# APERC Transport model

The Aperc transport model is intended to provide a simple to use and understand model of transport energy economies. The input data has been limited to what was deemed essential. It’s structure is designed to be intuitive, and the code, easy to read.

The model’s input data is as follows, split into base year data and growth rate data:

Below is a schema that details the columns used in the model, split into **change state** **n** and **base year + n** to try and give some idea as to the process. You can think of the model as a big for loop that will iterate through each year from the base year to the final forecasted year, calculating the values for each year using the values from the year before, growth rates and user defined values. The change state dataframe is just the dataframe where all the operations take place before finalizing the new year’s values.

Activity, Energy and stocks are the data types that are usually analysed after the model has been run, but the other input data is just as important for forecasting the data.

# Transport data

Transport data is difficult to collect because of the need for total stocks, total travel km, occupancy rates and so on. As of yet, there are few central sources of data, so keeping track of data sources for most datasets is important. (i.e. labelling where travel km for economy X is from)

These issues lead to a major difficulty for the user of the transport model to acquire and use new data because this data are usually of different formats and incomplete.

This leads to a need to maintain a space within or side by side to the transport model for cleaning and preparing input data. Currently this is done within the same workflow as the transport model but as we work towards building an official process for getting new transport data, this process should probably be moved towards a standalone process.

Below is a brief overview of the current process for cleaning and preparing data for the transport model:

This is just a guide, cleaning data changes according to the needs and can sometimes be too messy to fit into these boxes. And sometimes it is not even worth designing processes that are intended to be reused or reread even.

There is consideration of working with iTEM to build a open source transport database to provide a sustainable solution to the data problems.

## Categories for data used in aperc transport data are currently:

|  |  |  |
| --- | --- | --- |
| Category/column name | Description | Format |
| Year |  |  |
| Economy | labelled with APERC naming convention, eg, 01\_AUS = Australia. There is a mapping from these codes to their real names in the config/utilities folder. | The same format as the economy labels |
| Transport Type | either 'Passenger' or 'Freight'. | All in lower case |
| Medium | either of ['road', 'air', 'ship', 'rail'] | All in lower case |
| Vehicle Type | if the medium is not road, this is the medium, but if the medium is road, it could be one of ['2w', 'ht', 'lt', 'lv'] or even a new vehicle type | All in lower case |
| Drive | if the medium is not road, this is the medium, but if the medium is road, it can be one of ['d', 'g', 'bev', 'cng', 'phevg', 'phevd'] or even a new drive type | All in lower case |
| Scenario | One of the scenarios used in the model. | Begins with Capital letter |
| Fuel | Any fuel type used in the transport system. Fuel type named using the APERC naming conventions. The mappings for these to other naming conventions used in APERC should be in ./config/utilities/ | All in lower case |
| Measure | A label to describe what measure the data is in. | All in lower case |

## Measures used in the transport model and their definitions

|  |  |
| --- | --- |
| Activity |  |
| Freight tonne km |  |
| Passsenger km |  |
| Energy |  |
| Energy use by drive type |  |
| Energy demand by fuel type (eg. PHEV's) |  |
| Energy supply by fuel type (eg. biofuel mixing) |  |
| Stocks |  |
| Other factors |  |
| turnover rates | The percent of vehicle stocks removed from the total stocks each year. |
| occupancy and load factors | Depending on transport type, this reflects the average number of people who use a vehicle at a time, or the average tonne’s transported by freight transport, for a given vehicle type. |
| new vehicle efficiency | The efficiency for the average new vehicle introduced to the vehicle stocks in a given year. |
| non road efficiency | We assume there is only 1 stock in the non-road mediums, so the rate that efficiency is improved each year is just a flat growth rate on top of the current efficiency. |
| Demand side fuel mixing | The share of a certain fuel type used in a certain drive type, for a certain vehicle type. This is focused on the demand side, so for any cases where other fuel types are mixed in the supply side, this assumes only the original fuel is used, eg. For biofuel mixing into diesel, the demand side will assume this mixed diesel is just diesel. |
| Supply side fuel mixing | The share of a certain fuel type used in a certain drive type, for a certain vehicle type. This is focused on the supply side so it is only focused on the mixing of fuels into an original fuel type, for example biofuel mixing. |
| User Adjustments | User adjustments are intended to allow for changes to growth rates where the user doesn’t fully understand the effect of the changes? **But what is the point since the user also doesn’t understand the effect of these changes.** |
| vehicle sales share adjustment |  |
| occupancy and load adjustment |  |
| turnover rate adjustment |  |
| new vehicle efficiency adjustment |  |
| non road efficiency adjustment |  |
| Intermediary measures |  |
| Travel km |  |
| Surplus stocks | If new stocks needed each year is negative then we have too many preexisting stocks. In this case, we will assume that the absolute amount of this negative value of new stocks needed will sit in surplus. This can occur because ??? |
| Activity growth |  |
| Efficiency |  |
| Travel\_km\_per\_stock |  |
| Vehicle\_sales\_share | The share of drive types for each vehicle type sold, normalized so the sum of shares for each transport type sums to 1. |
|  |  |
|  |  |

# Units

Currently it is not clear how the data’s units are defined. It is assumed that by cross refereincing the data the user can learn this easily. They are based on the data used for the 8th edition outlook.

# Osemosys integration

The transport model output is currently intended to be used by the APERC osemosys model, so the transport model needs to put its output data into the format needed by this.

So the outputs are:

**Accumulated Demand** = the total activity, by transport type, vehicle type and drive type.Please note that it doesn’t reflect the amount of activity by fuel type.

**Input Activity Ratio** = not efficiency, but like efficiency. Calculated as energy by fuel type, divided by Accumulated Demand, so it indicates the share of energy in each fuel type, drive type category, for each unit of activity in each drive type.

# Model simulation

The spreadsheet model\_simulation.xlsx is intended to simulate the way the transport model works so that you can more easily understand it than reading the code.

# Comparing the 8th edition model vs this:

Below is the schema that was used for the 7th and 8th edition models. An effort has been made to provide more useful information than this by focusing on measures used rather than the categories of data included.

Graphical user interface, text

Description automatically generated

Generally it seems the models have the same inputs, the real change with this model is an effort to make it more easily usable. However, the output data is not the same. Because of the issues with the code in the 8th edition, its not expected that we will be able to make the new model replicate the results from the 8th edition exactly (even using the same inputs). Below is a graph of total stocks, activity and energy per vehicle type / drive type combination:

# Visualising data

* It’s important that it is easy to inspect the outputs from the system.
  + Useful for my own analysis
  + Useful for communicating with the economy’s
* Big effort is being put towards developing easy-to-use plotting of charts I expect I will use often.

# Useful sources

# To do list:

**Estiamtion of international transport use of bunkers supply** – probably calculate the average efficiency of international transport and then calcalate total activity using this energy supply. There is also a small chance that the ESTO/EGEDA team has estimated this kind of data so we could use their estimates.

**Pipeline transport** – it is unclear how this was done in the 7th and 8th editions. Perhaps we could see if there are any estimates already done within APERC for historical data. Otherwise some sort of factor will need to be found. The forecasts will be simple.

**Capital costs model –** it is intended that this would also provide a space for looking at how many new EV’s are needed for an economy to reach its goals, e.g. California 100% by 2035. Intention is that battery shortages are looked into.

Data