CIVITAS
Sustainable and smart mobility for all
2030

CIVITAS indicators

CO2 emissions performance of road vehicles (ENV_DC_EF2)

DOMAIN

Transport	**Environment**	Energy	Society	Economy

TOPIC	**Decarbonisation**	
IMPACT	**Climate impact of vehicles** *Reducing CO2 emissions from road vehicles*	**ENV_DC**

Category

Key indicator	Supplementary indicator	State indicator

CONTEXT AND RELEVANCE

Transport activity is a major contributor to pollution, significantly impacting air quality, human health, and climate change. A substantial portion of transport activity takes place in urban areas, where high population density and concentrated economic activity lead to high transport demand. The reliance on motorized vehicles powered by fossil fuels exacerbates climate change by emitting greenhouse gases, such as CO2. By addressing urban transport emissions, cities can enhance air quality and reduce carbon footprints.

This indicator is an estimation of the CO2 emissions performance of vehicles in the experiment area. **It is a relevant indicator when the policy action is aimed at reducing the impact of urban mobility and transport on climate. A successful action is reflected in a LOWER value of the indicator.**

DESCRIPTION

The indicator is the average CO2 emissions per kilometre travelled of **cars registered in the experiment area.** The unit of measurement of the indicator is **grams of CO2 per kilometre**.

METHOD OF CALCULATION AND INPUTS

There are two methods for the calculation of the indicator. One method consists of **retrieving the number of vehicles registered in the experiment area by fuel technology from the local vehicle registration authority**. This method is straightforward and fully significant. **The requirement for its application is that data on vehicles registrations is available at the required spatial and temporal level of detail**. Often data on registered cars is published only at a level of spatial aggregation coarser than the pilot area (e.g. NUTS 3 regions). This issue is especially relevant if the pilot area is just one part of a municipality. Furthermore, data on registrations might be published for the whole year, without further detail.

An alternative method is estimating the number of vehicles by fuel technology by means of a **sample survey**. The survey should ask a sample of individuals for the number and fuel technology of cars that are owned by their household or otherwise available to them—including, for example, company and leased cars. On the one hand, a sampling estimation is less significant than an observed data drawn from a register. On the other hand, this method can work even if the pilot area is spatially limited as the sample can be collected among the inhabitants of the area. Organising a sample survey requires some resources and implies some complexities, but the survey can be used to collect more information than the just one needed for this indicator. See the dedicated “Sample surveys guidelines” for methodological indications.

METHOD 1	METHOD 2
Calculation of the indicator using vehicles registration data	**Estimation of the indicator using responses from a sample survey**
Complexity 	Complexity 
Significance 	Significance 

Whatever the method used, the indicator is computed by the supporting tool based on the input data and some pre-defined parameters coded in the tool itself. The estimation process is explained in detail for both methods below.

Method 1

Calculation of CO2 emissions per kilometre using vehicles registration data

Significance: **1.00** 

INPUTS

The following information is needed to compute the indicator:

a) **The number of cars by fuel technology** registered in the pilot area. This information can be retrieved from the local vehicle registration authority.
The data must cover the following fuel technologies:
- Gasoline
- Diesel
- LPG
- CNG
- Non-plug-in hybrid
- Plug-in-hybrid
- Battery electric
- Fuel cells

The experiment would result in a modification of the number of cars per fuel technology.

METHOD OF CALCULATION

The indicator is computed **by the supporting tool** based on the number of cars by fuel technology retrieved from the local vehicle registration authority.

The user **inputs the number of cars by fuel technology** in the supporting tool.

The supporting tool computes the value of the indicator according to the equation and parameters reported in the section below.

EQUATIONS

The value of the indicator is **computed by the supporting tool** as:

$$AvgCO2Car = \frac{Car^f * EmFctr^f}{\sum_f Car^f}$$

Where:

Car^f = Number of cars of fuel technology *f*

$EmFctr^f$ = Average CO2 emissions per kilometre driven by a car of fuel technology *f*

The emission factors by fuel technology $EmFctr^f$ are predefined values in the supporting tool. The emission factor values are summarized in the following table.

	CO2 [gCO2/km]
Gasoline	106.4
Diesel	147.6
LPG	120.5
CNG	106.8
Non-plug-in hybrid	95.0
Plug-in-hybrid	30.6
Battery electric	0.0
Fuel cells	0.0

Method 2

Calculation of CO2 emissions per kilometre using responses from a sample survey

Significance: **0.75**

INPUTS

The following information should be collected by means of the sample survey for each respondent:

a) **The number and fuel technology of cars owned by the respondent's household or otherwise available to them.** The information must include all cars available to the household, including company or leased cars. An example of a survey question to gather this information can be found in the document titled 'Guidelines for Survey.'

The experiment would result in a modification of the number of cars per fuel technology available to the households.

METHOD OF CALCULATION

The indicator is computed **by the supporting tool** based on the number of cars by fuel technology collected via the sample survey.

The user should perform the following steps:

- **Calculate the number of cars available to the households of the sampled individuals by fuel technology** (see equation below).
- **Input the number of cars available to the households of the sampled individuals by fuel technology** in the supporting tool.

The supporting tool computes the value of the indicator according to the equation and parameters reported in the section below.

EQUATIONS

After administering the sample survey, the user must compute the total number of cars available to the households of the sampled individuals **by fuel type**. This data is obtained as the summation of number of cars by fuel type reported by the sampled individuals:

$$Car^{f} = \sum_{d} Car_{d}^{f}$$

Where:

f is the fuel type.

d is the generic component of the sample.

The user then **inputs** the total number of cars available to the households of the sampled individuals by fuel type **in the supporting tool**. The tool computes the value of the indicator as described in Method 1.

ALTERNATIVE INDICATORS

This indicator measures the average CO2 emissions per kilometre travelled of the car fleet of the experiment area. Since many cars remain in the fleet for several years, even if new vehicles have significantly lower emissions, their impact on the overall fleet's emissions performance can remain minimal for some time. This indicator helps quantify the overall CO2 emissions performance of the cars in the experiment area, but it does not reflect the extent to which new low-emission vehicles enter the fleet, because their impact is dampened by the permanence of older vehicles in the fleet. This latter information is provided by the indicator **ENV_DC_EF1**, which considers the average CO2 emissions per kilometre of new registered cars, instead of the whole fleet.

Indicators **ENV_DC_APV1** and **ENV_DC_APV2** assess the share of electric and hydrogen cars among the newly registered vehicles and in the total fleet, respectively. These indicators offer therefore insight into the adoption of non-carbon-emitting vehicles, while ENV_DC_EF1 and ENV_DC_EF2 quantify the carbon emissions performance of the resulting fleet.

If the focus is on air pollution instead of carbon emissions, indicators **ENV_PL_PF1** and **ENV_PL_PF2** can be used. These track the share of zero- and low-emission vehicles among newly registered vehicles and within the overall fleet, respectively, offering insight into the fleet's contribution to local air quality.