

Value of Weight Reduction to PEV/PHEVs

Opportunities with Aluminum

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Novelis

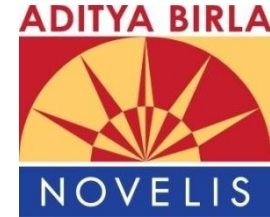
on behalf of

The Aluminum Association's
Aluminum Transportation Group (ATG)

Fred Jacquelin RICARDO

Defining Who We Are

The Aluminum Association's Aluminum Transportation Group (ATG)



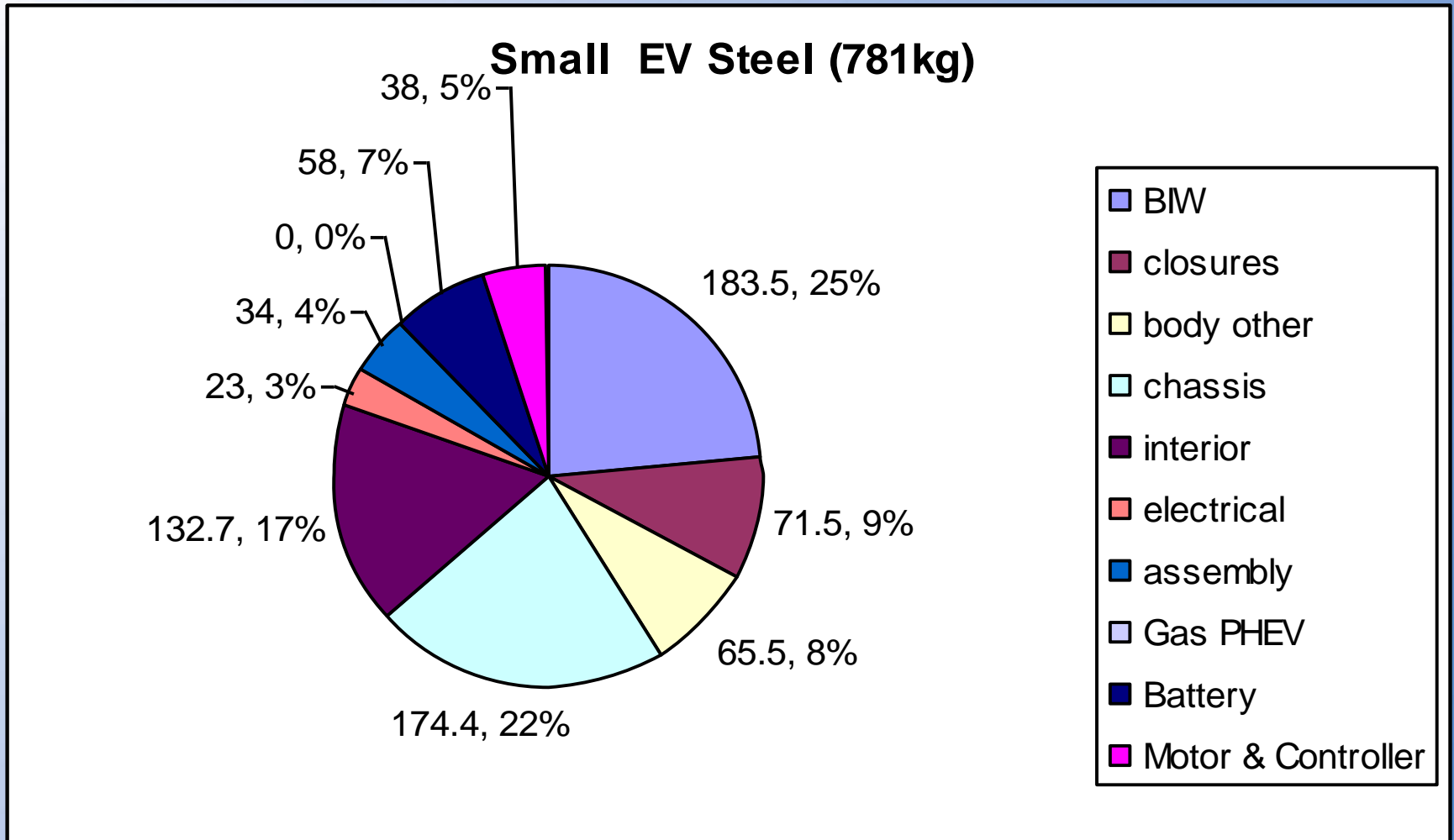
Key Topics

- 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?

Assumptions

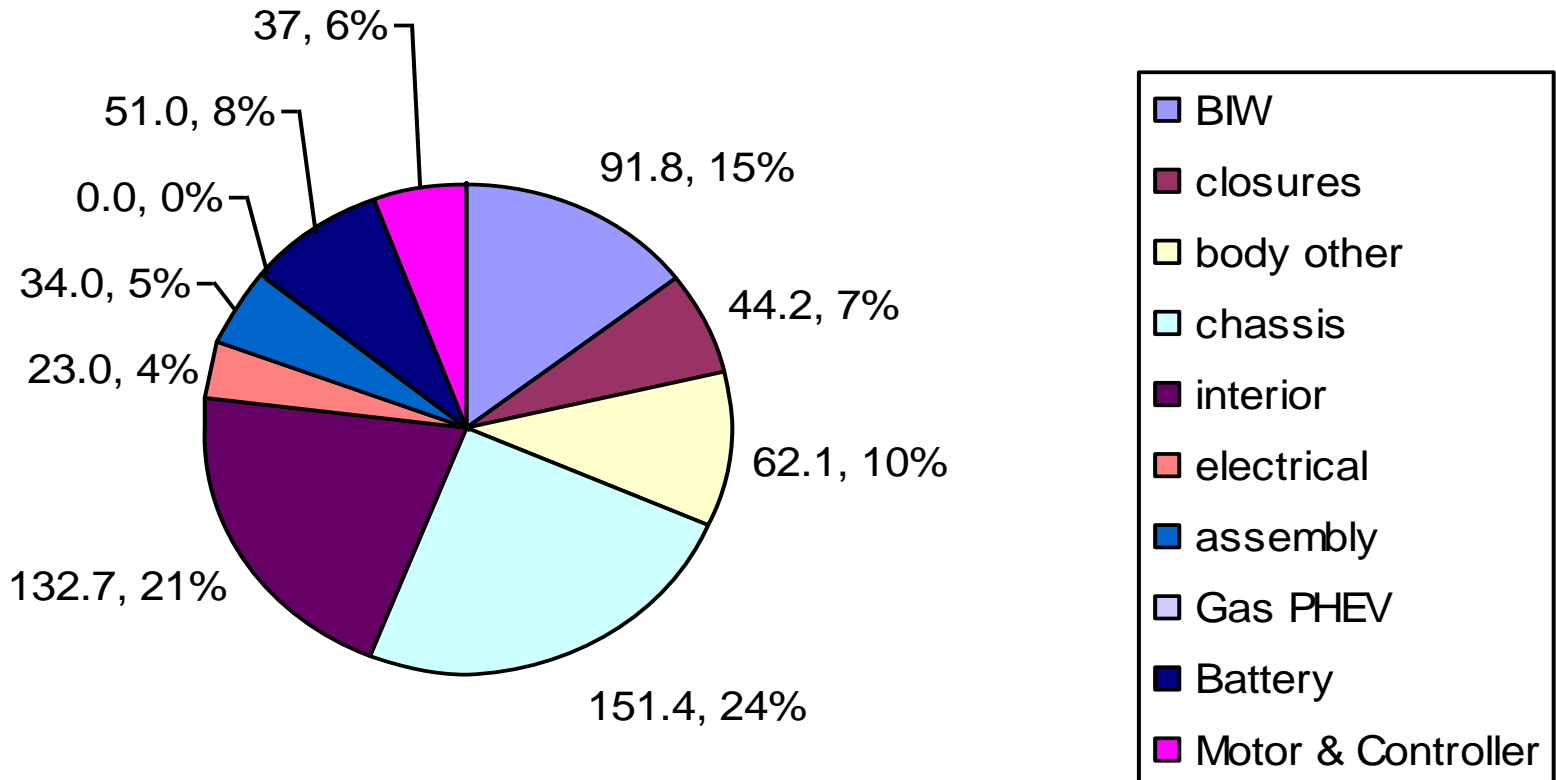
- Li –Ion battery:
 - 115 Wh/kg (51-209 kg)
 - 155 Wh/l
 - SOC 0.9-0.25
 - \$750 kWh
- Small Vehicle based on BMW Mini:
 - Tradition Design =781 kg
 - Lightweight Design = 627kg (154 kg savings or 19.7%)
 - 40 and 80 mile range

Mass Breakout (Traditional)



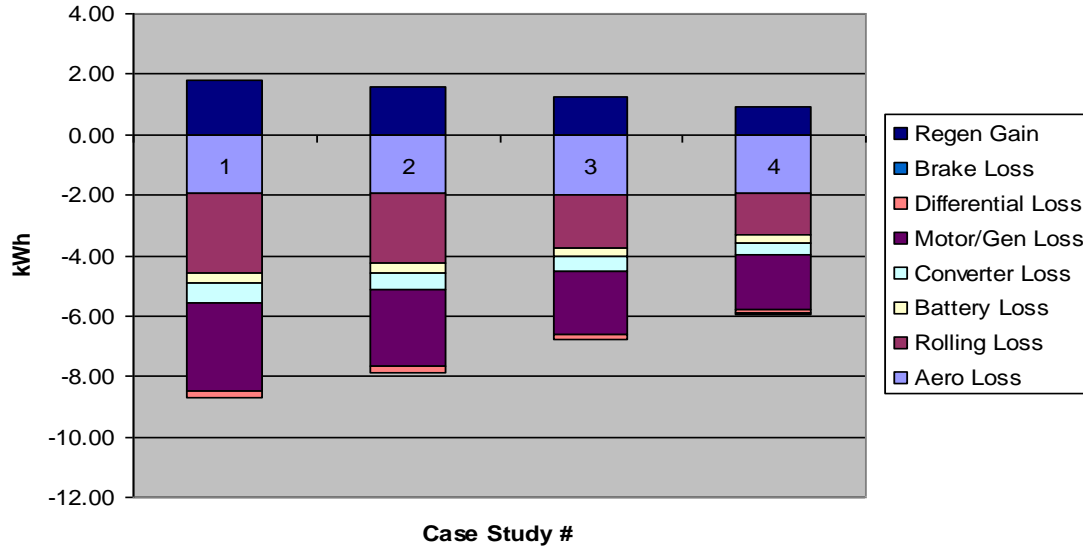
Mass Breakout (Lightweight)

Small EV Aluminium (627kg)



Energy Balance

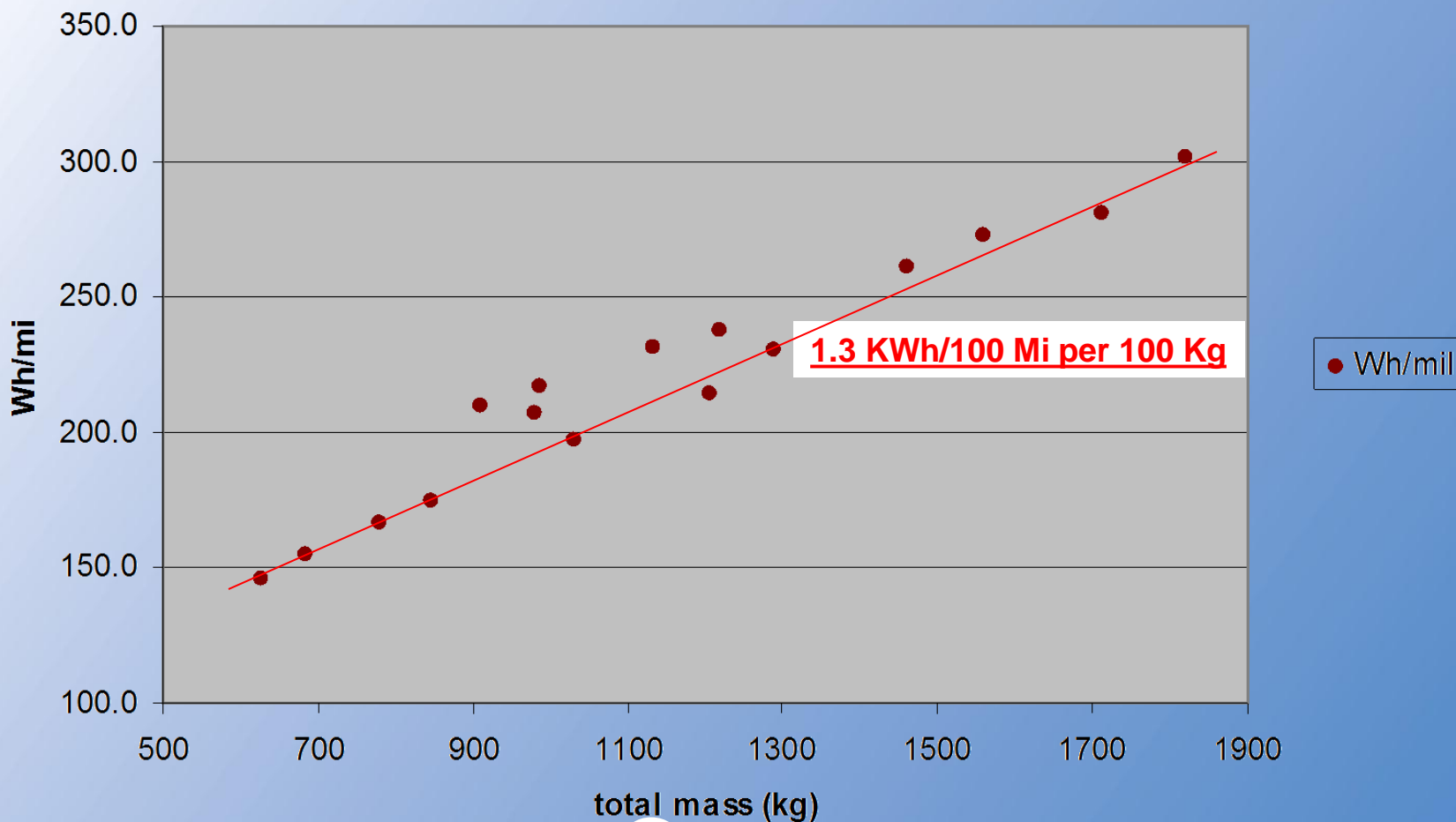
Small Car Energy Balance (40 mile)



	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4
	FTP				FTP			
	%				kWh			
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

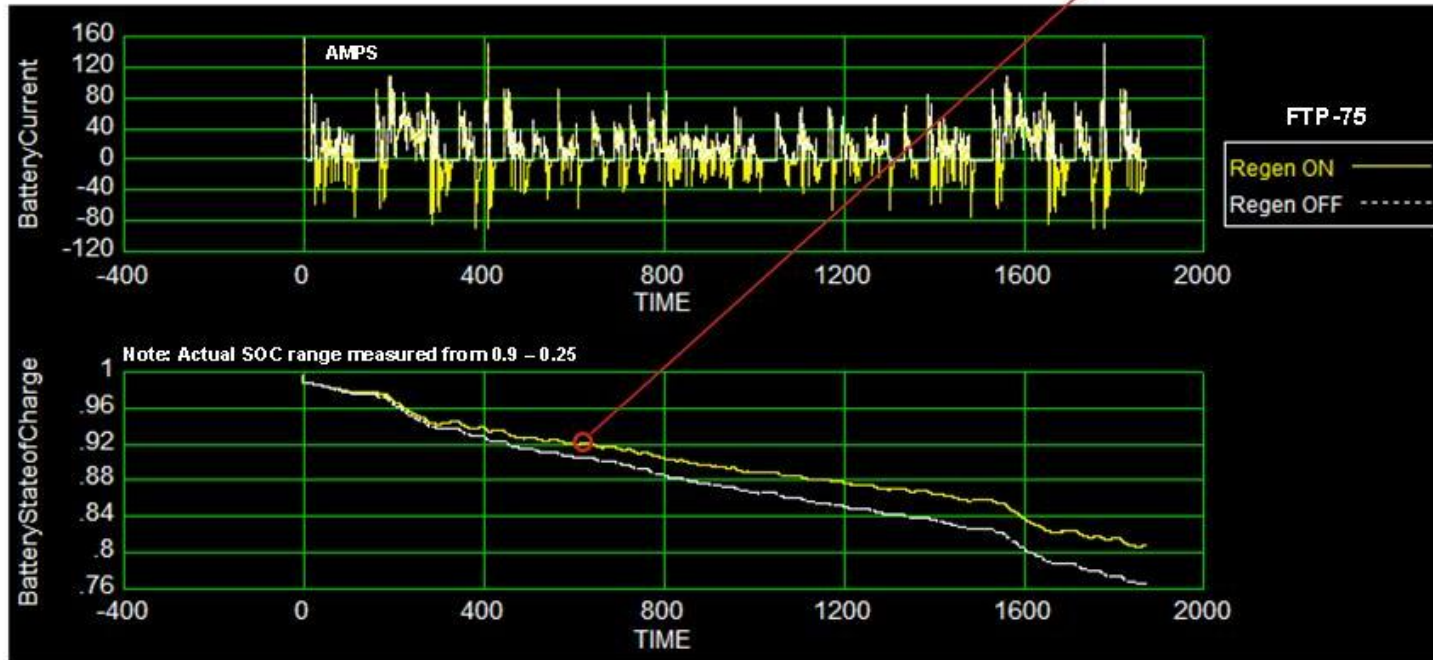
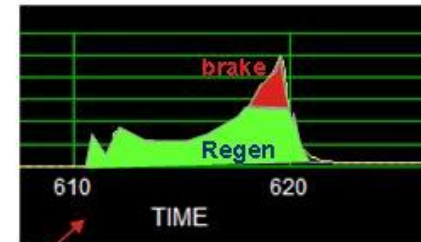
EV Mass vs.. Energy Consumption

Wh/mil



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.



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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