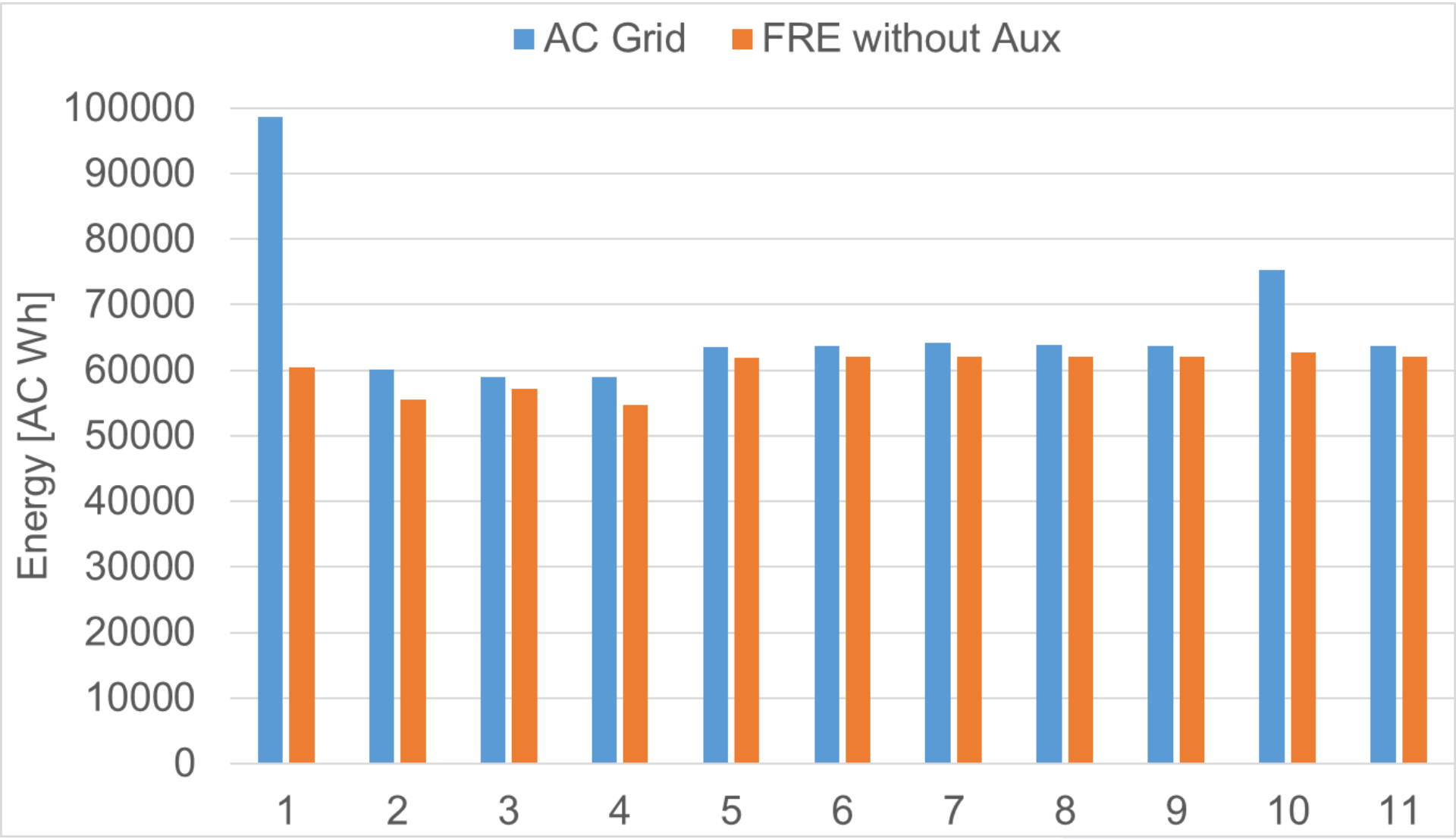

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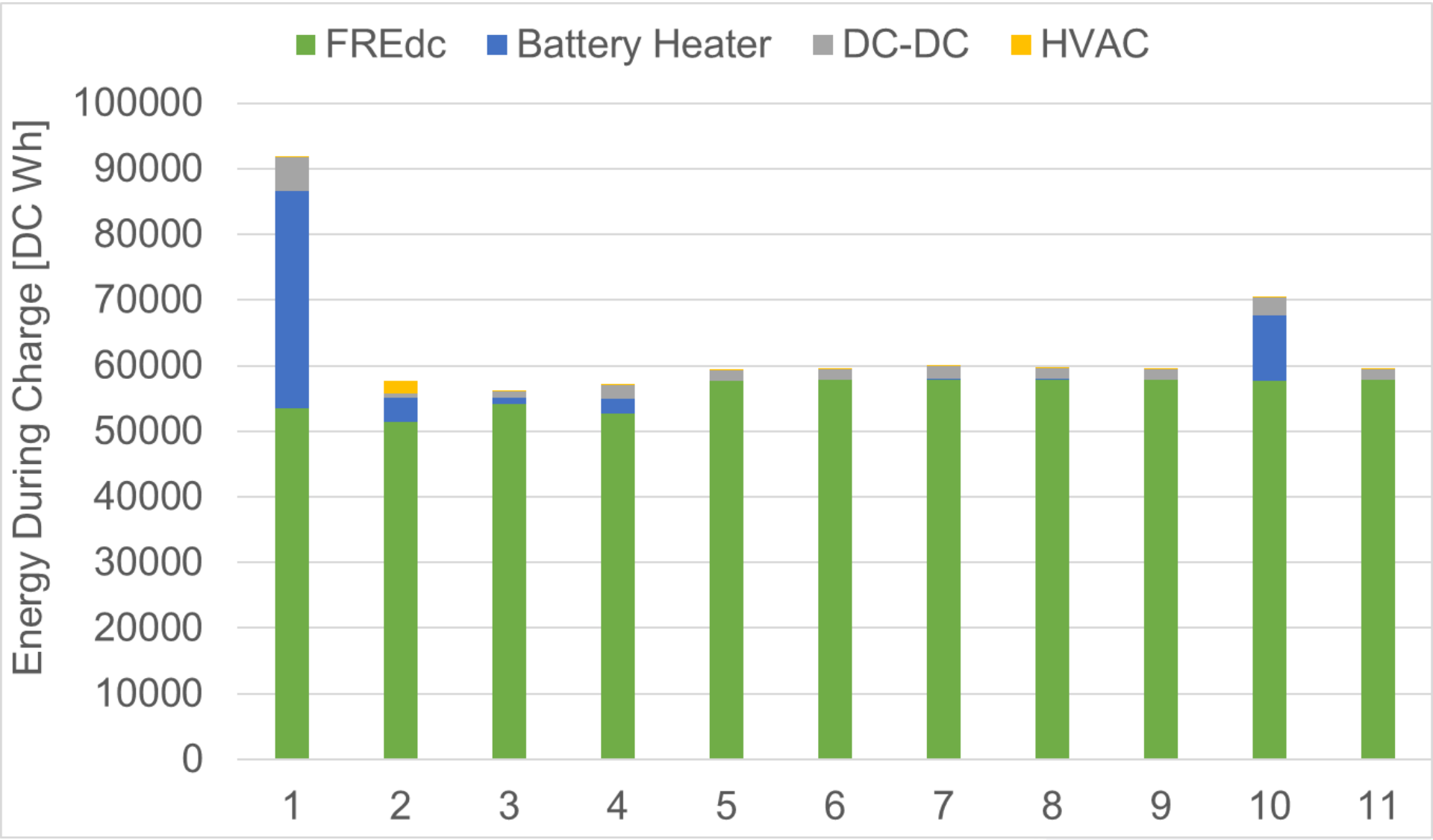

Big Takeaways

- Compared to the new condition, the LMV lost 8% UBE over 7 years primarily due to calendar aging.
- Compared to the LMV in its new condition, the HMV lost 20% UBE over 7 years and 176,000km.
- 160,000km more mileage results in the HMV having 8kWh less in available useable energy than the LMV, or 12% less original UBE than the LMV.

Big Takeaways

- The unknown history of the HMV adds some uncertainty to the performance of the HMV
- The unknown history of the HMV may contribute to its inconsistent performance
- The HMV OBC and battery exhibit higher energy transfer losses than the 2016 and 2023 LMV tests

Next Steps

- What is the history of the LMV? We can access this and determine if it was stored/used optimally, poorly, or anywhere in between
- OBD files need to be included in each test file, and will shed light on other metrics, such as battery cell temperatures, imbalances, states of charge, and range estimations. The OBD files will provide metrics that allow comparisons between CANbus and our high-fidelity regulation instruments

Next Steps - 2

- This is preliminary data. It requires further vetting.
- Cycle-specific energy consumptions and range estimations will be calculated
- Temporary effects of temperature on range, energy consumption and battery energy metrics will be analyzed
- Battery degradation results from both test vehicles will be compared to the Calendar and Usage Fade model developed by the JRC's TEMA group and described in Case Studies in Transport Policy 8 (2020) 517-534.
- Electric Vehicle Symposium 38?

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THANK YOU!

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