ESU-services

fair consulting in sustainability

# Life Cycle Assessment of Battery Electric Vehicles and Concept Cars

Implemented in ecoinvent data v2.2 (2010)


## Authors

Marianne Leuenberger

Rolf Frischknecht

ESU-services Ltd.


Uster, June 2010 Report


ESU-services Ltd.
Rolf Frischknecht
Niels Jungbluth
Sybille Büsser
Marianne Leuenberger
Matthias Stucki
www.esu-services.ch

Kanzleistrasse 4
T +41 44 940 61 91
T +41 44 940 61 32
T +41 44 940 61 35
T +41 44 940 61 38
T +41 44 940 67 94
F +41 44 940 61 94

CH - 8610 Uster
frischknecht@esu-services.ch
jungbluth@esu-services.ch
buesser@esu-services.ch
leuenberger@esu-services.ch
stucki@esu-services.ch

## Imprint

| | |
|---|---|
| Title | Life Cycle Assessment of Battery Electric Vehicles and Concept Cars |
| Authors | Marianne Leuenberger, Rolf Frischknecht |
| | ESU-services Ltd., fair consulting in sustainability<br>Kanzleistr. 4, CH-8610 Uster<br>www.esu-services.ch<br>Phone +41 44 940 61 91, Fax +41 44 940 61 94<br>email: frischknecht@esu-services.ch |
| Copyright | ESU-services Ltd. owns the life cycle inventory data shown in this study. |
| Liability Statement | Information contained herein have been compiled or arrived from sources believed to be reliable. Nevertheless, the authors or their organizations do not accept liability for any loss or damage arising from the use thereof. Using the given information is strictly your own responsibility. |
| Version | BEV_ecoinvent_report_v1.0.doc, 30 June 2010 09:11 |

# Summary

Battery electric vehicles (BEV) are seen as a part of future fossil fuel independent mobility. With the recent achievements in lithium-ion battery technology for vehicle application, operating range and driving attitudes of battery electric vehicles begin to meet the needs of passenger car users. The car industry is about to release several battery electric vehicles from serial production to competitive conditions. Two types of electric vehicles are assessed:

- Passenger car BEV ($LiMn_2O_4$ batteries), equipped with current technology, size comparable to a VW Golf, electricity consumption: 20kWh/100km. The energy density is 130 Wh/kg battery cell and 100 Wh/kg in a battery pack (Gauch et al. 2009)
- Light weight passenger car BEV ($LiMn_2O_4$ batteries), comparable to small city concept car, electricity consumption: 7kWh/100km

The light weight vehicle represents a near-future concept car, with more efficient Lithium-ion batteries, with an energy density of 150 Wh/kg battery cells. In order to compare the electric concept car with a fuel based concept car, a third data set is established:

- Light weight passenger car, diesel ICE; comparable to small city concept car, 2 litres/100km

This chapter about the BEV and the concept cars establishes data sets in order to compare transport by BEV and concept cars with other means of transport. For this purpose, the following life cycle inventories are needed:

- LCI of BEV/concept car manufacture
- LCI of BEV/concept car maintenance
- LCI of BEV/concept car disposal
- LCI of BEV/concept car operation
- LCI of transport by BEV/concept car

The data on transport by these vehicles is derived from the life cycle inventories of transport by passenger car. A special focus is put on the influence of the electricity mix used for battery charging.

# Abbreviations and Glossary

| | |
|---|---|
| BEV | Battery electric vehicle |
| LiIo | Lithium-ion |

# Contents

# 1 Battery electric vehicles and future concept cars

Author: Marianne Leuenberger, Rolf Frischknecht, ESU-services, Uster
Review: Christian Bauer, PSI
Last changes: 2010

## 1.1 Introduction

In this section the life cycle inventory of battery electric vehicles (BEV) with a $LiMn_2O_4$ battery pack and a near-future concept diesel car is established. As the electricity production for BEV operation has a major influence on the environmental impacts, the LCA is carried out for electricity consumption from the Swiss grid and from certified sources in Switzerland. These electricity mixes are different regarding the shares of electricity from fossil, nuclear, hydroelectric and other power plants. The passenger car data are extrapolated from existing data sets from the ecoinvent data v2.01.

The assumptions and changes applied to existing ecoinvent data sets are described in detail in the following sections. Firstly, the LCI of transportation by passenger cars is specified. Furthermore, the adjustment for vehicle operation of electric vehicles, which includes energy demand per kilometre and emissions to air, is outlined. The LCI of conventional car manufacturing is adapted to better represent the BEV manufacture. The assumptions taken for the electric motor of electric vehicles are described in Section 1.9.

## 1.2 Characterisation of battery electric vehicles and concept cars

The LCI of the battery electric vehicles and the concept cars includes the manufacturing process of car production, car operation and road maintenance. The functional unit of this study is the transport of one person on one kilometre (1 pkm) by passenger car (transport, passenger car) (see Tab. 1.1).

**Tab. 1.1: Components, activities and corresponding data sets related to electric vehicles**

| Components, activities | Name of data set |
|---|---|
| Electric motor used in electric vehicles, per kg | electric motor, electric vehicle, at plant |
| Production of a passenger BEV, per piece | passenger car, electric, LiMn2O4, at plant |
| Production of a light weight BEV, per piece | passenger car, electric, LiMn2O4, city car, at plant |
| Maintenance of a passenger BEV, per piece | maintenance, passenger car, electric, LiMn2O4 |
| Maintenance of a light weight BEV, per piece | maintenance, passenger car, electric, city car, LiMn2O4 |
| Disposal of a passenger BEV, per piece | disposal, passenger car, electric, LiMn2O4 |
| Disposal of a light weight BEV, per piece | disposal, passenger car, electric, city car, LiMn2O4 |
| Operation of a passenger BEV, per km | operation, passenger car, electric, LiMn2O4 |
| Operation of a passenger BEV with certified electricity, per km | operation, passenger car, electric, LiMn2O4, certified electricity |
| Operation of passenger car BEV, CityCar, per km | operation, passenger car, electric, LiMn2O4, city car |
| Operation of passenger car BEV, CityCar, with certified electricity | operation, passenger car, electric, LiMn2O4, city car, certified electricity |
| Transport of one person in a BEV with Swiss electricity mix, per pkm | transport, passenger car, electric, LiMn2O4 |
| Transport of one person in a BEV with certified electricity, per pkm | transport, passenger car, electric, LiMn2O4, certified electricity |
| Transport of one person in a BEV, CityCar, with Swiss electricity mix, per pkm | transport, passenger car, electric, LiMn2O4, city car, |
| Transport of one person in a BEV, CityCar, with certified electricity, per pkm | transport, passenger car, electric, LiMn2O4, city car, certified electricity |

The diesel fuelled concept car requires the establishment of similar data sets as the electric concept car. The data sets described in this report are listed in Tab. 1.2.

**Tab. 1.2: Components, activities and corresponding data sets related to the diesel concept car**

| Components, activities | Name of data set |
|---|---|
| Production of a light weight diesel car, per piece | passenger car, city car, diesel, EURO5, at plant |
| Maintenance of a light weight diesel car, per piece | maintenance, passenger car, diesel, EURO5, city car |
| Disposal of a light weight diesel car, per piece | disposal, passenger car, diesel, EURO5, city car |
| Operation of a light weight diesel car, per km | operation, passenger car, diesel, EURO5, city car |
| Transport of one person in a light weight diesel car, per pkm | transport, passenger car, diesel, EURO5, city car |

The inventory of one BEV reflects the current technology of available electric vehicles in the compact size class. The concept car on the other hand represents small and light weight BEV with a more efficient battery technology and a body structure optimized towards low weight. In both cases, the battery pack consists of Lithium-ion cells, containing a LiMn2O4 cathode and a graphite anode. Data set refers to the ecoinvent data set for a Lithium-ion battery (Hischier et al. 2007, Gauch et al. 2009). The electricity consumption of the current BEV is assumed to be 20 kWh per 100 km, the concept city car consumes 7 kWh per 100km (Loremo 2010). Further properties are outlined in Tab. 1.3 and described in detail the following sections.

**Tab. 1.3: Overview of the data used for the life cycle inventories of BEVs and diesel concept car**

| Property | Unit | Current BEV | City carBEV[1] | Diesel city car[2] | Source |
|---|---|---|---|---|---|
| Total vehicle weight | kg | 1632 | 650 | 550 | Spielmann et al. 2007, Loremo 2010 |
| Net vehicle weight[3] | kg | 1320 | 480 | 550 | Own calculation, Loremo 2010 |
| Battery weight (LiIo) | kg | 312 | 100 | - | Own calculation, Assumption |
| Energy density $LiMn_2O_4$/graphite cell | Wh/kg | 130 | 150 | - | Gauch et al. 2009, Assumption |
| Operating distance | km | 133 | 143 | - | Assumption, Calculation |
| Electric motor weight | kg | 104 | 70 | - | Toyota 2009, Assumption |
| Life expectancy | km | 150000 | 150000 | 150000 | Spielmann et al. 2007, Assumption |
| Electricity consumption per 100 km | kWh | 20 | 7 | - | Assumption, Loremo 2010 |
| Diesel consumption per 100 km | litres | - | - | 2.0 | Loremo 2010 |
| Capacity utilisation | per-sons | 1.6 | 1.6 | 1.6 | Spielmann et al. 2007 |

## 1.3 Main Data Sources

The main data source for the LCI of transport by passenger car is the ecoinvent data v2.01 (ecoinvent Centre 2007), including the changes described in the ecoinvent report No. 14 (Spielmann et al. 2007). The ecoinvent database contains data on passenger car production, operation and transport for different types of fossil fuelled passenger cars. The new data sets of BEV and the concept cars are derived from these data sets. Specific LCI data on BEV and the concept cars are obtained from manufacturers factsheets, e.g. battery weight and energy consumption.

## 1.4 Life cycle inventories of transport by battery electric vehicle

### 1.4.1 Current technology BEV

The transport data set is expressed in person kilometres. It includes the operation of the vehicle per kilometre, the average number of persons transported on this kilometre, the infrastructure use and the maintenance of the vehicle.

The operating grade (1.6 persons per car), the life expectancy and maintenance of BEV are considered equal to those of conventional cars modelled in the ecoinvent datasets on passenger car transport (Spielmann et al. 2007) (see Tab. 1.4). Therefore, the input values for vehicle operation, passenger car use and maintenance as well as the disposal of the vehicle are identical for BEV and conventional passenger cars. Specific changes apply in the datasets of operation, vehicle manufacture, maintenance and disposal. Furthermore, the road use intensity increases with the vehicle weight. The share of road infrastructure provision, maintenance and disposal is therefore extrapolated according to the total vehicle weight of 1632 kg.

[1] retrieved from: http://www.loremo.com/02der02_varianten.htm, 2010-01-18

[2] retrieved from: http://www.loremo.com/02der02_varianten.htm, 2010-01-18

[3] Net weight: vehicle weight without battery pack and electric motor

**Tab. 1.4: Unit process raw data of transport by current technology BEV operated in Switzerland**

| | Name | Location | InfrastructurePr | Unit | transport, passenger car, electric, LiMn2O4, certified electricity | transport, passenger car, electric, LiMn2O4 | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | CH | | | |
| | InfrastructureProcess | | | | 0 | 0 | | | |
| | Unit | | | | pkm | pkm | | | |
| | transport, passenger car, electric, LiMn2O4, certified electricity | CH | 0 | pkm | 1 | 0 | | | |
| | transport, passenger car, electric, LiMn2O4 | CH | 0 | pkm | 0 | 1 | | | |
| output technosphere | operation, passenger car, electric, LiMn2O4, certified electricity | CH | 0 | km | 6.25E-1 | 0 | 1 | 2.02 | (2,1,2,1,1,4); calculated according to passenger car in ecoinvent report Nr.14 |
| output technosphere | operation, passenger car, electric, LiMn2O4 | CH | 0 | km | 0 | 6.25E-1 | 1 | 2.02 | (2,1,2,1,1,4); calculated according to passenger car in ecoinvent report Nr.14 |
| output technosphere | passenger car, electric, LiMn2O4, at plant | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 1.30 | (4,5,na,na,na,na); calculated according to passenger car in ecoinvent report Nr.14 |
| output technosphere | maintenance, electric vehicle, LiMn2O4 | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 3.09 | (4,5,na,na,na,na); calculated according to passenger car in ecoinvent report Nr.14 |
| output technosphere | road | CH | 1 | ma | 4.89E-4 | 4.89E-4 | 1 | 3.06 | (2,4,1,1,1,5); calculated according to passenger car in ecoinvent report Nr.14 |
| | operation, maintenance, road | CH | 1 | ma | 8.87E-4 | 8.87E-4 | 1 | 3.06 | (2,4,1,1,1,5); calculated according to passenger car in ecoinvent report Nr.14 |
| output technosphere | disposal, electric vehicle, LiMn2O4 | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 3.06 | (2,4,1,1,1,5); calculated according to passenger car in ecoinvent report Nr.14 |
| | disposal, road | RER | 1 | ma | 4.89E-4 | 4.89E-4 | 1 | 3.06 | (2,4,1,1,1,5); calculated according to passenger car in ecoinvent report Nr.14 |

### 1.4.2 Light weight BEV (concept car)

For the transport by light weight electric vehicles, the values for road infrastructure use are adapted to the lower vehicle weight. The infrastructure use is extrapolated applying the weight ratio of the total weight of the two vehicle types. The other parameters are identical to the other passenger car data sets (see Tab. 1.5).

**Tab. 1.5: Unit process raw data of transport by light weight electric vehicle operated in Switzerland**

| | Name | Location | InfrastructurePr | Unit | transport, passenger car, electric, LiMn2O4, city car | transport, passenger car, electric, LiMn2O4, city car, certified electricity | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | CH | | | |
| | InfrastructureProcess | | | | 0 | 0 | | | |
| | Unit | | | | pkm | pkm | | | |
| | transport, passenger car, electric, LiMn2O4, city car | CH | 0 | pkm | 1 | 0 | | | |
| | transport, passenger car, electric, LiMn2O4, city car, certified electricity | CH | 0 | pkm | 0 | 1 | | | |
| output technosphere | operation, passenger car, electric, LiMn2O4, city car | CH | 0 | km | 6.25E-1 | 0 | 1 | 2.02 | (2,1,2,1,1,4); Identical to transport passenger car in ecoinvent report no.14 |
| output technosphere | operation, passenger car, electric, LiMn2O4, city car, certified electricity | CH | 0 | km | 0 | 6.25E-1 | 1 | 2.02 | (2,1,2,1,1,4); Identical to transport passenger car in ecoinvent report no.14 |
| output technosphere | passenger car, electric, LiMn2O4, city car, at plant | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 3.06 | (2,4,1,1,1,5); Identical to transport passenger car in ecoinvent report no.14 |
| output technosphere | maintenance, passenger car, electric, LiMn2O4, city car | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 3.06 | (2,4,1,1,1,5); Identical to transport passenger car in ecoinvent report no.14 |
| output technosphere | road | CH | 1 | ma | 1.91E-4 | 1.91E-4 | 1 | 3.06 | (2,4,1,1,1,5); Extrapolated from passeger car (ecoinvent report no.14) according to weight ratio |
| | operation, maintenance, road | CH | 1 | ma | 3.46E-4 | 3.46E-4 | 1 | 3.06 | (2,4,1,1,1,5); Extrapolated from passeger car (ecoinvent report no.14) according to weight ratio |
| output technosphere | disposal, passenger car, electric, LiMn2O4, city car | RER | 1 | unit | 4.17E-6 | 4.17E-6 | 1 | 3.06 | (2,4,1,1,1,5); Identical to transport passenger car in ecoinvent report no.14 |
| | disposal, road | RER | 1 | ma | 1.91E-4 | 1.91E-4 | 1 | 3.06 | (2,4,1,1,1,5); Extrapolated from passeger car (ecoinvent report no.14) according to weight ratio |

## 1.5 Life cycle inventories of battery electric vehicle operation

### 1.5.1 Current technology BEV

The vehicle operation of BEV differs from the conventional cars in several respects. Firstly, the energy source for operation is electricity instead of petrol or diesel. Due to this, there are no tail-pipe emissions. We assume that emissions are limited to tyre and brake wear and abrasion from road surface. These values are calculated using the data available in the ecoinvent report (see Tab. 1.6 and Tab.

1.7) (Spielmann et al. 2007). All three origins of emissions are summarized. The emissions of heavy metals are calculated by subtracting the fuel based particle emissions into the air from the overall heavy metal emissions of an average diesel passenger car. Emissions to soil and water manly arise from abrasion, tyre wear and brake wear. These emissions depend on the vehicle weight. As the vehicle weight of the current technology BEV is the same as of the ICE passenger car, the values are assumed to be identical.

The electricity consumption of the current technology BEV is set to 20 kWh/100km (INL 2009) and to 7 kWh/100km for the light weight electric vehicle (Loremo 2010). A literature study showed that the energy consumption of current BEV differs widely. Smaller cars consume only 10 kWh/100km, whereas heavier or more recently launched cars need between 12 and 20 kWh/100km (e'mobile 2009a; 2009b; 2009c). Recent field test reveal substantially higher electricity consumption values compared to the manufacturer information (xxx Präsentationen FH Luzern)

**Tab. 1.6: Emissions of particulate matter due to tyre and brake wear and abrasion from road surface, according to ecoinvent report Nr. 14 (Spielmann et al. 2007)**

| Category | Unit | Tyre Wear | Brake Wear | Road Surface | Total |
|---|---|---|---|---|---|
| **PM < 2.5** | mg/vkm | 2.7 | 3.1 | 2 | **7.8** |
| **PM 2.5 - 10** | mg/vkm | 3.7 | 4.3 | 5 | **13** |
| **PM > 10** | mg/vkm | 4.3 | 0.2 | 7.5 | **12** |

**Tab. 1.7: Emissions to air of heavy metals due to tyre and brake wear and abrasion from road surface, according to ecoinvent report Nr. 14 (Spielmann et al. 2007)**

| kg/vkm | Total emissions | Ecoinvent, fuel based emissions | Difference (not fuel based emissions) |
|---|---|---|---|
| **Cadmium** | 7.07E-10 | 5.80E-10 | **1.27E-10** |
| **Copper** | 4.84E-07 | 3.10E-07 | **1.74E-07** |
| **Chromium** | 8.28E-09 | 2.90E-10 | **7.99E-09** |
| **Nickel** | 7.89E-09 | 4.10E-11 | **7.85E-09** |
| **Zinc** | 2.02E-07 | 2.90E-13 | **2.02E-07** |
| **Lead** | 2.46E-08 | 4.50E-21 | **2.46E-08** |

Two data sets are established in order to take into account different types of electricity mixes used for battery charging. Tab. 1.8 shows the data set using the Swiss electricity mix and “certified electricity”. The electricity input “certified electricity” is composed of electricity produced from certified renewable energy sources. The electricity mix is derived from actual statistical values provided by AEE (AEE 2009).

**Tab. 1.8: Unit process raw data of current technology BEV operation charged with Swiss electricity mix and with certified electricity**

| | Name | Location | InfrastructureProcess | Unit | operation, passenger car, electric, LiMn2O4 | operation, passenger car, electric, LiMn2O4, certified electricity | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|
| | Location | CH | 0 | km | CH | CH | | | |
| | InfrastructureProcess | 0 | | | 0 | 0 | | | |
| | Unit | km | | | km | km | | | |
| product | operation, passenger car, electric, LiMn2O4 | CH | 0 | km | 1 | 0 | | | |
| | operation, passenger car, electric, LiMn2O4, certified electricity | CH | 0 | km | 0 | 1 | | | |
| technosphere | electricity, low voltage, consumer mix, at grid | CH | 0 | kWh | 2.00E-1 | 0 | 1 | 1.12 | (1,3,1,1,1,4); factssheets BEVs |
| | electricity, low voltage, certified electricity, at grid | CH | 0 | kWh | 0 | 2.00E-1 | 1 | 1.12 | (1,3,1,1,1,4); factssheets BEVs |
| emission air, unspecified | Carbon dioxide, fossil | - | - | kg | 0 | 0 | 1 | 1.23 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Sulfur dioxide | - | - | kg | 0 | 0 | 1 | 1.23 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Cadmium | - | - | kg | 6.49E-10 | 6.49E-10 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, calculated from ecoinvent report no. 14 |
| | Copper | - | - | kg | 4.53E-7 | 4.53E-7 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, calculated from ecoinvent report no. 14 |
| | Chromium | - | - | kg | 8.25E-9 | 8.25E-9 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, calculated from ecoinvent report no. 14 |
| | Nickel | - | - | kg | 7.89E-9 | 7.89E-9 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, calculated from ecoinvent report no. 14 |
| | Zinc | - | - | kg | 2.02E-7 | 2.02E-7 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, calculated from ecoinvent report no. 14 |
| | Lead | - | - | kg | 2.46E-8 | 2.46E-8 | 1 | 5.06 | (2,3,2,1,3,1); abrasion, calculated from ecoinvent report no. 14 |
| | Selenium | - | - | kg | 0 | 0 | 1 | 5.27 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| | Mercury | - | - | kg | 0 | 0 | 1 | 5.27 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| | Chromium VI | - | - | kg | 0 | 0 | 1 | 5.27 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| | Carbon monoxide, fossil | - | - | kg | 0 | 0 | 1 | 5.06 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Nitrogen oxides | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Particulates, < 2.5 um | - | - | kg | 7.80E-6 | 7.80E-6 | 1 | 3.05 | (2,3,2,1,3,1); abrasion, calculated from ecoinvent report no. 14 |
| | Particulates, > 10 um | - | - | kg | 1.20E-5 | 1.20E-5 | 1 | 1.57 | (2,3,2,1,3,1); abrasion, calculated from ecoinvent report no. 14 |
| | Particulates, > 2.5 um, and < 10um | - | - | kg | 1.35E-5 | 1.35E-5 | 1 | 2.06 | (2,3,2,1,3,1); abrasion, calculated from ecoinvent report no. 14 |
| | NMVOC, non-methane volatile organic compounds, unspecified origin | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Methane, fossil | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Benzene | - | - | kg | 0 | 0 | 1 | 3.05 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Toluene | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Xylene | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Formaldehyde | - | - | kg | 0 | 0 | 1 | 1.79 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| | Acetaldehyde | - | - | kg | 0 | 0 | 1 | 1.79 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| | Ammonia | - | - | kg | 0 | 0 | 1 | 1.31 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | Dinitrogen monoxide | - | - | kg | 0 | 0 | 1 | 1.57 | (2,3,2,1,3,1); no combustion engine --> assumption zero emission |
| | PAH, polycyclic aromatic hydrocarbons | - | - | kg | 0 | 0 | 1 | 3.24 | (2,3,2,1,4,3); no combustion engine --> assumption zero emission |
| emission air, high population density | Heat, waste | - | - | MJ | 7.20E-1 | 7.20E-1 | 1 | 1.52 | (2,3,2,1,4,3); calculated from electricity consumption |
| emission water, unspecified | Zinc, ion | - | - | kg | 2.70E-7 | 2.70E-7 | 1 | 5.27 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Copper, ion | - | - | kg | 6.39E-9 | 6.39E-9 | 1 | 3.24 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Cadmium, ion | - | - | kg | 9.55E-11 | 9.55E-11 | 1 | 3.24 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Chromium, ion | - | - | kg | 4.55E-10 | 4.55E-10 | 1 | 3.24 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Nickel, ion | - | - | kg | 1.23E-9 | 1.23E-9 | 1 | 5.27 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Lead | - | - | kg | 3.93E-9 | 3.93E-9 | 1 | 5.27 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| emission soil, unspecified | Zinc | - | - | kg | 2.70E-7 | 2.70E-7 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| emission soil, agricultural | Copper | - | - | kg | 6.39E-9 | 6.39E-9 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| emission soil, unspecified | Cadmium | - | - | kg | 9.55E-11 | 9.55E-11 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Chromium | - | - | kg | 4.55E-10 | 4.55E-10 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Nickel | - | - | kg | 1.23E-9 | 1.23E-9 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |
| | Lead | - | - | kg | 3.93E-9 | 3.93E-9 | 1 | 1.79 | (2,3,2,1,4,3); identical to passenger car in ecoinvent report no.14 |

## 1.5.2 Light weight BEV (concept car)

The operation of the light weight BEV differs in two aspects. Firstly, the weight of the car is significantly lower. Secondly, electricity consumption per 100km is much lower and set to 7kWh (Loremo 2010). Thirdly, the emissions from break and tyre wear and abrasion are lower, too. They are extrapolated according to the weight ratio of the total vehicle weight (see Tab. 1.3). As for the current technology BEV, two operation data sets are established. One data set describes the operation using the Swiss electricity mix for battery charging. The second data set refers to battery charging with certified electricity (see Tab. 1.9).

**Tab. 1.9: Unit process raw data of light weight BEV operation charged with Swiss electricity mix and with certified electricity**

| | Name | Location | InfrastructurePr | Unit | operation, passenger car, electric, LiMn2O4, city car | operation, passenger car, electric, LiMn2O4, city car, certified electricity | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|
| | Location | CH | 0 | | CH | CH | | | |
| | InfrastructureProcess | | | | 0 | 0 | | | |
| | Unit | | | | km | km | | | |
| product | operation, passenger car, electric, LiMn2O4, city car | CH | 0 | km | 1 | 0 | | | |
| product | operation, passenger car, electric, LiMn2O4, city car, certified electricity | CH | 0 | km | 0 | 1 | | | |
| technosphere | electricity, low voltage, at grid | CH | 0 | kWh | 7.00E-2 | 0 | 1 | 1.12 | (1,3,1,1,1,4); 7kWh/100km |
| technosphere | electricity, low voltage, certified electricity, at grid | CH | 0 | kWh | 0 | 7.00E-2 | 1 | 1.12 | (1,3,1,1,1,4); 7kWh/100km |
| | Cadmium | - | - | kg | 6.26E-11 | 6.26E-11 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Copper | - | - | kg | 8.56E-8 | 8.56E-8 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Chromium | - | - | kg | 3.93E-9 | 3.93E-9 | 2 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Nickel | - | - | kg | 3.87E-9 | 3.87E-9 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Zinc | - | - | kg | 9.95E-8 | 9.95E-8 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Lead | - | - | kg | 1.21E-8 | 1.21E-8 | 1 | 5.06 | (2,3,2,1,3,1); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Particulates, < 2.5 um | - | - | kg | 3.84E-6 | 3.84E-6 | 1 | 3.05 | (2,3,2,1,3,1); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Particulates, > 10 um | - | - | kg | 5.91E-6 | 5.91E-6 | 1 | 1.57 | (2,3,2,1,3,1); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Particulates, > 2.5 um, and < 10um | - | - | kg | 6.65E-6 | 6.65E-6 | 1 | 2.06 | (2,3,2,1,3,1); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| emission air, high population density | Heat, waste | - | - | MJ | 1.36E+0 | 1.36E+0 | 1 | 1.52 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| emission water, unspecified | Zinc, ion | - | - | kg | 1.33E-7 | 1.33E-7 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Copper, ion | - | - | kg | 3.15E-9 | 3.15E-9 | 1 | 3.24 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Cadmium, ion | - | - | kg | 4.70E-11 | 4.70E-11 | 1 | 3.24 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Chromium, ion | - | - | kg | 2.24E-10 | 2.24E-10 | 1 | 3.24 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Nickel, ion | - | - | kg | 6.08E-10 | 6.08E-10 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Lead | - | - | kg | 1.94E-9 | 1.94E-9 | 1 | 5.27 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| emission soil, unspecified | Zinc | - | - | kg | 1.33E-7 | 1.33E-7 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| emission soil, agricultural | Copper | - | - | kg | 3.15E-9 | 3.15E-9 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| emission soil, unspecified | Cadmium | - | - | kg | 4.70E-11 | 4.70E-11 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Chromium | - | - | kg | 2.24E-10 | 2.24E-10 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Nickel | - | - | kg | 6.08E-10 | 6.08E-10 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |
| | Lead | - | - | kg | 1.94E-9 | 1.94E-9 | 1 | 1.79 | (2,3,2,1,4,3); abrasion, extrapolated from ecoinvent report Nr. 14 according to weight ratio of BEVs |

# 1.6 Life cycle inventory of battery electric vehicle manufacture

## 1.6.1 Current technology BEV

All types of passenger cars share similar basic equipment such as the chassis and the body. Consequently, the dataset of BEV manufacturing can be derived from the ecoinvent dataset of passenger car manufacture (Spielmann et al. 2007). On the other hand, BEVs neither need a fuel tank nor a fuel gas treatment (three-way catalyst). They contain an electric motor instead of an internal combustion engine and they need more (and different) battery capacity. Consequently, the tank, the motor, the lead acid battery and the catalyst are omitted and an electric motor and a battery pack are added to the data set.

According to Röder (2001), the specific weight of a tank is 0.55kg/ per litre capacity. We assume an average tank volume of 50 litres. This assumption leads to the material input outlined in Tab. 1.10. These amounts of aluminium and epoxy fibres are subtracted from the total amounts recorded in the original ecoinvent dataset of passenger car manufacture.

**Tab. 1.10: Material weight and composition of a fuel tank (Röder 2001)**

| Material | Percentage | Weight in a 27.5 kg tank |
|---|---|---|
| Aluminium | 36% | 9.9 kg |
| Epoxy fibres | 64% | 17.6 kg |

The weight of the electric motor is assumed to be equal to the electric motor used in a Toyota Prius. The composition of a combustion engine is roughly described in the LCI of a VW Golf. The main component is aluminium (42 kg), some parts are made of steel (15 kg) (Schweimer & Levin 2002). These values are subtracted from the total aluminium and total steel demand of the conventional car as modelled in the ecoinvent dataset v2.01.

Because no three-way catalyst is needed all inputs of platinum group metals are set to zero.

The battery electric vehicle needs a battery pack as energy storage. The battery weight is approximated using literature data (Schlüter in Rantik 1999). Schlüter calculated the weight of battery packs using the following formula:

$$m_b = \frac{m_{car}}{\frac{e_b}{c_{car} \times x_{cycle}} - 1}$$

**Tab. 1.11: Values used for the calculation of battery weights**

| Symbols/Explanation | | Unit | Current BEV | Source | City Car | Source |
|---|---|---|---|---|---|---|
| $m_b$ | Battery weight cells (+ pack) | kg | 240 (+ 72) | own calculation | 75 (+25) | assumption based on Loremo 2010 |
| $m_{car}$ | Car weight without battery | kg | 1320 | Spielmann et al. 2007 | 580 | Loremo 2010 |
| $e_b$ | Energy density of the battery cell | Wh/kg | 130 | Gauch et al. 2009 | 150 | assumption |
| $c_{car}$ | Energy consumption | Wh/kg*km | 0.15 | assumption | 0.12 | Loremo 2010 |
| $x_{cycle}$ | Operating range per charging cycle | km | 133 | assumption | 143 | calculation |

In comparison to other battery electric vehicles, using lithium manganese and other battery technologies, the battery weight of 312 kg lies above the range of batteries used in current BEVs. This is mainly due to operating range of the current BEV, which assumed to be 133 km. A Zebra battery weighs used in a Fiat Panda Elektra (999 kg total weight) and a Renault Twingo Quickshift Elektra (933 kg total weight) weighs 165 kg and 183kg, respectively. The Mitsubishi MIEV (1080 kg total weight) runs on a 165 kg Lithium-ion battery, which consists of 22 modules with 4 cells each (GS-Yuasa 2009). The Li-ion battery of the Tesla Roadster sports car weighs 450 kg (e'mobile 2009a; 2009b; 2009c). In the Opel Ampera we find a Lithium-ion battery of 175 kg (energy density 90 Wh/kg) (Vezzini 2009). Thus, the operation range assumed for a BEV is the main driver for high or low battery weights.

**Tab. 1.12: Weight of additional components used in a BEV**

| Material | Value | Source |
|---|---|---|
| Battery weight Li-ion | 312 kg | Assumption, based on factsheets of actual BEV and on literature |
| Weight electric motor | 104 kg | Factsheet Toyota Prius Toyota 2009 |

The Li-ion battery in the electric vehicles replaces the lead acid battery. The lead and sulphuric acid inputs are therefore set to zero. The data set of the $LiMn_2O_4$ battery is taken from the ecoinvent data set for Lithium-ion batteries (Hischier et al. 2007).

**Tab. 1.13: Unit process raw data of the production of a current technology BEV**

| | Name | Location | InfrastructureP | Unit | passenger car, electric, LiIo, at plant | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | passenger car, electric, LiIo, at plant | RER | 1 | unit | 1 | | | |
| | steel, low-alloyed, at plant | RER | 0 | kg | 8.40E+1 | 1 | 1.27 | (2,4,3,1,3,3); Input ecoinvent data set of passenger car (Spielmann et al. 2007) without 15 kg steel for ICE motor, No.14 Transport |
| | reinforcing steel, at plant | RER | 0 | kg | 8.31E+2 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | sheet rolling, steel | RER | 0 | kg | 5.41E+2 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | section bar rolling, steel | RER | 0 | kg | 2.03E+2 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | wire drawing, copper | RER | 0 | kg | 1.01E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | copper, at regional storage | RER | 0 | kg | 1.01E+1 | 2 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | chromium, at regional storage | RER | 0 | kg | 2.40E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | nickel, 99.5%, at plant | GLO | 0 | kg | 1.40E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 8.32E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | polypropylene, granulate, at plant | RER | 0 | kg | 4.90E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | polyvinylchloride, at regional storage | RER | 0 | kg | 1.60E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | synthetic rubber, at plant | RER | 0 | kg | 4.41E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | flat glass, uncoated, at plant | RER | 0 | kg | 3.01E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | alkyd paint, white, 60% in solvent, at plant | RER | 0 | kg | 4.16E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | zinc, primary, at regional storage | RER | 0 | kg | 5.89E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | natural gas, burned in industrial furnace >100kW | RER | 0 | MJ | 2.22E+3 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | electricity, medium voltage, production UCTE, at grid | UCTE | 0 | kWh | 2.14E+3 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | light fuel oil, burned in boiler 100kW, non-modulating | CH | 0 | MJ | 6.30E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | tap water, at user | RER | 0 | kg | 3.22E+3 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | ethylene, average, at plant | RER | 0 | kg | 1.85E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | ethylene glycol, at plant | RER | 0 | kg | 4.80E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | battery, LiIo, rechargeable, prismatic, at plant | GLO | 0 | kg | 3.12E+2 | 1 | 1.33 | (4,3,1,1,3,4); 312 kg in BEV (according to formula in Rantik 1999) |
| | electric motor, electric vehicle, at plant | RER | 0 | kg | 1.04E+2 | 1 | 1.33 | (4,3,1,1,3,4); 104kg in Toyota Prius |
| | transport, lorry >16t, fleet average | RER | 0 | tkm | 5.30E+1 | 1 | 2.09 | (4,5,na,na,na,na); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | transport, freight, rail | CH | 0 | tkm | 5.30E+2 | 1 | 2.09 | (4,5,na,na,na,na); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | road vehicle plant | RER | 1 | unit | 2.91E-7 | 1 | 3.25 | (5,4,3,1,1,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | NMVOC, non-methane volatile organic compounds, un | - | | kg | 4.80E+0 | 1 | 1.58 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| emission air, unspecified | Heat, waste | - | | MJ | 7.70E+3 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | COD, Chemical Oxygen Demand | - | | kg | 1.93E-1 | 1 | 1.58 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | BOD5, Biological Oxygen Demand | - | | kg | 2.60E-2 | 1 | 1.58 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | Phosphate | - | | kg | 1.00E-3 | 1 | 1.58 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |

### 1.6.2 Light weight BEV (concept car)

The life cycle inventory of the concept car is based on the data shown in Tab. 1.13. The differences for the light weight vehicle are outlined in Tab. 1.3. The input materials for all parts, with the exception of the electric motor and the battery, are extrapolated using the weight ratio of the net vehicle weight of the two BEV vehicle types. The battery and the electric motor weight are set to 104 kg and 70 kg, respectively (Loremo 2010). The light weight vehicle does not contain an air conditioning system. Consequently, the ethylene gycol input is omitted.

**Tab. 1.14: Unit process raw data of the production of a light weight BEV**

| | Name | Location | InfrastructureP | Unit | passenger car, electric, LiMn2O4, city car, at plant | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | passenger car, electric, LiMn2O4, city car, at plant | RER | 1 | unit | 1 | | | |
| | steel, low-alloyed, at plant | RER | 0 | kg | 4.59E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | reinforcing steel, at plant | RER | 0 | kg | 3.85E+2 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | sheet rolling, steel | RER | 0 | kg | 2.51E+2 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | section bar rolling, steel | RER | 0 | kg | 9.41E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | wire drawing, copper | RER | 0 | kg | 4.68E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | copper, at regional storage | RER | 0 | kg | 4.68E+0 | 2 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | chromium, at regional storage | RER | 0 | kg | 1.11E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | nickel, 99.5%, at plant | GLO | 0 | kg | 6.49E-1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 3.85E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | polypropylene, granulate, at plant | RER | 0 | kg | 2.27E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | polyvinylchloride, at regional storage | RER | 0 | kg | 7.41E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | synthetic rubber, at plant | RER | 0 | kg | 2.04E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | flat glass, uncoated, at plant | RER | 0 | kg | 1.39E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | alkyd paint, white, 60% in solvent, at plant | RER | 0 | kg | 1.93E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | zinc, primary, at regional storage | RER | 0 | kg | 2.73E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | heat, natural gas, at industrial furnace >100kW | RER | 0 | MJ | 1.03E+3 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | electricity, medium voltage, production UCTE, at grid | UCTE | 0 | kWh | 9.92E+2 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | light fuel oil, burned in boiler 100kW, non-modulating | CH | 0 | MJ | 2.92E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | tap water, at user | RER | 0 | kg | 1.49E+3 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | ethylene, average, at plant | RER | 0 | kg | 8.57E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | battery, LiIo, rechargeable, prismatic, at plant | GLO | 0 | kg | 1.00E+2 | 1 | 1.33 | (4,3,1,1,3,4); 100kg LiIo, according to Loremo CityCar |
| | electric motor, electric vehicle, at plant | RER | 0 | kg | 7.00E+1 | 1 | 1.33 | (4,3,1,1,3,4); 70kg estimation for Loremo CityCar |
| | transport, lorry >16t, fleet average | RER | 0 | tkm | 2.46E+1 | 1 | 2.09 | (4,5,na,na,na,na); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | transport, freight, rail | CH | 0 | tkm | 2.46E+2 | 1 | 2.09 | (4,5,na,na,na,na); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | road vehicle plant | RER | 1 | unit | 1.35E-7 | 1 | 3.25 | (5,4,3,1,1,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | NMVOC, non-methane volatile organic compounds, un | - | | kg | 2.22E+0 | 1 | 1.58 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| emission air, unspecified | Heat, waste | - | | MJ | 3.57E+3 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | COD, Chemical Oxygen Demand | - | | kg | 8.94E-2 | 1 | 1.58 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | BOD5, Biological Oxygen Demand | - | | kg | 1.20E-2 | 1 | 1.58 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |
| | Phosphate | - | | kg | 4.63E-4 | 1 | 1.58 | (2,4,3,1,3,3); Extrapolated from ecoinvent data set of passenger car (Spielmann et al. 2007), no.14 Transport, weight ratio |

# 1.7 Life cycle inventory of battery electric vehicle maintenance

## 1.7.1 Current technology BEV

Lithium ion battery packs for electric vehicles were recently introduced in the market, so that producers and scientists have only little experience with the life expectancy of LiIo batteries in BEV. According to laboratory testing, LiIo batteries may have a life span of 150'000 km. Under real traffic conditions these values might be overrated. Nissan states a lifespan of five years and a decrease of mileage to 80% after six years for 80% of the battery used in the Nissan Leaf (Nissan 2009). Experience with electric scooters showed, the actual life expectancy of battery packs is about half of the potential life expectancy. Therefore, we assume that the battery is replaced once in the lifetime of a vehicle, which is set to 150'000 km (Bossche et al. 2005). The dataset maintenance bases on the ecoinvent dataset of passenger car maintenance. For all replaced materials the input variables are assumed to be identical.

**Tab. 1.15: Unit process raw data of electric vehicle maintenance, current technology BEV**

| | Name<br>Location<br>InfrastructureProcess<br>Unit | Location | InfrastructureP | Unit | maintenance, electric vehicle, LiMn2O4<br>RER<br>1<br>unit | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| product | maintenance, electric vehicle, LiMn2O4 | RER | 1 | unit | 1 | | | |
| technosphere | steel, low-alloyed, at plant | RER | 0 | kg | 1.10E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | copper, at regional storage | RER | 0 | kg | 3.00E-1 | 2 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 5.00E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | polypropylene, granulate, at plant | RER | 0 | kg | 6.00E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | synthetic rubber, at plant | RER | 0 | kg | 1.16E+2 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | electricity, medium voltage, production UCTE, at grid | UCTE | 0 | kWh | 5.83E+2 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | ethylene, average, at plant | RER | 0 | kg | 3.80E+1 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | ethylene glycol, at plant | RER | 0 | kg | 2.00E+0 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | battery, LiIo, rechargeable, prismatic, at plant | GLO | 0 | kg | 3.12E+2 | 1 | 1.33 | (4,3,1,1,3,4); assumption: battery life 100000km --> one replacement per lifetime |
| | disposal, Li-ions batteries, mixed technology | GLO | 0 | kg | 3.12E+2 | 1 | 1.33 | (4,3,1,1,3,4); assumption: battery life 100000km -->312 kg batteries disposed |
| | transport, lorry >16t, fleet average | RER | 0 | tkm | 2.96E+1 | 1 | 2.09 | (4,5,na,na,na,na); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| | transport, freight, rail | CH | 0 | tkm | 5.93E+1 | 1 | 2.09 | (4,5,na,na,na,na); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |
| emission air, unspecified | Heat, waste | - | | MJ | 2.10E+3 | 1 | 1.27 | (2,4,3,1,3,3); Identical to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport |

## 1.7.2 Light weight BEV (concept car)

In contrast to the maintenance of the current technology BEV, the battery of the concept car is assumed to last for the entire life expectancy of the vehicle (150'000 km). Therefore, no replacement of the battery is therefore not accounted for in this data set. The other material inputs are extrapolated from the data set of the maintenance of the current technology BEV, using the vehicle weight without

battery as extrapolation factor. The vehicle weights without battery are 1140 kg for the current technology BEV and 550 kg for the concept car.

**Tab. 1.16: Unit process raw data of electric vehicle maintenance, light weight BEV (concept car)**

| | Name | Location | InfrastructureProc | Unit | maintenance, passenger car, electric, LiMn2O4, city car | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | maintenance, passenger car, electric, LiMn2O4, city car | RER | 1 | unit | 1 | | | |
| technosphere | steel, low-alloyed, at plant | RER | 0 | kg | 5.31E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | copper, at regional storage | RER | 0 | kg | 1.45E-1 | 2 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 2.41E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | polypropylene, granulate, at plant | RER | 0 | kg | 2.89E+0 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | synthetic rubber, at plant | RER | 0 | kg | 5.60E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | electricity, medium voltage, production UCTE, at grid | UCTE | 0 | kWh | 2.81E+2 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | ethylene, average, at plant | RER | 0 | kg | 1.83E+1 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | transport, lorry >16t, fleet average | RER | 0 | tkm | 1.43E+1 | 1 | 2.09 | (4,5,na,na,na,na); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| | transport, freight, rail | CH | 0 | tkm | 2.86E+1 | 1 | 2.09 | (4,5,na,na,na,na); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |
| emission air, unspecified | Heat, waste | - | | MJ | 1.01E+3 | 1 | 1.27 | (2,4,3,1,3,3); Extrapolated from to ecoinvent data set of passenger car (Spielmann et al. 2007), No.14 Transport: weight ratio |

# 1.8 Life cycle inventory of battery electric vehicle disposal

## 1.8.1 Current technology BEV

The BEV disposal is basically identical to the disposal of a conventional passenger car (Spielmann et al. 2007). The metal parts are mostly recycled, whereas plastics are incinerated. The waste treatment of the lithium ion battery is attributed to the battery electric vehicle disposal (see Tab. 1.17).

**Tab. 1.17: Unit process raw data of electric vehicle disposal, current technology BEV**

| | Name | Location | InfrastructureP | Unit | disposal, electric vehicle, LiMn2O4 | UncertaintyTyp e | StandardDevia tion95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | disposal, electric vehicle, LiMn2O4 | RER | 1 | unit | 1 | | | |
| technosphere | transport, lorry 20-28t, fleet average | CH | 0 | tkm | 3.26E+1 | 1 | 2.05 | (4,1,1,1,1,3); Indentical to disposal of passenger car in Spielmann et al. 2007, no.14 transports |
| | disposal, plastics, mixture, 15.3% water, to municipal incineration | CH | 0 | kg | 6.50E+1 | 1 | 1.31 | (4,1,1,1,3,3); Indentical to disposal of passenger car in Spielmann et al. 2007, no.14 transports |
| | disposal, glass, 0% water, to municipal incineration | CH | 0 | kg | 3.01E+1 | 1 | 1.22 | (2,1,1,1,3,3); Indentical to disposal of passenger car in Spielmann et al. 2007, no.14 transports |
| | disposal, emulsion paint remains, 0% water, to hazardous waste incineration | CH | 0 | kg | 1.00E+2 | 1 | 1.22 | (2,1,1,1,3,3); Indentical to disposal of passenger car in Spielmann et al. 2007, no.14 transports |
| | disposal, zinc in car shredder residue, 0% water, to municipal incineration | CH | 0 | kg | 5.89E+0 | 1 | 1.22 | (2,1,1,1,3,3); Indentical to disposal of passenger car in Spielmann et al. 2007, no.14 transports |
| | disposal, Li-ions batteries, mixed technology | GLO | 0 | kg | 3.12E+2 | 1 | 1.22 | (2,1,1,1,3,3); Disposal of Lithiumion battery 312kg |

## 1.8.2 Light weight BEV (concept car)

The disposal of the light weight BEV is extrapolated from the disposal of the current technology BEV car as described in section 1.8.1.The extrapolation bases on the weight ratio of the two cars: 1140 kg for the current technology BEV and 550 kg for the light weight BEV (see Tab. 1.18).

**Tab. 1.18: Unit process raw data of electric vehicle disposal, light weight BEV (concept car)**

| | Name | Location | InfrastructureP | Unit | disposal, passenger car, electric, Lilo, 7kWh/100km | UncertaintyTyp e | StandardDevia tion95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | disposal, passenger car, electric, Lilo, 7kWh/100km | RER | 1 | unit | 1 | | | |
| technosphere | transport, lorry 20-28t, fleet average | CH | 0 | tkm | 1.57E+1 | 1 | 2.05 | (4,1,1,1,1,3); Extrapolated from disposal of passenger car in Spielmann et al. 2007, no.14 transports according to weight ratio |
| | disposal, plastics, mixture, 15.3% water, to municipal incineration | CH | 0 | kg | 3.14E+1 | 1 | 1.31 | (4,1,1,1,3,3); Extrapolated from disposal of passenger car in Spielmann et al. 2007, no.14 transports according to weight ratio |
| | disposal, glass, 0% water, to municipal incineration | CH | 0 | kg | 1.45E+1 | 1 | 1.22 | (2,1,1,1,3,3); Extrapolated from disposal of passenger car in Spielmann et al. 2007, no.14 transports according to weight ratio |
| | disposal, emulsion paint remains, 0% water, to hazardous waste incineration | CH | 0 | kg | 4.82E+1 | 1 | 1.22 | (2,1,1,1,3,3); Extrapolated from disposal of passenger car in Spielmann et al. 2007, no.14 transports according to weight ratio |
| | disposal, zinc in car shredder residue, 0% water, to municipal incineration | CH | 0 | kg | 2.84E+0 | 1 | 1.22 | (2,1,1,1,3,3); Extrapolated from disposal of passenger car in Spielmann et al. 2007, no.14 transports according to weight ratio |
| | disposal, Li-ions batteries, mixed technology | GLO | 0 | kg | 1.00E+2 | 1 | 1.22 | (2,1,1,1,3,3); Disposal of Lithiumion battery |

# 1.9 Life cycle inventory of an electric motor

In his PhD thesis, (Röder 2001) provides a rough estimation of materials used in an electric motor in an electric vehicle. These data are adopted and extended by adding material processing. The main part of an electric motor consists of low alloyed steel and contains a smaller fraction of aluminium. Copper is used for the coil and wiring. Some metal processing is included in the data set.

**Tab. 1.19: Unit process raw data of electric motor production**

| | Name | Location | InfrastructureProcess | Unit | electric motor, electric vehicle, at plant | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 0 | | | |
| | Unit | | | | kg | | | |
| output | electric motor, electric vehicle, at plant | RER | 0 | kg | 1 | | | |
| input from technosphere | steel, low-alloyed, at plant | RER | 0 | kg | 7.50E-1 | 1 | 1.35 | (4,3,3,2,3,4); Roeder, 2001 |
| | aluminium, production mix, at plant | RER | 0 | kg | 1.65E-1 | 1 | 1.35 | (4,3,3,2,3,4); Roeder, 2001 |
| | copper, at regional storage | RER | 0 | kg | 9.00E-2 | 1 | 1.35 | (4,3,3,2,3,4); Roeder, 2001 |
| | sheet rolling, steel | RER | 0 | kg | 7.50E-1 | 1 | 1.35 | (4,3,3,2,3,4); assumption |
| | wire drawing, copper | RER | 0 | kg | 9.00E-2 | 1 | 1.35 | (4,3,3,2,3,4); assumption |

## 1.10 Life cycle inventories of transport by diesel concept cars

The diesel concept car is a small passenger car with a total weight of 550 kilograms (Loremo 2010). It offers four (2+2) seats, which is comparable to a small conventional passenger car. Consequently, the utilization of the vehicle is comparable to an average small passenger car and is set to 1.6 passengers. The life span of the vehicle is assumed to being identical to the one of a today's passenger car (150'000km). The road infrastructure use mainly depends on the vehicle weight. The values set for road infrastructure use, maintenance and disposal are extrapolated according to the weight ratio of the conventional passenger car (1320 kg) and the concept car (550 kg).

**Tab. 1.20: Unit process raw data of transport by a diesel concept car**

| | Name | Location | InfrastructureProcess | Unit | transport, passenger car, diesel, EURO5, 2lt/100km | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | InfrastructureProcess | | | | 0 | | | |
| | Unit | | | | pkm | | | |
| product | transport, passenger car, diesel, EURO5, 2lt/100km | CH | 0 | pkm | 1 | | | |
| technosphere | passenger car, diesel, EURO5, 2lt/100km, at plant | RER | 1 | unit | 4.19E-6 | 2 | 3.06 | (2,2,1,1,3,4,BU:3); Identical to passenger car, ecoinvent report no.14: life span 150'000km |
| | operation, passenger car, diesel, EURO5, 2lt/100km | CH | 0 | km | 6.29E-1 | 1 | 2.06 | (2,2,1,1,3,4,BU:2); Identical to passenger car, ecoinvent report no.14: 1.6 passengers |
| | maintenance, passenger car, diesel, EURO5, 2lt/100km | RER | 1 | unit | 4.19E-6 | 1 | 3.06 | (2,2,1,1,3,4,BU:3); Identical to passenger car, ecoinvent report no.14: life span 150'000km |
| | disposal, passenger car, diesel EURO5, 2lt/100km | RER | 1 | unit | 4.19E-6 | 1 | 3.06 | (2,2,1,1,3,4,BU:3); Identical to passenger car, ecoinvent report no.14: life span 150'000km |
| | road | CH | 1 | ma | 1.82E-4 | 1 | 3.06 | (2,2,1,1,3,4,BU:3); Extrapolated from passenger car, ecoinvent report no.14, according to weight ratio |
| | operation, maintenance, road | CH | 1 | ma | 3.08E-4 | 1 | 3.06 | (2,2,1,1,3,4,BU:3); Extrapolated from passenger car, ecoinvent report no.14, according to weight ratio |
| | disposal, road | RER | 1 | ma | 1.82E-4 | 1 | 3.06 | (2,2,1,1,3,4,BU:3); Extrapolated from passenger car, ecoinvent report no.14, according to weight ratio |

## 1.11 Life cycle inventories of diesel concept car operation

The fossil fuelled concept car is based on the same design like the electic car (see xxx). The diesel consumption of the concept car is set to 2 litres per 100 kilometres (Loremo 2010). In order to reflect state-of-the-art or near future technology, the emissions are modelled according to the actual emission standard EURO5. Fuel based emissions are extrapolated according to the fuel consumption of the EURO5 diesel passenger car and the diesel concept car. The emissions to soil and water from tyre and brake wear, as well as of road surface abrasion, are extrapolated according to the vehicle weight of the

two vehicles. The non-exhaust emissions to the air are subtracted from the exhaust emissions and further extrapolated according to the weight ratio of the vehicles (1320 kg to 550 kg). The standard fuel consumption of a EURO5 passenger car in ecoinvent (Spielmann et al. 2007) is 52.75 g diesel per kilometre. The concept car on the other hand consumes 16.6 g diesel per kilometre.

**Tab. 1.21: Values used for the calculation of the fuel dependent and not fuel dependent emission of Diesel car operation**

| Substance | Unit | Total (ecoinvent) | Fuel dependent (ecoinvent) | Not fuel dependent (calculated) | Fuel dependent emissions city car (extra-polated) | Not fuel dependent emissions city car (extra polated) | Total emssions (extra-polated) |
|---|---|---|---|---|---|---|---|
| PM >10um | kg/vkm | 7.82E-05 | 1.90E-07 | 7.80E-05 | 2.46E-05 | 3.25E-05 | **5.71E-05** |
| PM 2.5-10um | kg/vkm | 1.38E-05 | 3.71E-07 | 1.34E-05 | 4.22E-06 | 5.58E-06 | **9.80E-06** |
| PM <2.5um | kg/vkm | 1.11E-05 | 4.44E-06 | 6.70E-06 | 2.11E-06 | 2.79E-06 | **4.90E-06** |
| Cadmium | kg/vkm | 1.26E-09 | 5.27E-10 | 7.30E-10 | 2.30E-10 | 3.04E-10 | **5.34E-10** |
| Copper | kg/vkm | 1.01E-07 | 8.96E-08 | 1.10E-08 | 3.47E-09 | 4.59E-09 | **8.06E-09** |
| Chromium | kg/vkm | 9.19E-09 | 2.63E-09 | 6.56E-09 | 2.07E-09 | 2.73E-09 | **4.80E-09** |
| Nickel | kg/vkm | 9.52E-09 | 3.69E-09 | 5.84E-09 | 1.84E-09 | 2.43E-09 | **4.27E-09** |
| Selenium | kg/vkm | 5.28E-10 | 5.27E-10 | 5.00E-13 | 1.57E-13 | 2.08E-13 | **3.66E-13** |
| Zinc | kg/vkm | 6.38E-07 | 5.27E-08 | 5.85E-07 | 1.84E-07 | 2.44E-07 | **4.28E-07** |
| Lead | kg/vkm | 3.65E-09 | 5.80E-12 | 3.65E-09 | 1.15E-09 | 1.52E-09 | **2.67E-09** |
| Mercury | kg/vkm | 1.06E-12 | 1.05E-12 | 1.00E-15 | 3.15E-16 | 4.17E-16 | **7.32E-16** |
| Chromium VI | kg/vkm | 5.28E-12 | 5.27E-12 | 5.00E-15 | 1.57E-15 | 2.08E-15 | **3.66E-15** |

**Tab. 1.22: Unit process raw data of diesel concept car operation**

| | Name | Location | InfrastructureP | Unit | operation, passenger car, diesel, EURO5, city car | UncertaintyTyp e | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | InfrastructureProcess | | | | 0 | | | |
| | Unit | | | | km | | | |
| product | operation, passenger car, diesel, EURO5, city car | CH | 0 | km | 1 | | | |
| technosphere | diesel, low-sulphur, at regional storage | CH | 0 | kg | 1.66E-2 | 1 | 1.24 | (1,2,1,1,3,4,BU:1.05); Concept car: 2lt/100km (e.g. Loremo) |
| emission air, unspecified | Carbon dioxide, fossil | - | - | kg | 5.25E-2 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Sulfur dioxide | - | - | kg | 3.36E-7 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Cadmium | - | - | kg | 5.34E-10 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Copper | - | - | kg | 8.06E-9 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Chromium | - | - | kg | 4.80E-9 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Nickel | - | - | kg | 4.27E-9 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Zinc | - | - | kg | 4.28E-7 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Lead | - | - | kg | 2.67E-9 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Selenium | - | - | kg | 3.66E-13 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Mercury | - | - | kg | 7.32E-16 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Chromium VI | - | - | kg | 3.66E-15 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Carbon monoxide, fossil | - | - | kg | 1.60E-4 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Nitrogen oxides | - | - | kg | 6.29E-5 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Particulates, < 2.5 um | - | - | kg | 4.90E-6 | 1 | 3.06 | (2,2,2,1,3,4,BU:3); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Particulates, > 10 um | - | - | kg | 5.71E-5 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | Particulates, > 2.5 um, and < 10um | - | - | kg | 9.80E-6 | 1 | 2.07 | (2,2,2,1,3,4,BU:2); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption and vehicle weight |
| | NMVOC, non-methane volatile organic compounds, unspecified origin | - | - | kg | 3.41E-5 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Methane, fossil | - | - | kg | 8.60E-7 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Benzene | - | - | kg | 4.19E-7 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Toluene | - | - | kg | 1.15E-7 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Xylene | - | - | kg | 2.87E-7 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Ammonia | - | - | kg | 3.15E-7 | 1 | 1.33 | (2,2,2,1,3,4,BU:1.2); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | Dinitrogen monoxide | - | - | kg | 1.77E-6 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| | PAH, polycyclic aromatic hydrocarbons | - | - | kg | 2.20E-10 | 1 | 3.06 | (2,2,2,1,3,4,BU:3); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| emission air, high population density | Heat, waste | - | - | MJ | 7.54E-1 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to fuel consumption |
| emission water, unspecified | Zinc, ion | - | - | kg | 1.13E-7 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Copper, ion | - | - | kg | 2.66E-9 | 1 | 3.06 | (2,2,2,1,3,4,BU:3); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Cadmium, ion | - | - | kg | 3.98E-11 | 1 | 3.06 | (2,2,2,1,3,4,BU:3); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Chromium, ion | - | - | kg | 1.90E-10 | 1 | 3.06 | (2,2,2,1,3,4,BU:3); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Nickel, ion | - | - | kg | 5.13E-10 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Lead | - | - | kg | 2.67E-9 | 1 | 5.07 | (2,2,2,1,3,4,BU:5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| emission soil, unspecified | Zinc | - | - | kg | 4.28E-7 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| emission soil, agricultural | Copper | - | - | kg | 8.06E-9 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| emission soil, unspecified | Cadmium | - | - | kg | 5.34E-10 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Chromium | - | - | kg | 4.80E-9 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Nickel | - | - | kg | 4.27E-9 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |
| | Lead | - | - | kg | 2.67E-9 | 1 | 1.58 | (2,2,2,1,3,4,BU:1.5); Extrapolated from passenger car emissions EURO5, ecoinvent report no.14, according to vehicle weight |

## 1.12 Life cycle inventories of diesel concept car manufacture and maintenance

The data set of the concept car manufacture bases on the life cycle inventory of the standard passenger car modelled in ecoinvent (Spielmann et al. 2007). The total weight of the VW Golf represented in the ecoinvent data base is 1320 kg. The concept car has a total weight of 550 kg, which leads to an extrapolation factor of 0.417 for all input materials, processes and disposals. In contrast to the VW Golf, the diesel car has no three-way catalyst and no air conditioning system. Consequently, the precious metals (platinum and palladium) and the ethylene glycol are not included in the LCI of concept car manufacture.

The same assumptions are applied to the life cycle inventory of concept car maintenance. All values for the vehicle maintenance are extrapolated using the weight ratio as extrapolation factor (see Tab. 1.23).

**Tab. 1.23: Unit process raw data of diesel concept car manufacture and maintenance**

| | Name | Location | InfrastructureProcess | Unit | passenger car, diesel, EURO5, city car, at plant | maintenance, passenger car, diesel, EURO5, city car | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | RER | | | |
| | InfrastructureProcess | | | | 1 | 1 | | | |
| | Unit | | | | unit | unit | | | |
| product | passenger car, diesel, EURO5, city car, at plant | RER | 1 | unit | 1 | 0 | | | |
| | maintenance, passenger car, diesel, EURO5, city car | RER | 1 | unit | 0 | 1 | | | |
| technosphere | steel, low-alloyed, at plant | RER | 0 | kg | 4.13E+1 | 4.58E+0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | reinforcing steel, at plant | RER | 0 | kg | 3.71E+2 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | sheet rolling, steel | RER | 0 | kg | 2.25E+2 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | section bar rolling, steel | RER | 0 | kg | 8.46E+1 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | wire drawing, copper | RER | 0 | kg | 4.21E+0 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | copper, at regional storage | RER | 0 | kg | 4.21E+0 | 1.25E-1 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | chromium, at regional storage | RER | 0 | kg | 1.00E+0 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | nickel, 99.5%, at plant | GLO | 0 | kg | 5.83E-1 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 4.25E+1 | 2.08E+0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | polypropylene, granulate, at plant | RER | 0 | kg | 2.04E+1 | 2.50E+0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | polyvinylchloride, at regional storage | RER | 0 | kg | 6.67E+0 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | synthetic rubber, at plant | RER | 0 | kg | 1.84E+1 | 4.83E+1 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | flat glass, uncoated, at plant | RER | 0 | kg | 1.25E+1 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | alkyd paint, white, 60% in solvent, at plant | RER | 0 | kg | 1.73E+0 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | zinc, primary, at regional storage | RER | 0 | kg | 2.45E+0 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | natural gas, burned in industrial furnace >100kW | RER | 0 | MJ | 9.25E+2 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | electricity, low voltage, production UCTE, at grid | UCTE | 0 | kWh | 0 | 2.43E+2 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | electricity, medium voltage, production UCTE, at grid | UCTE | 0 | kWh | 8.92E+2 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | lead, at regional storage | RER | 0 | kg | 5.42E+0 | 1.04E+1 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | sulphuric acid, liquid, at plant | RER | 0 | kg | 3.33E-1 | 5.83E-1 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | aluminium, production mix, at plant | RER | 0 | kg | 2.16E+1 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | light fuel oil, burned in industrial furnace 1MW, non-modulating | RER | 0 | MJ | 2.63E+1 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | tap water, at user | RER | 0 | kg | 1.34E+3 | 0 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | ethylene, average, at plant | RER | 0 | kg | 7.71E+0 | 1.58E+1 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | transport, lorry >16t, fleet average | RER | 0 | tkm | 2.21E+1 | 1.23E+1 | 1 | 2.09 | (4,5,na,na,na,na,BU:2); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | transport, freight, rail | CH | 0 | tkm | 2.21E+2 | 2.47E+1 | 1 | 2.09 | (4,5,na,na,na,na,BU:2); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | road vehicle plant | RER | 1 | unit | 1.21E-7 | 0 | 1 | 3.07 | (2,3,2,1,3,4,BU:3); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| emission air, unspecified | NMVOC, non-methane volatile organic compounds, unspecified origin | - | - | kg | 2.00E+0 | 0 | 1 | 1.59 | (2,3,2,1,3,4,BU:1.5); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | Heat, waste | - | - | MJ | 3.21E+3 | 8.75E+2 | 1 | 1.25 | (2,3,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| emission water, unspecified | COD, Chemical Oxygen Demand | - | - | kg | 8.04E-2 | 0 | 1 | 1.59 | (2,3,2,1,3,4,BU:1.5); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | BOD5, Biological Oxygen Demand | - | - | kg | 1.08E-2 | 0 | 1 | 1.59 | (2,3,2,1,3,4,BU:1.5); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |
| | Phosphate | - | - | kg | 4.17E-4 | 0 | 1 | 1.59 | (2,3,2,1,3,4,BU:1.5); Extrapolated from passenger car, ecoinvent report no. 14, weight ratio |

## 1.13 Life cycle inventories of diesel concept car disposal

The metal parts of a passenger car are recycled and are modelled according to the life cycle inventories of passenger car disposal in the ecoinvent report no.14 (Spielmann et al. 2007). The transport of the recycled material to the recycling plant is accounted for. The weight of the recycled materials and the residues from not recycled materials are extrapolated from the life cycle inventory of passenger car disposal using the weight ratio as extrapolation factor (see Tab. 1.24).

**Tab. 1.24: Unit process raw data of diesel concept car disposal**

| | Name | Location | InfrastructureProcess | Unit | disposal, passenger car, diesel EURO5, 2lt/100km | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | InfrastructureProcess | | | | 1 | | | |
| | Unit | | | | unit | | | |
| product | disposal, passenger car, diesel EURO5, 2lt/100km | RER | 1 | unit | 1 | | | |
| technosphere | transport, lorry 20-28t, fleet average | CH | 0 | tkm | 1.36E+1 | 1 | 2.09 | (4,5,na,na,na,na,BU:2); Extrapolated from passenger car, ecoinvent report no.14 |
| | disposal, plastics, mixture, 15.3% water, to municipal incineration | CH | 0 | kg | 2.71E+1 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no.14 according to weight ratio |
| | disposal, glass, 0% water, to municipal incineration | CH | 0 | kg | 1.25E+1 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no.14 according to weight ratio |
| | disposal, emulsion paint remains, 0% water, to hazardous waste incineration | CH | 0 | kg | 4.17E+1 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no.14 according to weight ratio |
| | disposal, zinc in car shredder residue, 0% water, to municipal incineration | CH | 0 | kg | 2.45E+0 | 1 | 1.25 | (2,2,2,1,3,4,BU:1.05); Extrapolated from passenger car, ecoinvent report no.14 according to weight ratio |

## 1.14 References


AEE 2009 — AEE (2009) Ökostrom in der Schweiz - der Marktanteil erneuerbarer Stromprodukte im Jahr 2008, Ergebnisse einer Umfrage bei Schweizer Energieversorgungsunternehmen. Agentur für erneuerbare Energien und Energieeffizienz, Zürich.

Bossche et al. 2005 — Bossche P. V. d., Vergels F., Mierlo J. V., Matheys J. and Autenboer W. V. (2005) SUBAT: An assessment of sustainable battery technology. *In: Journal of power sources*, **162**(2), pp. 913-919.

ecoinvent Centre 2007 — ecoinvent Centre (2007) ecoinvent data v2.01, ecoinvent reports No. 1-25. Swiss Centre for Life Cycle Inventories, Duebendorf, Switzerland, retrieved from: www.ecoinvent.org.

e'mobile 2009a — e'mobile (2009a) Panda Elektra Technische Informationen. Schweizerischer Verband für elektrische und effiziente Strassenfahrzeuge.

e'mobile 2009b — e'mobile (2009b) Tesla Roadster Edition Signature Technische Informationen. Schweizerische Vereinigung für elektrische und effiziente Strassenfahrzeuge.

e'mobile 2009c — e'mobile (2009c) Twingo Quickshift Elektra Technische Informationen. Schweizerischer Verband für elektrische und effiziente Strassenfahrzeuge.

Frischknecht et al. 2007 — Frischknecht R., Jungbluth N., Althaus H.-J., Bauer C., Doka G., Dones R., Hellweg S., Hischier R., Humbert S., Margni M. and Nemecek T. (2007) Implementation of Life Cycle Impact Assessment Methods. ecoinvent report No. 3, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.

Gauch et al. 2009 — Gauch M., Widmer R., Notter D., Stamp A., Althaus H.-J. and Wäger P. (2009) Life Cycle Assessment LCA of Li-Ion batteries for electric vehicles. Project presentation. EMPA - Swiss Federal Laboratories for Materials Testing and Research, St. Gallen.

GS-Yuasa 2009 — GS-Yuasa (2009) Description of Battery Products. Retrieved 2009-04-20 retrieved from: http://www.gs-yuasa.com/us/products/index.html.

Hischier et al. 2007 — Hischier R., Classen M., Lehmann M. and Scharnhorst W. (2007) Life Cycle Inventories of Electric and Electronic Equipment - Production, Use & Disposal. ecoinvent report No. 18, v2.0. EMPA St. Gallen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.

INL 2009 — INL (2009) Comparing Energy Costs per Mile for Electric and Gasoline-Fueled Vehicles retrieved from: http://avt.inl.gov/pdf/fsev/costs.pdf.

Loremo 2010 — Loremo (2010) Technische Informationen zu Loremo LS, Loremo GT und Loremo EV. Retrieved 2010-01-25 retrieved from: http://www.loremo.com/02der02_varianten.htm.

Nissan 2009 — Nissan (2009) Nissan LEAF Frequently Asked Questions. Retrieved 2009-10-05 retrieved from: http://www.nissanusa.com/leaf-electric-car/#/car/index.

Rantik 1999 — Rantik M. (1999) Life Cycle Assessment of Five Batteries for Electric Vehicles under Different Charging Regimes. *In: KFB-Meddelande, KFB-Kommunikationsforskningsberedning, Stockholm*, **28**, pp.

Röder 2001 — Röder A. (2001) Life-cycle inventory and costs of different car powertrains. PSI, Villigen.

Schweimer & Levin 2002 — Schweimer G. W. and Levin M. (2002) Sachbilanz des Golf A4. Forschung Umwelt und Verkehr, Volkswagen AG

Wissenschaftliches Zentrum für Umweltsystemforschung, Gesamthochschule Kassel, Wolfsburg, retrieved from: http://www.volkswagen.com/etc/medialib/vwcms/virtualmaster/de/Unternehmen/mobilitaet_und_nachhaltigkeit/downloads/umweltbilanz.Par.0001.File.pdf/sachbilanz_golf_a4_deutsch.pdf.

Spielmann et al. 2007 — Spielmann M., Dones R., Bauer C. and Tuchschmid M. (2007) Life Cycle Inventories of Transport Services. ecoinvent report No. 14, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.

Toyota 2009 — Toyota (2009) Toyota Prius Specifications. Retrieved 2009-04-14 retrieved from: http://www.toyota-europe.com/cars/new_cars/prius/specs.aspx.

Vezzini 2009 — Vezzini A. (2009) Mobilität und erneuerbare Energie: Elektrofahrzeuge. *In: Physik in unserer Zeit*, **41**(1), pp. 36-42.

# Appendices: EcoSpold Meta Information

**Tab. A. 1: Metainformation of the datasets „transport", current technology BEV**

| | | | |
|---|---|---|---|
| ReferenceFunction | Name | transport, passenger car, electric, LiMn2O4, certified electricity | transport, passenger car, electric, LiMn2O4 |
| Geography | Location | CH | CH |
| ReferenceFunction | InfrastructureProcess | 0 | 0 |
| ReferenceFunction | Unit | pkm | pkm |
| | IncludedProcesses | This data set includes the material and infrastructure used to transport one person on one km. Battery charging using certfied electricity. Battery replacement and disposal accounted for by maintenance. Takes into account average load factor of 1.6 persons | This data set includes the material and infrastructure used to transport one person one km. Battery charging using Swiss cohsumer mix. Battery replacement and disposal accounted for by maintenance. Takes into account average load factor of 1.6 persons |
| | LocalName | Transport, Personenwagen, elektro, LiMn2O4, zertifizierter Strom | Transport, Personenwagen, elektro, LiMn2O4 |
| | Synonyms | | |
| | GeneralComment | Battery electric vehicle using a LiIo battery pack charged with Swiss certified electricity. The data includes maintenance and disposal of vehicle and road. | Battery electric vehicle using a LiIo battery pack charged with Swiss consumer mix. The data includes maintenance and disposal of vehicle and road. |
| | InfrastructureIncluded | 1 | 1 |
| | Category | transport systems | transport systems |
| | SubCategory | road | road |
| | LocalCategory | Transportsysteme | Transportsysteme |
| | LocalSubCategory | Strasse | Strasse |
| | Formula | | |
| | StatisticalClassification | | |
| | CASNumber | | |
| TimePeriod | StartDate | 2009 | 2009 |
| | EndDate | 2010 | 2010 |
| | DataValidForEntirePeriod | 1 | 1 |
| | OtherPeriodText | | |
| Geography | Text | Data from Europe and Switzerland. | Data from Europe and Switzerland. |
| Technology | Text | BEV with LiIo battery pack, usual middle class passenger car (comparable to VW Golf) | BEV with LiIo battery pack, usual middle class passenger car (comparable to VW Golf) |
| Representativeness | Percent | | |
| | ProductionVolume | unknown | unknown |
| | SamplingProcedure | Literature | Literature |
| | Extrapolations | none | none |
| | UncertaintyAdjustments | none | none |

**Tab. A. 2: Metainformation of the datasets „transport", light weight BEV (concept car)**

| | | | |
|---|---|---|---|
| ReferenceFunction | Name | transport, passenger car, electric, LiMn2O4, city car | transport, passenger car, electric, LiMn2O4, city car, certified electricity |
| Geography | Location | CH | CH |
| ReferenceFunction | InfrastructureProcess | 0 | 0 |
| ReferenceFunction | Unit | pkm | pkm |
| | IncludedProcesses | This data set includes the material and infrastructure used to transport one person one km. Battery charging at Swiss grid. Takes into account average load factor of 1.6 persons | This data set includes the material and infrastructure used to transport one person one km. Battery charging using certfied electricity (e.g. naturemade star) in Switzerland. Takes into account average load factor of 1.6 persons |
| | LocalName | Transport, Personenwagen, elektro, LiMn2O4, City Car | Transport, Personenwagen, elektro, LiMn2O4, City Car, zertifizierter Strom |
| | Synonyms | 0 | 0 |
| | GeneralComment | Battery electric light weight concept vehicle using a 100kg LiIo battery pack charged with Swiss electricity mix. The data includes maintenance of vehicle and road. | Battery electric light weight concept vehicle using a 100kg LiIo battery pack charged with certified electricity. The data includes maintenance of vehicle and road. |
| | InfrastructureIncluded | 1 | 1 |
| | Category | transport systems | transport systems |
| | SubCategory | road | road |
| | LocalCategory | Transportsysteme | Transportsysteme |
| | LocalSubCategory | Strasse | Strasse |
| | Formula | | |
| | StatisticalClassification | | |
| | CASNumber | | |
| TimePeriod | StartDate | 2010 | 2010 |
| | EndDate | 2015 | 2015 |
| | DataValidForEntirePeriod | 1 | 1 |
| | OtherPeriodText | | |
| Geography | Text | Data from Europe and Switzerland. | Data from Europe and Switzerland. |
| Technology | Text | BEV with LiMn2O4, 100Wh/kg battery pack, light weight city car, 7kWh/100km | BEV with LiMn2O4, 100Wh/kg battery pack, light weight city car, 7kWh/100km |
| Representativeness | Percent | 0 | 0 |
| | ProductionVolume | unknown | unknown |
| | SamplingProcedure | Literature | Literature |
| | Extrapolations | none | none |
| | UncertaintyAdjustments | none | none |

**Tab. A. 3: Metainformation of the dataset "BEV operation", current technology BEV**

| | | | |
|---|---|---|---|
| ReferenceFunction | Name | operation, passenger car, electric, LiMn2O4 | operation, passenger car, electric, LiMn2O4, certified electricity |
| Geography | Location | CH | CH |
| ReferenceFunction | InfrastructureProcess | 0 | 0 |
| ReferenceFunction | Unit | km | km |
| | IncludedProcesses | Energy consumption from consumer mix is included. Emissions of particulate matters and heavy metals are accounted for, unless of combustion origin. Particulate emissions comprise abrasions emissions only. Heavy metal emissions to soil and water caused by tyre abrasion are included. | Energy consumption from Swiss certified electricity is included. Emissions of particulate matters and heavy metals are accounted for, unless of combustion origin. Particulate emissions comprise abrasions emissions only. Heavy metal emissions to soil and water caused by tyre abrasion are included. |
| | LocalName | Betrieb, Personenwagen, elektro, LiMn2O4 | Betrieb, Personenwagen, elektro, LiMn2O4, zertifizierter Strom |
| | Synonyms | | |
| | GeneralComment | Average data for the operation of an average battery electric vehicle. 20kWh/100km from consumer mix electricity. | Average data for the operation of an average battery electric vehicle. 20kWh/100km from Swiss certified electricity. |
| | InfrastructureIncluded | 1 | 1 |
| | Category | transport systems | transport systems |
| | SubCategory | road | road |
| | LocalCategory | Transportsysteme | Transportsysteme |
| | LocalSubCategory | Strasse | Strasse |
| | Formula | | |
| | StatisticalClassification | | |
| | CASNumber | | |
| TimePeriod | StartDate | 2009 | 2009 |
| | EndDate | 2010 | 2010 |
| | DataValidForEntirePeriod | 1 | 1 |
| | OtherPeriodText | | |
| Geography | Text | Data refer to Swiss conditions | Data refer to Swiss conditions |
| Technology | Text | BEV, LiMn2O4/graphite battery pack, 100Wh/kg, actual standard, 2009. Middle class passenger car (similar to VW Golf) | BEV, LiMn2O4/graphite battery pack, 100Wh/kg, actual standard, 2009. Middle class passenger car (similar to VW Golf) |
| Representativeness | Percent | | |
| | ProductionVolume | unknown | unknown |
| | SamplingProcedure | unknown | unknown |
| | Extrapolations | none | none |
| | UncertaintyAdjustments | none | none |

**Tab. A. 4: Metainformation of the dataset "BEV operation", light weight BEV (concept car)**

| | | | |
|---|---|---|---|
| ReferenceFunction | Name | operation, passenger car, electric, LiMn2O4, city car | operation, passenger car, electric, LiMn2O4, city car, certified electricity |
| Geography | Location | CH | CH |
| ReferenceFunction | InfrastructureProcess | 0 | 0 |
| ReferenceFunction | Unit | km | km |
| | IncludedProcesses | Energy consumption from Swiss electricity mix is included. Emissions of particulate matters and heavy metals are accounted for, unless of combustion origin. Particulate emissions comprise abrasions emissions only. Heavy metal emissions to soil and water caused by tyre abrasion are included. | Energy consumption from certfied electricity is included. Emissions of particulate matters and heavy metals are accounted for, unless of combustion origin. Particulate emissions comprise abrasions emissions only. Heavy metal emissions to soil and water caused by tyre abrasion are included. |
| | LocalName | Betrieb, Personenwagen, elektro, LiMn2O4, City Car | Betrieb, Personenwagen, elektro, LiMn2O4, City Car, zertifizierter Strom |
| | Synonyms | 0 | 0 |
| | GeneralComment | Average data for the operation of a light weight concept (650kg) battery electric vehicle. | Average data for the operation of an light weight concept (650kg) battery electric vehicle. Electricity certified. |
| | InfrastructureIncluded | 1 | 1 |
| | Category | transport systems | transport systems |
| | SubCategory | road | road |
| | LocalCategory | Transportsysteme | Transportsysteme |
| | LocalSubCategory | Strasse | Strasse |
| | Formula | | |
| | StatisticalClassification | | |
| | CASNumber | | |
| TimePeriod | StartDate | 2010 | 2010 |
| | EndDate | 2015 | 2015 |
| | DataValidForEntirePeriod | 1 | 1 |
| | OtherPeriodText | | |
| Geography | Text | Data refer to Swiss conditions | Data refer to Swiss conditions |
| Technology | Text | BEV, LiMn2O4/graphite battery pack, 100Wh/kg, actual standard, 2009 | BEV, LiMn2O4/graphite battery pack, 100Wh/kg, actual standard, 2009 |
| Representativeness | Percent | 0 | 0 |
| | ProductionVolume | unknown | unknown |
| | SamplingProcedure | unknown | unknown |
| | Extrapolations | Emission extrapolated from ICE passenger car according to weight ratio | Emission extrapolated from ICE passenger car according to weight ratio |
| | UncertaintyAdjustments | none | none |

**Tab. A. 5: Metainformation of the dataset "BEV manufacture", current technology BEV**

| | | |
|---|---|---|
| ReferenceFunction | Name | passenger car, electric, LiMn2O4, at plant |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | The inventory includes processes of material, energy and water use in vehicle manufacturing. Rail and road transport of materials is accounted for. Plant infrastructure is included, addressing issues such as land use, building, road and parking construction. Additionally, battery and electric motor manufacture is included. |
| | LocalName | Personenwagen, elektro, LiMn2O4, ab Werk |
| | Synonyms | |
| | GeneralComment | The data set reflects a middle class electric passenger car comparable to a VW Golf. |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2009 |
| | EndDate | 2010 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data for manufacturing and retail in Europe |
| Technology | Text | Battery electric vehicle using a LiMn2O4/graphite, battery pack of 312 kg, 100Wh/kg, and an electric motor of 104 kg. |
| Representativeness | Percent | |
| | ProductionVolume | unknown |
| | SamplingProcedure | Literature |
| | Extrapolations | All values extrapolated from average passenger car production (VW Golf). Some adaptations made for change of |
| | UncertaintyAdjustments | none |

**Tab. A. 6: Metainformation of the dataset "BEV manufacture", light weight vehicle (concept car)**

| | | |
|---|---|---|
| ReferenceFunction | Name | passenger car, electric, LiMn2O4, city car, at plant |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | The inventory includes processes of material, energy and water use in vehicle manufacturing. Rail and road transport of materials is accounted for. Plant infrastructure is included, addressing issues such as land use, building, road and parking construction. Additionally, battery and electric motor manufacture is included. Furthermore, inputs for lead acid batteries were excluded. For BEVs the tank and combustion motor input is excluded as well. |
| | LocalName | Personenwagen, elektro, LiMn2O4, City Car, ab Werk |
| | Synonyms | |
| | GeneralComment | The data set reflects a BEV of 650kg total weight with a 100kg LiMn2O4 battery and 70kg electric motor |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2010 |
| | EndDate | 2015 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data for manufacturing and retail in Europe |
| Technology | Text | LiMn2O4 battery, 70kg, 120Wh/kg battery pack, light weight construction, max. 4 Persons |
| Representativeness | Percent | |
| | ProductionVolume | unknown |
| | SamplingProcedure | Literture |
| | Extrapolations | All values extrapolated from passenger car manufacture using weight ratio. Some adaptations made for change of material. |
| | UncertaintyAdjustments | none |

**Tab. A. 7: Metainformation of the dataset "maintenance", current technology BEV**

| | | |
|---|---|---|
| ReferenceFunction | Name | maintenance, electric vehicle, LiMn2O4 |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | The inventory includes materials used for alteration parts and energy consumption of garages. Rail and road transport of materials is accounted for. Battery pack replacement and disposal included |
| | LocalName | Unterhalt, Elektroauto, LiMn2O4 |
| | Synonyms | |
| | GeneralComment | The maintenance of the battery electric vehicle is derived from the maintenance of a conventional passenger car. Additionally, the battery replacement is included (312kg). Life expectancy of battery pack: 100'000 km. |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2000 |
| | EndDate | 2009 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data represent Swiss conditions, but are also valid for other European countries |
| Technology | Text | Middle class passsenger car using a LiMn2O4 battery pack, 100Wh/kg, 312 kg |
| Representativeness | Percent | |
| | ProductionVolume | unknown |
| | SamplingProcedure | Data is derived from LCI of a Golf A4. |
| | Extrapolations | Data for Germany is used as an estimate for Europe |
| | UncertaintyAdjustments | none |

**Tab. A. 8: Metainformation of the dataset "maintenance", light weight BEV (concept car)**

| | | |
|---|---|---|
| ReferenceFunction | Name | maintenance, electric vehicle, LiMn2O4 |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | The inventory includes materials used for alteration parts and energy consumption of garages. Rail and road transport of materials is accounted for. Battery pack replacement and disposal included |
| | LocalName | Unterhalt, Elektroauto, LiMn2O4 |
| | Synonyms | |
| | GeneralComment | The maintenance of the battery electric vehicle is derived from the maintenance of a conventional passenger car. Additionally, the battery replacement is included (312kg). Life expectancy of battery pack: 100'000 km. |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2000 |
| | EndDate | 2009 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data represent Swiss conditions, but are also valid for other European countries |
| Technology | Text | Middle class passsenger car using a LiMn2O4 battery pack, 100Wh/kg, 312 kg |
| Representativeness | Percent | |
| | ProductionVolume | unknown |
| | SamplingProcedure | Data is derived from LCI of a Golf A4. |
| | Extrapolations | Data for Germany is used as an estimate for Europe |

**Tab. A. 9: Metainformation of data set “BEV disposal”, current technology BEV**

| | | |
|---|---|---|
| ReferenceFunction | Name | disposal, electric vehicle, LiMn2O4 |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | This data set includes the disposal of all remaining parts, that are not recycled. All recycled parts are attributed to the reuse process (cut-off) |
| | LocalName | Entsorgung, Elektroauto, LiMn2O4 |
| | Synonyms | 0 |
| | GeneralComment | The data set reflects the disposal of a BEV with a LiIo battery. Aluminium and steel parts are fully recycled. Plastics are disposed. |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2009 |
| | EndDate | 2010 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data for disposal of vehicle parts in Europe. |
| Technology | Text | Disposal to incineration or recycling (metals and batteries) |
| Representativeness | Percent | 0 |
| | ProductionVolume | unknown |
| | SamplingProcedure | Literture |
| | Extrapolations | Data derived from car disposal |
| | UncertaintyAdjustments | none |

**Tab. A. 10: Metainformation of data set “BEV disposal”, light weight BEV (concept car)**

| | | |
|---|---|---|
| ReferenceFunction | Name | disposal, passenger car, electric, LiMn2O4, city car |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 1 |
| ReferenceFunction | Unit | unit |
| | IncludedProcesses | This data set includes the disposal of all remaining parts, that are not recycled. All recycled parts are attributed to the reuse process (cut-off) |
| | LocalName | Entsorgung, Personenwagen, elektro, LiMn2O4, City Car |
| | Synonyms | 0 |
| | GeneralComment | The data set reflects the disposal of a light weight BEV with a 100kg LiIo battery. Aluminium and steel parts are fully recycled. Plastics are disposed. |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2010 |
| | EndDate | 2015 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data for disposal of vehicle parts in Europe. |
| Technology | Text | Disposal to incineration or recycling (metals and batteries) |
| Representativeness | Percent | 0 |
| | ProductionVolume | unknown |
| | SamplingProcedure | Literture |
| | Extrapolations | Data derived from car disposal |
| | UncertaintyAdjustments | none |

**Tab. A. 11: Metainformation of the dataset "electric motor"**

| | | |
|---|---|---|
| ReferenceFunction | Name | electric motor, electric vehicle, at plant |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | This data set includes the material used for the production of 1 kg electric motor for a electric vehicle |
| | LocalName | Elektromotor, Elektroauto, ab Werk |
| | Synonyms | |
| | GeneralComment | The module reflects an average electric motor used in BEV or HEV |
| | InfrastructureIncluded | 1 |
| | Category | transport systems |
| | SubCategory | road |
| | LocalCategory | Transportsysteme |
| | LocalSubCategory | Strasse |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2000 |
| | EndDate | 2009 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | Data valid for average electric motor |
| Technology | Text | Production of electric motor for BEV or HEV |
| Representativeness | Percent | |
| | ProductionVolume | unknown |
| | SamplingProcedure | Literature |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Tab. A. 12: Metainformation of the datasets of the diesel concept car**

| | | | | | | |
|---|---|---|---|---|---|---|
| ReferenceFunction | Name | transport, passenger car, diesel, EURO5, city car | operation, passenger car, diesel, EURO5, city car | passenger car, diesel, EURO5, city car, at plant | maintenance, passenger car, diesel, EURO5, city car | disposal, passenger car, diesel EURO5, city car |
| Geography | Location | CH | CH | RER | RER | RER |
| ReferenceFunction | InfrastructureProcess | 0 | 0 | 1 | 1 | 1 |
| ReferenceFunction | Unit | pkm | km | unit | unit | unit |
| | IncludedProcesses | This data set includes the operation of the vehicle, road and vehicle infrastructure use, maintenance and disposal. Takes into account average load factor of 1.6 persons | This data set includes the fuel consumption and emission from the combustion engine, tyre wear and abrasion. | This data set includes the materials and energy resources needed for passenger car manufacture. Transports included. | This data set includes material and energy use for passenger car maintenance. | This data set includes the disposal of material, which are not recycled. For recycled materials, transport is accounted for. |
| | LocalName | Transport, Pkw, Diesel, EURO5, City Car | Betrieb, Pkw, Diesel, EURO5, City Car | Personenwagen, Diesel, EURO5, City Car, ab Werk | Unterhalt, Pkw, Diesel, EURO5, City Car | Entsorgung, Pkw, Diesel, EURO5, City Car |
| | Synonyms | 0 | 0 | 0 | 0 | 0 |
| | GeneralComment | The data set reflects the transport of one person with a light weight concept car, diesel, on one km. Takes into account average load factor of 1.6 persons | The data set reflects a light weight concept car, diesel engine, 650 kg | The data set reflects a light weight concept passenger car of 550 kg total weight, diesel engine | The data set reflects the maintenance of a light weight concept passenger car of 550kg, total weight, diesel engine | The data set reflects the disposal of a light weight concept passenger car of 550kg total weight, diesel engine |
| | InfrastructureIncluded | 1 | 1 | 1 | 1 | 1 |
| | Category | transport systems | transport systems | transport systems | transport systems | transport systems |
| | SubCategory | road | road | road | road | road |
| | LocalCategory | Transportsysteme | Transportsysteme | Transportsysteme | Transportsysteme | Transportsysteme |
| | LocalSubCategory | Strasse | Strasse | Strasse | Strasse | Strasse |
| | Formula | | | | | |
| | StatisticalClassification | | | | | |
| | CASNumber | | | | | |
| TimePeriod | StartDate | 2010 | 2010 | 2010 | 2010 | 2010 |
| | EndDate | 2015 | 2015 | 2015 | 2015 | 2015 |
| | DataValidForEntirePeriod | 1 | 1 | 1 | 1 | 1 |
| | OtherPeriodText | | | | | |
| Geography | Text | Data valid for Switzerland | Data valid for Switzerland | Data from a German company but also valid for Europe. | Data from a German company but also valid for Europe. | Data from a German company but also valid for Europe. |
| Technology | Text | Diesel car, light weight concept, 2lt/100km, EURO5, life span: 150'000km | Diesel car, light weight concept, 2lt/100km, EURO5 | Diesel car, 550 kg, light weight concept car | Diesel car, 550 kg, light weight concept car | Cut-off allocation for recycled materials. |
| Representativeness | Percent | 0 | 0 | 0 | 0 | 0 |
| | ProductionVolume | unknown | unknown | unknown | unknown | unknown |
| | SamplingProcedure | unknown | unknown | unknown | unknown | unknown |
| | Extrapolations | Road infrastructure use extrapolated from average passenger car according to weight ratio | Emission data extrapolated from average diesel passenger car EURO5 according to fuel consumption | All values extrapolated from average passenger car manufacture according to weight ratio | All values extrapolated from average passenger car manufacture according to weight ratio | All values extrapolated from average passenger car manufacture according to weight ratio |
| | UncertaintyAdjustments | none | none | none | none | none |