CIVITAS
Sustainable and smart mobility for all
2030

# CIVITAS indicators

## Greenhouse gases well to wheel emissions (ENV_DC_CE2)

### DOMAIN

| Transport | **Environment** | Energy | Society | Economy |
|---|---|---|---|---|

| | | |
|---|---|---|
| **TOPIC** | **Decarbonisation** | |
| **IMPACT** | **Transport greenhouse gases emissions**<br>*Reducing the greenhouse gases emissions of urban mobility* | **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 travel demand. The reliance on motorized vehicles powered by fossil fuels or electricity and hydrogen derived from 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 amount of urban mobility greenhouse gases emissions. **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 directly the quantity of well-to-wheel emissions expressed in **tonnes/year**.

## METHOD OF CALCULATION AND INPUTS

There are two methods for the calculation of the indicator. One method is extracting the value of emissions from an urban transport model. **If a city transport model exists** and provides an estimation of the well-to-wheel greenhouse gas emissions from all relevant modes of transport, this method has zero complexity. Furthermore, assuming that the model is reliable, results have a good level of significance. However, **if an urban model does not exist**, its complexity becomes high because building an urban transport model is not straightforward.

An alternative method is estimating well-to-wheel greenhouse gas emissions building on energy use for urban transport activity. The energy use should be available by fuel type. Energy use by fuel type can be obtained from different sources. One option is collecting energy supplied at refuelling stations and energy operators (see factsheet related to the indicator ENG_EF_ED1). Another option is estimating energy used building on vehicle fleets, mileage and use factors (see factsheet related to the indicator ENG_EF_ED3). A third option is extracting energy consumption from an urban transport model, if there is a city transport model providing energy consumption by fuel type (but not greenhouse gas emissions, otherwise the first method can be applied). This method is more complex than extracting emissions from an existing model, but definitely less complex than building an urban transport model to estimate emissions. Its level of significance depends on the completeness of the data on energy use (e.g., the electricity used to recharge vehicles provided by recharging stations operators' is only a partial data as home recharging is not included). On average, method 2 is probably less significant than method 1.

**Whatever the method used, the greenhouse gas emissions should be computed exogenously and then coded in the supporting tool**.

| METHOD 1 | | METHOD 2 | |
|---|---|---|---|
| **Well-to-wheel greenhouse gas emissions drawn from an urban transport model** | | **Well-to-wheel greenhouse gas emissions estimated from energy consumption by fuel type** | |
| Complexity | 1/4 | Complexity | 2/4 |
| Significance | 3/4 | Significance | 2/4 |

The estimation process is explained below for both methods.

## Method 1

**Well-to-wheel greenhouse gas emissions drawn from an urban transport model**

Significance: **0.75**

**The following information is needed** to compute the indicator:

a) **The volume of well-to-wheel greenhouse emissions** in the period covered by the urban transport model.

   Urban transport models can refer to different periods e.g., one peak hour, two peak hours, one peak and one off-peak hour, an average day and so on. Whatever is the period, the greenhouse emissions provided by the model are the input required, which need to be translated in an annual value (see Method of Calculation). If the model already provides annual emissions, this information is already the indicator.

The experiment would result in a modification of well-to-wheel greenhouse emissions estimated by the model.

### METHOD OF CALCULATION

The indicator should be computed **exogenously** according to the following steps:

- **Identification of the period covered by the transport model** (e.g., one peak hour, two peak hours, whole day, etc.)**.**

- **Identification of the share of daily of traffic covered by the transport model.** The share of traffic covered by the transport model depends on the modelled period and on the distribution of transport activity in the 24 hours. This distribution is different in different contexts. If a transport model exists, this parameter is usually known. If not, 10% is a reasonable value for a morning peak hour.

- **Definition of the factor to extrapolate from day to year.** Most of the models refer to an average working day. If so, this term depends on the number of working days per year. Again, if a model exists, this parameter is usually known. If not, 270 working days/year can be considered.

- **Calculation of the extrapolation factor**. The extrapolation factor should be the product of two terms above (see the following equations).
- **Application of the extrapolation factor and estimation of the indicator** (see the following equations).

## EQUATIONS

The extrapolation factor should be computed as:

$$\boldsymbol{ExtpFact = \frac{1}{DayModShr} * DaytoYear}$$

Where:

$DayModShr$ = share of daily of traffic covered by the transport model

$DaytoYear$ = Factor to extrapolate from day to year

Example, if the model covers two hours and $DayModShr$ = 16% of daily traffic, and 270 working days ($DaytoYear$) are considered, the extrapolation factor is:

$$ExtpFact = \frac{1}{0.16} * 270 = 1687$$

The value of the indicator is then computed as:

$$\boldsymbol{GHGEmis = ModGHGEm * ExtpFact}$$

Where:

$ModGHGEm$ = GHG emissions related to the modelled period extracted from the model

## Method 2

| **Well-to-wheel greenhouse gas emissions estimated from energy consumption by fuel type** | Significance: **0.50** |
|---|---|

**The following information is needed** to compute the indicator:

a) **The amount of energy used in a given period** for each relevant fuel type. The fuel types to be considered are the followings:
   - **Gasoline**
   - **Diesel**
   - **Biodiesel**
   - **Bioethanol**
   - **LPG**
   - **CNG**
   - **Biomethane**
   - **Hydrogen**
   - **Electricity**

**If some of these fuel types are not relevant in the experiment area, they are not considered**.

b) **The carbon content** of each fossil fuel type. This element consists of a set of values based on chemical characteristics of the fossil fuels. The following values can be used unless more specific values are available in the pilot site:
Gasoline: 2.31 kg/l
Diesel: 2.68 kg/l
Biodiesel: 0.38 kg/l (production cycle)
Bioethanol: 0.40 kg/l (production cycle)
LPG: 1.51 kg/kg
CNG: 2.74 kg/kg
Biomethane: 0.20 kg/l (production cycle)
Hydrogen: 1.5 kg/kg (production cycle)

**For Electricity, the carbon content depends on the mix of fuels used for its production**. This mix changes region by region, indicative values cannot be provided.

The experiment would result in a modification of the amount of energy used. The carbon content of each fuel is fixed.

## METHOD OF CALCULATION

The indicator should be computed **exogenously** according to the following steps:

- **Identification of the existing refuelling/recharging stations.**
- **Identification of the operators managing recharging facilities for electric vehicles**.
- **Definition of a sample of refuelling stations supplying gasoline and diesel** if their total number is too large for collecting data from all of them.
- **Collection of data from the operators and the refuelling stations**
- **Estimation of total amount of gasoline and diesel supplied** in case the data is collected from a sample of stations (see equation below).
- **Estimation of the GHG emissions** (see equation below)

## EQUATIONS

If the amount of gasoline and diesel is collected from a sample of refuelling stations, the total value of energy supplied for these two fuel types should be estimated according to the following equation:

$$EngSupl^e = \frac{\sum_s EngSupl_s^e}{n} * N$$

Where:

$EngSupl_s^e$ = Amount of fuel type *e* supplied by sampled refuelling station *s* in the monitored four weeks

$n$ = Number of sampled refuelling stations

$N$ = Total number of refuelling stations supplying fuel type *e* in the urban area

The Well-to-Wheel GHG emissions can be obtained by simply applying carbon content factors to the total value of energy by fuel type:

$$\boldsymbol{WTWGHGEmiss} = \sum_{\boldsymbol{e}} (\boldsymbol{EngSupl^e} * \boldsymbol{CarbCont^e})$$

Where:

$CarbCont^e$ = the carbon content factor of fuel type *e*

## ALTERNATIVE INDICATORS

This indicator refers to well-to-wheel greenhouse emissions from transport in the pilot environment, i.e. emissions for the production of non-fossil fuels are considered. Since greenhouse gas emissions have a broad impact, rather than a local one, it is reasonable considering that e.g., electric car are not really zero-emission vehicles, in a broad sense, considering that emissions are generated for the production of electricity. An alternative, simpler although less comprehensive, indicator is **ENV_DC_CE1**, which considers only tank-to-wheel emissions for fossil fuels.

.