# Value of Weight Reduction to PEV/PHEVs

*Opportunities with Aluminum*


**Michael Bull**

**Novelis**

on behalf of

The Aluminum Association's

**Aluminum Transportation Group (ATG)**

**Fred Jacquelin RICARDO**

# Defining Who We Are

***The Aluminum Association's Aluminum Transportation Group (ATG)***

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# Key Topics

- Range vs. Weight and Cost (vehicle & battery)
- Business Trade-offs:
  - Structure cost & weight vs. Battery cost & weight
- Regenerative Braking vs. Vehicle mass
  - More or less weight sensitive?

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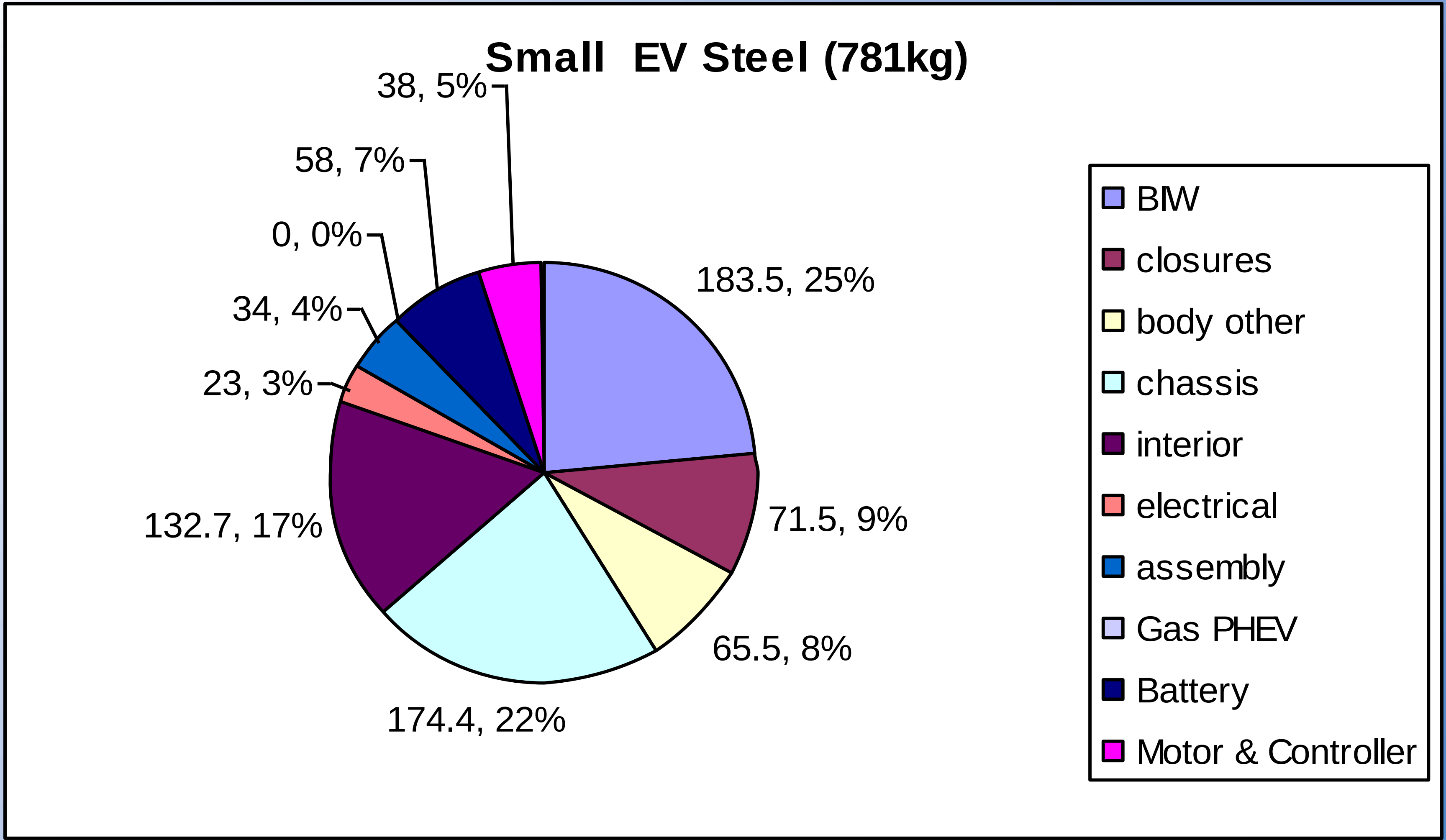
# Assumptions

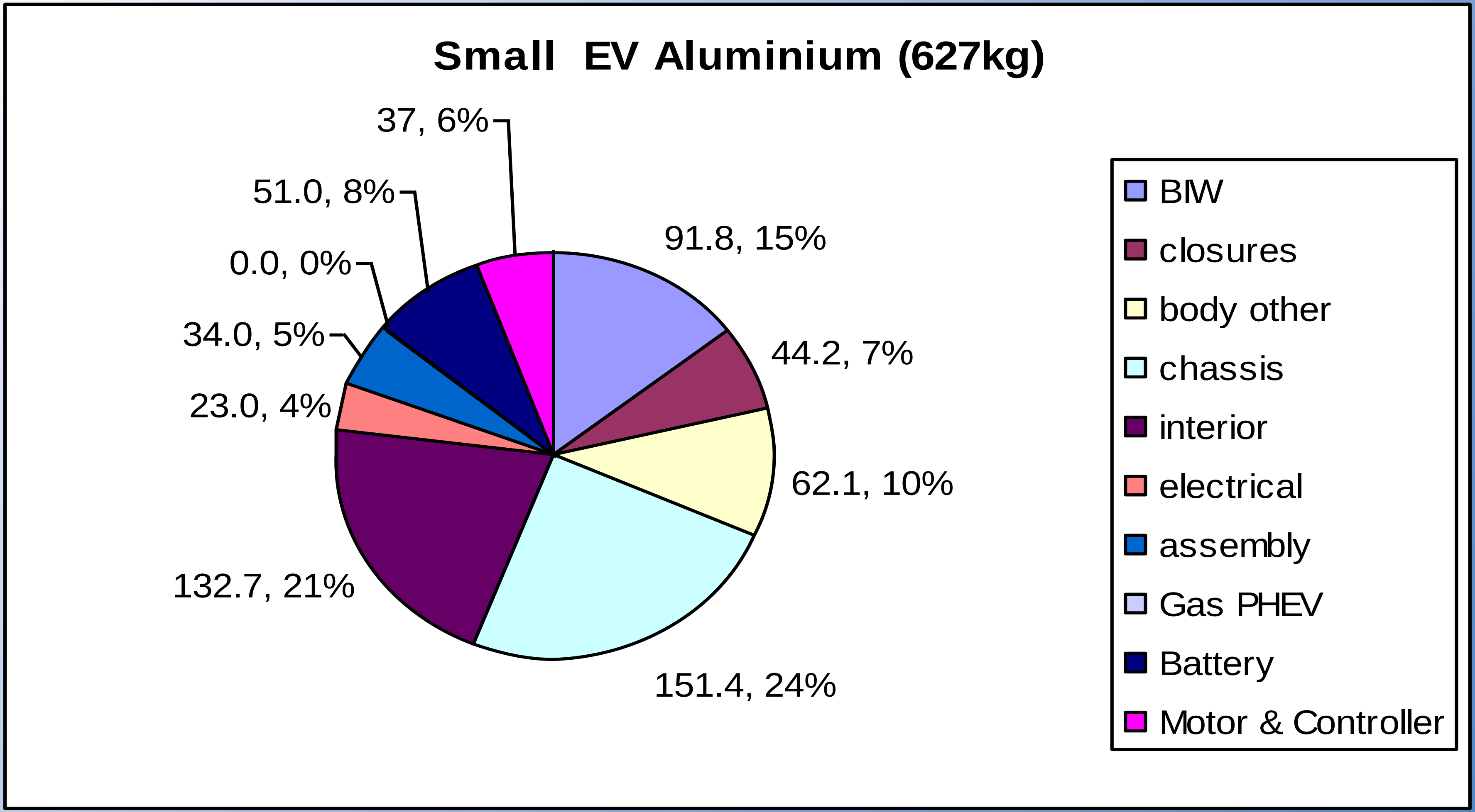
- Li –Ion battery:
  - 115 Wh/kg (51-209 kg)
  - 155 Wh/l
  - SOC 0.9-0.25
  - $750 kWh

- Small Vehicle based on BMW Mini:
  - Tradition Design =781 kg
  - Lightweight Design = 627kg (154 kg savings or 19.7%)
  - 40 and 80 mile range

# Mass Breakout (Traditional)



# Mass Breakout (Lightweight)



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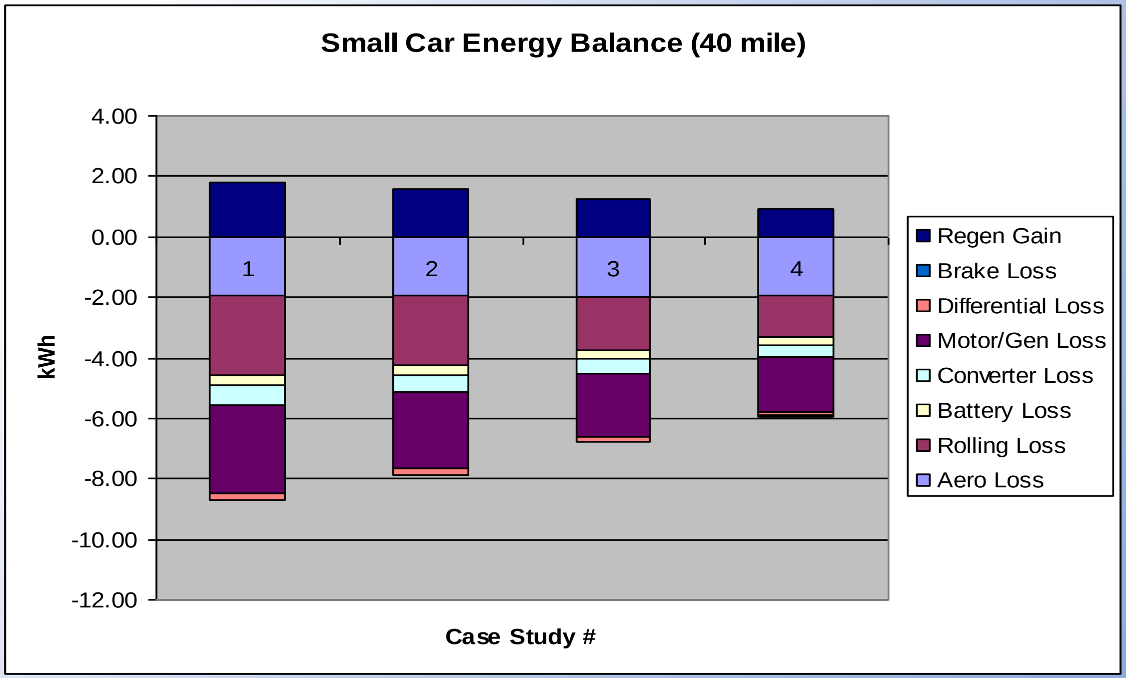
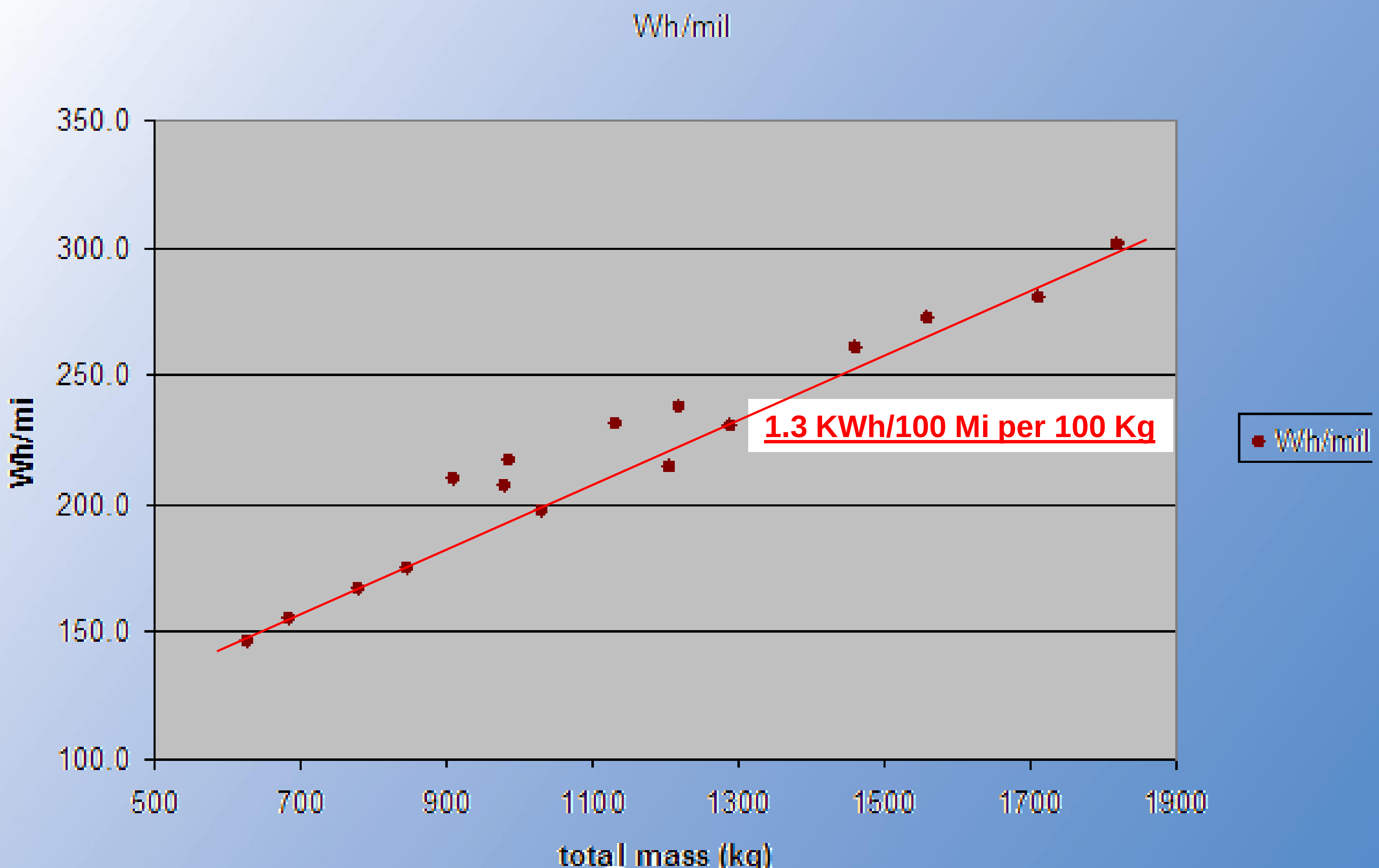
# Energy Balance




| | Case 1 FTP % | Case 2 | Case 3 | Case 4 | Case 1 FTP kWh | Case 2 | Case 3 | Case 4 |
|---|---|---|---|---|---|---|---|---|
| Aero | 22.3 | 24.8 | 29.4 | 32.7 | 1.97 | 1.97 | 1.97 | 1.93 |
| rolling | 30.2 | 28.9 | 26.2 | 23.6 | 2.67 | 2.29 | 1.75 | 1.40 |
| battery | 4.1 | 4.1 | 4 | 3.8 | 0.36 | 0.33 | 0.27 | 0.22 |
| converter | 7.6 | 7.5 | 7.2 | 6.8 | 0.67 | 0.59 | 0.48 | 0.40 |
| motor/generator | 33.2 | 32.2 | 30.8 | 30.8 | 2.93 | 2.55 | 2.06 | 1.82 |
| differential | 2.5 | 2.4 | 2.3 | 2.2 | 0.22 | 0.19 | 0.15 | 0.13 |
| brake | 0.1 | 0.1 | 0.1 | 0.1 | 0.01 | 0.01 | 0.01 | 0.01 |
| regen | 20.9 | 20 | 18.1 | 15.6 | 1.85 | 1.59 | 1.21 | 0.92 |

# EV Mass vs.. Energy Consumption



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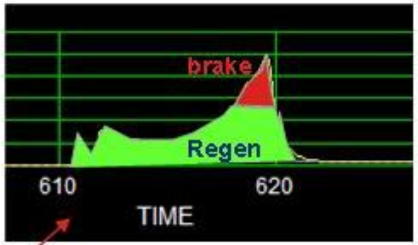
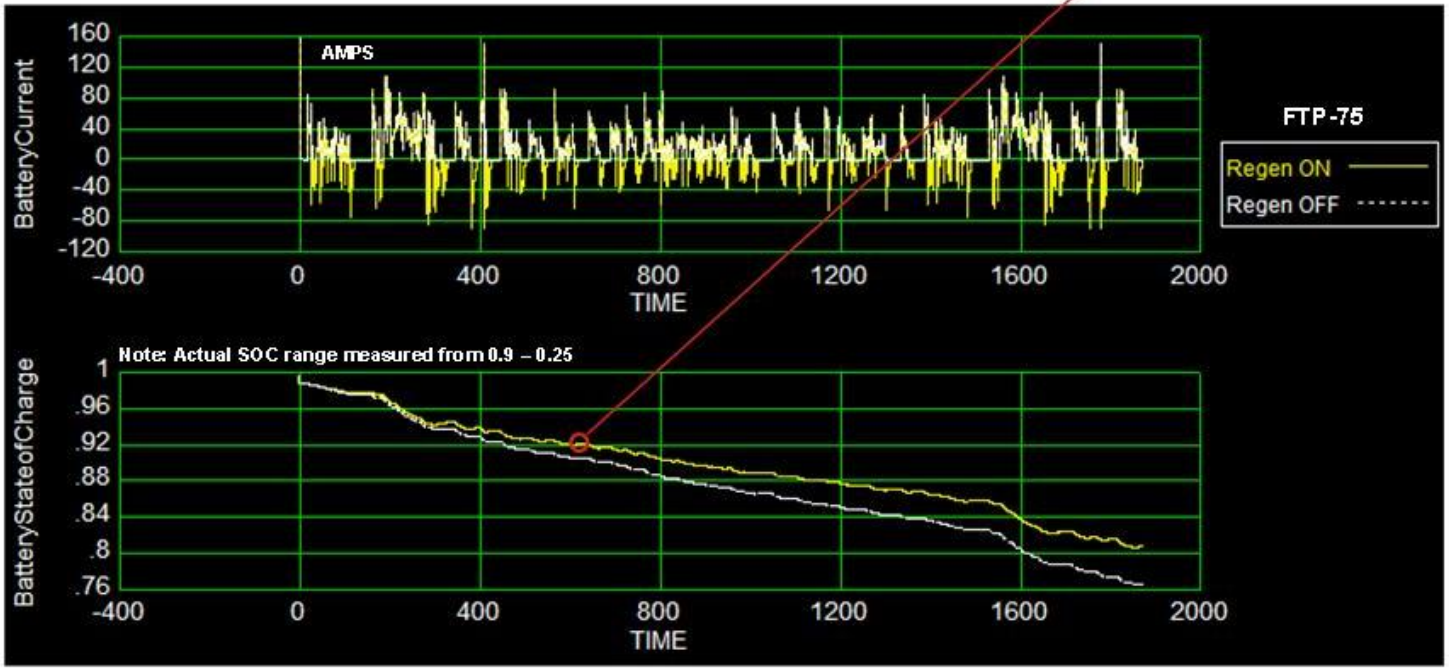
# Regen Braking – Small Car

The EV motor and battery size allow for large brake regeneration capture. No safety control was implemented and a fixed threshold was used to separate regen braking from mechanical braking.



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# Summary

- PEV or PHEV, with so little stored energy, places emphasis on low mass design (and low aero losses).
  - Consumption ranged 0.146 kWh/mi (600 Kg) to 0.302 kWh/mi (1800 Kg). Or 1.5-3 kg of battery/mile travelled.
  - 10% mass reduction approximates to 10% increase in range and 4-6% reduction in battery size.
- Regenerative braking is equally important to low mass vehicles. (66-69% recovery of rolling in city, 2-5% in highway drive cycle).
- Lighter mass structures reduced energy requirements from 1.2 – 3.4 kWh, about 10%, which can significantly reduce vehicle costs at current Lithium-ion battery costs.

# Thank you

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