Sensitivity Analysis in the Life-Cycle Assessment of Electric vs. Combustion Engine Cars under Approximate Real-World Conditions

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Supplement 1

Detailed life cycle inventories for the VW Caddy and the SMART. (production, maintenance, transport of vehicle components, waste treatment, energy consumption, electricity mixes DE 2013/DE 2050), Includes as well: metal recovery percentages (recycling), electricity and heat generation in waste incineration plants, material losses during production (waste factors)

Production of the glider						
process type	**material**	**Ecoinvent module**	**unit**	**loca-tion**	**input[1]**	
					Caddy	**Smart**
primary metals						
material	conventional steel	steel, converter, unalloyed, at plant	kg	RER	43.87	24.69
	stainless steel	steel, converter, chromium steel 18/8, at plant	kg	RER	1.59	0.83
	high tensile steel	steel, converter, low-alloyed, at plant	kg	RER	9.85	3.07
	aluminium, cast alloy	aluminium, primary, at plant	kg	RER	2.14	1.09
	aluminium, wrought alloy	aluminium, primary, at plant	kg	RER	0.61	0.31
	magnesium	magnesium, at plant	kg	RER	0.09	0.08
	copper	copper, primary, at refinery	kg	RER	0.06	0.04
	zinc	zinc, primary, at regional storage	kg	RER	0.18	0.16
	other metals	copper,primary,at refinery	kg	RER	0.03	0.08
secondary metals[2]						
material	conventional steel	steel, electric, un- and low-alloyed, at plant	kg	RER	833.44	469.03
	stainless steel	steel, electric, chromium steel 18/8, at plant	kg	RER	30.19	15.84
	high tensile steel	steel, electric, un- and low-alloyed, at plant	kg	RER	187.09	58.33
	aluminium, cast alloy	aluminium, secondary, from old scrap	kg	RER	40.67	20.71
	aluminium, wrought alloy	aluminium, secondary, from old scrap	kg	RER	11.55	5.88
	magnesium	aluminium, secondary, from old scrap	kg	RER	1.75	1.51
	copper	copper, secondary, at refinery	kg	RER	5.89	3.91
	zinc	steel, electric, un- and low-alloyed, at plant	kg	RER	3.50	3.01
	other metals	copper, secondary, at refinery	kg	RER	2.88	7.85

other materials						
material	polypropylene (PP)	polypropylene, granulate, at plant	kg	RER	96.64	43.78
	polyethylene (PE)	polyethylene, LDPE, granulate, at plant	kg	RER	28.14	11.56
	polyethylene terephthalate (PET)	polyethylene terephthalate, granulate, amorphous, at plant	kg	RER	2.96	1.66
	polyurethane (PU)	polyurethane, flexible foam, at plant	kg	RER	32.16	18.09
	polyamide (PA)	nylon 6, at plant	kg	RER	-	0.09
	acrylonitrile butadiene styrene (ABS)	acrylonitrile-butadiene-styrene copolymer, ABS, at plant	kg	RER	8.79	4.33
	other plastics	polyvinylchloride, at regional storage	kg	RER	2.20	2.13
	fibreglass	glass fibre reinforced plastic, polyester resin, hand lay-up, at plant	kg	RER	2.99	1.95
	resins	epoxy resin, liquid, at plant	kg	RER	7.03	4.39
	textiles	viscose fibres, at plant	kg	GLO	10.02	6.58
	glass	flat glass, uncoated, at plant	kg	RER	19.17	11.96
	rubber	synthetic rubber, at plant	kg	RER	68.44	26.92
	oil & lubricants	lubricating oil, at plant	kg	RER	3.61	1.32
	insulating material	polyurethane, flexible foam, at plant	kg	RER	7.03	4.39
	paints	coating powder, at plant	kg	RER	14.91	2.99
	LED	light emitting diode, LED, at plant	kg	GLO	0.01	0.15
	circuit board	Printed wiring board, mixed mounted, unspec., solder mix, at plant	kg	GLO	0.14	2.84
other process types						
energy[3]		electricity, medium voltage, production UCTE, at grid	kWh	UCTE	2,006.04	1,033.49
		heat, natural gas, at industrial furnace > 100 kW	MJ	RER	565.86	352.82
		light fuel oil, burned in industrial furnace 1MW, non-modulating	MJ	RER	67.04	34.12
processing		sheet rolling, steel	kg	RER	1,106.02	571.78
		sheet rolling, aluminium	kg	RER	54.97	27.99
		wire drawing, copper	kg	RER	5.95	3.95
		metal product manufacturing, average metal working	kg	RER	8.44	12.69
		injection moulding	kg	RER	177.92	86.04
		tempering, flat glass	kg	RER	19.17	11.96
		tap water, at user	kg	RER	3,426.65	1,744.05
transport		transport, freight, rail	tkm	RER	295.92	152.31
		transport, lorry > 16t, fleet average	tkm	RER	147.96	76.16
infrastructure		Road vehicle plant	p	RER	3.10E-07	1.58E-07
emissions	emissions in air	heat, waste	MJ	-	8.20E+03	4.17E+03
		NMVOC, non-methane volatile organic compounds	kg	-	5.11E+00	2.60E+00
	emissions in water	BOD5, Biological Oxygen Demand	kg	-	2.77E-02	1.41E-02
		COD, Chemical Oxygen Demand	kg	-	2.05E-01	1.05E-01
		Phosphate	kg	-	1.06E-03	5.42E-04

[1] The input includes the material losses in production and is therefore in many cases higher than the amount of the respective material in the finished car. [2] Metals obtained by recycling the car at the end of the product life cycle. For metal recovery percentages see below. [3] Energy requirements of production after offsetting the credits from thermal recycling at the end of the product life cycle.

Production of the ICEV drive train						
process type	**material**	**Ecoinvent module**	**unit**	**loca-tion**	**input[1]**	
					Caddy	**Smart**
primary metals						
material	conventional steel	steel, converter, unalloyed, at plant	kg	RER	12.83	0.55
	stainless steel	steel, converter, chromium steel 18/8, at plant	kg	RER	0.23	-
	high tensile steel	steel, converter, low-alloyed, at plant	kg	RER	1.66	2.21
	cast iron	steel, converter, unalloyed, at plant	kg	RER	-	0.64
	aluminium	aluminium, primary, at plant	kg	RER	2.24	1.77
	copper	copper, primary, at refinery	kg	RER	0.03	0.04
	lead	lead, primary, at plant	kg	RER	0.58	0.38
	other metals	copper, primary, at refinery	kg	RER	0.02	-
secondary metals[2]						
material	conventional steel	steel, electric, un- and low-alloyed, at plant	kg	RER	243.83	10.54
	stainless steel	steel, electric, chromium steel 18/8, at plant	kg	RER	4.33	-
	high tensile steel	steel, electric, un- and low-alloyed, at plant	kg	RER	31.59	41.99
	cast iron	steel, electric, un- and low-alloyed, at plant	kg	RER	-	12.18
	aluminium	aluminium, secondary, from old scrap	kg	RER	42.65	33.59
	copper	copper, secondary, at refinery	kg	RER	3.14	3.86
	lead	lead, secondary, at plant	kg	RER	10.96	7.20
	other metals	copper, secondary, at refinery	kg	RER	1.51	-
other materials						
material	polypropylene (PP)	polypropylene, granulate, at plant	kg	RER	3.07	8.15
	polyethylene (PE)	polyethylene, LDPE, granulate, at plant	kg	RER	2.45	5.05
	polyethylene terephthalate (PET)	polyethylene terephthalate, granulate, amorphous, at plant	kg	RER	7.82E-04	-
	polyamide (PA)	nylon 6, at plant	kg	RER	6.01	3.23
	polyurethane (PU)	polyurethane, flexible foam, at plant	kg	RER	0.04	-
	acrylonitrile butadiene styrene (ABS)	acrylonitrile-butadiene-styrene copolymer, ABS, at plant	kg	RER	0.08	0.66
	polyoxymethylene (POM)	polypropylene, granulate, at plant	kg	RER	0.81	-
	polyvinylchloride (PVC)	polyvinylchloride, at regional storage	kg	RER	0.10	-
	polyphenylene sulfide	polyphenylene sulfide, at plant	kg	GLO	-	9.75

	other plastics	polyvinylchloride, at regional storage	kg	RER	12.67	-
	fibreglass	glass fibre reinforced plastic, polyester resin, hand lay-up, at plant	kg	RER	0.49	0.22
	textils	viscose fibres, at plant	kg	GLO	0.53	-
	rubber	synthetic rubber, at plant	kg	RER	5.49	1.27
	oil & lubricants	lubricating oil, at plant	kg	RER	22.15	8.02
	sulfuric acid	sulphuric acid, liquid, at plant	kg	RER	1.34	0.88
	antimony	silver, from combined gold-silver production, at refinery	kg	GLO	0.12	0.08
	arsenic	-	-	-	0.01	3.31E-03
	water	water, completely softened, at plant	kg	RER	2.34	1.54
other process types						
energy[3]		electricity, medium voltage, production UCTE, at grid	kWh	UCTE	547.38	203.04
		electricity, medium voltage, at grid	kWh	CN	-	14.98
		heat, natural gas, at industrial furnace > 100 kW	MJ	RER	499.55	101.19
		light fuel oil, burned in industrial furnace 1MW, non-modulating	MJ	RER	24.44	10.90
processing		steel product manufacturing, average metal working	kg	RER	294.47	55.29
		aluminium product manufacturing, average metal working	kg	RER	44.90	35.35
		copper product manufacturing, average metal working	kg	RER	3.18	3.91
		metal product manufacturing, average metal working	kg	RER	1.53	12.83
		injection moulding	kg	RER	30.73	28.10
		oxygen, liquid, at plant	kg	RER	0.38	0.25
		tap water, at user	kg	RER	1072.01	432.36
transport		transport, freight, rail	tkm	RER	89.48	35.19
		transport, lorry > 16t, fleet average	tkm	RER	41.33	15.38
infrastructure		Road vehicle plant	p	RER	9.69E-08	3.91E-08
emissions	emissions in air	heat, waste	MJ		2.56E+03	1.03E+03
		NMVOC, non-methane volatile organic compounds, unspecified origin	kg		1.60E+00	6.47E-01
		Lead, air, non-urban air or from high stacks	kg		2.65E-05	1.74E-05
	emissions in water	BOD5, Biological Oxygen Demand	kg		8.66E-03	3.49E-03
		COD, Chemical Oxygen Demand	kg		6.43E-02	2.59E-02
		Phosphate	kg		3.34E-04	1.35E-04
		lead, water, surface water	kg		7.96E-05	5.23E-05

[1] The input includes the material losses in production and is therefore in many cases higher than the amount of the respective material in the finished car. [2] Metals obtained by recycling the car at the end of the product life cycle. For metal recovery percentages see below. [3] Energy requirements of production after offsetting the credits from thermal recycling at the end of the product life cycle.

Production of the BEV drive train						
process type	**material**	**Ecoinvent module**	**unit**	**loca-tion**	**input[1]**	
					Caddy	**Smart**
primary metals						
material	conventional steel	steel, converter, unalloyed, at plant	kg	RER	5.03	0.23
	stainless steel	steel, converter, chromium steel 18/8, at plant	kg	RER	0.19	1.17
	high tensile steel	steel, converter, low-alloyed, at plant	kg	RER	5.48	0.08
	cast iron	steel, converter, unalloyed, at plant	kg	RER	0.05	2.13
	aluminium, wrought alloy	aluminium, primary, at plant	kg	RER	1.08	1.95
	aluminium, production mix	aluminium, primary, at plant	kg	RER	4.46	0.82
	copper	copper, primary, at refinery	kg	RER	0.36	0.19
	lead	lead, primary, at plant	kg	GLO	0.30	0.20
	brass	brass, at plant	kg	CH	1.36E-02	0.01
secondary metals[2]						
material	conventional steel	steel, electric, un- and low-alloyed, at plant	kg	RER	95.55	4.35
	stainless steel	steel, electric, chromium steel 18/8, at plant	kg	RER	3.65	22.30
	high tensile steel	steel, electric, un- and low-alloyed, at plant	kg	RER	104.12	1.49
	cast iron	steel, electric, un- and low-alloyed, at plant	kg	?	1.01	40.42
	aluminium, wrought alloy	aluminium, secondary, from old scrap	kg	RER	20.61	37.01
	aluminium, production mix	aluminium, secondary, from old scrap	kg	RER	84.79	15.61
	copper	copper, secondary, at refinery	kg	RER	35.27	19.04
	lead	lead, secondary, at plant	kg	RER	5.76	3.86
	brass	copper, secondary, at refinery	kg	RER	1.34	1.06
other materials						
material	polypropylene (PP)	polypropylene, granulate, at plant	kg	RER	3.15	
	polyethylene (PE)	polyethylene, LDPE, granulate, at plant	kg	RER	3.26	3.89
	polystyrene	polystyrene, high impact, HIPS, at plant	kg	RER	0.65	0.51
	polyamide (PA)	nylon 6, at plant	kg	RER	0.74	
	polyvinylchloride (PVC)	polyvinylchloride, at regional storage	kg	RER	9.91	
	acrylonitrile butadiene styrene (ABS)	acrylonitrile-butadiene-styrene copolymer, ABS, at plant	kg	RER	-	0.35
	rubber	synthetic rubber, at plant	kg	RER	1.61	0.49
	fibreglass	glass fibre reinforced plastic, polyester resin, hand lay-up, at plant	kg	RER	0.24	0.12
	sulfuric acid	sulphuric acid, liquid, at plant	kg	RER	0.70	0.47
	antimony	silver, from combined gold-silver production, at refinery	kg	GLO	0.06	0.04
	arsenic	-	-	-	2.65E-03	1.78E-03

	water	water, completely softened, at plant	kg	RER	1.23	0.83
	potting material	polyester resin, unsaturated, at plant	kg	RER	0.99	0.73
	silicone	silicone product, at plant	kg	RER	0.02	0.02
	ferrite	ferrite, at plant	kg	GLO	3.50	2.31
	ceramics	aluminium oxide, at plant	kg	RER	0.24	0.23
	plywood	plywood, outdoor use, at plant	kg	RER	19.00	-
	barium titanate	-	-	-	0.30	0.05
	carbon	-	-	-	-	0.07
	printed circuit board (FR4+Cu+SMD)	printed wiring board, surface mounted, unspec., solder mix, at plant	kg	GLO	2.35	2.09
	printed circuit board (FR4)	printed wiring board, through-hole, at plant	kg	GLO	1.00	0.59
	resistor	resistor, SMD type, surface mounting, at plant	kg	GLO	0.04	0.04
	capacitor	capacitor, film, through-hole mounting, at plant	kg	GLO	2.43	1.89
	integrated circuit	integrated circuit, IC, logic type, at plant	kg	GLO	0.73	0.26
other process types						
energy[3]		electricity, medium voltage, production UCTE, at grid	kWh	UCTE	778.11	1222.58
		electricity, medium voltage, at grid	kWh	CN	49.82	33.52
		heat, natural gas, at industrial furnace > 100 kW	MJ	RER	739.97	308.82
		light fuel oil, burned in industrial furnace 1MW, non-modulating	MJ	RER	26.19	11.08
processing		steel product manufacturing, average metal working	kg	RER	207.64	26.17
		aluminium product manufacturing, average metal working	kg	RER	84.26	34.68
		copper product manufacturing, average metal working	kg	RER	25.94	13.07
		metal product manufacturing, average metal working	kg	RER	1.21	42.57
		sheet rolling, steel	kg	RER	6.38	3.45
		sheet rolling, aluminium	kg	RER	26.69	20.71
		wire drawing, copper	kg	RER	9.69	6.17
		injection moulding	kg	RER	18.63	4.70
		selective coating, aluminium sheet, nickel pigmented aluminium oxide	m²	SK	4.89E-03	4.27E-03
		zinc coating, coils	m²	RER	0.05	0.03
		production efforts, resistors	kg	GLO	0.24	0.23
		oxygen, liquid, at plant	kg	RER	0.20	0.13
		tap water, at user	kg	RER	1,254.93	503.50
transport		transport, freight, rail	tkm	RER	87.83	35.76
		transport, lorry > 16t, fleet average	tkm	RER	42.12	16.69
infrastructure		Road vehicle plant	p	RER	1.13E-07	4.55E-08
		plastics processing factory	Unit	RER	1.68E-09	5.89E-10
emissions	emissions in air	heat, waste	MJ		2.62E+03	9.07E+02

		NMVOC, non-methane volatile organic compounds	kg		1.62E+00	5.62E-01
		Lead, air, low population density	kg		1.39E-05	9.35E-06
	emissions in water	BOD5, Biological Oxygen Demand	kg		8.84E-03	3.06E-03
		COD, Chemical Oxygen Demand	kg		6.56E-02	2.27E-02
		Phosphate	kg		3.39E-04	1.18E-04
		Lead, water, river	kg		4.18E-05	2.81E-05

[1] The input includes the material losses in production and is therefore in many cases higher than the amount of the respective material in the finished car. [2] Metals obtained by recycling the car at the end of the product life cycle. For metal recovery percentages see below. [3] Energy requirements of production after offsetting the credits from thermal recycling at the end of the product life cycle.

Production of the Li-battery ($LiFePO_4$)						
process type	**material**	**Ecoinvent module**	**unit**	**loca-tion**	**input[1]**	
					Caddy	**Smart**
primary metals						
material	aluminium	aluminium, primary, at plant	kg	RER	4.02	2.17
	copper	copper, primary, at refinery	kg	RER	0.28	0.15
secondary metals[2]						
material	aluminium	aluminium, secondary, from old scrap	kg	RER	76.29	41.24
	copper	copper, secondary, at refinery	kg	RER	27.97	15.12
other materials						
material	graphite	graphite, at plant	kg	RER	25.86	13.98
	carbon	carbon black, at plant	kg	GLO	4.22	2.28
	polyethylene (PE)	polyethylene, LDPE, granulate, at plant	kg	RER	5.61	3.03
	polypropylene (PP)	polyppropylene, granulate, at plant	kg	RER	5.61	3.03
	polytetrafluorethylene	polyethylene, HDPE, granulate, at plant	kg	RER	8.12	4.39
	N-methyl-2-pyrrolidone (NMP)	N-methyl-2-pyrrolidone, at plant	kg	RER	31.24	16.89
	lithium hydroxide	lithium hydroxide, at plant	kg	GLO	10.90	5.89
	phosphoric acid	phosphoric acid, industrial grade, 85% in H2O, at plant	kg	RER	15.39	8.32
	iron sulphate	iron sulphate, at plant	kg	RER	23.68	12.80
	lithium hexafluorophosphate	lithium hexafluorophosphate, at plant	kg	CN	4.90	2.65
	ethylene carbonate	ethylene carbonate, at plant	kg	CN	35.92	19.42
other process types						
energy[3]		electricity, medium voltage, at grid	kWh	CN	2,541.17	1,373.68
		heat, natural gas, at industrial furnace low-NOx >100kW	MJ	RER	7,407.08	4,004.06

		heat, light fuel oil, at industrial furnace 1MW	MJ	RER	986.77	533.42
		heat, unspecific, in chemical plant	MJ	RER	491.35	265.61
processing		sheet rolling, aluminium	kg	RER	80.30	43.41
		sheet rolling, copper	kg	RER	28.25	15.27
		Injection moulding	kg	RER	11.23	6.07
		water, decarbonised, at plant	kg	RER	129,301.71	69,896.81
		water, deionised, at plant	kg	CH	1,089.40	588.90
transport		transport, freight, rail	tkm	RER	168.00	90.82
		transport, lorry >16t, fleet average	tkm	RER	28.00	15.14
infrastructure		facilities precious metal refinery	Unit	SE	6.46E-06	3.49E-06
		chemical plant, organics	Unit	RER	2.57E-08	1.39E-08
		metal working factory	Unit	RER	4.99E-08	2.70E-08
		plastics processing factory	Unit	RER	8.31E-09	4.49E-09
emissions	emissions in air	heat, waste	MJ		1.79E+04	9.66E+03
		N-methyl-2-pyrrolidone (NMP), to air, unspecified	kg		3.13E+01	1.69E+01
	emissions in water	lithium, ion	kg		2.37E+00	1.28E+00
		iron, ion	kg		4.50E-01	2.43E-01
		phosphate	kg		7.58E-01	4.10E-01

[1] The input includes the material losses in production and is therefore in many cases higher than the amount of the respective material in the finished car. [2] Metals obtained by recycling the car at the end of the product life cycle. For metal recovery percentages see below. [3] Energy requirements of production after offsetting the credits from thermal recycling at the end of the product life cycle.

Car maintenance in use phase								
process type	material	Ecoinvent module	unit	loca-tion	input[1]			
					Caddy		Smart	
					ICEV	BEV	ICEV	BEV
primary metals								
material	high tensile steel	steel, converter, low-alloyed, at plant	kg	RER	0.75	0.59	0.37	0.36
	copper	copper,primary, at refinery	kg	RER	0.004	0.003	0.002	0.002
	lead	lead, primary, at plant	kg	GLO	1.70	-	0.83	-
secondary metals[2]								
material	high tensile steel	steel, electric, un- and low-alloyed, at plant	kg	RER	14.23	11.27	6.96	6.75
	copper	copper, secondary, at refinery	kg	RER	0.40	0.32	0.20	0.19
	lead	lead, secondary, at plant	kg	RER	32.35	-	15.83	-
other materials								
material	polyethylene, HDPE	polyethylene, HDPE, granulate, at plant	kg	RER	6.81	5.39	3.33	3.22
	polypropylene (PP)	polypropylene, granulate, at plant	kg	RER	8.17	6.47	4.00	3.86
	rubber	synthetic rubber, at plant	kg	RER	158.00	125.10	77.31	74.89
	ethylene	ethylene, average, at plant	kg	RER	51.76	40.98	25.33	24.47
	ethylene glycol	ethylene glycol, at plant	kg	RER	2.72	2.16	1.33	-
	sulphuric acid	sulphuric acid, liquid, at plant	kg	RER	1.91	-	0.93	-
other process types								
energy[3]		electricity, medium voltage, production UCTE, at grid	kWh	UCTE	647.08	512.31	316.62	306.11
		heat, natural gas, at industrial furnace > 100 kW[4]	MJ	RER	-1,070.74	-847.74	-523.92	-507.40
		light fuel oil, burned in industrial furnace 1MW, non-modulating	MJ	RER	0.00	0.00	0.00	0.00
transport		transport, freight, rail	tkm	RER	80.77	63.95	39.52	38.25
		transport, lorry >16t, fleet average	tkm	RER	40.32	31.92	19.73	19.12
emissions		heat, waste	MJ		2,860.42	2,264.71	1,399.64	1,350.67

[1] The input includes the material losses in production and is therefore in many cases higher than the amount of the respective material in the finished car. [2] Metals obtained by recycling the car at the end of the product life cycle. For metal recovery percentages see below. [3] Energy requirements of production after offsetting the credits from thermal recycling at the end of the product life cycle. If the heat generation exceeds the heat requirement, a negative value is shown in the table.

metal recovery percentages (recycling)	
aluminium	95.0%
brass	99.0%
copper	99.0%
ferrous materials	95.0%
lead	95.0%
magnesium	95.0%
zinc	95.0%
other metals	99.0%

electricity and heat generation in waste incineration plants		
Ecoinvent module	**electricity**	**heat**
	MJ/kg	**MJ/kg**
disposal, plastics, mixture, 15.3% water, to municipal incineration	3.48	7.03
disposal, rubber, unspecified, 0% water, to municipal incineration	3.02	6.11
disposal, polyurethane, 0.2 water, to municipal incineration	3.47	7.00
disposal, used mineral oil, 10% water, to hazardous waste incineration	25.82	2.44

material losses during production (waste factors)									
material group	material	glider		drive train				Li-battery	
				ICEV		BEV			
		Caddy	Smart	Caddy	Smart	Caddy	Smart	Caddy	Smart
ferrous materials	conventional steel	1.50	1.50	1.50	1.50	1.50	1.50	modelling without waste factors	
	stainless steel	1.25	1.25	1.25	-	1.05	1.07		
	high tensile steel	1.25	1.25	1.25	1.25	1.25	1.25		
	cast iron	-	-	-	1.25	1.25	1.25		

aluminium	aluminium, cast alloy	1.10	1.10	-	-	-	-	
	aluminium, wrought alloy	1.25	1.25	-	-	1.25	1.25	
	aluminium, production mix	-	-	1.10	1.22	1.10	1.13	
non ferrous materials	magnesium	1.01	1.01	-	-	-	-	
	copper	1.00	1.00	1.00	1.00	1.00	1.00	
	zinc	1.01	1.01	-	-	-	-	
	lead	-	-	1.01	1.01	1.01	1.01	
	brass	-	-	-	-	1.01	1.03	
	other metals	1.01	1.01	1.25	-	-	-	
plastics	polypropylene (PP)	1.01	1.01	1.06	1.01	1.03	-	
	polyethylene (PE)	1.01	1.01	1.04	1.01	1.02	1.01	
	polyethylene terephthalate (PET)	1.01	1.01	1.01	-	-	-	
	polyamide (PA)	-	1.01	1.01	1.01	1.01	-	
	polyurethane (PU)	1.10	1.10	1.10	-	-	-	
	acrylonitrile butadiene styrene (ABS)	1.01	1.01	1.01	1.01	-	1.01	
	polystyrene	-	-	-	-	1.01	1.01	
	polyoxymethylene (POM)	-	-	1.01	-	-	-	

	polyvinylchloride (PVC)	-	-	1.01	-	1.01	-	
	other plactics	1.01	1.01	1.01	1.10	-	-	
other materials	fibreglass	1.10	1.10	1.03	1.00	1.03	1.00	
	resins	1.10	1.10	-	-	-	-	
	textiles	1.10	1.10	1.10	-	-	-	
	glass	1.00	1.00	-	-	-	-	
	rubber	1.01	1.01	1.01	1.01	1.01	1.01	
	oil & lubricants	1.01	1.01	1.01	1.00	-	-	
	insulating material	1.10	1.10	-	-	-	-	
	paints	1.00	1.00	-	-	-	-	
	sulfuric acid	-	-	1.00	1.00	1.00	1.00	
	antimony	-	-	1.00	1.00	1.00	1.00	
	arsenic	-	-	1.00	1.00	1.00	1.00	
	water	-	-	1.00	1.00	1.00	1.00	
	potting material	-	-	-	-	1.10	1.10	
	silicone	-	-	-	-	1.01	1.01	
	ferrite	-	-	-	-	1.01	1.01	
	ceramics	-	-	-	-	1.01	1.01	
	carbon	-	-	-	-	-	1.00	
	plywood	-	-	-	-	1.00	-	

	barium titanate	-	-	-	-	1.00	1.00	
electronics	LED	1.00	1.00	-	-	-	-	
	circuit board	1.00	1.00	-	-	-	-	
	printed circuit board (FR4+Cu+SMD)	-	-	-	-	1.00	1.00	
	printed circuit board (FR4)	-	-	-	-	1.00	1.00	
	resistor	-	-	-	-	1.00	1.00	
	capacitor	-	-	-	-	1.00	1.00	
	integrated circuit	-	-	-	-	1.00	1.00	

Transport of the vehicle components to the place of final assembly								
vehicle component		**start point**	**end point**	**distance [km]**	**transport method**	**transport weight [kg]**	**payload-distance [tkm]**	**Ecoinvent module**
Caddy (BEV)								
drive train	electric motor	Liscate (Italy)	Neubrücke (Germany)	701	lorry	128.0	89.73	transport, lorry > 16t, fleet average [RER]
	transmission	Palazzuolo sul Senio (Italy)	Neubrücke (Germany)	965	lorry	27.0	26.06	transport, lorry > 16t, fleet average [RER]
	Pb battery	Rodgau (Germany)	Neubrücke (Germany)	170	lorry	8.8	1.49	transport, lorry > 16t, fleet average [RER]
	PowerpAC	Ranica (Italy)	Neubrücke (Germany)	718	lorry	23.0	16.51	transport, lorry > 16t, fleet average [RER]
	Charger	Hangzhou (China)	Antwerpen (Belgium)	19,402	ship	20.0	388.04	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Neubrücke (Germany)	341	lorry		6.82	transport, lorry > 16t, fleet average [RER]
	BMS	Hefei (China)	Shanghai (China)	475	lorry	7.3	3.48	transport, lorry > 16t, fleet average [RER]
		Shanghai (China)	Antwerpen (Belgium)	19,373	ship		141.81	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Neubrücke (Germany)	341	lorry		2.50	transport, lorry > 16t, fleet average [RER]
	remaining parts	estimation of transportation distance		400	lorry	138.3	55.33	transport, lorry > 16t, fleet average [RER]
Li-battery		Luoyang (China)	Shanghai (China)	1,036	lorry	280.0	290.08	transport, lorry > 16t, fleet average [RER]
		Shanghai (China)	Antwerpen (Belgium)	19,378	ship		5,425.84	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Neubrücke (Germany)	341	lorry		95.48	transport, lorry > 16t, fleet average [RER]
Caddy (ICEV)								
drive train	motor	Salzgitter (Germany)	Poznań (Polen)	489	lorry	157.0	76.77	transport, lorry > 16t, fleet average [RER]
	transmission	Kassel (Germany)	Poznań (Polen)	637	lorry	38.5	24.52	transport, lorry > 16t, fleet average [RER]
	Pb battery	Hannover (Germany)	Poznań (Polen)	540	lorry	16.7	9.03	transport, lorry > 16t, fleet average [RER]
	remaining parts	estimation of transportation distance		200	lorry	102.7	20.54	transport, lorry > 16t, fleet average [RER]
glider		estimation of transportation distance		200	lorry	1,127.6	225.51	transport, lorry > 16t, fleet average [RER]

Smart (BEV)								
drive train	electric motor	Liscate (Italy)	Hambach (France)	593	lorry	58.0	34.39	transport, lorry > 16t, fleet average [RER]
	transmission	Neuenstein (Germany)	Hambach (France)	251	lorry	25.0	6.28	transport, lorry > 16t, fleet average [RER]
	Pb battery	Shenzhen (China)	Antwerpen (Belgium)	18,063	ship	5.9	106.57	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Hambach (France)	380	lorry		2.24	transport, lorry > 16t, fleet average [RER]
	PowerpAC	Bergamo, Italien	Hambach (France)	611	lorry	23.0	14.05	transport, lorry > 16t, fleet average [RER]
	Charger	Hangzhou (China)	Antwerpen (Belgium)	19,402	ship	10.2	198.68	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Hambach (France)	380	lorry		3.89	transport, lorry > 16t, fleet average [RER]
	BMS	Harbin (China)	Dalian (China)	946	lorry	2.6	2.42	transport, lorry > 16t, fleet average [RER]
		Dalian (China)	Antwerpen (Belgium)	20,223	ship		51.77	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Hambach (France)	380	lorry		0.97	transport, lorry > 16t, fleet average [RER]
	remaining parts	estimation of transportation distance		400	lorry	19.3	7.72	transport, lorry > 16t, fleet average [RER]
Li-battery		Luoyang (China)	Shanghai (China)	1,036	lorry	151.4	156.81	transport, lorry > 16t, fleet average [RER]
		Shanghai (China)	Antwerpen (Belgium)	19,378	ship		2,933.15	transport, transoceanic freight ship [OCE]
		Antwerpen, Belgien	Hambach (France)	380	lorry		57.52	transport, lorry > 16t, fleet average [RER]
glider		estimation of transportation distance		80	lorry	573.9	45.91	transport, lorry > 16t, fleet average [RER]
Smart (ICEV)								
drive train	motor	Berlin (Germany)	Hambach (France)	746	lorry	41.8	31.18	transport, lorry > 16t, fleet average [RER]
	transmission	Neuenstein (Germany)	Hambach (France)	251	lorry	25.0	6.28	transport, lorry > 16t, fleet average [RER]
	Pb battery	Shenzhen (China)	Antwerpen (Belgium)	18,063	ship	11.0	198.69	transport, transoceanic freight ship [OCE]
		Antwerpen (Belgium)	Hambach (France)	380	lorry		4.18	transport, lorry > 16t, fleet average [RER]
	remaining parts	estimation of transportation distance		80	lorry	53.5	4.28	transport, lorry > 16t, fleet average [RER]
glider		estimation of transportation distance		80	lorry	573.9	45.91	transport, lorry > 16t, fleet average [RER]

Energy consumption of the modelled cars				
		quantity	unit	Ecoinvent module
Caddy				
ICEV	petrol	8.89	l/100 km	petrol, low-sulphur, at regional storage [CH]
	diesel	7.02	l/100 km	diesel, low-sulphur, at regional storage [CH]
BEV		23.57	kWh/100 km	electricity, low voltage, at grid [DE][1]
Smart				
ICEV	petrol	5.3	l/100 km	petrol, low-sulphur, at regional storage [CH]
BEV		13.4	kWh/100 km	electricity, low voltage, at grid [DE][1]

[1] The module was manually adjusted to the electricity mix of Germany in 2013 and 2050.

Modelling of the electricity mix in Germany in 2013	
Ecoinvent module	**amount**
electricity, hard coal, at power plant [DE]	20.41%
electricity, lignite, at power plant [DE]	22.76%
electricity, natural gas, at power plant [DE]	8.60%
electricity, industrial gas, at power plant [DE]	1.06%
electricity, oil, at power plant [DE]	0.93%
electricity, nuclear, at power plant [DE]	14.37%
electricity, at wind power plant [RER]	8.59%
electricity, production mix photovoltaic, at plant [DE]	4.68%
electricity, hydropower, at power plant [DE]	3.05%
electricity, hydropower, at pumped storage power plant [DE]	0.98%
electricity, at cogen. with biogas engine, allocation exergy [CH]	3.64%
electricity, at cogen. ORC 1400kWth, wood, allocation exergy [CH]	4.25%
electricity, production mix DK [DK]	0.50%
electricity, production mix SE [SE]	0.17%
electricity, production mix PL [PL]	0.26%
electricity, production mix CZ [CZ]	1.81%
electricity, production mix AT [AT]	2.87%
electricity, production mix CH [CH]	0.61%
electricity, production mix FR [FR]	0.46%
electricity, production mix NL [NL]	0.02%
	100.00%

Modelling of the electricity mix in Germany in 2050	
Ecoinvent module	**amount**
electricity, at wind power plant [RER]	51.79%
electricity, production mix photovoltaic, at plant [DE]	31.53%
electricity, at cogen. with biogas engine, allocation exergy [CH]	2.88%
electricity, at cogen. ORC 1400kWth, wood, allocation exergy [CH]	3.36%
electricity, hydropower, at power plant [DE]	2.85%
electricity, natural gas, at power plant [DE]	3.35%
electricity, oil, at power plant [DE]	3.35%
electricity, hard coal, at power plant [DE]	0.90%
	100.00%

Waste treatment - Caddy									
process	**Ecoinvent module**	**unit**	**loca-tion**	**input**					
				waste materials due to vehicle production				waste materials due to vehicle maintenance	
				glider	drive train		Li-battery	ICEV	BEV
					IVEV	BEV			
waste treatment with energy generation									
disposal of plastics, textiles, resins	disposal, plastics, mixture, 15.3% water, to municipal incineration	kg	CH	155.77	25.73	18.72	11.21	14.98	11.86
disposal of rubber	disposal, rubber, unspecified, 0% water, to municipal incineration	kg	CH	68.44	5.49	1.61	-	158.00	125.10
disposal of insulating material	disposal, polyurethane, 0.2 water, to municipal incineration	kg	CH	39.19	0.04	-	-	-	-
disposal of oil & lubricants	disposal, used mineral oil, 10% water, to hazardous waste incineration	kg	CH	3.61	22.15	-	-	-	-
waste treatment without energy generation									
disposal of glass & fibreglass	disposal, glass, 0% water, to municipal incineration	kg	CH	22.16	0.49	0.24	-	-	-
disposal of paints	disposal, emulsion paint, 0% water, to municipal incineration	kg	CH	14.91	-	-	-	-	-
disposal of circuit boards	disposal, treatment of printed wiring boards	kg	GLO	0.14	-	3.35	-	-	-
disposal of capacitors	disposal, capacitors, 0% water, to hazardous waste incineration	kg	CH	-	-	2.43	-	-	-

Waste treatment - Smart									
process	**Ecoinvent module**	**unit**	**loca-tion**	**input**					
				waste materials due to vehicle production				waste materials due to vehicle maintenance	
				glider	drive train		Li-battery	ICEV	BEV
					IVEV	BEV			
waste treatment with energy generation									
disposal of plastics, textiles, resins	disposal, plastics, mixture, 15.3% water, to municipal incineration	kg	CH	92.62	26.83	5.50	6.06	7.33	7.09
disposal of rubber	disposal, rubber, unspecified, 0% water, to municipal incineration	kg	CH	26.92	1.27	0.49	-	77.31	74.89
disposal of insulating material	disposal, polyurethane, 0.2 water, to municipal incineration	kg	CH	4.39	-	-	-	-	-
disposal of oil & lubricants	disposal, used mineral oil, 10% water, to hazardous waste incineration	kg	CH	1.32	8.02	-	-	-	-
waste treatment without energy generation									
disposal of glass & fibreglass	disposal, glass, 0% water, to municipal incineration	kg	CH	13.91	0.22	0.12	-	-	-
disposal of paints	disposal, emulsion paint, 0% water, to municipal incineration	kg	CH	2.99	-	-	-	-	-
disposal of circuit boards	disposal, treatment of printed wiring boards	kg	GLO	2.84	-	2.68	-	-	-
disposal of capacitors	disposal, capacitors, 0% water, to hazardous waste incineration	kg	CH	-	-	1.89	-	-	-

Note: **Fuel combustion and abrasion emissions** are documented in Spielmann et al. (2007, Ecoinvent v2), and Simons (2013, Ecoinvent v3) and modified as described in the main text (tables 4 + 5). For further modelling results of the SMART see Helmers et al. 2017

Supplement 2

Material balances for the VW Caddy and the SMART (the SMART initially modelled in Helmers et al. 2017)

Table S1. balance of the gliders (masses).

Material Balance Gliders Masses			
Group of Material	**Material**	**[kg]**	
		Caddy	**Smart**
ferrous material	conventional steel	584.87	329.14
	stainless steel	25.43	13.34
	high tensile steel	157.55	49.12
	sum ferrous material	767.84	391.60
aluminium	Al casting alloy	38.92	19.82
	Al wrought alloy	9.73	4.95
	sum Al	48.65	24.77
non ferrous material	Mg	1.83	1.57
	Cu	5.95	3.95
	Zn	3.65	3.14
	other metals	2.88	7.85
	sum non-ferrous metals	14.30	16.52
plastics	polypropylene (PP)	95.69	43.35
	polyethylene (PE)	27.86	11.45
	polyethylenterephthalate (PET)	2.93	1.64
	polyurethane (PU)	29.24	16.45
	acrylnitril-butadiene-styrol (ABS)	8.70	4.29
	polyamide (PA)	-	0.09
	other plastics	2.18	2.11
	sum plastics	166.59	79.38
synthetics	fibreglass	2.72	1.77
	resins	6.39	3.99
	textiles	9.11	5.98
	glass	19.17	11.96
	sum synthetics	37.39	23.70
further materials	insulating material	6.39	3.99
	paints	14.91	2.99
	rubber	67.76	26.65
	oil & lubricants	3.57	1.30
	sum further materials	92.63	34.93
electronics	LED	0.007	0.15
	circuit board	0.14	2.84

	sum electronics	0.15	2.99
Sum		1,127.56	573.89

Table S2. balance of the gliders (percentages).

Material Balance Gliders Percentages			
Group of Material	**Material**	**Share**	
		Caddy	**Smart**
ferrous material	conventional steel	51.9%	57.4%
	stainless steel	2.3%	2.3%
	high tensile steel	14.0%	8.6%
	sum ferrous material	68.1%	68.2%
aluminium	Al casting alloy	3.5%	3.5%
	Al wrought alloy	0.9%	0.9%
	sum Al	4.3%	4.3%
non ferrous material	Mg	0.2%	0.3%
	Cu	0.5%	0.7%
	Zn	0.3%	0.5%
	other metals	0.3%	1.4%
	sum non-ferrous metals	1.3%	2.9%
plastics	polypropylene (PP)	8.5%	7.6%
	polyethylene (PE)	2.5%	2.0%
	polyethylenterephthalate (PET)	0.3%	0.3%
	polyurethane (PU)	2.6%	2.9%
	acrylnitril-butadiene-styrol (ABS)	0.8%	0.7%
	polyamide (PA)	-	-
	other plastics	0.2%	0.4%
	sum plastics	14.8%	13.8%
synthetics	fibreglass	0.2%	0.3%
	resins	0.6%	0.7%
	textiles	0.8%	1.0%
	glass	1.7%	2.1%
	sum synthetics	3.3%	4.1%
further materials	insulating material	0.6%	0.7%
	paints	1.3%	0.5%
	rubber	6.0%	4.6%
	oil & lubricants	0.3%	0.2%

	sum further materials	8.2%	6.1%
electronics	LED	0.001%	0.03%
	circuit board	0.013%	0.49%
	sum electronics	0.013%	0.52%
Sum		100.0%	100.0%

Table S3. balance of the drivetrain (ICEV petrol, masses).

Material Balance Drivetrain (ICEV Petrol) Masses			
Group of Material	**Material**	**[kg]**	
		Caddy	**Smart**
ferrous material	conventional steel	171.11	7.39
	stainless steel	3.65	-
	high tensile steel	26.60	35.36
	cast iron	-	10.26
	sum ferrous material	201.36	53.01
	aluminium	40.81	29.06
non ferrous material	Cu	3.17	3.90
	Pb	11.42	7.51
	other metals	1.22	-
	sum non-ferrous metals	15.81	11.41
Plastics	polypropylene (PP)	2.91	8.07
	polyethylene (PE)	2.37	5.00
	polyethylenterephthalate (PET)	7.74E-04	-
	polyurethane (PU)	0.04	-
	acrylnitril-butadiene-styrol (ABS)	0.08	0.65
	polyamide (PA)	5.95	3.20
	Polyoxymethylen (POM)	0.80	-
	Polyvinylchlorid (PVC)	0.10	-
	other plastics	12.54	8.86
	sum plastics	24.80	25.77
Synthetics	fibreglass	0.47	0.22
	textiles	0.48	-
	sum synthetics	0.95	0.22
further materials	rubber	5.44	1.26
	oil & lubricants	21.93	8.02
	sulfuric acid	1.34	0.88

	Sb	0.12	0.08
	As	0.005	0.003
	H_2O	2.34	1.54
	sum further materials	31.17	11.78
Sum		314.91	131.26

Table S4. balance of the drivetrain (ICEV petrol, percentages).

Material Balance Drivetrain (ICEV Petrol) Percentages			
Group of Material	**Material**	**Share**	
		Caddy	**Smart**
ferrous material	conventional steel	54.3%	5.6%
	stainless steel	1.2%	-
	high tensile steel	8.4%	26.9%
	cast iron	0.0%	7.8%
	sum ferrous material	63.9%	40.4%
	aluminium	13.0%	22.1%
non ferrous material	Cu	1.0%	3.0%
	Pb	3.6%	5.7%
	other metals	0.4%	-
	sum non-ferrous metals	5.0%	8.7%
plastics	polypropylene (PP)	0.9%	6.1%
	polyethylene (PE)	0.8%	3.8%
	polyethylenterephthalate (PET)	2.5E-4%	-
	polyurethane (PU)	0.01%	-
	acrylnitril-butadiene-styrol (ABS)	0.03%	0.5%
	polyamide (PA)	1.89%	2.4%
	Polyoxymethylen (POM)	0.25%	-
	Polyvinylchlorid (PVC)	0.03%	-
	other plastics	3.98%	6.8%
	sum plastics	7.9%	19.6%
synthetics	fibreglass	0.15%	0.2%
	textiles	0.15%	-
	sum synthetics	0.30%	0.2%
further materials	rubber	1.73%	1.0%
	oil & lubricants	6.96%	6.1%
	sulfuric acid	0.43%	0.7%

	Sb	0.04%	0.1%
	As	0.002%	0.003%
	H_2O	0.74%	1.2%
	sum further materials	9.9%	9.0%
Sum		100.0%	100.0%

Table S5. balance of the "remaining" drivetrain = drivetrain without engine, gearbox and Pb battery (ICEV petrol, percentages). This material being included in complete material balance of the drivetrain (ICEV petrol, Tables S3 + S4).

Material Balance Drivetrain (ICEV Petrol) Without Engine, Gearbox and Pb Battery Percentages		
Group of Material	**Material**	**Caddy**
ferrous material	conventional steel	59.4%
	sum ferrous material	59.4%
aluminium		1.7%
non ferrous material	Cu	2.2%
	other metals	1.2%
	sum non-ferrous metals	5.1%
plastics	polypropylene (PP)	2.2%
	polyethylene (PE)	1.1%
	polyurethane (PU)	0.04%
	acrylnitril-butadiene-styrol (ABS)	0.08%
	polyamide (PA)	3.6%
	Polyoxymethylen (POM)	0.78%
	Polyvinylchlorid (PVC)	0.10%
	other plastics	2.21%
	sum plastics	10.1%
synthetics	fibreglass	0.14%
	textiles	0.47%
	sum synthetics	0.6%
further materials	rubber	3.6%
	oil & lubricants	21.2%
	sum further materials	24.8%
Sum		100.0%

Table S6. balance of the drivetrain (BEV, masses).

Material Balance Drivetrain (BEV) Masses			
Group of Material	**Material**	**[kg]**	
		Caddy	**Smart**
ferrous material	conventional steel	67.05	3.05
	stainless steel	3.66	1.46
	high tensile steel	87.68	18.78
	cast iron	0.85	34.04
	sum ferrous material	159.24	57.33
aluminium	Al wrought alloy	17.35	13.15
	Al, mix of production	81.14	34.37
	sum Aluminium	98.50	47.52
non ferrous material	Cu	35.63	19.24
	Pb	6.00	4.05
	brass	1.34	1.04
	bariumtitanate	0.30	-
	titanium	-	0.05
	sum non-ferrous metals	43.27	24.37
Plastics	polyethylene (PE)	3.19	3.85
	Polypropylen (PP)	3.05	-
	polystyrene	0.65	0.51
	polyamide (PA)	0.73	-
	polyvinylchloride (PVC)	9.81	-
	acrylnitril-butadiene-styrol (ABS)	-	0.35
	sum plastics	17.43	4.71
further materials	rubber (EPDM)	1.59	0.49
	fibreglass	0.24	0.12
	sulphuric acid	0.70	0.47
	Sb	0.06	0.04
	As	0.0026	0.00
	H_2O	1.23	0.83
	potting material	0.90	0.66
	silicone	0.02	0.01
	ferrite	3.47	2.28
	ceramics	0.24	0.23
	plywood	19.00	-

	carbon	-	0.07
	sum further materials	27.45	5.20
Electronics	printed circuit	0.73	0.26
	printed circuit (FR4+Cu+SMD)	2.35	2.09
	printed circuit (FR4)	1.00	0.59
	resistors	0.04	0.04
	capacitor	2.43	1.89
	sum electronics	6.55	4.86
Sum		352.44	143.99

Table S7. balance of the drivetrain (BEV, percentages).

Material Balance Drivetrain (BEV) Percentages			
Group of Material	**Material**	**Share**	
		Caddy	**Smart**
ferrous material	conventional steel	19.0%	2.1%
	stainless steel	1.0%	1.0%
	high tensile steel	24.9%	13.0%
	cast iron	0.2%	23.6%
	sum ferrous material	45.2%	39.8%
aluminium	Al wrought alloy	4.9%	9.1%
	Al, mix of production	23.0%	23.9%
	Summe Aluminium	27.9%	33.0%
non ferrous material	Cu	10.1%	13.4%
	Pb	1.7%	2.8%
	brass	0.4%	0.7%
	bariumtitanate	0.1%	-
	titanium	-	0.0%
	sum non-ferrous metals	12.3%	16.9%
plastics	polyethylen (PE)	0.9%	2.7%
	polypropylene (PP)	0.9%	-
	polystyrene	0.2%	0.4%
	polyamide (PA)	0.2%	-
	polyvinylchloride (PVC)	2.8%	-
	acrylnitril-butadiene-styrol (ABS)	-	0.2%
	sum plastics	4.9%	3.3%
further materials	rubber (EPDM)	0.5%	0.3%

	fibreglass	0.1%	0.1%
	sulphuric acid	0.2%	0.3%
	Sb	0.02%	0.03%
	As	0.0008%	0.001%
	H_2O	0.3%	0.6%
	potting material	0.3%	0.5%
	silicone	0.006%	0.01%
	ferrite	1.0%	1.6%
	ceramics	0.1%	0.2%
	plywood	5.4%	-
	carbon	-	0.05%
	sum further materials	7.8%	3.6%
electronics	printed circuit	0.2%	0.2%
	printed circuit (FR4+Cu+SMD)	0.7%	1.5%
	printed circuit (FR4)	0.3%	0.4%
	resistors	0.0%	0.0%
	capacitor	0.7%	1.3%
	sum electronics	1.9%	3.4%
Sum		100.0%	100.0%

Table S8. balance of the "remaining" drivetrain = drivetrain without engine, gearbox, Pb battery, powerpac, charger, BMS (BEV, percentages). This material being included in the complete material balance of the drivetrain (BEV, Tables S6 + S7).

Material Balance Drivetrain (BEV without Engine, Gearbox, Pb Battery, Powerpac, Charger, BMS) Percentages		
Group of Material	**Material**	**Caddy**
ferrous material	conventional steel (battery case)	48.5%
	sum ferrous material	48.5%
aluminium		17.5%
non ferrous material	Cu	8.6%
	cast iron	0.6%
	brass	0.1%
	sum non-ferrous metals	26.8%
plastics	polypropylene (PP)	1.9%

	polyamide (PA)	0.5%
	Polyvinylchlorid (PVC)	7.1%
	sum plastics	9.5%
synthetics	fibreglass	0.1%
	ethylene propylene diene methylene (EPDM) rubber	1.2%
	sum synthetics	1.3%
further materials	Bariumtitanate	0.2%
	plywood	13.7%
	sum further materials	13.9%
Sum		100.0%

Table S9. balance of the Li-ion batteries (masses).

Li-ion batteries Masses		
Material ($LiFePO_4$)	**[kg]**	
	Caddy	**Smart**
Al	80.30	43.41
Cu	28.25	15.27
graphite	25.86	13.98
carbon	4.22	2.28
polyethylene (PE)	5.61	3.03
polypropylene (PP)	5.61	3.03
polytetrafluorethylene (PTFE)	8.12	4.39
N-methyl-2-pyrrolidone (NMP)	31.24	16.89
lithiumhydroxide	10.90	5.89
phosphoric acid	15.39	8.32
ferrous sulphate	23.68	12.80
lithiumhexafluorphosphate	4.90	2.65
ethylene carbonate	35.92	19.42
sum	280.00	151.36

Table S10. balance of the Li-ion batteries (percentages).

Li-ion batteries Percentages		
Material	**share**	
	$LiFePO_4$	**$LiFeMnPO_4$**
Al	28.7%	5.0%
Cu	10.1%	7.5%
graphite	9.2%	11.3%
carbon	1.5%	1.3%
polyethylene (PE)	2.0%	1.5%
polypropylene (PP)	2.0%	1.5%
polytetrafluorethylene (PTFE)	2.9%	2.6%
N-methyl-2-pyrrolidone (NMP)	11.2%	-
lithiumhydroxide	3.9%	10.1%
phosphoric acid	5.5%	14.2%
ferrous sulphate	8.5%	8.8%
lithiumhexafluorphosphate	1.8%	1.6%
ethylene carbonate	12.8%	11.8%
manganese concentrate	-	14.4%
sulfuric acid	-	8.5%
Sum	100%	100%

Table S11. $LiFePO_4$-cell production ReCiPe midpoints as per 1 kWh battery capacity for four types of electricity provision (Table 3). UCTE = UCTE (2004) as described in the paper. PV = photovoltaic.

		China	**UCTE**	**PV**	**Wind**
Particulate matter formation	kg PM10-eq	0.40	0.15	0.10	0.09
Freshwater toxicity	kg 1.4-DCB	0.75	1.14	0.57	0.46
Human toxicity	kg 1.4-DCB	52.65	67.19	45.58	35.04
Ionising radiation	kg U235-eq	10.58	49.50	10.84	8.41
Climate change	kg CO_2-eq	155.74	92.04	48.81	41.26
Agricultural land occupation	m^2a	4.28	1.53	1.21	0.89
Natural land transformation	m^2	0.02	0.02	0.01	0.01
Photochemical oxidant formation	kg NMVOC	0.61	0.27	0.19	0.17
Ozone depletion	kg CFC-11-eq	6.41E-06	8.32E-06	7.48E-06	5.83E-06
Marine ecotoxicity	kg 1.4-DCB	0.88	1.26	0.74	0.59
Terrestrial acidification	kg SO_2-eq	1.28	0.48	0.30	0.27
Terrestrial ecotoxicity	kg 1.4-DCB	0.01	0.02	0.03	0.01

Urban land occupation	m^2a	1.57	0.76	0.67	0.69
Water depletion	m^3	5.99	6.13	5.80	5.72
Fossil resource depletion	kg oil-eq	39.18	30.18	17.67	15.39
Mineral resource depletion	kg Fe-eq	11.70	11.69	14.41	12.73
Freshwater eutrophication	kg P-eq	0.05	0.08	0.04	0.03
Marine eutrophication	kg N-eq	0.32	0.22	0.18	0.18

Table S12. Ecoinvent modules applied (each with regions specified).

A) Materials

A.1 Ferrous materials

reinforcing steel, at plant	RER
chromium steel 18/8, at plant	RER
steel, low-alloyed, at plant	RER
cast iron, at plant	RER
steel, converter, unalloyed, at plant	RER
steel, converter, chromium steel 18/8, at plant	RER
steel, converter, low-alloyed, at plant	RER
steel, electric, un- and low-alloyed, at plant	RER
steel, electric, chromium steel 18/8, at plant	RER

A.2 Non-ferrous metals

aluminium, production mix, cast alloy, at plant	RER
aluminium, production mix, wrought alloy, at plant	RER
aluminium, production mix, at plant	RER
magnesium, at plant	RER
copper, at regional storage	RER
zinc, primary, at regional storage	RER
lead, at regional storage	RER
brass, at plant	CH
aluminium, primary, at plant	RER
copper, primary, at refinery	RER
lead, primary, at plant	RER
aluminium, secondary, from old scrap	RER
copper, secondary, at refinery	RER

lead, secondary, at plant	RER

A.3 Plastics

polypropylene, granulate, at plant	RER
polyethylene, LDPE, granulate, at plant	RER
polyethylene terephthalate, granulate, amorphous, at plant	RER
polyurethane, flexible foam, at plant	RER
acrylonitrile-butadiene-styrene copolymer, ABS, at plant	RER
polyvinylchloride, at regional storage	RER
nylon 6, at plant	RER
polystyrene, high impact, HIPS, at plant	RER
polyethylene, HDPE, granulate, at plant	RER

A.4 Electronics

light emitting diode, LED, at plant	GLO
Printed wiring board, mixed mounted, unspec., solder mix, at plant	GLO
printed wiring board, surface mounted, unspec., solder mix, at plant	GLO
printed wiring board, through-hole, at plant	GLO
resistor, SMD type, surface mounting, at plant	GLO
capacitor, film, through-hole mounting, at plant	GLO
integrated circuit, IC, logic type, at plant	GLO

A.5 Further materials

glass fibre reinforced plastic, polyester resin, hand lay-up, at plant	RER
epoxy resin, liquid, at plant	RER
viscose fibres, at plant	GLO
flat glass, uncoated, at plant	RER
coating powder, at plant	RER
synthetic rubber, at plant	RER
lubricating oil, at plant	RER
sulphuric acid, liquid, at plant	RER
silver, from combined gold-silver production, at refinery	GLO
water, completely softened, at plant	RER
polyester resin, unsaturated, at plant	RER
silicone product, at plant	RER

ferrite, at plant	GLO
aluminium oxide, at plant	RER
plywood, outdoor use, at plant	RER
graphite, at plant	RER
carbon black, at plant	GLO
iron sulphate, at plant	RER
ethylene carbonate, at plant	CN
lithium hexafluorophosphate, at plant	CN
lithium hydroxide, at plant	GLO
manganese concentrate, at beneficiation	GLO
phosphoric acid, industrial grade, 85% in H2O, at plant	RER
ethylene, average, at plant	RER
ethylene glycol, at plant	RER

B) Processing

sheet rolling, steel	RER
sheet rolling, aluminium	RER
wire drawing, copper	RER
steel product manufacturing, average metal working	RER
aluminium product manufacturing, average metal working	RER
copper product manufacturing, average metal working	RER
metal product manufacturing, average metal working	RER
injection moulding	RER
tempering, flat glass	RER
tap water, at user	RER
oxygen, liquid, at plant	RER
selective coating, aluminium sheet, nickel pigmented aluminium oxide	SK
zinc coating, coils	RER
production efforts, resistors	GLO
water, decarbonised, at plant	RER
water, deionised, at plant	CH
N-methyl-2-pyrrolidone, at plant	RER
disposal, non-sulfidic tailings, off-site	GLO

C) Energy

electricity, medium voltage, production UCTE, at grid	UCTE
electricity, medium voltage, at grid	CN
electricity, low voltage, at grid	DE
electricity, medium voltage, at grid	DE
electricity, high voltage, at grid	DE
electricity mix	DE
electricity, hard coal, at power plant	DE
electricity, lignite, at power plant	DE
electricity, oil, at power plant	DE
electricity, natural gas, at power plant	DE
electricity, industrial gas, at power plant	DE
electricity, hydropower, at power plant	DE
electricity, hydropower, at pumped storage power plant	DE
electricity, nuclear, at power plant	DE
electricity, production mix photovoltaic, at plant	DE
electricity, at wind power plant	RER
electricity, at cogen with biogas engine, allocation exergy	CH
electricity, at cogen ORC 1400kWth, wood, allocation exergy	CH
electricity, production mix AT	AT
electricity, production mix CZ	CZ
electricity, production mix DK	DK
electricity, production mix FR	FR
electricity, production mix NL	NL
electricity, production mix SE	SE
electricity, production mix CH	CH
heat, natural gas, at industrial furnace > 100 kW	RER
light fuel oil, burned in industrial furnace 1MW, non-modulating	RER
heat, unspecific, in chemical plant	RER
hard coal coke, at plant	GLO
natural gas, high pressure, at consumer	RER

D) Transport

transport, freight, rail	RER
transport, lorry > 16t, fleet average	RER
transport, transoceanic freight ship	OCE

E) Infrastructure

Road vehicle plant	RER
plastics processing factory	RER
aluminium hydroxide, plant	RER
chemical plant, organics	RER
facilities precious metal refinery	SE
metal working factory	RER
non-ferrous metal mine, underground	GLO

F) Waste management (metals disposal included in raw material modules)

disposal, plastics, mixture, 15.3% water, to municipal incineration	CH
disposal, rubber, unspecified, 0% water, to municipal incineration	CH
disposal, polyurethane, 0.2 water, to municipal incineration	CH
disposal, used mineral oil, 10% water, to hazardous waste incineration	CH
disposal, glass, 0% water, to municipal incineration	CH
disposal, emulsion paint, 0% water, to municipal incineration	CH
disposal, treatment of printed wiring boards	CH
disposal, capacitors, 0% water, to hazardous waste incineration	GLO

G) Use phase

operation, passenger car, petrol EURO 5	CH
operation, passenger car, diesel EURO 5	CH
operation, passenger car, electric, $LiMn_2O_4$	CH
maintenance, passenger car	RER
maintenance, passenger car, electric, $LiMn_2O_4$	RER
petrol, low sulphur, at regional storage	CH
Diesel, low sulphur, at regional storage	CH

Table S13. Midpoint indicator impacts per 1 km for selected VW Caddy models (based on modelling 150,000 km of lifetime mileage).

Midpoint Indicator	Life cycle Component	Models #						
		ICEV		BEV				
		3	6	9	10	11	12	13
Particulate matter formation (kg PM10-eq)	Glider	4.53E-05	4.53E-05	4.53E-05	4.53E-05	4.53E-05	4.53E-05	4.53E-05
	Powertrain	1.88E-05	1.88E-05	4.42E-05	4.42E-05	4.42E-05	4.42E-05	4.42E-05
	Battery	-	-	6.92E-05	6.92E-05	2.67E-05	1.74E-05	1.55E-05
	Use phase	1.88E-04	3.07E-04	1.22E-04	7.39E-05	1.22E-04	1.22E-04	1.22E-04
	Disposal	6.75E-07	6.75E-07	6.61E-07	6.61E-07	6.61E-07	6.61E-07	6.61E-07
	Total	2.52E-04	3.71E-04	2.81E-04	2.33E-04	2.39E-04	2.29E-04	2.28E-04
Freshwater ecotoxicity (kg 1.4-DCB)	Glider	4.51E-04	4.51E-04	4.51E-04	4.51E-04	4.51E-04	4.51E-04	4.51E-04
	Powertrain	2.29E-04	2.29E-04	1.01E-03	1.01E-03	1.01E-03	1.01E-03	1.01E-03
	Battery	-	-	1.29E-04	1.29E-04	1.97E-04	9.87E-05	7.87E-05
	Use phase	3.00E-04	2.41E-04	2.94E-03	4.30E-04	2.94E-03	2.94E-03	2.94E-03
	Disposal	2.23E-05	2.23E-05	2.36E-05	2.36E-05	2.36E-05	2.36E-05	2.36E-05
	Total	1.00E-03	9.43E-04	4.56E-03	2.04E-03	4.63E-03	4.53E-03	4.51E-03
Human toxicity (kg 1.4-DCB)	Glider	2.24E-02	2.24E-02	2.24E-02	2.24E-02	2.24E-02	2.24E-02	2.24E-02
	Powertrain	1.40E-02	1.40E-02	7.64E-02	7.64E-02	7.64E-02	7.64E-02	7.64E-02
	Battery	-	-	9.09E-03	9.09E-03	1.16E-02	7.87E-03	6.05E-03

	Use phase	1.98E-02	2.26E-02	1.50E-01	3.85E-02	1.50E-01	1.50E-01	1.50E-01
	Disposal	5.43E-04	5.43E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04
	Total	5.68E-02	5.96E-02	2.59E-01	1.47E-01	2.61E-01	2.57E-01	2.56E-01
Ionising radiation (kg U235-eq)	**Glider**	1.02E-02	1.02E-02	1.02E-02	1.02E-02	1.02E-02	1.02E-02	1.02E-02
	Powertrain	4.12E-03	4.12E-03	9.54E-03	9.54E-03	9.54E-03	9.54E-03	9.54E-03
	Battery	-	-	1.83E-03	1.83E-03	8.55E-03	1.87E-03	1.45E-03
	Use phase	8.57E-03	6.72E-03	4.56E-02	5.28E-03	4.56E-02	4.56E-02	4.56E-02
	Disposal	6.77E-05	6.77E-05	6.56E-05	6.56E-05	6.56E-05	6.56E-05	6.56E-05
	Total	2.29E-02	2.11E-02	6.72E-02	2.69E-02	7.39E-02	6.73E-02	6.68E-02
Climate change (kg CO_2-eq)	**Glider**	2.42E-02	2.42E-02	2.42E-02	2.42E-02	2.42E-02	2.42E-02	2.42E-02
	Powertrain	1.04E-02	1.04E-02	2.27E-02	2.27E-02	2.27E-02	2.27E-02	2.27E-02
	Battery	-	-	2.69E-02	2.69E-02	1.59E-02	8.43E-03	7.12E-03
	Use phase	2.67E-01	2.28E-01	1.71E-01	3.55E-02	1.71E-01	1.71E-01	1.71E-01
	Disposal	9.18E-03	9.18E-03	8.24E-03	8.24E-03	8.24E-03	8.24E-03	8.24E-03
	Total	3.10E-01	2.72E-01	2.54E-01	1.18E-01	2.43E-01	2.35E-01	2.34E-01
Agricultural land occupation (m^2a)	**Glider**	1.72E-03	1.72E-03	1.72E-03	1.72E-03	1.72E-03	1.72E-03	1.72E-03
	Powertrain	3.17E-04	3.17E-04	2.27E-03	2.27E-03	2.27E-03	2.27E-03	2.27E-03
	Battery	-	-	7.40E-04	7.40E-04	2.64E-04	2.09E-04	1.54E-04

	Use phase	3.64E-04	2.94E-04	5.54E-03	3.44E-03	5.54E-03	5.54E-03	5.54E-03
	Disposal	3.41E-06	3.41E-06	3.25E-06	3.25E-06	3.25E-06	3.25E-06	3.25E-06
	Total	2.40E-03	2.33E-03	1.03E-02	8.16E-03	9.80E-03	9.74E-03	9.69E-03
Natural land transformation (m^2)	**Glider**	4.39E-06	4.39E-06	4.40E-06	4.40E-06	4.40E-06	4.40E-06	4.40E-06
	Powertrain	2.77E-06	2.77E-06	4.43E-06	4.43E-06	4.43E-06	4.43E-06	4.43E-06
	Battery	-	-	3.14E-06	3.14E-06	2.80E-06	2.13E-06	1.87E-06
	Use phase	1.03E-04	8.00E-05	1.13E-05	9.52E-06	1.13E-05	1.13E-05	1.13E-05
	Disposal	8.86E-09	8.86E-09	1.70E-08	1.70E-08	1.70E-08	1.70E-08	1.70E-08
	Total	1.11E-04	8.72E-05	2.33E-05	2.15E-05	2.29E-05	2.23E-05	2.20E-05
Ozone depletion (kg CFC-11-eq)	**Glider**	2.69E-09	2.69E-09	2.69E-09	2.69E-09	2.69E-09	2.69E-09	2.69E-09
	Powertrain	1.11E-09	1.11E-09	2.29E-09	2.29E-09	2.29E-09	2.29E-09	2.29E-09
	Battery	-	-	1.11E-09	1.11E-09	1.44E-09	1.29E-09	1.01E-09
	Use phase	3.75E-08	3.42E-08	6.37E-09	4.38E-09	6.37E-09	6.37E-09	6.37E-09
	Disposal	1.73E-11	1.73E-11	2.02E-11	2.02E-11	2.02E-11	2.02E-11	2.02E-11
	Total	4.13E-08	3.80E-08	1.25E-08	1.05E-08	1.28E-08	1.27E-08	1.24E-08
Photochemical oxidant formation (kg NMVOC)	**Glider**	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04
	Powertrain	4.42E-05	4.42E-05	9.02E-05	9.02E-05	9.02E-05	9.02E-05	9.02E-05
	Battery	-	-	1.05E-04	1.05E-04	4.68E-05	3.35E-05	2.87E-05

	Use phase	5.82E-04	1.21E-03	2.23E-04	1.05E-04	2.23E-04	2.23E-04	2.23E-04
	Disposal	2.58E-06	2.58E-06	2.54E-06	2.54E-06	2.54E-06	2.54E-06	2.54E-06
	Total	7.39E-04	1.37E-03	5.30E-04	4.13E-04	4.73E-04	4.59E-04	4.55E-04
Marine ecotoxicity (kg 1.4-DCB)	**Glider**	4.60E-04	4.60E-04	4.60E-04	4.60E-04	4.60E-04	4.60E-04	4.60E-04
	Powertrain	2.47E-04	2.47E-04	1.03E-03	1.03E-03	1.03E-03	1.03E-03	1.03E-03
	Battery	-	-	1.52E-04	1.52E-04	2.18E-04	1.28E-04	1.02E-04
	Use phase	4.75E-04	4.02E-04	2.97E-03	5.71E-04	2.97E-03	2.97E-03	2.97E-03
	Disposal	1.90E-05	1.90E-05	2.00E-05	2.00E-05	2.00E-05	2.00E-05	2.00E-05
	Total	1.20E-03	1.13E-03	4.64E-03	2.23E-03	4.70E-03	4.61E-03	4.59E-03
Terrestrial acidification (kg SO_2-eq)	**Glider**	1.01E-04	1.01E-04	1.01E-04	1.01E-04	1.01E-04	1.01E-04	1.01E-04
	Powertrain	4.49E-05	4.49E-05	1.21E-04	1.21E-04	1.21E-04	1.21E-04	1.21E-04
	Battery	-	-	2.20E-04	2.20E-04	8.35E-05	5.26E-05	4.69E-05
	Use phase	5.16E-04	7.69E-04	2.64E-04	1.37E-04	2.64E-04	2.64E-04	2.64E-04
	Disposal	1.75E-06	1.75E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06	1.74E-06
	Total	6.63E-04	9.16E-04	7.08E-04	5.81E-04	5.71E-04	5.40E-04	5.35E-04
Terrestrial ecotoxicity (kg 1.4-DCB)	**Glider**	4.55E-06	4.55E-06	4.55E-06	4.55E-06	4.55E-06	4.55E-06	4.55E-06
	Powertrain	1.84E-06	1.84E-06	5.86E-06	5.86E-06	5.86E-06	5.86E-06	5.86E-06
	Battery	-	-	2.59E-06	2.59E-06	2.68E-06	4.99E-06	2.06E-06

	Use phase	4.34E-05	4.02E-05	5.95E-05	6.30E-05	5.95E-05	5.95E-05	5.95E-05
	Disposal	1.22E-07	1.22E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07	1.41E-07
	Total	4.99E-05	4.67E-05	7.27E-05	7.61E-05	7.28E-05	7.51E-05	7.21E-05
Urban land occupation (m^2a)	**Glider**	2.65E-04	2.65E-04	2.65E-04	2.65E-04	2.65E-04	2.65E-04	2.65E-04
	Powertrain	1.67E-04	1.67E-04	5.06E-04	5.06E-04	5.06E-04	5.06E-04	5.06E-04
	Battery	-	-	2.71E-04	2.71E-04	1.32E-04	1.15E-04	1.19E-04
	Use phase	4.87E-04	3.68E-04	6.29E-04	3.07E-04	6.29E-04	6.29E-04	6.29E-04
	Disposal	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06
	Total	9.21E-04	8.02E-04	1.67E-03	1.35E-03	1.53E-03	1.52E-03	1.52E-03
Water depletion (m^3)	**Glider**	2.32E-04	2.32E-04	2.32E-04	2.32E-04	2.32E-04	2.32E-04	2.32E-04
	Powertrain	1.12E-04	1.12E-04	2.64E-04	2.64E-04	2.64E-04	2.64E-04	2.64E-04
	Battery	-	-	1.03E-03	1.03E-03	1.06E-03	1.00E-03	9.88E-04
	Use phase	3.59E-04	2.99E-04	1.03E-03	1.77E-04	1.03E-03	1.03E-03	1.03E-03
	Disposal	5.71E-06	5.71E-06	4.93E-06	4.93E-06	4.93E-06	4.93E-06	4.93E-06
	Total	7.09E-04	6.48E-04	2.57E-03	1.71E-03	2.59E-03	2.54E-03	2.52E-03
Fossil resource depletion (kg oil-eq).	**Glider**	9.44E-03	9.44E-03	9.44E-03	9.44E-03	9.44E-03	9.44E-03	9.44E-03
	Powertrain	3.56E-03	3.56E-03	6.65E-03	6.65E-03	6.65E-03	6.65E-03	6.65E-03
	Battery	-	-	6.77E-03	6.77E-03	5.21E-03	3.05E-03	2.66E-03

	Use phase	9.39E-02	7.90E-02	4.75E-02	1.23E-02	4.75E-02	4.75E-02	4.75E-02
	Disposal	4.99E-05	4.99E-05	5.59E-05	5.59E-05	5.59E-05	5.59E-05	5.59E-05
	Total	1.07E-01	9.20E-02	7.04E-02	3.53E-02	6.88E-02	6.67E-02	6.63E-02
Mineral resource depletion (kg Fe-eq),	**Glider**	5.94E-03	5.94E-03	5.94E-03	5.94E-03	5.94E-03	5.94E-03	5.94E-03
	Powertrain	3.06E-03	3.06E-03	1.68E-02	1.68E-02	1.68E-02	1.68E-02	1.68E-02
	Battery	-	-	2.02E-03	2.02E-03	2.02E-03	2.49E-03	2.20E-03
	Use phase	1.48E-03	1.07E-03	6.78E-03	9.99E-03	6.78E-03	6.78E-03	6.78E-03
	Disposal	1.29E-05	1.29E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05	1.24E-05
	Total	1.05E-02	1.01E-02	3.15E-02	3.47E-02	3.15E-02	3.20E-02	3.17E-02
Freshwater eutrophication (kg P-eq)	**Glider**	1.58E-05	1.58E-05	1.58E-05	1.58E-05	1.58E-05	1.58E-05	1.58E-05
	Powertrain	9.88E-06	9.88E-06	5.00E-05	5.00E-05	5.00E-05	5.00E-05	5.00E-05
	Battery	-	-	8.30E-06	8.30E-06	1.46E-05	7.03E-06	5.89E-06
	Use phase	1.09E-05	8.49E-06	2.13E-04	1.94E-05	2.13E-04	2.13E-04	2.13E-04
	Disposal	1.25E-07	1.25E-07	9.95E-08	9.95E-08	9.95E-08	9.95E-08	9.95E-08
	Total	3.67E-05	3.43E-05	2.87E-04	9.35E-05	2.94E-04	2.86E-04	2.85E-04
Marine eutrophication (kg N-eq)	**Glider**	2.47E-05	2.47E-05	2.47E-05	2.47E-05	2.47E-05	2.47E-05	2.47E-05
	Powertrain	1.12E-05	1.12E-05	2.80E-05	2.80E-05	2.80E-05	2.80E-05	2.80E-05
	Battery	-	-	5.52E-05	5.52E-05	3.77E-05	3.17E-05	3.03E-05

	Use phase	1.25E-04	3.94E-04	1.13E-04	3.30E-05	1.13E-04	1.13E-04	1.13E-04
	Disposal	1.16E-06	1.16E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06	1.15E-06
	Total	1.62E-04	4.31E-04	2.22E-04	1.42E-04	2.04E-04	1.98E-04	1.97E-04

Table S14. Endpoint indicator impacts per 1 km for selected VW Caddy models (based on modelling 150,000 km of lifetime mileage).

Endpoint Indicator	**Life Cycle Component**	**Models (No)**						
		ICEV		**BEV**				
		3	**6**	**9**	**10**	**11**	**12**	**13**
Human health	**Glider**	1.22E-03	1.22E-03	1.22E-03	1.22E-03	1.22E-03	1.22E-03	1.22E-03
	Powertrain	5.81E-04	5.81E-04	1.92E-03	1.92E-03	1.92E-03	1.92E-03	1.92E-03
	Battery	-	-	1.23E-03	1.23E-03	7.43E-04	4.34E-04	3.62E-04
	Use phase	8.66E-03	8.23E-03	7.51E-03	1.92E-03	7.51E-03	7.51E-03	7.51E-03
	Disposal	2.65E-04	2.65E-04	2.39E-04	2.39E-04	2.39E-04	2.39E-04	2.39E-04
	Total	1.07E-02	1.03E-02	1.21E-02	6.54E-03	1.16E-02	1.13E-02	1.13E-02
Resources	**Glider**	1.14E-03	1.14E-03	1.14E-03	1.14E-03	1.14E-03	1.14E-03	1.14E-03
	Powertrain	4.29E-04	4.29E-04	8.06E-04	8.06E-04	8.06E-04	8.06E-04	8.06E-04
	Battery	-	-	8.13E-04	8.13E-04	6.26E-04	3.67E-04	3.20E-04
	Use phase	1.13E-02	9.49E-03	5.69E-03	1.49E-03	5.69E-03	5.69E-03	5.69E-03
	Disposal	5.98E-06	5.98E-06	6.71E-06	6.71E-06	6.71E-06	6.71E-06	6.71E-06
	Total	1.29E-02	1.11E-02	8.45E-03	4.25E-03	8.27E-03	8.01E-03	7.96E-03
Ecosystem	**Glider**	5.15E-04	5.15E-04	5.15E-04	5.15E-04	5.15E-04	5.15E-04	5.15E-04
	Powertrain	2.16E-04	2.16E-04	5.17E-04	5.17E-04	5.17E-04	5.17E-04	5.17E-04
	Battery	-	-	5.41E-04	5.41E-04	3.20E-04	1.80E-04	1.53E-04
	Use phase	5.24E-03	4.45E-03	3.36E-03	7.99E-04	3.36E-03	3.36E-03	3.36E-03
	Disposal	1.67E-04	1.67E-04	1.50E-04	1.50E-04	1.50E-04	1.50E-04	1.50E-04
	Total	6.13E-03	5.35E-03	5.09E-03	2.52E-03	4.87E-03	4.73E-03	4.70E-03
Single Score	**Glider**	2.87E-03	2.87E-03	2.87E-03	2.87E-03	2.87E-03	2.87E-03	2.87E-03
	Powertrain	1.23E-03	1.23E-03	3.25E-03	3.25E-03	3.25E-03	3.25E-03	3.25E-03
	Battery	-	-	2.58E-03	2.58E-03	1.69E-03	9.81E-04	8.35E-04
	Use phase	2.52E-02	2.22E-02	1.66E-02	4.21E-03	1.66E-02	1.66E-02	1.66E-02
	Disposal	4.37E-04	4.37E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04	3.95E-04

	Total	2.97E-02	2.67E-02	2.57E-02	1.33E-02	2.48E-02	2.41E-02	2.39E-02