

KlimaLink Standard

Calculation of emissions from motor vehicles

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Description

Cars are used for private and business travel. In addition, cars are used in the form of chauffeur-driven vehicles such as taxis, private transfers, safari jeeps, etc.

The simplest and most accurate way to determine emissions for car journeys is to multiply the amount of fuel or electrical energy consumed by the corresponding emission factor (kilograms of CO₂e per litre or kWh). If this information is available, accurate calculations can be made. However, as KlimaLink usually calculates emissions before the journey begins (ex-ante), it can be assumed that this option can only be used in rare cases.¹

Alternatively, emissions can be determined based on the number of kilometres to be driven. In this case, an emission factor (kilograms of CO₂e per kilometre) is applied and the total emissions are divided by the actual or assumed utilisation. Since the actual fuel consumption is not available in this case, average values for the vehicle type must be assumed.

Data availability

KlimaLink uses the publicly available dataset "Real-world CO₂ emissions from new cars and vans" (real CO₂ emissions from new passenger cars and light commercial vehicles), which was collected by the EU and published by the European Environment Agency (EEA)², as its primary data source for real-world fuel consumption.

This dataset contains data from approximately 1 million vehicles newly registered in the EU in 2021 and 2022. All of these vehicles are equipped with an on-board fuel consumption measuring device (OBFCM) that measures actual fuel consumption and transmits it to the manufacturer either wirelessly or during maintenance at a workshop.

Relevant findings from the data and the accompanying report:

- The dataset specifies the fuel type for each vehicle, allowing the analysis to distinguish between petrol/diesel and hybrid engines (pure electric cars are not included in the dataset).
- Real-world fuel consumption is consistently about 20% higher than WLTP (Worldwide Harmonised Light Vehicles Test Procedure) values, making the latter a distorted estimate of actual fuel consumption.
- In the case of plug-in hybrid electric vehicles (PHEVs), i.e. vehicles equipped with both a combustion engine and a battery electric motor, the fuel savings achieved by the battery electric motor are much lower than indicated in the WLTP data. The real fuel consumption of these vehicles is about 3.5 times higher than the WLTP values and amounts to about 75-80% of the consumption of the corresponding models with pure combustion engines.

The data set lists, among other things, the total fuel consumption and total mileage for each individual vehicle. Therefore, fuel efficiency, expressed in litres of fuel/100 km, can be calculated as the ratio of these values. The accompanying document recommends excluding all vehicles with a mileage of less than 100 km, as they systematically show excessively high fuel consumption.

¹ For example, there may be private individuals who want to calculate the emissions of a car journey online in their browser after the event.

² <https://climate-energy.eea.europa.eu/topics/transport/real-world-emissions/data>

ACRIS vehicle categories

The KlimaLink standard uses the first and last letters of the 4-digit ACRIS code to indicate the vehicle category and fuel type. The ACRIS algorithm that assigns codes to individual vehicle models is not publicly available.

The first letter of the ACRIS code indicates the general vehicle category, e.g. Economy, Economy Elite, Standard, Luxury, etc. The fourth letter stands for the combination of fuel type and the presence or absence of air conditioning. Research on the websites of car rental companies was used to identify a number of example vehicles for each vehicle category (first letter). This information was then used to determine the real fuel consumption values for the petrol and diesel versions of each example vehicle (with the exception of vehicles that are only available with a petrol engine) by calculating the average of all matching database entries with a total mileage of more than 100 km.

As the EU data set does not contain any information on air conditioning, it is assumed that the average fuel consumption values determined in this way include both vehicles with and without air conditioning.

KlimaLink vehicle categories

As an alternative to the first and fourth letters of the ACRIS code, vehicles can also be specified using the KlimaLink vehicle categories:

- Small cars
- Medium-sized car
- SUV/Jeep
- Luxury/saloon

Therefore, a mapping of KlimaLink vehicle categories to ACRIS vehicle categories is created, with each KlimaLink category covering several ACRIS categories. Overlaps between categories are permitted; for example, the ACRIS category "Premium (P)" includes both luxury saloons and SUV models, meaning that it is included in both the KlimaLink category "Luxury/Saloon" and the category "SUV".

For each vehicle specified via a KlimaLink vehicle category, the average fuel consumption of the corresponding ACRIS categories must be used (e.g. the fuel consumption of "small cars" is the average of the ACRIS categories Mini, Mini Elite, Economy, Economy Elite).

KlimaLink	ACRIS
Small	M, N, E, H
Mid-range	C, D, I, J, S, R
SUV/Jeep	F, G, P
Luxury/saloon	P, U, L, W, X

Fuel types

The fourth letter of ACRIS covers a wide range of possible fuel types (including LPG, methanol, hydrogen and multi-fuel), which are currently considered irrelevant for leisure travel. Therefore, KlimaLink only takes petrol, diesel and electric cars into account when calculating emissions.

Electric cars

The electricity consumption of electric cars is determined via a subscription to the Electric Vehicle Database (EVDB, <https://ev-database.org>). The EVDB provides its own estimates of the electricity consumption of a wide range of electric cars, which are not based on manufacturer specifications and exceed the official WLTP values.

For each car model, the EVDB provides two estimates for electricity consumption, one for cold weather (when heating would be used) and one for mild weather.

These consumption values correspond to the TTW values and do not take charging losses into account. Estimates for charging losses in the literature³ range from 12 to 20% (charging efficiency 80-88%); KlimaLink calculates a 15% loss.

Plug-in hybrid electric vehicles (PHEVs)

The EU data set report states that fuel savings from PHEVs compared to identical non-hybrid vehicle models are in the range of 15 to 20%. This value is used empirically to estimate the fuel consumption of PHEVs by reducing the fuel consumption of vehicles with pure combustion engines accordingly.

Currently, due to insufficient data, the method does not take into account electricity emissions generated when charging PHEVs.

Full and mild hybrid vehicles

Unlike plug-in hybrids, full and mild hybrids do not have an external charging port. They can recharge their internal batteries either through recuperation during braking or by using the kinetic energy of the combustion engine to drive an electric generator. Mild and full hybrids differ in the extent to which the internal electric motor can be used on its own. In mild hybrids, the electric motor usually serves as a support for the combustion engine (e.g. to restart the engine at traffic lights), while full hybrids can cover a certain distance purely on electric power without the combustion engine.

Practical tests by the Australian Automobile Association showed fuel savings of between 17% and 32% compared to the corresponding pure petrol model, with one vehicle model showing higher hybrid consumption (+3.2%)⁴. However, the savings are less pronounced with mild hybrids than with full hybrids. However, as the ACRIS codes do not distinguish between these two types (both are represented by the 4th code letter H, while PHEVs are represented by I), they should be treated equally. The fuel savings according to the above source are in the same range as for PHEVs, so the same mechanism can be used for all types of hybrid vehicles.

³ Reick, B., Konzept, A., Kaufmann, A., Stetter, R., & Engelmann, D. (2021). Influence of charging losses on the energy consumption and CO₂ emissions of battery electric vehicles. *Vehicles* 2021, Volume 3, Pages 736-748, 3(4), 736–748. <https://doi.org/10.3390/VEHICLES3040043>

Pasaoglu, G., Fiorello, D., Zani, L., Martino, A., Zubaryeva, A., & Thiel, C. (2013). *Projections for Electric Vehicle Load Profiles in Europe Based on Travel Survey Data*. <https://doi.org/10.2790/24108>

⁴ Test data: <https://realworld.org.au/results/>, summary article: <https://www.carexpert.com.au/car-news/real-world-testing-shows-not-all-hybrids-are-created-equal-at-saving-fuel>

Emission factors

The KlimaLink standard specifies the emission factors for petrol and diesel as follows:

- Petrol: 2.37 kg CO₂ per litre of fuel
- Diesel: 2.65 kg CO₂ per litre of diesel

These values were taken from the website of the Federal Environment Agency and cover the entire fuel production chain (well-to-wheel).

Country-specific emission factors for electrical energy should be used for electricity consumption. A source with good global coverage is Our World in Data, based on data from Ember and the Energy Institute (<https://ourworldindata.org/grapher/carbon-intensity-electricity>). Until this function is fully implemented, an EU average value of 342 g CO₂e /kWh will be used.

Air conditioning

The EU fuel consumption database does not provide information on the presence or absence of air conditioning, so the average fuel consumption values per ACRIS or KlimaLink vehicle class include a mix of journeys with and without air conditioning. We assume that this mix is also representative of the tourist use of vehicles.

Calculation formula

Depending on the input, KlimaLink displays emission data in different levels of accuracy, tiers 1-3.

- **Tier 1:** Ex-post determination based on actual fuel consumption multiplied by the emission factor, including upstream emissions.
- **Tier 2:** Emission factor of the vehicle categories multiplied by the estimated distance (preferably in descending order):
 - Actual distance of the route (e.g. determined via Google Maps)
 - Number of days multiplied by the assumption of a distance travelled of 50 km/day
- **Tier 3:** Emission factor of the above vehicle category multiplied by a flat-rate distance.

In all tiers, the energy source must be included in the emission factor (diesel or petrol incl. upstream chain, or electric). Average emission factors are used for tiers 2 and 3.

$$CO_2e = f_F * f_F$$

The calculation of the fuel quantity or electrical energy F depends on the tier used:

- Tier 1: Direct user input
- Tier 2/3: $F = d * c_{cat}$

Variable	Description	Units	Source
CO ₂ e	Formula symbol for the specific CO ₂ e for a journey per passenger.	kg	-
F	Tank capacity or consumption	L or kWh	User
f _B	CO ₂ e emission factor per km based on a vehicle category	g CO ₂ e / km	UBA, DIN EN 16258, KlimaLink research ⁵
f _F	CO ₂ e emission factor in CO ₂ e based on the fuel consumed	kg CO ₂ e /L or kg CO ₂ e /kWh	DIN EN 16258
d	Distance (actual/planned/flat rate)	km	
c _{cat}	Consumption of the vehicle category	L/km or kWh/km	

Appendix

Acriss codes⁶

Vehicle Matrix- Car Classification Codes

CATEGORY		TYPE	TRANSMISSION / DRIVE		FUEL/AIR COND.	
M	Mini	B 2-3 Door	M	Manual Unspecified Drive	R	Unspecified Fuel/Power With Air
N	Mini Elite	C 2/4 Door	N	Manual 4WD	N	Unspecified Fuel/Power Without Air
E	Economy	D 4-5 Door	C	Manual AWD	D	Diesel Air
H	Economy Elite	W Wagon/Estate	A	Auto Unspecified Drive	Q	Diesel No Air
C	Compact	V Passenger Van	B	Auto 4WD	H	Hybrid
D	Compact Elite	L Limousine/Sedan	D	Auto AWD	I	Hybrid Plug in
I	Intermediate	S Sport			E	Electric
J	Intermediate Elite	T Convertible			C	Electric
S	Standard	F SUV			L	LPG/Compressed Gas Air
R	Standard Elite	J Open Air All Terrain			S	LPG/Compressed Gas No Air
F	Fullsize	X Special			A	Hydrogen Air
G	Fullsize Elite	P Pick up (single/extended cab) 2 door			B	Hydrogen No Air
P	Premium	Q Pick up (double cab) 4 door			M	Multi Fuel/Power Air
U	Premium Elite	Z Special Offer Car			F	Multi fuel/power No Air
L	Luxury	E Coupe			V	Petrol Air
W	Luxury Elite	M Monospace			Z	Petrol No Air
O	Oversize	R Recreational Vehicle			U	Ethanol Air
X	Special	H Motor Home			X	Ethanol No Air
		Y 2 Wheel Vehicle				
		N Roadster				
		G Crossover				
		K Commercial Van/Truck				

Emission factors

Vehicle class	EF petrol (kgCO ₂ e/km)	EF diesel (kgCO ₂ e/km)	EF electric* (kgCO ₂ e/km)	Source
Small	0.148	0.172	0.057	Own calculation based on European Environment Agency
Middle class	0.180	0.216	0.061	
SUV/Jeep	0.229	0.268	0.078	
Luxury	0.243	0.262	0.067	

As of July 2025

The KlimaLink standard is dynamic. The factors are adjusted when new data or scientific findings become available.

⁶ ACRIS codes <https://www.acriss.org/car-codes/>