1. Scenarios and policy measures whose impact/influence can be evaluated by the ForFITS model

ForFITS enables users to evaluate the impact of different combinations of policy measures to maximize CO_2 emissions reduction under different scenarios/cases.

Scenarios are defined by the user to contextualize potential future developments in a country or region as the result of expected evolution of macroeconomic variables having an influence on the transport sector.

Policy interventions that can be taken into account by the model refer to specific measures that may be implemented with the objective to mitigate CO_2 emissions from the transport sector. Policy options can generally be classified in three different types depending on the target impact area:

- **Avoid**: Managing travel demand, e.g. avoiding or reducing the need for travel;
- **Shift**: Shifting travel to more sustainable transport modes;
- **Improve**: Improving the sustainability of vehicles, fuels and infrastructure concerning all modes, leveraging technologies capable of reducing or eliminating GHG emissions and noxious pollutants (across the entire life cycle of products), as well as noise.

Most of the relevant scenarios and common ASI policies can be simulated in the ForFITS model although they differ in levels of complexity. The complexity to simulate a policy/scenario depends on the following characteristics: (a) modelling issues (e.g. manipulation of ForFITS formulas is required by developers), (b) data requirements (e.g. data that not often available are required), and (c) the analysis of these data to convert it in proper model inputs (e.g. extensive analysis is required to ensure the scenario is properly modelled). According to these criteria, levels of complexity are classified as follows:

- **Baseline**: This category represents default scenarios that are always taken into account when running ForFITS without any user action since they consider the expected changes in some technical variables which are more likely to be generic rather than country specific. For instance, this includes energy efficiency improvements expected to be introduced by the industry in different powertrain technologies in the short and long term. The data behind these scenarios are based on extensive and deep research and should not be manipulated by the user unless specific and reliable information for the specific country is available and expected to be more representative than the default numbers.
- **Low**: Scenarios/policies easily simulated in ForFITS because they can be defined without the need to go beyond minimum input data requirements (M inputs) and without additional analytical and modelling work. This category primarily refers to common national policies which require specific model user input to quantify the magnitude of the policy intervention. Changes in projections of key macroeconomic parameters (main drivers of the model) are also included here.

- **Medium**: Scenarios/policies possible to be taken into account in ForFITS if information beyond minimum input data requirements (M inputs) are available and then analyzed outside of the model to input proper values to ForFITS. This also includes scenarios/policies that require slight adjustments to the methodology that must be done by model developers.
- **High**: Scenarios/policies unlikely to be considered in ForFITS unless specific and substantial data, much beyond minimum input data requirements (M inputs), are available, default numbers in the model are carefully revised and complex analytical work is performed before the simulation.

Section 2 lists all polices/scenarios whose impact/influence can be evaluated by the ForFITS model as classified by type of scenario/policy and simulation complexity level. Sections 3 to 5 briefly describe each scenario or policy.

2. Summary table

Scenarios/policies	*Baseline*	*Low*	*Medium*	*High*
3. Economic scenarios and avoid/shift policies normally implemented through economic instruments				
3.1. Changes to macroeconomic parameters (GDP and population)		✖		
3.2. Changes to fuel cost (excludes national fuel taxation schemes)		✖		
3.3. Changes to national fuel taxation schemes		✖		
3.4. Changes to purchase vehicle cost	✖			
3.5. Changes to road pricing			✖	
3.6. Changes to crew cost			✖	
3.7. Structural changes in freight transport due to changes in the country's economy orientation				✖
3.8. Environmental culture (participatory instruments)				✖
3.9. Changes to pipelines network extension		✖		
4. Shift policies/scenarios				
4.1. Shift from/to personal vehicles to/from public transport		✖		
4.2. Shift between large-freight modes		✖		
4.3. Changes to shares within transport modes which are grouped together in activity projections		✖		
5. Improve policies/scenarios				
5.1. Expected energy efficiency technology improvements	✖			
5.2. Penetration of new technologies (Endogenous technology choice)				✖
5.3. Penetration of new technologies (Exogenous technology choice)		✖		
5.4. Changes to fuel characteristics (Biofuels)			✖	
5.5. Vehicle fleet renewal			✖	

3. Economic scenarios and avoid/shift policies normally implemented through economic instruments

3.1. Changes to macroeconomic parameters (GDP and population)

The expected evolution of GDP and population from the base year to the last year of the projections is a required input. The model can be run several times according to different growth levels defined by the user.

3.2. Changes to fuel cost (excludes national fuel taxation schemes)

The model user needs to input how fuel cost by fuel blend (GASOLINE, METHANE, LPG, DIESEL, DME, HYDROGEN, ELECTRICITY, KEROSENE, PIPELINE) will change over time relative to oil price changes. This input is not country specific and corresponds to the fuel cost as set by the energy sector before applying national taxation schemes. It may not be easy to estimate how the oil price will change and, thus, the fuel cost by fuel blend remains constant at the base year value by default.

3.3. Changes to national fuel taxation schemes

The model user needs to enter the taxation by fuel blend (GASOLINE, METHANE, LPG, DIESEL, DME, HYDROGEN, ELECTRICITY, KEROSENE, PIPELINE) expressed as percentage of the fuel cost (Fuel price = Fuel cost x (1+%Taxation)). The user can define how the fuel taxation will vary over time in comparison with the base year value. ForFITS offers the possibility to distinguish fuel taxation between passenger and freight transport.

3.4. Changes to purchase vehicle cost

The model contains by default an evolution of purchase vehicle costs according to technology improvements expected in each powertrain technology (GASOLINE, DIESEL, HYBRID, ELECTRIC…) in the short and long term. It is advised that users do not modify the default data unless specific and reliable information for the specific country is available and expected to be more representative than the default numbers.

3.5. Changes to road pricing

The model addresses road pricing policies with the possibility to differentiate between transport services (PERSONAL PASSENGER VEHICLES, PUBLIC TRANSPORT VEHICLES, FREIGHT VEHICLES) and between transport modes (TWO WHEELERS, THREE WHEELERS, LDVS, BUSES, MEDIUM TRUCKS, HEAVY TRUCKS). The user needs to input road pricing at the base year as well as over time expressed as constant base year USD/vkm.

There is no default data in the model on road pricing (it is by default considered as zero) since this is country specific and must be the user who specifies this information. The fact that the model input needs to be entered as USD/vkm would require sufficient data as well as calculations to be made outside of the model in order to get the proper average value. For instance, implementation of tolls on

specific portions of the road network would require calculating the average USD/vkm through weighting by the share of total vkm actually affected by the toll fees. In these cases, the simulation is unlikely to be done unless very detailed national data is available.

3.6. Changes to crew cost

ForFITS calculates the cost of driving (USD/vkm) as the sum of purchase vehicle cost, fuel price, road pricing, and crew cost, when applicable. The crew cost per day input refers to the crew on vehicles engaged in transporting passengers or goods. In particular, it is relevant in case of public passenger transport, air passenger transport and freight transport. Default values for the base year are included in the model, although they should be revised according to national labor statistics if the user wants to change them over time to see the effect of changing crew costs.

3.7. Structural changes in freight transport due to changes in the country's economy orientation

Structural changes include, for instance, shifts towards more (or fewer) exports; behavioral or trade related evolutions leading towards shorter (or longer) supply chains; and changes in the nature of the economy, e.g. from a condition where it is heavily dependent on primary materials to a situation where primary materials are locally processed in a large manufacturing sector, excluding effects due to changes in costs. The user has the possibility to evaluate the impact of these changes through specifying how the shares of tons lifted by good type (BULK, MANUFACTURED, FOOD, OTHER), by transport distance (SHORT, MEDIUM, LARGE, VERY LARGE) and by transport zone (IN-AREA, EXPORT) will vary over time.

To simulate these structural changes the user needs to input data beyond minimum input data requirements. Particularly, the user needs to have reliable data on the shares of tons lifted at the base year (disaggregated by good type, transport distance and transport zone) as well as average haul lengths (km/haul must be indicated for each freight transport mode and for each transport distance).

3.8. Environment culture (participatory instruments)

ForFITS enables users to simulate participatory instruments such as awareness raising campaigns addressing environmental characteristics of transport vehicles, or labeling schemes on energy consumption and CO_2 emissions. This is done through the "environment culture index" aiming to take into account the effect of behavioral changes associated with environmental consciousness. The index can be changed over time but it is complex to convert participatory policies into index variations. This is the reason why the index is more qualitative than quantitative.

An index value of 1 aims to represent a culture strongly focused on protecting the environment, while a value of 0 considers the case where issues related to the environment are poorly considered. The initial default value is 0.5. but some analytical work should be done to calibrate the value for each specific country at the base year.

3.9. Changes to pipelines network extension

The user can specify how the length of network extension of pipelines, representing the average distance travelled for each cubic meter transported, is likely to vary over time. The network extension remains the same as the base year value in the default scenario.

4. Shift policies/scenarios

4.1. Shift from/to personal vehicles to/from public transport

The “passenger transport system index” is calculated at the base year on the basis of the input data entered by the user. The “passenger transport system index” is an instrument that was specifically developed to help understand the changes in the passenger transport system associated with shifts caused by a wide number of policies (excluding cost effects) favoring public transport over personal vehicles, such as parking and access restrictions for personal vehicles, land use policies that encourage the vertical development of the city and mixed use areas, and support for the provision of appealing, widely available and high-quality public transport services. The user can change the “passenger transport system index” over time to see the impact caused by modal shift due to structural changes in the passenger transport system.

The index ranges from 0 (indicating that the transport system is primarily focused on personal vehicles and the share of pkm on personal vehicles tends to 100% when GDP per capita increases) to 1 (indicating that the transport system is fully public transport-oriented and share of pkm on personal vehicles is 0%). An index value of 0 is associated to low population density areas with a significant presence of urban sprawl, whereas a value of 1 is associated to very high density population areas where geographical and other constraints lead to vertical development of the urban areas. The index measures differences in modal choice due to structural characteristics of the passenger transport system and independently of differences in GDP per capita, cost of driving and behavioral aspects. In other words, changes in modal shares over time for a country or region with a constant index value (the default option) are attributed to changes in GDP per capita, behavioral aspects and cost of driving. According to historical data, the maximum reasonable value for the passenger transport system index is approximately 0.7.

4.2. Shift between large-freight modes

The user can simulate shifts between modes associated with policies intended to vary modal competitiveness through instruments promoting specific large-freight modes (e.g. through development of new infrastructure). This can be simulated through modifying the base year values on shares of tons lifted by large-freight mode (MEDIUM TRUCKS, HEAVY TRUCKS, RAIL, AIR, PIPELINES, INLAND WATERWAY, SHORT-SEA, MARITIME). The model offers the possibility to simulate modal shift for specific transport zones (IN-AREA, EXPORT) and transport distances (SHORT, MEDIUM, LARGE, VERY LARGE) only.

4.3. Changes to shares within transport modes which are grouped together in activity projections

ForFITS aggregates some transport modes as a single category when projecting transport activity. This is the case of public transport which includes TWO WHEELERS, THREE WHEELERS, VESSELS, RAIL, BUSES and TAXIS all together. The user may decide how to distribute total projected pkm on public transport across the different public transport modes taking into account changes on modal competitiveness. ForFITS also considers personal TWO WHEELERS and personal THREE WHEELERS together. In each case the user may specify how the shares of these modes will vary in future years. By default the shares remain always at the base year values.

5. Improve policies/scenarios

5.1. Expected energy efficiency technology improvements

The model contains by default expected technology improvements in each powertrain technology (GASOLINE, DIESEL, HYBRID, ELECTRIC…) in the short and long term which result in vehicles consuming less energy per km in the future. It is advised that users do not modify the default data unless specific and reliable information for the specific country is available and expected to be more representative than the default numbers.

5.2. Penetration of new technologies (Endogenous technology choice)

The model can calculate how the projected new vehicle registrations will be allocated across different powertrain technologies (percentage of GASOLINE, DIESEL, METHANE, LPG, GASOLINE-ELECTRIC HYBRID, DISEL ELECTRIC-HYBRID, ELECTRIC,…) on the basis of costs information and fuel consumption reduction potentials coupled with expected technology improvements in the future. The cheaper is the technology, the more its market share will increase. This enables the user to evaluate the impact of subsidies and taxation schemes based on powertrain technology type applied to purchase vehicle costs.

Default costs for each powertrain technology are included in ForFITS but are likely to be more representative for developed countries rather than for developing economies. Running the model with the endogenous technology choice is very sensitive and may be misleading unless all default data on future purchase vehicle costs and fuel consumption reduction potentials are revised to suit the characteristics of the specific country. The exogenous technology choice explained below is generally a safer option.

5.3. Penetration of new technologies (Exogenous technology choice)

Unlike the previous case, the user can directly tell the model how projected new vehicle registrations should be allocated across different powertrain technologies (percentage of GASOLINE, DIESEL, METHANE, LPG, GASOLINE-ELECTRIC HYBRID, DISEL ELECTRIC-HYBRID, ELECTRIC,…). The default scenario considers that powertrain technology shares remain always at the base year values (proportion of GASOLINE, DIESEL, HYBRID….will be always the same).

5.4. Changes to fuel characteristics (biofuels)

Introduction of biofuels can be simulated by ForFITS through changing the emissions factors over time. In this case it is necessary to know the exact biofuel and its particular characteristics (emissions factors), as well as how much of the total energy content of the fuel blend is provided by each fuel (biofuel and oil-based fuel).

5.5 Vehicle fleet renewal

ForFITS determines the average vehicle life at the base year according to the user input data on the number of vehicles registered in the past and the number of vehicles currently in the fleet. Vehicle fleet renewal can be considered in ForFITS by changing the average vehicle life of the fleet over time. This means that the presence of new vehicles will be more significant over time, whereas aged vehicles will be scrapped at a lower age. When the policy to be simulated consists of banning circulation of vehicles above a certain age some analytical work needs to be done outside of the model to convert this policy into average vehicle life changes (model input).