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Midsize and SUV Vehicle Simulation Results for Plug-In HEV Component Requirements

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FreedomCAR & Vehicle Technologies Program

FreedomCAR & Fuel Partnership

Argonne Has Leading Role in DOE PHEV Technology Development Efforts

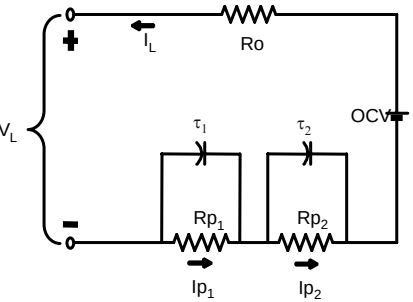
- Li-ion Battery Development and Testing
- Vehicle Modeling and Simulation
- Vehicle Control Strategy Development
- Vehicle Benchmarking
- Vehicle Test Procedure
- Market Penetration
- Cost Analysis

Energy Storage Requirements Include Systems-Level Testing

Component

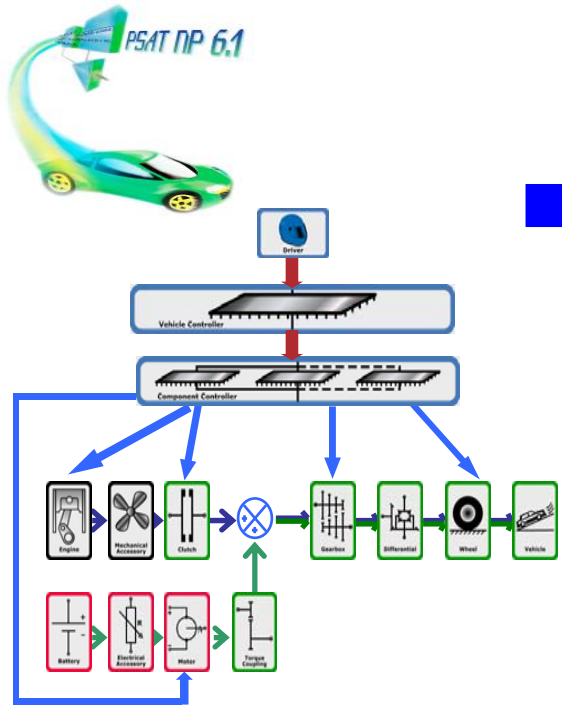
JCS VL41M

Testing



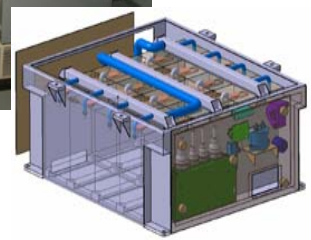
Model

Vehicle Simulation



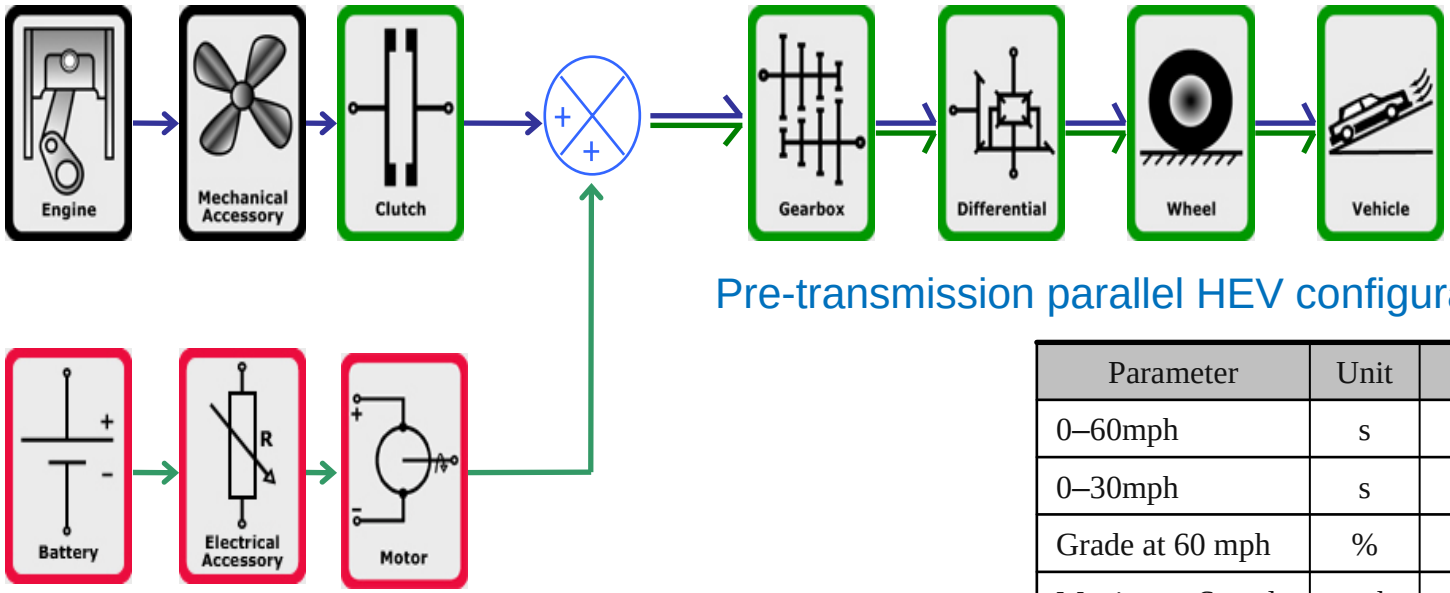
Component in System Context

ABC 150



JCS VL41M

Vehicle Assumptions



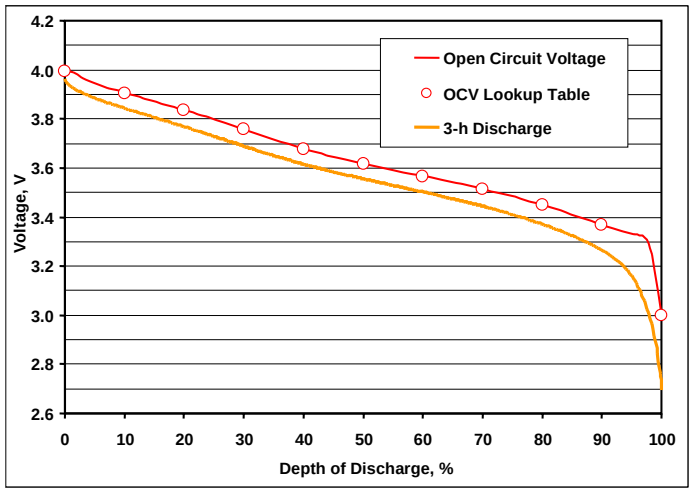
Pre-transmission parallel HEV configuration

Parameter	Unit	Value
0–60mph	s	9 +/- 0.1
0–30mph	s	3
Grade at 60 mph	%	6
Maximum Speed	mph	> 100

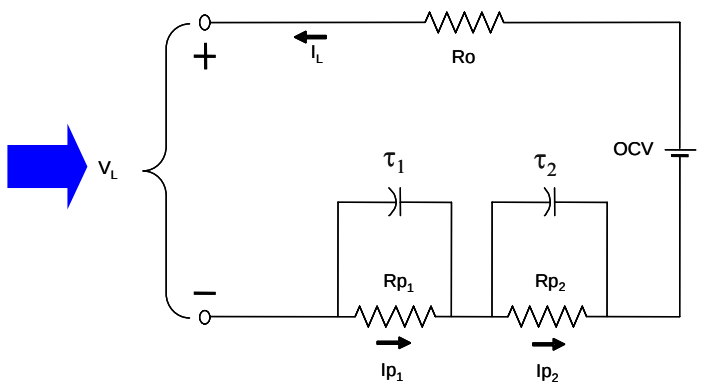
Parameter	Unit	Midsize Car	Midsize SUV
Curb weight	kg	889	1132
Frontal Area	m^2	2.244	2.46
Drag Coefficient		0.315	0.41
Electrical Power	W	800	1200

Accurate Battery Modeling Crucial to Generate PHEV Battery Requirements

- Discharge requirements for long periods resulting in considerable diffusion over-voltage.
- Available data from large capacity Li-Ion SAFT cells applied to SAFT VL41 M cell.
- These data were modeled and are the basis of the impedance equations used in the PHEV vehicle simulation study.



Test data

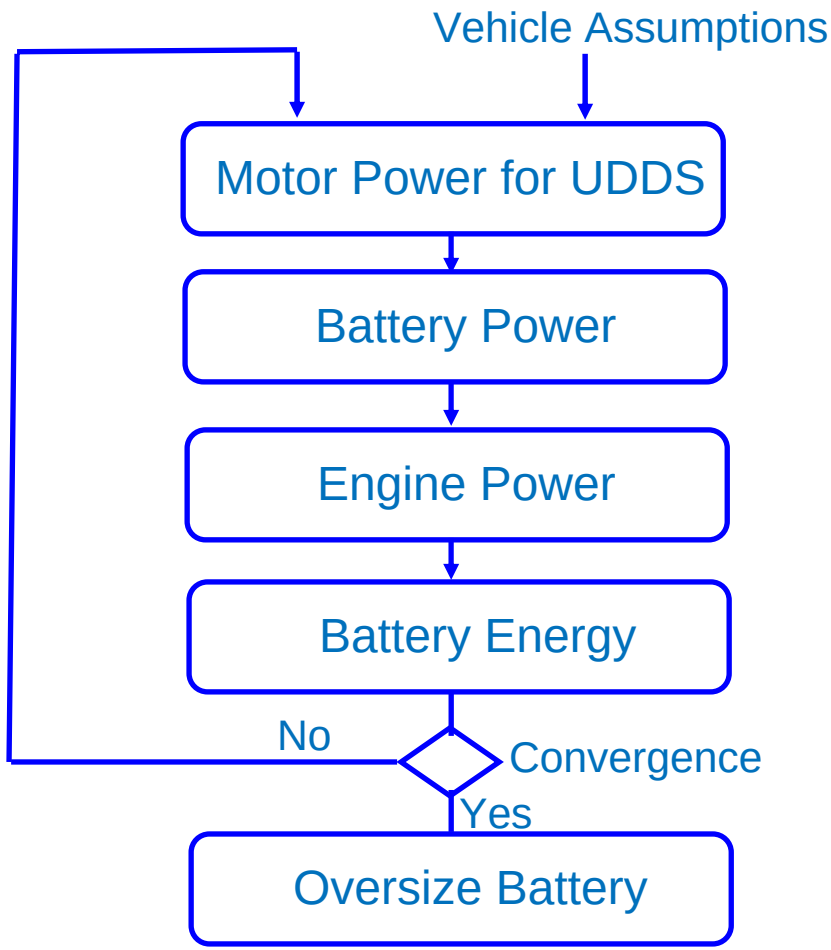


PHEV Model

Scaling Algorithm for Power & Energy

Scaling

Automated Sizing Process Implemented Including Oversizing



Associated Requirements

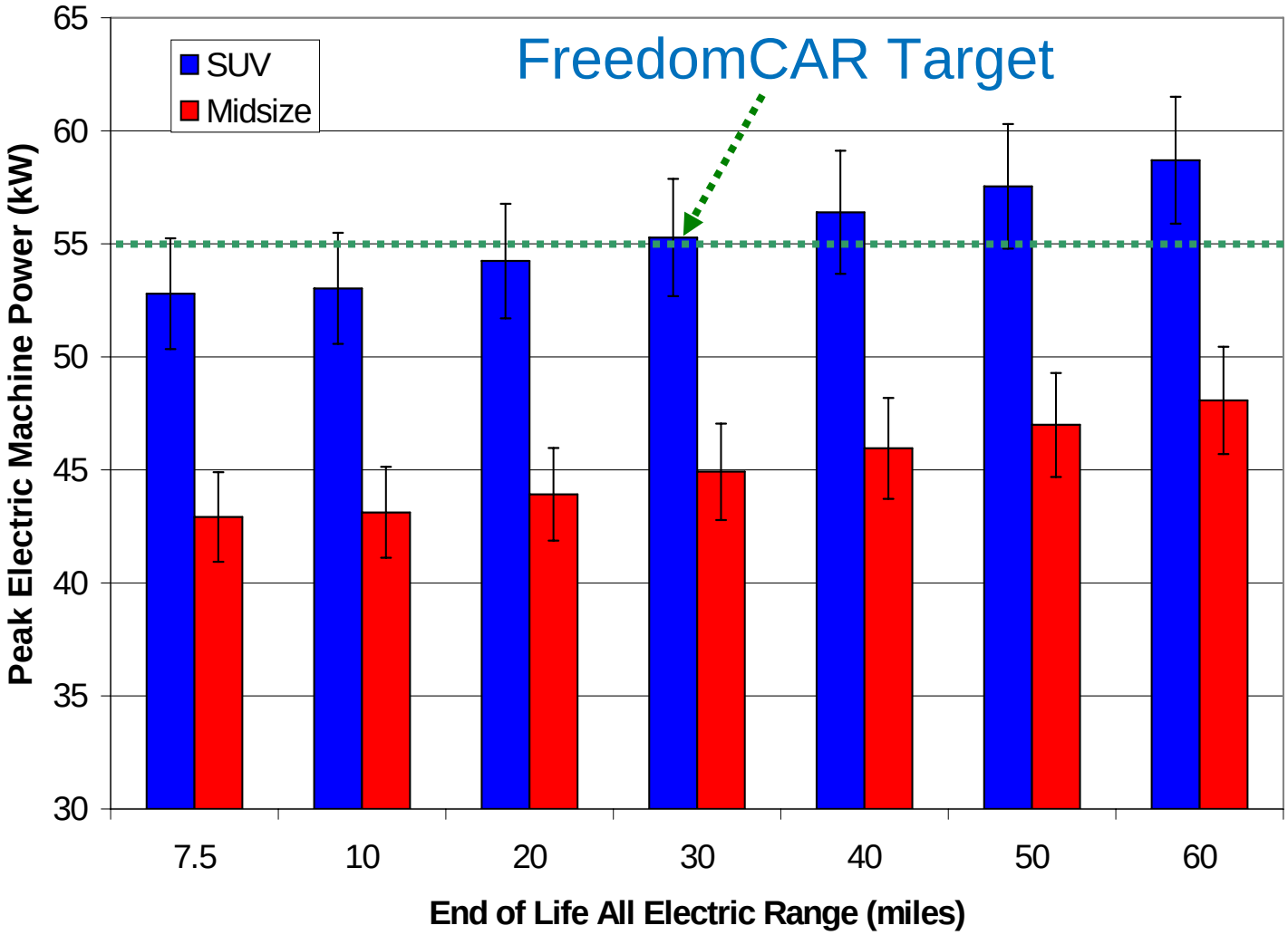
Satisfy CARB EV Range Definition

Perfo:
IVM-60 mph
Grade:
1.5 x Safety
60 mph 6% grade

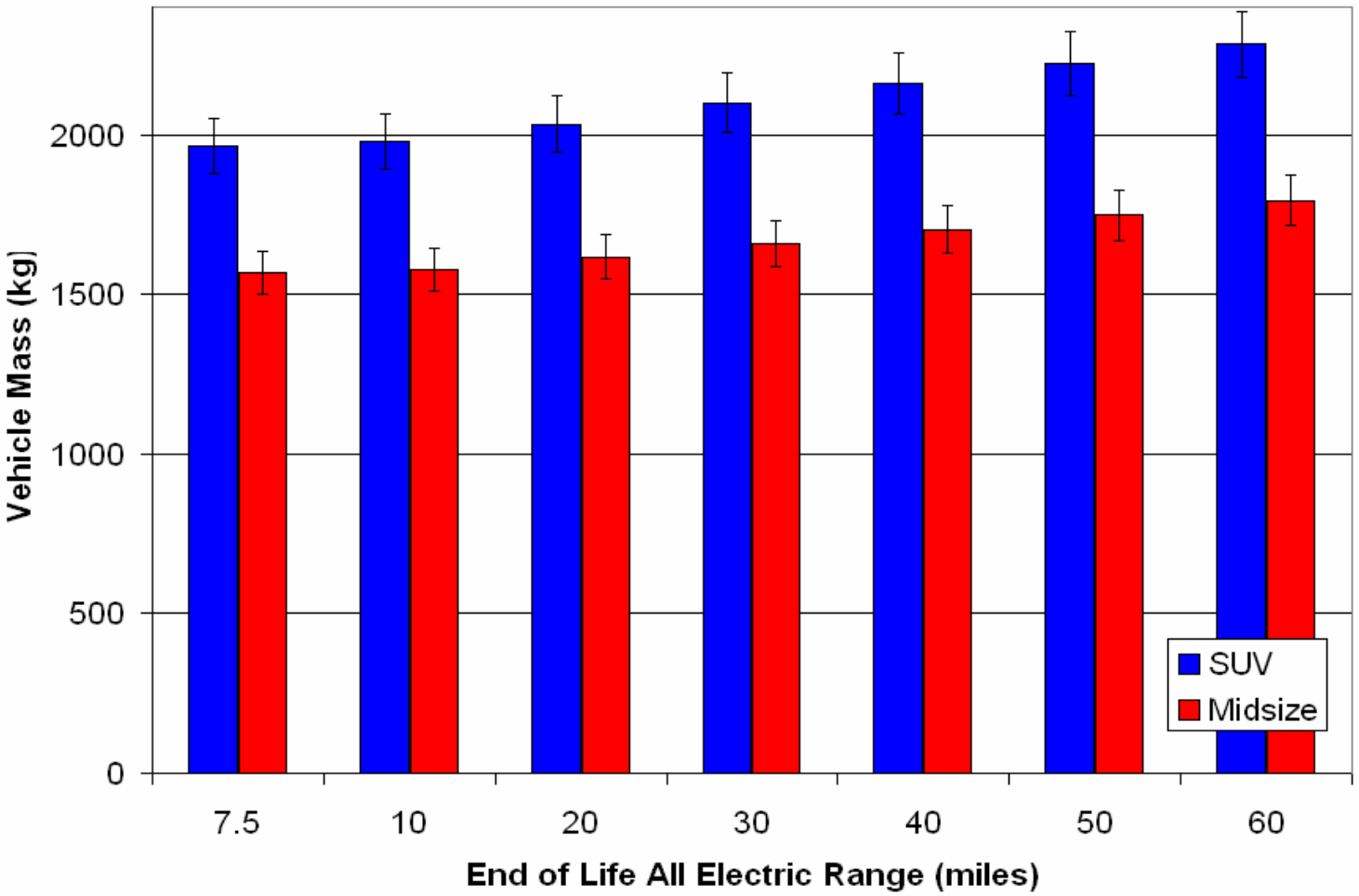
Range

30% Power, 20% Energy to have same performance at EOL

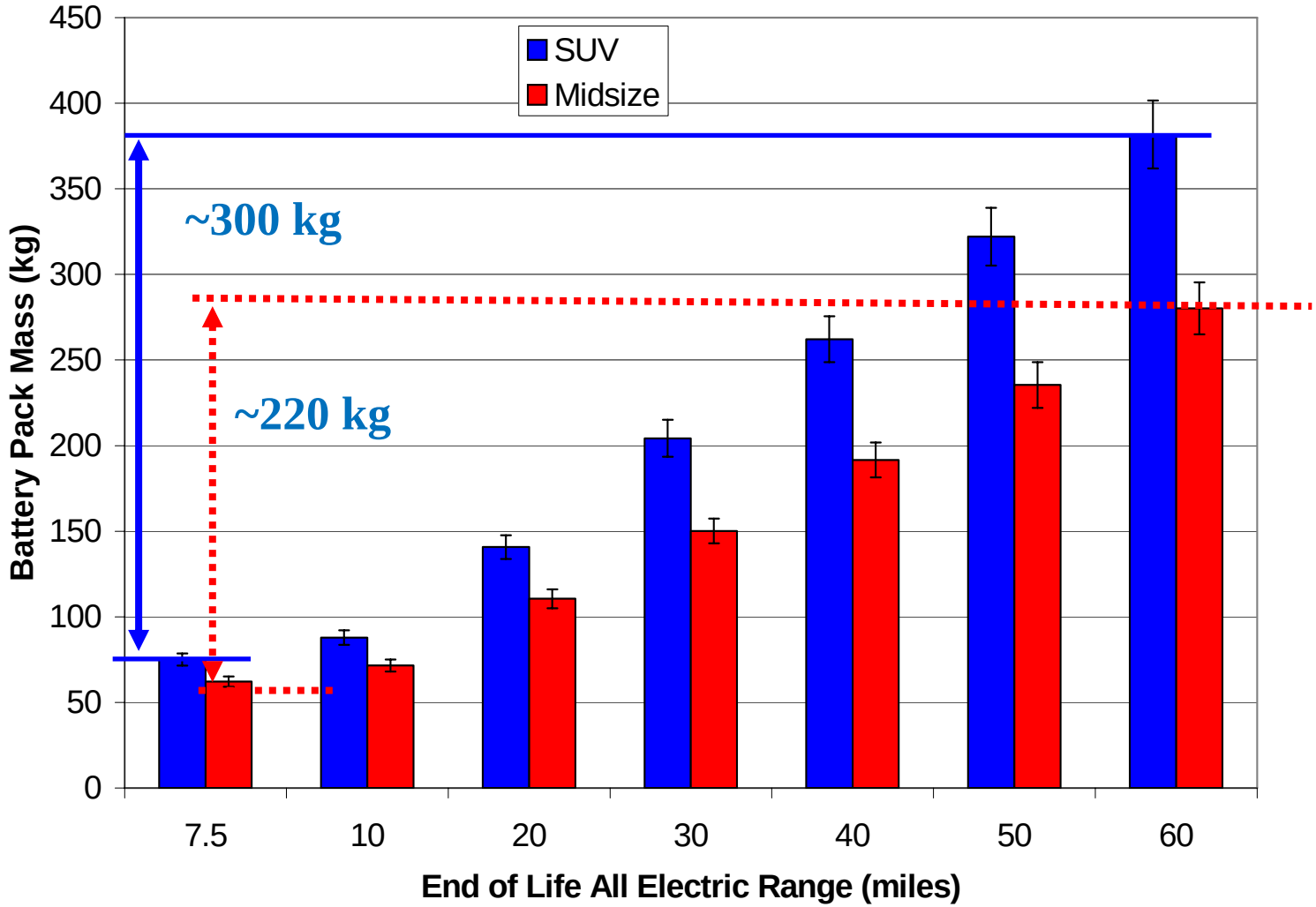
Electric Machine Power for UDDS



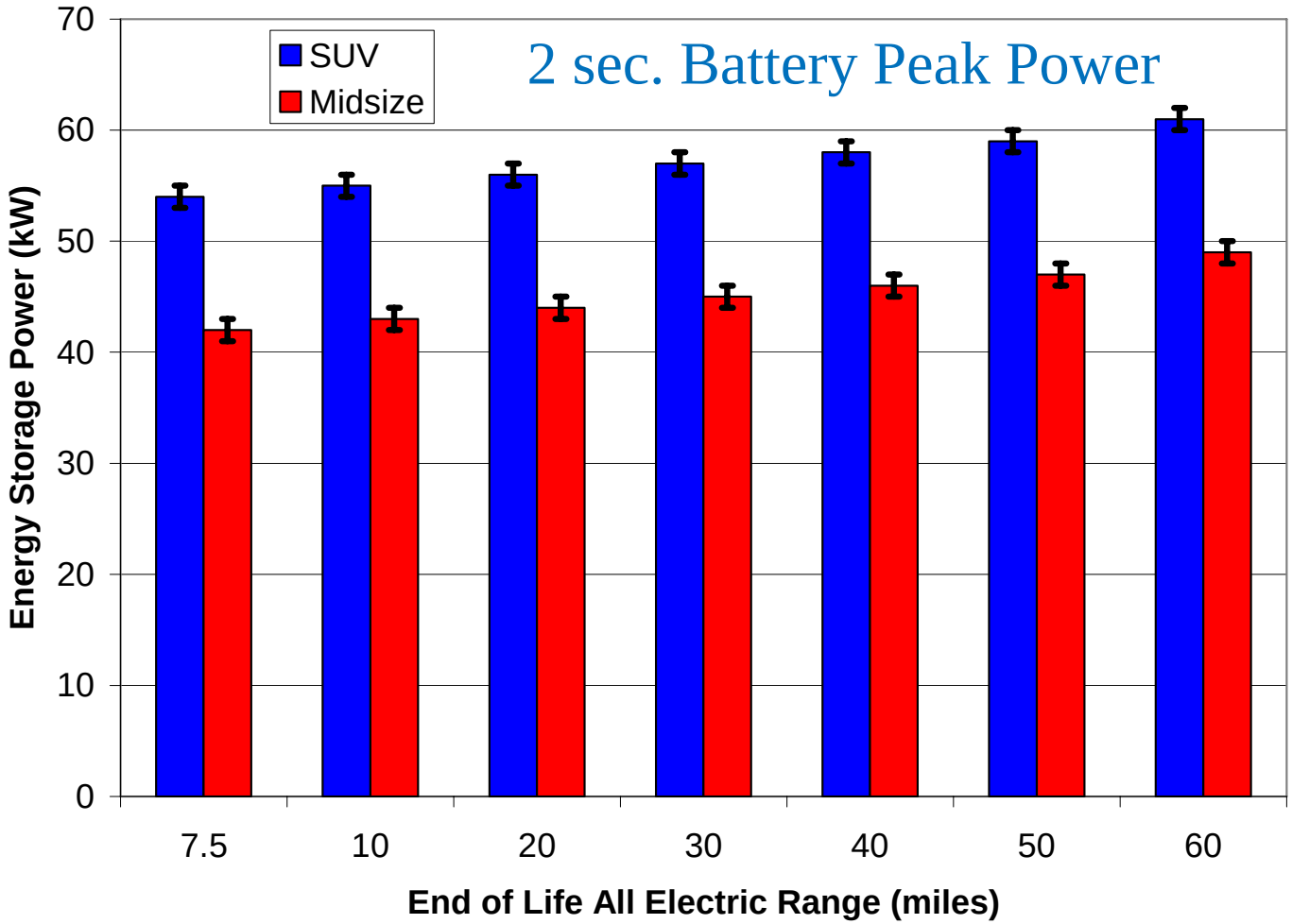
All Electric Range (AER) Increase Leads to Small Vehicle Mass Increase…



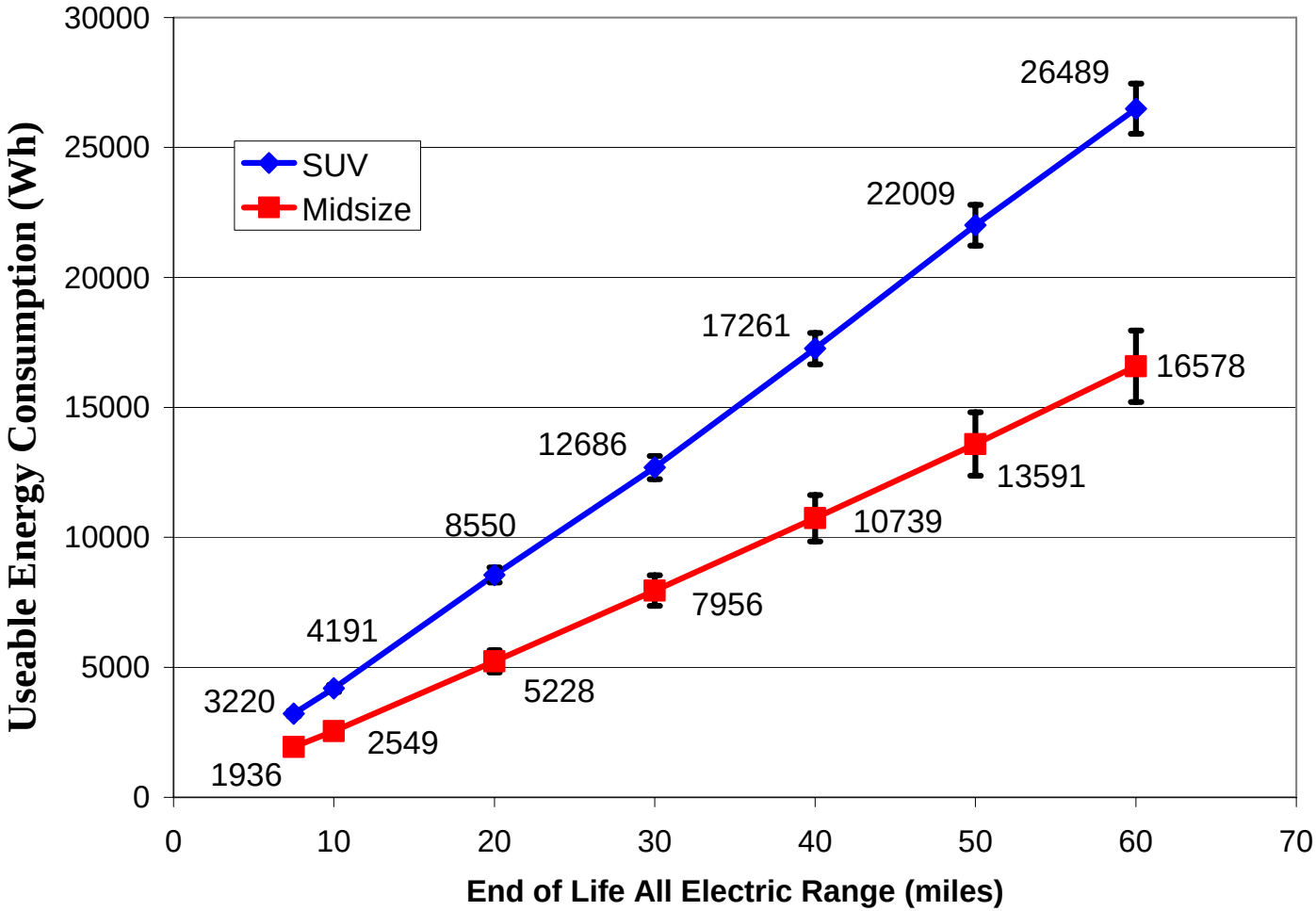
Due to High Li-ion Specific Energy



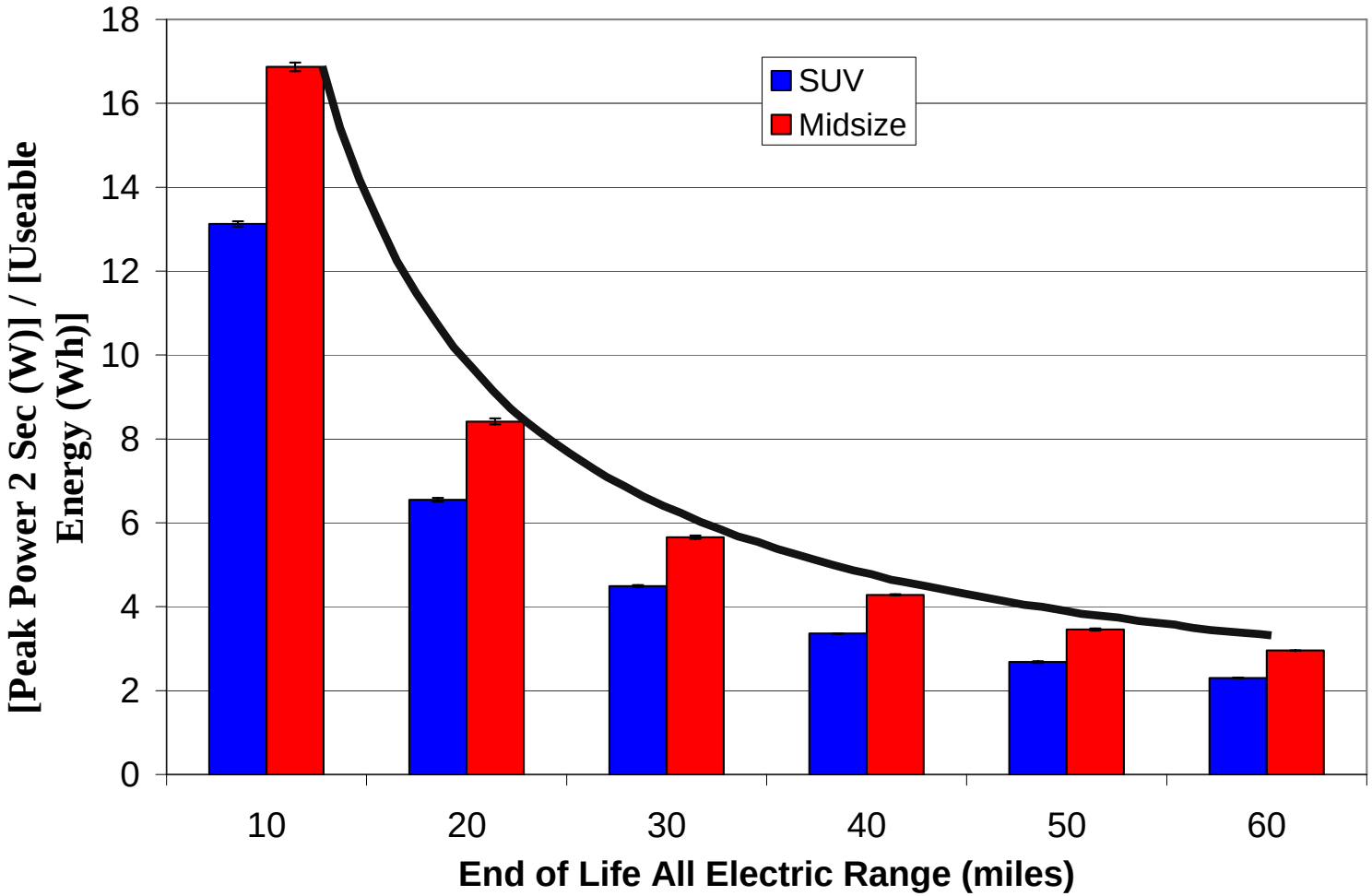
As a Consequence, Power Requirements Remain Approximately Constant



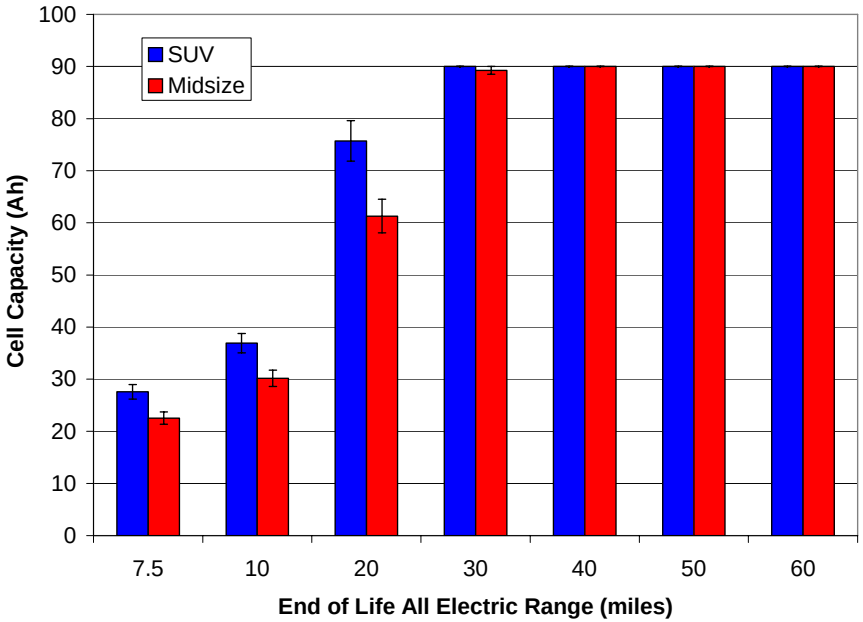
Energy Consumption is a Linear Function of AER

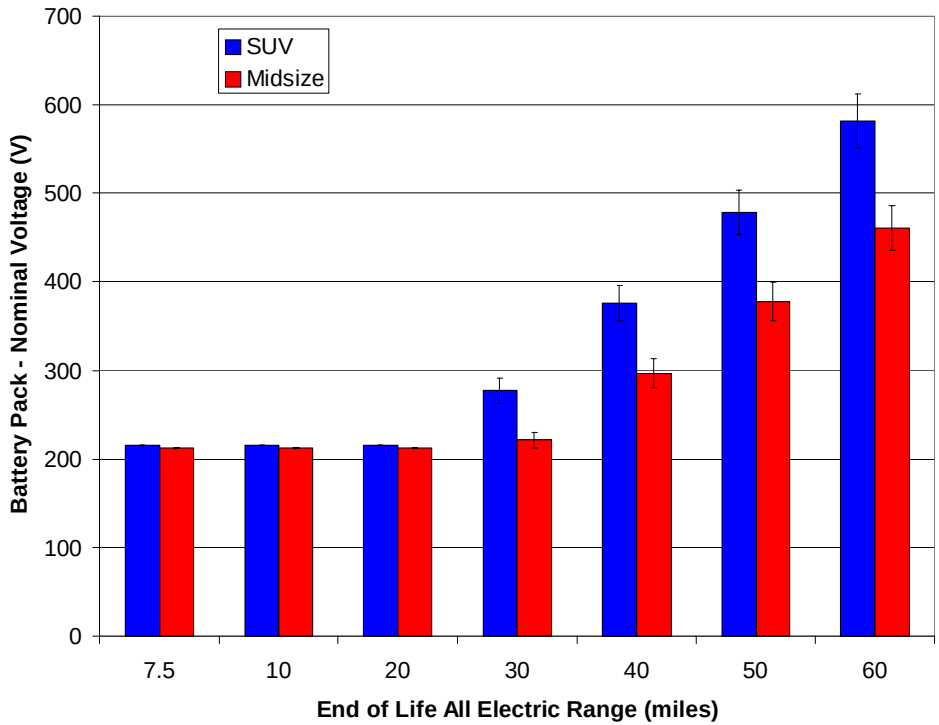


Specific Power/Energy Ratio Batteries Should be Designed for Targeted Applications

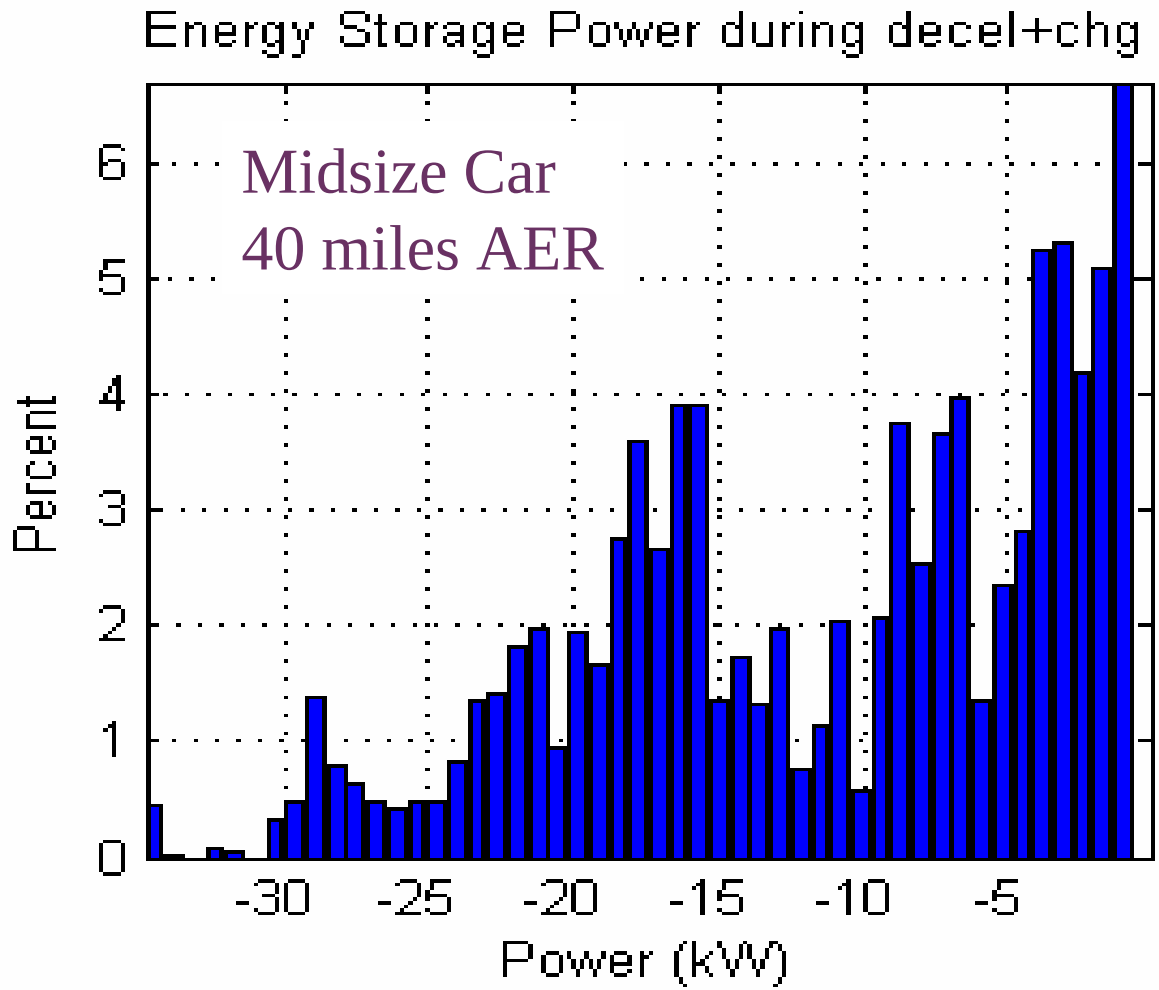


At High AER, Battery Pack Voltage Increases Due to Capacity Limitation





Charging Power Calculated Based on US06 Driving Cycle



Conclusion

- Component power requirements are fairly independent of AER.
- Battery energy is linear function of AER as a result of the Li-Ion battery high specific energy.
- Battery pack voltage needs to be taken into consideration for high AER (above 40 mi). Higher capacities or battery packs in parallel might need to be used

Current/Future Work

- Evaluate battery requirement uncertainties based on:
  - Drivetrain configurations (e.g., series, power split…)
  - Component sizing assumptions (e.g., other than UDDS)
  - Vehicle and component assumptions (e.g. vehicle mass, electrical accessories…)

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