

Supplementary Materials

Table S1 LCIA for e-moped fleets with German electricity mix of 2019

Impact category	Unit	Active fleet: 2,500 vehicles			10,000 vehicles			50,000 vehicles		
		Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle
Ozone formation, Terrestrial ecosystems - production	kg NOx eq	1.03E+04	3.39E-05	3.05E+00	4.11E+04	3.59E-05	3.05E+00	2.05E+05	4.93E-05	3.05E+00
Ozone formation, Human health - production	kg NOx eq	9.75E+03	3.22E-05	2.89E+00	3.90E+04	3.41E-05	2.89E+00	1.95E+05	4.68E-05	2.89E+00
Fine particulate matter formation - production	kg PM2.5 eq	1.27E+04	4.20E-05	3.77E+00	5.08E+04	4.45E-05	3.77E+00	2.54E+05	6.10E-05	3.77E+00
Fossil resource scarcity - production	kg oil eq	7.85E+05	2.59E-03	2.33E+02	3.14E+06	2.75E-03	2.33E+02	1.57E+07	3.77E-03	2.33E+02
Land use - production	m2a crop eq	6.10E+04	2.02E-04	1.81E+01	2.44E+05	2.14E-04	1.81E+01	1.22E+06	2.93E-04	1.81E+01
Human carcinogenic toxicity - production	kg 1,4-DCB	5.32E+05	1.76E-03	1.58E+02	2.13E+06	1.86E-03	1.58E+02	1.06E+07	2.55E-03	1.58E+02
Stratospheric ozone depletion - production	kg CFC11 eq	1.50E+00	4.96E-09	4.46E-04	6.01E+00	5.26E-09	4.46E-04	3.00E+01	7.21E-09	4.46E-04
Water consumption - production	m3	3.15E+04	1.04E-04	9.35E+00	1.26E+05	1.10E-04	9.35E+00	6.30E+05	1.51E-04	9.35E+00
Marine eutrophication - production	kg N eq	1.34E+02	4.42E-07	3.97E-02	5.35E+02	4.68E-07	3.97E-02	2.67E+03	6.42E-07	3.97E-02
Freshwater eutrophication - production	kg P eq	3.09E+03	1.02E-05	9.18E-01	1.24E+04	1.08E-05	9.18E-01	6.19E+04	1.49E-05	9.18E-01
Freshwater ecotoxicity - production	kg 1,4-DCB	1.94E+06	6.40E-03	5.75E+02	7.74E+06	6.78E-03	5.75E+02	3.87E+07	9.30E-03	5.75E+02
Human non-carcinogenic toxicity - production	kg 1,4-DCB	2.00E+07	6.62E-02	5.94E+03	8.01E+07	7.01E-02	5.94E+03	4.00E+08	9.61E-02	5.94E+03
Ionizing radiation - production	kBq Co-60 eq	1.54E+05	5.09E-04	4.57E+01	6.16E+05	5.39E-04	4.57E+01	3.08E+06	7.39E-04	4.57E+01
Marine ecotoxicity - production	kg 1,4-DCB	2.47E+06	8.16E-03	7.33E+02	9.88E+06	8.65E-03	7.33E+02	4.94E+07	1.19E-02	7.33E+02
Global warming - production	kg CO2 eq	2.79E+06	9.22E-03	8.28E+02	1.12E+07	9.77E-03	8.28E+02	5.58E+07	1.34E-02	8.28E+02
Terrestrial ecotoxicity - production	kg 1,4-DCB	8.29E+07	2.74E-01	2.46E+04	3.31E+08	2.90E-01	2.46E+04	1.66E+09	3.98E-01	2.46E+04
Mineral resource scarcity - production	kg Cu eq	2.01E+05	6.64E-04	5.96E+01	8.04E+05	7.04E-04	5.96E+01	4.02E+06	9.65E-04	5.96E+01
Terrestrial acidification - production	kg SO2 eq	3.37E+04	1.11E-04	9.99E+00	1.35E+05	1.18E-04	9.99E+00	6.73E+05	1.62E-04	9.99E+00
Ozone formation, Terrestrial ecosystems - use	kg NOx eq	1.13E+04	3.74E-05	3.36E+00	4.27E+04	3.74E-05	3.17E+00	1.56E+05	3.74E-05	2.31E+00
Ozone formation, Human health - use	kg NOx eq	1.08E+04	3.58E-05	3.22E+00	4.09E+04	3.58E-05	3.04E+00	1.49E+05	3.58E-05	2.21E+00
Fine particulate matter formation - use	kg PM2.5 eq	5.84E+03	1.93E-05	1.73E+00	2.21E+04	1.93E-05	1.64E+00	8.04E+04	1.93E-05	1.19E+00
Fossil resource scarcity - use	kg oil eq	1.92E+06	6.35E-03	5.71E+02	7.26E+06	6.35E-03	5.39E+02	2.65E+07	6.35E-03	3.93E+02
Land use - use	m2a crop eq	5.61E+05	1.85E-03	1.66E+02	2.12E+06	1.85E-03	1.57E+02	7.72E+06	1.85E-03	1.15E+02
Human carcinogenic toxicity - use	kg 1,4-DCB	4.39E+05	1.45E-03	1.30E+02	1.66E+06	1.45E-03	1.23E+02	6.05E+06	1.45E-03	8.98E+01
Stratospheric ozone depletion - use	kg CFC11 eq	5.34E+00	1.77E-08	1.59E-03	2.02E+01	1.77E-08	1.50E-03	7.36E+01	1.77E-08	1.09E-03
Water consumption - use	m3	4.69E+04	1.55E-04	1.39E+01	1.77E+05	1.55E-04	1.31E+01	6.46E+05	1.55E-04	9.59E+00
Marine eutrophication - use	kg N eq	4.48E+02	1.48E-06	1.33E-01	1.69E+03	1.48E-06	1.26E-01	6.17E+03	1.48E-06	9.16E-02

Freshwater eutrophication - use	kg P eq	6.85E+03	2.26E-05	2.03E+00	2.59E+04	2.26E-05	1.92E+00	9.43E+04	2.26E-05	1.40E+00
Freshwater ecotoxicity - use	kg 1,4-DCB	9.13E+05	3.02E-03	2.71E+02	3.45E+06	3.02E-03	2.56E+02	1.26E+07	3.02E-03	1.87E+02
Human non-carcinogenic toxicity - use	kg 1,4-DCB	1.72E+07	5.68E-02	5.10E+03	6.49E+07	5.68E-02	4.81E+03	2.37E+08	5.68E-02	3.51E+03
Ionizing radiation - use	kBq Co-60 eq	1.09E+06	3.60E-03	3.23E+02	4.11E+06	3.60E-03	3.05E+02	1.50E+07	3.60E-03	2.22E+02
Marine ecotoxicity - use	kg 1,4-DCB	1.20E+06	3.96E-03	3.55E+02	4.52E+06	3.96E-03	3.35E+02	1.65E+07	3.96E-03	2.45E+02
Global warming - use	kg CO2 eq	6.91E+06	2.28E-02	2.05E+03	2.61E+07	2.28E-02	1.94E+03	9.52E+07	2.28E-02	1.41E+03
Terrestrial ecotoxicity - use	kg 1,4-DCB	1.69E+07	5.57E-02	5.00E+03	6.36E+07	5.57E-02	4.72E+03	2.32E+08	5.57E-02	3.44E+03
Mineral resource scarcity - use	kg Cu eq	3.83E+04	1.27E-04	1.14E+01	1.45E+05	1.27E-04	1.07E+01	5.28E+05	1.27E-04	7.84E+00
Terrestrial acidification - use	kg SO2 eq	1.60E+04	5.30E-05	4.76E+00	6.06E+04	5.30E-05	4.49E+00	2.21E+05	5.30E-05	3.28E+00
Ozone formation, Terrestrial ecosystems - EoL	kg NOx eq	2.36E+02	7.79E-07	6.99E-02	9.42E+02	8.25E-07	6.99E-02	4.71E+03	1.13E-06	6.99E-02
Ozone formation, Human health - EoL	kg NOx eq	2.33E+02	7.70E-07	6.91E-02	9.32E+02	8.16E-07	6.91E-02	4.66E+03	1.12E-06	6.91E-02
Fine particulate matter formation - EoL	kg PM2.5 eq	2.57E+02	8.50E-07	7.63E-02	1.03E+03	9.00E-07	7.63E-02	5.14E+03	1.23E-06	7.63E-02
Fossil resource scarcity - EoL	kg oil eq	2.17E+04	7.16E-05	6.43E+00	8.66E+04	7.58E-05	6.43E+00	4.33E+05	1.04E-04	6.43E+00
Land use - EoL	m2a crop eq	1.56E+03	5.14E-06	4.62E-01	6.22E+03	5.45E-06	4.62E-01	3.11E+04	7.47E-06	4.62E-01
Human carcinogenic toxicity - EoL	kg 1,4-DCB	7.15E+03	2.36E-05	2.12E+00	2.86E+04	2.50E-05	2.12E+00	1.43E+05	3.43E-05	2.12E+00
Stratospheric ozone depletion - EoL	kg CFC11 eq	6.62E-02	2.19E-10	1.96E-05	2.65E-01	2.32E-10	1.96E-05	1.32E+00	3.18E-10	1.96E-05
Water consumption - EoL	m3	1.33E+03	4.39E-06	3.94E-01	5.31E+03	4.65E-06	3.94E-01	2.65E+04	6.37E-06	3.94E-01
Marine eutrophication - EoL	kg N eq	8.46E+00	2.80E-08	2.51E-03	3.38E+01	2.96E-08	2.51E-03	1.69E+02	4.06E-08	2.51E-03
Freshwater eutrophication - EoL	kg P eq	4.18E+01	1.38E-07	1.24E-02	1.67E+02	1.46E-07	1.24E-02	8.36E+02	2.01E-07	1.24E-02
Freshwater ecotoxicity - EoL	kg 1,4-DCB	7.33E+03	2.42E-05	2.18E+00	2.93E+04	2.57E-05	2.18E+00	1.47E+05	3.52E-05	2.18E+00
Human non-carcinogenic toxicity - EoL	kg 1,4-DCB	1.26E+05	4.15E-04	3.73E+01	5.02E+05	4.40E-04	3.73E+01	2.51E+06	6.03E-04	3.73E+01
Ionizing radiation - EoL	kBq Co-60 eq	9.07E+03	3.00E-05	2.69E+00	3.63E+04	3.18E-05	2.69E+00	1.81E+05	4.35E-05	2.69E+00
Marine ecotoxicity - EoL	kg 1,4-DCB	9.64E+03	3.19E-05	2.86E+00	3.86E+04	3.37E-05	2.86E+00	1.93E+05	4.63E-05	2.86E+00
Global warming - EoL	kg CO2 eq	9.86E+04	3.26E-04	2.93E+01	3.94E+05	3.45E-04	2.93E+01	1.97E+06	4.73E-04	2.93E+01
Terrestrial ecotoxicity - EoL	kg 1,4-DCB	3.66E+05	1.21E-03	1.09E+02	1.46E+06	1.28E-03	1.09E+02	7.32E+06	1.76E-03	1.09E+02
Mineral resource scarcity - EoL	kg Cu eq	7.27E+02	2.40E-06	2.16E-01	2.91E+03	2.55E-06	2.16E-01	1.45E+04	3.49E-06	2.16E-01
Terrestrial acidification - EoL	kg SO2 eq	4.89E+02	1.62E-06	1.45E-01	1.96E+03	1.71E-06	1.45E-01	9.79E+03	2.35E-06	1.45E-01

Table S2 LCIA for e-moped fleets with renewable electricity mix

Impact category	Unit	Active fleet: 2,500 vehicles			10,000 vehicles			50,000 vehicles		
		Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle
Ozone formation, Terrestrial ecosystems - production	kg NOx eq	1.03E+04	3.39E-05	3.05E+00	4.11E+04	3.59E-05	3.05E+00	2.05E+05	4.93E-05	3.05E+00
Ozone formation, Human health - production	kg NOx eq	9.75E+03	3.22E-05	2.89E+00	3.90E+04	3.41E-05	2.89E+00	1.95E+05	4.68E-05	2.89E+00
Fine particulate matter formation - production	kg PM2.5 eq	1.27E+04	4.20E-05	3.77E+00	5.08E+04	4.45E-05	3.77E+00	2.54E+05	6.10E-05	3.77E+00
Fossil resource scarcity - production	kg oil eq	7.85E+05	2.59E-03	2.33E+02	3.14E+06	2.75E-03	2.33E+02	1.57E+07	3.77E-03	2.33E+02
Land use - production	m2a crop eq	6.10E+04	2.02E-04	1.81E+01	2.44E+05	2.14E-04	1.81E+01	1.22E+06	2.93E-04	1.81E+01
Human carcinogenic toxicity - production	kg 1,4-DCB	5.32E+05	1.76E-03	1.58E+02	2.13E+06	1.86E-03	1.58E+02	1.06E+07	2.55E-03	1.58E+02
Stratospheric ozone depletion - production	kg CFC11 eq	1.50E+00	4.96E-09	4.46E-04	6.01E+00	5.26E-09	4.46E-04	3.00E+01	7.21E-09	4.46E-04
Water consumption - production	m3	3.15E+04	1.04E-04	9.35E+00	1.26E+05	1.10E-04	9.35E+00	6.30E+05	1.51E-04	9.35E+00
Marine eutrophication - production	kg N eq	1.34E+02	4.42E-07	3.97E-02	5.35E+02	4.68E-07	3.97E-02	2.67E+03	6.42E-07	3.97E-02
Freshwater eutrophication - production	kg P eq	3.09E+03	1.02E-05	9.18E-01	1.24E+04	1.08E-05	9.18E-01	6.19E+04	1.49E-05	9.18E-01
Freshwater ecotoxicity - production	kg 1,4-DCB	1.94E+06	6.40E-03	5.75E+02	7.74E+06	6.78E-03	5.75E+02	3.87E+07	9.30E-03	5.75E+02
Human non-carcinogenic toxicity - production	kg 1,4-DCB	2.00E+07	6.62E-02	5.94E+03	8.01E+07	7.01E-02	5.94E+03	4.00E+08	9.61E-02	5.94E+03
Ionizing radiation - production	kBq Co-60 eq	1.54E+05	5.09E-04	4.57E+01	6.16E+05	5.39E-04	4.57E+01	3.08E+06	7.39E-04	4.57E+01
Marine ecotoxicity - production	kg 1,4-DCB	2.47E+06	8.16E-03	7.33E+02	9.88E+06	8.65E-03	7.33E+02	4.94E+07	1.19E-02	7.33E+02
Global warming - production	kg CO2 eq	2.79E+06	9.22E-03	8.28E+02	1.12E+07	9.77E-03	8.28E+02	5.58E+07	1.34E-02	8.28E+02
Terrestrial ecotoxicity - production	kg 1,4-DCB	8.29E+07	2.74E-01	2.46E+04	3.31E+08	2.90E-01	2.46E+04	1.66E+09	3.98E-01	2.46E+04
Mineral resource scarcity - production	kg Cu eq	2.01E+05	6.64E-04	5.96E+01	8.04E+05	7.04E-04	5.96E+01	4.02E+06	9.65E-04	5.96E+01
Terrestrial acidification - production	kg SO2 eq	3.37E+04	1.11E-04	9.99E+00	1.35E+05	1.18E-04	9.99E+00	6.73E+05	1.62E-04	9.99E+00
Ozone formation, Terrestrial ecosystems - use	kg NOx eq	7.40E+03	2.45E-05	2.20E+00	2.80E+04	2.45E-05	2.07E+00	1.02E+05	2.45E-05	1.51E+00
Ozone formation, Human health - use	kg NOx eq	6.96E+03	2.30E-05	2.06E+00	2.63E+04	2.30E-05	1.95E+00	9.58E+04	2.30E-05	1.42E+00
Fine particulate matter formation - use	kg PM2.5 eq	4.49E+03	1.48E-05	1.33E+00	1.69E+04	1.48E-05	1.26E+00	6.18E+04	1.48E-05	9.17E-01
Fossil resource scarcity - use	kg oil eq	8.63E+05	2.85E-03	2.56E+02	3.26E+06	2.85E-03	2.42E+02	1.19E+07	2.85E-03	1.76E+02
Land use - use	m2a crop eq	2.76E+05	9.11E-04	8.18E+01	1.04E+06	9.11E-04	7.72E+01	3.79E+06	9.11E-04	5.63E+01
Human carcinogenic toxicity - use	kg 1,4-DCB	1.99E+05	6.56E-04	5.89E+01	7.50E+05	6.56E-04	5.56E+01	2.73E+06	6.56E-04	4.06E+01
Stratospheric ozone depletion - use	kg CFC11 eq	1.95E+00	6.45E-09	5.79E-04	7.37E+00	6.45E-09	5.47E-04	2.69E+01	6.45E-09	3.99E-04
Water consumption - use	m3	3.22E+04	1.07E-04	9.56E+00	1.22E+05	1.07E-04	9.03E+00	4.44E+05	1.07E-04	6.58E+00
Marine eutrophication - use	kg N eq	8.09E+01	2.67E-07	2.40E-02	3.05E+02	2.67E-07	2.27E-02	1.11E+03	2.67E-07	1.65E-02
Freshwater eutrophication - use	kg P eq	9.97E+02	3.29E-06	2.96E-01	3.76E+03	3.29E-06	2.79E-01	1.37E+04	3.29E-06	2.04E-01
Freshwater ecotoxicity - use	kg 1,4-DCB	9.29E+05	3.07E-03	2.76E+02	3.51E+06	3.07E-03	2.60E+02	1.28E+07	3.07E-03	1.90E+02
Human non-carcinogenic toxicity - use	kg 1,4-DCB	1.40E+07	4.64E-02	4.16E+03	5.30E+07	4.64E-02	3.93E+03	1.93E+08	4.64E-02	2.87E+03

Ionizing radiation - use	kBq Co-60 eq	1.38E+05	4.57E-04	4.11E+01	5.22E+05	4.57E-04	3.88E+01	1.90E+06	4.57E-04	2.83E+01
Marine ecotoxicity - use	kg 1,4-DCB	1.20E+06	3.97E-03	3.56E+02	4.53E+06	3.97E-03	3.36E+02	1.65E+07	3.97E-03	2.45E+02
Global warming - use	kg CO2 eq	2.79E+06	9.21E-03	8.27E+02	1.05E+07	9.21E-03	7.81E+02	3.84E+07	9.21E-03	5.69E+02
Terrestrial ecotoxicity - use	kg 1,4-DCB	2.54E+07	8.39E-02	7.53E+03	9.58E+07	8.39E-02	7.11E+03	3.49E+08	8.39E-02	5.19E+03
Mineral resource scarcity - use	kg Cu eq	4.43E+04	1.46E-04	1.32E+01	1.67E+05	1.46E-04	1.24E+01	6.10E+05	1.46E-04	9.06E+00
Terrestrial acidification - use	kg SO2 eq	1.02E+04	3.38E-05	3.03E+00	3.86E+04	3.38E-05	2.86E+00	1.41E+05	3.38E-05	2.09E+00
Ozone formation, Terrestrial ecosystems - EoL	kg NOx eq	2.36E+02	7.79E-07	6.99E-02	9.42E+02	8.25E-07	6.99E-02	4.71E+03	1.13E-06	6.99E-02
Ozone formation, Human health - EoL	kg NOx eq	2.33E+02	7.70E-07	6.91E-02	9.32E+02	8.16E-07	6.91E-02	4.66E+03	1.12E-06	6.91E-02
Fine particulate matter formation - EoL	kg PM2.5 eq	2.57E+02	8.50E-07	7.63E-02	1.03E+03	9.00E-07	7.63E-02	5.14E+03	1.23E-06	7.63E-02
Fossil resource scarcity - EoL	kg oil eq	2.17E+04	7.16E-05	6.43E+00	8.66E+04	7.58E-05	6.43E+00	4.33E+05	1.04E-04	6.43E+00
Land use - EoL	m2a crop eq	1.56E+03	5.14E-06	4.62E-01	6.22E+03	5.45E-06	4.62E-01	3.11E+04	7.47E-06	4.62E-01
Human carcinogenic toxicity - EoL	kg 1,4-DCB	7.15E+03	2.36E-05	2.12E+00	2.86E+04	2.50E-05	2.12E+00	1.43E+05	3.43E-05	2.12E+00
Stratospheric ozone depletion - EoL	kg CFC11 eq	6.62E-02	2.19E-10	1.96E-05	2.65E-01	2.32E-10	1.96E-05	1.32E+00	3.18E-10	1.96E-05
Water consumption - EoL	m3	1.33E+03	4.39E-06	3.94E-01	5.31E+03	4.65E-06	3.94E-01	2.65E+04	6.37E-06	3.94E-01
Marine eutrophication - EoL	kg N eq	8.46E+00	2.80E-08	2.51E-03	3.38E+01	2.96E-08	2.51E-03	1.69E+02	4.06E-08	2.51E-03
Freshwater eutrophication - EoL	kg P eq	4.18E+01	1.38E-07	1.24E-02	1.67E+02	1.46E-07	1.24E-02	8.36E+02	2.01E-07	1.24E-02
Freshwater ecotoxicity - EoL	kg 1,4-DCB	7.33E+03	2.42E-05	2.18E+00	2.93E+04	2.57E-05	2.18E+00	1.47E+05	3.52E-05	2.18E+00
Human non-carcinogenic toxicity - EoL	kg 1,4-DCB	1.26E+05	4.15E-04	3.73E+01	5.02E+05	4.40E-04	3.73E+01	2.51E+06	6.03E-04	3.73E+01
Ionizing radiation - EoL	kBq Co-60 eq	9.07E+03	3.00E-05	2.69E+00	3.63E+04	3.18E-05	2.69E+00	1.81E+05	4.35E-05	2.69E+00
Marine ecotoxicity - EoL	kg 1,4-DCB	9.64E+03	3.19E-05	2.86E+00	3.86E+04	3.37E-05	2.86E+00	1.93E+05	4.63E-05	2.86E+00
Global warming - EoL	kg CO2 eq	9.86E+04	3.26E-04	2.93E+01	3.94E+05	3.45E-04	2.93E+01	1.97E+06	4.73E-04	2.93E+01
Terrestrial ecotoxicity - EoL	kg 1,4-DCB	3.66E+05	1.21E-03	1.09E+02	1.46E+06	1.28E-03	1.09E+02	7.32E+06	1.76E-03	1.09E+02
Mineral resource scarcity - EoL	kg Cu eq	7.27E+02	2.40E-06	2.16E-01	2.91E+03	2.55E-06	2.16E-01	1.45E+04	3.49E-06	2.16E-01
Terrestrial acidification - EoL	kg SO2 eq	4.89E+02	1.62E-06	1.45E-01	1.96E+03	1.71E-06	1.45E-01	9.79E+03	2.35E-06	1.45E-01

Table S3 CED for e-moped fleets with German electricity mix of 2019

CED component	Unit	Active fleet: 2,500 vehicles			10,000 vehicles			50,000 vehicles		
		Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle
Renewable, wind, solar, geoth - production	MJ	3.01E+05	9.94E-04	8.93E+01	1.20E+06	1.05E-03	8.93E+01	6.01E+06	1.44E-03	8.93E+01
Renewable, water – production	MJ	2.47E+06	8.17E-03	7.33E+02	9.88E+06	8.65E-03	7.33E+02	4.94E+07	1.19E-02	7.33E+02
Renewable, biomass - production	MJ	7.82E+05	2.58E-03	2.32E+02	3.13E+06	2.74E-03	2.32E+02	1.56E+07	3.75E-03	2.32E+02
Non-renewable, nuclear - production	MJ	3.00E+06	9.92E-03	8.90E+02	1.20E+07	1.05E-02	8.90E+02	6.00E+07	1.44E-02	8.90E+02
Non-renewable, biomass - production	MJ	4.24E+03	1.40E-05	1.26E+00	1.69E+04	1.48E-05	1.26E+00	8.47E+04	2.03E-05	1.26E+00
Non-renewable, fossil - production	MJ	3.34E+07	1.10E-01	9.90E+03	1.33E+08	1.17E-01	9.90E+03	6.67E+08	1.60E-01	9.90E+03
Renewable, wind, solar, geoth - use	MJ	1.16E+07	3.83E-02	3.44E+03	4.37E+07	3.83E-02	3.24E+03	1.59E+08	3.83E-02	2.36E+03
Renewable, water - use	MJ	2.60E+06	8.59E-03	7.72E+02	9.81E+06	8.59E-03	7.28E+02	3.58E+07	8.59E-03	5.31E+02
Renewable, biomass - use	MJ	8.17E+06	2.70E-02	2.43E+03	3.09E+07	2.70E-02	2.29E+03	1.13E+08	2.70E-02	1.67E+03
Non-renewable, nuclear - use	MJ	2.07E+07	6.84E-02	6.14E+03	7.81E+07	6.84E-02	5.79E+03	2.85E+08	6.84E-02	4.23E+03
Non-renewable, biomass - use	MJ	9.15E+02	3.03E-06	2.72E-01	3.46E+03	3.03E-06	2.56E-01	1.26E+04	3.03E-06	1.87E-01
Non-renewable, fossil - use	MJ	8.02E+07	2.65E-01	2.38E+04	3.03E+08	2.65E-01	2.25E+04	1.10E+09	2.65E-01	1.64E+04
Renewable, wind, solar, geoth - EoL	MJ	1.93E+04	6.39E-05	5.74E+00	7.74E+04	6.77E-05	5.74E+00	3.87E+05	9.29E-05	5.74E+00
Renewable, water - EoL	MJ	1.91E+05	6.30E-04	5.66E+01	7.63E+05	6.68E-04	5.66E+01	3.81E+06	9.16E-04	5.66E+01
Renewable, biomass - EoL	MJ	2.48E+04	8.21E-05	7.37E+00	9.93E+04	8.70E-05	7.37E+00	4.97E+05	1.19E-04	7.37E+00
Non-renewable, nuclear - EoL	MJ	1.67E+05	5.53E-04	4.96E+01	6.69E+05	5.85E-04	4.96E+01	3.34E+06	8.03E-04	4.96E+01
Non-renewable, biomass - EoL	MJ	3.07E+01	1.01E-07	9.11E-03	1.23E+02	1.07E-07	9.11E-03	6.14E+02	1.47E-07	9.11E-03
Non-renewable, fossil - EoL	MJ	9.17E+05	3.03E-03	2.72E+02	3.67E+06	3.21E-03	2.72E+02	1.83E+07	4.40E-03	2.72E+02

Table S4 CED for e-moped fleets with renewable electricity mix

CED component	Unit	Active fleet: 2,500 vehicles			10,000 vehicles			50,000 vehicles		
		Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle	Value	Value per km	Value per vehicle
Renewable, wind, solar, geoth - production	MJ	3.01E+05	9.94E-04	8.93E+01	1.20E+06	1.05E-03	8.93E+01	6.01E+06	1.44E-03	8.93E+01
Renewable, water – production	MJ	2.47E+06	8.17E-03	7.33E+02	9.88E+06	8.65E-03	7.33E+02	4.94E+07	1.19E-02	7.33E+02
Renewable, biomass - production	MJ	7.82E+05	2.58E-03	2.32E+02	3.13E+06	2.74E-03	2.32E+02	1.56E+07	3.75E-03	2.32E+02
Non-renewable, nuclear - production	MJ	3.00E+06	9.92E-03	8.90E+02	1.20E+07	1.05E-02	8.90E+02	6.00E+07	1.44E-02	8.90E+02
Non-renewable, biomass - production	MJ	4.24E+03	1.40E-05	1.26E+00	1.69E+04	1.48E-05	1.26E+00	8.47E+04	2.03E-05	1.26E+00
Non-renewable, fossil - production	MJ	3.34E+07	1.10E-01	9.90E+03	1.33E+08	1.17E-01	9.90E+03	6.67E+08	1.60E-01	9.90E+03
Renewable, wind, solar, geoth - use	MJ	4.09E+07	1.35E-01	1.21E+04	1.54E+08	1.35E-01	1.15E+04	5.63E+08	1.35E-01	8.35E+03
Renewable, water - use	MJ	2.47E+06	8.18E-03	7.34E+02	9.34E+06	8.18E-03	6.93E+02	3.41E+07	8.18E-03	5.05E+02
Renewable, biomass - use	MJ	7.00E+05	2.31E-03	2.08E+02	2.64E+06	2.31E-03	1.96E+02	9.64E+06	2.31E-03	1.43E+02
Non-renewable, nuclear - use	MJ	2.61E+06	8.62E-03	7.74E+02	9.84E+06	8.62E-03	7.30E+02	3.59E+07	8.62E-03	5.33E+02
Non-renewable, biomass - use	MJ	5.44E+02	1.80E-06	1.62E-01	2.05E+03	1.80E-06	1.52E-01	7.49E+03	1.80E-06	1.11E-01
Non-renewable, fossil - use	MJ	3.68E+07	1.22E-01	1.09E+04	1.39E+08	1.22E-01	1.03E+04	5.07E+08	1.22E-01	7.53E+03
Renewable, wind, solar, geoth - EoL	MJ	1.93E+04	6.39E-05	5.74E+00	7.74E+04	6.77E-05	5.74E+00	3.87E+05	9.29E-05	5.74E+00
Renewable, water - EoL	MJ	1.91E+05	6.30E-04	5.66E+01	7.63E+05	6.68E-04	5.66E+01	3.81E+06	9.16E-04	5.66E+01
Renewable, biomass - EoL	MJ	2.48E+04	8.21E-05	7.37E+00	9.93E+04	8.70E-05	7.37E+00	4.97E+05	1.19E-04	7.37E+00
Non-renewable, nuclear - EoL	MJ	1.67E+05	5.53E-04	4.96E+01	6.69E+05	5.85E-04	4.96E+01	3.34E+06	8.03E-04	4.96E+01
Non-renewable, biomass - EoL	MJ	3.07E+01	1.01E-07	9.11E-03	1.23E+02	1.07E-07	9.11E-03	6.14E+02	1.47E-07	9.11E-03
Non-renewable, fossil - EoL	MJ	9.17E+05	3.03E-03	2.72E+02	3.67E+06	3.21E-03	2.72E+02	1.83E+07	4.40E-03	2.72E+02

Table S5 Personnel cost structure for e-moped fleets for main scenarios

Personnel category	Annual labor burden for employer	Active fleet: 2,500 vehicles		10,000 vehicles		50,000 vehicles	
		Number of employees	Total costs	Number of employees	Total costs	Number of employees	Total costs
Management	119,444 €	2	238,889 €	2	238,889 €	2	238,889 €
Business Development Manager	74,653 €	1	74,653 €	1	74,653 €	1	74,653 €
Operations Manager	73,578 €	2	147,156 €	3	220,733 €	6	441,467 €
Data Specialist	74,294 €	2	148,589 €	2	148,589 €	2	148,589 €
Software Engineer	83,611 €	4	334,444 €	4	334,444 €	4	334,444 €
Marketing Manager	67,486 €	1	67,486 €	1	67,486 €	1	67,486 €
Legal Counsel	103,319 €	1	103,319 €	1	103,319 €	1	103,319 €
Customer Service Agent	33,444 €	2	66,889 €	5	167,222 €	25	836,111 €
Warehouse Manager	48,972 €	2	97,944 €	3	146,917 €	6	293,833 €
Mechanic	44,792 €	2	89,583 €	9	403,125 €	44	1,970,833 €
Cleaner	29,861 €	1	29,861 €	3	89,583 €	8	238,889 €
Battery swapper	29,861 €	62	1,851,389 €	202	6,031,944 €	717	21,410,417 €
Total		82	3,250,203 €	236	8,026,906 €	817	26,158,931 €

Table S6 Personnel cost structure for e-moped fleets for additional scenarios (PF - personal factor, BS - 8h battery swap)

Personnel category	Annual labor burden for employer	Active fleet: 500 vehicles		2,500 vehicles (PF)		2,500 vehicles (BS)	
		Number of employees	Total costs	Number of employees	Total costs	Number of employees	Total costs
Management	119,444 €	2	238,889 €	2	238,889 €	2	238,889 €
Business Development Manager	74,653 €	1	74,653 €	1	74,653 €	1	74,653 €
Operations Manager	73,578 €	1	73,578 €	2	147,156 €	2	147,156 €
Data Specialist	74,294 €	2	148,589 €	2	148,589 €	2	148,589 €
Software Engineer	83,611 €	4	334,444 €	4	334,444 €	4	334,444 €
Marketing Manager	67,486 €	1	67,486 €	1	67,486 €	1	67,486 €
Legal Counsel	103,319 €	1	103,319 €	1	103,319 €	1	103,319 €
Customer Service Agent	33,444 €	1	33,444 €	2	66,889 €	2	66,889 €
Warehouse Manager	48,972 €	1	48,972 €	2	97,944 €	2	97,944 €
Mechanic	44,792 €	1	44,792 €	2	89,583 €	2	89,583 €
Cleaner	29,861 €	1	29,861 €	1	29,861 €	1	29,861 €
Battery swapper	29,861 €	11	328,472 €	34	1,015,278 €	45	1,343,750 €
Total		27	1,526,500 €	54	2,414,092 €	65	2,742,564 €

Table S7 Cross-scenario operation parameters for e-moped fleets

Parameter	Unit	Electric cargo bike	Electric panel van
Share of working hours of paid hours		90%	
Health check duration per vehicle	min	6	
Weekly working hours per battery swapper	h	40	
Battery capacity	kWh	0.4	40
Range	km	60	250
Maximum load	kg	130	550
Number of batteries per tour		14	59
Number of tours per shift		12	4
Batterys swapped per shift		166	234

Table S8 Scenario-specific operation parameters for e-moped fleets for main scenarios

	<i>Active fleet: 2,500 vehicles</i>		<i>10,000 vehicles</i>		<i>50,000 vehicles</i>	
Parameter	Electric cargo bike	Electric panel van	Electric cargo bike	Electric panel van	Electric cargo bike	Electric panel van
Daily batteries swapped	4,206		15,860		57,638	
Batteries swapped per average shift	1,402		5,287		19,213	
Daily Batteries swapped by vehicle per average shift	421	981	1,586	3,701	5,764	13,449
Distance driven per average shift	86	82	79	71	75	65
Total number of vehicles in fleet	18	15	60	48	210	174
Total shift hours per week	2,464		8,064		28,672	
Number of battery swapper needed	62		202		717	

Table S9 Scenario-specific operation parameters for e-moped fleets for additional scenarios (PF - personal factor, BS - 8h battery swap)

	<i>Active fleet: 500 vehicles</i>		<i>2,500 vehicles (PF)</i>		<i>2,500 vehicles (BS)</i>	
Parameter	Electric cargo bike	Electric panel van	Electric cargo bike	Electric panel van	Electric cargo bike	Electric panel van
Daily batteries swapped	808		2,165		3,312	
Batteries swapped per average shift	269		722		1,104	
Daily Batteries swapped by vehicle per average shift	81	189	217	505	331	773
Distance driven per average shift	102	109	86	82	86	82
Total number of vehicles in fleet	3	3	9	9	12	12
Total shift hours per week	448		1,344		1,792	
Number of battery swapper needed	11		34		45	