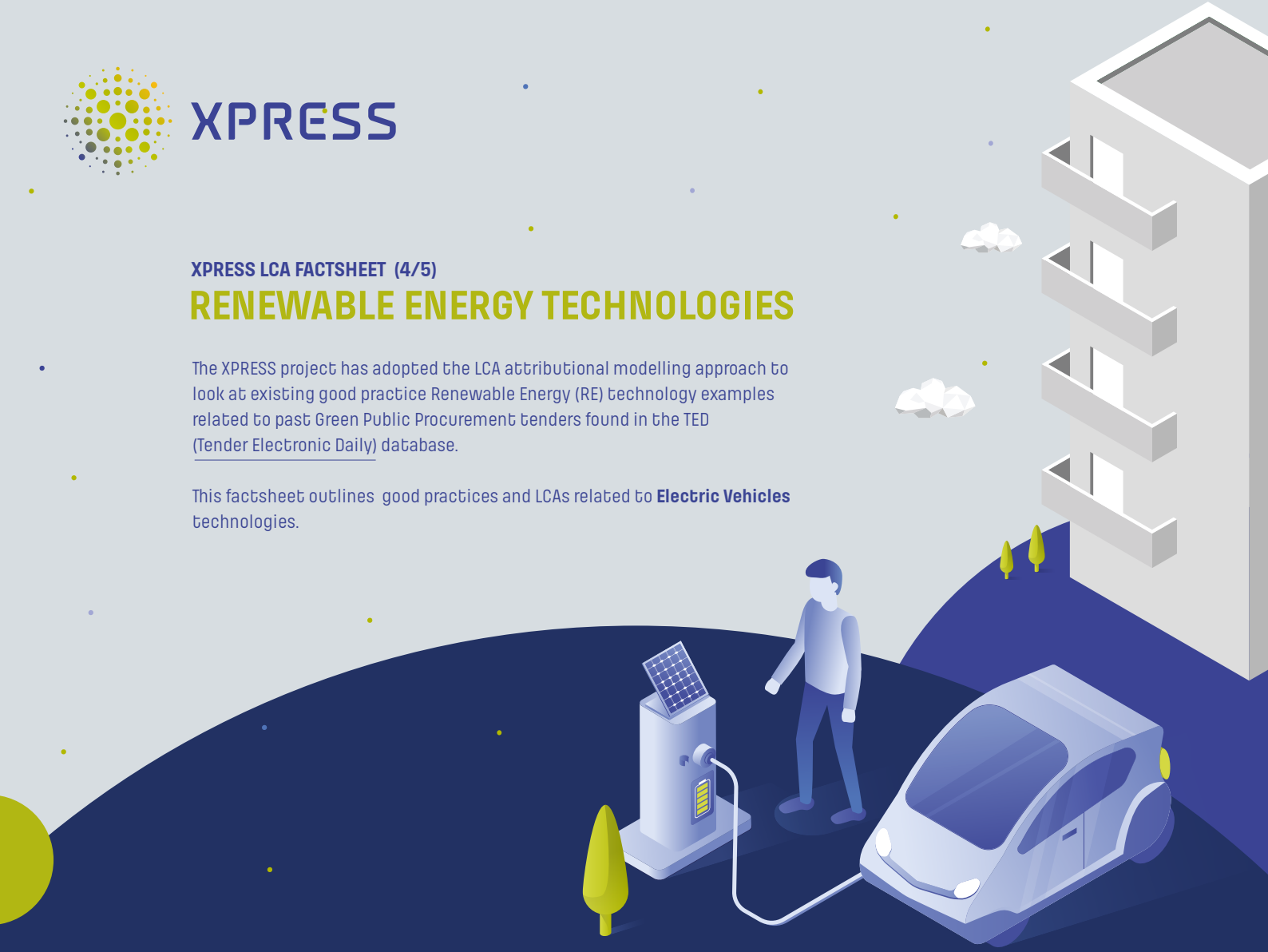
XPRESS

XPRESS LCA FACTSHEET (4/5)

RENEWABLE ENERGY TECHNOLOGIES

The XPRESS project has adopted the LCA attributional modelling approach to look at existing good practice Renewable Energy (RE) technology examples related to past Green Public Procurement tenders found in the TED (Tender Electronic Daily) database.

This factsheet outlines good practices and LCAs related to **Electric Vehicles** technologies.



Electric Vehicle

The transport sector alone is one of the main drivers of GHG emissions with relevant impact on Climate Change (Pachauri et al., 2014). The transport sector has the highest final energy consumption in the EU-28 (30.8% in 2017), when compared to Households (27.2%) and Industry (24.6%) (Eurostat, 2019). The EU agreed in the RE Directive (European Commission, 2009) to set a common target of 10% on the share of renewable energy (including liquid biofuels, hydrogen, biomethane, 'green' electricity, etc.) in the transport sector by 2020. The average share of energy from renewable sources in transport increased from 1.4 % in 2004 to 7.6 % in 2017. Among the EU Member States the relative share of renewable energy in transport fuel consumption ranged from 38.6 % in Sweden and 18.8 % in Finland to 9.7 % in Austria and less than 2.0 % in Croatia, Greece and Estonia.

There has been a steady increase in the number of electric and hybrid electric cars registered across the EU in recent years. More specifically, the number of hybrid electric-petrol cars in 2017 (1.5 million) was almost seven times the number recorded in 2013 (0.2 million). This trend is an indicator of the continuous electrification efforts of the transport sector, which is the main fossil fuel and energy consumption sector and one of the main airborne pollutant (like particle matter (PM) and NOx emissions which are cause of multiple diseases and premature death to humans) emitters in highly populated areas. Electric vehicles (EVs), if charged with electricity from a grid with high RE shares, are therefore a potential solution for the damaging airborne pollution in cities and the fossil fuel dependency of the EU (liquid fossil fuels are difficult to be substituted by biofuels in a sustainable way at the required scale).

E-cars

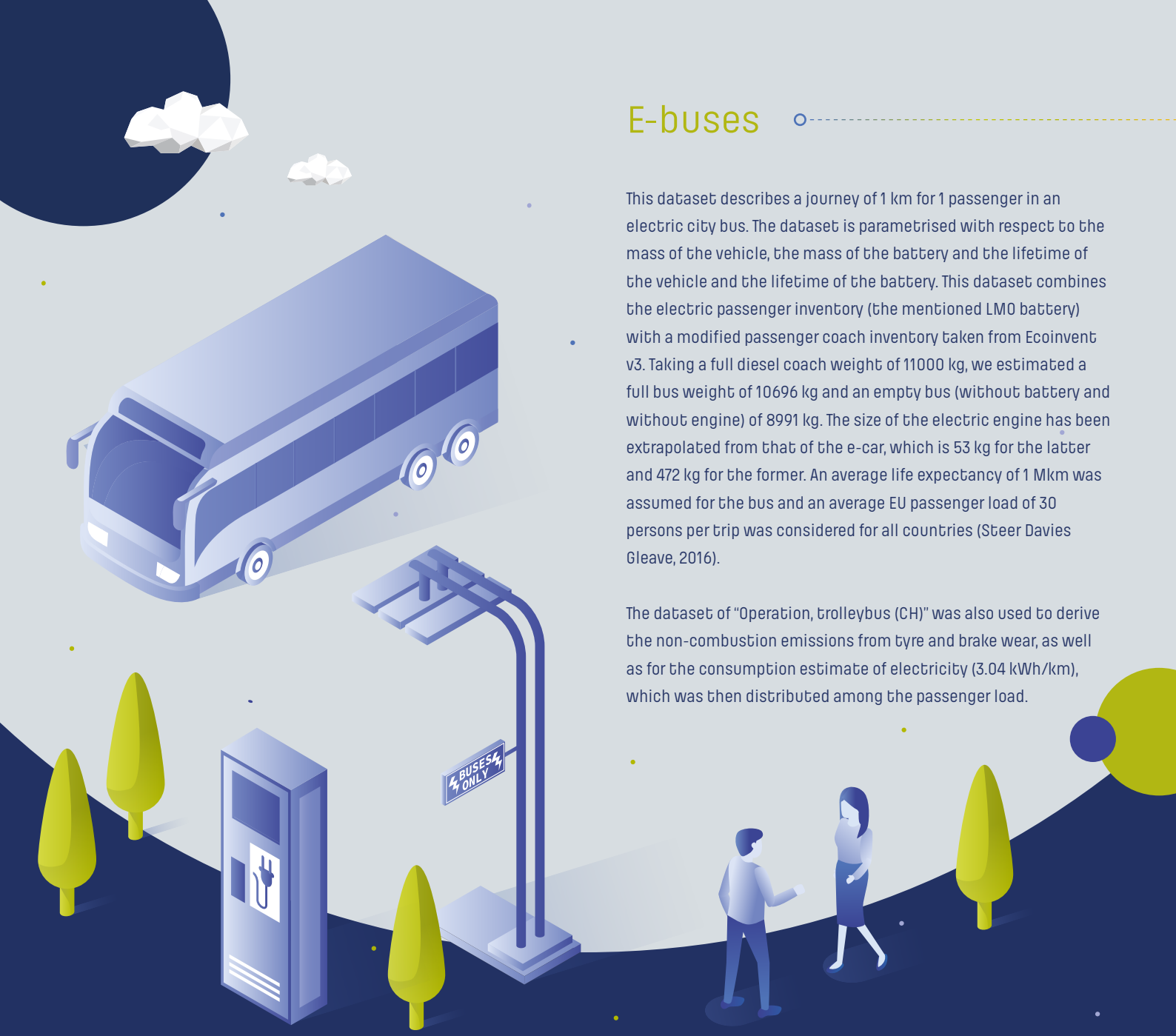
This dataset describes a journey of 1 km with an electric passenger car. The dataset is parametrised with respect to the mass of the vehicle, mass of the battery and lifetimes of vehicle and battery. The EV is described in terms of a vehicle without battery plus the battery. The amount of battery includes battery exchange due to maintenance. Currently, default values for a compact size car with a weight without battery of 918 kg were assumed. An average life expectancy for the car of 150000 km was assumed with a total consumption of 1.5 batteries during its lifetime. An electricity consumption of 0.2 kWh/km was assumed, as described in the database Ecoinvent v3 (representative of modern cars, up to 2015).

The environmental performance of the e-car transportation is closely related to the electricity grid-mix of each country where Norway is showing the lowest carbon footprint and Germany the highest. However, besides the electricity consumption necessary to load the battery, the e-car transportation's environmental burden also heavily depends on the battery itself and on the car (without battery). Taking an average load factor of 1.2 passengers per car in Europe, the carbon (and environmental) footprint figures are still much higher for e-cars than for e-buses.

Impact Category	Unit	BE	DE	DK	ES	IT
Climate change	kg CO2 eq	1.52E-01	2.19E-01	1.70E-01	1.70E-01	1.87E-01
Ozone depletion	kg CFC11 eq	2.00E-08	1.42E-08	1.20E-08	1.70E-08	2.12E-08
Ionising radiation	kBq U-235 eq	9.75E-02	4.07E-02	3.05E-02	6.76E-02	3.07E-02
Photochemical ozone formation	kg NMVOC eq	5.49E-04	6.25E-04	6.07E-04	7.29E-04	6.64E-04
Particulate matter	disease inc.	9.06E-09	9.58E-09	9.55E-09	9.73E-09	1.00E-08
Human toxicity, non-cancer	CTUh	7.73E-09	8.35E-09	8.08E-09	8.19E-09	7.95E-09
Human toxicity, cancer	CTUh	2.74E-10	2.83E-10	2.82E-10	2.85E-10	2.81E-10
Acidification	mol H+ eq	1.06E-03	1.27E-03	1.20E-03	1.54E-03	1.39E-03
Eutrophication, freshwater	kg P eq	1.22E-04	2.73E-04	1.57E-04	1.37E-04	1.33E-04
Eutrophication, marine	kg N eq	1.58E-04	2.13E-04	1.82E-04	2.20E-04	1.91E-04
Eutrophication, terrestrial	mol N eq	1.67E-03	2.18E-03	2.01E-03	2.33E-03	2.21E-03
Ecotoxicity, freshwater	CTUe	7.58E+00	8.02E+00	8.24E+00	7.99E+00	7.82E+00
Water use	m3 depriv.	5.00E-02	3.73E-02	4.15E-02	7.71E-02	8.01E-02
Resource use, fossils	MJ	3.56E+00	3.17E+00	2.47E+00	3.15E+00	2.84E+00
Resource use, minerals and metals	kg Sb eq	1.67E-05	1.70E-05	1.67E-05	1.66E-05	1.67E-05

Impact Category	Unit	NO	PT	SK	SE	UK
Climate change	kg CO2 eq	1.07E-01	1.83E-01	2.06E-01	1.13E-01	1.79E-01
Ozone depletion	kg CFC11 eq	1.00E-08	1.38E-08	1.82E-08	1.47E-08	1.75E-08
Ionising radiation	kBq U-235 eq	2.28E-02	2.57E-02	9.25E-02	1.04E-01	8.17E-02
Photochemical ozone formation	kg NMVOC eq	4.85E-04	7.40E-04	7.22E-04	5.04E-04	6.33E-04
Particulate matter	disease inc.	8.48E-09	9.84E-09	1.07E-08	8.88E-09	9.31E-09
Human toxicity, non-cancer	CTUh	7.50E-09	8.13E-09	8.43E-09	7.60E-09	8.01E-09
Human toxicity, cancer	CTUh	2.67E-10	2.81E-10	2.92E-10	2.71E-10	2.78E-10
Acidification	mol H+ eq	9.75E-04	1.61E-03	1.67E-03	1.00E-03	1.23E-03
Eutrophication, freshwater	kg P eq	1.13E-04	1.42E-04	2.51E-04	1.16E-04	1.28E-04
Eutrophication, marine	kg N eq	1.32E-04	2.21E-04	2.38E-04	1.42E-04	1.87E-04
Eutrophication, terrestrial	mol N eq	1.42E-03	2.35E-03	2.27E-03	1.51E-03	2.00E-03
Ecotoxicity, freshwater	CTUe	7.02E+00	8.13E+00	7.99E+00	7.35E+00	7.91E+00
Water use	m3 depriv.	3.63E-02	7.38E-02	5.69E-02	4.62E-02	3.47E-02
Resource use, fossils	MJ	1.67E+00	2.61E+00	3.89E+00	2.79E+00	3.47E+00
Resource use, minerals and metals	kg Sb eq	1.64E-05	1.66E-05	1.69E-05	1.65E-05	1.67E-05

E-buses



This dataset describes a journey of 1 km for 1 passenger in an electric city bus. The dataset is parametrised with respect to the mass of the vehicle, the mass of the battery and the lifetime of the vehicle and the lifetime of the battery. This dataset combines the electric passenger inventory (the mentioned LMO battery) with a modified passenger coach inventory taken from Ecoinvent v3. Taking a full diesel coach weight of 11000 kg, we estimated a full bus weight of 10696 kg and an empty bus (without battery and without engine) of 8991 kg. The size of the electric engine has been extrapolated from that of the e-car, which is 53 kg for the latter and 472 kg for the former. An average life expectancy of 1 Mkm was assumed for the bus and an average EU passenger load of 30 persons per trip was considered for all countries (Steer Davies Gleave, 2016).

The dataset of "Operation, trolleybus (CH)" was also used to derive the non-combustion emissions from tyre and brake wear, as well as for the consumption estimate of electricity (3.04 kWh/km), which was then distributed among the passenger load.

Impact Category	Unit	BE	DE	DK	ES	IT
Climate change	kg CO2 eq	3.42E-02	6.83E-02	4.33E-02	4.32E-02	5.22E-02
Ozone depletion	kg CFC11 eq	7.00E-09	4.07E-09	2.94E-09	5.48E-09	7.61E-09
Ionising radiation	kBq U-235 eq	4.14E-02	1.24E-02	7.22E-03	2.61E-02	7.33E-03
Photochemical ozone formation	kg NMVOC eq	1.07E-04	1.45E-04	1.36E-04	1.98E-04	1.65E-04
Particulate matter	disease inc.	3.16E-09	3.42E-09	3.41E-09	3.50E-09	3.63E-09
Human toxicity, non-cancer	CTUh	1.17E-09	1.48E-09	1.35E-09	1.40E-09	1.28E-09
Human toxicity, cancer	CTUh	3.62E-11	4.11E-11	4.02E-11	4.19E-11	4.00E-11
Acidification	mol H+ eq	1.64E-04	2.71E-04	2.37E-04	4.06E-04	3.33E-04
Eutrophication, freshwater	kg P eq	1.55E-05	9.27E-05	3.36E-05	2.34E-05	2.13E-05
Eutrophication, marine	kg N eq	3.16E-05	5.94E-05	4.37E-05	6.29E-05	4.83E-05
Eutrophication, terrestrial	mol N eq	3.31E-04	5.89E-04	5.00E-04	6.64E-04	6.03E-04
Ecotoxicity, freshwater	CTUe	1.17E+00	1.40E+00	1.51E+00	1.38E+00	1.29E+00
Water use	m3 depriv.	1.17E-02	5.29E-03	7.42E-03	2.55E-02	2.71E-02
Resource use, fossils	MJ	1.16E+00	9.64E-01	6.11E-01	9.56E-01	7.98E-01
Resource use, minerals and metals	kg Sb eq	1.29E-06	1.49E-06	1.30E-06	1.28E-06	1.33E-06

Impact Category	Unit	NO	PT	SK	SE	UK
Climate change	kg CO2 eq	1.15E-02	5.02E-02	6.17E-02	1.46E-02	4.82E-02
Ozone depletion	kg CFC11 eq	1.95E-09	3.87E-09	6.11E-09	4.30E-09	5.76E-09
Ionising radiation	kBq U-235 eq	3.34E-03	4.77E-03	3.88E-02	4.45E-02	3.33E-02
Photochemical ozone formation	kg NMVOC eq	7.39E-05	2.04E-04	1.95E-04	8.38E-05	1.49E-04
Particulate matter	disease inc.	2.86E-09	3.55E-09	3.97E-09	3.06E-09	3.28E-09
Human toxicity, non-cancer	CTUh	1.05E-09	1.37E-09	1.53E-09	1.11E-09	1.31E-09
Human toxicity, cancer	CTUh	3.30E-11	4.00E-11	4.56E-11	3.49E-11	3.86E-11
Acidification	mol H+ eq	1.20E-04	4.44E-04	4.76E-04	1.35E-04	2.52E-04
Eutrophication, freshwater	kg P eq	1.12E-05	2.60E-05	8.14E-05	1.27E-05	1.87E-05
Eutrophication, marine	kg N eq	1.83E-05	6.35E-05	7.25E-05	2.36E-05	4.61E-05
Eutrophication, terrestrial	mol N eq	2.01E-04	6.77E-04	6.37E-04	2.49E-04	5.00E-04
Ecotoxicity, freshwater	CTUe	8.85E-01	1.45E+00	1.38E+00	1.06E+00	1.34E+00
Water use	m3 depriv.	4.76E-03	2.39E-02	1.53E-02	9.83E-03	3.98E-03
Resource use, fossils	MJ	2.04E-01	6.80E-01	1.33E+00	7.74E-01	1.12E+00
Resource use, minerals and metals	kg Sb eq	1.18E-06	1.26E-06	1.41E-06	1.21E-06	1.29E-06

Consortium

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