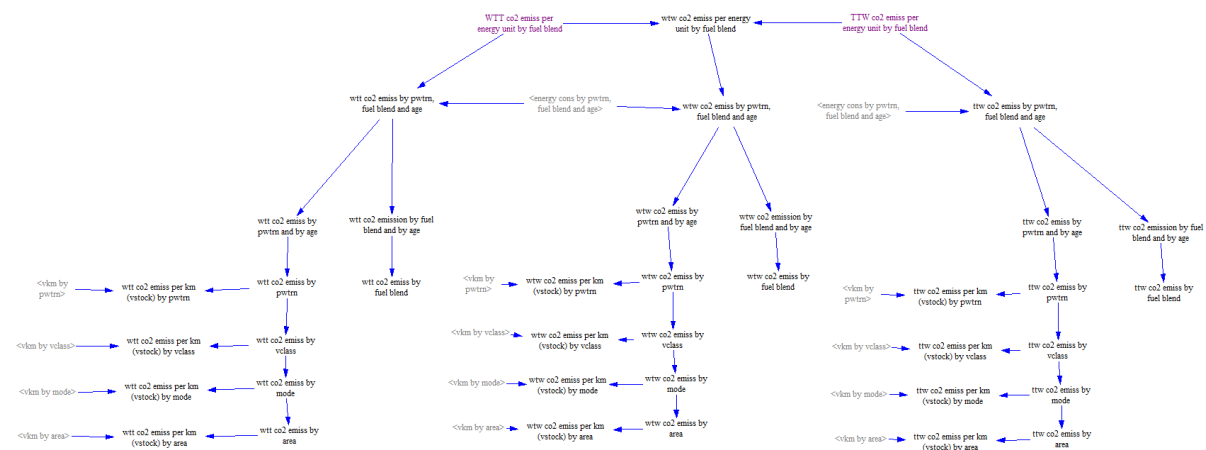# 37.   CO$_2$ emissions

Overview

Target

The target of this view is to convert energy consumption into CO$_2$ emissions through the application of emission factors. The total amount of CO$_2$ emissions is calculated on a well-to-wheel, well-to-tank and tank-to-wheel basis.

Structure

Figure 37.1 shows the Vensim sketch of this view. The calculations flow is from top to bottom. Well-to-tank results are on the bottom left, well-to-wheel results in the centre, and tank-to-wheel results on the right.

Figure 37.1   Vensim sketch

Detailed description of the view

Inputs

The amount of CO$_2$ emissions per energy unit by fuel blend is an exogenous input introduced by the user in the ForFITS Excel file ("User inputs (over time)" sheet). The default data entered in the excel file are based on the literature sources quoted on pages 24-26 of UNECE, 2012. The user can modify these values and can enter information over time to define scenarios by means of an index.

The user inputs enter this view in the variables "WTT CO2 EMISS PER ENERGY UNIT BY FUEL BLEND" (well-to-tank) and "TTW CO2 EMISS PER ENERGY UNIT BY FUEL BLEND" (tank-to-wheel), used to calculate well-to-wheel emission factors.

The energy consumption multiplying the emission factors is an input calculated in the view "energy cons by age". Emissions are calculated in the basis of the following formula (see also Figure 37.2)Figure 37.2:

$$CO_2 \; emissions \left(\frac{kg \; CO_2}{year}\right) = Energy \; consumption \left(\frac{litres}{year}\right) \times Emission \left(\frac{kg \; CO_2}{litre}\right)$$

The amount of CO$_2$ emissions emitted over time by the vehicles belonging to a particular area, service, mode, vehicle class, powertrain, fuel blend and age is stored in the "WTT CO2 EMISS BY PWTRN, FUEL BLEND AND AGE", "WTW CO2 EMISS BY PWTRN, FUEL BLEND AND AGE" and "TTW CO2 EMISS BY PWTRN, FUEL BLEND AND AGE" variables (Figure 37.2).

Figure 37.2   CO$_2$ emission by area, service, mode, vehicle class, powertrain, fuel blend and age
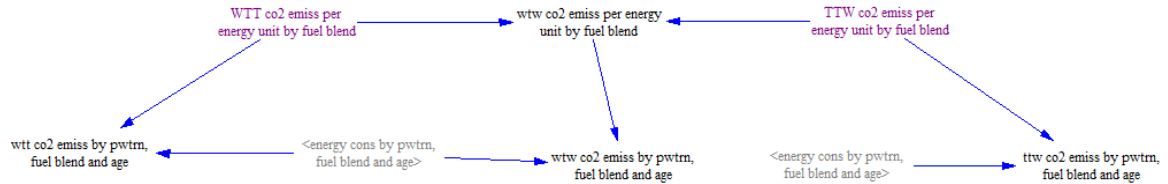
Other endogenous inputs used in this view are variables concerning vkm coming from the transport activity modules. They enable to aggregate the CO$_2$ emissions at different levels.

Outputs

In order to calculate the total CO$_2$ emissions (kg CO$_2$/year) at different aggregate levels, the same pyramidal structure as in the view "energy cons by age" is established in the three sets of calculations located at the bottom of the view.

For simplicity, the structure of these sets is reproduced in Figure 37.3 and Figure 37.4, as well as the explanation provides below, refer to the well-to-wheel emissions (central part of the bottom area of the view).

Figure 37.3   Well-to-wheel CO$_2$ emissions: aggregates
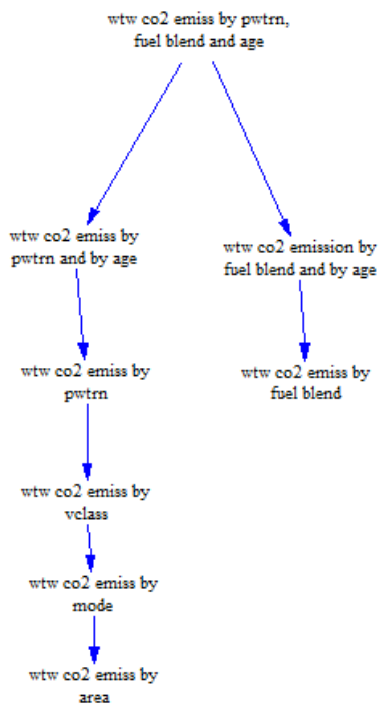
The right column of each set contains information by fuel blend and by age:

$$WTW\ CO_2\ emissions\ by\ fuel\ blend\ and\ by\ age = \sum_{powertrains} WTW\ CO_2\ emissions_{powertrain\ i}$$

$$WTW\ CO_2\ emissions\ by\ fuel\ blend = \sum_{ages} WTW\ CO_2\ emissions_{age\ i}$$

The left column contains aggregates by age, powertrain, vehicle class, mode and area:

$$WTW\ CO_2\ emissions\ by\ age = \sum_{fuel\ blends} WTW\ CO_2\ emissions_{fuel\ blend\ i}$$

$$WTW\ CO_2\ emissions\ by\ powertrain = \sum_{ages} WTW\ CO_2\ emissions_{age\ i}$$

$$WTW\ CO_2\ emissions\ by\ vehicle\ class = \sum_{powertrains} WTW\ CO_2\ emissions_{powertrain\ i}$$

$$WTW\ CO_2\ emissions\ by\ mode = \sum_{vehicle\ classes} WTW\ CO_2\ emissions_{vehicle\ class\ i}$$

$$WTW\ CO_2\ emissions\ by\ area = \sum_{modes} WTW\ CO_2\ emissions_{mode\ i}$$

Combining these variables with information of the vehicle activity allows calculating the well-to-wheel CO_2 emissions per km for the vehicle stock (Figure 37.4). This corresponds to the application of the following equation: WTW CO_2 emissions per km = WTW CO_2 emissions / vkm.

Figure 37.4   Well-to-wheel CO_2 emissions per km: aggregates
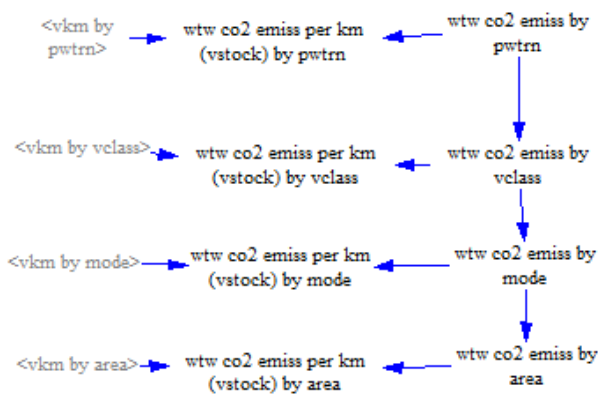
Similar aggregates, for well to tank and tank to wheel estimates, are located on the bottom left and bottom right of the view (Figure 37.5 and Figure 37.6). Such aggregates are evaluated with the same logic described earlier, for well-to-wheel emissions.
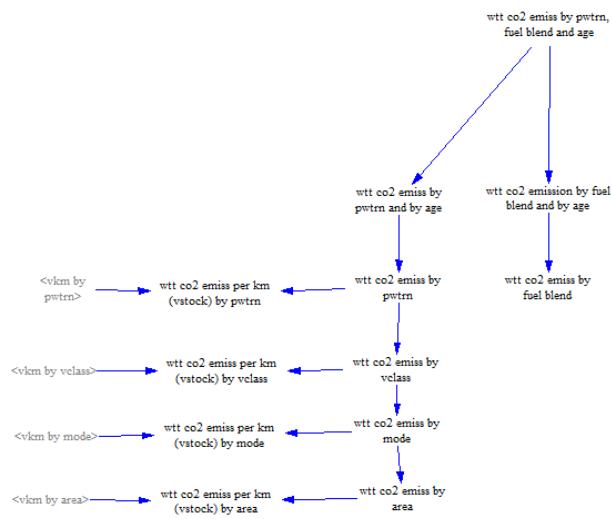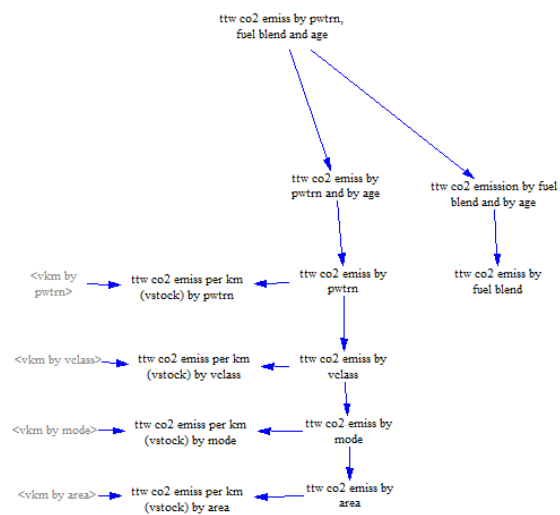
Figure 37.5   Well-to-tank aggregates

Figure 37.6   Tank-to-wheel aggregates

References

UNECE (United Nations Economic Commission for Europe) (2012), *CO₂ emissions from inland transport: statistics, mitigation polices, and modelling tools*, http://staging.unece.org/fileadmin/DAM/trans/doc/themes/2012_-_UNECE_-_Global_Status_Report__October_2012__-_final_version.pdf