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Supplementary Materials

Dockless e−Scooter: A Green Solution for Mobility? Comparative Case Study between Dockless e−Scooters, Displaced Transport and Personal e−Scooters

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Table S1. List of the e−scooter materials.

Materials/assemblies	Quantity	Unit
Synthetic rubber	1.5225	kg
Cable, unspecified	0.198	kg
Acrylonitrile−butadiene−styrene copolymer	0.596	kg
Polyvinylchloride, suspension polymerised	0.083	kg
Steel, chromium steel 18/8	0.4805	kg
Steel, low−alloyed	1.924	kg
Light emitting diode	0.035	kg
Aluminium alloy, AlMg3	7.2086	kg
Tetrafluoroethylene	0.108	kg
Polymethyl methacrylate, sheet	0.012	kg
Battery, Li−ion, rechargeable, prismatic	2.026	kg
Cobalt	0.0006	kg
Copper	0.0012	kg
Cast iron	0.0006	kg
Nickel, 99.5%	0.0006	kg
Silicone product	0.001	kg
Seal, natural rubber based	0.034	kg
Polyethylene, high density	0.027	kg
Printed wiring board	0.041	kg
Controller, for electric scooter	0.151	kg
Electric motor, for e−scooter	1.224	kg
Wire drawing, steel	0.032	kg
Powder coat, aluminium sheet	0.8	m2

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Table S2. Impact assessment results for the dockless e–scooter use in Brussels for the eighteen impact categories per passenger.kilometer.

Impact category	Unit	Total	Materials	Manufacturing	Transport	Distribution	Charging
Global warming	kg CO2 eq	1.31×10^{-1}	9.58×10^{-2}	8.33×10^{-3}	2.76×10^{-3}	1.94×10^{-2}	4.67×10^{-3}
Stratospheric ozone depletion	kg CFC11 eq	3.37×10^{-7}	3.20×10^{-7}	2.40×10^{-9}	1.34×10^{-9}	9.62×10^{-9}	3.23×10^{-9}
Ionizing radiation	kBq Co–60 eq	1.46×10^{-2}	3.93×10^{-3}	6.15×10^{-4}	1.02×10^{-4}	7.74×10^{-4}	9.21×10^{-3}
Ozone formation, Human health	kg NOx eq	3.28×10^{-4}	2.13×10^{-4}	1.37×10^{-5}	3.26×10^{-5}	6.03×10^{-5}	8.12×10^{-6}
Fine particulate matter formation	kg PM2.5 eq	2.96×10^{-4}	2.33×10^{-4}	1.29×10^{-5}	1.38×10^{-5}	3.15×10^{-5}	4.54×10^{-6}
Ozone formation, Terrestrial ecosystems	kg NOx eq	3.38×10^{-4}	2.20×10^{-4}	1.39×10^{-5}	3.29×10^{-5}	6.34×10^{-5}	8.22×10^{-6}
Terrestrial acidification	kg SO2 eq	6.26×10^{-4}	4.83×10^{-4}	2.52×10^{-5}	4.19×10^{-5}	6.78×10^{-5}	8.37×10^{-6}
Freshwater eutrophication	kg P eq	1.23×10^{-4}	1.10×10^{-4}	2.65×10^{-6}	3.40×10^{-7}	7.93×10^{-6}	1.12×10^{-6}
Marine eutrophication	kg N eq	6.84×10^{-6}	5.23×10^{-6}	1.01×10^{-6}	2.36×10^{-8}	5.06×10^{-7}	7.00×10^{-8}
Terrestrial ecotoxicity	kg 1,4–DCB	1.46×10^{0}	1.30×10^{0}	1.10×10^{-2}	9.33×10^{-3}	1.21×10^{-1}	1.95×10^{-2}
Freshwater ecotoxicity	kg 1,4–DCB	3.76×10^{-2}	3.48×10^{-2}	9.58×10^{-4}	1.91×10^{-5}	1.71×10^{-3}	1.43×10^{-4}
Marine ecotoxicity	kg 1,4–DCB	4.93×10^{-2}	4.54×10^{-2}	1.27×10^{-3}	3.13×10^{-5}	2.38×10^{-3}	2.14×10^{-4}
Human carcinogenic toxicity	kg 1,4–DCB	1.53×10^{-2}	1.35×10^{-2}	3.24×10^{-4}	5.52×10^{-5}	1.17×10^{-3}	2.55×10^{-4}
Human non–carcinogenic toxicity	kg 1,4–DCB	6.40×10^{-1}	5.71×10^{-1}	2.06×10^{-2}	5.43×10^{-4}	4.27×10^{-2}	5.01×10^{-3}
Land use	m2a crop eq	2.54×10^{-3}	1.66×10^{-3}	2.60×10^{-4}	3.63×10^{-5}	4.96×10^{-4}	8.98×10^{-5}
Mineral resource scarcity	kg Cu eq	1.97×10^{-3}	1.78×10^{-3}	1.39×10^{-5}	3.46×10^{-6}	1.49×10^{-4}	2.41×10^{-5}
Fossil resource scarcity	kg oil eq	3.16×10^{-2}	2.15×10^{-2}	1.71×10^{-3}	8.77×10^{-4}	5.94×10^{-3}	1.61×10^{-3}
Water consumption	m3	1.86×10^{-2}	8.39×10^{-4}	5.14×10^{-5}	7.84×10^{-6}	9.41×10^{-5}	1.76×10^{-2}

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Table S3. Absolute values of the contribution analysis of the material phase for the four impact categories analyzed. ABS: Acrylonitrile butadiene styrene, PVC: Polyvinylchloride, LED: Light emitting diode, PTFE: polytetrafluoroethylene.

Impact category	Rubber	Cable	ABS	PVC	Chromium Steel	Steel, low−alloyed	LED	Aluminium	PTFE	Battery, Li−ion	Wiring board	Controller	Electric motor	Powder coat	Others
Global warming kg CO2 eq	4.49×10^{0}	8.22×10^{-1}	2.86×10^{0}	1.62×10^{-1}	2.35×10^{0}	3.43×10^{0}	1.10×10^{1}	5.19×10^{1}	1.49×10^{1}	1.15×10^{1}	1.49×10^{1}	7.25×10^{0}	1.16×10^{1}	2.75×10^{0}	2.73×10^{-1}
Fine particulate matter formation kg PM2.5 eq	8.09×10^{-3}	1.46×10^{-2}	2.28×10^{-3}	1.08×10^{-4}	8.59×10^{-3}	8.47×10^{-3}	2.53×10^{-2}	1.19×10^{-1}	2.04×10^{-3}	4.97×10^{-2}	3.59×10^{-2}	1.73×10^{-2}	4.43×10^{-2}	4.18×10^{-3}	7.10×10^{-4}
Mineral resource scarcity kg Cu eq	1.60×10^{-2}	1.58×10^{-1}	9.25×10^{-4}	6.36×10^{-5}	2.38×10^{-1}	1.80×10^{-1}	8.87×10^{-2}	4.58×10^{-1}	4.65×10^{-3}	5.45×10^{-1}	4.35×10^{-1}	9.25×10^{-2}	3.77×10^{-1}	4.51×10^{-3}	7.04×10^{-3}
Fossil resource scarcity kg oil eq	2.64×10^{0}	2.58×10^{-1}	1.23×10^{0}	8.47×10^{-2}	5.27×10^{-1}	7.83×10^{-1}	2.65×10^{0}	1.06×10^{1}	3.43×10^{-1}	2.98×10^{0}	3.60×10^{0}	1.75×10^{0}	3.04×10^{0}	7.52×10^{-1}	1.42×10^{-1}

Table S4. Evolution of the contribution of the life cycle phases for the different prolonged lifetime scenarios on the global warming impact category. Unit: kg CO_2−eq.

Scenario	Materials	Manufacturing	Transport	Distribution	Charging	Maintenance
5 years	1.20×10^{-2}	1.04×10^{-3}	3.47×10^{-4}	1.94×10^{-2}	4.67×10^{-3}	2.45×10^{-3}
2.5 years	2.40×10^{-2}	2.09×10^{-3}	6.93×10^{-4}	1.94×10^{-2}	4.67×10^{-3}	
1 year	6.01×10^{-2}	5.22×10^{-3}	1.73×10^{-3}	1.94×10^{-2}	4.67×10^{-3}	
Base Case	9.58×10^{-2}	8.33×10^{-3}	2.76×10^{-3}	1.94×10^{-2}	4.67×10^{-3}	

Table S5. Impact assessment results for the displaced modal share, the e−scooter use base case and the three different lifetime scenarios.

	Base Case	Modal report	1 years	2years	5 years
Global warming kg CO_2 eq	0.131	0.110	0.091	0.051	0.040
Fine particulate matter formation kg PM2.5 eq	2.96×10^{-4}	1.44×10^{-4}	1.99×10^{-4}	1.01×10^{-4}	7.63×10^{-5}
Mineral resource scarcity kg Cu eq	1.97×10^{-3}	5.76×10^{-4}	1.30×10^{-3}	6.24×10^{-4}	4.66×10^{-4}
Fossil resource scarcity kg oil eq	3.16×10^{-2}	3.43×10^{-2}	2.26×10^{-2}	1.36×10^{-2}	1.12×10^{-2}

Table 6. Mode of transport displaced by e−scooter users in 5 different locations.

	Brussels personal users	Brussels dockless users	France	Raleight, North Carolina	Portland, Oregon	Rosslyn, Virginia
Public transportation	30.2%	29.2%	28.6%	11.31%	8.7%	7.0%
Car	28.4%	26.7%	8.8%	36.35%	39.1%	46.0%
Walk	21.1%	26.1%	46.6%	44.31%	36.3%	33.0%
Bicycle	15.5%	14.2%	9.8%	7.95%	7.6%	12.0%
Electric bicycle	1.6%	1.5%				
Added trips	1.5%	1.8%	3.0%	0.08%	6.9%	
Other	1.1%	0.1%	0.2%		1.2%	2.0%
Motorcycle	0.6%	0.4%	2.2%			
Personal e−scooter			0.9%		0.2%	

Table S7. Comparison of the GWP between the use of shared dockless e–scooter vs personal e–scooter including the impacts of the mode of transportation they both replace.

Global Warming kg CO_2–eq	Total	Materials	Manufacturing	Distribution	Transport	Charging
Modal report dockless users	0.110					
PSS model		0.096	0.008326	0.019	0.003	0.005
Ownership model		0.057	0.003908		0.002	0.005
Modal report personal users	0.117					