

20. Travel per vehicle (freight)

Overview

Target

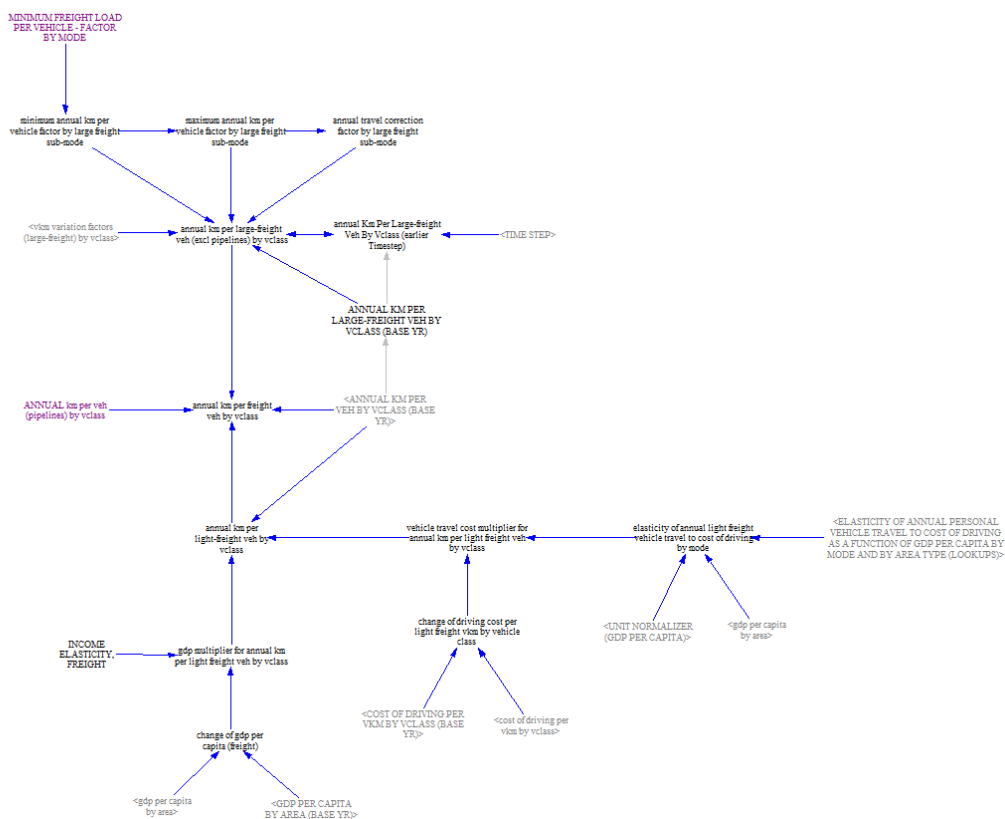
The view is intended to calculate the annual travel per vehicle over time for the freight transport service. Light-freight and large-freight vehicles are treated in different ways. The evolution of the annual travel in case of light freight-vehicles is considered in a way that is similar to the approach used for personal passenger road motor vehicles. The travel of large-freight vehicles depends on the variation of the activity (vkm) and exogenous factors that limit the impact of such variation on the travel component.

Structure

Figure 20.1 shows the sketch corresponding to this view.

The top part of the view deals with the annual travel per vehicle for large-freight according to the changes of vkm and minimum/maximum travel factors. The bottom section targets the estimation of the annual travel for light-freight vehicles. This takes into account the influence of certain variables such as the GDP per capita and the cost of driving. Their impact is applied through elasticities. The central part of the view gathers information on the annual travel per freight vehicles by area, mode and vehicle class in a single variable.

Figure 20.1 Sketch of the view "Travel per vehicle (freight)"



Detailed description of the view

Inputs

The annual travel per vehicle by vehicle class at the base year is an exogenous input from the user ("User Inputs (BASE Y)" sheet of the ForFITS Excel file). This is used in this view as starting point to determine its evolution over time according to several parameters.

Large-freight vehicles (LARGE ROAD, RAIL, AIR, VESSELS)

Vkm result from the product of vehicle stock and annual travel per vehicle. Therefore, vkm changes forecasted over time may cause modifications on travel. The variable "VKM VARIATION FACTORS (LARGE-FREIGHT) BY VCLASS" is the ratio between the target vkm over time and the vkm at the base year. This parameter comes from the view "load (freight)" and is used here to evaluate the impact of the projected vkm on the annual travel per vehicle.

The minimum and maximum travel factors enable to set a range in which the annual travel per vehicle must be always. The logic behind the range is that the vkm variations fully impact in the travel per vehicle as long as this component remains within the limits set by the factors. However, when the magnitude of the vkm variations moves the annual travel per vehicle out of the range, then the variations are partly absorbed by changes in the vehicle stock component.

The minimum and maximum travel factors are currently set (by using exogenous inputs on "MINIMUM FREIGHT LOAD PER VEHICLE - FACTOR BY MODE") in a way that the annual travel per vehicle remains always constant over time. With the current settings, changes in vkm are fully absorbed by changes in the vehicle stock without any impact on the travel component. In the future, ForFITS may be adapted to distribute the vkm variations between the two components. In this case, the minimum and maximum travel factors setting the width of the range could be defined depending on the magnitude agreed to be absorbed by each component.

Light freight vehicles (TWO WHEELERS, THREE WHEELERS, LDVS)

The annual travel per vehicle in case of light freight is modified by changes in the GDP per capita and the cost of driving. The variation of annual travel on light freight vehicles is calculated applying the same logic used for personal passenger vehicles (this is the reason because the bottom of this view looks like the right side of the view "travel per vehicle passenger").

An increase of the GDP per capita triggers a rise in the annual travel per vehicle, while a decrease in the income level results in a lower use of the vehicle. The impact is quantified through an elasticity that is an exogenous input set by default as 0.02 (same as in personal passenger vehicles).

An increment of the cost of driving provokes a reduction in the annual travel per vehicle, while an increased cost leads to a higher use of the vehicle. The elasticities through which this effect is applied are the applied for personal passenger vehicles, but in this case the elasticities correspond always to the GENERAL area, since there is no area characterization for freight (no distinction between URBAN and NON-URBAN). These elasticities are function of the GDP per capita. This means that the impact caused by a variation of the cost of driving is assumed to have different magnitudes depending on the income level. In particular, the annual travel per vehicle is more elastic in low average income scenarios and more rigid at higher values of GDP per capita.

The variations of GDP per capita and cost of driving over time (compared to the base year values) are deduced from user inputs on economic parameters ("Socio-economic data" sheet of the ForFITS Excel file) and endogenous inputs on cost per vkm from the view "cost of driving".

NMT and pipelines

The network extension in the case of pipelines is directly a time dependent user input ("User inputs (over time)" sheet of the ForFITS Excel file).

Non-motorized modes are not considered in freight transport.

Outputs

Large-freight vehicles (LARGE ROAD, RAIL, AIR, VESSELS)

The minimum and maximum factors are multiplied by the initial annual travel per vehicle in order to set the limits that the variable should never exceed, as in the equations below.

Min. annual travel per vehicle = Annual travel per vehicle at the base year × Min. factor

Max. annual travel per vehicle = Annual travel per vehicle at the base year × Max. factor

When a variation of vkm falls in the range set by the minimum/maximum factors, the annual travel per vehicle absorbs the variation, as in the equation below.

Annual travel per vehicle = Annual travel per vehicle (base year) × $\frac{\text{target vkm}}{\text{vkm (base year)}}$

If the vkm variation does not fall in the range set by the minimum/maximum factors, the approach outlined in the equations below is adopted.

If annual travel per vehicle > Max. annual travel per vehicle

Annual travel per vehicle = Annual travel per vehicle at the base year

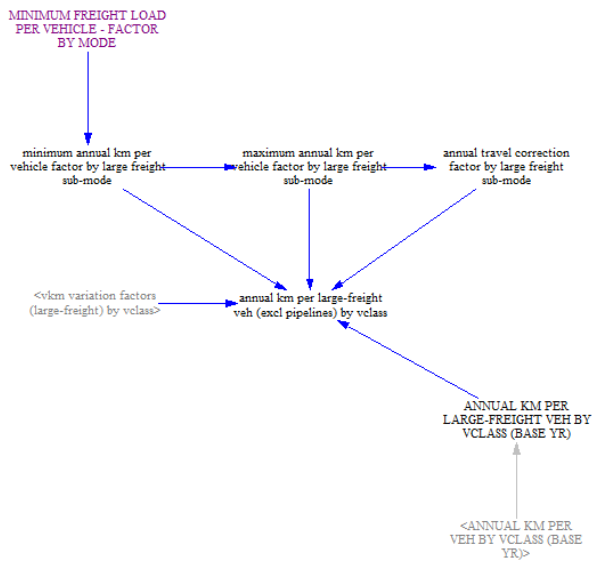
If annual travel per vehicle < Min. annual travel per vehicle

Annual travel per vehicle = Min. annual travel per vehicle

In the current version of ForFITS, the minimum and maximum travel factors are set by default to 1. This means that the annual travel per vehicle is forced to remain always at the base year value and in consequence the vkm variations are entirely passed to the vehicle stock component. This aspect may be further improved in order to distribute appropriately the impact between the two components taking into account the particular case of the user.

Figure 20.2 shows the Vensim sketch corresponding to the calculations flow that results in the annual travel per vehicle over time for large-freight service.

Figure 20.2 Annual travel per vehicle for large-freight service – Vensim sketch



Light freight vehicles (TWO WHEELERS, THREE WHEELERS, LDVS)

The GDP per capita is assumed to influence the annual travel per vehicle. The elasticity of the annual travel per vehicle with respect to the GDP per capita is part of the multiplier applied to the travel per vehicle in the base year.

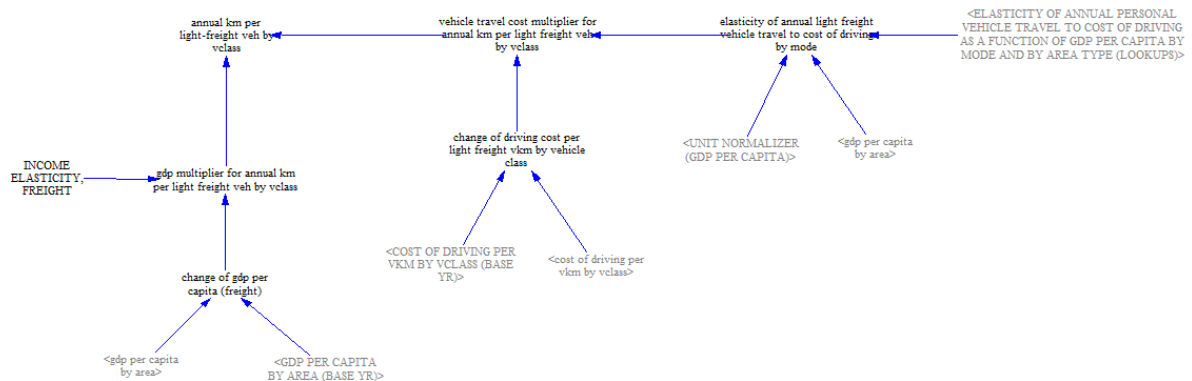
$$GDP \text{ multiplier for travel per vehicle} = 1 + \% \text{ change of the GDP per capita} \times \text{Income elasticity}$$

A similar procedure is used to calculate the multiplier that modifies the annual travel per vehicle due to variations of the cost of driving. The percentage change of the cost is calculated and the specific elasticity to be applied is derived from the value of the GDP per capita over time.

$$Cost \text{ multiplier for travel per vehicle} = 1 + \% \text{ change of cost of driving per vkm} \times \text{Cost elasticity}(GDP \text{ per capita})$$

Figure 20.3 shows how both multipliers affect the annual travel per vehicle at the base year to provide the annual travel per vehicle over time under the effect of the relevant factors.

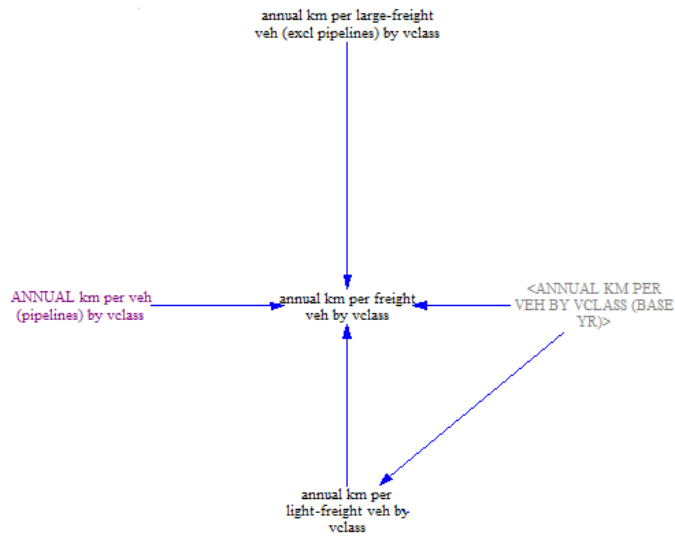
Figure 20.3 Annual travel per vehicle for light-freight service – Vensim sketch



Annual km per freight vehicle by vehicle class

Finally, the annual travel per vehicle for all freight modes and vehicle classes is determined by means of gathering the outputs from the two previous sections plus the exogenous input for pipelines (Figure 20.4).

Figure 20.4 Annual travel per freight vehicle by area, mode and vehicle class – Vensim skecth



The variable "ANNUAL KM PER FREIGHT VEH BY VCLASS" is used in the view "travel per vehicle" to be disaggregated at the powertrain level in order to differentiate across the technologies.