

# Assumptions and input data calculations

## Circular economy

Chalmers Industriteknik

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## Introduction

The tool estimates the CO<sub>2</sub>-eq emissions of all passenger cars in Sweden based on input data (see below) and certain assumptions. Based on an estimation of how many cars there will be on the road in a certain year, what the age of the fleet is, what the mix in powertrain is (i.e. how many of these cars are fully electric, hybrid, diesel, petrol, etc.), how fuel efficient the cars are, how far they drive and how much CO<sub>2</sub> is associated with one liter fuel, the CO<sub>2</sub>-eq emissions of passenger cars in the next 30 years is calculated. The tool is calibrated with data of the current Swedish car fleet. The input data and assumptions in the tool are further explained below.

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# 1. Input data and assumptions

## 1.1. Number of cars on the road and distance driven

The number of new cars on the road in the past 17 years is taken from SCB<sup>1</sup>. To simplify the calculations, it is assumed that all cars registered on the road in Sweden will live for exactly 17 years (which is the average lifespan) and are then taken off the road. This means that the calculations, compared to the reality, underestimates the number of old vehicles on the road.

Following the prognosis made after the decision on the national plan for transport system in Sweden 2018-2029, the total travel distance of all Swedish registered passenger cars is assumed to increase from 61 200 million km in 2014, to 79 100 million km in 2040, and 86 500 million km in 2060<sup>2</sup>. For 2014 to 2040, this corresponds to a yearly increase of 1%. For 2040 to 2060, this corresponds to 0.45% increase per year. Note that according to this prognosis, the total distance driven in 2019 should be almost 64 300 million km, while the reported distance driven in 2019 was 67 142 million km<sup>3</sup>. Recalculating the annual trend from the actual 67 142 million km in 2019 to the projected 79 100 million km in 2040, an 0.84% annual increase in total distance driven is included in the model from 2019 to 2040. From 2040 to 2050, a 0.45% increase is included.

The total distance is divided by 12 040 km (the average annual distance per car) to derive the number of cars on the road in the various years. The number of new cars coming on the road in a certain year equals the cars scrapped in a certain year plus the increase in the overall car fleet.

## 1.2. Split between different powertrains

Data on the split of different powertrains (i.e. petrol, diesel, hybrids, electric vehicles, etc) of cars sold in previous years are taken from SCB<sup>4</sup> and Bilsweden<sup>5</sup>. An assumption regarding the share of hybrids on petrol versus diesel is based on kvdbil internal data. The share of electric vehicles will increase in the future. Bilsweden published a prognosis that electric vehicles will account for 24% in 2020 and 30% in 2021. After that, a stronger transition to electric vehicles is assumed following the prognosis made by 2030-sekretariatet, which means that electric vehicles are responsible for 76% of the new car sales in 2030. It is assumed that in the beginning

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<sup>1</sup> <https://www.scb.se/hitta-statistik/statistik-efter-amne/transporter-och-kommunikationer/vagtrafik/fordonsstatistik/>

<sup>2</sup> [https://www.trafikverket.se/contentassets/7e1063efbcbfd4b34a4591b0d4e00f855/2018/oversikt\\_prognosresultat\\_trv\\_basprognoser\\_20180401\\_ver-2018111....xlsx](https://www.trafikverket.se/contentassets/7e1063efbcbfd4b34a4591b0d4e00f855/2018/oversikt_prognosresultat_trv_basprognoser_20180401_ver-2018111....xlsx)

<sup>3</sup> [https://www.trafa.se/globalassets/statistik/vagtrafik/korstrackor/2020/korstrackor\\_2019.pdf?](https://www.trafa.se/globalassets/statistik/vagtrafik/korstrackor/2020/korstrackor_2019.pdf?)

<sup>4</sup> <https://www.scb.se/hitta-statistik/statistik-efter-amne/transporter-och-kommunikationer/vagtrafik/fordonsstatistik/>

<sup>5</sup> [http://www.bilsweden.se/statistik/nyregistreringar\\_per\\_ar/arkiv\\_1997-2012/nyregistreringar\\_per\\_ar\\_2005/definitiva\\_nyregistreringar\\_2005](http://www.bilsweden.se/statistik/nyregistreringar_per_ar/arkiv_1997-2012/nyregistreringar_per_ar_2005/definitiva_nyregistreringar_2005)

(year 2020 to 2024) the majority (i.e. 70%) of electric vehicles are plug-in hybrids, while from year 2025 the majority (i.e. 70%) of the electric vehicles are full electric cars. It is further assumed that the share of ethanol and gas vehicles (both only a small percentage) remain constant over time. The remaining share of newly sold cars each year is divided between petrol, diesel, and elhybrider following the same divide as in 2019. In 2019, petrol, diesel, and elhybrider accounted together for 87%, which means that for petrol 46/87 is assumed, for diesel 32/87, and for elhybrider 9/87.

### 1.3. Fuel consumption

The average fuel consumption of newly registered cars in the previous years in liter per 100 km is taken from Trafikverket<sup>6</sup>. According to some prognosis, the fuel consumption of the Swedish car fleet of both petrol and diesel cars is assumed to decrease to 6.1 l / 100 km in 2030 and to 4.9 l/100 km in 2040<sup>7</sup>, which corresponds to a 2.2% annual decrease. This is based on the assumption that buyers will select a more fuel-efficient car when buying a new car. Recently the trend is that buyers select even more larger and heavier cars (more SUVs) than before. We included therefore a more conservative improvement rate of 1.65% for petrol and 1.44% for diesel cars based on the trend that we saw in the past 27 years. A similar extrapolation of fuel efficiency improvements of other powertrains is made based on the trend seen in the past year. Regarding ethanol and gas vehicles, Trafikverket<sup>8</sup> publishes the fuel consumption for driving on petrol. For ethanol cars, we assume a 10% increase in fuel consumption when fueled with ethanol compared to petrol. For gas vehicles, the CO<sub>2</sub> emissions in terms of g / km of gas vehicles driving on biogas are published for various years by Gröna Bilister<sup>9</sup>, which is used for the calculation. We assume that the CO<sub>2</sub> per km improvement is equal to the improvement expected for petrol vehicles. It is possible to select the share of petrol versus biofuel for ethanol and gas vehicles as well as for those petrol vehicles converted to ethanol vehicles (see below).

### 1.4. Distance driven per car

The average distance driven per car differs per powertrain (diesel cars driving the most per year) as well as age of the car. Data is taken from trafikanalys korsstrackor 2018 (excell file tabell PB4). From this, a correction factor is calculated which allows to vary the average distance per year per car (including all cars) but keeping the difference based on powertrain and age. For example, the average distance is multiplied with 1.18 for brand new cars and with 1.05 for plug-in hybrids. Note that there is a combined effect meaning that a brand-new plug-in hybrid is multiplied with

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<sup>6</sup> <https://www.trafikverket.se/contentassets/07f80f01d92144eebf1a01fcb60ac923/pm-vagtrafikens-utslapp-200224.pdf>

<sup>7</sup> Table 5 [https://www.trafikverket.se/contentassets/8a378cdce4f24e6cb2e2592e89e04632/beskrivning-av-scenarioverktyget\\_version-1.0.pdf](https://www.trafikverket.se/contentassets/8a378cdce4f24e6cb2e2592e89e04632/beskrivning-av-scenarioverktyget_version-1.0.pdf)

<sup>8</sup> <https://www.trafikverket.se/contentassets/07f80f01d92144eebf1a01fcb60ac923/pm-vagtrafikens-utslapp-200224.pdf>

<sup>9</sup> Drivmedelsfakta <http://www.gronabilister.se/rappporter>

both 1.05 and 1.18. The assumed powertrain mix and average lifespan in the model influences the average annual driving distance.

### **1.5. CO2 value per liter fuel**

The CO<sub>2</sub>-equivalent emissions associated with one liter of fuel in Sweden in recent years is taken from Energimyndigheten<sup>10</sup>. The CO<sub>2</sub> reduction per liter fuel for petrol and diesel in the years 2018, 2019 and 2020 is calculated from the already decided share of biofuel that will be blended into petrol and diesel. After that, we assume that the CO<sub>2</sub> value per liter fuel will not reduce further. It is assumed that all cars drive in a certain year on fuel sold in that respective year. For ethanol, we use 1.12 kg CO<sub>2</sub>-eq/liter and HVO 0.3 kg CO<sub>2</sub>-eq/liter<sup>11</sup>. We keep both factors constant over the years.

## **2. Scenarios**

### **2.1. Conversion to ethanol**

If the option to conversion to ethanol is selected, it is assumed that from 2020 each year 20 000 petrol cars are converted to ethanol. The cars, at the moment of converting them to ethanol, are 5 years old. 20 000 is a maximum per year, if there are fewer 5-year old petrol cars in a certain year, those will all be converted to ethanol.

### **2.2. HVO for new diesel cars**

If the option of HVO for new diesel cars is chosen, it is assumed that the new diesel cars coming on the market are gradually driving on HVO. In this scenario it is assumed that in 2020, no HVO is used while in 2030 all diesel cars drive on HVO, i.e. a linear trend is projected meaning each year 10% more of the new cars drive on HVO. If this HVO for new diesel cars option is not selected, it is assumed that all diesel cars will drive on conventional diesel.

### **2.3. Lifespan of cars**

The average lifespan of a car in Sweden is today 17 years. The tool allows to reduce the average lifespan to any number between 1 and 17 years to project the effect on the CO<sub>2</sub> emissions from passenger cars in the next 40 years. Reducing the lifespan to 1 year, will mean that all cars are scrapped after one year and replaced with new ones, i.e. only new cars drive the latest fuel efficiency drive on the road. Reducing the lifespan has an effect on both the acceleration to different powertrains (more electric cars on the road) but has as downside that more kilometers are driven (the annual driving distance for newer cars is higher than for older cars – see distance driven per car above). Note that the CO<sub>2</sub> emissions of the production and recycling of cars is not included in the tool.

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<sup>10</sup> <https://www.energimyndigheten.se/globalassets/statistik/drivmedel-2018.pdf>

<sup>11</sup> <https://www.miljofordon.se/bilar/miljoepaaverkan/>

## 2.4. CO2 value per liter fuel

In addition to the reduction in CO2 per one liter of petrol or diesel in 2020, further reduction is to be expected after 2020. In the additional reduction scenario, the assumption is made that the CO2 per liter petrol will decrease with 27.6% and with 60% for diesel between 2019 and 2030. A constant linear decrease in those years is assumed to reach the 27.6 and 60% reduction by 2030. There is no further reduction after 2030 included in the model. The CO2 value of ethanol and HVO is assumed to be constant over time in all scenarios.