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Programme & Part: Electrical Engineering Part 4
Project Role: Electric Vehicle Battery System
Subgroup: Electric Vehicle
Frontline Task: EV Team Lead

Design V- Cost and Sustainability Report

Bill of Materials

The following pages contain the bought parts and made parts (with detailed processes) that go into making the High Voltage battery and Battery Management System

Some notes for Mass manufacture

- While it may be viable to assemble the Printed circuit boards by hand for the prototypes, it becomes cost prohibitive and excessively time consuming in the case of mass manufacture hence it would be better to outsource this process to a contract manufacturer.
- It would be better to use bent sheet metal for the battery box as opposed to riveted parts when it comes to mass manufacturing.

€ 0.00

System	Assembly	Part	M/B	P/M/F/T		Comments	Qt	Cost (per piece)	Cost Comments	ID
BRAKES						**Total**	***1***	***€ 0.00***	***€ 0.00***	
ENGINE & DRIVETRAIN						**Total**	***1***	***€ 0.00***	***€ 0.00***	
FRAME & BODY						**Total**	***1***	***€ 0.00***	***€ 0.00***	
ELECTRICAL						**Total**	***1***	***€ 0.00***	***€ 0.00***	
EL	HV-Battery						*1*			EL-A-0400
		LG HB2 18650 Cell	b				*1125*			EL-400-010
		Battery Box	m				*1*			EL-400-011
				M	Aluminum	4mm thick Al sheet	*1*			EL-400-011-01
				P	Plasma Cutting	Cut out the two sides from Sheet	*2*			EL-400-011-02
				P	Plasma Cutting	Cut out the base	*1*			EL-400-011-04
				P	Plasma Cutting	Cut out the back piece	*1*			EL-400-011-05
				P	Plasma Cutting	Cut out the inner dividers	*5*			EL-400-011-06
				P	Plasma Cutting	Cut out the front divider piece	*1*			EL-400-011-07
				P	Plasma Cutting	Cut out the front piece	*1*			EL-400-011-08
				P	Plasma Cutting	Cut out the top cover	*1*			EL-400-011-09
				P	Adjustment - Misc.	Bend Pieces to create flanges as	*11*			EL-400-011-010
				P	Drilled hole	Drill holes in Front Divider Piece	*8*			EL-400-011-027
				P	Drilled hole	Make holes for fasteners	*132*			EL-400-011-011
				F	Rivet		*132*			EL-400-011-016
				P	Riveting	Use rivets to fasten pieces	*132*			EL-400-011-017
				M	Rubber	Rubber Sealing Gasket	*1*			EL-400-011-018
				P	Cut (scissors, knife)	Cut gasket to size of exposed fla	*1*			EL-400-011-019
				P	Resin Application	Glue Gasket to Top cover	*1*			EL-400-011-020
				P	Drilled hole	Make holes in Top Cover, Front F	*24*			EL-400-011-021
				F	Bolt	For sealing top cover to box	*24*			EL-400-011-022
				F	Nut	For sealing Top Cover to box	*24*			EL-400-011-023
				P	Cut (scissors, knife)	Cut Nomex Paper to inner dimen	*1*			EL-400-011-025
				P	Resin Application	Glue Nomex to the inside of the a	*1*			EL-400-011-026
				P	Assemble	Insert completed sections into Bc	*5*			EL-400-011-052
		Copper Busbars	m			Made from Cu101 (Electrical gra	*150*			EL-400-012
				M	Copper	2mm sheet	*1*			EL-400-012-028
				P	Plasma Cutting	Cut into copper busbars	*150*			EL-400-012-029
		Parallel String	m				*75*			EL-400-016
				M	Electronic Component	LG HB2	*15*			EL-400-016-042
				M	Plastic	18650 Cell Spacers	*30*			EL-400-016-043
				M	Copper	Copper Busbars	*2*			EL-400-016-044

			M	Electronic Component	Temperature Circuit	1		EL-400-016-045
			P	Assemble	Clip Cells to spacers	30		EL-400-016-046
			P	Weld	Spot Weld Copper Busbars to ce	2		EL-400-016-047
			P	Resin Application	Glue temprerature sensors from	1		EL-400-016-048
			P	Fastener Install (every)	Screw in PCB to end of cell spac	2		EL-400-016-049
	Battery Section	m			aka Brick	5		EL-400-017
			M	Electronic Component	Parallel String	15		EL-400-017-050
			M	Electronic Component	Section PCB	1		EL-400-017-051
			P	Assemble	Join 15 Parallel strings to form a	15		EL-400-017-053
			P	Wire Dressing (Install an	Install wires to connect Temp PC	15		EL-400-017-054
			P	Weld	Connect busbars (from parallel st	15		EL-400-017-055
			P	Wire Dressing (Install an	Install Voltage taps on series con	15		EL-400-017-056
			F	Crimp Terminal	M10 Uninsulated terminal	1		EL-400-017-057
			F	Nut	M10 locknut	2		EL-400-017-058
			F	Washer	M10	2		EL-400-017-059
			F	Screw	M10	1		EL-400-017-060
			M	Plastic	Anderson Powerpole PP180 Hou	1		EL-400-017-061
			M	Copper	Anderson Powerpole Contact	1		EL-400-017-062
			P	Assemble	Assemble Maintainance plug	1		EL-400-017-063
			P	Fastener Install (every)	Screw maintainance plugs into ba	1		EL-400-017-064
	Battery Charger	b			Emotorwerks 40A/10kWh	1	€ 580.00	EL-400-018
	000AWG wire	b				1		EL-400-019
	Shutdown Switches	b			XB4 Pushbutton switch	3		EL-400-020
	XB4 Collar	b				3		EL-400-021
	XB4 Legend Plate	b				3		EL-400-022
	Main Fuse	b			Littelfuse Class L, LDC series 60	1		EL-400-023
	Accumulator Insulato	b			TE Kilovac EV200	2		EL-400-024
	Insulation Monitoring	b			Bender Isometer IR155-3204	1		EL-400-025
	Inertia Switch	b			Pegasus Racing Inertia Switch	1		EL-400-026
	High Voltage Discon	b			Anderson SBX Series 2 Way Mal	1		EL-400-027
	HVD handle	b			Frame Handle, For Use With SB	1		EL-400-028
	Master Switches	b			0-605-21 75A Rated at 24V Batte	2		EL-400-029
	Tractive System Mea	b			Cinch Connectors Red Banana J	1		EL-400-030
EL	Battery Management System				BMS	1		EL-A-0404
	Section PCB	m				5		EL-404-014
			M	Electronic Component	BQ76940, Batter Monitor and Pro	1		EL-404-014-034
			M	Electronic Component	BQ78350-r1m CEDV Li-ion Gua	1		EL-404-014-035
			M	Electronic Component	FET Driver, BQ76200	1		EL-404-014-036
			M	Electronic Component	Blank PCB	1		EL-404-014-037
			M	Electronic Component	Capacitor, 0.22 microfarads, 060	19		EL-404-014-073
			M	Electronic Component	Capacitor, 1.5 microfarads, 0805	1		EL-404-014-074
			M	Electronic Component	Capacitor, 0.1 microfarads, 0603	4		EL-404-014-075
			M	Electronic Component	Capacitor, 470picofarads, 0603	2		EL-404-014-076

	M	Electronic Component	Capacitor, 0.1 microfarads, 0603	5			EL-404-014-077
	M	Electronic Component	Capacitor, 10 microfarad, 1210	3			EL-404-014-078
	M	Electronic Component	MOSFET, N/P-CH, 12V, 2.1A	15			EL-404-014-079
	M	Electronic Component	Diode, Ultrafast, 100V, SOD-123	5			EL-404-014-080
	M	Electronic Component	Resistor, 100 Ohm, 0805	2			EL-404-014-081
	M	Electronic Component	Resistor, 100 kiloohm, 0805	3			EL-404-014-082
	M	Electronic Component	Resistor, 300kiloOhm, 0603	4			EL-404-014-083
	P	Assemble	Solder Electronic Components to	1			EL-404-014-084
Temperature Acquis	m			75			EL-404-015
	M	Electronic Component	Blank PCB	1			EL-404-015-038
	M	Electronic Component	Resistor, 20 0hm	1			EL-404-015-039
	M	Electronic Component	Capacitor, 10 Microfarad	1			EL-404-015-040
	M	Electronic Component	Inductor, 10 MicroHenry	1			EL-404-015-041
	M	Electronic Component	Resistor, 385 KiloOhms	1			EL-404-015-065
	M	Electronic Component	Resistor, 125 KiloOhms	1			EL-404-015-066
	M	Plastic	Header, Female, 1row 3 pin	8			EL-404-015-067
	M	Electronic Component	SN74LV4051A, 8 Channel Analo	1			EL-404-015-068
	M	Electronic Component	LM3670 DC-DC buck converter	1			EL-404-015-069
	M	Electronic Component	LMT84, 3-Pin Thermometer, TO9	8			EL-404-015-070
	M	Plastic	Header, JXT-SH, Male, 7 pin	1			EL-404-015-071
	P	Assemble	Solder Electronic Components to	1			EL-404-015-072
MSP430 Ultra-Low F	b		Main MCU	1			EL-404-031

MISCELLANEOUS, FIT, FINISH & ASSEMBLY	**Total**	***1***	***€ 0.00***	***€ 0.00***
STEERING SYSTEM	**Total**	***1***	***€ 0.00***	***€ 0.00***
SUSPENSION SYSTEM	**Total**	***1***	***€ 0.00***	***€ 0.00***
WHEELS, WHEEL BEARINGS AND TIRES	**Total**	***1***	***€ 0.00***	***€ 0.00***

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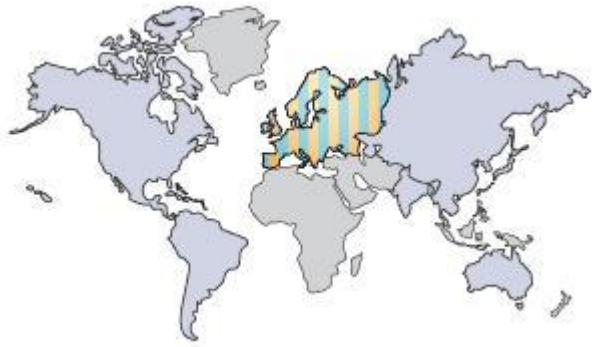
Sustainability Report

A Sustainability report was carried out on the battery box and the assembled battery sections which will go into the box (the bricks). This was done using the Solidworks Sustainability function. The box was set to be manufactured and used in Europe while the battery section was set to be manufactured in Asia and used in Europe. The results are shown below:



Manufacturing Region
The choice of manufacturing region determines the energy sources and technologies used in the modeled material creation and manufacturing steps of the product's life cycle.

Use Region
The use region is used to determine the energy sources consumed during the product's use phase (if applicable) and the destination for the product at its end-of-life. Together with the manufacturing region, the use region is also used to estimate the environmental impacts associated with transporting the product from its manufacturing location to its use location.

Sustainability report for battery box

Environmental Impact (calculated using TRACI impact assessment methodology)

Carbon Footprint

1200 kg CO_2e

Material:	990 kg CO_2e
Manufacturing:	45 kg CO_2e
Use:	0.00 kg CO_2e
Transportation:	23 kg CO_2e
End of Life:	130 kg CO_2e

Total Energy Consumed

1.3E+4 MJ

Material:	1.2E+4 MJ
Manufacturing:	750 MJ
Use:	0.00 MJ
Transportation:	350 MJ
End of Life:	95 MJ

Air Acidification

350 mol H^+ e

Material:	320 mol H^+ e
Manufacturing:	15 mol H^+ e
Use:	0.00 mol H^+ e
Transportation:	9.4 mol H^+ e
End of Life:	5.1 mol H^+ e

Water Eutrophication

0.133 kg N e

Material:	0.086 kg N e
Manufacturing:	5.4E-3 kg N e
Use:	0.00 kg N e
Transportation:	9.0E-3 kg N e
End of Life:	0.033 kg N e

Material Financial Impact 176.10 USD

Comments

Component Environmental Impact

Top Ten Components Contributing Most to the Four Areas of Environmental Impact

Component	Carbon	Water	Air	Energy
box_TopCover	37	3.3E-3	11	460
box_base	33	2.9E-3	10	400
box_back	20	1.8E-3	6.3	250
box_side	20	1.8E-3	6.2	250
box_sidemirrored	20	1.7E-3	6.1	240
box_frontdivider	17	1.5E-3	5.4	220
box_inner	12	1.1E-3	3.9	150
box_front	5.7	5.0E-4	1.8	71

Sustainability Report for Section Assembly

Model Name:	SectionAssembly	Weight:	21597.07 g
		Built to last:	5.0 year
		Duration of use:	5.0 year

Carbon Footprint

390 kg CO_2e

Material:	280 kg CO_2e
Manufacturing:	91 kg CO_2e
Use:	0.00 kg CO_2e
Transportation:	6.2 kg CO_2e
End of Life:	12 kg CO_2e

Total Energy Consumed

4700 MJ

Material:	3700 MJ
Manufacturing:	910 MJ
Use:	0.00 MJ
Transportation:	82 MJ
End of Life:	8.7 MJ

Air Acidification

130 mol H^+ e

Material:	57 mol H^+ e
Manufacturing:	61 mol H^+ e
Use:	0.00 mol H^+ e
Transportation:	8.5 mol H^+ e
End of Life:	0.408 mol H^+ e

Water Eutrophication

0.391 kg N e

Material:	0.359 kg N e
Manufacturing:	0.023 kg N e
Use:	0.00 kg N e
Transportation:	5.2E-3 kg N e
End of Life:	3.7E-3 kg N e

Material Financial Impact

102.70 USD

Sustainability Report

Model Name:	SectionAssembly	Weight:	21597.07 g
		Built to last:	5.0 year
		Duration of use:	5.0 year

Component Environmental Impact

Top Ten Components Contributing Most to the Four Areas of Environmental Impact

Component	Carbon	Water	Air	Energy
DummyPCBForSection	1.3	3.2E-4	0.598	18
HB2	0.520	5.0E-4	0.164	6.0
DummyPCB	0.444	1.1E-4	0.199	6.0
CopperConductor	0.034	9.3E-6	0.014	0.439
pan slot head_am	7.5E-3	3.7E-5	1.4E-3	0.074
EndCap	0.016	5.2E-6	5.1E-3	0.285
EndCapWithM3	0.015	4.8E-6	4.8E-3	0.266

It should be noted that these are just rough estimates of the Environmental Impact of the parts. For example the battery itself was analysed as a stainless steel part as there is no specific battery material available.