EU Transport GHG: Routes to 2050?

SULTAN Illustrative Scenarios Tool – User Guide

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1   Using the SULTAN Illustrative Scenarios Tool

This section comprises a basic user-guide to the SULTAN (**SU**stainab**L**e **T**r**AN**sport) Illustrative Scenarios Tool that is written so that it can be provided as a stand-alone document.

1.1   About SULTAN

The SULTAN Illustrative Scenarios Tool was developed for the European Commission's Environment Directorate-General as part of the *EU Transport GHG: Routes to 2050?* Project. The project as a whole reviewed the options – technical and non-technical – that could contribute to reducing transport's greenhouse gas (GHG) emissions, both up to 2020 and in the period from 2020 to 2050.

SULTAN is a Microsoft Excel-based tool that can be used to investigate GHG emissions, and some other quantities, associated with transport from the EU-27 countries in the period 2010-2050. It allows users to create and edit 'Policy Scenarios' – illustrative scenarios for the EU transport system that make assumptions on how policy has impacted on the system – and then view the outcomes of the scenarios in terms of GHG emissions, some other pollutant emissions, and some costs.

The tool is freely distributed and all aspects can be viewed and edited by users should they wish, though this user guide only covers those aspects needed to view, edit and run Policy Scenarios through the tool.

1.2   Purpose and Limitations

1.2.1   Purpose

The purpose of the tool is to allow preliminary scoping of illustrative Policy Scenarios; to help answer the question: **what is the scale of action required to get to a sustainable transport system in Europe?**

The aim of the tool is to help transport and climate change stakeholders to develop Policy Scenarios, based on assumptions on how policy will impact the future transport system, and then to allow them to quickly and easily view the GHG emissions that would result from the system under the Policy Scenario developed.

The tool covers the following areas:

- **GHG emissions** are covered in the most detail;

- **PM and NOx emissions** (particulate matter and nitrous oxide emissions) are included but only to give an approximation of their magnitudes;

- **Stock and activity** are explored as a necessary intermediate step to estimating emissions;

- **Costs** associated with buying and operating vehicles are also considered, though in less detail than emissions.

1.2.2   Limitations

When using any tool that produces results for forty-year time frames it is important to be aware of the limitations and to treat the outputs with caution.

The calculations in this tool are relatively simple compared to more complex and comprehensive models (such as TREMOVE). This helps it to be transparent, and its various simplifying assumptions

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allows a very diverse transport system to be treated in a consistent way and also facilitates high-level/scoping scenario analysis to be carried out relatively quickly. However, this means that the outputs are estimates of scale only and are not suitable for many of the uses typically associated with more detailed policy studies, such as for example cost-benefit analysis.

Where this tool can be used is to quickly assess impacts of different options individually, or to assess the magnitude of shift in the transport system that is required to meet a given emissions target, with some indication of how this might impact costs. It allows various long-term policy options to be compared in a structured way, to promote further discussion and research.

SULTAN Illustrative Scenarios Tool is a basic scoping tool and the outputs should be treated as such. The results are calculated directly from the inputs; there is no optimisation, and no feedback loops that adjust some quantities in reaction to others. Please note that the results are provided to the full accuracy used in calculation, but this does not reflect the error bounds inherent in them.

The user must estimate the impacts of policy or other options/measures. The tool will then indicate how these impacts effect emissions, etc. from the transport system. Estimating the impact of policy, even retrospectively, is very challenging.

Extrapolation of transport demand and impacts beyond 2030 is highly uncertain. With such uncertainty in the inputs, the relative benefits of using more complex models may not be so great over this time frame. This is one reason why this tool does not attempt sophisticated modelling techniques.

1.3   Basic structure

The tool comprises four separate MS Excel files:

- **The Tool workbook** itself contains the calculation engine used to produce results from a set of inputs. It also contains fixed (does not change between Policy Scenarios) datasets, and user interfaces to run the tool and view and edit Policy Scenario inputs.

- **The Policy Scenario database** contains all the inputs for each Policy Scenario, stored in a database format. These inputs could be edited directly, but to make this process easier the tool workbook contains an editor sheet.

- **The Results database** is generated when the tool is run, and contains all of the output data for each Policy Scenario that is run through the tool, stored in a database format. The results can be viewed directly, but a Results Viewer (see below) is provided to make it easier for users to quickly view the results.

- **The Results Viewer** is a separate tool that generates a series of summary tables and charts to allow quick viewing of Policy Scenario results, by loading data from a Results database.

Figure 1:   Schematic diagram of the separate files making up the SULTAN Illustrative Scenarios Tool
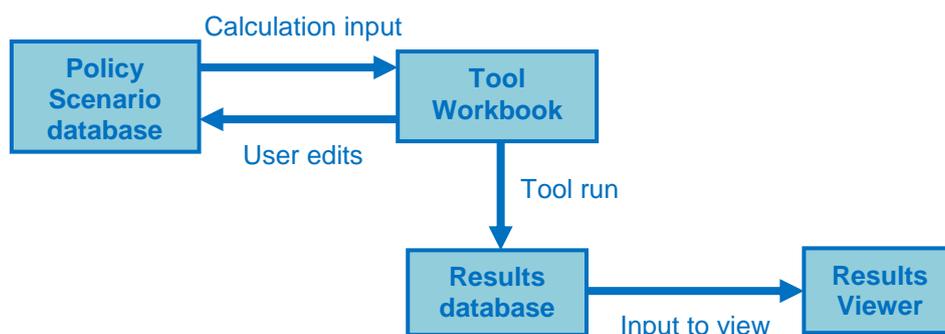
1.3.1   Glossary of terms

The tool, databases and results viewer use some shorthand terms to refer to aspects of the transport system and Policy Scenarios. For clarity, they are defined below.

Policy Scenario

An illustrative scenario of the EU transport system where certain policies have been implemented, and assumptions made on the impacts of these policies on the system. Each policy scenario contains enough information to estimate the emissions, and some of the costs, associated with the transport system in the EU between 2010 and 2050.

Policy Scenario Number

Each group of Policy Scenarios that use the same overall policy options or instruments has a Policy Scenario number.

Policy Scenario Version

Variants on a Policy Scenario that explore the same policy options or instruments (with a Policy Scenario number) but that make different assumptions on the mode(s) affected, or the effectiveness of the policy that is implemented.

Payload

A generic term for the quantity being transported, meaning either passenger (passengers) or freight (tonnes) depending on the mode in question.

Mode

Modes perform different functions within the transport network. Different modes satisfy different types of passenger \ freight demand (e.g. high or low value goods) and \ or provide different range, speed or flexibility of transport.

Powertrain

Powertrains are (usually) interchangeable technologies used to power vehicles within a mode. All vehicles in a mode fall into one of the powertrain categories within it. Each powertrain has different physical characteristics, e.g. cost, energy efficiency, fuels and load factor.

Fuel

Fuels are energy carriers that supply motive energy to powertrains. Each powertrain can be powered by up to three fuels, though only some powertrains are multi-fuel (e.g. plug-in hybrid electric vehicles). Each fuel has different emissions factors and costs per unit of energy supplied. Biofuels are not explicitly included as fuels in the tool; instead, they are implicitly accounted for by changing the emissions factors of conventional fuels.

Direct emissions

The emissions released from the point of use of the fuel or energy carrier (i.e. from the vehicle); sometimes termed 'tailpipe' or 'tank-to-wheel' emissions.

Indirect emissions

The emissions released during extraction, refining, transport and supply of a fuel or energy carrier; sometimes termed 'fuel cycle' or 'well-to-tank' emissions.

Combined emissions

The combined direct and indirect emissions; sometimes termed 'life cycle' or 'well-to-wheel' emissions.

Cost to society

The direct costs from purchasing an item or service excluding any government taxation or incentives, i.e. the pre-tax end user retail price. No externalities are included.

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Cost to consumer   The direct costs from purchasing an item or service, including all government taxation and incentives, i.e. the end user retail price. No externalities are included.

1.3.2   Modes, Powertrains, Fuels

Figure 2:   Structure of a Policy Scenario showing modes, powertrains and fuels
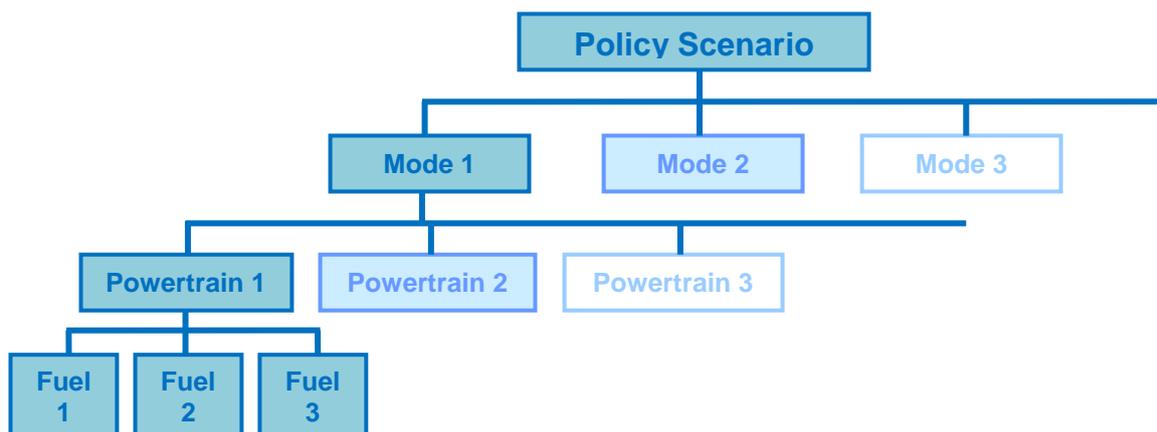

Figure 2 shows the structure of each Policy Scenario. Every Policy Scenario is divided into 13 modes (7 passenger and 6 freight); each mode contains up to 15 powertrains and up to 15 fuels (most have considerably less). For internal consistency, each mode has the same structure of inputs and results, and is calculated in the same way. Similarly, every powertrain and fuel in the tool has the same inputs and results.

Modes, powertrains and fuels are broadly defined as follows:

- **Modes** perform different functions within the transport network. Different modes satisfy different types of passenger \ freight demand (e.g. high or low value goods) and \ or provide different range, speed or flexibility of transport.

- **Powertrains** are (usually) interchangeable technologies used to power vehicles within a mode. All vehicles in a mode fall into one of the powertrain categories within it. Each powertrain has different physical characteristics, e.g. cost, energy efficiency, fuels and load factor.

- **Fuels** are energy carriers that supply motive energy to powertrains. Each powertrain can be powered by up to three fuels, though only some powertrains are multi-fuel (e.g. plug-in hybrid electric vehicles). Each fuel has different emissions factors and costs per unit of energy supplied. Biofuels are not explicitly included as fuels in the tool; instead, they are implicitly accounted for by changing the emissions factors of conventional fuels.

1.3.3   Input & Contextual help

All user-input cells have a help box that appears when the cell is selected. In addition, user interface sheets in the Tool and Results Viewer contain contextual help cells, which when selected display a box containing help on specific nearby items.

User-input cells are coloured yellow with a red border, and

?	Contextual help cells are coloured green with a question-mark symbol.

1.4 Viewing and Editing Policy Scenarios

Each Policy Scenario comprises a set of inputs for each mode. Through the Scenario Editor sheet in the main Tool workbook, it is possible to view and edit all the current Policy Scenario inputs, and create and edit new Policy Scenarios.

## 1.4.1 Edit an existing Policy Scenario

1	**Open the SULTAN Tool workbook**

Open the main Tool workbook in Excel.

You need to enable macros in order to use the Tool. This may require changing your Excel security settings.

2	**Select the Policy Scenarios source file to work with**

Select the 'Run' sheet. In box 1, click on the 'Change source file…' button to select a new Policy Scenario source file to work with:
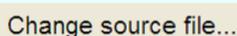
Change source file...

This will open a dialogue box to allow you to select the Excel file containing the Policy Scenario inputs you wish to edit. The tool will remember the last source file you selected, so if you wish to work on the same source file again you may skip this step.

The file name of the source file you have selected should now appear in box 1 under: '**Source File:**'

3	**Go to the 'Scenario Editor' worksheet**

You can select this sheet either by clicking on the 'Scenario Editor' sheet tab at the bottom of the Excel window, or by clicking the button:

Go to Scenario Editor
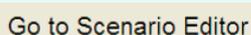
In box 1.

4	**Select the Policy Scenario and Mode to view \ edit, and the Reference Policy Scenario**

At the top of the Scenario Editor sheet there are two user inputs: Policy Index (Policy Scenario Number – Version) and Mode:

Policy Index: **BAU-a**

Mode: **Car**

Click on the cells and select the Policy Scenario and Mode you wish to view \ edit from the drop-down boxes.

Scroll right to select the Reference Policy Scenario. This is the Policy Scenario that is displayed for comparison on the charts. The Reference Policy Scenario is selected in exactly the same way as the editable Policy Scenario, by clicking on the user input and selecting from the drop-down box.

When you have made your selections, click the 'Load from database' button to display the current values of the inputs:

Load from database

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5   View and edit Policy-specific and Mode-specific inputs

The Scenario Editor sheet is divided into two columns. On the left-hand side are the user inputs for the selected Policy Scenario (cells with a yellow fill and red border). On the right-hand side are the same inputs displayed for the Reference Policy Scenario you selected in step 4 (not editable). In between the two, you can choose to display charts showing a comparison of the Policy Scenario being edited with the Reference Policy Scenario. This allows you to see the impacts of any changes as you make them, and to see how they compare with another Policy Scenario. Click the 'Show \ hide charts' button in the top centre of the Scenario_Editor worksheet to toggle whether the charts are visible:

Show \ hide
Charts

Inputs are divided into two sections:

Policy-specific inputs consist of demand and stock changes to all of the modes. You only need to edit these once per Policy Scenario (not for every mode). Demand and stock values are input in percentage terms, but to see how the inputs translate into absolute demand (passenger- or tonne-km) and stock (vehicles), click the 'Show \ hide…' buttons located in the title bars of the tables, e.g.:

Show \ hide passenger demand table

Mode-specific inputs are related to the powertrains, fuels and tax regime for specific modes. These are different for each mode **and** Policy Scenario.

Simply change the values in the input cells to edit the Policy Scenario. The charts will update automatically to show how your changes compare to the Baseline Policy Scenario.

In addition, some 'Sense Check' tables are provided that show some of the implications of the Policy Scenario. Viewing these tables may provide insight as to whether the changes you are making will lead to realistic results.

For more information on the inputs and some guidance on how to change them, see Table 1 at the end of this section.

6   Save changes

Once you have made all the desired changes to a particular Policy Scenario and Mode, you need to update the Policy Scenario database file. Do this by clicking the button 'Save to database':

Save to database

If you wish to overwrite the inputs from one Policy Scenario with the inputs from another, you can load inputs from one Policy Scenario using step 4 above, then change the Policy Index input cell at the top of the sheet to the Policy Scenario you wish to overwrite. Now, clicking on 'Save to database' will overwrite the inputs for the Policy Scenario you have just selected with the inputs displayed on the screen. Overwriting inputs for one mode with inputs for another is **not** recommended.

Note: there is no undo function once you have clicked 'Save to database'. However, changes are not finalised until you save the Excel file containing the Policy Scenario database – if you close this file without saving, all changes made since you last saved the file will be lost.

Table 1:   Details of policy-specific inputs that can be edited by the user

1. Policy-Specific Inputs – details					
Section	**Name**	**Unit**	**Description**	**Potential Impacts** (on other inputs)	**Examples**
	Policy description	N/A	A brief description of the policy scenario, used to identify it when viewing Policy Scenario inputs and results.	N/A	N/A
	Version description	N/A	A brief description of the policy version, used to identify it when viewing Policy Scenario inputs and results.	N/A	N/A
Demand *(Policy-specific inputs)*	New modal split of passenger demand	% of BAU total passenger-km	The change in passenger demand due to the impacts of the Policy Scenario. Expressed as a percentage of the total business-as-usual demand for passenger transport (i.e. the total demand in passenger-km in the whole transport system); this unit allows for adjustment of demand for all passenger modes simultaneously in the Policy Scenario editor, to model the effects of modal shift.	Large changes in demand are likely to impact vehicle stock. Depending on the physical reason for the change in demand, split of vehicle demand by travel location type, split of new vehicle sales by powertrain and powertrain average capacity factor values may change to reflect a change in the fleet characteristics.	To effect a modal shift of 5% of total passenger transport from Car to PassengerRail, subtract 5% from Car values, and add 5% to PassengerRail values. To effect an overall demand reduction of 10% against the BAU scenario in all modes, change values so that the total at the bottom of this input table is 90%.

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1. Policy-Specific Inputs – details

Section	Name	Unit	Description	Potential Impacts (on other inputs)	Examples
	New modal split of freight demand	% of BAU total tonne-km	The change in freight demand due to the impacts of the Policy Scenario. Expressed as a percentage of the total business-as-usual demand for freight transport (i.e. the total demand in tonne-km in the whole transport system); this unit allows for adjustment of demand for all freight modes simultaneously in the Policy Scenario editor, to model the effects of modal shift.	Large changes in demand are likely to impact vehicle stock. Depending on the physical reason for the change in demand, split of vehicle demand by travel location type, split of new vehicle sales by powertrain and powertrain average capacity factor values may change to reflect a change in the fleet characteristics.	To effect a modal shift of 5% of total freight transport from HeavyTruck to FreightRail, subtract 5% from HeavyTruck values, and add 5% to FreightRail values. To effect an overall demand reduction of 10% against the BAU scenario in all modes, change values so that the total at the bottom of this input table is 90%.
Stock *(Policy-specific inputs)*	Change in stock due to policy	% change on BAU stock	The percentage change in vehicles in circulation compared with the business-as-usual projection.	Large changes in stock are likely to impact on total vehicle demand (though usually demand would drive stock, see above). If the change in stock is accompanied by changes in the fleet breakdown by powertrain, then split of new vehicle sales by powertrain and powertrain average capacity factor values may change.	To effect a 5% decrease in total Car a numbers from 2020 onwards compared with the business-as-usual, input -5% under years 2020, 2030, 2040 and 2050 against Car.

Table 2: Details of mode-specific inputs

2. Mode-Specific Inputs – details					
Section	**Name**	**Unit**	**Description**	**Potential Impacts**	**Examples**
	Activation	'Yes' or 'No'	A quick way to toggle the effects of a Policy Scenario on an individual mode on and off. If a mode is active, then its inputs are used when calculating results. If it is not active, it is assumed that the Policy Scenario has no impact on the mode, and inputs from the baseline policy scenario are used instead (except for stock and demand effects due to modal shift).	None. If activation is set to 'No', none of the mode-specific inputs for this Policy Scenario and mode are used in calculation of the results; the equivalent inputs from the Baseline Policy Scenario (specified on the 'Run' worksheet) are used instead.	For a Policy Scenario involving the extensive use of biofuels, the effect of using biofuels only in certain modes could be investigated by changing the activation to remove the impact of the policy on some modes.
	Split of vehicle demand by travel location type	% of total vehicle demand (veh-km)	The proportion of vehicle-km for a mode that occur in a given type of geographical location. Example location types for roads would be: motorway, urban road, non-urban road.	Could impact the type of powertrain used or the way they are used (split of new vehicle sales by powertrain, powertrain average capacity factor, blanket reduction in fleet energy consumption).	When considering modal shift from car to bus, it is mainly urban travel that can shift, so modal shift would result in a reduced proportion of urban car travel.
Powertrains *(Mode-specific inputs)*	Split of new vehicle sales by powertrain	% of total new vehicle sales	The proportion of new vehicle sales in a given year consisting of vehicles of this powertrain type.	If a shift in split by powertrain has cost implications, it could impact demand and stock due to consumer sensitivities (or taxes could change to compensate)	To effect an aggressive penetration of electric vehicles (EVs) in Cars, increase the proportion of the EV powertrain type compared with the BAU proportions from 2020 onwards.
	Powertrain average capacity factor	% of maximum payload capacity	The proportion of maximum capacity, in passengers or tonnes of freight, that an average vehicle fills on an average journey.	Greater capacity factors could result in cost reductions that might result in increased demand due to rebound effects.	To simulate more effective loading of short-haul flights, increase the average capacity factor for EUAviation.

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2. Mode-Specific Inputs – details

Section	Name	Unit	Description	Potential Impacts	Examples
	New vehicle average energy consumption	MJ/km	The amount of external energy supply needed on average per km of travel for an average new vehicle.	Increases in some powertrain energy efficiencies could result in a greater proportion of new vehicles of that powertrain. More efficient vehicles are likely to be cheaper to operate which could lead to an increase in demand through rebound effects	To simulate improved efficiency in gasoline and diesel cars due to technological improvements, reduce the energy consumption of these powertrain types.
	Blanket reduction in fleet energy consumption	% change on fleet energy consumption	The percentage reduction in vehicle energy consumption (MJ/km) affecting all vehicles in the fleet across the entire mode in a given year. This could be caused by, for example, a reduction in road speed limits.	As above, a reduction in energy consumption is likely to reduce operating costs, which could increase demand through rebound effects.	Examples of measures that could improve energy consumption across the fleet would be: reduced vehicle speeds or accelerations, or retro-fitted efficiency technologies.
	Blanket reduction in new vehicle energy consumption	% change on new vehicle energy consumption	The percentage reduction in vehicle energy consumption (MJ/km) affecting all new vehicles entering the fleet across the entire mode in a given year. This could be caused by, for example, acceleration limiters being fitted to all new passenger cars.	As above, a reduction in energy consumption is likely to reduce operating costs, which could increase demand through rebound effects.	Examples of measures that could improve new vehicle energy consumption across the fleet would be: mandatory efficiency technologies in new vehicles.

2. Mode-Specific Inputs – details

Section	Name	Unit	Description	Potential Impacts	Examples
	Powertrain fuel use	% of total energy use	The proportion of total external energy used by a vehicle that is supplied by a given fuel or energy carrier. (most relevant to plug-in hybrid road vehicles that use varying proportions of gasoline \ diesel and electricity).	A move towards cheaper fuels is likely to reduce operating costs, which could increase demand through rebound effects.	If battery plug-in hybrid vehicles saw an improvement in battery technology that allowed them to travel further in electric-only mode, the proportion of electricity use per km would increase.
Fuels *(Mode-specific inputs)*	Fuel direct GHG emissions factor	$kgCO_2e/MJ$	The amount of GHGs released when one MJ of fuel or energy carrier is utilised at the point of use (by the vehicle). Also known as tailpipe or tank-to-wheel emissions.	May change fuel duty or vehicle purchase or annual tax if they are CO_2-linked.	Direct fuel decarbonisation (for example through the introduction of biofuels) would reduce the direct GHG emissions factor.
	Fuel indirect GHG emissions factor	$kgCO_2e/MJ$	The amount of GHGs released extracting, refining, transporting and supplying one MJ of fuel or energy carrier to the vehicle. Also known as fuel-cycle or well-to-tank emissions.	May change fuel duty or vehicle purchase or annual tax if they are CO_2-linked.	Fuel cycle decarbonisation (e.g. decarbonising grid electricity by using more low-carbon generation) would reduce the indirect GHG emissions factor; some fuel decarbonisation (e.g. some biofuels) may increase it.
	Fuel PM emissions factor	g/MJ	The amount of particulate matter released when one MJ of fuel or energy carrier is utilised at the point of use (by the vehicle). Also known as tailpipe or tank-to-wheel emissions.	May change fuel duty or vehicle purchase or annual tax if they are PM-linked.	Changing the fuel combustion technology may result in a change in PM emissions factor.

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2. Mode-Specific Inputs – details					
Section	**Name**	**Unit**	**Description**	**Potential Impacts**	**Examples**
	Fuel NOx emissions factor	g/MJ	The amount of nitrous oxide released when one MJ of fuel or energy carrier is utilised at the point of use (by the vehicle). Also known as tailpipe or tank-to-wheel emissions.	May change fuel duty or vehicle purchase or annual tax if they are NOx-linked.	Changing the fuel combustion technology may result in a change in NOx emissions factor.
Taxes & Subsidies *(Mode-specific inputs)*	VAT	% of price	The value-added tax levied on all consumer prices (vehicle capital and annual cost, fuel cost) after all other taxes or duties.	Changing the cost of transport may impact upon demand.	
	Powertrain purchase tax	% of marginal cost	The tax, as a percentage of pre-tax retail price, levied on an average new vehicle.	Changing the purchase tax on a powertrain may make it more or less appealing to end users, which could change demand and the proportion of new vehicle sales.	This input would need to be changed to reflect any tax banding on new vehicles (e.g. CO_2-based passenger car taxation)
	Powertrain purchase support	% of cost to society	The purchase support, as a percentage of pre-tax retail price, granted on an average new vehicle. (Net tax is tax less purchase support)	Changing the purchase support on a powertrain may make it more or less appealing to end users, which could change demand and the proportion of new vehicle sales.	This input would need to be changed to reflect any grant schemes to incentivise low-carbon vehicle technologies (e.g. capital grants for electric cars).
	Powertrain annual tax	€ per vehicle	The circulation or road tax levied on an average vehicle per year.	Changing the annual tax on a powertrain may make it more or less appealing to end users, which could change demand and the proportion of new vehicle sales.	This input would need to be changed to reflect any tax banding on vehicles (e.g. CO_2-based passenger car taxation)

2. Mode-Specific Inputs – details					
Section	**Name**	**Unit**	**Description**	**Potential Impacts**	**Examples**
	Fuel duty	€/MJ	The duty levied for one MJ of fuel or energy carrier, on top of its pre-tax retail price.	Changing the fuel duty is likely to impact significantly on the cost of transport per vehicle-km, which could affect demand and the proportion of new vehicle sales (based on the fuel they use).	This input would need to be changed to reflect any CO_2-based fuel duty to internalise the cost of carbon.
	Fuel subsidy	€/MJ	The subsidy supplied for one MJ of fuel or energy carrier, subtracted from its pre-tax retail price. (Net fuel duty is duty less subsidy)	Changing the fuel subsidy is likely to impact significantly on the cost of transport per vehicle-km, which could affect demand and the proportion of new vehicle sales (based on the fuel they use).	This input would need to be changed to reflect any CO_2-based fuel duty to internalise the cost of carbon.

1.4.2 Create a new Policy Scenario (or delete an existing one)

1 Open the SULTAN Tool workbook

Open the main Tool workbook in Excel.

You need to enable macros in order to use the Tool. This may require changing your Excel security settings.

2 Select the Policy Scenarios source file to work with

Select the 'Run' sheet. In box 1, click on the 'Change source file…' button to select a new Policy Scenario source file to work with:

Change source file...

This will open a dialogue box to allow you to select the Excel file containing the Policy Scenario inputs you wish to edit. The tool will remember the last source file you selected, so if you wish to work on the same source file again you may skip this step.

The file name of the source file you have selected should now appear in box 1 under: '**Source File:**'

3 Go to the bottom of the 'Scenario Editor' worksheet

The create and delete tools are located at the bottom of the 'Scenario_Editor' sheet. You can select this sheet either by clicking on the 'Scenario Editor' sheet tab at the bottom of the Excel window, or by clicking the button:

Go to Scenario Editor

In box 1 of the 'Run' sheet. Then scroll to the bottom to find the 'Create a new Policy Scenario' and 'Delete and existing Policy Scenario' boxes.

Alternatively, click the hyperlink 'Click here to create a new Policy Scenario' in box 1 of the 'Run' sheet.

4 To create a new Policy Scenario:

Use the left-hand box, titled 'Create a new Policy Scenario':

   a) **Define the Policy Scenario Number** for the Policy Scenario you want to create. You can either pick an existing Policy Scenario Number from the drop-down list in the right-hand box if you want to create a new Policy Version under that number, or enter a new Policy Scenario Number in the left-hand box.

   b) **Define the Policy Scenario Version** for the Policy Scenario you want to create. The combination of Policy Scenario Number and Version (termed the 'Policy Scenario Index') must not already exist.

   c) **Define the Policy Scenario to copy inputs from.** Select an existing Policy Scenario from the drop-down list. The new Policy Scenario will be created using all the inputs from an existing Policy Scenario defined by the user. This provides a useful starting point when creating a new Policy Scenario.

Once you have made your selections, click the button 'Create' in the top-right of the 'Create a new Policy Scenario' box to create:

Create

5	To delete an existing Policy Scenario:

a) **Select the Policy Scenario to delete.** Select an existing Policy Scenario from the drop-down list.

Once you have made your selection, click the button 'Delete' in the top-right of the 'Delete an existing Policy Scenario' sheet:

Delete

Note: there is no undo function once you have clicked 'Delete'. Make sure you have selected the correct Policy Scenario for deletion.

1.5 Editing Fixed Input Datasets

The majority of users of the SULTAN Illustrative Scenario Tool will only wish to view and edit Policy Scenario inputs. However, in addition to these inputs, there are some Fixed Inputs used by the tool to calculate results. Fixed Inputs do not vary with Policy Scenario, because it is assumed that they are unaffected by policy.

Each Fixed Input has three Datasets, which are interchangeable so that users can switch Dataset to use different Fixed Inputs based on different source data \ assumptions. Each Fixed Input has up to three different Datasets:

- **'Default'**, the dataset provided with the tool that is used by default, and
- **'A' and 'B'**, two user-editable datasets.

Using the 'Dataset_Editor' worksheet, users can view and modify the Datasets for Editable Fixed Inputs.

1	Open the SULTAN Tool workbook

Open the main Tool workbook in Excel.

You need to enable macros in order to use the Tool. This may require changing your Excel security settings.

2	Go to the 'Dataset_Editor' worksheet

Select the 'Dataset_Editor' worksheet using the sheet tabs at the bottom of the Excel window.

3	Select the Mode, Field and Dataset to view \ edit

At the top of the Dataset Editor sheet there are three user inputs: Mode, Field, and Dataset:

Mode: Field: Dataset:

Car **BAU stock** **Default**

Click on the cells and select the Mode, Field (the name of the series of Fixed Inputs) and Dataset you wish to view.

When you have made your selections, click the 'Load from database' button to display the current values of the Fixed Inputs:

Load from database

Note: the 'Default' Datasets can be viewed, but not edited as they are supplied with the tool.

4   View and edit the Fixed Inputs

The Database Editor sheet has a single table which contains the inputs for the selected Mode, Field and Dataset. Unless the dataset selected is 'Default', these values can be edited (cells with a yellow fill and red border).

You can also change the 'Dataset description', a short description that identifies each dataset.

For more information on the Fixed Inputs, see Table 3 at the end of this section.

5   Save changes

Once you have made all the desired changes to a particular Dataset, you need to update the Fixed Inputs database. Do this by clicking the button 'Save to database':

If you wish to overwrite the inputs from one Dataset with the inputs from another, you can load inputs from one Dataset using step 4 above, then change the Datset input cell at the top of the sheet to the Dataset you wish to overwrite. Now, clicking on 'Save to database' will overwrite the inputs for the Dataset you have just selected with the inputs displayed on the screen. Overwriting inputs for one mode with inputs for another is **not** recommended.

Note: there is no undo function once you have clicked 'Save to database'.

Table 3:   Fixed inputs contained within the 'DFleet' and 'DSurvival' worksheets

Applies to…	'Field' Identifier	Unit	Description
Modes	BAU stock	vehicles	The total number of vehicles for a given mode that would be present under a business-as-usual scenario.
	BAU payload demand	M payload-km	The total demand for transport in passenger- or tonne-km (payload is a generic term used to mean either passenger [p-km] or freight [t-km]) for a given mode.
	Baseline capital cost	2009 EUR	The basic pre-tax price (for what is considered to be the baseline powertrain) for an average vehicle in a given mode. For example, for cars this would be the average cost of a conventional gasoline car.
	Societal discount rate	%	The discount rate applied by society. In practice this may be constant for all modes.
	Consumer discount rate	%	The discount rate applied by the consumer (in this case, the entity making the vehicle purchasing decision). This can vary between modes depending on the decision-making process of the consumer.
Powertrains	Marginal capital cost	2009 EUR	The pre-tax price of the powertrain over and above the mode's baseline capital cost (see above).

Applies to…	'Field' Identifier	Unit	Description
	Annual cost	2009 EUR	The annual costs, excluding taxes, fuel and depreciation, associated with the operation of the vehicle.
	Maximum payload capacity	payload per vehicle	The maximum capacity (in passengers or tonnes) that the vehicle can carry under normal operation.
	Learning rate	factor	A factor that determines the rate at which the capital cost of a powertrain reduces with increased production (due to manufacturing and technological improvements and economies of scale).
	Initial stock	vehicles	An order-of-magnitude estimate for the number of units of a powertrain that have been manufactured in the EU prior to 2010 (used in the learning rate calculation). In practice, this is difficult to define and is used as a weighting factor based on practical experience of the cost evolution of the powertrain.
Fuels	Fuel cost	2009 EUR/MJ	The pre-tax retail unit price of the fuel or energy carrier.

1.6 Running the Tool

1 Open the SULTAN Tool workbook

Open the main Tool workbook in Excel.

You need to enable macros in order to use the Tool. This may require changing your Excel security settings.

2 Select the Policy Scenarios source file to work with

Select the 'Run' sheet. In box 1, click on the 'Change source file…' button to select a new Policy Scenario source file to work with:

Change source file...

This will open a dialogue box to allow you to select the Excel file containing the Policy Scenario inputs you wish to use. The tool will remember the last source file you selected, so if you wish to work on the same source file again you may skip this step.

The file name of the source file you have selected should now appear in box 1 under: '**Source File:**'

3   Select Policy Scenarios to run

The table below box 2 lists the Policy Scenarios contained in the source file. It lists the number, version, description, and activation matrix for each Policy Scenario. The activation matrix (far right of the table) shows whether each mode is active ('Yes') or not active ('No') in a Policy Scenario. If a mode is not active, then the Policy Scenario has no effect on that mode, except for on its journey demand and stock (due to, for example, modal shift).

Column 1 ('Selected') of the Policy Scenario table shows whether or not each Policy Scenario is selected to be run through the Tool and output into the Results file. Each cell displays the following:

Off	If a Policy Scenario is not selected, and
On	If a Policy Scenario is selected.

To change whether or not a Policy Scenario is selected, either click on the cell to toggle selection, or use the drop-down box once the cell is selected.

Only Policy Scenarios that are selected, with 'On' in the 'Selected' column, will be run through the tool and have results generated.

4   Select the Baseline Policy Scenario

Scroll down below the table of available Policy Scenarios to box 3. Here, you select the Baseline Policy Scenario.

Inputs from the Baseline Policy Scenario are used whenever a mode is not activated ('No' in the activation matrix section of the table of Policy Scenarios) in replacement of the Policy Scenario inputs for that mode. **The Baseline Policy Scenario should therefore represent the business-as-usual case for when no new policy is implemented.**

Select a Baseline Policy Scenario by clicking on the user input cell in box 3 (yellow fill with red border) and making a selection from the drop-down box.

5   Select datasets for Fixed Inputs

As well as the Policy Scenario inputs, the Tool workbook contains some Fixed Inputs that are used to generate results. These inputs are not usually edited when running the tool; however you can switch between different datasets based on different source data and \ or assumptions.

Box 4 contains the inputs to switch between datasets for four inputs: social and consumer discount rate, BAU vehicle stock and demand, and fuel costs. In addition, you can directly edit a custom dataset for social and consumer discount rates.

To select the dataset you wish to use, click on the user input cells (yellow fill with red border) for the four fixed inputs, and select a dataset from the drop-down list. A description of the dataset will display next to the input cell.

To edit the custom datasets for social and consumer discount rates, first select 'A' or 'B' from their dataset input cell ('Default' datasets cannot be modified). You will now see that the 'Values' table to the right of the input cell changes to input cells (yellow fill with red border). These cells can now be modified. To save changes you make, press the 'Save changes' button next to the values table:

Save changes
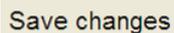
6	Run the selected Policy Scenario to generate results

Click the button 'Run selected Policy Scenarios' to begin generating results (for convenience there is one button at the top of the 'Run' sheet, and another in box 5 at the bottom of the sheet):

Run selected Policy Scenarios

You will be prompted to select a location and filename for the Results file which will be created by the tool to store the results. Once selected, the tool will begin calculating results. This takes between 10s and 1min 30 s per Policy Scenario, depending on the speed of your PC. Closing other programs and processes will speed up execution. The calculation status is displayed in the Status Bar at the bottom of the Excel window.

Once calculation is complete, the results file is ready to view with the Results Viewer.

1.7 The Results Viewer

The Results Viewer is a separate MS Excel file that is designed to allow users to quickly view and analyse the results of running Policy Scenarios through the tool. It does this by loading results from a Results Database file, generated from a Tool run, and displaying them in a series of summary tables and charts.

The Results Viewer contains seven worksheets:

- **'Main'**, where a Results Database file can be loaded for viewing;

- **5 Analysis sheets**, which are described in the following sections;

- **'Historical'**, which contains historical emissions records that are used for comparison elsewhere in the workbook.

To begin viewing results, follow the steps below:

1	Open the SULTAN Results Viewer workbook

Open the Results Viewer workbook in Excel.

You need to enable macros in order to use the Tool. This may require changing your Excel security settings.

2	Select the Results Database source file to work with

Select the 'Main' sheet. In box 1, press the 'Select results file to view' button to select a new Results Database source file to analyse:

Select results file to view

This will open a dialogue box to allow you to select the Excel file containing the Policy Scenario results you wish to view. The tool will remember the last results file you selected, so if you wish to view the same results file again you may skip this step.

The file name of the source file you have selected should now appear in box 1 under: '**Results File:**' The results file contents are displayed in a table underneath box 2 on the 'Main' sheet.

3   Go to an analysis page to view the results

You can navigate to one of the five analysis pages in two ways: using the sheet tabs at the bottom of the Excel window, or by clicking on the hyperlinks in box 2 of the 'Main' sheet.

Once on one of the analysis pages, there are a number of user input cells (yellow background with red border) at the top of the sheet; these are described in more detail below. Select these cells and choose an option from the drop-down box. The tables and charts on the analysis page update automatically when you change an input.

1.7.1   Individual Scenario

The Individual Scenario analysis sheet looks at a single Policy Scenario in detail. Changing the filters at the top of the sheet changes the scope of the results tables and charts; the filters are described in Table 4 below.

Table 4:   Description of filters on the Individual Scenario sheet in the Results Viewer

Individual Scenario Filters		
Filter	**Description**	**Tables effected**
Policy Scenario *(Primary filter)*	Selects which Policy Scenario to display results for.	All tables.
GHG emissions type	Selects whether to view direct, indirect or combined emissions results.	All emissions-based results (except cumulative emissions): tables A,D,H,I,J,K,L,M,Q,R.
Cost type	Selects whether to view costs to society or costs to consumer in cost-based results.	All cost-based results: tables U,V,W,X.
Reference scenario	Selects the Policy Scenario to be displayed as a reference (results are superimposed on some charts for comparison).	All results with a 'total' row: tables A,B,C,G,O,P,Q,S,T,Y.
Travel location type	Selects the travel location type to view results for. Note if a mode does not use the selected travel location type, it will display zero results when this filter is used. Select 'Sum All' to display all travel.	Effects tables A,C,D,E,G,N,O,P,Q,R,S,T. All other tables will be blank unless travel location type is set to 'Sum All'.
Mode	Selects the mode for which to view the breakdown of energy and emissions results by energy carrier. Select 'Sum All' to display the results for all modes.	All tables that give results by energy carrier: tables P,Q,R.

1.7.2   Individual Decomposition

The Individual Decomposition sheet examines the breakdown of GHG emissions from a Policy Scenario. It does this by comparing the GHG emissions to a reference (the Baseline Policy Scenario), and decomposing the difference into three categories:

- **System efficiency** is the change in GHG emissions due to a change in efficiency of the transport system bringing about a change in demand for transport (in passenger- or tonne-km). Improvements in transport efficiency could be bought about by, for example, better spatial planning, internalising external costs of transport, harmonising of transport taxes).

- **Vehicle efficiency (technical and operational)** is the change in GHG emissions due to vehicles using energy more or less efficiently (i.e. transporting more passengers or tonnes per MJ of energy), both by technical efficiency changes (making the vehicles more or less energy efficient) and by operational efficiency changes (using the vehicles more or less efficiently, shifting to more or less efficient vehicles or modes).

- **Energy GHG intensity** is the change in GHG emissions due to a change in fuel \ energy carrier GHG intensity, either by changing the GHG intensity of the fuel \ energy carrier (e.g. by blending fossil fuels with biofuels, decarbonising electricity generation) or by shifting use of fuels to those with a different GHG intensity (e.g. shifting from gasoline-powered cars to electric-powered cars).

The filters for this sheet, described in Table 5 below, are very similar to those in the Individual Scenario sheet. The filters allow users to view the decomposition for different Policy Scenarios, and different subcategories within each Policy Scenario.

Table 5:   Description of filters on the Individual Scenario sheet in the Results Viewer

Individual Decomposition Filters		
Filter	Description	Tables effected
Policy Scenario *(Primary filter)*	Selects which Policy Scenario to display results for.	All tables.
GHG emissions type	Selects whether to view direct, indirect or combined emissions results.	All tables.
Reference scenario	Selects the Policy Scenario to be displayed as a reference (decomposition is relative to the reference scenario).	All tables.
Travel location type	Selects the travel location type to view results for. Note if a mode does not use the selected travel location type, it will display zero results when this filter is used. Select 'Sum All' to display all travel.	All tables.
Mode	Selects the mode for which to view the breakdown of energy and emissions results by energy carrier. Select 'Sum All' to display the results for all modes.	All tables.

1.7.3   Multi Scenario, Single Year

The Multi Scenario, Single Year sheet lets users compare the breakdown of up to ten Policy Scenarios in a single year, displaying results side-by-side for easy comparative viewing. Table 6 below describes the filters that can be used on this sheet.

Table 6   Description of filters on the Individual Scenario sheet in the Results Viewer

Multi Scenario, Single Year Filters		
Filter	**Description**	**Tables effected**
Year *(Primary filter)*	Selects which year to view results for.	All tables.
GHG emissions type	Selects whether to view direct, indirect or combined emissions results.	All emissions-based results (except cumulative emissions): tables A,D,H,I,J,K,L,M,Q.
Travel location type	Selects the travel location type to view results for. Note if a mode does not use the selected travel location type, it will display zero results when this filter is used. Select 'Sum All' to display all travel.	Effects tables A,C,D,E,G,N,O,P,Q,R,S. All other tables will be blank unless travel location type is set to 'Sum All'.
Cost type	Selects whether to view costs to society or costs to consumer in cost-based results.	All cost-based results: tables T,U,V,W.
Mode	Selects the mode for which to view the breakdown of energy and emissions results by energy carrier. Select 'Sum All' to display the results for all modes.	All tables that give results by energy carrier: tables P,Q.
Select Policy Scenarios *(Primary filter)*	Selects which Policy Scenarios to compare results for.	All tables.
Enter custom descriptions *(Chart labels)*	Users can enter custom text against each Policy Scenario that will display on the chart labels instead of the Policy Scenario number and version.	All charts.

1.7.4   Multi Scenario, Full Timeseries

The Multi Scenario, Full Timeseries sheet allows comparative analysis of up to ten Policy Scenarios for the full period 2010 – 2050. However there is no breakdown by mode; instead users can choose which mode to view results for (or view the combined totals for all modes). Table 7 below describes the filters that can be used to change the type of results viewed on this sheet.

Table 7:   Description of filters on the Individual Scenario sheet in the Results Viewer

Multi Scenario, Full Timeseries Filters		
Filter	**Description**	**Tables effected**
Mode *(Primary filter)*	Selects which mode to view results for. Select 'Sum All' to display results for all modes.	All tables. Tables T,U,V,W will be blank if the mode is set to 'Sum All'.
GHG emissions type	Selects whether to view direct, indirect or combined emissions results.	All emissions-based results (except cumulative emissions): tables A,D,H,I,J,K,L,M,Q.
Travel location type	Selects the travel location type to view results for. Note if a mode does not use the selected travel location type, it will display zero results when this filter is used. Select 'Sum All' to display all travel.	Effects tables A,C,D,E,G,N,O,P,Q,R,S. All other tables will be blank unless travel location type is set to 'Sum All'.

Multi Scenario, Full Timeseries Filters		
Filter	**Description**	**Tables effected**
Cost type	Selects whether to view costs to society or costs to consumer in cost-based results.	All cost-based results: tables T,U,V,W.
Energy Carrier	Selects which fuel \ energy carrier for which to view the breakdown of energy use and GHG emissions.	All tables that give results by energy carrier: tables P,Q.
Select Policy Scenarios *(Primary filter)*	Selects which Policy Scenarios to compare results for.	All tables.
Enter custom descriptions *(Chart labels)*	Users can enter custom text against each Policy Scenario that will display on the chart labels instead of the Policy Scenario number and version.	All charts.

1.7.5   Multi Scenario Differences

The Multi Scenario Differences sheet contains two sets of summary tables and charts: one set identical to those in the 'Multi Scenario Single Year' sheet, and the other identical to those in the 'Multi Scenario Full Timeseries' sheet. However, all results are displayed as a difference to a user-defined reference Policy Scenario. This allows results to be compared in the context of a defined reference; for example if the reference Policy Scenario were a business-as-usual (BAU) projection, this sheet would allow the results to be viewed in terms of an improvement (or worsening) against the BAU.

There are two sets of filters, identical to those in the 'Multi Scenario Single Year' and 'Multi Scenario Full Timeseries' sheets; Table 6 and Table 7 above describe the details of these filters.

1.7.6   Results Database Contents

The quickest way to view results is through the Results Viewer, but for users who wish to view and manipulate the tool outputs themselves, a description of the results contained within the Results Database is provided in Table 8 below.

Table 8:   Description of Policy Scenario results contained in the Results database

Description of results contained in the Results database			
Applies to…	**'Field' Identifier**	**Unit**	**Description**
Policy Scenario	Policy description	N/A	A brief description of the policy scenario, used to identify it when viewing Policy Scenario inputs and results.
Policy Version	Version description	N/A	A brief description of the policy version, used to identify it when viewing Policy Scenario inputs and results.
Modes *Activation*	Activation	Yes\No	A quick way to toggle the effects of a Policy Scenario on an individual mode on and off. If a mode is active, then its inputs are used when calculating results. If it is not active, it is assumed that the Policy Scenario has no impact on the mode, and inputs from the baseline policy scenario are used instead.
Modes *Stock*	Total vehicle stock	vehicles	The total number of vehicles in active circulation for a given mode.

Description of results contained in the Results database			
Applies to…	**'Field' Identifier**	**Unit**	**Description**
	New vehicle stock	vehicles	The number of vehicles entering circulation for the first time in a given year (i.e. new vehicle sales).
Modes *Demand*	Payload journey demand	M payload-km*	The total demand for transport of passengers \ freight from a given mode, in units of million tonne- or passenger-km.
	Vehicle journey demand	M veh-km	The total demand for transport expressed in terms of km of vehicle travel (i.e. vehicle loading is taken into account).
	Annual km per vehicle	km	The average distance an average vehicle for the mode travels in one year.
	Location type	% of total vehicle demand	The proportion of vehicle-km that occur in a given type of geographical location. Example location types for roads would be: motorway, urban road, non-urban road.
Modes *Energy*	New vehicle energy consumption (average for mode)	MJ/km for calendar year	The external energy input required to travel one kilometre in an average new vehicle for the mode (the average for vehicles sold in a given year).
	Average vehicle energy consumption (average for mode)	MJ/km for calendar year	The external energy input required to travel one kilometre in an average vehicle for the mode (the average for all vehicles in circulation in a given year).
	Total energy consumption	PJ	The total external energy supplied to power transport of all vehicles in a given mode in a year.
Modes *Emissions*	Average new vehicle direct GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted from an average new vehicle during one kilometre of travel. (Tailpipe or point-of-use emissions)
	Average vehicle direct GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted from a fleet average vehicle during one kilometre of travel. (Tailpipe or point-of-use emissions)
	Total direct GHG emissions	$MtCO_2e$	The total greenhouse gases (GHGs) emitted from use of all vehicles in a given mode in a year. (Tailpipe or point-of-use emissions)
	Average new vehicle indirect GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted indirectly in supplying external energy to an average new vehicle during one kilometre of travel. (Fuel cycle or well-to-tank emissions)
	Average vehicle indirect GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted indirectly in supplying external energy to a fleet average vehicle during one kilometre of travel. (Fuel cycle or well-to-tank emissions)

Description of results contained in the Results database			
Applies to…	**'Field' Identifier**	**Unit**	**Description**
	Total indirect GHG emissions	MtCO$_2$e	The total greenhouse gases (GHGs) emitted indirectly in supplying external energy for transport to all vehicles in a given mode in a year. (Fuel cycle or well-to-tank emissions)
	Average new vehicle combined GHG emissions	kgCO$_2$e/km	The greenhouse gases (GHGs) emitted directly (at the point of use) and indirectly in supplying external energy to an average new vehicle during one kilometre of travel. (Life cycle or well-to-wheel emissions)
	Average vehicle combined GHG emissions	kgCO$_2$e/km	The greenhouse gases (GHGs) emitted directly (at the point of use) and indirectly in supplying external energy to an average new vehicle during one kilometre of travel. (Life cycle or well-to-wheel emissions)
	Total combined GHG emissions	MtCO$_2$e	The total greenhouse gases (GHGs) emitted indirectly in supply, and directly in use, from external energy for transport to all vehicles in a given mode in a year. (Life cycle or well-to-wheel emissions)
	Total cumulative GHG emissions	MtCO$_2$e	The total combined greenhouse gas (GHG) emissions (see above) emitted from a given mode from 2010 until a given year.
	Total PM emissions	kt	The total particulate matter (PM) emitted from use of all vehicles in a given mode in a year.
	Total NOx emissions	kt	The total nitrous oxides (NOx) emitted from use of all vehicles in a given mode in a year.
Modes *Costs*	Average new vehicle capital cost to society	€	The pre-tax retail price of an average new vehicle in a given mode.
	Total annual capital cost to society	€million	The sum of pre-tax retail prices of all new vehicles bought in a given year for a given mode.
	Average new vehicle capital cost to consumer	€	The end-user price (including taxes and subsidies) of an average new vehicle in a given mode.
	Total annual capital cost to consumer	€million	The sum of end-user prices (including taxes and subsidies) of all new vehicles bought in a given year for a given mode.
	Average fuel cost to society per km	€/km	The pre-tax retail price of supplying external energy to a fleet average vehicle sufficient to travel one kilometre.
	Total annual fuel cost to society	€billion	The sum of pre-tax retail price paid for all fuels and energy carriers used to power all vehicles in a mode in a given year.

Description of results contained in the Results database			
Applies to…	**'Field' Identifier**	**Unit**	**Description**
	Average fuel cost to consumer per km	€/km	The end-user price (including duties and rebates) of supplying external energy to a fleet average vehicle sufficient to travel one kilometre.
	Total annual fuel cost to consumer	€billion	The sum of end-user price (including duties and rebates) paid for all fuels and energy carriers used to power all vehicles in a mode in a given year.
	Average annual cost to society per vehicle	€	The pre-tax retail price associated with upkeep (repairs, maintenance, consumables etc.) of a fleet-average vehicle in a given year. (Excludes capital and fuel costs)
	Total annual cost to society	€billion	The sum of pre-tax retail price paid for upkeep (repairs, maintenance, consumables etc.) of all vehicles in the fleet in a given year. (Excludes capital and fuel costs)
	Average annual cost to consumer per vehicle	€	The end-user price (including taxes and subsidies) associated with upkeep (repairs, maintenance, consumables etc.) of a fleet-average vehicle in a given year. (Excludes capital and fuel costs)
	Total annual cost to consumer	€billion	The sum end-user price (including taxes and subsidies) paid for upkeep (repairs, maintenance, consumables etc.) of all vehicles in the fleet in a given year. (Excludes capital and fuel costs)
	Average annualised cost of ownership to society	€ per vehicle	The pre-tax retail price of: annualised vehicle capital cost (annualised over the average vehicle lifetime using the societal discount rate), all external energy supply, and other annual spend for a fleet-average vehicle in the mode for a given year.
	Average annualised cost of ownership to consumer	€ per vehicle	The end-user price (including taxes and subsidies) of: annualised vehicle capital cost (annualised over the average vehicle lifetime using the societal discount rate), all external energy supply, and other annual spend for a fleet-average vehicle in the mode for a given year.
	Combined capital, annual and fuel cost to society	€billion	The sum of 'Total annual capital cost to society', 'Total annual cost to society', and 'Total annual fuel cost to society' in a given year. (See above for individual definitions)
	Combined capital, annual and fuel cost to consumer	€billion	The sum of 'Total annual capital cost to consumer', 'Total annual cost to consumer', and 'Total annual fuel cost to consumer' in a given year. (See above for individual definitions)

	Description of results contained in the Results database		
Applies to…	**'Field' Identifier**	**Unit**	**Description**
	Net fiscal revenue	€billion	The net income \ outgoing for government treasuries as a result of all taxes, duties, grants and rebates collected and paid in relation to the purchase, upkeep and fuelling of all vehicles in a given mode and year.
Powertrains *Stock*	Proportion of fleet	% of total vehicle stock	The proportion of total stock in circulation in a given year comprising of vehicles of a given powertrain type.
Powertrains *Energy*	New vehicle energy consumption	MJ/km for calendar year	The amount of external energy supply needed on average per km of travel for an average new vehicle of a given powertrain type.
	Average vehicle energy consumption	MJ/km for calendar year (interpolated)	The amount of external energy supply needed on average per km of travel for a fleet average vehicle of a given powertrain type.
Powertrains *Emissions*	New vehicle direct GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted from an average new vehicle of a given powertrain type during one kilometre of travel. (Tailpipe or point-of-use emissions)
	Average vehicle direct GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted from a fleet average vehicle of a given powertrain type during one kilometre of travel. (Tailpipe or point-of-use emissions)
	Total direct GHG emissions	$MtCO_2e$	The total greenhouse gases (GHGs) emitted from use of all vehicles of a given powertrain type in a year. (Tailpipe or point-of-use emissions)
	New vehicle indirect GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted indirectly in supplying external energy to an average new vehicle of a given powertrain type during one kilometre of travel. (Fuel cycle or well-to-tank emissions)
	Average vehicle indirect GHG emissions	$kgCO_2e$/km	The greenhouse gases (GHGs) emitted indirectly in supplying external energy to a fleet average vehicle of a given powertrain type during one kilometre of travel. (Fuel cycle or well-to-tank emissions)
	Total indirect GHG emissions	$MtCO_2e$	The total greenhouse gases (GHGs) emitted indirectly in supplying external energy for transport to all vehicles of a given powertrain type in a year. (Fuel cycle or well-to-tank emissions)
Fuels *Energy*	New vehicle energy consumption by fuel	MJ/km for calendar year	The amount of external energy supply needed on average per km of travel for an average new vehicle to be supplied by a given fuel.
	Average vehicle energy consumption by fuel	MJ/km for calendar year	The amount of external energy supply needed on average per km of travel for a fleet average vehicle to be supplied by a given fuel.

Description of results contained in the Results database			
Applies to…	**'Field' Identifier**	**Unit**	**Description**
	Total energy consumption by fuel	PJ	The total external energy supplied to power transport of all vehicles in a given mode in a year to be supplied by a given fuel.
Fuels *Emissions*	Total direct GHG emissions by fuel	$MtCO_2e$	The total greenhouse gases (GHGs) emitted from use of a given fuel \ energy carrier in all vehicles in a given mode in a year. (Tailpipe or point-of-use emissions)
	Total indirect GHG emissions by fuel	$MtCO_2e$	The total greenhouse gases (GHGs) emitted indirectly in supplying a given fuel \ energy carrier to all vehicles in a given mode in a year. (Fuel cycle or well-to-tank emissions)
	Total combined GHG emissions by fuel	$MtCO_2e$	The total greenhouse gases (GHGs) emitted indirectly in supply, and directly in use, from a given fuel \ energy carrier in all vehicles in a given mode in a year. (Life cycle or well-to-wheel emissions)

* 'payload' is the generic term given to transport of either passengers or freight. Hence, 'payload-km' can mean either 'passenger-km' or 'tonne-km', dependant on whether the mode in question transports passengers or freight.

1.8   How the Tool works

SULTAN is designed to be fully transparent. Some aspects of the tool and results viewer are hidden from users to simplify the interface, and to prevent accidental changes that could stop the tool working correctly. However, users who wish to discover how certain results are derived, or how the tool as a whole works, are free to do so.

The tool is based entirely in Microsoft Excel, with much of the functionality achieved through code written in Visual Basic for Excel.

1.8.1   Unlocking restricted content

To view or modify any content that is restricted in normal use, use the relevant Excel or Visual Basic command. If prompted for a password, insert '**GHG2050**' (case sensitive). In this way, it is possible to access every component of the tool (including the base calculation and data sheets which have been hidden by default). Note: unlocking the tool and changing elements in the worksheets may cause the tool to work incorrectly or not at all, so this is not recommended for most users.

1.8.2   More information

The tool's development was funded by the European Commission under the *EU Transport GHG: Routes to 2050?* Project. More information on the design of the tool, and the development of Policy Scenarios provided with the tool, can be found in the reports prepared for the Commission by the project team and on the project website at: www.eutransportghg2050.eu.

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