Study On European Urban Transport Roadmaps 2030

Tool description and user guide

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1 Overview of the Urban Transport Roadmaps Tool

1.1 Introduction

Cities in Europe are vital centres of economic activity, innovation and employment. However, they face increasing challenges to their mobility systems such as congestion, air quality, ambient noise, CO_2 emissions, accidents and urban sprawl. To tackle these problems cities need to develop and implement coherent and challenging Sustainable Urban Mobility Plans (SUMPS).

The aim of the on-line policy support tool developed in the urban transport roadmaps project is to assist city authorities in the development of Sustainable Urban Mobility Plans (SUMPs). It is a decision support tool that will help cities to:

- explore and identify potential; sustainable transport policy measures;
- quantify the transport, environmental and economic impacts of these measures;
- consider an implementation pathway (roadmap) for the policy scenario.

In terms of the overall SUMPs development process the roadmaps tool is focused on developing the overall goals, approach and basic policies packages that form the basis of a SUMP before further elaboration and implementation. This relationship to the SUMPs process is illustrated in Figure 1 below

Figure 1: Overview of how the tool interacts with the SUMPs process

Therefore the tool is designed to carry out initial scoping of potential policies that could be applied to a city. It allows single policies and groups of policies to be assessed providing estimates of the impact on a range of transport, environment and economic indicators. As such it can be used for:

- initial sifting of potential sustainable transport policies options;
- grouping or packaging of policies to develop an overall approach to a sustainable transport strategy for a city;
- engaging a range of city stakeholders, many with little direct experience of transport modelling, in sifting and exploring policy options;

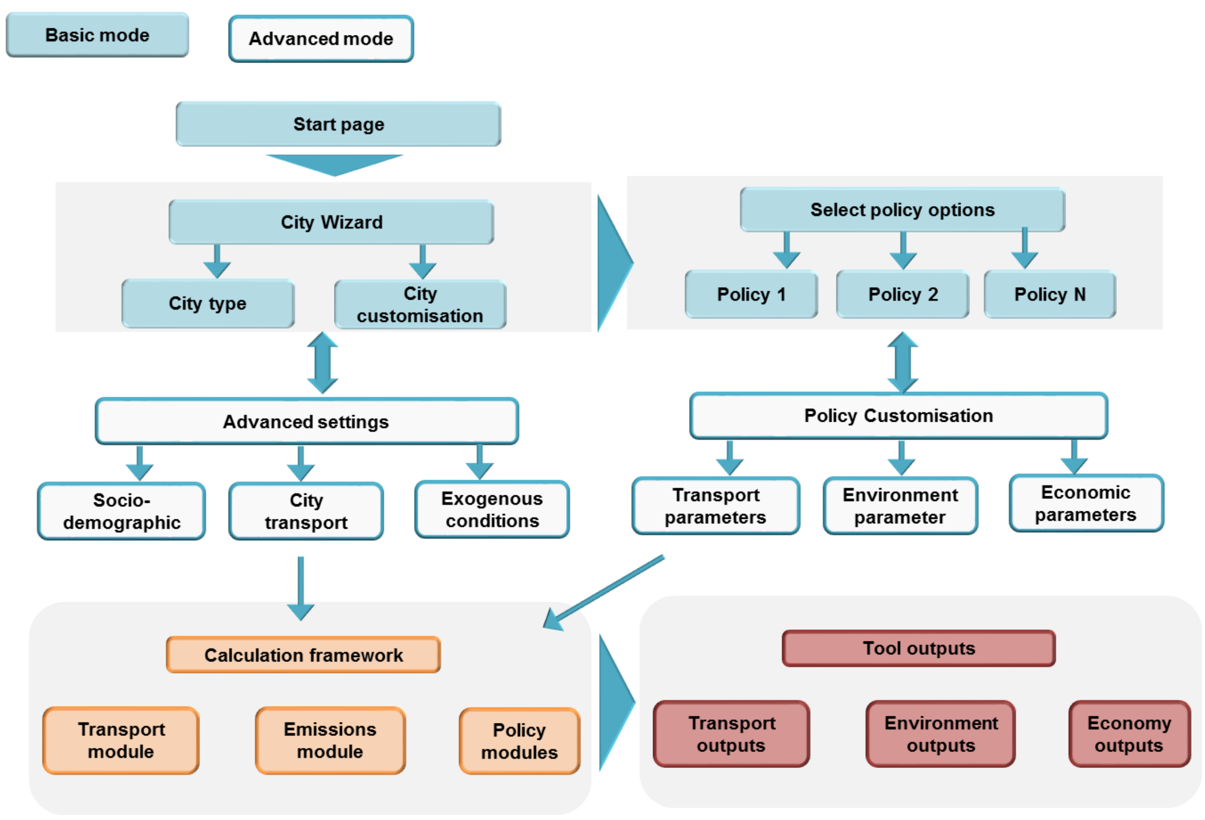
It is not a substitute for detailed transport models that are set up and developed for specific cities and require expert use. Similarly is should not be used for detailed planning, development and implementation of policies which will require more and detailed assessment approaches.

This document provides an overview of the on-line tool, a user guide to the tool and a detailed description of all the tool variables. This document is complemented by the project report on urban transport policy roadmaps. The roadmaps report provides details of the process of developing an urban transport policy roadmap, along with five illustrative roadmaps and how these are set up and assessed in the tool.

1.2 Structure of the tool

The tool has five main structural elements, as illustrated in **Figure 2** below.

Figure 2 Outline structure of the tool



These elements comprise:

- ➢ ***The City Wizard*** – this is the main entry point of the tool and allows the user to select some basic information to characterise their city. This basic information allows the model to set up the most appropriate basic transport patterns to represent the city, providing simple and quick initial configuration of the model.
- ➢ ***Advanced Settings*** – for the more advanced user there is the ability to customise the default data, using local data, to provide a more accurate representation of the city.

- ***Policy selection*** – having selected a city type, and potentially customised it, the user can then select various policies to apply in their city. The primary policy measures will be associated with default parameters, again allowing the user a simple and quick way to use the tool.
  - *Policy customisation* – as with the city types the default data for the policy options can be customised to refine the policy measure. For example by adjusting tariff values for a charging scheme.
- ***Calculation framework*** – this forms the core of the tool and takes the city setup parameters and policy measure parameters to calculate the results for the policy measures in the selected city. The calculation framework comprises three key elements:
  - The transport module - that calculates the base transport patterns for the city and then adjusts them in relation to the policies.
  - The emissions module - that calculates the emissions and environmental data associated with the transport activity.
  - The policy modules - that translates the policies into impacts.
- ***Tool outputs*** – these provide the numerical and graphical representations of the impacts of the transport policies on the city. There are three main types of impact that are generated by the tool:
  - Transport impacts – including mode share, average trip distances and traffic levels;
  - Environment outputs – covering CO2, CO, PM, NOx and VOC emissions, and accident rates;
  - Economic outputs – providing the direct cost/benefits associated with the policies, and the social cost of emissions and accidents.

1.3 The city wizard and advance settings

The city wizard allows the user to initially configure the calculation tool to represent their city. From some simple information the tool will use a range of default data to set up a basic transport model to represent the city to which transport policies can be applied. The information is entered as basic choices from drop down menus covering the variables listed below in Table 1

Table 1 Variables in the city wizard

Topic	Variables
City type	Country
	City type (five alternative categories)
	Population at the base year (inhabitants)
	Population by zone (Urban core, outskirts)
	City economy type (industrial/non-industrial)
City customisation	Public transport use
	Bicycle use
	Motorcycle use
	Presence of Tram or metro network
	Level of road congestion
	Share and mode of incoming trips

Once the city wizard has been used to do the basic configuration of the model, the user can do further customisation of the city before applying any policies. This further customisation is done via the advanced settings. The variables that can be adjusted here are shown below in Table 2.

Table 2 Advance settings

Topic	Variables
Sociodemographic	Population trend (% grow per year)
	Sprawling trend (or land use density)
	Average income level per capita
Traffic	Initial mode split for city
	Mode split trend (car share growth)
	Share of freight vehicles
	Trend in freight vehicle share (% growth)
	Electric and hydrogen refuelling infrastructure
Parking	Amount of regulated parking in the city
	Average parking tariff (euro/hr)
	Park and ride tariffs
	Length and frequency of park and ride routes
	Number of park and ride space
Public transport and cycling	Average public transport fare
	Public transport mode split (bus, tram, metro)
	Length of segregated bus and tram ways
	Length of cycle paths
Vehicle fleet	Initial car ownership level
	Car fleet share by fuel type
	Bus fleet share by fuel type
	Number of car sharing subscribers
	Type of car sharing system
	Car sharing tariffs
	Average time to car sharing station
Exogenous conditions	Technology scenario
	Energy price scenario
	Fuel tax policies

All of the variables except the exogenous variables allow customisation of the transport aspects of the city. The exogenous variables are designed to reflect background trends that are outside of the control of the city such as fuel prices and technology trends.

1.4 Policies

A wide range of policy measures exist that are potentially useful for setting up urban strategies aimed at addressing transport sustainability. Sources such as the ELTIS, CIVITAS and EPOMM websites provide a wide range of examples of individual actions to promote sustainable mobility. These existing catalogues of solutions and best practice formed the basis for developing a prioritised set of policy measures. A long list of policy measures was identified from these sources by clustering the actions into broader measures. From this long list of measures a short-listed set of key generic policy measures was identified based on criteria including:

- Policy type (i.e. demand management; green fleets; infrastructure investment; pricing and financial incentives; and traffic management/control);
- Institutional level of implementation (i.e. by national or local authorities);
- Effectiveness on key impact areas, cost distribution, and transport modes covered.

The short-list comprised the 19 policy measures detailed below in Table 3 and are the policies that can be selected in the tool.

Table 3 Policy measures in the tool

Policy Type	Measure
Demand Management	• Sustainable travel information and promotion • Bike Sharing Scheme • Car sharing (Car Clubs) • Delivery and Servicing Plans • Land-use planning - density and transport infrastructure
Green Fleets	• Green energy refuelling infrastructures • Green public fleets
Infrastructure Investments	• Bus, trolley and tram network and facilities • Walking and cycling networks and facilities • Park and ride • Metro network and facilities • Urban Delivery Centres and city logistics facilities
Pricing and financial incentives	• Congestion and pollution charging • Parking pricing • Public Transport integrated ticketing and tariff schemes
Traffic management and control	• Legal and regulatory framework of urban freight transport • Prioritising Public Transport • Access regulation and road and parking space reallocation • Traffic calming measures

The user is able to select individual policies or groups of policies. In terms of the groups they can select all of the measures in one of the policy category types, such as demand management. Alternatively polices can be selected in relation to their expected key outcome such as reducing emissions or improving safety. This last grouping in relation to outcomes is termed policy sets.

The policies are added to the model with pre-defined characterisation. However the characteristics of each individual policy can be customised to more accurately reflect the expected implementation of the policy in the city. The customisable variations are in the following basic form but are specific to each type of policy:

- **The definition of the time when the measure is activated.** This is an input for the user which can decide when the measure is implemented.
- **The definition of a ramp-up period for the full implementation of the measure.** Some measures are relatively easy to implement and, since the model makes calculations on a yearly basis, it can be safely assumed that their impacts occur in the same year of implementation. Other measures are more complex (e.g. infrastructures) and need several years before being

fully implemented and/or to achieve their full effect after an adaptation period. For these measures this ramp-up period is considered and in some cases it is also a user input.

- **The specification of parameters or variables defining scope of the policy and (where relevant) its intensity.** For instance, for road charging the parameters include not only its introduction, but also the value of the charge, its differentiation between vehicle types, and the size of the charged area.
- **The quantification of the capital and operational costs of the measures.** Some policies have almost no direct costs associated with them except administrative costs to set up (e.g. the introduction of a legal and regulatory framework for urban freight transport) but most of them require capital investment to build infrastructure (e.g. park and ride facilities, reserved lanes, etc) and a yearly operating expenditure to manage the system (e.g. as is the case for road charging schemes).
- **The potential adjustment of the magnitude of the effects of the policy on other core modules in the calculation framework.** The user can modulate the impacts in order to further customise the tool based on the city configuration, i.e. if the mode share of public transport is already high at the base year the elasticity of the impacts on this mode should be decreased. Furthermore, the adjustments could be used for sensitivity tests. For instance, the introduction of urban delivery centres increases the share of freight deliveries transhipped and consolidated at urban platforms. Another example is that the prioritisation of public transport improves its speed and therefore its modal share. Here the user has the chance of modulating some of the effects in the form of impact elasticities.

The variables that can be customised for each policy are also categorised as ‘primary’ which are those that the user should adjustto set up the policy such as year of implementation, and ‘advanced’ which are those that are less necessary to adjust or require specialist knowledge such as the elasticities of impact.

1.5 Tool outputs

Once the city has been configured through the city wizard a set of graphical outputs are shown in relation to the transport, environmental and economic aspects of the city’s transport system. These outputs will change as policies are added and configured. The key outputs calculated by the tool are summarised below in Table 4 with detail of all the outputs provided in Section 3.

Table 4 Summary of key tool outputs

Output category	Key outputs
Transport	Car ownership level Mode split Average car and bus speeds Public transport occupancy levels Average trip length Share of freight vehicles Penetration of alternative fuel vehicles
Environment	Total emissions covering: CO_2, PM, CO, NOx, VOC Fuel consumption by mode Accident rates
Economy	Transport expenditure of individuals Transport expenditure by the municipality Transport revenue received by the municipality Net cost to the municipality

1.6 The Calculation framework

The calculation framework is the theoretical structure of the tool. It includes the equations used for the background calculations building on the pre-coded values of parameters and variables as well as on the user input provided through the interface.

1.6.1 How it works

The city's transport system is described at a strategic level (e.g. networks are not represented) in relation to three city zones by means of several key variables, many of which are linked to each other. Non-transport elements and exogenous aspects which affect urban mobility are also represented (e.g. population size, energy prices). For all elements of the calculation framework pre-coded values are defined as defaults, however many of them can be customised to tailor the calculations to specific local conditions.

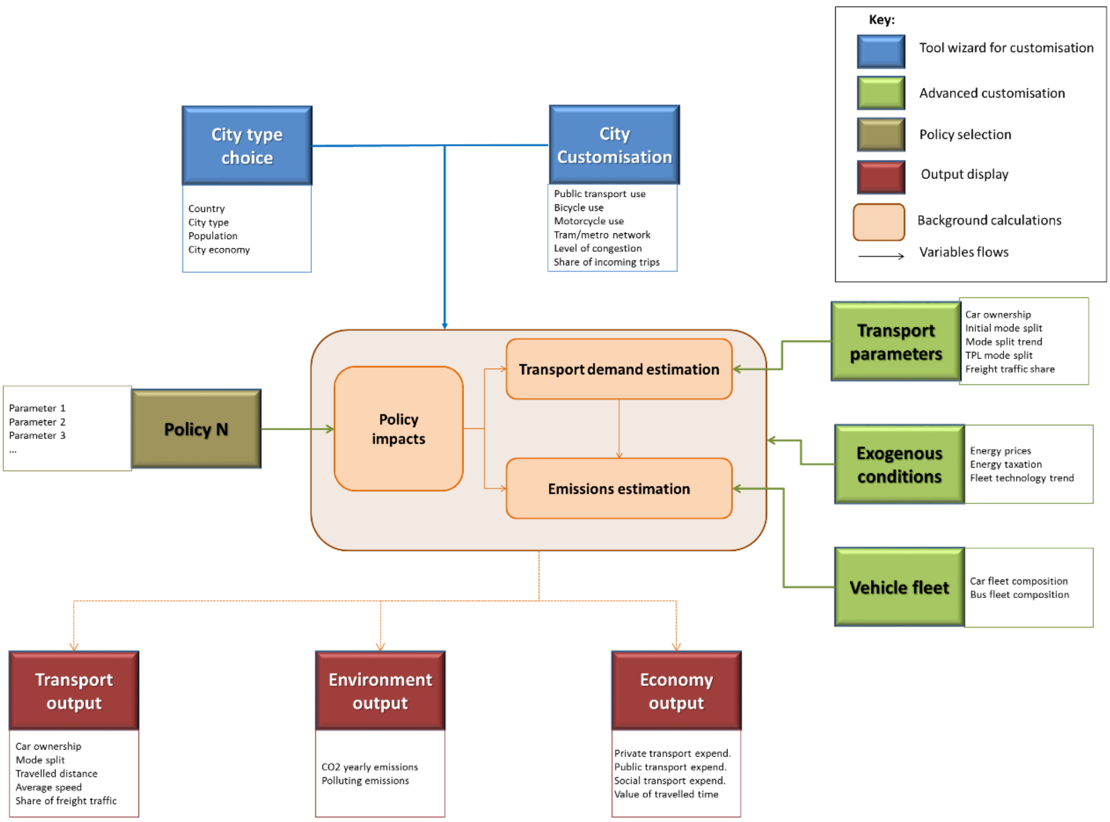
The variables describing urban mobility are calculated annually between the years 2015 and 2030 on a yearly basis. The basic development of the annual trends is the result of exogenous trends (e.g. urban population growth) and of the interactions between the variables. These interactions are managed by means of parameters (e.g. elasticities). Initially a reference trend of the urban mobility and of its effects (e.g. local pollution) is computed based on the set up defined by the user in the city wizard. This trend can be affected by policy measures. The conditions of urban mobility and its impacts are then summarised by several indicators which are also used to assess the impact of policy measures.

The core of the calculation framework consists of:

- The transport demand calculation module which is a basic strategic transport model at the city scale;
- The policy impact modules that estimate the impact of policies on key transport parameters;
- The emissions calculation module

The city wizard modules provide the initial configuration parameters that are used to set up the transport and emissions modules. The advanced settings module then allows further adjustment of key parameters in the transport and emissions modules. The policy module allows for the implementation and configuration of policies and how these affect the core transport and emissions modules. These core modules then generate the transport, environment and economic outputs that are displayed in the tool. This framework is illustrated in Figure 3 below.

Figure 3 Illustration of calculation framework



1.6.2 The core calculation modules

The calculation framework represents the urban mobility system and its main components with a level of detail consistent with the strategic nature of the tool, namely:

- At a spatial level, the urban area is divided into three types of zones generating transport demand: (i) urban core, (ii) outskirts with good public transport services, and (iii) outskirts with poor public transport services. The urban core is not just the inner centre of the city but the main urban area, i.e. characterised by a continuously urbanised area. Outskirts are suburbs or neighbourhoods which are someway distinct from the city (they can be also different municipalities surrounding the main city in a metropolitan area). Trips generated in each area are distinguished but without origin-destination details.
- Passenger demand segments are modelled according to:
  - where trips are generated - internal trips (within the urban area) or incoming trips;
  - their purpose - working or personal, where "working" includes both commuting and business, whilst all other trip purposes are classed as "personal;
  - period - peak and off-peak, where "Peak" includes both morning and afternoon peak periods
  - and mode - pedestrian, bike, motorbike, car, bus, tram, metro, car sharing.
- Freight demand is differentiated by:
  - vehicle type - light truck, heavy truck;
  - freight type - retail, mail, other;
  - and period - peak, off-peak.
- Road vehicle fleets are segmented by
  - fuel type - gasoline, diesel, CNG, LPG, hybrid electric, battery electric, fuel cells;
  - and emission standard - Pre-Euro, Euro 1-6 and post Euro 6 for cars and LDV, and pre-Euro, Euro I-VI and post Euro VI for HDV.
- The car private fleet is distinguished by the car sharing fleet (where it exists). In addition the fleet composition of the goods vehicles used for distribution from urban logistic platforms can be specified separately, for example as all electric.
- Fuel consumption is estimated by fuel type - gasoline, diesel, CNG, LPG, electricity, hydrogen.
- Pollutant emissions are estimated for PM, CO, NOx and VOC. Greenhouse gas emissions (CO_2) are estimated as well.
- For road safety indicators, fatalities are distinguished from serious injuries.

Given the strategic level of detail of the tool, the calculation framework will always work with generic descriptions of the urban mobility system, but the customisation process allows for taking into account differences that can affect the trend of mobility and especially the impact of the policies.

In some cases the customisation modules support the introduction of exact values of the customisable variables/parameters. In some other cases a selection between alternative sets of pre-coded values is available.

1.6.3 Modelling the policy measures

There are a number of assumptions included in relation to the policy measures that allow the model to estimate the impacts. In order to gain a detailed understanding of the model it is important to consider how these assumptions will interact with the data entered.

1.6.3.1 Demand Management measures modules

The **Bike sharing scheme** measure assumes that such a scheme is introduced with a certain annual fee for subscription[1] and a certain coverage of the urban area. The direct impact of the measure is that some people are incentivised to use bicycles instead of another mode. The numbers of people using bicycles will be negatively affected by tariffs and positively affected by the width of the area covered by the service. Appropriate elasticities (segmented by trip purpose) quantify these effects. It can be defined whether the urban municipality pays a yearly fee to the service providers contributing to the coverage

[1] An additional time-based usage tariff is not implemented because in most of the cases subscribers can use bike for free for a certain franchise time (e.g. the first 15 or 30 minutes) and it is assumed that most of the users will complete their trip within this time

of operating costs. An investment cost is borne by the city authority to implement and start the service, covering the installation of the stations, the bikes and other initial fixed costs.

Car sharing (car clubs) is modelled under the assumption that a car sharing service is introduced in the urban area. It is assumed that the service has a fixed element (annual fee) and a variable element (tariff per hour) to the user charges. It is also assumed that the number of cars and car stations can be smaller or larger and therefore a different time is needed to reach a car when it is needed. Furthermore, there is a choice between two different types of car sharing; one-way system (the car can be collected and returned in any point in the city) or collect-and-return system (the car must be returned to specific parking locations). The tariffs and accessibility of cars in the scheme affect the number of people subscribing the car sharing services. Assuming that on average each subscriber uses the service for a certain number of trips per year, a number of trips is computed. These trips replace trips made by other modes and the type of car sharing affects how the different modes are affected. The result will be a modification of mode shares. It is possible to take into account whether the service is operated by private companies that pay an annual fee to the municipality in compensation of free parking, free entrance in charged areas (where they exist) and so on.

The assumed effect of **Delivery and Servicing Plans** is a reduction of the number of goods vehicles entering the urban area as result of more efficiency. The size of the reduction is pre-defined but can be tuned by the user. There are no other implementation parameters. The implementation cost to the city authority is also null as it is assumed that plans are implemented by private operators (firms, forwarders and so on).

The idea behind **Sustainable Land Use Planning** is to avoid sprawl and to reduce the need of citizens to travel long distances to reach jobs, shops, services and so on. So, the complex land-use planning process is translated in modelling terms by assuming that the trend of the population distribution among the city zones is affected (this in turn has an impact on the use of car) and that the share of pedestrian and cycle trips is increased in the outskirts where new developments are built. Two main strategies for land use are considered: on the one hand the strategy could be to restore living opportunities in the urban core to avoid sprawl. Under this strategy the impact of the measure is to increase the share of inhabitants in the urban core. On the other hand, planning can promote sustainable new developments. Under this strategy the impact of the measure is to increase the share of inhabitants in peripheral areas well served by public transport rather than in outskirts with poor transit connections. The user can choose one of these two strategies or a mixture of the two. The costs associated to this policy are those for the provision of public housing in the urban core either for building new dwellings or to purchase empty houses, which is assumed to be part of the strategy when oriented to restore living opportunities in this area of the city. It is assumed that public houses are provided for rent and so the municipality obtains a revenue.

The implementation of **Sustainable travel information** and personalised travel marketing is assumed to have an impact on the mode share of public transport switching demand from private modes. So a simple elasticity for the implementation of the measure is modelled (although the impact is different for working and personal trips). A cost for the provision of the information is assumed in the initial year.

1.6.3.2 Green fleet measures modules

The policy measure for the provision of **Green energy refuelling infrastructures** is modelled assuming that such infrastructure promotes the penetration of innovative vehicles (electric or fuel cell) in the car fleet. The share of the urban area equipped with the infrastructures can be defined by the users: the larger this share the stronger the effect on the penetration of innovative cars. A cost for the implementation and the management of the infrastructures is assumed.

The promotion of **Green public fleets** is modelled assuming that the urban authorities invest money to contribute to the renewal of the public transport fleet. The renewal can have two different targets: reducing local pollution or reducing greenhouse gases emissions. In the former case the effect of the measure is more oriented to replace older buses with new ones (e.g. Euro II and Euro III vehicles are replaced by Euro V vehicles). In the latter case the measure is more oriented to include in the fleet innovative bus types (CNG and later electric buses). The cost of the measure depends of course on the number of bus replaced every year given the cost of a bus.

1.6.3.3 Infrastructure Investments measures modules

The measures **Bus, trolley and tram network and facilities** and **Metro networks and facilities** consist of making the public transport modes more accessible. This means improving bus stops, stations, etc. but also extending the service (new lines, better frequency). Therefore both measures are modelled in terms of increased extension of the network and/or an improvement in the frequency of service. Both these two elements, through elasticity parameters, influence the mode share of the related public transport modes. The improvement of the services requires investments (new buses, new tracks, new stops, etc.) which are accounted under investment and management costs.

The provision of **Walking and cycling networks and facilities** is aimed in general at making pedestrian and cycling trips easier and safer. The implementation of the measure in the tool is focusing on cycling, assuming that when these facilities are provided the mode share of cycling increases at the expense of competing modes. Furthermore, accident rates are also reduced because it is assumed that citizens can cycle in protected lanes, pathways, etc. thus reducing the risk of being hit by motor vehicles. Elasticity parameters rule the size of the mode shift and of the accidents reduction. Implementation and management costs are also considered.

The concept of **Park and Ride** is modelled assuming that parking areas are provided at the border of the city area with efficient public transport connections to the city centres. This means that a larger share of trips incoming from external zones by car will interchange to bus. The intensity of the effect depends on the features of the Park and Ride service, i.e. its cost (parking costs), the capacity of the parking areas (the larger the capacity the lower the risk to not find a parking lot), the coverage of the urban area by means of the public transport services (the more destinations that can be reached directly from the park and ride service without further interchange the higher the attractiveness of the service) and the frequency of the public transport connections (the more frequent the service the lower the waiting time and the more attractive is the Park and Ride alternative). The implementation costs however also grow with the number of parking lots provided and the number of buses needed to guarantee the service. The public administration also gets the revenues of the service. Different trip purposes have different elasticities as they travel in different traffic conditions.

The measure **City logistics facilities** is modelled assuming that logistics platforms are created at the border and within the urban area in appropriate locations to serve as hubs for the final distribution. A share of the shipments arriving from outside the city pass through the delivery centres, where loads are consolidated and distributed in a more efficient way, increasing the load factor of vehicles, shortening consignment routes and using cleaner vehicles. This impact is translated in the policy module as an increase of the share of freight traffic under the segment “distribution to retailers” which goes through the urban centres. This means fewer freight vehicles-km in the urban area. The share depends on the number of centres built, so the user can choose if the measure has a limited, medium or large application. This affects also the implementation cost for building and management the delivery centres.

1.6.3.4 Pricing and financial incentives measures modules

Congestion and pollution charging is the application of a toll for entering a certain portion of the urban area aimed at reducing traffic and/or local pollution. The difference between the two options is that in the former case the toll level does not depend on the environmental impacts of the vehicles whereas in the latter case it does. In the module it is implemented as a charge applied to cars and trucks (buses, motorbikes and car sharing cars are considered exempted). The user can decide the level of the charge (for car and truck separately) and its differentiation between peak and off-peak time and between vehicles that meet different emissions standards (i.e. Euro class), if pollution charging is assumed . Also the share of the city area subject to the charge is defined by the user. Given cost elasticities (these vary by trip purpose), the application of the charge affects car use and induces some mode shift. On the freight side it is assumed that forwarders react to charges by improving the efficiency of loads and thus reducing the number of freight vehicles. If the charge is differentiated by Euro emissions standard another effect is the acceleration of the fleet renewal (which of course progressively reduces the effectiveness of the measure). The implementation and the management of the system has some costs for the public administration, which, on the other hand, collect the revenues of the charge. The implementation and management costs are estimated endogenously according to the extension of the area where the measure is implemented.

The modelling of **Parking regulation and pricing** is similar to the modelling of road charging. The difference is that in this case it is assumed that parking is charged and therefore only the share of drivers using regulated parking areas incur the charge (this share is internally specified in the passenger demand module. Also, the parking tariff can be discounted for innovative vehicles (hybrid, battery electric, fuel cells). As for road charging, the higher car usage costs impact on the car mode share. Implementation costs for this measure are modest as the regulation on parking is already in place in most of the urban areas and the measure consists only of an adaptation of the tariffs and the parking rules and/or the enlargement of the area subject to regulated parking. The implementation and management costs are estimated endogenously according to the extension of the area where the measure is implemented.

Public Transport integrated ticketing and tariff schemes are modelled by changing the fare level for using urban public transport. The change is differentiated by trip purpose to simulate, for instance, a policy to discount tariffs for regular commuters and increase tariffs for infrequent users. Again, through cost elasticities there is an impact on the mode share of public transport. In addition, the implementation of integrated ticketing systems is modelled, resulting in increased mode share for public transport thanks to seamless travel and no requirement to buy tickets whilst switching either transport modes or services. The implementation and management costs are assumed only for the activation of integrated ticketing. The revenues can of course change.

1.6.3.5 Traffic management and control measures modules

The **Legal and regulatory framework of urban freight transport** can address several aspects but for the modelling of this measure the assumption is that the activity of freight modes in the urban area is regulated to reduce traffic especially in some zones and times of the day. Therefore, when this measure is activated, a reduction of freight vehicles within the urban area is modelled and the reduction is larger in peak time. Being just a matter of regulation, there are no implementation costs associated.

Prioritising Public Transport requires regulations but also appropriate infrastructures such as reserved lanes and automated traffic lights to give way to buses and trams when they approach crossroads. The modelling of the measure assumes that such infrastructures are realised. The result is an improvement of public transport speed. Faster public transport is more attractive for users so time elasticities transform the higher speed in a higher mode share of bus and tram. Since the measure includes some infrastructures, there is an investment cost for the public administration modelled.

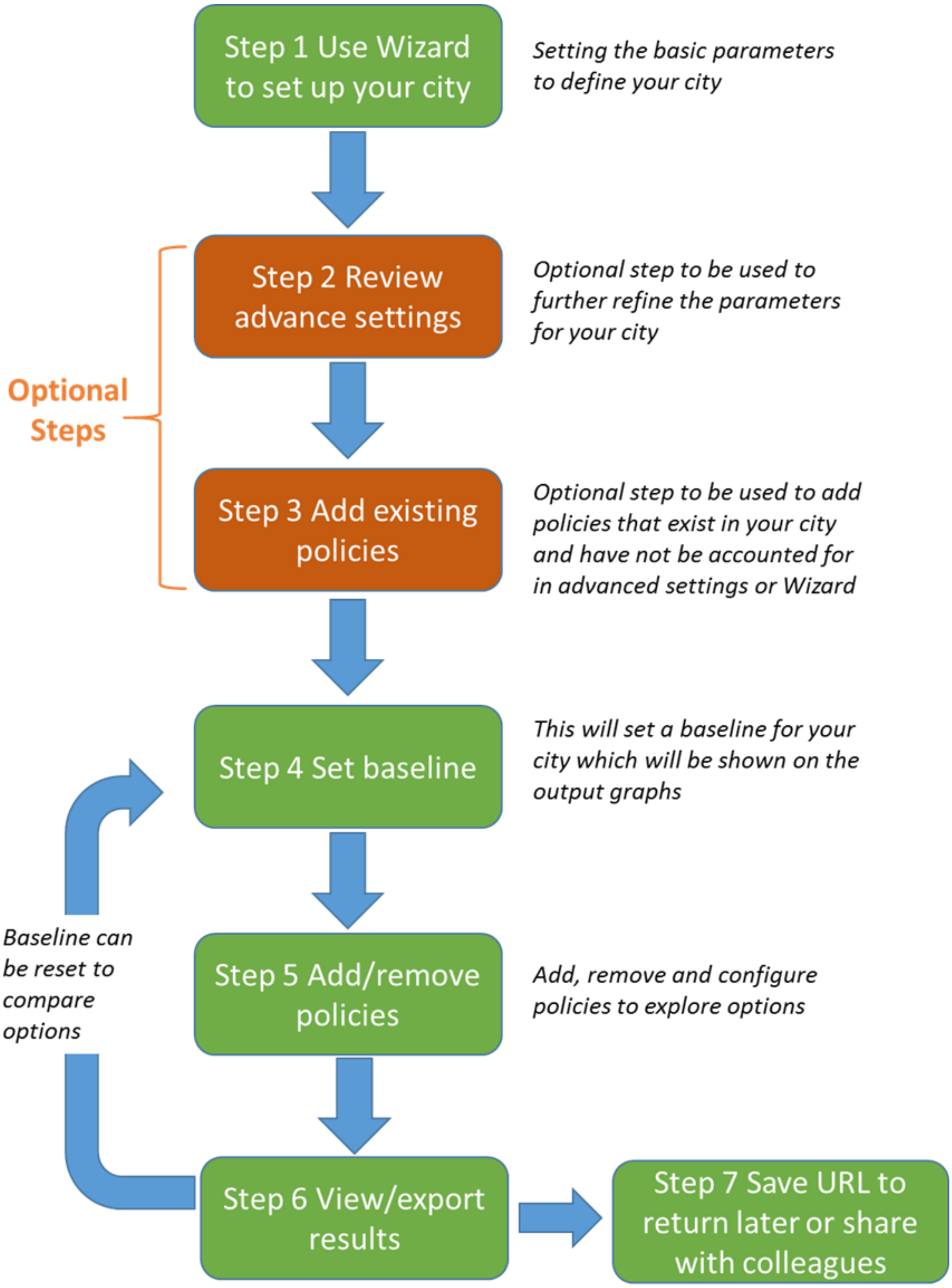
The measure **Access regulations** covering road and parking space reallocation and low emission zones aims at reducing the space available for using cars and for parking cars in order to increase the liveability of the urban space. This measure has a strong spatial dimension, but at the strategic level of the model this dimension cannot be simulated. The module assumes that the restrictions applied make it less convenient to use a car for some trips and so applies a reduction in the share of cars in traffic movements in favour of other modes. Another outcome of this measure is that where the access of private motor vehicles is restricted, the risk of accidents is reduced. This is reflected in lower accident rates. The user can control the share of urban area where restrictions are applied: the larger the share the stronger the effects. The user can also define that the restriction applies only to conventional vehicles, in that case the measure become less and less effective as the share of innovative vehicles in the fleet grows. Implementation and management costs for this measure are estimated endogenously according to the extension of the area where the measure is implemented.

Basically the same approach is used to model **Traffic calming measures**. Again the assumption is that using a car becomes less convenient for a portion of trips. For this measure the strength of the effect is partially dependent on a speed reduction through time elasticity. Also for this measure there is a reduction in accident rates. Traffic calming consists of regulation (e.g. zones with maximum allowable speed of 30 km/h) but also in various physical interventions (e.g. to restrict carriageways). The implementation and management costs for this measure are estimated endogenously according to the extension of the area where traffic calming measures are implemented.

2 Using the tool

2.1 Overview of the user process

On launching the tool the "City Wizard" will take you through the basic set up process for your city. Once this has been done you can then proceed to further advanced customisation of your city and adding polices. The overall process of setting up your city and assessing sustainable urban transport policies is illustrated in the flow chart below and described in the following sections.

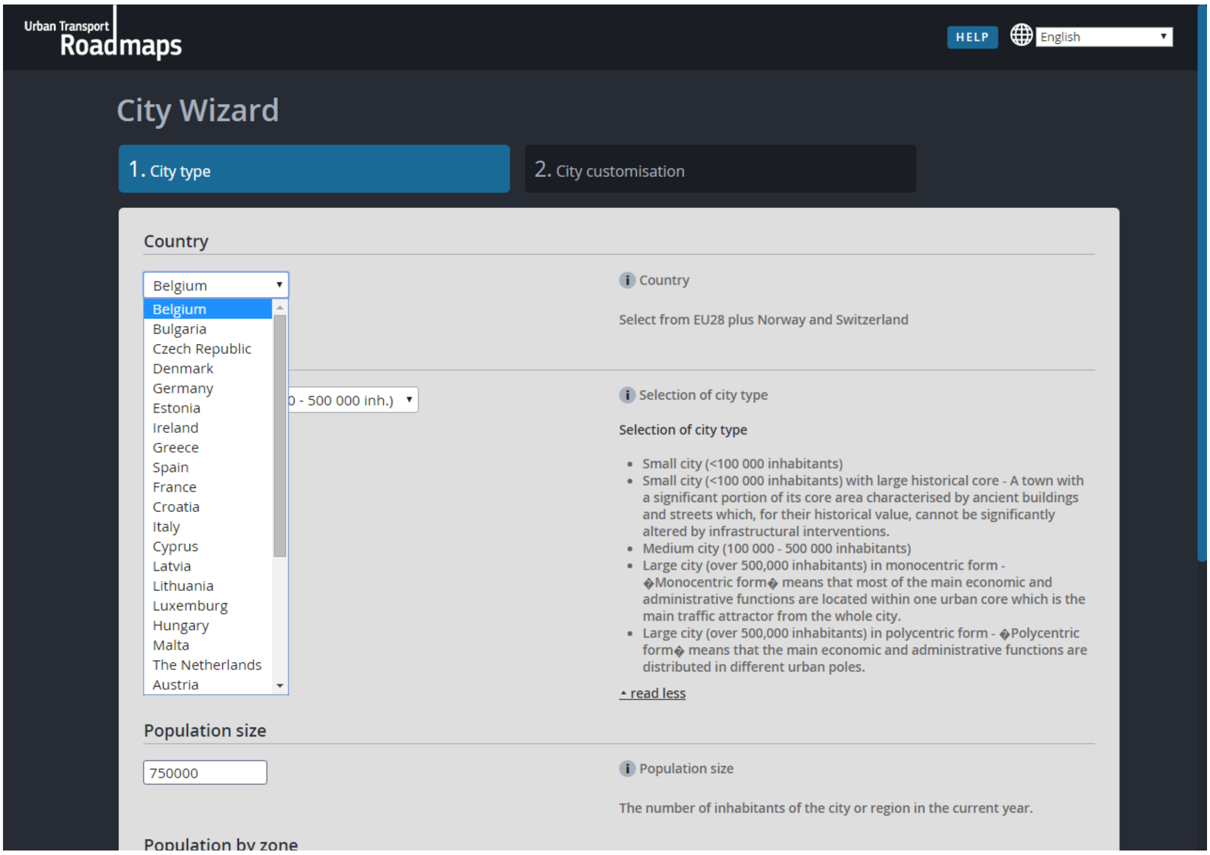


2.2 Step 1. City Wizard:

2.2.1 City Type

Immediately after launching the tool from the *home page* the user is taken to the City Wizard function. This enables the user to quickly build up a basic profile of their city. It starts with some basic information such as the country your city is located in and the type of city it is in terms of its population size and layout. A full list of the customisable options was set out in Table 1 in section 1.3 above with further details available in section 3.1.1.

Figure 4 City type view in the city wizard



Complete these sections first using the tutorial information on the right of the page to refine your selections. Remember these cannot be edited so it may be worth researching these before continuing. Once all the fields are complete select “NEXT” to go to “2. City Customisation” tab.

2.2.2 City Customisation

The City Customisation page of the wizard allows the user to choose further options in relation to the basic nature of the city and its transport system. Follow the same process used for the City Type page. The list of options that can be selected is give in Table 1 in section 1.3 above with further details provided in section 3.1.2.

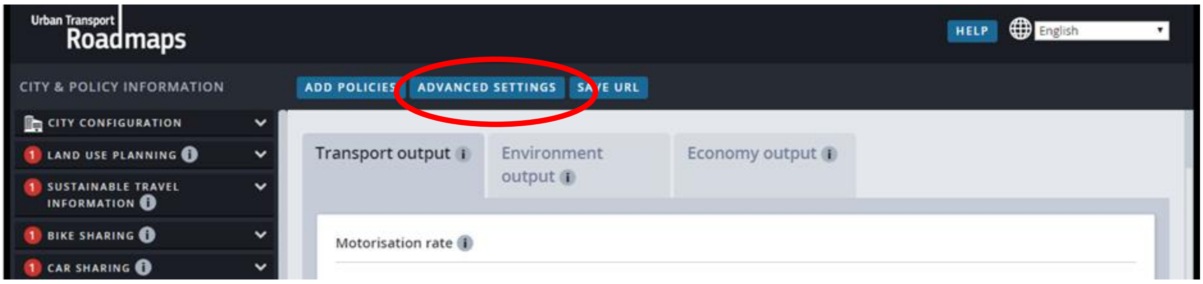
Once all the fields are complete select the “FINISH” button at the bottom of the page. This will then set up the tool to represent a city with your initial customisation. This initial customisation will use range of default data and assumptions based on the choices that you have made in the City Wizard. You will then be presented with a graphics page showing initial output values for this city and with several tabs for adding policies and further customisation of the tool.

2.3 Step 2. Advanced Settings (Optional)

Now that the city configuration has been completed via the City Wizard, it is possible to start to build up a picture of how the various policies and characteristics of your city and its population will impact on the transportation services. However, before adding any policies it is helpful to consider further customisation of your city’s current characteristics. You can do this by selecting the “ADVANCED

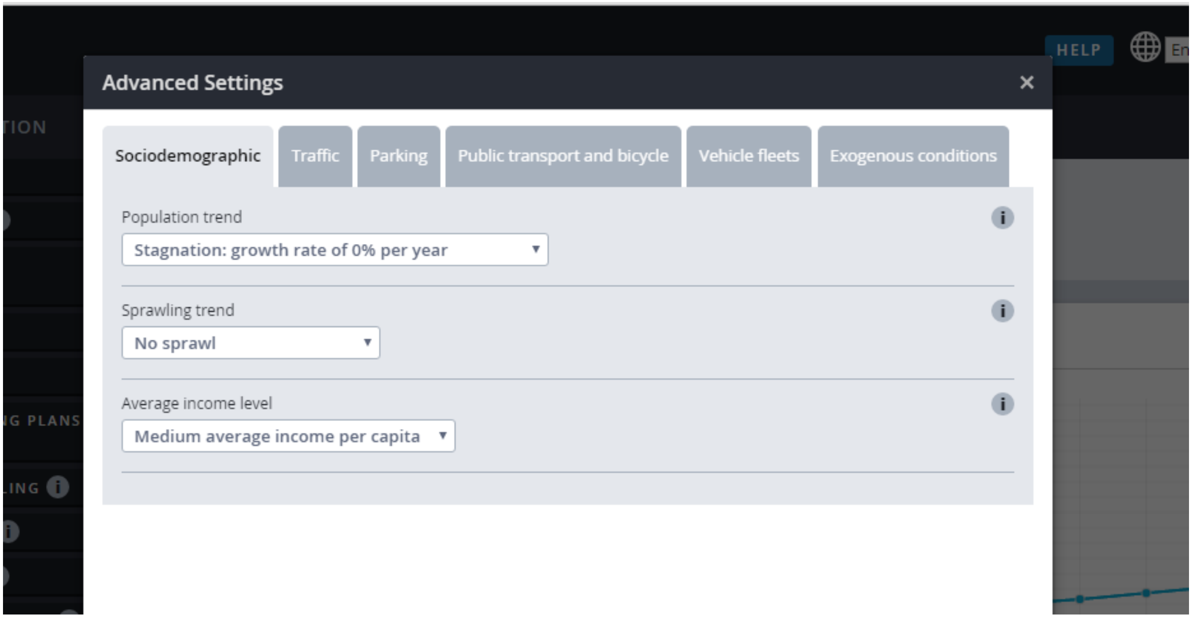
SETTINGS" tab. Here it is possible to set various characteristics and base year averages that will refine the basis of the calculations for your policies. This step is optional and requires you to have more detail information about your city and its transport system. However, the closer the initial set up and customisation of the tool to you your current situation the more realistic will be the outputs of the model in relation to the impact of policies on your city.

Figure 5 Selecting the advance settings page



Work through the tabs in this window selecting the most appropriate settings for your city. Use the "i" icon to access the tutorial tips for each setting. Unlike the City Configuration in Step 1, if you realise that one of these settings is incorrect it can be adjusted at any time. Full details of all the variables that can be configured from the advanced setting pages is provided in section 3.2.

Figure 6 The advance settings page



Once you have made the necessary changes in the advance settings page close this page and the tool will be automatically updated to reflect these changes and produce a new set of outputs.

2.4 Step 3. Add Existing Policies (Optional)

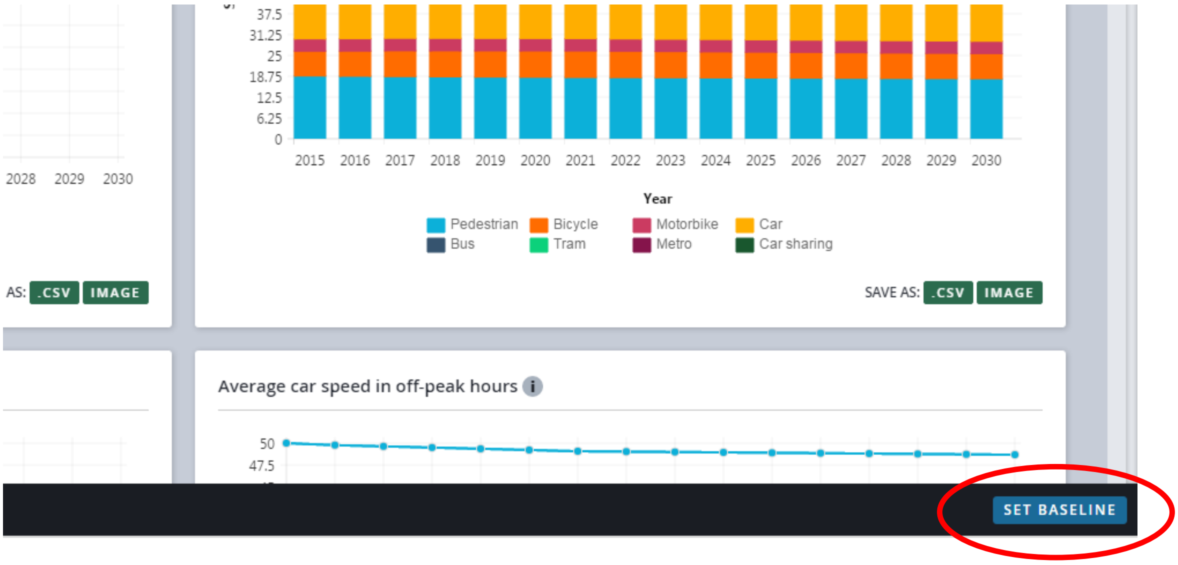
Your city is now ready to have various policies applied to improve a number of potential objectives. At this stage it is worth considering if particular policies have already been implemented in you city. Some of these may be accounted for in the advanced setting above for example by adjusting initial mode split or use of a car share scheme. However, you can also add existing polices at this stage before setting a baseline against which to measure the impact of new policy interventions. If you do this be careful not to double count by adjusting both the advance settings to replicate the current situation and adding additional policies.

This is an optional step and is carried out in exactly the same as adding additional polices as described below.

2.5 Step 4. Set a Baseline

Now that you have set up your city in its current form it is possible to set this as a baseline by using the "SET BASELINE" button in the bottom left corner of the tool. Once selected this will save a set of results against which changes will be shown as you add new or adjust existing policies. The baseline will be shown on all outputs graphs as a fixed set of results. This baseline can be reset at any time.

Figure 7 The set baseline button

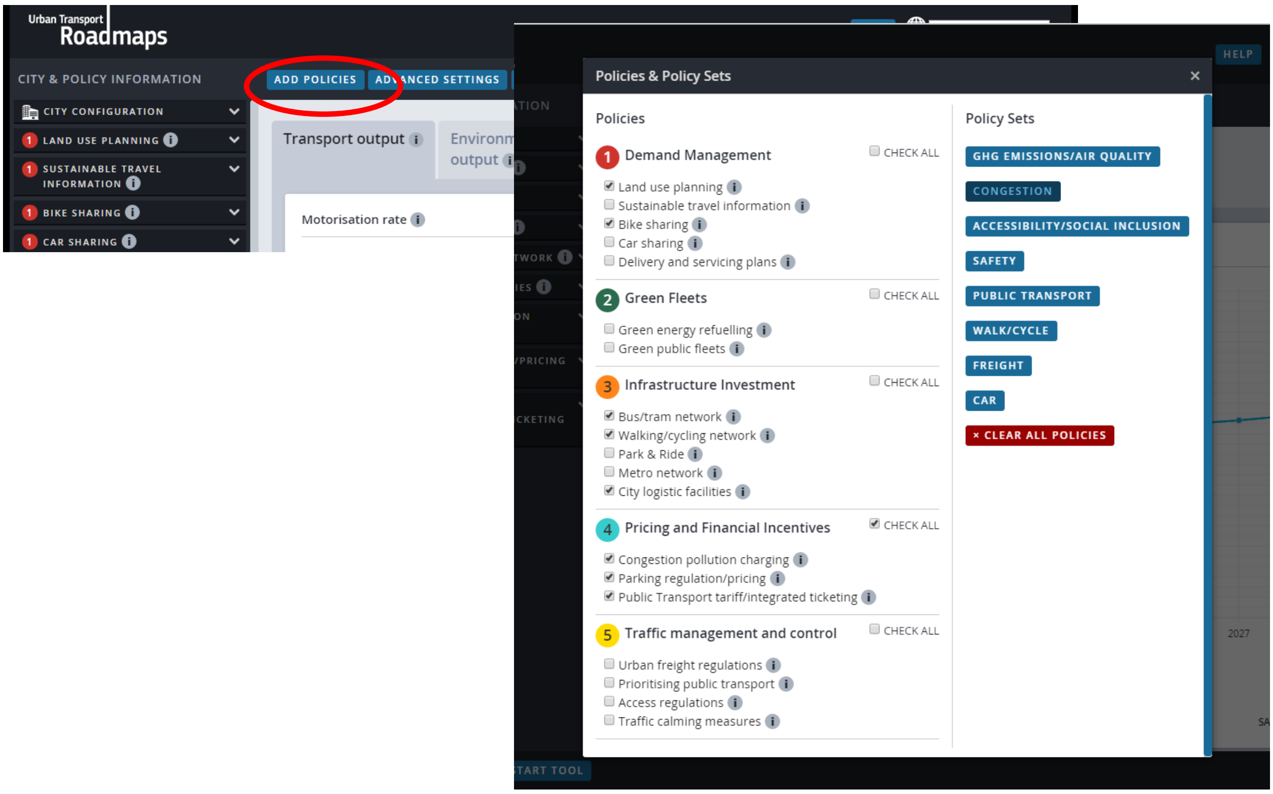


It is important to set a baseline before adding new policies as this provides the primary way of interpreting the output results in terms of changes against the baseline.

2.6 Step 5. Add and Adjust the Policies

With the model set up to represent your existing situation as closely as you can and with the baseline set you are now ready to explore the potential impact of new policies on your city. By clicking the "ADD POLICIES" button a range of policy options will appear as shown below in Figure 8.

Figure 8 The add policies button and screen

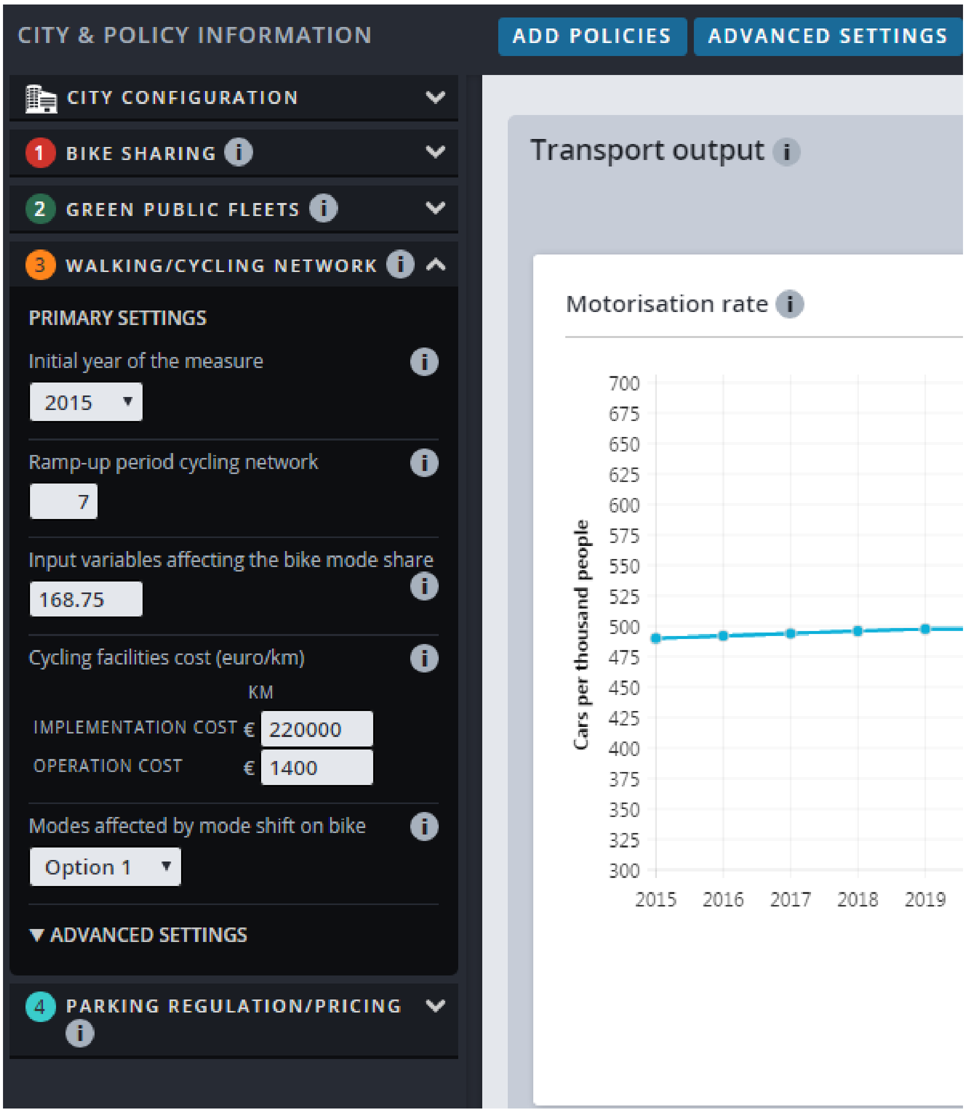


The policies are arranged in 5 groups reflecting the type of policy. Information about each of the policies can be accessed by clicking the "i" icon beside it. You can select individual polices or an entire group. You can also select sets of policies that have been tailored to meet a particular objective, such as reducing congestion, by using the sets of policies on the right. This will auto select certain policies relevant for that objective. The list of policies that can be selected is set out in Table 3 in section 1.4 above with a description of how these policies are modelled in section 1.6.3 above.

Once you have selected your policies click the "X" in the top right and those policies will be applied automatically. You can apply or remove policies at any time by clicking the "Add Policies" button again and then the "X" when you're ready.

Now you have selected your set of policies they will appear on the left of the webpage under City Configuration. You can explore each one and adjust the variables for your particular policy requirements. The tuition text can again be accessed by clicking the "i" icon. If you are unsure which values to enter the tool will auto-populate them for you. Otherwise you can try adjusting them to see what impact it will have on the city model.

Figure 9 The policy configuration panel



The full details of all the policy options and configuration variables are provided in section 3.3. It is recommended that these configuration options are consulted alongside the description of how the policy has been implemented in the tool to ensure that the policy is implemented appropriately in the tool.

2.7 Step 6. View and export results

The results window allows you to view the results immediately in the form of graphs. There are three groups of graphical outputs covering transport impacts, environmental impacts and economic impacts. Again by clicking the "i" icon you will be provided with further explanation about this output. The full details of all the model outputs are described in section 3.4.

The primary interpretation of the results should be considered in relation to the baseline and changes that are generated by implementing policies. In this way you can quickly see whether policies are having a positive or negative impact on the model outputs and the degree of this impact.

In order to further assess and explore the results it is possible to extract the results for use in presentations and other applications. The data can be extracted as a CSV or the image can be exported ready to go as a PNG. Simply click the appropriate button for output at the bottom of each graph in the results window. The .csv files only provide the results for the current scenario so if you want to compare the .csv data for both the scenario and baseline outside of the tool it is necessary to download the .csv results for the baseline before adding any policies.

Figure 10 Exporting model outputs

In developing and exploring policy options and their impact on the city one of the key aims is to move the city forward in terms of meeting the objectives European Transport white paper. The key goals within the white paper that relate to relate to urban transport that cities should be trying to achieve are:

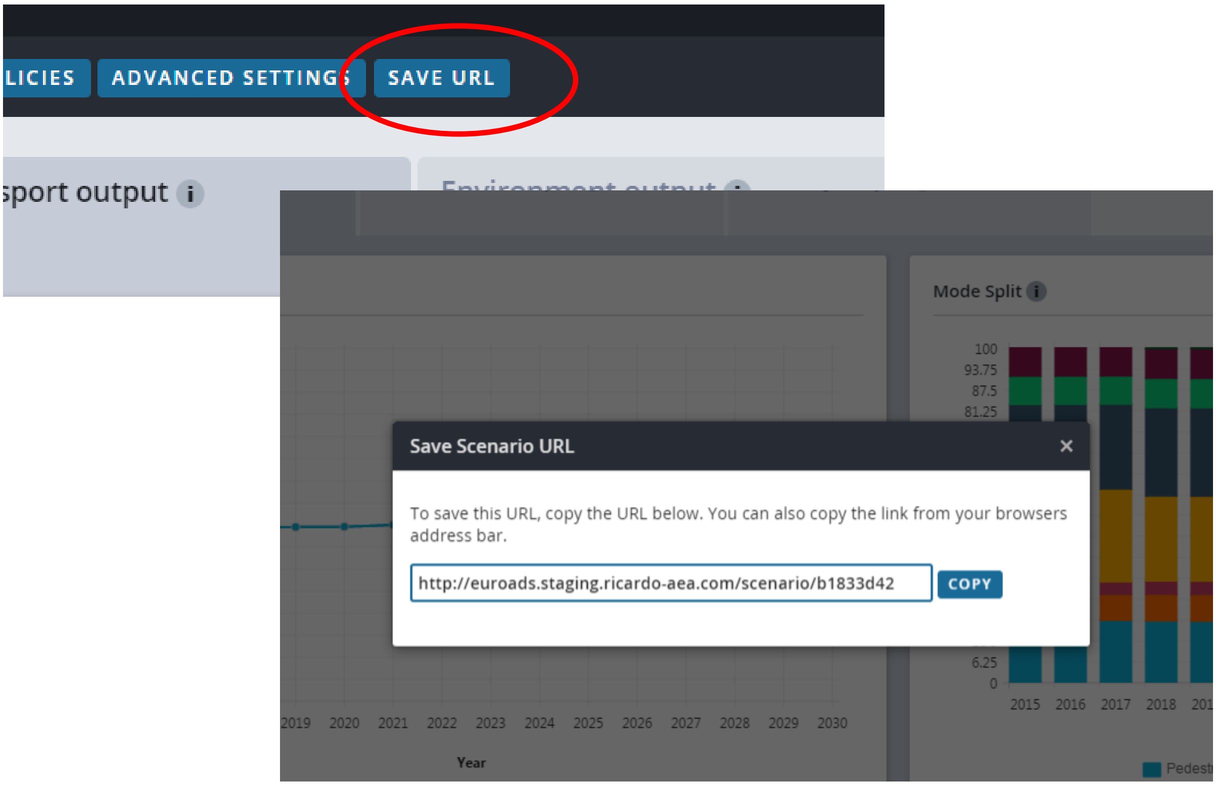
- To halve the use of conventionally fuelled cars in cities by 2030, and phase them out completely by 2050;
- To achieve CO2 free city logistics in major urban centres by 2030;
- To halve road casualties by 2020 and move close to zero fatalities in road transport by 2050.

The process of developing urban transport policy roadmaps to meet these objectives is explored more fully in the deliverable on 'Urban transport policy roadmaps'. This document also provide 5 illustrative policy roadmaps and how these have been developed and set up with the online tool.

2.7.1 Step 7. Save URL

At any time you can save your city policy selections and then start back where you left off. This is accomplished by clicking the “SAVE URL” button above the results window. A pop up window will appear from which you can save the address and enter it back into your internet browser at any time.

Figure 11 Save scenario



This URL can also be shared with your colleagues so that you can collaborate on developing and exploring policies. This saved URL will be single version of your city and the policies you have implemented. If you wish to set up a new set of policies or scenario you will need to restart the tool and re-run the wizard. You can then save the URL for this scenario. You will then have two version of your city with different scenarios. This can allow you to create, explore and share a range of scenarios with your colleagues.

3 Detailed description of tool variables

This section provides a detailed description of all the user inputs and variables included in the tool.

3.1 City Wizard

3.1.1 City Type

This section includes basic information for the configuration of the tool according to the city type under analysis. The user input available from the interface to customise the tool are reported in the following table.

Table 5 City type variables

Variable	Description	Unit	Notes
Population size	Number of inhabitants of the city	Inhabitants	Number of inhabitants at the base year (2015). The study area can be identified by the administrative borders of the city. In that case this input is the number of inhabitants of the city. However, the study area can be a metropolitan area including several municipalities. In that case the input is the number of inhabitants of the whole area including suburbs and neighbouring municipalities.
Country	Country where the city is located	-	Selection among a predefined list of countries (EU28 plus Norway and Switzerland). The country is used in the tool to set automatically initial values for several parameters using average national data (e.g. car ownership, vehicle fleet composition, car ownership taxes, energy mix for electricity generation, etc.).
City type	Selection of city type	-	Predefined set: • Small city (<100 000 inhabitants), • Small city (<100 000 inhabitants) with large historical core • Medium city (100 000 - 500 000 inhabitants), • Large city (over 500,000 inhabitants) in monocentric form, • Large city (over 500,000 inhabitants) in polycentric form. “Small city with large historical core” represents a town with a significant portion of its core area characterised by ancient buildings and streets which, for their historical value, cannot be significantly altered by infrastructural interventions and, at the same time attract visitors. “Monocentric form” means that most of the main economic and administrative functions are located within one urban core which is the main traffic attractor from the whole city. “Polycentric form” means that the main economic and administrative functions are distributed in different urban poles. City type is used in the tool to set automatically some parameters (e.g. average travel distance).

Variable	Description	Unit	Notes
Population by zone	Share of inhabitants living in each of the three area types: • urban core • outskirts with good transit service • outskirts with poor transit service	%	The urban core is defined within the tool as the main part of the urbanised area under analysis characterised by a continuous fabric. The outskirts zone refers to the remaining parts of the urbanised area, e.g. to peripheral urban blocks not contiguous with the urban core or also different municipalities in case a metropolitan area is considered in the analysis. Outskirt is considered to have a good transit service when public transport is recognised to be a reasonable alternative to reach other destinations in the city in terms of capacity, speed and reliability. Initial values are provided to allow the tool working in case the user does not have information available The total sum of the shares have to be 100%;
City economy type	Selection of whether the industrial sector is relevant for the city economy or not	-	Indicatively, the industrial sector is defined as relevant if the share of employees in the city working in manufacturing, construction and public utilities (electricity, gas, and water) is higher than 30%. This element is used in the tool to set automatically some parameters related to the freight traffic.

3.1.2 City Customisation

This section includes basic information on the mobility system of the city type under analysis. The user inputs available from the interface to customise the tool are reported in the following table.

Table 6 City customisation variables

Variable	Description	Unit	Notes
Public transport use	Selection of a qualitative description of the relevance of Public Transport for the mobility of the city	-	• “Public transport is extensively used” means that the mode share of PT is indicatively of 30% or more • “Public transport is used” means that the mode share of PT is indicatively in a range within 15% and 30% • “Public transport is rarely used” means that the mode share of PT is indicatively below 15% This element is used in the tool to set automatically an initial value for the mode share of public transport.
Bicycle use	Selection of a qualitative description of the relevance of cycling for the mobility of the city	-	• “Bikes are extensively used” means that. the mode share of cycling is indicatively of 15% or more • “Bikes are used” means that the mode share of cycling is indicatively in a range within 3% and 15% • “Bikes are rarely used” means that the mode share of cycling is indicatively below 3% This element is used in the tool to set automatically an initial value for the mode share of cycling.
Motorbikes use	Selection of a qualitative description of the relevance	-	• “Motorbikes are extensively used” means that. the mode share of cycling is indicatively of 8% or more

Variable	Description	Unit	Notes
	of motorbikes for the mobility of the city		• "Motorbikes are used" means that the mode share of cycling is indicatively in a range within 3% and 8% • "Motorbikes are rarely used" means that the mode share of cycling is indicatively below 3% This element is used in the tool to set automatically an initial value for the mode share of motorbikes.
Tram network	Selection of a qualitative description of the relevance of the tram network in the city	-	• "An extensive tram network exists" means that tram is a relevant component of the urban public transport, indicatively more than 25% of PT passengers are transported by tram • "Only some tram lines exist" means that tram is a component of the urban public transport but plays a relatively minor role, indicatively less than 25% of PT passengers are transported by tram • "Tram lines do not exist" means that tram is not available in the city. This element is used in the tool to set automatically an initial value for the mode share of tram.
Metro network	Selection of a qualitative description of the relevance of the metro network in the city	-	Three options available: • "An extensive metro network exists" means that metro is a relevant component of the urban public transport, indicatively more than 25% of PT passengers are transported by metro • "Only some metro lines exist" means that metro is a component of the urban public transport but plays a relatively minor role, indicatively less than 25% of PT passengers are transported by metro • "Metro lines do not exist" means that metro is not available in the city This element is used in the tool to set automatically an initial value for the mode share of metro.
Road congestion	Selection of a qualitative description of road congestion in the city	-	• "Road congestion is very limited", means that delays caused by traffic are only occasional even in peak time • "There is some road congestion" means that traffic causes significant delays usually during peak hours • "Road congestion is significant" means that traffic causes significant delays during both peak and off-peak hours This element is used in the tool to set automatically an initial value for the average speed of road modes.

Variable	Description	Unit	Notes
City users (incoming trips)	Selection of a qualitative description of the amount of incoming trips generated by city users.	-	City users are those who do not live in the city (or in the metropolitan area if the study area includes more municipalities) but reach the city for working or personal purposes. The share of inhabitants in the outskirts defined in a different setting are NOT city users but are considered internal residents. • ”Limited amount of city users” means that the largest part of the urban mobility is generated by the city inhabitants, indicatively at least 70% of trips are generated internally and 30% or less is entering from outside • ”Moderate amount of city users” means that indicatively 50% of trips are generated internally and 50% is entering from outside • “Consistent amount of city users”, means that the largest part of the urban mobility is generated by the city users, indicatively no more than 40% of trips are generated internally and 60% or more is entering from outside This element is used in the tool to set automatically an initial value for the number of trips incoming from outside the study area.
Mode split of incoming trips	Mode shares of transport modes used by incoming trips	%	It is assumed that incoming trips enter the city using one of three alternative modes: car, coach or train. The share of each one is required here as input. Initial values are provided to allow the tool working in case the user does not have information available The total sum of the shares have to be 100%.

3.2 Advanced Settings

The inputs included in the advanced settings allow the user to tailor the application to a specific urban case. Inputs are split into different sections, such as the user can access only the subset of elements she is interested in. Default values are provided for each variable, in order to ensure in any case the functionality of the tool. The user input available from the interface to customise the tool are reported in the following tables.

3.2.1 Sociodemographic

Variable	Description	Unit	Notes
Population trend	Selection of a population growth trend	-	This parameter is the growth rate of the population living in the city (or in the metropolitan area if the study area includes several municipalities). This rate is used in the tool to compute total population over the whole period of analysis, i.e. until 2030, so it should be considered as an average rate for the period 2015 – 2030. The options available are the following: • Stagnation: growth rate 0% per year • Limited decline: growth rate -0.5% per year • Significant decline: growth rate -1% per year • Limited growth: growth rate 0.5% per year

Variable	Description	Unit	Notes
			• Significant growth: growth rate 1% per year
Sprawling trend	Selection of a qualitative description of the sprawling trend in the city	-	Sprawl is low density land development taking place on the edges of urban centres. This type of development is often unplanned and generates fragmented fabric of car-dependent residential or commercial areas. This parameter describes the strength of sprawl around the urban study area as observed and expected (without policy interventions) in the future years. In the tool the sprawl is interpreted in terms of growth of the share of population living in outskirts especially outskirt with poor transit service. The options available are the following: • "No sprawl" means that there is no significant urban sprawl trend. The share of population living in outskirts is assumed to be stable. • "Limited sprawl" means that only a few external scattered land developments are expected. The share of population living in urban core would be slightly reduced (not more than 5%-10% between 2015 and 2030) whereas the share of population living in outskirts would slightly grow • "Some sprawl" means that some external scattered land developments are expected. The share of population living in urban core would be reduced (some 10%-15% between 2015 and 2030) whereas the share of population living in outskirts would grow. • "Significant sprawl" means that several external scattered land developments are expected. The share of population living in urban core would be significantly reduced (more than 15% between 2015 and 2030) whereas the share of population living in outskirts would significantly grow.
Income level	Selection of a qualitative description of the average income level in the city	-	• "High average income", means that the average income of city inhabitants is more than 30,000 euro per capita • "Medium average income" means that the average income of city inhabitants is in the range 20,000 to 30,000 euro per capita • "Low average income" means that the average income of city inhabitants is less than 20,000 euro per capita This element is used in the tool to scale elasticity parameters reflecting behavioural responsiveness to changes of elements like transport costs, travel speed and others.

3.2.2 Traffic

Variable	Description	Unit	Notes
Mode split initial values	Mode shares of transport modes used for internal trips in the base year	%	Internal trips are those generated by the inhabitants of the city (or metropolitan area) and with destination within the city (or metropolitan area). The input required is the share of trips made with each of the available alternatives: car, motorbike, bikes, pedestrian, Public transport. An initial value is provided based on the options selected under city customisation (see table 2) The total sum of the shares have to be 100%.
Mode split trend	Selection of a qualitative description of the trend of mode split in the city	-	Even without any policy intervention, the use of transport modes changes over time. This input allows the tool updating the mode shares of the base year according to either observed or expected trend. The input is focused on the role of car for urban mobility.. • "car share growth" means that car mode share is expected to grow in the future at the expense especially of slow modes • **"**car share decrease**"**: means that car mode share is expected to fall in the future compensated especially by an increase of other private modes (bike and motorbike) • **"**car share strong decrease**"**: means that car mode share is expected to fall in the future compensated especially by an increase of sustainable modes (bike and public transport).
Share of freight vehicles with respect to cars	Share of freight vehicles travelling within the city	%	This is the share of freight vehicles with respect to car trips. For instance a share of 10% means that one vehicle circulating in the urban area every ten cars is a freight vehicle. An initial value is provided based on average conditions.
Share of freight vehicles trend	Selection of a qualitative description of the trend of the share of freight traffic in the city	%	Even without any policy intervention, the relevance of freight traffic changes over time. This input allows the tool updating the number of freight vehicles according to either observed or expected trend. The user should set the expected yearly growth (in %) of the share of freight vehicles. For instance, if in the base year freight vehicles represent 5% of the vehicles circulating and it is expected that they can be 11% at the horizon of the year 2030, the corresponding yearly growth (0.4%) should be set. An initial value is provided based on average conditions.
Electric charging stations at base year	Selection of the amount of charging stations at the base year	-	Three choices are provided for selection 1. Limited or no charging stations 2. Some charging infrastructure

Variable	Description	Unit	Notes
			3. A significant amount of infrastructure
Fuel cell refuelling stations at base year	Selection of the amount of refuelling stations at the base year	-	Three choices are provided for selection 1. Limited or no refuelling infrastructure 2. Some refuelling infrastructure 3. A significant amount of infrastructure

3.2.3 Parking

Variable	Description	Unit	Notes
Regulated parking area	Selection of a qualitative description of the extension of the regulated parking area in the city	-	Regulated parking is defined as parking space where a payment is required. It includes public parking lots as well as those in private garages. Non-regulated parking means all other places where cars are parked in the urban area (or metropolitan area) including free parking space kerbside as well as free parking spaces in private buildings (e.g. firms, shops) and also irregular but generally tolerated parking. The input required is the share of regulated parking areas within the city (or the metropolitan area): • "Most of parking lots are charged" means that 50% or more of parking spaces are charged. • "Mix of charged and free parking lots" means that more than 20% but less than 50% of parking spaces are charged. • "Most of parking lots are free" means that 20% or less of parking spaces are charged.
Average parking tariff	Average parking tariff	Euro/hour	In a city usually various parking tariffs exist (e.g. public parkings and private garages apply differently charges, within public parking tariffs depend on the zone of the city, etc.). The input required is an average parking tariff per hour that can be considered representative of the cost of using regulated parking within the city. An initial value of 1 euro/hour is provided.
Park&ride tariff	Cost per hour for parking at Park&Ride terminals	Euro/hour	Average cost (Euro/hour) for parking a car in an existing Park&Ride terminal. Parking cost is differentiated by purpose (commuting, business, non-business) under the assumption that regular users (commuters and some of those moving for business) enjoy discounted tariffs Initial values are provided: • Commuters tariff: 0.2 €/hour • Business tariff: 0.3 €/hour • Non-business tariff: 0.4 €/hour These values are not used unless the number of parking lots available (see above) is set to a value larger than zero.
Coverage of PT services	Length of bus lines directly connected with	km	Length of bus lines directly connected with existing Park&Ride terminals at the base year. In case more Park&Ride terminals exist, the input should

Variable	Description	Unit	Notes
from/to the P&R stations	existing Park&Ride terminals at the base year		be the sum of the lines connecting all the terminals . An initial value of 5 km is provided. This value is not used unless the number of parking lots available (see above) is set to a value larger than zero.
Park&ride - PT frequency of services	Average frequency of bus services directly connected with existing Park&Ride terminals at the base year	Minutes	Average frequency (in terms of headways: minutes between two services) of bus services directly connected with existing Park&Ride terminals at the base year. Different lines can have different frequencies. Also, in case more Park&Ride terminals exist, lines connecting one terminal can have different frequencies of lines connecting another terminal. In these cases, the input should be a value representative of the frequency of PT services available from Park&Ride terminals. An initial value of 15 minutes is provided. This value is not used unless the number of parking lots available (see above) is set to a value larger than zero.
Capacity of Park&Ride parking lots	Capacity of parking areas of the existing Park&Ride terminals at the base year	Slots	Park&Ride terminals make available a certain number of parking lots for users switching to public transport. The input required here is the total capacity (number of slots) of the parking areas of the existing Park&Ride terminals. Total capacity means that in case more terminals exist the value should be the sum of parking slots across all terminals. Initial value is set to 0 as the default case is that Park&Ride terminals do not exist.

3.2.4 Public transport and bike

Variable	Description	Unit	Notes
Average PT fare	Average Public Transport fares	Euro/trip	In a city usually various public transport tariffs exist. The input required is two average tariffs (cost per trip) that can be considered representative of the cost of using public transport within the city. One tariff should represent the cost for those using public transport daily or anyway frequently (e.g. for trips to workplaces or schools so this group is named “commuters”). This group of users is assumed to purchase season tickets. The other tariff should represent the cost for those using public transport occasionally (i.e. not for trips to workplaces or schools so this group is named “non-commuters”). This group of users is assumed to use single trip tickets. Initial values are provided based on country selection, e.g.: • Commuters fare: 0.6 €/trip • Non-commuters fare: 1.2 €/trip

Variable	Description	Unit	Notes
PT mode split	Market share of each public transport mode	%	Shares of each public transport mode (bus, tram and metro) calculated on the total number of trips made by public transport. Therefore the sum of the shares have to be 100%. Initial values are provided based on the options selected under city customisation (see table 2)
PT vkm by detailed mode	Amount of vehicles-km travelled by PT modes	Million vkm/year	Value of the yearly performance (vehicles-km) of each urban transport mode (bus, tram, metro). This information is usually available by companies providing the public transport service. An initial value is provided based on the ratio between passenger-km and occupancy factor estimated by the tool.
PT reserved lanes	Selection of a qualitative description of the extension of public transport reserved lanes in the city	-	If one consider the overall length of the public transport network (i.e. the sum of the length of all public transport lines) a certain share of this length consists of lanes reserved to public transport modes (bus or tram). The input required here is the share of the public transport network consisting of reserved lanes: • “An extensive network of reserved lanes for bus/tram exists” means that 15% or more of the PT network length consists of reserved lanes. • “A limited number of reserved lanes for bus/tram exist”, means that a share between 5% and 15% of the PT network length consists of reserved lanes. • “Reserved lanes for bus/tram do not exist or are negligible” means that less than 5% of the PT network length consists of reserved lanes.
Cycling reserved lanes	Selection of a qualitative description of the extension of Cycling reserved lanes in the city	-	Cycling reserved lanes are defined here as paths clearly separated from the space used by cars. So lanes identified just by a painted line are NOT considered reserved lanes here. The input required here is the share of the length of reserved lanes for cycling as proportion of the road network length: • “An extensive network of bike reserved paths exists” means that bike reserved lanes length is 8% or more of the road network length. • “A limited number of bike reserved paths exist”, means that bike reserved lanes length is between 1% and 8% of the road network length. • “Bike reserved paths do not exist or are negligible” means that bike reserved lanes length is 1% or less of the road network length.

3.2.5 Vehicle fleet

Variable	Description	Unit	Notes
Car ownership level	Car ownership level	Cars/1000 inhabitants	This initial value shown here is generated from the city wizard selections in terms of country. The user can adjust this to reflect the actual car ownership level for their city.
Car fleet composition by fuel type - initial values	Car fleet composition by fuel type in the city at the base year	%	Composition by fuel type (Gasoline, Diesel, CNG, LPG, Hybrid electric, Battery electric, fuel cells) of the car fleet of the city at the base year. Initial values are provided based on Country selection.
Bus fleet composition by fuel type - initial values	Bus fleet composition by fuel type in the city at the base year	%	Composition by fuel type (Diesel, CNG, Hybrid electric, Battery electric) of the bus fleet of the city at the base year. This information is usually available by companies providing the public transport service. Initial values are provided based on Country selection.
Number of car sharing clients	Number of clients of existing car sharing service at the base year	Individuals	In order to use a car sharing service (car club) a subscription is needed. This input is the number of inhabitants of the city who subscribed a car sharing service. Initial value is set to 0 as the default case is that Car Sharing services do not exist.
Car Sharing type	Selection of the type of car sharing service available at the base year	-	Car sharing services can be classified under to categories: • one-way system: car can be collected and returned in any point in the city • round system: car must be collected and returned in specific stations The user should select which of the two types of car sharing service exist. In case both services exist the user should select the type more used in the city. This input is used in the tool to set the impact of car sharing on competing modes.
Car sharing fixed cost	Annual fee for subscription of the service at the base year	euro/year	In order to use a car sharing service (car club) a fixed annual fee is generally required. The input required here is the cost of this annual fee. An initial value of 80 €/year is provided. This value is not used unless the number of clients of car sharing (see above) is set to a value larger than zero.
Car sharing variable cost	Usage fee at the base year	Euro/hour	In order to use a car sharing service (car club) a variable tariff based on the duration and/or the distance of the trip is required. The input required here is the cost of this tariff. The input is required in terms of Euro/hour. If the service applies (also) a tariff per km an estimation is needed to obtain the input required here. The most straightforward way to make this estimation is to consider an average speed (average speed of urban trips including stop at traffic lights, time for parking, etc). For instance, if an average speed of 30 km/h is

Variable	Description	Unit	Notes
			considered a tariff of 0.25 Euro/km is equivalent to 0.25 x 30 = 7.5 Euro/hour. An initial value of 15 €/hour is provided. This value is not used unless the number of clients of car sharing (see above) is set to a value larger than zero.
Average time to pick up a car (min)	Average time needed to reach a car	minutes	The coverage of a car sharing service can be variable depending on the number of cars available to the subscribers and, in case of a round system, on the location of the dedicated stations. The coverage of the service is used in the tool as one parameter for the definition of the attractiveness of the service. The coverage is represented by the average time needed to pick up a car when one decide to use the service. This time can be variable of course. An estimation of a representative time is needed here. An initial value of 10 minutes is provided. This value is not used unless the number of clients of car sharing (see above) is set to a value larger than zero.

3.2.6 Exogenous Conditions

Variable	Description	Unit	Notes
Technology scenarios	Selection of one trend	-	This scenario includes the exogenous conditions related to technology (vehicle technology, fuel economy and polluting emission factors). Three options are available: • Reference trend, • slow technical progress (slower penetration of innovative vehicles, slower improvements of fuel economy and of polluting emission factors), • fast technical progress (faster penetration of innovative vehicles, faster improvements of fuel economy and of polluting emission factors) The content of the alternative scenarios is presented in more details in table 11 below.
Energy scenarios	Selection of one trend	-	This scenario includes the exogenous conditions related to energy (energy resource price, car ownership trend, trip rates trend, energy mix for electricity generation). Three options are available: • reference, • energy shortage (faster fuel price growth, reduced mobility, car ownership reduction); • energy wealth (slower fuel price growth, faster car ownership growth) The content of the alternative scenarios is presented in more details in table 12 below.

Variable	Description	Unit	Notes
Policy scenarios	Selection of one trend	-	This scenario includes the exogenous conditions related to transport policy at the national or sovranational level (fuel tax, car ownership tax). Three options are available: • reference, • green taxation (higher fuel duties and car ownership taxation). The content of the alternative scenarios is presented in more details in table 13 below.

3.2.6.1 Technology scenarios

Depending on the selection the following variables are set with different projection values:

- **Vehicle technology**, i.e. penetration of innovative vehicles in car fleet (hybrid electric, battery electric, fuel cells), LDV fleet (battery electric), bus fleet (CNG, Hybrid electric, Battery electric).
- **Fuel economy**, i.e. average fuel consumption trend by road vehicles.
- **Polluting emissions factors**, i.e. trend of pollutant emission factors by transport mode (to simulate the consequence of vehicle fleet renewal and progressive more restrictive EURO Emission standards).

Indicators	Variable	Unit	Average values at 2030
Vehicle technology	penetration of innovative vehicles in car fleet	%	• Reference: hybrid 28.5%, battery electric 0.9%, fuel cell 0.1% • slow technical progress: hybrid 8.5%, battery electric 0%, fuel cell 0% • fast technical progress: hybrid 15%, battery electric 25%, fuel cell 4%
	penetration of innovative vehicles in LDV fleet	%	• Reference: electric (hybrid and battery) 1.6% • slow technical progress: electric (hybrid and battery) 0% • fast technical progress: electric (hybrid and battery) 26%
	penetration of innovative vehicles in LDV fleet used to distribute goods from urban platforms	%	• Reference: electric (hybrid and battery) 3.6% • slow technical progress: electric (hybrid and battery) 1.6% • fast technical progress: electric (hybrid and battery) 33%

Indicators	Variable	Unit	Average values at 2030
	bus innovative vehicle fleet	%	The values depends on country selection / user input. As an example, for Italy: • Reference: CNG 12.5%, Hybrid electric 6.1%, Battery electric 0.3%. In case of green fleet measure could be: CNG 19.2%, Hybrid electric 8.7%, Battery electric 0.3%. • slow technical progress: CNG 12.5%, Hybrid electric 6.1%, Battery electric 0.3%. In case of green fleet measure could be: CNG 19.5%, Hybrid electric 8.4%, Battery electric 0.3% • fast technical progress: CNG 12.5%, Hybrid electric 6.1%, Battery electric 0.3%. In case of green fleet measure could be: CNG 18.5%, Hybrid electric 9.1%, Battery electric 0.4%
Fuel economy	Car average fuel consumption trend	%	• Reference: gasoline, diesel, CNG and LPG about -1.3 / -1.5 % per year, innovative vehicles -0.4 % per year • slow technical progress: gasoline, diesel, CNG and LPG about -0.6 / -0.7 % per year, innovative vehicles -0.2 % per year • fast technical progress: gasoline, diesel, CNG and LPG about -2.6 / -3.0 % per year, innovative vehicles -0.9 % per year
Polluting emissions factors	PM polluting emissions factors	%	• Reference: on average -6% per year • slow technical progress: on average -4% per year • fast technical progress: on average -9% per year
	CO polluting emissions factors	%	• Reference: on average -3% per year • slow technical progress: on average -2% per year • fast technical progress: on average -4% per year
	NOx polluting emissions factors	%	• Reference: on average -5% per year • slow technical progress: on average -4% per year • fast technical progress: on average -8% per year
	VOC polluting emissions factors	%	• Reference: on average -2% per year • slow technical progress: on average -1.5% per year • fast technical progress: on average -3.5% per year

3.2.6.2 Energy Scenarios

Depending on the selection the following variables are set with different projection values:

- **Energy price**, i.e. resource fuel price trend (Gasoline, Diesel, CNG, LPG, Electricity, Hydrogen),
- **Car ownership trend**, i.e. yearly change of cars/1000 inhabitants
- **Trip rates trend**, i.e. yearly growth rate of average number of trips made per individual (assuming that higher energy cost leads to reduce personal mobility)
- **Energy mix for electricity generation**, trend of the energy mix for electricity generation (use of Solid fuel, Oil, Gas, Nuclear, Renewables)

Indicators	Variable	Unit	Average values at 2030
Energy price	resource fuel price trend	%	• Reference growth rates per year: gasoline, diesel 0.4%, CNG 1.1%, LPG 0.6%,electricity - 0.6% hydrogen 0%. • Energy shortage growth rates per year: gasoline 1.7%, diesel 3%, CNG 2.2%, LPG 1.1%,electricity 2.2% hydrogen 1.1%. • Energy wealth growth rates per year: gasoline, diesel 0.4%, CNG, LPG, electricity and hydrogen 0%.
Car ownership trend	Car ownership yearly change	cars/1000 inhabitants	• Reference: on average +2.6 cars/1000 inhabitants per year • Energy shortage: on average + 2.0 cars/1000 inhabitants per year • Energy wealth: +2.6 cars/1000 inhabitants per year
Trip rates trend	yearly growth rate of average number of trips made per individual	%	• Reference: working and personal trips 0% per year • Energy shortage: working trips -0.3% per year; personal trips -0.6% per year • Energy wealth: working and personal 0%
Energy mix for electricity generation	trend of the energy mix for electricity generation	%	• Reference: average EU share of renewable sources 44% • Energy shortage: average EU share of renewable sources 60% • Energy wealth: average EU share of renewable sources 44%

3.2.6.3 Policy Scenarios

Depending on the selection the following variables are set with different projection values:

- **Fuel taxation**, i.e. fuel tax trend (Gasoline, Diesel, CNG, LPG, Electricity, Hydrogen),
- **Car ownership taxation**, i.e. Car ownership taxes (circulation/ownership tax).

Indicators	Variable	Unit	Average values at 2030
Fuel taxation	fuel tax trend	%	• Reference growth rates per year: gasoline, diesel 0.4%, CNG 0%, LPG 0.6%,electricity - 0.6% hydrogen -3%. • Green taxation growth rates per year: gasoline 1.8%, diesel 2.7%, CNG 6.6%, LPG 3.2%,electricity 0% hydrogen 0%.
Car ownership taxation	Car ownership tax trend	%	• Reference growth rate per year: 0% • Green taxation growth rate per year: 2%

3.3 Policy Measures

The following sections describe each of the policy measures, how they are defined and how they can be configured.

3.3.1 Demand management

3.3.1.1 Bike sharing scheme

Description of the policy measure:

The bike sharing service provides short term bicycle rental at unattended stations. Bike sharing systems (BSSs) provide convenient rental bicycles for short and utilitarian urban trips. One of the main expected impacts of BSS is to reduce journeys by car and to promote a healthier mode of transport.

Modelling of the policy measure:

This policy is modelled assuming that a bike sharing service increases the mode share of bike and that the size of this increase depends on three main factors:

- The bike sharing annual cost for users: the higher the cost the lower the number of users.
- The bike sharing urban coverage, i.e. the percentage of urban area served by bike sharing stations: the higher the share of city where the service is available the higher the number of users.
- The availability of cycling reserved lanes: when the measure “walking and cycling networks and facilities” is activated the impact of this measure is emphasised (the increase of cycling reserved lanes length increases the number of users).

The influence of these three elements on bike mode share has been quantified according to *ITDP (2013)*.

The mode share of bike is increased at the expense of other modes. Alternative assumptions are used here defined according to the document of *Steer Davies Gleave (2011).*

Building on the model share the tool estimates the total amount of additional trips by bike and the number of users of the service, under the assumption of an average amount of trips per year (based on *ITDP (2013)*).

Policy costs for the city authority depend on the amount of bike per person given the assumed coverage of the service. This estimation is based on *ITDP (2013)*. The initial values of the implementation and management costs are estimated based on *United Nations Department of Economic and Social Affairs (2011).*

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 7: Bike sharing scheme: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window “ADD POLICIES”			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period of 2 years.
Bike share annual cost	Annual fee for subscription of the service	euro/year	The annual fee is one driver of the number of bike users: the higher the fee the lower the number of users. An additional time-based usage fee is not implemented because in most of the cases subscribers can use bike for free for a certain franchise time (e.g. the first 15 or 30 minutes) and it is assumed that most of the users will complete their trip within this time.
Bike sharing coverage	Percentage of urban area served by bike sharing stations.	%	The city coverage is one driver of the number of bike users: the higher the share of city where the service is available the higher the number of users. In many cases bike sharing stations cover only one part of the city territory (usually the central area). To set the

Variable	Description	Unit	Notes
			value of this parameter one can consider the part of city from where a bike sharing station can be reached within a 10 minute walk.
Advanced settings: Policy costs			
Bike sharing implementation cost	Investment cost for the city authority	euro/bike	This is the cost borne by the city authority to implement and start the service. It covers the installation of the stations, the bikes and other initial fixed costs. Usually the bike sharing services is operated by a service provider. If this is the case this implementation cost is the value of the contract awarded to the external provider.
Bike sharing operating cost	Operating cost for the city authority	euro/bike per year	This is the cost for operating the service each year. If it is assumed that the service is operated by an external provider this cost is normally zero.
Advanced settings: Tool responsiveness			
Level of elasticity versus cost	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of bike sharing fee on the number of bike users. Set this parameter to a value > 1 to amplify the impact of bike sharing fee on the number of bike users. Range: 0.3 – 2.0.
Level of elasticity versus coverage	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of service coverage on the number of bike users. Set this parameter to a value > 1 to amplify the impact of service coverage on the number of bike users. Range: 0.3 – 2.0.
Level of elasticity versus cycling reserved lanes	Tuning parameter to adjust the level of elasticity	-	It is assumed that the impact is enhanced by the availability of cycling reserved lanes. When the measure “cycling reserved lanes” is activated the impact of this measure is emphasised. Set this parameter to a value < 1 to smooth the impact of cycling reserved lanes on the number of bike users. Set this parameter to a value > 1 to amplify the impact of cycling reserved lanes on the number of bike users. Range: 0.3 – 2.0

Synergies with other measures

It is assumed that the impact of this measure is enhanced by the availability of cycling reserved lanes. When the measure “walking and cycling networks and facilities” is activated the impact of this measure is emphasised.

References

ITDP, 2013, The Bikeshare Planning Guide,

United Nations Department of Economic and Social Affairs, 2011, Bicycle-sharing schemes: enhancing sustainable mobility in urban areas.

Steer Davies Gleave, 2011, Are Cycle Hire schemes the future of urban mobility?

3.3.1.2 Car sharing (car clubs)

Description of the policy measure:

Car-sharing (Car clubs) provides access to a car without the need for ownership. The “pay-as-you-drive” principle supports the rational choice of transport modes with the result of a modal shift from the

car towards sustainable modes (including rail for long-distance travel). It is also a solution to the increasing problem of parking in urban neighbourhoods.
Car-sharing schemes differ primarily in the level of commercialisation. They can be:

- Fully commercial: organised and financed by one or more commercial businesses. The authorities are not directly involved.
- Fully collective: organised and financed fully by the local authority. No commercial partners involved.
- Public-private partnership: a combination of the local authorities and a commercial provider.
- Citizens' initiative: organised by a group of citizens, with some financing in the form of subsidies and operational assistance.

Modelling of the policy measure:

This policy is modelled assuming that a car sharing service is operated by one or more private operators, which pay a fee per car to city authority.

The impact is modelled in terms of individuals subscribing the car sharing service, depending on:

- The car sharing fares, i.e. fixed yearly cost and variable cost per hour. The higher the cost the lower the number of users.
- The car sharing service coverage, i.e. the average time to pick up a car. The higher the share of city where the service is available (lower average time to pick up a car) the higher the number of users.
- The activation of complementary pricing measures or public transport service improvements (pricing measures enhance the use of car sharing service while PT service improvements reduce the number of users).

These impacts have been quantified according to the outcome of a direct survey carried out to assess the potential demand of alternative car sharing schemes in Milan (*TRT, 2013).*

Given an average number of yearly car sharing trips per individual, the total amount of trips by car sharing are computed and shifted from other modes depending on the car sharing model assumed[2]:

- one-way system (car can be collected and returned in any point in the city)
- round system (car must be returned in specific stations).

It is assumed that in the one-way system trips are shifted mainly from public transport (80%), followed by car (15%) and motorbike (5%). In the round system the order of the impacts is the same, but private cars are more affected (30%) with reduced impact for public transport (65%).

Policy costs for the city authority is null, since the car sharing service is assumed to be operated by one or more private operators. On the contrary, a fee per car is paid back to city authority for the coverage of mobility services provided (e.g. free parking, free access to LTZ, free road charging, etc.). Therefore, assuming an average number of daily trips per car sharing vehicle, the total number of cars used for the car sharing service is estimated as well as the resulting "revenues" for the city authority. The initial value of car sharing operation cost per car is estimated on the basis of the data of the *Municipality of Milan (2013)*[3]: the resulting total Car Sharing operation cost has a negative value since it represents revenue for the city authority.

User input

To activate and setup the policy, the user is required to implement the inputs reported in the following table.

[2] Glotz-Richter, 2013; Louvet, 2014.
[3]http://www.ecodallecitta.it/notizie.php?id=376776

Table 8: Car sharing (car clubs): User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Car sharing fixed tariff	Annual fee for subscription of the service	euro/year	The annual fee is one driver of the number of users: the higher the fee the lower the number of users.
Car sharing variable tariff	Usage fee	Euro/hour	The usage fee is one driver of the number of users: the higher the fee the lower the number of users.
Car sharing coverage	Average time to pick up a car	minutes	The coverage of the service is one driver of the number of users: the higher the time to pick up a car the lower the number of users.
Car Sharing type flag	Choice between one-way system or round system	-	The Car Sharing type choice influences the modes affected by the shift to car sharing services • one-way system: car can be collected and returned in any point in the city • round system: car must be returned in specific stations It is assumed that in the one-way system trips are shifted mainly from public transport (80%), followed by car (15%) and motorbike (5%). In the round system the order of the impacts is the same, but private cars are more affected (30%) with reduced impact for public transport (65%).
Advanced settings: Policy costs			
Car sharing operating cost	Fee per car provided to city authority	euro/car	This is the cost per car for covering the cost of mobility services provided (free parking, free access to LTZ, free road charging, etc.). It is paid by the private company to the city authority.

Synergies with other measures

It is assumed that the impact is influenced by complementary pricing measures or public transport service improvements: pricing measures enhance the use of car sharing service while PT service improvements reduce the number of users.

References

Glotz-Richter M., 2013: What a city government can do – the example of the City of Bremen (Germany) Eight treasures for successful support for Car-Sharing. presentation at Guangzhou Award for Urban Innovation

Louvet N., 2014: One-way carsharing: which alternative to private cars?. 6-t, Paris

TRT, 2013: *Sviluppo e redazione di uno studio sulle preferenze dichiarate in merito all'utilizzo di un nuovo servizio di car sharing (*A Stated Preference study on the use of an innovative car sharing scheme). Study on behalf of Politecnico di Milano – INDACO department as part of the GREENMOVE project

3.3.1.3 Delivery and servicing plans

Description of the policy measure:

Delivery and Servicing Plans (DSPs) are detailed plans to consolidate and reduce delivery and servicing vehicles accessing a site or building.

They can be done by a single organisation for a building or a group of organisations in a business park. They are often implemented alongside a company travel plan to help reduce both passenger and freight traffic to a site. They also need to form part of the companies' procurement and supply chain strategy.

Successful plans have been shown to reduce delivery trips by 15 - 20%.

A successful DSP should not only reduce delivery trips but also reduce procurement costs as a result of the reduced deliveries.

Modelling of the policy measure:

This policy is modelled assuming that delivery plans help to improve the efficiency of freight consignments in the city, resulting in changing the amount of freight vehicles entering the urban area.

The impact on the amount of freight vehicles has been quantified according to *Tfl (2009)* and *N. Dasburg, J. Schoemaker, NEA (2006)*.

It is assumed that where the policy is applied the amount of freight vehicle deliveries is reduced by 20%; nevertheless, the policy does not affect the freight volume in the area. The user can smooth or enhance the impact through a specific tuning parameter representing the share of freight traffic involved. Depending on this parameter the impact ranges from a reduction of 3% to 12% (application of the policy to about 15% to 60% of the traffic).

The implementation cost to the city authority is null as it is assumed that plans are implemented by private operators (firms, forwarders and so on).

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 9: Delivery and servicing plans: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period of 2 years.
Advanced settings: Tool responsiveness			
Tuning effect on freight vehicles	Tuning parameter to adjust the impact on freight vehicles	-	Set this parameter to a value < 1 to smooth the impact on freight vehicles. Set this parameter to a value > 1 to amplify the impact on freight vehicles. Range: 0.5 – 2.0.

Synergies with other measures

None.

References

Tfl, 2009, A Pilot Delivery Servicing Plan for TfL's Palestra Offices in Southwark : A Case Study

N. Dasburg, J. Schoemaker, NEA, 2006, BESTUFS II - Best Urban Freight Solutions: Deliverable 5.2 - Quantification of urban freight transport effects II

3.3.1.4 Land-use planning, density and transport infrastructure

Description of the policy measure:

Land-use planning can play a key role in the long term development of sustainable urban transport. Key aspects of land use planning to consider are density, mix of development and accessibility, with the aim of avoiding sprawl and reducing the need of citizens to travel long distances to reach jobs, shops, services and so on.

High density development encourages the use of walking, cycling and public transport as distances are shorter and public transport is more cost effective.

Research has shown that as densities increase car ownership and use decrease. Similarly mixed development provides greater access to work and retail, again reducing travel distances.

Land use can also be used to encourage public transport by locating developments close to key transport corridors and nodes.

Modelling of the policy measure:

This policy is modelled assuming that the urban development is planned to avoid sprawling and reduce travel distances for citizens. Two main strategies for land use are considered: on the one hand the strategy could be to restore living opportunities in the urban core to avoid sprawl. Under this strategy the impact of the measure is to increase the share of inhabitants in the urban core. On the other hand, planning can promote sustainable new developments. Under this strategy the impact of the measure is to increase the share of inhabitants in peripheral areas well served by public transport rather than in outskirts with poor transit connections. The user can choose one of these two strategies or a mixture of the two.

The impact of the measure is modelled by changing the trend of population by zone, under the hypothesis that ¼ of population originally leaving in the outskirts without good connections by public transport is relocating: as a result, mobility generation (and therefore mobility pattern and mode shares) is affected. In addition the mode share of pedestrian trips in the outskirts with poor transport services is increased assuming that policies improving proximity between different land uses are implemented.

The impacts are basically quantified according to *Victoria Transport Policy Institute (2014).*

The initial year for the application for the measure is fixed at 2015 as the measure needs time to provide results and a late implementation would be meaningless.

The cost of the measure is due to the provision of public houses in the urban core (building new dwellings or purchasing empty houses), which is assumed to be part of the strategy when oriented to restore living opportunities in this area of the city. Public houses are provided for rent and so the city authority obtains revenue. In order to estimate the total cost of the measure in this case, assumptions on the share of new public houses in the core area, living space per inhabitant, unitary provision cost and unitary rent of public houses are made. Management costs are taken into account as well: the net cost of land use policies results from the sum of provision and management cost reduced by the revenues of public houses renting. The estimation of the related parameters is based on *Audit Commission for Local Authorities and the National Health Service in England and Wales (2002).* In case the user select as a policy the option of planning new sustainable settlements in the outskirts, the cost of the measure is null.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 10: Land-use planning, density and transport infrastructure: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy.
Primary settings for policy setup			
Type of land use planning	Choice between restore urban core or plan new sustainable settlements	-	The type choice influences the population relocation among the zones (urban core, outskirts with good PT services, outskirts with poor PT services). • 1 = restore living places in the urban core; • 2 = partially restore living places in the urban core and partially plan new sustainable settlements;

Variable	Description	Unit	Notes
			• 3 = plan new sustainable settlements
Share of new public houses in the core area	Percentage of population relocating in the core area and living in new public houses	%	Default value is 50%. To set the value of this parameter one can consider social housing policies and availability in the core area of the city.
Advanced settings: Policy costs			
Unitary provision cost of public houses	Investment cost for the city authority	euro/sqm	This is the cost per sqm borne by the city authority to provide public houses: it can either be a building cost or the price to purchase empty buildings.
Unitary rent of public houses	Yearly revenues per sqm for the city authority	euro/sqm	Yearly revenues per sqm of the city authority from renting public houses.
Advanced settings: Tool responsiveness			
Intensity of land use planning			Set this parameter to a value > 1 to amplify the pre-defined changes in terms of population relocation induced by the measure. When the value is set to 1, ¼ of population originally living in the outskirts without good connections by public transport is relocating. If set to 2, half of population originally living in the outskirts without good connections by public transport is relocating. Range: 1 - 2

Synergies with other measures

None.

References

Victoria Transport Policy Institute , 2014, Land Use Impacts on Transport

Audit Commission for Local Authorities and the National Health Service in England and Wales, 2002, Housing Repairs And Maintenance – Handbook

3.3.1.5 Area wide and personalised travel marketing

Description of the policy measure:

Sustainable travel information and promotion campaigns aim to change people's travel behaviour and induce a shift towards a new sustainable mobility.

Different initiatives include:

- informative campaigns aimed at promoting sustainable travel modes by informing people on infrastructures and services availability;
- educational campaigns aimed at promoting active modes by showing how beneficial these modes could be for health and for increased liveability of the urban environment;
- incentivising campaigns by establishing reward schemes such as raffle prizes (e.g. seasonal ticket for PT, new bikes or bicycle equipment, etc.) to induce target groups to put aside the car.

Personalised travel marketing is a type of travel behaviour campaign that works at the level of the individual household. Generally, specific communities or city districts are targeted. Households are visited and they are provided with 'personalised' information to help them change their travel patterns. The information provided can include public transport, walking and cycling information for their work commute, local bus maps and information on car clubs.

Modelling of the policy measure:

This policy is modelled assuming that information, including personal plans, is provided to citizens to promote the use of public transport and cycling. The impact is modelled in terms of increased market share of both public transport and bike, switching demand from private motorised modes, as well as a reduction in single occupancy vehicle (increased average car occupancy factor).

The impacts on public transport and bike mode share and on the average car occupancy factor have been quantified mainly according to *Dft (2007), The TRAVEL PLAN PLUS Consortium (2010)*.

The cost of the measure is associated to the preparation and provision of the information material in the first year of implementation. The initial value of cost per inhabitant is estimated based on *Dft (2005), Dft (2007), Socialdata (2002).*

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 11: Area wide and personalised travel marketing: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Advanced settings: Policy costs			
Sustainable travel information and personalised travel marketing implementation cost	Investment cost for the city authority	euro/inhabitant	This is the cost borne by the city authority for the provision of the information material in the first year of implementation.
Advanced settings: Tool responsiveness			
Tuning effect of the policy measure on PT share	Tuning parameter to adjust the impact	-	Set this parameter to a value < 1 to smooth the impact on the mode share of PT and on car occupancy factor. Set this parameter to a value > 1 to amplify the impact on the mode share of PT and on car occupancy factor. Range: 0.5 – 2.0.
Tuning effect of the policy measure on bike share	Tuning parameter to adjust the impact	-	Set this parameter to a value < 1 to smooth the impact on the mode share of bike. Set this parameter to a value > 1 to amplify the impact on the mode share of bike. Range: 0.5 – 2.0

Synergies with other measures

None.

References

Dft, 2005, Personalised travel planning: evaluation of 14 pilots part funded by DfT

Dft, 2007, Making Personal Travel Planning Work: Research Report

The TRAVEL PLAN PLUS Consortium, 2010, TRAVEL PLAN PLUS Travel Reduction Attainment Via Energy-efficient Localities PLANning. Local Travel Plan Networks: Interim Implementation and Evaluation Report

Socialdata, 2002, Individualised Marketing: Changing Travel Behaviour for a better Environment

3.3.2 Green fleets

3.3.2.1 Green energy refuelling infrastructures

Description of the policy measure:

The use of green vehicles and fuels is considered one of the main themes for developing a more sustainable urban mobility system: green energy infrastructure is a key element of a package of measures and incentives to promote their use, to be supported with local policy measures backed or complemented at the national level.

During the last decade policy actions mostly addressed fuel and vehicle developments; the lack of green energy refuelling infrastructure is considered a major obstacle to the market introduction of alternative fuels and vehicles and consumer acceptance.

The main expected impact of these measures is to support the diffusion of alternative vehicles, thus finally reducing GHG and pollutant emissions, especially in urban areas.

Modelling of the policy measure:

This policy is modelled assuming that the provision of an adequate number of fuelling stations for electricity (and, in the longer terms, hydrogen) might accelerate the penetration trend of electric cars and fuel cell vehicles.

The acceleration of fleet renewal depends on the availability of fuelling stations in the urban area, but the average car usage cost of green vehicles is taken into account as well. The larger the share of the urban area equipped with fuelling stations the stronger the effect on the penetration of innovative cars; the higher the car usage cost of green vehicles (with respect to conventional cars) the lower the effect on the penetration of innovative cars.

Furthermore, the impact is modulated depending on the assumption in terms of technology scenario: in case a fast technical progress is simulated, the impact of the measure is smoothed assuming that other actions already stimulate the penetration of innovative vehicle.

The impacts in terms of penetration of innovative electric vehicles have been quantified on the basis of information included in *RSE (2012), CE Delft, Ecologic, ICF (2011).*

The impacts related to the penetration of fuel cells vehicles have been quantified based on *HyWays consortium (2008).*

The cost of the measure with reference to electric fuelling stations is associated to the implementation and operation of the infrastructures. The initial value of cost per station is estimated assuming fast / rapid charging outlets and based on *CE Delft, Ecologic, ICF (2011), Mayor of London (2009), JRC (2010), UK Committee on Climate Change (2013), UK Committee on Climate Change (2009).*

The initial value of implementation cost of hydrogen fuelling stations is estimated based on *Icp Portale industria chimica (2014)*. Management cost related to hydrogen infrastructures are null from the city authority perspective under the assumption that the service is operated by an external provider.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 12: Green energy refuelling infrastructures: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy.
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started: electric and hydrogen infrastructure have two separate variables. The assumption is that the impact is fully achieved after a ramp-up period of 7 years in both cases.

Variable	Description	Unit	Notes
Availability of fuelling stations	Percentage of urban area served by fuelling stations (final target when the measure is fully implemented)	%	The availability of fuelling stations is one driver of the green vehicle penetration trend: the higher the share of city served by fuelling stations the higher the number of green vehicles in the car fleet. Electric and hydrogen infrastructure have two separate variables. To set the value of this parameter one can consider the part of city from where a fuelling station can be reached within a 5 minute driving. The availability of refuelling stations at the base year is defined in the advanced settings (see paragraph 3.2.2)
Advanced settings: Policy costs			
Refuelling infrastructures implementation cost	Investment cost for the city authority	euro/ station	This is the cost borne by the city authority to implement and build the refuelling stations. Electric and hydrogen infrastructure have two separate values.
Refuelling infrastructures operating cost	Operating cost for the city authority	euro/ station	This is the yearly operating cost of the refuelling stations. For hydrogen it is assumed that the service is operated by an external provider, therefore the cost for the city authority is zero.
Advanced settings: Tool responsiveness			
Level of elasticity versus infrastructure coverage	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of infrastructure coverage on the vehicle penetration trend. Set this parameter to a value > 1 to amplify the impact of infrastructure coverage on the vehicle penetration trend. In case the availability of fuelling stations is already high the elasticity should be decreased, while in case the availability is low, the elasticity should be increased. Range: 0.5 – 2.0.
Level of elasticity versus car usage cost of green vehicles	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of green vehicles usage cost on the vehicle penetration trend. Set this parameter to a value > 1 to amplify the impact of green vehicles usage cost on the vehicle penetration trend. Range: 0.5 – 2.0.

Synergies with other measures

There aren't synergies with other measures. Nevertheless, the impact is modulated depending on the assumption in terms of technological background trend: in case a fast technical progress is simulated, the impact of the measure is smoothed assuming that other actions already stimulate the penetration of innovative vehicle.

References

RSE, 2012, Valutazione dell'impatto sulla qualità dell'aria della diffusione dei veicoli PEV/PHEV

CE Delft, Ecologic, ICF, 2011, Impacts of Electric Vehicles - Deliverable 5; Impact analysis for market uptake scenarios and policy implications

HyWays consortium, 2008, HyWays project - the European hydrogen energy roadmap

Mayor of London, 2009, London's Electric Vehicle Infrastructure strategy

JRC, 2010, Plug-in Hybrid and Battery Electric Vehicles: Market penetration scenarios of electric drive vehicles

UK Committee on Climate Change, 2013, Pathways to high penetration of electric vehicles

UK Committee on Climate Change, 2009, Strategies for the uptake of electric vehicles and associated infrastructure implications

icp Portale industria chimica, 2014, HyFIVE project: L'idrogeno per la mobilità? Riparte da Bolzano

3.3.2.2 Green public fleets

Description of the policy measure:

The use of green vehicles and fuels is considered one of the main themes for developing a more sustainable urban mobility system, starting from public fleet (i.e. buses and garbage trucks as well as taxis). This approach is underpinned by the 'Clean Vehicles Directive'. A major determining factor in fuel/technology selection is the priority in terms of environmental performance: air pollution or CO_2 reduction target.

Modelling of the policy measure:

This policy is modelled assuming an investment of the city authority to purchase 'clean' public transport vehicle (namely buses), in order to reduce pollutant emissions and/or CO_2 emission and fuel consumption. The user can decide the investment period and select the priority in terms of environmental performance: local air pollution and/or global environmental pollution (one or both). The options available for the user are:

A. CO_2 reduction target
   - No reduction
   - limited reduction (about -6% of bus emissions in case of 5 years of investments)
   - large reduction (about -14% of bus emissions in case of 5 years of investments)

B. Local air pollution reduction target
   - No reduction
   - limited reduction (about -30% PM, -20% CO, -25% NOx, -11% VOC of bus emissions in case of 5 years of investments
   - large reduction (about -60% PM, -40% CO, -45% NOx, -22% VOC of bus emissions in case of 5 years of investments)

Depending on the target and the intensity selected by the user, the total share of bus vehicle to be renewed is estimated: the higher the intensity the higher the total share of innovative buses. Furthermore, the CO_2 reduction target generates higher renewal share than the air pollution target.

In case of air pollution reduction target, the effect of the measure is more oriented to replace older buses with new ones (e.g. Euro II and Euro III vehicles are replaced by Euro V vehicles). In the latter case the measure is more oriented to include in the fleet innovative bus types (CNG and later electric buses).

The total share of buses purchased is modulated in terms of technology (CNG, hybrid electric, battery electric) also depending on the assumption of technology scenario: in case a fast technical progress is simulated, the measure assumes the purchase of more battery electric vehicles, while in the other cases CNG and/or hybrid vehicles are more used.

The impacts in terms of bus vehicles purchase have been quantified in order to achieve the target reduction with the new vehicle fleet composition and based on the emission and fuel consumption factor of each vehicle technology. As a result, also the average pollutant emission factors and fuel consumption factors are reduced according to the new bus fleet composition. The target reductions are estimated based on *Clean Fleets (2014).*

The cost of the measure for the city authority depends of course on the number of bus replaced every year for the investment period, given the cost of a bus by vehicle technology. The initial cost per vehicle technology is estimated based on *Clean Fleets (2014), CIVITAS (2013), TfL (2010).*

Management costs of the measure are null, since they are already included in the general estimation of public transport management costs.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 13: Green public fleets: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy.

Variable	Description	Unit	Notes
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Investment period	Year(s) of application of the policy	Year	This is the number of years of investment in vehicle fleet planned by the city authority.
Target on reduction of pollution flag	Choice of the intensity of the target on pollution	-	The intensity of the target on pollution influences the renewal of the public transport fleet. • No reduction • limited reduction (about -30% PM, -20% CO, -25% NOx, -11% VOC of bus emissions in case of 5 years of investments) • large reduction (about -60% PM, -40% CO, -45% NOx, -22% VOC of bus emissions in case of 5 years of investments)
Target on energy and CO_2 reduction flag	Choice of the intensity of the target on CO_2 reduction	-	The intensity of the target on CO_2 reduction influences the renewal of the public transport fleet. • No reduction • limited reduction (about -6% of bus emissions in case of 5 years of investments) • large reduction (about -14% of bus emissions in case of 5 years of investments)
Advanced settings: Policy costs			
Green public fleet implementation cost	Investment cost for the city authority	euro/ vehicle by technology	This is the cost borne by the city authority to purchase new bus vehicles. The cost is differentiated by technology (diesel, CNG, hybrid electric, battery electric).

Synergies with other measures

There aren't synergies with other measures. Nevertheless, the impact is modulated depending on the assumption in terms of technology scenario: in case a fast technical progress is simulated, the measure assumes the purchase of more battery electric vehicles, while in the other cases CNG and/or hybrid vehicles are more used.

References

Clean Fleets, 2014, Clean Buses – Experiences with Fuel and Technology Options

CIVITAS, 2013, Smart Choices for Cities: Clean Buses for your City

TfL, 2010, Surface Transport Panel - Hybrid Buses

3.3.3 Infrastructure investments

3.3.3.1 Bus, trolley and tram network and facilities

Description of the policy measure:

Redesigning the network layout of bus (tram) services is one of the measures to make public transport services more attractive and thereby reduce car use.

For example the network can be extended to new areas of the cities that are not yet served by public transport, or improved in terms of providing high frequency services.

Regarding facilities interventions these may cover:

- Modernising the infrastructure e.g. by installing high quality waiting facilities (seats, shelters, convenience services etc.)
- Enhancing the accessibility for all persons, especially for people with special needs;

- Improving the safety and security at stops and on the vehicles for passengers and drivers.

With these measures public transport becomes more convenient, comfortable, accessible and understandable for everyone and the number of passengers will normally increase.

Modelling of the policy measure:

This policy is modelled assuming that redesigning the bus (tram) network layout (high quality waiting facilities, extended network, enhancing the accessibility for all persons, improving the safety and security at stops and on the vehicles, etc.) and improving frequency and extension of the services increases the mode share of bus (tram).

The user can select the target mode for the policy: either bus or tram (modes cannot be activated at the same time). The impact on the mode share of bus (tram) mode depends on:

- frequency: the higher the frequency the higher the mode share.
- share of network subject to frequency improvement: the higher the share of network the higher the mode share.
- network extension (when activated): the higher the network extension the higher the mode share.

The influence of these elements on public transport mode share and the overall impact has been quantified according to *GHG-TransPoRD project (2011), NICHES (2011).*

The user can modulate the policy in terms of intensity of the improvement of the service frequency (moderate or consistent) and in terms of share of network subject to frequency improvement (this share can be set to 0% in case improvements in the frequency are not foreseen). Furthermore, the option of an extension of the network can be activated, specifying the length of the new line(s) (this length can be set to 0 km in case network extensions are not foreseen). The two options can be implemented alternatively or at the same time.

The mode share of bus (tram) is increased at the expense of other modes. Alternative assumptions are used here, although car mode is always the main affected (three options are provided).

Building on changes of frequency and / or network length, the tool estimates the total amount of additional vehicles (bus or tram) required to provide the service, according to the following relationships. Assuming the following formula to estimate the frequency,

$$f = \frac{L \cdot 2}{s \cdot N}$$

with f= frequency, L = network length, s= commercial speed, N= number of vehicles

the additional number of vehicles is estimated as follows:

$$\Delta N = \frac{L(t2) \cdot 2}{s \cdot f(t2)} - \frac{L(t0) \cdot 2}{s \cdot f(t0)}$$

The cost of the measure is associated on one hand to the purchase of additional vehicles and, on the other hand, to the implementation of the infrastructures required for the extension of the network (when activated). The initial value of cost per vehicle (bus or tram) is estimated based on *UITP (2004), CIVITAS (2013).* The initial value of infrastructure cost per km (for bus or tram) is estimated based on *GHG-TransPoRD project (2011), Worcestershire County Council (2007), J. Blonn, D. Carlson, P. Mueller, I. Scott (2006), Dr. Mir F. Ali (2009).*

Under the assumption of an average distance travelled by each public transport vehicle (about 25,000 km/year), the amount of additional vehicles is used to estimate the total additional vehicle-km of service provided.

Management costs of the measure are null, since they are already accounted for in public transport management costs including the additional vehicle-km.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 14: Bus, trolley and tram network and facilities: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Public transport mode selection	-	-	The policy can be activated alternatively for bus mode or tram mode.
Bus (tram) frequency variation - flag	Selecting the intensity of the frequency improvement	-	The intensity influences the impact on PT mode share: the higher the frequency the higher the mode share • no improvement • moderate improvement (reduction of headways by 3 minutes) • consistent improvement (reduction of headways by 5 minutes)
Share of Bus (tram) network subject to frequency improvement	Percentage of network subject to frequency improvement	%	The share of network subject to frequency improvement influences the impact on PT mode share: the higher the share of network the higher the mode share
Network extension	Length of network extension	km	The length of the additional line(s) implemented (one-way).
Modes affected by mode shift on PT - flag	Selecting the distribution among the modes affected by mode shift on PT	-	The share of bus (tram) mode is increased at the expense of other modes. Alternative assumptions are available: • Option 1 = 70% of increase is taken from car, 10% from pedestrian, bike, motorbike respectively • Option 2 = 40% of increase is taken from car, 20% from pedestrian, bike, motorbike respectively • Option 3 = 50% of increase is taken from car, 30% from motorbike, 10% from pedestrian, bike, respectively
Advanced settings: Policy costs			
Bus/tram network length implementation cost	Investment cost for the city authority to extend the PT network	euro/km	This is the cost borne by the city authority to implement and build the new line(s) and extend the network. It includes facilities (stops, etc.) and guideway cost. Different values are available for bus and tram mode.
Bus/tram frequency implementation cost	Investment cost for the city authority to improve PT frequency	euro/ vehicle	This is the cost borne by the city authority to purchase new vehicles and provide the service. Different values are available for bus and tram mode.

Variable	Description	Unit	Notes
Advanced settings: Tool responsiveness			
Level of elasticity of PT share versus bus frequency	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of frequency improvements on the mode share of bus (tram). Set this parameter to a value > 1 to amplify the impact of bus frequency improvements on the mode share of bus (tram). In case the mode share of bus (tram) is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.
Level of elasticity of PT share versus bus network extension	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of network extension on the mode share of bus (tram). Set this parameter to a value > 1 to amplify the impact of network extension on the mode share of bus (tram). In case the mode share of bus (tram) is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.

Synergies with other measures

None.

References

GHG-TransPoRD project, 2011, Bottom-up quantifications of selected measures to reduce GHG emissions of transport for the time horizons 2020 and 2050 Cost assessment of GHG mitigation measures of transport Deliverable 3.1 (D3)

NICHES, 2011, Implementing Key Corridor Improvement Schemes, incorporating Innovative Bus Systems

UITP, 2004, Improving Access to Public Transport - European Conference of Ministers of transport

CIVITAS, 2013, Smart Choices for Cities: Clean Buses for your City

Worcestershire County Council, 2007, Integrated Passenger Transport Strategy: Bus Priority Measures Best Practice Report

J. Blonn, D. Carlson, P. Mueller, I. Scott, 2006, Transport 2020 Bus Rapid Transit: A Cost Benefit Analysis

Dr. Mir F. Ali, 2009, Transformation of Bus Rapid Transit into Guided Buses: An Interesting Transit Perspective

3.3.3.2 Walking and cycling networks and facilities

Description of the policy measure:

The aim of this policy measure is to encourage non-motorised transport modes (walking and cycling) by enhancing the quality and/or convenience of infrastructure, thus finally aiming at reducing traffic, raising air quality, cutting carbon emissions, improving public health and the quality of life and the general feeling of safety by having more people on the streets.

Examples of measures are:

- extension and requalification of existing networks;
- improvement of networks connectivity (i.e. provision of missing links);
- improvement in comfort and safety (i.e. walking and cycling protected lanes) as well as adaptation of road infrastructure (e.g. crosswalks and junctions crossings);
- installation of proper traffic signals to give pedestrians and cyclists priority and safer journeys;
- provision of facilities (i.e. bicycle parking racks, covered storage spaces, etc.).

Modelling of the policy measure:

This policy is modelled focusing on cycling, assuming that the provision of cycling network facilities increases the mode share of bike. The size of the increase depends on extension of cycling reserved lanes network with respect to the existing network, weighted through elasticity.

The impact on bike mode share has been quantified according to *CIVITAS (2007), CIVITAS GUARD (2010)*.

The mode share of bike is increased at the expense of other modes. Alternative assumptions are used here defined according to the document of *Steer Davies Gleave (2011).*

The provision of additional cycling network facilities, compared with existing availability of cycling network in the urban area, impacts also

- on the accident rates of pedestrian and cyclist: the higher the length of the network the higher the reduction of the accident rate,
- on car speed: the higher the length of the network the higher the reduction of car speed.

Impacts are estimated on the basis of available literature.

Policy costs for the city authority depend on the length of the additional cycling network lanes and facilities. The estimation of initial values of the implementation and management costs per km is based on *Cycling Embassy of Denmark (2012), CIVITAS (2007), Fiab (2014)*.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 15: Walking and cycling networks and facilities: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy.
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Ramp-up period cycling lanes	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures to fully achieve the impact of the measure, i.e. to implement infrastructures and facilities.
Cycling lanes network	Length of the Cycling lanes network (final target when the measure is fully implemented)	km	The length of the cycling lanes network is the driver of the impact on bike mode share: the higher the length the higher the bike mode share. This value refers to the whole network: the additional lanes related to the policy implementation and the cycling lanes network already existing at the base year. The availability of cycling lanes at the base year is defined in the advanced settings (see paragraph 3.2.43.2.2)
Advanced settings: Policy costs			
Cycling lanes implementation cost	Investment cost for the city authority	euro/km	This is the cost borne by the city authority to implement and build the new lanes and extend the network.
Cycling lanes operating cost	Operating cost for the city authority	euro/km	This is the cost for the maintenance of the new cycling lanes.

Variable	Description	Unit	Notes
Modes affected by mode shift on bike	Selecting the distribution among the modes affected by mode shift on bike	-	The share of bike mode is increased at the expense of other modes. Alternative assumptions are available: • 1 = 65% of increase is taken from PT, 5% from car and motorbike respectively, 25% from pedestrian • 2 = 70% of increase is taken from PT, 2.5% from car and motorbike respectively, 25% from pedestrian • 3 = 60% of increase is taken from PT, 7.5% from car and motorbike respectively, 25% from pedestrian
Advanced settings: Tool responsiveness			
Level of elasticity of bike share versus cycling lanes network extension	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of cycling lanes network extension on the mode share of bike. Set this parameter to a value > 1 to amplify the impact of cycling lanes network extension on the mode share of bike. In case the mode share of bike is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.

Synergies with other measures

It is assumed that this measure emphasises the impacts of the policy “bike sharing scheme”.

References

CIVITAS, 2007, CIVITAS in Europe - A proven framework for progress in urban mobility

CIVITAS GUARD, 2010, Cluster Report 3: Cycling and Walking

Steer Davies Gleave, 2011, Are Cycle Hire schemes the future of urban mobility?

Cycling Embassy of Denmark, 2012, Collection of Cycle Concepts 2012

Fiab, 2014, Costi stimati piste ciclabili

3.3.3.3 Park & Ride

Description of the policy measure:

Park and Ride (P&R) facilities are parking areas located at strategic nodes of the public transport (PT) network that allow citizens, visitors of the city and commuters to park their cars and travel further into the city centre by public transport. Parking is generally cheaper than in urban centres.

The main aim of these measures is the promotion of intermodality: ideal locations for these structures are PT stations or major stops and car sharing or bike sharing stations. Although only a portion of travellers use P&R facilities, all road users can benefit from reduced traffic congestion, crash risk and pollution.

Modelling of the policy measure:

This policy is modelled assuming that the Park & Ride facilities reduces the share of incoming trips travelling and entering the urban area by car, since the final destination could be alternatively reached by public transport (bus, tram, metro) with an intermodal approach.

The impact depends on several factors:

- Park & Ride public transport fare: the higher the cost the lower the number of users
- Park&Ride coverage of public transport services i.e. the length of the network linked to P&R parking: the more destinations can be reached directly from the external parking without further interchange the higher the attractiveness of the service

- Park&Ride frequency of public transport services linked to P&R parking: the more frequent the service the lower the waiting time and the more attractive is the Park and Ride alternative
- Park&Ride capacity of parking: the higher the number of slots the higher the number of users (but taking into account the capacity limit)

The user can modulate the policy modifying all the elements mentioned above.

The share of multimodal car incoming trips is therefore increased depending on the elements above; the impact has been quantified according to *KonSULT (2000), ASSIST project (2013)*.

Building on the level of frequency and network length of public transport services linked to P&R parking, the tool estimates the total amount of additional vehicles (e.g. bus) required to provide the service, according to the following relationships. Assuming the following formula to estimate the frequency,

$$f = \frac{L \cdot 2}{s \cdot N}$$

with f= frequency, L = network length, s= commercial speed, N= number of vehicles

the additional number of vehicles is estimated as follows:

$$\Delta N = \frac{L(t2) \cdot 2}{s \cdot f(t2)} - \frac{L(t0) \cdot 2}{s \cdot f(t0)}$$

The implementation cost of the measure is associated on one hand to the purchase of additional vehicles and the implementation of dedicated PT services on the other hand to the implementation of the parking infrastructures required to provide the service. The estimation of initial values of the implementation cost per parking slot is based on *KonSULT (2000)*, while cost per bus vehicle is based on the references used for the policy assuming infrastructure investments on 1.4.1Bus, trolley and tram network and facilities.

Operating costs are related to the management of parking infrastructures: initial values are based on *KonSULT (2000)*. Management costs related to the provision of public transport services are null, since they are already accounted for in public transport management costs including the additional vehicle-km.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 16: Park & Ride: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Ramp-up period Park & Ride	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures to fully achieve the impact of the measure, i.e. to implement the infrastructures and facilities.
Park & Ride parking fare	Cost per hour for parking	Euro/h	The parking fare is one driver of the impact on car multimodal share: the higher the fare the lower the car multimodal share. The cost is related to parking only because the cost of using bus is already modelled according to public transport tariffs. Parking cost is differentiated by purpose (commuting, business, non-business) under the assumption that discount tariffs for regular commuters and increase tariffs for infrequent users are in place. In case more than one P&R park is available with different fares, the variable should be the average of the fare of all parks.

Variable	Description	Unit	Notes
Park & Ride coverage of public transport services	the length of the urban network linked to P&R parking	km	The coverage of PT services is one driver of the impact on car multimodal share: the more destinations can be reached directly from the external parking without further interchange the higher the attractiveness of the service. In case more than one P&R park is available, the variable should be the sum of the PT services from all parks.
Park & Ride frequency of public transport services	The time period between PT rides from the P&R parking	minutes	The frequency of PT services is one driver of the impact on car multimodal share: the more frequent the service the lower the waiting time and the more attractive is the Park and Ride alternative. In case more than one P&R park is available, the variable should be the average of the frequency of PT services from all parks.
Park & Ride capacity of parking	Number of parking lots provided	slots	The capacity of parking is one driver of the impact on car multimodal share: the larger the capacity the more attractive is the Park and Ride alternative (and lower the risk to not find a parking lot). In case more than one park is available, the variable should be the sum of all parking slots.
Advanced settings: Policy costs			
Park & Ride parking implementation cost	Investment cost for the city authority	euro/slot	This is the cost borne by the city authority to implement and build the P&R parking facilities. It includes also the cost for the interchange area with PT services. The unitary investment cost for the city authority to extend and improve the frequency of PT services from P&R facilities is defined according to the values of the policy measure “Bus, trolley and tram network and facilities (assuming the use of bus mode).
Park & Ride parking operating cost	Operating cost for the city authority	euro/slot	This is the cost for the maintenance and management of the Park & Ride parking.
Advanced settings: Tool responsiveness			
Level of elasticity of car multimodal share versus Park & Ride parking fare	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of P&R fare on the car multimodal share of incoming trips. Set this parameter to a value > 1 to amplify the impact of P&R fare on the car multimodal share. In case the car multimodal share of incoming trips is already high the elasticity should be decreased, while in case the share is low, the elasticity should be increased. Range: 0.5 – 2.0.
Level of elasticity of car multimodal share versus Park & Ride coverage of public transport services	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of P&R coverage of PT services on the car multimodal share of incoming trips. Set this parameter to a value > 1 to amplify the impact of P&R coverage of PT services on the car multimodal share. In case the car multimodal share of incoming trips is already high the elasticity should be decreased, while in case the share is low, the elasticity should be increased. Range: 0.5 – 2.0.
Level of elasticity of car multimodal share versus Park & Ride frequency of public transport services	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of P&R frequency of PT services on the car multimodal share of incoming trips. Set this parameter to a value > 1 to amplify the impact of P&R frequency of PT services on the car multimodal share. In case the car multimodal share of incoming trips is already high the elasticity should be decreased, while in case the share is low, the elasticity should be increased. Range: 0.5 – 2.0.

Variable	Description	Unit	Notes
Level of elasticity of car multimodal share versus Park & Ride capacity of parking	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of P&R capacity of parking on the car multimodal share of incoming trips. Set this parameter to a value > 1 to amplify the impact of P&R capacity of parking on the car multimodal share. In case the car multimodal share of incoming trips is already high the elasticity should be decreased, while in case the share is low, the elasticity should be increased. Range: 0.5 – 2.0.

Synergies with other measures

It is assumed that the impacts of the policy are enhanced by the activation of the measure related to Prioritising Public Transport.

References

KonSULT, 2000, Policy Instruments: A Policy Guidebook, Park and ride: Evidence on Performance

ASSIST project, 2013, ASSIST - Assessing the social and economic impacts of past and future sustainable transport policy in Europe. Deliverable D2.1: Assessment of the Social and Economic Impacts of Transport Policy Measures

3.3.3.4 Metro network and facilities

Description of the policy measure:

The infrastructure provision of metro lines is generally conceived for serving high-density zones or when planning new urban developments, with the aim of making public transport services more attractive and thereby reduce car use.

Modelling of the policy measure:

This policy is modelled assuming that redesigning the metro network layout (high quality waiting facilities, extended network, enhancing the accessibility for all persons, improving the safety and security at stops and on the vehicles, etc.) increases the mode share of metro.

The impact on the mode share of metro mode depends on:

- frequency: the higher the frequency the higher the mode share.
- share of network subject to frequency improvement: the higher the share of network the higher the mode share.
- network extension (when activated): the higher the network extension the higher the mode share.

The influence of these elements on metro mode share has been quantified according to *GHG-TransPoRD project (2011), NEXUS (2014).*

The user can modulate the policy in terms of intensity of the improvement in the frequency of service (moderate or consistent) and share of network subject to frequency improvement (it could be set to 0% in case improvements in the frequency are not foreseen). Furthermore, the option of an extension of the network can be activated, specifying the length of the new line(s) (it could be set to 0 km in case network extensions are not foreseen). The two options can be implemented alternatively or at the same time.

The mode share of metro is increased at the expense of other modes. Alternative assumptions are used here, although car mode is always the main affected (three options are provided).

Building on changes of frequency and / or network length, the tool estimates the total amount of additional metro vehicles required to provide the service, according to the following relationships. Assuming the following formula to estimate the frequency,

$$f = \frac{L \cdot 2}{s \cdot N}$$

with f= frequency, L = network length, s= commercial speed, N= number of vehicles

the additional number of vehicles is estimated as follows:

$$\Delta N = \frac{L(t2) \cdot 2}{s \cdot f(t2)} - \frac{L(t0) \cdot 2}{s \cdot f(t0)}$$

The cost of the measure is associated on one hand to the purchase of additional vehicles on the other hand to the implementation of the infrastructures required for the extension of the network (when activated). The initial value of cost per vehicle is estimated based on *ERRAC - The European Rail Research Advisory Council, UITP (2009), GHG-TransPoRD project (2011).* The initial value of infrastructure cost per km is estimated based on*, European Journal of Transport and Infrastructure Research (2008).*

Under the assumption of an average distance travelled by each metro vehicle (about 30,000 km/year), the amount of additional vehicles is used to estimate the total additional vehicle-km of service provided.

Management costs of the measure are null, since they are already accounted for in the overall public transport management cost including the additional vehicle-km.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 17: Metro network and facilities: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Ramp-up period metro network facilities	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures to fully achieve the impact of the measure, i.e. to implement the infrastructures and facilities.
Metro frequency variation - flag	Selecting the intensity of the frequency improvement	-	The intensity influences the impact on PT mode share: the higher the frequency the higher the mode share • no improvement • moderate improvement (reduction of headways by 3 minutes) • consistent improvement (reduction of headways by 5 minutes)
Share of Metro network subject to frequency improvement	Percentage of network subject to frequency improvement	%	The share of network subject to frequency improvement influences the impact on PT mode share: the higher the share of network the higher the mode share
Network extension	Length of network extension	km	The length of the additional line(s) implemented (one-way).

Variable	Description	Unit	Notes
Modes affected by mode shift on metro - flag	Selecting the distribution among the modes affected by mode shift on metro	-	The share of metro mode is increased at the expense of other modes. Alternative assumptions are available: • Option 1 = 70% of increase is taken from car, 10% from pedestrian, bike, motorbike respectively • Option 2 = 40% of increase is taken from car, 20% from pedestrian, bike, motorbike respectively • Option 3 = 50% of increase is taken from car, 30% from motorbike, 10% from pedestrian, bike, respectively
Advanced settings: Policy costs			
Metro network length implementation cost	Investment cost for the city authority to extend the PT network	euro/km	This is the cost borne by the city authority to implement and build the new line(s) and extend the network. It includes facilities (stops, etc.) and guideway cost.
Metro frequency implementation cost	Investment cost for the city authority to improve metro frequency	euro/ vehicle	This is the cost borne by the city authority to purchase new vehicles and provide the service.
Advanced settings: Tool responsiveness			
Level of elasticity of PT share versus bus frequency	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of frequency improvements on the mode share of metro. Set this parameter to a value > 1 to amplify the impact of bus frequency improvements on the mode share of metro. In case the mode share of metro is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.
Level of elasticity of PT share versus bus network extension	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of network extension on the mode share of metro. Set this parameter to a value > 1 to amplify the impact of network extension on the mode share of metro. In case the mode share of metro is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.

Synergies with other measures

None.

References

GHG-TransPoRD project, 2011, Bottom-up quantifications of selected measures to reduce GHG emissions of transport for the time horizons 2020 and 2050 Cost assessment of GHG mitigation measures of transport Deliverable 3.1 (D3)

European Journal of Transport and Infrastructure Research (EJTIR), 2008, Comparison of Capital Costs per Route-Kilometre in Urban Rail (8, no. 1 (2008), pp. 17-30)

ERRAC - The European Rail Research Advisory Council, UITP, 2009, Metro, light rail and tram systems in Europe

NEXUS, 2014, Metro Strategy 2030: Draft Summary Consultation Document

3.3.3.5 Urban Delivery Centres and city logistics facilities

Description of the policy measure:

Delivery centres and city logistics facilities aim to increase the efficiency of freight deliveries, by consolidating loads so increasing load factors and reducing costs.

Modelling of the policy measure:

This policy is modelled assuming that logistics platforms are created at the border and within the urban area in appropriate locations to serve as hubs for the final distribution. A share of the shipments arriving from outside the city pass through the delivery centres, where loads are consolidated and distributed in a more efficient way, increasing the load factor of vehicles, shortening consignment routes and using cleaner vehicles.

This impact is translated in the policy module as an increase of the share of freight traffic under the segment "distribution to retailers" which goes through the urban centres. This means fewer freight vehicles-km in the urban area. The share depends on the number of centres built, so the user can choose if the measure has a limited, medium or large application: it is assumed that with a limited application one centre every 30,000 inhabitants is built, with medium application one centre every 20,000 inhabitants and for large application one centre every 10,000 inhabitants.

It is assumed that whereas the policy is applied vehicle-km travelled in the urban area is reduced by 20%; nevertheless, the policy is not applied to the whole freight traffic in the area and therefore the impact ranges from a reduction of 3% to 10% depending on the user selection (application of the policy to about 15% to 50% of the traffic).

The impact in terms of vehicle-km reduction has been quantified according to *NEA (2006)*.

Although delivery centres are usually implemented by private operators, public grants are often required for the financial sustainability of the measure. Therefore there is a cost for local authority associated to the building and management cost of delivery centres. The estimation of initial values of the implementation and operating cost is based on *NEA (2006)*.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 18: Urban Delivery Centres and city logistics facilities: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Ramp-up period delivery centre	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures to fully achieve the impact of the measure, i.e. to implement the infrastructures and facilities.
City logistics intensity - flag	Selecting the intensity of the city logistics application	-	The intensity influences the impact on urban freight vehicle-km: the higher the intensity the higher the impact • limited number of new delivery centres (one centre every 250,000 inhabitants) • higher number of delivery centres (one centre every 180,000 inhabitants) • full coverage of the city with delivery centres (one centre every 120,000 inhabitants)

Variable	Description	Unit	Notes
Advanced settings: Policy costs			
Building Cost of one delivery centre	Investment cost for the city authority	euro/centre	This is the cost borne by the city authority to support the building of one delivery centre. Although delivery centres are usually implemented by private operators, public grants are often required for the financial sustainability of the measure.
Yearly operating cost of one delivery centre	Operating cost for the city authority	euro/ centre	This is the cost borne by the city authority to support the management of one delivery centre. Although delivery centres are usually implemented by private operators, public grants are often required for the financial sustainability of the measure.

Synergies with other measures

None.

References

NEA, 2006, BESTUFS II - Best Urban Freight Solutions (2006): Deliverable 5.2 - Quantification of urban freight transport effects II

3.3.4 Pricing and financial incentives

3.3.4.1 Congestion and pollution charging

Description of the policy measure:

The aim of these schemes is to discourage the use of private motorised vehicle in the urban area through the internalisation of external costs.

- Congestion charging applies the "user pays" principle: users pay for the use of a scarce resource such as road space, i.e. to enter into business districts / urban core zone.
- Pollution charging applies the "polluter pays" principle: the more polluting the vehicle, the higher the charge to travel / enter into predefined zone of the city.

These policies can represent potential source of funds to improve public transport services and non-motorised modes.

Modelling of the policy measure:

This policy is modelled as a charge applied to cars and trucks (LDV and HDV), while buses, motorbikes and car sharing cars are considered exempted. The user can decide the average level of the charge per trip (for car, LDV and HDV separately) and, depending on the focus on pollution or congestion, its differentiation between vehicles type with different emissions standards (i.e. Euro class) and/or between peak and off-peak time. The value of the charge could be set to 0 in case the policy is not foreseen for one of the mode. Furthermore, the user defines the share of the city area subject to the charge. The policy is assumed to be applied only during weekdays (not during the weekends).

From the passenger side, the impact is simulated in terms of: reduction of the mode share of car for both internal mobility and incoming trips, increased car occupancy factor and reduced average pollutant emission factor per vehicle (when pollution charging is applied). With reference to incoming trips, the impact is simulated in a twofold way: on one hand the car mode share is reduced, on the other hand the share of car multimodal trips is increased (i.e. the final destination is reached by public transport (bus, tram, metro) with an intermodal approach).

The size of the impacts depends on the following factors:

- car charge and its differentiation between vehicles type and/or peak and off-peak time (where activated): the higher the charge the higher the reduction of car mode share and the increase of car occupancy factor
- area of implementation, i.e. the share of the city area subject to the charge: the larger the area the higher the reduction of car mode share and the increase of car occupancy factor
- availability of public transport service as alternative mode: if a poor level of PT service is provided, the reduction of car mode share and the increase of car occupancy factor is lower

- average car fleet composition by EURO standard: in case a pollution charge is applied, the car fleet composition is used to estimate the average value of charge for car users. Furthermore, when pollution charge is implemented, it is assumed that the renewal of the fleet is accelerated.

The impact is related to elasticity parameters differentiated by trip purpose and time period of the day.

From the freight side, the impact is simulated in terms of: reduction of the amount of freight vehicles entering the urban area (assuming e.g. higher load factors) and reduced average pollutant emission factor per vehicle (when pollution charging is applied). The size of the impacts depends on the following factors:

- truck charge and its differentiation between vehicles type and/or peak and off-peak time (where activated): the higher the charge the higher the reduction of freight vehicles
- area of implementation, i.e. the share of the city area subject to the charge: the larger the area the higher the reduction of freight vehicles
- average truck fleet composition by EURO standard: in case a pollution charge is applied, the car fleet composition is used to estimate the average value of charge for truck users. Furthermore, when pollution charge is implemented, it is assumed that the renewal of the fleet is accelerated.

The influence of the elements mentioned above on the impacts of the policy has been quantified according to *Rotaris et al. (2009), NEA (2006); TRT (2013), Victoria Transport Policy Institute (2011).*

The mode share of car is reduced in favour of other modes: it is assumed that mainly public transport benefit from the mode shift (65%), followed by car sharing schemes (15%, when available) and the residual part by bike or motorbike.

The implementation and the management of the system have some costs for the public administration, which, on the other hand, collect the revenues of the charge.

The implementation and the management cost of the measure are related to the extension of the urban area subject to the policy: the initial values of cost per inhabitant (depending on the area) are estimated based on *Victoria Transport Policy Institute (2011), Rotaris et al. (2009).*

The implementation cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 20 euro/inhabitant
- area between 10% and 25% : 40 euro/inhabitant
- area > 25% : 60 euro/inhabitant

The management cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 7 euro/inhabitant
- area between 10% and 25% : 12 euro/inhabitant
- area > 25% : 20 euro/inhabitant

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 19: Congestion and pollution charging: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.

Variable	Description	Unit	Notes
Car base charge	Base cost of the road charge for car vehicle	Euro/trip	This is the base value of the car charge, which is further differentiated in case the other options (peak time, euro class) are activated. Set this value to 0 in case the policy is not foreseen for cars. It influences the impacts of the policy: the higher the charge the higher the reduction of car mode share and the increase of car occupancy factor
Off-peak discounted value	Differentiation of the road charge for off-peak period	-	This parameter represents the differentiation of the road charge by time period of the day: peak period is set equal to 1, while the value for off-peak period set by the user consists of the discounted value with respect to the base charge (e.g. if set to 0.7 it means a discount of 30% with respect to base value). The off-peak period include any time of the day apart from the period 7:00-9:00 and 17:00-19:00. Set this value to 0 in case the policy is not foreseen for cars during off-peak period. It influences both cars and trucks charge. Range: 0.0 – 1.0
EURO standard differentiation for cars	Differentiation of the road charge for by car vehicle Euro standard	-	This parameter represents the differentiation of the road charge by Euro vehicle standard for cars: the value for each class set by the user consists of the discounted / increased value with respect to the base charge (e.g. if set to 0.7 it means a discount of 30% with respect to base value, if set to 1.5 it means an increase of 50% with respect to base value). 7 Euro class are available: pre-Euro, Euro 1 to Euro 5, post-Euro 5. Set the value to 0 in case the policy is not foreseen for a specific Euro class. Range: 0.0 – 20.0
Area where charge is implemented	Percentage of urban area where the charge is applied	%	The area of implementation is one driver of the impacts of the policy: the larger the area the higher the reduction of car mode share and the increase of car occupancy factor Usually road charging is implemented only in one part of the city territory (often the central area).
Truck base charge	Base cost of the road charge for truck vehicle	Euro/trip	This is the base value of the truck charge (separately for LDV and HDV), which is further differentiated in case the other options (peak time, euro class) are activated. Set this value to 0 in case the policy is not foreseen for trucks. It influences the impacts of the policy: the higher the charge the higher the reduction of freight vehicles travelling in the urban area
EURO standard differentiation for trucks	Differentiation of the road charge for by car vehicle Euro standard	-	This parameter represents the differentiation of the road charge by Euro vehicle standard for trucks: the value for each class set by the user consists of the discounted / increased value with respect to the base charge (e.g. if set to 0.7 it means a discount of 30% with respect to base value, if set to 1.5 it means an increase of 50% with respect to base value). 7 Euro class are available: preEuro, Euro 1 to Euro 5, post Euro 5. Set the value to 0 in case the policy is not foreseen for a specific Euro class. Range: 0.0 – 20.0
Advanced settings: Tool responsiveness			
Tuning elasticity of car share with respect to charge level	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of charge on car mode share and car occupancy factor. Set this parameter to a value > 1 to amplify the impact of charge on car mode share and car occupancy factor. The parameter is differentiated by trip purpose (working and personal). Range: 0.5 – 2.0.

Variable	Description	Unit	Notes
Tuning impact of charged area on the elasticity of car share	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of charged area on car mode share. Set this parameter to a value > 1 to amplify the impact of charged area on car mode share. Range: 0.5 – 2.0.
Tuning impact of charged area on the elasticity of truck traffic	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of charged area on truck traffic. Set this parameter to a value > 1 to amplify the impact of charged area on truck traffic. Range: 0.5 – 2.0.
Tuning impact of initial PT service level on the elasticity of car share	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of initial PT service level (i.e. the share of PT users) on car mode share. Set this parameter to a value > 1 to amplify the impact of initial PT service level on car mode share. Range: 0.5 – 2.0.
Tuning impact of PT service level on the elasticity of car share	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of PT service level improvements (i.e. the supply of PT services) on car mode share. Set this parameter to a value > 1 to amplify the impact of PT service level improvements on car mode share. Range: 0.5 – 2.0.
Tuning impact of off-peak differentiation on the elasticity of car share	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of the policy on the car mode share during off-peak period. Set this parameter to a value > 1 to amplify the impact of the policy on the car mode share during off-peak period. Range: 0.5 – 2.0.
Tuning elasticity of freight traffic with respect to charge level	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of charge on truck traffic. Set this parameter to a value > 1 to amplify the impact of charge on truck traffic. Range: 0.5 – 2.0.

Synergies with other measures

It is assumed a synergy with policies affecting the availability of public transport service (considered the main alternative mode): if the supply of PT service is increased, the reduction of car mode share and the increase of car occupancy factor is higher.

References

Rotaris et al., 2009, The urban road pricing scheme to curb pollution in Milan: a preliminary assessment

NEA, 2006, BESTUFS II - Best Urban Freight Solutions (2006): Deliverable 5.2 - Quantification of urban freight transport effects II

TRT, 2013, From pollution charge to congestion charge in Milan (13th WCTR, July 15-18, 2013 – Rio de Janeiro, Brazil)

Victoria Transport Policy Institute, 2011, London Congestion Pricing: Implications for Other Cities

3.3.4.2 Parking regulation and pricing

Description of the policy measure:

Local authorities should use parking policies alongside other planning and transport measures to promote sustainable transport choices and reduce reliance on the car.

Parking regulation could also encompass the set up of Low emission parking areas which give priority parking or reduced parking charges to low emission vehicles. Examples include special parking areas for electric cars, reduced parking charges for low emission cars, specific loading bays for low emission delivery vehicles and differential charges for residential parking permits.

Modelling of the policy measure:

This policy is modelled as a parking charge applied to car vehicles: depending on the extension of the parking areas only a share of drivers using those areas incurs the charge. The user defines the parking tariff per hour and the share of the city area subject to the charge. Furthermore, in case low emission parking areas are simulated, the parking tariff is discounted for innovative vehicles (hybrid and battery electric, fuel cells).

The policy is assumed to be applied every day of the year.

The impact is simulated in terms of: reduction of the mode share of car for both internal mobility and incoming trips. With reference to incoming trips, the impact is simulated in a twofold way: on one hand the car mode share is reduced, on the other hand the share of car multimodal trips is increased (i.e. the final destination is reached by public transport (bus, tram, metro) with an intermodal approach).

The size of the impacts depends on the following factors:

- Car parking tariff and its differentiation for innovative vehicles (where low emission parking areas are activated): the higher the charge the higher the reduction of car mode share and the increase of car occupancy factor
- area of implementation, i.e. the share of the city area subject to the charge: the larger the area the higher the reduction of car mode share and the increase of car occupancy factor
- availability of public transport service as alternative mode: if a poor level of PT service is provided, the reduction of car mode share is lower
- average car fleet composition by vehicle type: in case low emission parking areas are applied, the car fleet composition is used to estimate the average value of parking tariff for car users.

The impact is related to elasticity parameters differentiated by trip purpose.

The influence of the elements mentioned above on the impacts of the policy has been quantified according to *GHG-TransPoRD project (2011), Victoria Transport Policy Institute (2014).*

The mode share of car is reduced in favour of other modes: it is assumed that mainly public transport benefit from the mode shift (65%), followed by car sharing schemes (15%, when available) and the residual part by bike or motorbike.

Implementation and the management costs for this measure are modest as the regulation on parking is already in place in most of the urban areas and the measure consists of an extension of the area of implementation and/or an adaptation of the tariffs and the parking rules. Nevertheless, the purchase, installation and maintenance of parking meters is required if the area of implementation is extended with respect to the base situation. Of course, the city authority also collects the revenues of the policy.

The implementation and the management cost of the measure are related to the extension of the urban area subject to the policy: the initial values of cost per inhabitant (depending on the area) are estimated assuming 'kiosk-style' parking meters[4] and based on *Azienda Mobilità e Trasporti Bari S.p.A (2012), Boulevard Transportation group (2012).*

The implementation cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- additional area < 15% : 2.5 euro/inhabitant
- additional area between 15% and 30% : 6 euro/inhabitant
- additional area > 30% : 9 euro/inhabitant

The management cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- additional area < 15% : 0.3 euro/inhabitant
- additional area between 15% and 30% : 0.7 euro/inhabitant

additional area > 30% : 1.0 euro/inhabitant

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

[4] Central parking "kiosk" that replaces the need for individual meters at each parking space, including multiple payment options, realtime information, etc.

Table 20: Parking regulation and pricing: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window “ADD POLICIES”			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Average parking tariff	Parking tariff per hour per car vehicle	Euro/h	This is the value of the car parking tariff applied with the policy. In case Low emission areas are implemented, for innovative vehicles a discounted value is applied: -20% hybrid electric, -40% battery electric and fuel cells. It influences the impacts of the policy: the higher the charge the higher the reduction of car mode share and the increase of car occupancy factor
Share of regulated parking lots	Percentage of urban area where the parking policy is applied (final target of the measure)	%	The area of implementation is one driver of the impacts of the policy: the larger the area the higher the reduction of car mode share and the increase of car occupancy factor.
Advanced settings: Tool responsiveness			
Tuning elasticity of car share with respect to Parking pricing level	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of parking tariff on car mode share and car occupancy factor. Set this parameter to a value > 1 to amplify the impact of parking tariff on car mode share and car occupancy factor. The parameter is differentiated by trip purpose (working and personal). Range: 0.5 – 2.0.
Tuning impact of PT service level on the elasticity of car share	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of PT service level (i.e. the share of PT users) on car mode share. Set this parameter to a value > 1 to amplify the impact of PT service level improvements on car mode share. Range: 0.5 – 2.0.

Synergies with other measures

Indirectly, it is assumed a synergy with policies affecting the PT service level (i.e. the share of PT users): if the share of PT users is increased, the reduction of car mode share and the increase of car occupancy factor is higher.

Furthermore, in case Low emission parking areas are implemented, the policy Green energy refuelling infrastructures might influence the impact of this measure.

References

GHG-TransPoRD project, 2011, Bottom-up quantifications of selected measures to reduce GHG emissions of transport for the time horizons 2020 and 2050 Cost assessment of GHG mitigation measures of transport Deliverable 3.1 (D3)

Victoria Transport Policy Institute, 2014, Parking Pricing: Direct Charges for Using Parking Facilities-VTPI TDM Encyclopedia

Azienda Mobilità e Trasporti Bari S.p.A, 2012, Parking electronic meter maintenance contract

Boulevard Transportation group, 2012, CCNP Parking Implementation Strategy, City of Vernon, BC Canada

3.3.4.3 Public Transport integrated ticketing and tariff schemes

Description of the policy measure:

Integrated ticketing and tariff policies between different public transport operators (e.g. local public transport and the national railway) could attract more public transport passengers, resulting in less private cars entering the urban area and greater passenger satisfaction. Thanks to integrated ticketing systems, convenience is much improved due to seamless travel and no requirement to buy tickets whilst switching either transport modes or services.

The accessibility of public transport in general is enhanced with the introduction of ticketing and tariffs that are attractive and easy to understand for everyone: a complex fare structure may dissuade potential passengers from using local public transport.

Modelling of the policy measure:

This policy is modelled assuming that the user changes the fare of urban public transport services and / or implements integrated ticketing systems: the urban fare affects the mode share of PT modes (bus, tram, metro) of internal mobility, while integrated ticketing has an impact on both internal mobility and incoming trips.

The size of the impacts depends on the level of PT fare weighted with an elasticity factor; furthermore, in case integrated ticketing is applied, an increase of the mode share of PT modes is simulated. The fare (and elasticity) are implemented separately by trip purpose, assuming that discount tariffs for regular commuters and increase tariffs for infrequent users are in place.

The elasticity of users with respect to PT fare has been quantified according to *Transportation Victoria Transport Policy Institute (2011), Fermi F., Fiorello D., Krail M., Schade W. (2014).*

The mode share of bus (tram) is increased at the expense of other modes. Alternative assumptions are used here, although car mode is always the main affected (three options are provided, the same of the measure related to bus/tram network facilities).

Implementation and the management costs for this measure are null unless the option of integrated ticketing systems is applied: in this case the initial values of cost per inhabitant are estimated based on *LivingRail project library (2010), PWC (2011), Norwegian University of Science and Technology (2012).*

The revenues from PT service for city authority can of course change.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 21: Public Transport integrated ticketing and tariff schemes: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that in case of integrated ticketing the impact is fully achieved after a rump-up period of 3 years.
Average PT fare by purpose	Urban PT fare per trip (by purpose)	Euro/trip	This is the value of the urban PT fare per trip applied with the policy. It is differentiated by trip purpose, assuming that discount tariffs for regular commuters and increase tariffs for infrequent users are in place. It influences the impacts of the policy: the higher the fare the higher the reduction of PT mode share (and viceversa).
Modes affected by mode shift on PT - flag	Selecting the distribution among the modes affected	-	The share of PT mode is increased/decreased at the expense of other modes. Alternative assumptions are available:

Variable	Description	Unit	Notes
	by mode shift on PT		• Option 1 = 70% of change is taken from car, 10% from pedestrian, bike, motorbike respectively • Option 2 = 40% of change is taken from car, 20% from pedestrian, bike, motorbike respectively • Option 3 = 50% of change is taken from car, 30% from motorbike, 10% from pedestrian, bike, respectively
Advanced settings: Policy costs			
Integrated ticketing implementation cost	Investment cost for the city authority	Euro/ inhabitant	This is the cost borne by the city authority to implement the integrated ticketing systems. The initial values of cost per inhabitant is 10 euro/inhabitant
Integrated ticketing operating cost	Operating cost for the city authority	Euro/ inhabitant	This is the cost borne by the city authority for the management of the integrated ticketing systems. The initial values of cost per inhabitant is 16 euro/inhabitant
Advanced settings: Tool responsiveness			
Tuning elasticity of PT share with respect to PT fare	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of PT fare on PT mode share. Set this parameter to a value > 1 to amplify the impact of PT fare on PT mode share. The parameter is differentiated by trip purpose. Range: 0.5 – 2.0.

Synergies with other measures

None.

References

Victoria Transport Policy Institute, 2011, Transportation Elasticities - How Prices and Other Factors Affect Travel Behaviour

Fermi F., Fiorello D., Krail M., Schade W., 2014, Description of the ASTRA-EC model and of the user interface. Deliverable D4.2 of ASSIST (Assessing the social and economic impacts of past and future sustainable transport policy in Europe). Project co-funded by European Commission 7th RTD Programme. Fraunhofer-ISI, Karlsruhe, Germany

LivingRail project library, 2010, London's Oyster card for integrated ticketing

PWC, 2011, Smart & Integrated Ticketing Report for Scotland

Morten Welde, Norwegian University of Science and Technology, 2012, Are Smart Card Ticketing Systems Profitable? Evidence from the City of Trondheim (Journal of Public Transportation Article in Volume 15, Issue 1 (2012)

3.3.5 Traffic management and control

3.3.5.1 Legal and regulatory framework of urban freight transport

Description of the policy measure:

Managing the impact of goods delivery can be achieved through controls such as access regulations for urban areas for commercial freight vehicles, e.g. defining rules for fixed delivery time windows or restrictions by vehicle weight, size, or emission category etc. Key impacts are related to a reduction in the number of heavy transport vehicles in the city centre and the related environmental and traffic benefits.

Modelling of the policy measure:

This policy is modelled assuming that the activity of freight traffic in the urban area is regulated to reduce traffic especially in some zones and times of the day. Therefore, the impact of the measure is modelled by changing the amount of freight vehicles entering the urban area and their distribution between peak and off-peak (the impact is assumed to be larger in peak time). The user can smooth or enhance the impact through a specific tuning parameter.

Furthermore, since innovative LDVs (battery electric) are supposed to be unregulated, the fleet renewal affects the size of the impact: as innovative LDVs enter the fleet the effect of the regulation is reduced. The impact on the amount of freight vehicles has been quantified according to *MDS Transmodal Limited, CTL (2012), H. Quak (2008)*

Being just a matter of regulation, there are no implementation or management costs associated.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 22: Legal and regulatory framework of urban freight transport: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag	A binary variable.	-	Set this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Advanced settings: Tool responsiveness			
Tuning effect on freight vehicles	Tuning parameter to adjust the impact on freight vehicles	-	Set this parameter to a value < 1 to smooth the impact on freight vehicles. Set this parameter to a value > 1 to amplify the impact on freight vehicles. Range: 0.5 – 2.0. The assumption is that the impact might be smoothed by the renewal of LDV vehicle fleet, since it is assumed that battery electric vehicles are unregulated.

Synergies with other measures

None.

References

MDS Transmodal Limited, CTL, 2012, DG MOVE European Commission: Study on Urban Freight Transport

H. Quak, 2008, Sustainability of Urban Freight Transport Retail Distribution and Local Regulations in Cities

3.3.5.2 Prioritising Public Transport

Description of the policy measure:

These are a range of Public transport (PT) priority measures aimed at improving the commercial speed of PT vehicles, thus improving the service reliability and attractiveness to the general public. Principal measures include:

- Priority lanes, which are segregated lanes exclusively for trams and/or buses before an intersection or along entire sections of the road network enabling public transport vehicles to bypass congestion
- Priority systems, installed at traffic lights in order to detect a bus or a tram approaching and ensuring that the vehicles get a green light, if possible, when they arrive at a junction.

Modelling of the policy measure:

This policy is modelled assuming that a set of priority measures improving the commercial speed of PT vehicles is implemented (Priority lanes, Priority systems for PT at traffic lights.), therefore resulting in an improvement of public transport speed. Faster public transport is more attractive for users so time elasticities transform the higher speed in a higher mode share of bus and tram.

The impact on the mode share of PT mode depends on:

- Reduction of travel time thanks to priority systems: the higher the reduction the higher the mode share.
- Share of network subject to priority systems: the higher the share of network the higher the mode share.
- Implementation of priority lanes: the higher the extension of priority lanes the higher reduction of travel time and therefore the mode share.

The influence of these elements on public transport mode share has been quantified according to *Konsult (2000), Victoria Transport Policy Institute (2011), Fermi F., Fiorello D., Krail M., Schade W. (2014).*

The user can modulate the policy selecting between two options: on one hand the application of priority systems on a share of PT network, on the other hand the implementation of priority lanes. If priority lanes are not foreseen the length should be set to 0 km. In case priority systems are not foreseen, the share of PT network should be set to 0. The two options can be implemented alternatively or at the same time.

The mode share of bus (tram) is increased at the expense of other modes. Alternative assumptions are used here, although car mode is always the main affected (three options are provided, the same of the measure related to bus/tram network facilities).

The cost of the measure is associated on one hand to the application of priority systems on a share of PT network on the other hand the implementation of priority lanes (when activated). The initial value of cost per km is estimated based on *COST European COoperation in Science and Technology (2011), CIVITAS (2010), ICF International (2011).*

Management costs of the measure are assumed to be null.

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 23: Prioritising Public Transport: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started. The assumption is that the impact is fully achieved after a rump-up period defined by the user.
Ramp-up period PT priority implementation	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures/facilities to fully achieve the impact of the measure, i.e. to implement the infrastructures and facilities.

Variable	Description	Unit	Notes
Length of bus-tram network running on reserved lanes	Length of additional reserved lanes (to reach final target of the measure)	km	The length of the additional reserved lanes is one of the driver of the impact on PT mode share: the higher the length the higher the PT mode share. This value refers only to the additional lanes related to the policy implementation. The length of bus-tram network running on reserved lanes at the base year is defined in the advanced settings (see paragraph 3.2.43.2.2)
Share of Bus (tram) network subject to priority systems	Percentage of PT network subject to priority systems	%	The share of PT network subject to priority systems influences the impact on PT mode share: the higher the share of network the higher the mode share
Modes affected by mode shift on PT - flag	Selecting the distribution among the modes affected by mode shift on PT	-	The share of bus (tram) mode is increased at the expense of other modes. Alternative assumptions are available: • Option 1 = 70% of increase is taken from car, 10% from pedestrian, bike, motorbike respectively • Option 2 = 40% of increase is taken from car, 20% from pedestrian, bike, motorbike respectively • Option 3 = 50% of increase is taken from car, 30% from motorbike, 10% from pedestrian, bike, respectively
Advanced settings: Policy costs			
PT reserved lanes implementation cost	Investment cost for the city authority to implement reserved lanes	euro/km	This is the cost borne by the city authority to implement and build the new reserved lanes.
PT priority systems implementation cost	Investment cost for the city authority to improve PT frequency	euro/km	This is the cost borne by the city authority to implement PT priority systems at traffic lights
Advanced settings: Tool responsiveness			
Tuning of PT travel time reduction due to priority systems at traffic lights	Tuning parameter to adjust the level of impact	-	Set this parameter to a value < 1 to smooth the impact of priority systems on the bus (tram) travel time. Set this parameter to a value > 1 to amplify the impact of priority systems on the bus (tram) travel time. The reduction of travel time implemented is 15% (when the value is set to 1). Range: 0.5 – 2.0.
Tuning elasticity of PT mode share with respect to travel time improvements	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of PT travel time reduction on the mode share of bus (tram). Set this parameter to a value > 1 to amplify the impact of PT travel time reduction on the mode share of bus (tram). In case the mode share of bus (tram) is already high the elasticity should be decreased, while in case the mode share is low, the elasticity should be increased. Range: 0.5 – 2.0.
Tuning elasticity of PT travel time	Tuning parameter to	-	Set this parameter to a value < 1 to smooth the impact of reserved lanes on the bus (tram) travel time. Set this

Variable	Description	Unit	Notes
to reserved lanes extension	adjust the level of elasticity		parameter to a value > 1 to amplify the impact of reserved lanes on the bus (tram) travel time. Range: 0.5 – 2.0.

Synergies with other measures

It is assumed that the policy enhances the impact of Park & Ride measure.

References

Konsult, 2000, Policy Instruments: A Policy Guidebook, bus priorities - Evidence on performance

Victoria Transport Policy Institute, 2011, Transportation Elasticities - How Prices and Other Factors Affect Travel Behaviour

COST European COoperation in Science and Technology, 2011, Buses with High Level of Service Fundamental - characteristics and recommendations for decision-making and research: Results from 35 European cities

CIVITAS, 2010, Prioritisation of public transport in cities,

ICF International, 2011, Cost/Benefit Analysis Of Converting A Lane For Bus Rapid Transit—Phase Ii Evaluation And Methodology

Fermi F., Fiorello D., Krail M., Schade W., 2014, Description of the ASTRA-EC model and of the user interface. Deliverable D4.2 of ASSIST (Assessing the social and economic impacts of past and future sustainable transport policy in Europe). Project co-funded by European Commission 7th RTD Programme. Fraunhofer-ISI, Karlsruhe, Germany

3.3.5.3 Access regulations and road and parking space reallocation

Description of the policy measure:

Road space reallocation involves shifting road space currently devoted to vehicle traffic or parking to serve other modes, such as sidewalks and bike lanes.

This measure considers also interventions on:

- inner city zones where vehicle access regulation is a precondition to the creation of pedestrian zones;
- car-free development areas, which are part of city development conceived from the start to be free from car-traffic;
- Vehicle access regulation in proximity of naturally sensitive environments.

Access regulations might involve also the set up of Low Emission Zones (LEZ) which are areas of cities that have restricted access for vehicles not meeting certain emissions criteria. The restrictions may apply to heavy vehicles only or all vehicles. To date the key impact of these zones has been to reduce particulate emissions in cities.

Modelling of the policy measure:

This policy measure has a strong spatial dimension, but at the strategic level of the model this dimension cannot be fully simulated. The module assumes that applied vehicle access regulations make it less convenient to use a car for some trips and so applies a reduction in the share of cars in traffic movements in favour of other modes. An impact is simulated also on truck average distance travelled within the urban area, since the access regulation might cause longer round trips for freight distribution. Furthermore, the user can define if the regulation applies only to conventional vehicles: in that case the measure become less and less effective as the share of innovative vehicles in the fleet grows. Additionally, when this option is implemented, it is assumed that the renewal of the fleet is accelerated with the purchase of innovative vehicles.

The impacts of the measure depend on the share of urban area where access regulations are applied (urban core, Outskirts good transit, Outskirts poor transit).

The impacts have been quantified according to *EC Directorate General for Mobility and Transport (2010), H. Abel, R. Karrer, Rapp Trans AG (2006).*

The mode share of car is reduced in favour of other modes: it is assumed that mainly public transport benefit from the mode shift (40%), followed by motorbike, pedestrian and bike (20% each).

Implementation and the management costs for this measure are modest and depending on the share of urban area where regulations are applied. The initial value of cost per inhabitant (depending on the area) is estimated based on *H. Abel, R. Karrer, Rapp Trans AG (2006), N. Dasburg, J. Schoemaker (2006).*

The implementation cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 3 euro/inhabitant
- area between 10% and 25% : 5 euro/inhabitant
- area > 25% : 9 euro/inhabitant

The cost per inhabitant is estimated as average cost related to the share of the access regulated area by urban zone (urban core, outskirts good transit, outskirts poor transit).

The management cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 1 euro/inhabitant
- area between 10% and 25% : 2 euro/inhabitant
- area > 25% : 3 euro/inhabitant

The cost per inhabitant is estimated as average cost related to the share of the access regulated area by urban zone (urban core, outskirts good transit, outskirts poor transit).

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 24: Access regulations and road and parking space reallocation

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Share of regulated access zone	Percentage of urban area where the access regulation is applied (final target of the measure)	%	The area of implementation is the driver of the impacts of the policy: the larger the area the higher the reduction of car mode share and the increase of truck average distance. The value is differentiated by zone: urban core, outskirts good transit, outskirts poor transit
Advanced settings: Tool responsiveness			
Tuning elasticity of car mode share with respect to area	Tuning parameter to adjust the level of impact	-	Set this parameter to a value < 1 to smooth the impact of access regulated area on the car mode share. Set this parameter to a value > 1 to amplify the impact access restriction area on the car mode share. Range: 0.5 – 2.0.

Variable	Description	Unit	Notes
of implementation			
Tuning effect of the impact on car mode share with respect to innovative vehicle car fleet composition	Tuning parameter to adjust the level of elasticity	-	This parameter is involved when the Low emission zones are activated. Set this parameter to a value < 1 to smooth the impact of the share of innovative car in fleet composition on the mode share of car. Set this parameter to a value > 1 to amplify the impact of the share of innovative car in fleet composition on the mode share of car. Range: 0.5 – 2.0.
Tuning effect of the impact on truck distance in urban area with respect to area of implementation in urban core	Tuning parameter to adjust the level of elasticity	-	Set this parameter to a value < 1 to smooth the impact of the access regulated area in urban core zones on the truck average distance. Set this parameter to a value > 1 to amplify the impact of the access regulated area in urban core zones on the truck average distance. Range: 0.5 – 2.0.

Synergies with other measures

In case Low emission zones are implemented, the policy Green energy refuelling infrastructures might influence the impact of this measure.

References

EC Directorate General for Mobility and Transport, 2010, Study on urban access restrictions

H. Abel, R. Karrer, Rapp Trans AG (PTV Planung Transport Verkehr AG), 2006, BESTUFS DELIVERABLE D 2.2 Best Practice Handbook

N. Dasburg, J. Schoemaker, 2006, BESTUFS II - Best Urban Freight Solutions: Deliverable 5.2 - Quantification of urban freight transport effects II

3.3.5.4 Traffic calming measures

Description of the policy measure:

Traffic calming measures consist of various design features and strategies intended to reduce vehicle traffic speeds and volumes and so improve road safety.

Traffic calming projects can range from minor modifications of an individual street (volume or speed control devices), comprehensive redesign of the road network in specific areas (i.e. “30 Zone”), to the concept of "shared space" (under the principle that all transport modes must share the given street space).

Modelling of the policy measure:

This policy is modelled assuming that the application of traffic calming measures affects vehicle traffic speed and the mode share of private car, which becomes less convenient for a portion of trips. Thanks to the reduction of road vehicle speed, a positive impact is simulated in terms of reduction in accident rates.

The impacts of the measure depend on the share of urban area where traffic calming measures are applied (urban core, Outskirts good transit, Outskirts poor transit).

The impacts have been quantified according to *Victoria Transport Policy Institute (1999), New York City Department of Transportation (2004).*

The mode share of car is reduced in favour of other modes: it is assumed that mainly public transport, pedestrian and bike benefit from the mode shift (30% each), followed by motorbike (10%).

Traffic calming consists of regulation (e.g. zones with maximum allowable speed of 30 km/h) but also in various physical interventions (e.g. to restrict carriageways): therefore implementation and management costs are implemented. The initial value of implementation and management costs per inhabitant (depending on the area where traffic calming measures are applied) is estimated based on *New York City Department of Transportation (2004).*

The implementation cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 3 euro/inhabitant
- area between 10% and 25% : 6 euro/inhabitant
- area > 25% : 9 euro/inhabitant

The cost per inhabitant is estimated as average cost related to the share of traffic calming measures by urban zone (urban core, outskirts good transit, outskirts poor transit).

The management cost is estimated endogenously and depends on extension of the urban area subject to the policy: the initial values of cost per inhabitant depends on the area, as follows:

- area < 10% : 0.2 euro/inhabitant
- area between 10% and 25% : 0.4 euro/inhabitant
- area > 25% : 0.6 euro/inhabitant

The cost per inhabitant is estimated as average cost related to the share of traffic calming measures by urban zone (urban core, outskirts good transit, outskirts poor transit).

User input

The user input available from the interface to activate and setup the policy are reported in the following table.

Table 25: Traffic calming measures: User inputs

Variable	Description	Unit	Notes
Policy activation in the pop-up window "ADD POLICIES"			
Activation flag		-	Select this flag to activate the policy
Primary settings for policy setup			
Initial year of the measure	Year of initialisation of the policy.	Year	This is the year when the measure is started.
Ramp-up period traffic calming implementation	Year required to implement the policy.	Year	Period between the initial year and the completion year of the infrastructures/facilities to fully achieve the impact of the measure.
Share of traffic calming measures zone	Percentage of urban area where the traffic calming measures are applied (final target of the measure)	%	The area of implementation is the driver of the impacts of the policy: the larger the area the higher the reduction of car mode share and the reduction of speed (driving also the reduction of accident rates). The value is differentiated by zone: urban core, outskirts good transit, outskirts poor transit
Advanced settings: Tool responsiveness			
Tuning elasticity of car mode share with respect to area of implementation	Tuning parameter to adjust the level of impact	-	Set this parameter to a value < 1 to smooth the impact of the area with traffic calming measures on the car mode share. Set this parameter to a value > 1 to amplify the impact the area with traffic calming measures on the car mode share. Range: 0.5 – 2.0.

Variable	Description	Unit	Notes
Tuning elasticity of car speed with respect to area of implementation	Tuning parameter to adjust the level of impact	-	Set this parameter to a value < 1 to smooth the impact of the area with traffic calming measures on car speed. Set this parameter to a value > 1 to amplify the impact the area with traffic calming measures on car speed. Range: 0.5 – 2.0.

Synergies with other measures

None.

References

Victoria Transport Policy Institute, 1999, Traffic Calming Benefits, Costs and Equity Impacts

New York City Department of Transportation, 2004, Downtown Brooklyn Traffic Calming Study (Part I-Executive Summary, Part VI)

3.4 Outputs

The Output indicators module collects and computes the indicators for scenario assessment. The indicators are segmented into three domains: transport, environment and safety and economy. For each domain a set of indicators is available in terms of absolute values and shown in comparison to the reference scenario. The differences provide a clear evidence of the impact of policy scenarios. The following outputs are available from the interface to analyse the results of the policies.

3.4.1 Transport output indicators

Output	Description	Unit	Segmentation
Motorisation rate	Motorisation rate, in terms of ratio between cars and thousand inhabitants	Cars/1000 persons	None
Mode split	Percentage share of each mode of transport computed on total passenger demand travelling within the city (internal mobility and incoming trips using PT modes in a multimodal trip) in terms of passenger trips	%	• Pedestrian • Bike • Motorbike • Car • Bus • Tram • Metro • Car sharing
Average car speed in peak hours	Average speed of car vehicles during peak hours (morning from 7 to 9 and afternoon from 17 to 19)	km/h	None
Average car speed in off-peak hours	Average speed of car vehicles during off-peak hours (any time of the day apart from morning from 7 to 9 and afternoon from 17 to 19)	km/h	None
Average Occupancy factors of PT modes	Indicator of the capacity utilization of public transport services in terms of passengers per vehicle (daily average). Bus and tram are analysed together (assuming the same occupancy factor)	passengers/ vehicle	• Bus/tram • Metro

Output	Description	Unit	Segmentation
Average bus speed in peak hours	Average commercial speed of bus vehicles during peak hours (morning from 7 to 9 and afternoon from 17 to 19).	km/h	None
Average bus speed in off-peak hours	Average commercial speed of bus vehicles during off-peak hours (any time of the day apart from morning from 7 to 9 and afternoon from 17 to 19).	km/h	None
Average distance per trip	Average distance travelled per trip within the city (internal mobility). It is estimated as ratio between total passenger-km and total passenger trips.	km	None
Share of freight traffic in peak hours	Indicator of urban freight traffic within the city during peak hours (morning from 7 to 9 and afternoon from 17 to 19), as ratio between truck vehicle-km and car vehicle-km.	%	None
Share of freight traffic in Off-peak hours	Indicator of urban freight traffic within the city during off-peak hours (any time of the day apart from morning from 7 to 9 and afternoon from 17 to 19), as ratio between truck vehicle-km and car vehicle-km.	%	None
Penetration of alternatively fuelled car vehicles	Share of innovative (alternatively fuelled: hybrid electric, battery electric and fuel cells) vehicles in the car fleet	%	• Hybrid electric • Battery electric • Fuel cells
Penetration of alternatively fuelled bus vehicles	Share of innovative (alternatively fuelled: CNG, hybrid electric and battery electric) vehicles in the bus fleet	%	• CNG • Hybrid electric • Battery electric
Vehicles-km by car conventional vehicles	Traffic volume in terms of vehicle-km of passenger cars with conventional fuel (diesel, gasoline) travelling on the road network of the city	Million vkm / year	None

3.4.2 Environmental outputs indictors

Output	Description	Unit	Segmentation
Yearly CO_2 emissions	Transport yearly CO_2 emissions (tank-to-wheel, not including cold start emissions). Both internal mobility and incoming trips are considered.	Tonnes/year	None
Yearly PM emissions	Transport yearly PM polluting emissions (tank-to-wheel, not including cold start emissions). Both internal mobility and incoming trips are considered.	Tonnes/year	None

Output	Description	Unit	Segmentation
Yearly CO emissions	Transport yearly CO polluting emissions (tank-to-wheel, not including cold start emissions). Both internal mobility and incoming trips are considered.	Tonnes/year	None
Yearly NOx emissions	Transport yearly NOx polluting emissions (tank-to-wheel, not including cold start emissions). Both internal mobility and incoming trips are considered.	Tonnes/year	None
Yearly VOC emissions	Transport yearly VOC polluting emissions (tank-to-wheel, not including cold start emissions). Both internal mobility and incoming trips are considered.	Tonnes/year	None
CO2 cumulated emissions 2015-2030	Sum of transport CO2 emissions (tank-to-wheel, not including cold start emissions) over the whole period 2015 - 2030	Tonnes	None
PM cumulated emissions 2015-2030	Sum of transport PM emissions (tank-to-wheel, not including cold start emissions) over the whole period 2015 - 2030	Tonnes	None
CO cumulated emissions 2015-2030	Sum of transport CO emissions (tank-to-wheel, not including cold start emissions) over the whole period 2015 - 2030	Tonnes	None
NOx cumulated emissions 2015-2030	Sum of transport NOx emissions (tank-to-wheel, not including cold start emissions) over the whole period 2015 - 2030	Tonnes	None
VOC cumulated emissions 2015-2030	Sum of transport VOC emissions (tank-to-wheel, not including cold start emissions) over the whole period 2015 - 2030	Tonnes	None
Total fuel consumption by fuel type	Total yearly transport fuel consumption by fuel type (both internal mobility and incoming trips are considered).	Toe/year	• Gasoline • Diesel • CNG • LPG • Electricity • Hydrogen
Total truck fuel consumption	Total yearly fuel consumption of freight vehicles (LDVs and HDV)	Toe/year	None
Total passenger fuel consumption by mode	Total yearly fuel consumption by passenger mode (both internal mobility and incoming trips are considered).	Toe/year	• Motorbike • Car • Bus • Tram • Metro • Car sharing

Output	Description	Unit	Segmentation
Accidents by severity	Number of individuals involved in accidents by seriousness	Individuals	• Fatality • Serious injuries
Fatalities per 100,000 inhabitants	Ratio between the number of individuals involved in fatalities and total population	Individuals / 100,000 inhabitants	None

3.4.3 Economic Output Indicators

Output	Description	Unit	Segmentation
Transport expenditure per individual	Average individual expenditure for travelling in the city in a given year.	1000 Euro/year	None
Value of travelled time per individual	Monetary value of the average total time travelled by one individual in the city in a given year	1000 Euro/year	None
Transport expenditure of public administration	Public expenditure for transport services and infrastructures (implementation and maintenance) in a given year	1000 Euro/year	None
Revenues of public administration	Revenues of the city authority resulting from road charging, parking, PT tickets, P&R, bike sharing users in a given year	1000 Euro/year	None
Net Financial result for public administration	Difference between the total transport expenditure and the total revenues for the public administration. The difference is computed year by year, cumulated over the whole period 2015-2030 and discounted to base year values	million Euro	None
Transport social monetary costs	Sum of public expenditure on transport services and infrastructure excluding transfers between households and local Public Administration, i.e. Car operating costs, PT operating costs, implementation and management cost of policy measures are included whereas the cost of using Public transport and bike sharing, parking cost and urban tolls are excluded because they are expenditure for travellers but revenues for the Public Administration and so the two terms cancel out.	1000 Euro/year	None

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