Low carbon footprint Aluminum EV batteries housings require innovative design for dis-assembling

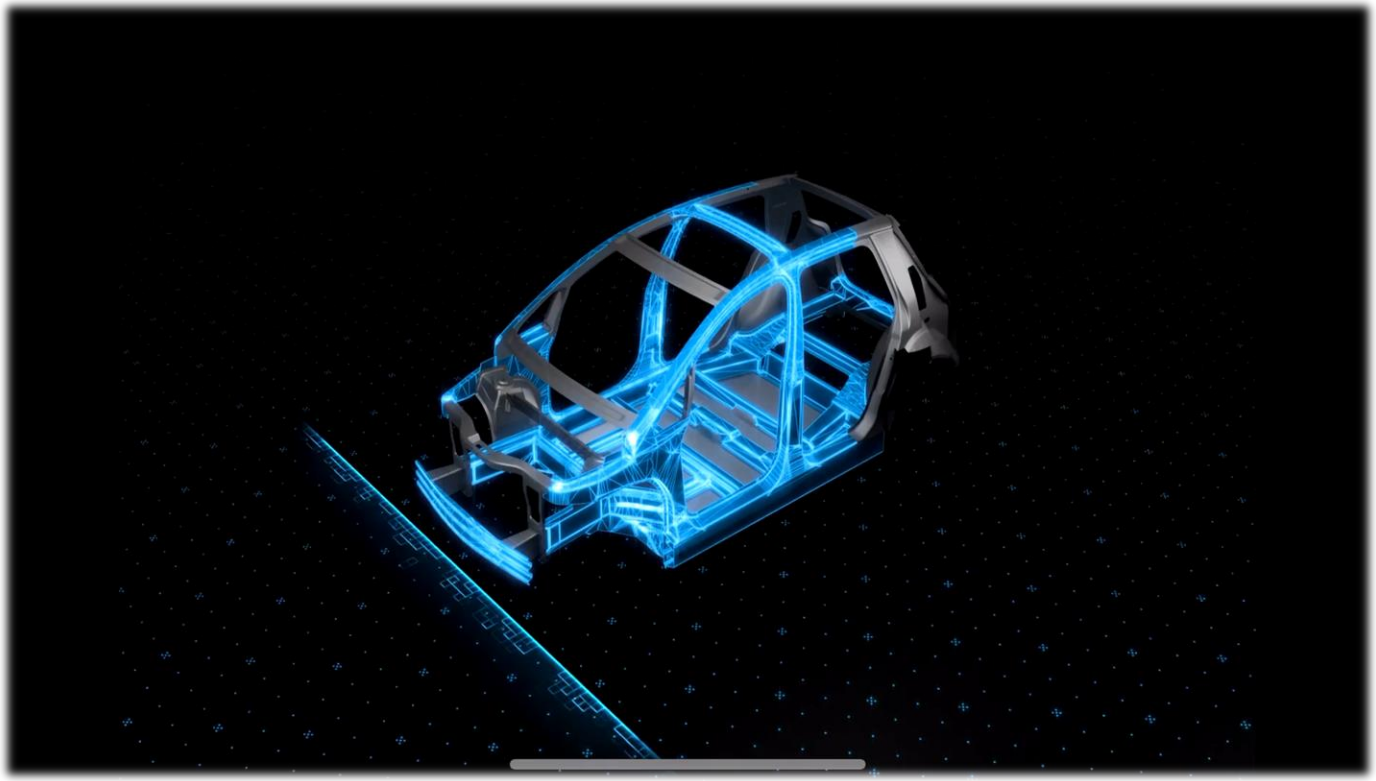
Claudio Mus – Technical R&D Director – Endurance Overseas

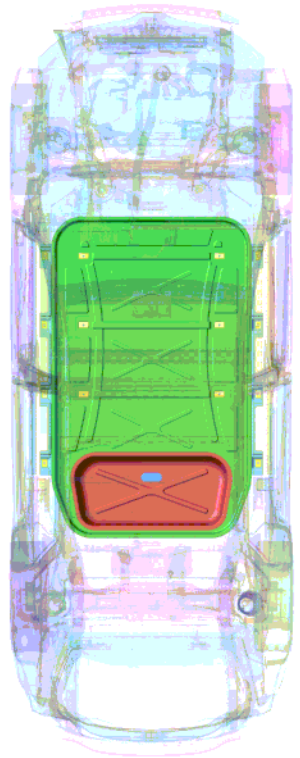
Summary

- EV battery housing requirements / design for re-purposing criteria
- Design for dis-assembling & modular approach
- Suitable low-carbon footprint foundry aluminum alloys
- «IPCEI alloys» : thermal & corrosion properties
- Conclusions

EV battery housing

ENDURANCE
Complete Solutions

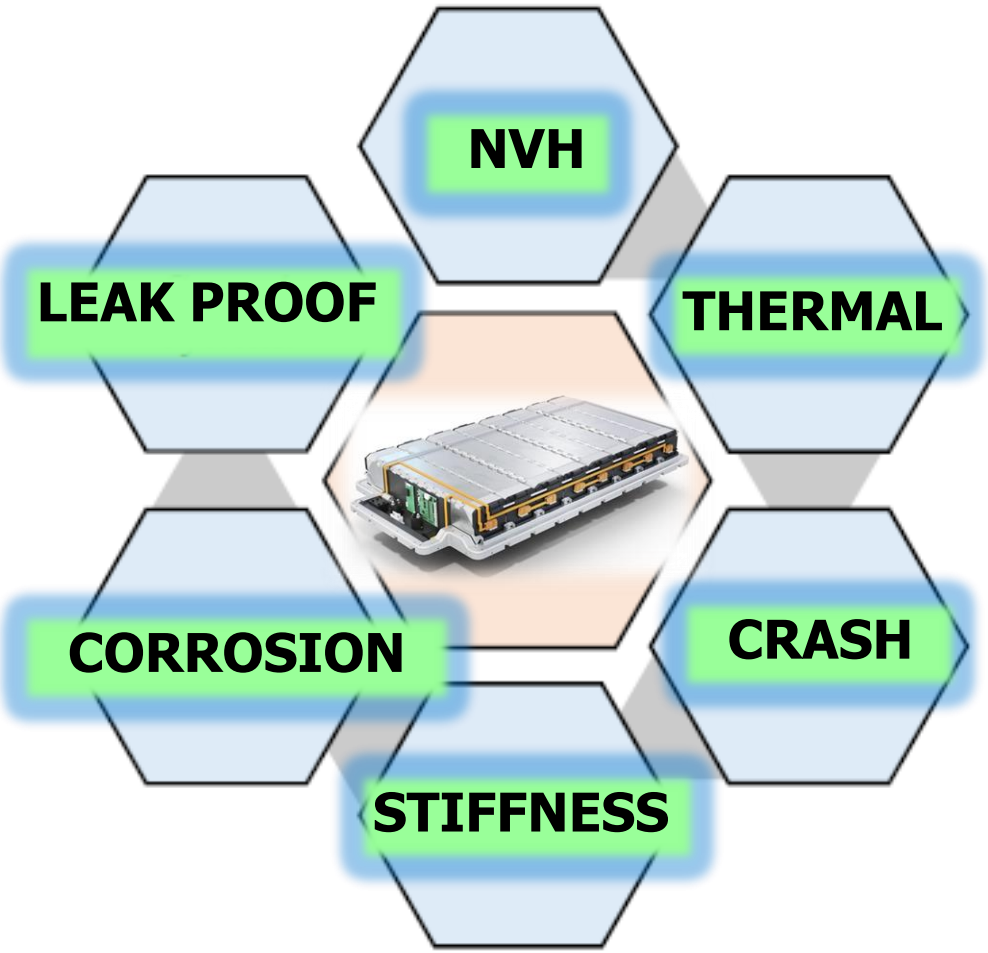




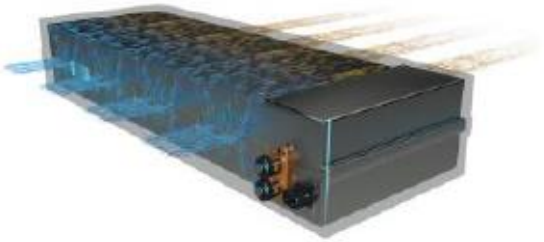
IPCEI BATTERIES

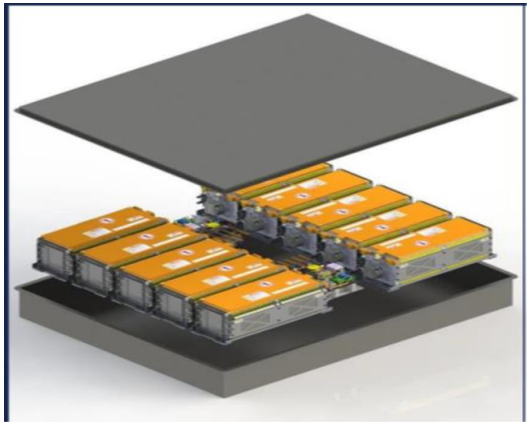
EV battery housing requirements

ENDURANCE
Complete Solutions

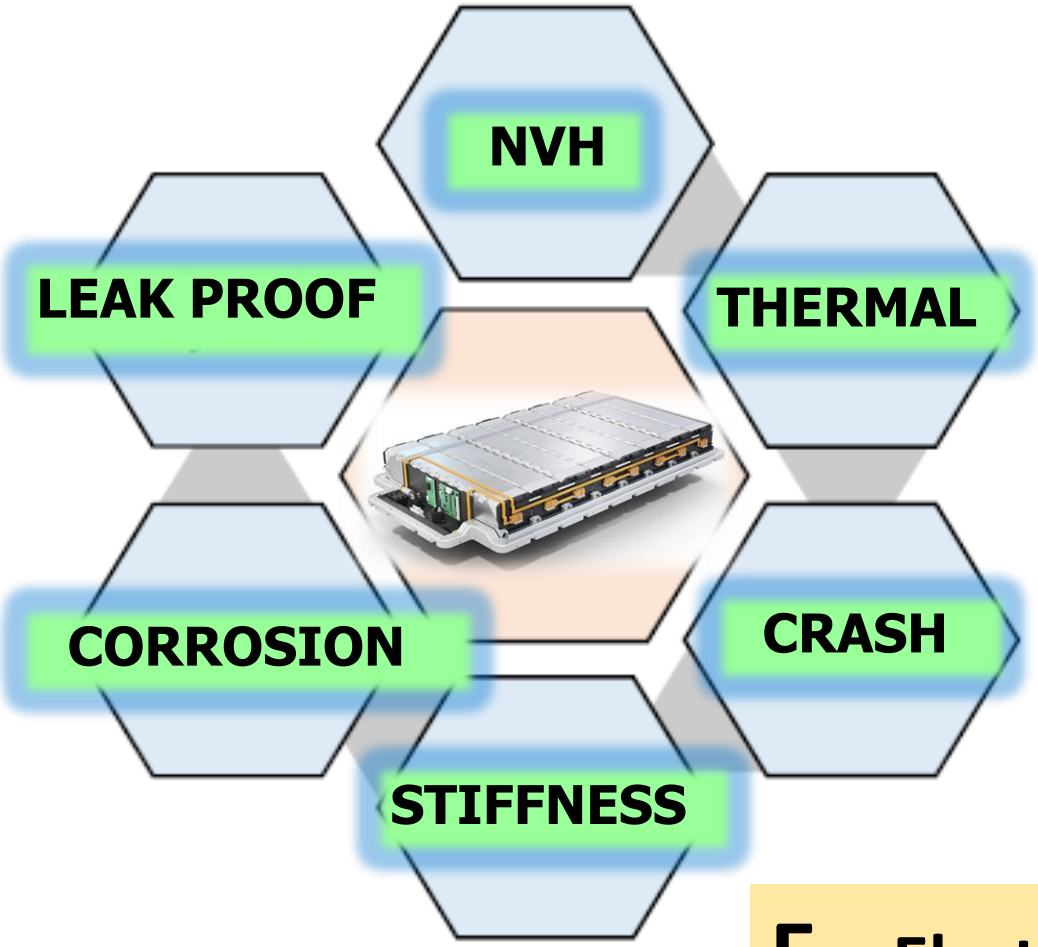


Air Cooling System





Material properties required



λ = Thermal conductivity

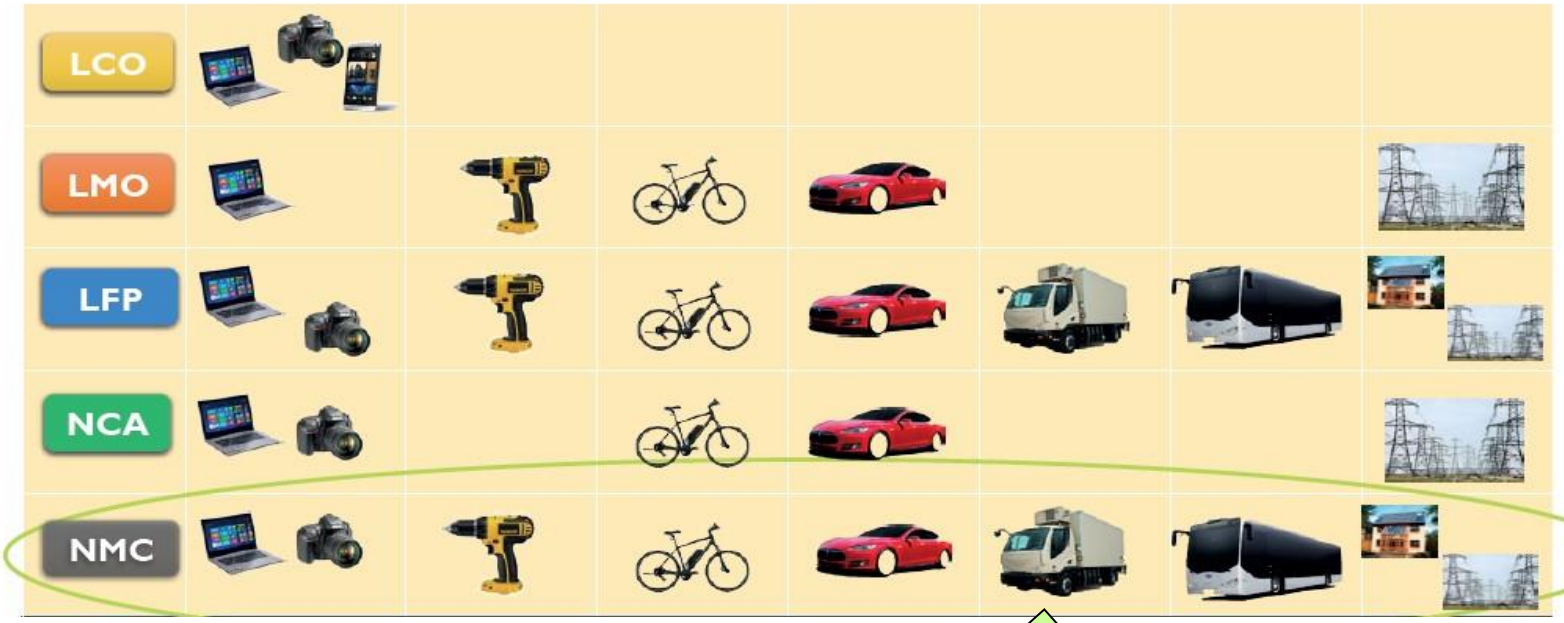
ε = Ductility

σ = Yield strenght

E = Elastic module

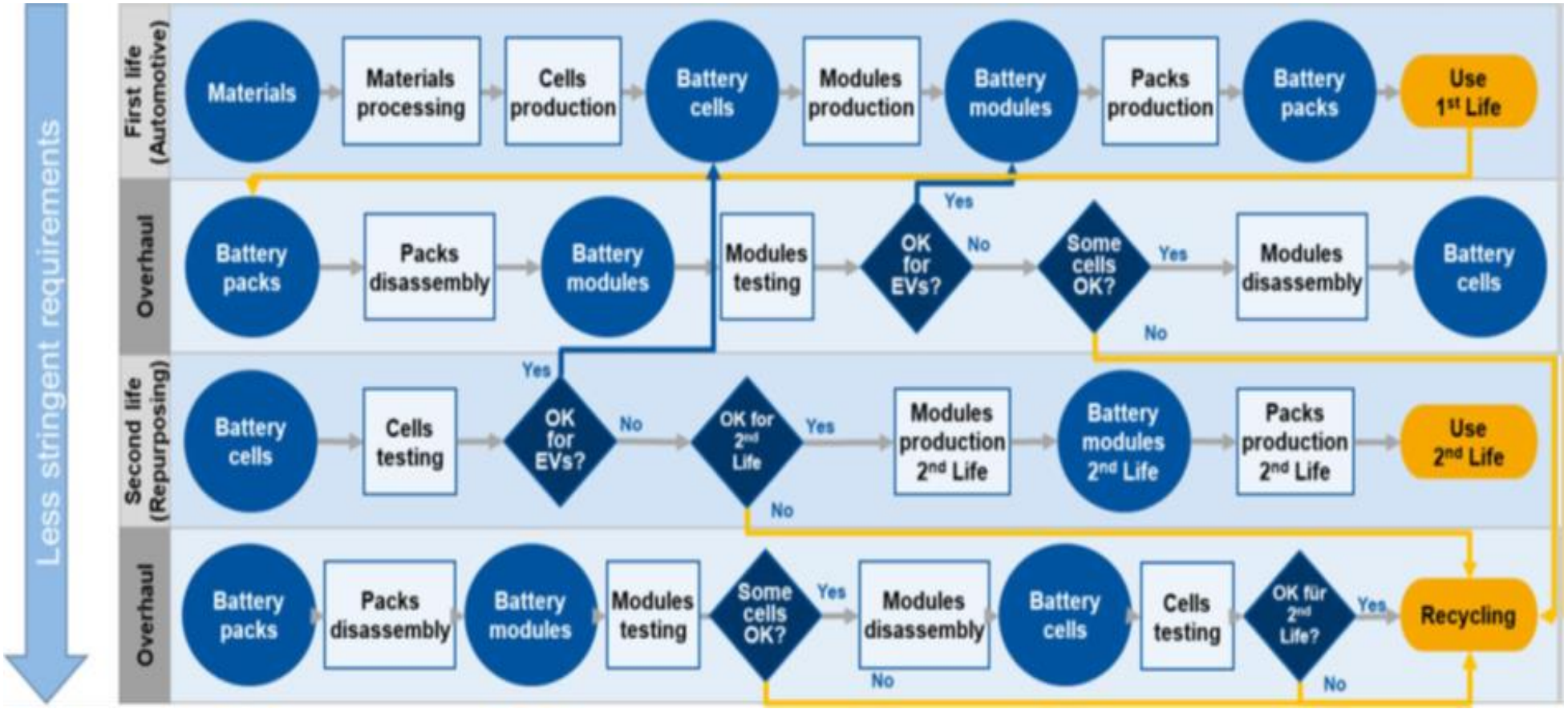
Fields of potential Li-Ion battery re-purposing

ENDURANCE
Complete Solutions



IPCEI BATTERIES

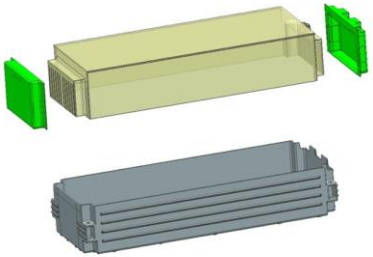
Battery 2nd life /repurposing flow-chart

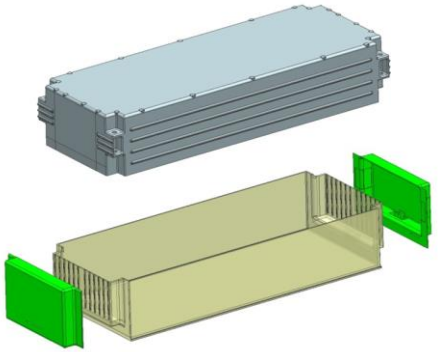


Guidelines for dis-assembling

DESIGN RELATED ITEMS	IMPACT			
	Cost/QA	LCFP	MP	OEE
Use of a minimum number of different materials	+	+	+	+
Easy separation of module elements	+		+	+
Reversible joining (i.e screw/bolt)		+	+	+
New potting binders / adhesive compound	+	+	+	+
No gluing or potting	++	++	++	++
Easy separation of sub-modules/cells	+		+	+

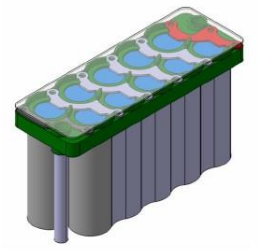
Dis-assembling is a must for re-purposing



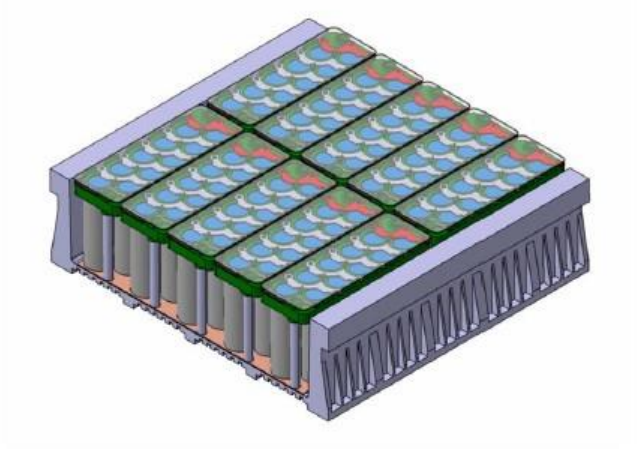


	ORIGINAL DESIGN Welded Aluminum profiles	IPCEI - HPDC 5 walls casting + cover	IPCEI – SSC 5 thin walls casting + cover
HOUSING WEIGHT [Kg]	3,4	3,6	3,3
DIS-ASSEMBLING	**NO**	**YES**	**YES**
DELTA WEIGHT	-	+ 6%	- 5%
ALUMINUM ALLOY	6060	SilvAL 10 / EN46000	EN42000

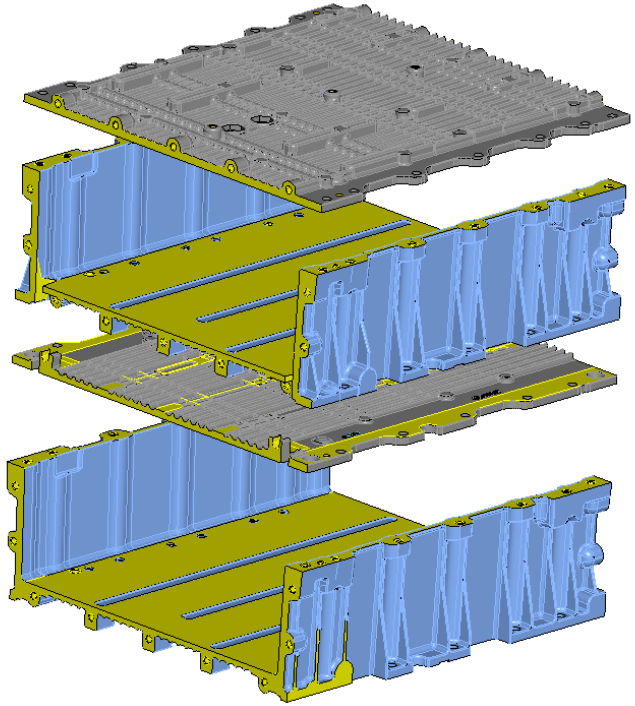
Li-Ion battery sub-module for modular housing



5s2p module:
18 V – 10 Ah – 180 Wh
132 mm x 75 mm x 46 mm



10s10p sub-pack:
36 V – 50 Ah – 1.440 kWh



Suitable low carbon foot-print aluminum alloys

PRIMARY

- EN 43400
- EN 43500 - AlSi10MnMg
- Castasil® 37 – AlSi9

SECONDARY

- EN 46000 - D226
- EN 46100 - ADC12
- EN 47100 - D231

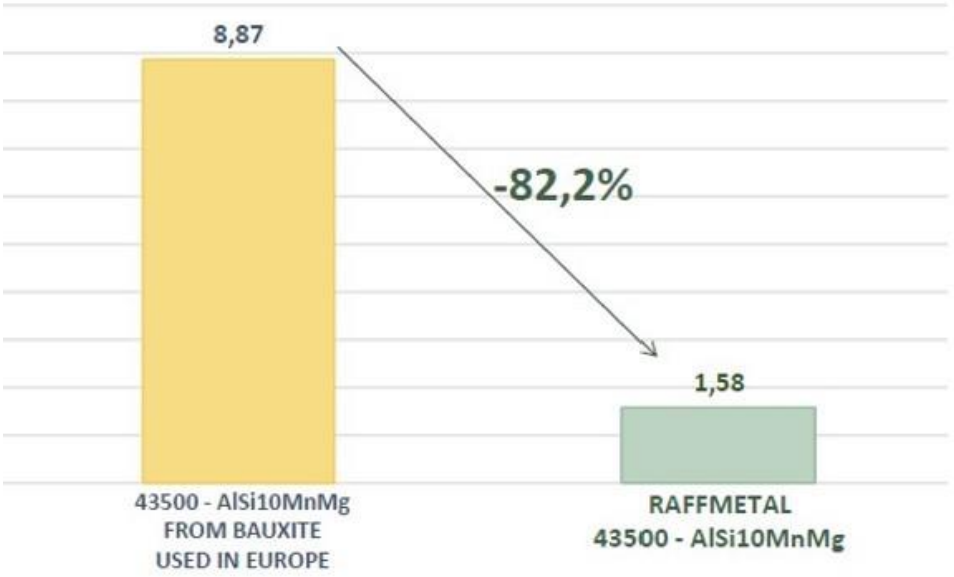
LOW CARBON FOOT-PRINT

Several options in development

CARBON FOOTPRINT

Cradle to Gate (kg CO2 eq/kg Al produced)

	U.O.M.	43500 - AlSi10MnMg FROM BAUXITE USED IN EUROPE	RAFFMETAL 43500 - AlSi10MnMg
CARBON FOOTPRINT Cradle to Gate	Kg CO_{2eq} /Kg Al	8,87	1,58
RECYCLING RATE	%	0	90



Process/alloy thermal conductivity

ENDURANCE
Complete Solutions

HPD Casting

EN 46000 - D226

110 - 120 W/(m K)

EN 43500 - AlSi10MnMg

140 - 170 W/(m K)

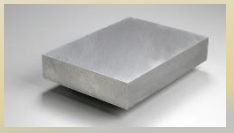
Extrusion

6061 – T6

160 -170 W/(m K)

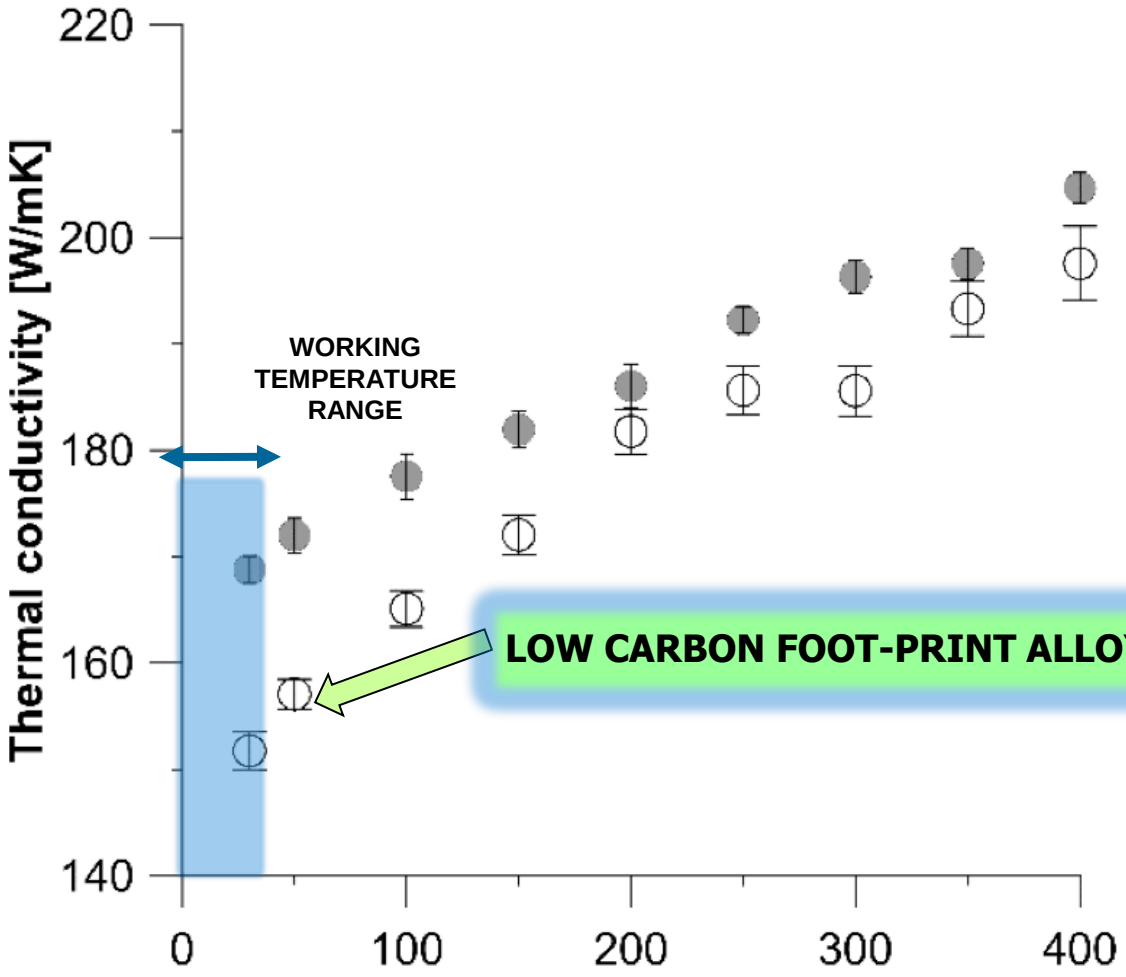
Plate

6082 – T6

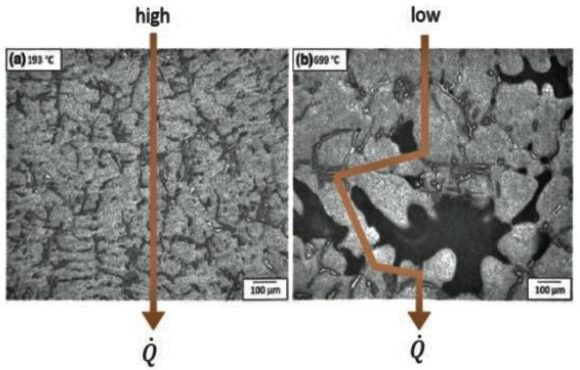


175-180 W/(m K)

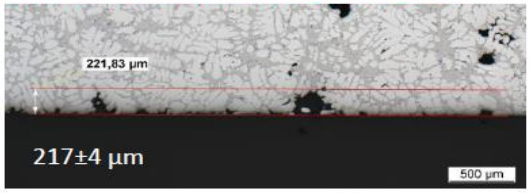
High thermal conductivity required

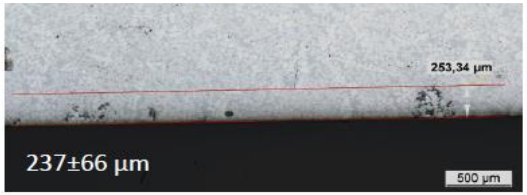


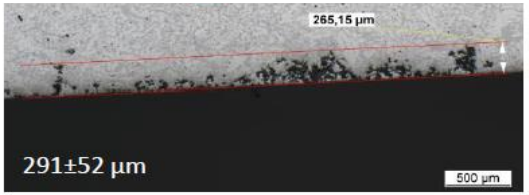
HPDC PROCESS QUALITY INDEX

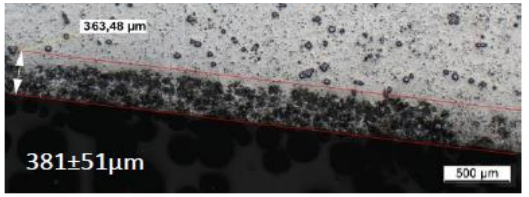


Corrosion resistance required



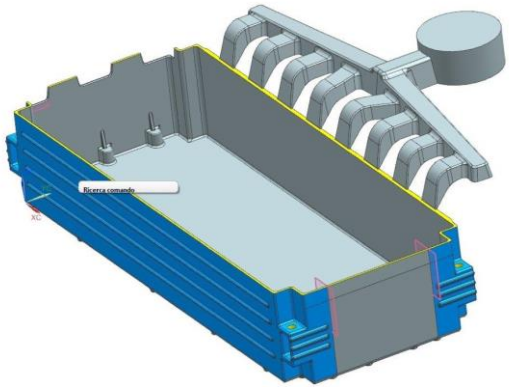


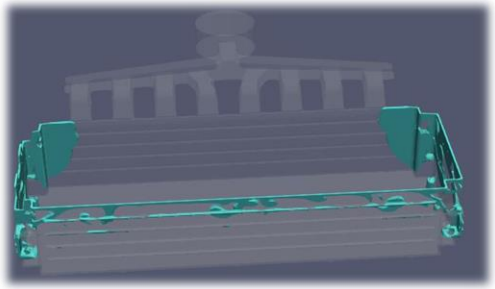


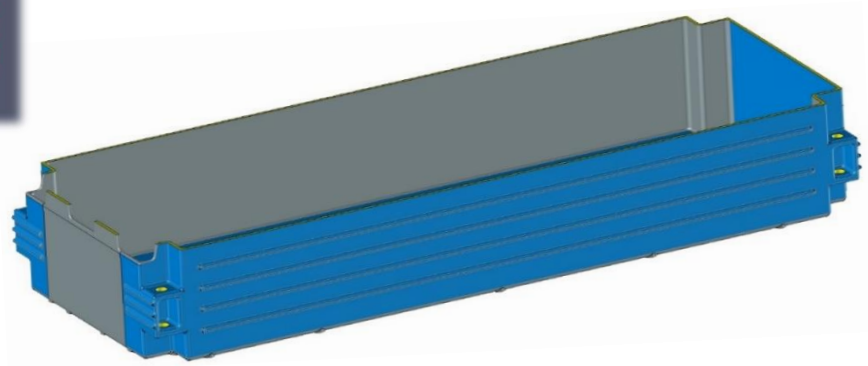


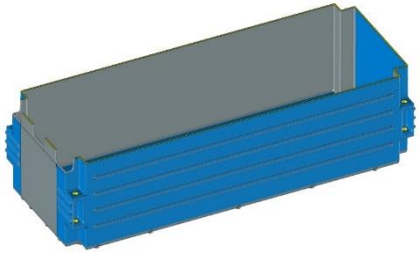
HPDC low carbon foot-print alloy “Basic Module”

ENDURANCE
Complete Solutions





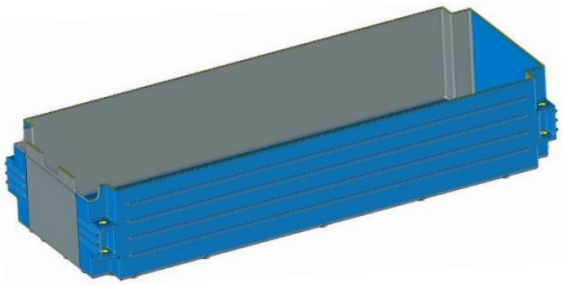




355

355mm long x 152mm wide x 108mm high

WEIGHT = 0,97 Kg



390

390mm long x 152mm wide x 108mm high

WEIGHT = 1,3 Kg

590

590mm long x 225mm wide x 108mm high

WEIGHT = 2,5 Kg

IPCEI BATTERIES

Conclusions

- EV battery housing requirements can be fulfilled with low-carbon footprint foundry aluminum alloys
- Applying product design criteria for an easy assembling and dis-assembling, Li-Ion battery re-purposing is possible
- A modular approach, both on batteries and housing, provides flexible solutions