SOLUTIONS

Sharing Opportunities for Low carbon Urban TransportatION

D1.1 Working Paper on innovative solutions in cities around the world

SOLUTIONS	Grant agreement No: 604714
Title of the document	Working Paper on innovative solutions in cities around the world
Deliverable	D1.1
Work package	WP1 Transferability analysis, methods and tools
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Status	Draft
Dissemination level	PU
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Submission date	31 March 2014

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1. About the SOLUTIONS project

The overall mission of SOLUTIONS is to support the uptake of innovative sustainable urban mobility solutions in Europe and other regions in the world, in particular in Asia, Latin America and the Mediterranean.

Transport is a key enabler of economic activity and social connectivity. While providing essential services to society, transport is also an important part of the economy and it is at the core of a number of major sustainability challenges, such as climate change, air quality, safety, energy, security and efficiency in the use of resources.

There will be a variety of aspects to be considered within the knowledge sharing and mutual learning elements of the SOLUTIONS project. While sharing experiences on sustainable urban mobility solutions the key focus of the project will be to identify innovative measures in the partner countries and test their applicability to European cities around the world. SOLUTIONS will facilitate a North-South-South-North dialogue and exchange, contributing to a high degree of integration of knowledge and resource sharing.

The project is organised into five main parts to realise the take-up of sustainable mobility solutions. An initial transferability assessment (WP1) is followed by a knowledge-sharing and capacity building plan (WP2). Both form the basis for transfer, take-up and future cooperation in Asia and Latin America (WP3) as well as transfer and future research cooperation in the Mediterranean (WP4). The results will be widely promoted through global dialogue, dissemination and outreach (WP5).

The strategic impact of the project will be to

- Foster the deployment of innovative transport solutions in Europe and across the world to reach European and global agreements on sustainable urban mobility, energy efficiency and fight against climate change.
- Support the structured transfer of innovative transport solutions from the European industry and service sector to other regions in the world.
- Contribute to better global dialogue amongst policy-makers and practitioners in urban transport from Europe and other industrialised and emerging countries.
- Develop research cooperation with Mediterranean partner countries in the field of urban transport.

2. About this document

This working document forms part of work package 1, which incorporates transferability analysis, as well as methods and tools, of the SOLUTIONS project. It is the outcome of Task 1.1, identification of innovative solutions, which is structured into three parts. The first part provides the context of the work within the six clusters. The second part, the thematic clusters, is the main part of the document. It describes in detail the potential solutions of the six thematic clusters to common urban transport challenges. The solutions are derived from practical experiences from Europe and other countries. It offers to transport professionals a catalogue of urban mobility measures, which are successfully implemented in cities around the world. The third part provides conclusions with an outlook towards the selected take-up, leading and training cities within SOLUTIONS.

3. Transferability approach

Cities around the world have a need to establish sustainable transport systems, which provide efficient and safe mobility for their citizens with minimum environmental impacts. With limited opportunity to build new infrastructure, many cities need to increase the efficiency and capacity of their transport systems and are turning to innovative and technically-advanced systems to contribute to this objective.

SOLUTIONS will build on a range of EU and international-cooperation projects that have assessed innovation and good practice in transport. It will identify innovative and green urban transport and mobility solutions from around the world and select a number of solutions that may be suitable for transfer to cities within the SOLUTIONS regions of Asia, Latin America and Europe.

Obviously, the take-up of urban mobility and transport solutions between global regions is particularly challenging as socio-economic conditions and policy frameworks differ substantially across the regions. Within Europe, a number of projects have successfully demonstrated take-up between cities, which confirms the value of collaborative learning and exchange of experiences within different cultures and planning practices (e.g. CIVITAS, TIDE, Niches).

Cities, regions and countries often share similar challenges and there are always more or less progressive cities. Whilst there are advantages to sharing examples, learning and best practices, it is more fruitful to follow a robust methodology to help achieve widespread implementation and harmonisation of successful policies, measures and technologies.

Transferability is a process of assessing the potential of a successful implementation of a measure in a new location. The process involves analysing various factors, which have the potential to influence the implementation and learning from the experiences in the pioneer cities. The use of a transferability methodology provides an opportunity to learn from the previous experience of implementation to better exploit opportunities and avoid mistakes.

A successful implementation of a measure in one city does not automatically mean that it is suitable for transfer to other cities; the right conditions are needed to make it a reality. The replication of success in a different urban context is challenging as the cities can differ in many aspects of transport and traffic conditions (demand, supply, infrastructure, traffic control and management etc.), geographical, environmental, demographic, socio-economic and cultural backgrounds as well as institutional and legal frameworks (CIVITAS, 2012). The transferability methodology developed for this project will help to identify those factors, which are key to the measure's success and must be addressed in a new location. It also helps to identify any factors, which may create barriers, so that they can either be overcome or the decision can be made not to introduce the measure.

4. Thematic clusters in SOLUTIONS

SOLUTIONS has identified a number of potential planning and policy measures and grouped them into six thematic clusters. The topic areas are derived from the call text and encompass measures to improve the sustainability of urban mobility, focusing on solutions that can be directly implemented by local authorities. The thematic depth and focus takes into account the different levels of maturity of sustainable mobility policy in the partner regions and the ability to adopt solutions.

The six thematic clusters are:

- Cluster 1: public transport
- Cluster 2: transport infrastructure
- Cluster 3: city logistics
- Cluster 4: integrated planning and Sustainable Urban Mobility Plans
- Cluster 5: network and mobility management
- Cluster 6: clean vehicles

4.1. Relevance and scope of the clusters

The six thematic clusters build on relevant previous research projects on urban mobility and their transferability, boosting their impact and adding value. The clusters provide the basis for targeted knowledge-exchange and the transfer of innovative sustainable urban mobility solutions and technologies.

The cluster leaders of the SOLUTIONS consortium have formed teams and identified solutions for each cluster theme. A workshop was held to prioritise the solutions according to their relevance and transferability potential, with approximately ten solutions selected for further elaboration into SOLUTIONS fact sheets.

During the workshop, it was realised that some solutions could not be clearly allocated to single clusters. Transport infrastructure and integrated planning solutions in particular intersect with the other clusters, for example with public transport and city logistics. Such overlaps have been identified and discussed, with expert input to where these measures fit best.

The structured transfer of individual measures is less challenging than addressing packages of measures, as sometimes such solutions include measures that cut across clusters. This approach simplified the process for the purposes of this project, although, in reality, transport policy development and implementation at municipal level is far more complex and influenced by internal and external factors.

4.2. Organisation of the clusters

For each of the six clusters a team of project partners discussed and elaborated a set of potential solutions which would cover the scope of the cluster and have good transferability potential for cities around the world. The teams have vast experience working on transport projects worldwide and are well positioned to identify and prioritise suitable measures for this work package.

Cluster 1, public transport, is led by the China Academy of Transportation Sciences, CATS; the major research institution in China on public transport, sustainable transport and mobility solutions. The cluster team includes EMBARQ, POLIS and Rupprecht Consult. CATS and Rupprecht Consult have cooperated for many years on public transport related topics.

Cluster 2, transport infrastructure, is led by FEHRL, teaming up with IFSTTAR and FEHRL third party members (leading European research institutes). As infrastructure was an example of measures that touched on many other cluster themes, the team decided to focus the cluster on sustainable transport infrastructure, with particular attention to the active modes walking and cycling.

Cluster 3, city logistics, is led by IFSTTAR and supported by CERTH/HIT and Wuppertal Institute. The close relationship to the infrastructure cluster was apparent (for example for loading/unloading facilities and guidance systems), and hence both clusters cooperated closely with each other.

Cluster 4, integrated planning and Sustainable Urban Mobility Plans, is led by Rupprecht Consult, supported by POLIS, Wuppertal Institute, LNEC and EMBARQ. The team has worked on numerous SUMP[1] related initiatives in Europe and worldwide. Measures and solutions from other clusters generally fall under the wider ‘planning-umbrella’ of SUMP and mutually reinforce each other.

Cluster 5, network and mobility management, is led by Austriatech and includes CERTH/HIT and IFSTTAR. The team follows a demand-led approach of addressing cluster categories through sub-measures, supported by measures from other clusters.

Cluster 6, clean vehicles, is led by Wuppertal Institute. The team includes CERTH/HIT, ICCT and AVERE. The team covered more than technology-based solutions, but also included the secondary effects of policy measures leading to the broader introduction of clean vehicles.

[1] SUMP – Sustainable Urban Mobility Plans

	Cluster 1: public transport	Cluster 2: Transport infrastructure	Cluster 3: City logistics	Cluster 4: Integrated planning/SUMP	Cluster 5: Network and mobility management	Cluster 6: Clean vehicles
1	BRT[2] system construction and operation with high service level	Dedicated bus lanes	Urban deliveries with cargo-cycles	General preparation of SUMP	Parking management	Registration restrictions/number plate auctions
2	Trolley bus systems	Intermodal interchanges	Forums, portals, labels and training programs	Vision building for future sustainable urban mobility	Access restriction	Management of electric two-wheelers
3	Metro systems	Pedestrian infrastructure	Promotion of out-of - hour deliveries	Stakeholder participation and citizen engagement	Traffic management	Fuel economy/CO2 standards
4	Use and operation of clean vehicles (CNG, LPG, LNG) in public transport systems	Improving non-motorised infrastructure – public space and urban road designs for cycling and walking	Networks of pick up points	Participatory budgeting in SUMP context	Multimodal journey planning	Fuel switch in taxi fleets to electric vehicles (EVs)
5	New technology vehicles such as electric and hybrid vehicles in public transport systems	Cycle infrastructure I - Innovative and safe cycling infrastructure	Increased use of rail and waterborne transport	SUMP audit schemes and quality management	Cooperative ITS systems (C-ITS)	Fuel switch in taxi fleets to LPG/CNG
6	ITS for public transport	Cycle Infrastructure II – cycle highways	Urban Consolidation Centres (UCCs)	Measure / measures package selection strategies	Car- and bike-sharing	Emission-based vehicle taxation
7	Integrated planning of public transport network	Infrastructure for car and bike sharing	Municipal procurement reorganisation	Monitoring and evaluation of SUMP		Clean vehicles in municipal fleets

[2] BRT: Bus Rapid Transit

8	Financing public transport	Pedestrianisation of city centres and streets	Lorry lanes for urban freight transport	Modelling and visualisation tools in SUMP		Low emission zones
9	Integrated fare systems		Pricing schemes, taxes and tolls	SUMP framework conditions		Information and promotion of clean vehicles
10	Eco-driving for professional drivers			Capacity building and training schemes in SUMP		Infrastructure for clean vehicles
11	Bus priority measures			Engaging external support for SUMP development		Clean modes of delivery in urban areas
12	Bike sharing and public bicycles					Replacement of private cars/motorcycles with clean ones

Table 1 overview of the solutions

4.3. Solutions from around the world

This part of chapter 4 summarises all solutions identified by describing the objective, the scope of the measure, its impact, drivers of the measure and barriers for implementation, examples of successful implementation and project references of each solution. The solutions were grouped following the internationally recognised ASI (Avoid, Shift and Improve) framework, as indicated in Table 2, below.

The descriptions of the solutions are rather general and wider in scope to allow the leading and take-up cities to focus on particular aspects of individual measures. Many of these measures have been widely applied cities worldwide; the references to specific cities and projects are examples only.

4.3.1. Cluster 1: public transport

Public transport is a crucial factor for providing access and achieving liveable cities and metropolitan areas. In face of urban traffic congestion, air pollution, climate change and energy consumption, public transport is taking an increasingly prominent role as the core part of sustainable urban mobility concepts.

The transferability of successful high-capacity mass transit is of significant interest and importance to cities in emerging countries suffering from increasing urban populations and limited space for transport. Cluster 1 (public transport) shares experiences and knowledge on public transport issues with particular focus on the following aspects:

SOLUTIONS for:	Type of impact (avoid, shift or improve)
BRT system construction and operating with high level service	Improve/shift
Trolley bus systems	Shift/improve)
Metro systems	Shift/improve
Use and operate clean vehicles such as CNG, LPG, LNG in public transport system	Improve
Use new technology vehicles such as electric and Hybrid vehicles in public transport system	Shift (Improve)
ITS for public transport	Improve
Integrated planning of public transport network	Improve
Financing public transport	Improve/shift
Integrated fare system	Improve
Eco-driving for professional drivers	Improve
Bus priority	Improve
Bike sharing and public bicycles	Shift (avoid)

Table 2: overview of selected solutions in the public transport cluster

Solution 1.1: BRT system construction and operation

Bus Rapid Transit (BRT) mimics a metro system, by using regular buses on city streets, but on dedicated lines, with relatively large capacity and high average speeds. As such, pubic transport is given clear preference on the urban road network and a reliable public transport service can be provided at a fraction of the cost of a metro system.

BRT is best implemented on main roads of cities and metropolitan areas, which need to transport large numbers of passengers. Due to its high capacity it helps to reduce congestion. As most BRT systems use modern buses running on dedicated corridors, they are usually accompanied by gains in local air quality and reduced greenhouse gas emissions over conventional city buses.

The drivers for adopting BRT systems are the increased capacity and reliability compared to conventional public transport, environmental benefits and cost effectiveness. The primary constraints include funding and investment, limited road space, and public opposition to reducing road space for cars and other traffic.

Approximately 160 cities across 38 countries have BRT systems or priority bus corridors, which are used by nearly 29 million passengers each day. The concept was develop in Latin America and has spread very fast across the continent, but also Asia, North America and Europe and more recently also Africa. Some European cities have developed an adapted version of BRT, called BHLS (Bus with a High Level of Service), which features many of the attributes of the larger systems found in Asia and Latin America.

Notable examples of well established BRT systems are found in Curitiba (Brazil), the TransMilenio system in Bogota, the Hubei–Yichang Sustainable Urban Transport Project and in Guangzhou in China.

Solution 1.2: trolley-bus systems

A trolley-bus system is a public transport mode using electric propulsion provided by overhead wires. It offers the opportunity to use renewable energy if available and hence reduces fossil energy use. Even with the use of the conventional electricity energy mix, it is a transport system with almost zero local air pollution and little noise emissions. It supports cities in achieving their climate goals by reducing fossil fuels in public fleets. It is also an effective means to implement electromobility in cities with high cost effectiveness. A trolley bus system is best implemented in the built up area of a city where its positive impact on local emissions can be especially advantageous.

The construction and maintenance of the power grid can be an obstacle in the urban landscape. In many countries, trolley busses are perceived as old fashioned, however there are new modern, well-designed vehicles available. Many EU projects, such as the TROLLEY project have demonstrated that such barriers can be successfully overcome. However, electricity supply shortages or intermittent supply can create challenges for the take-up in developing countries.

Figure 1. Trolley bus in Gdynia, Poland

Trolley buses have been removed from public transport systems in many cities in Eastern Europe, China and other countries. Now, because of the characteristics of clean energy and high efficiency, trolley buses are becoming more fashionable again. This technology also lends itself to hybridisation and there are a number of buses, which can drive for part of their route off-wire (for example in Gdynia, Poland). Good examples of trolley bus systems can be found in Zurich, Switzerland, Salzburg, Austria, Athens, Greece, Lyon, France, and Beijing and Taiyuan, China.

Solution 1.3: metro systems

Metro systems (MRT) offer rapid, high capacity rail-based public transport without affecting the structure of road networks and built-up areas. They are almost independent from the topography of cities.

The term “metro“ is a common international term that refers to underground subways and heavy rail transit. Metros are said to be one of the most expensive form of mass rapid transit per kilometre (except for Maglev trains), but have the highest capacity (Wright & Fjellstrom, 2005). They are best implemented in areas with high capacity requirements and are especially appropriate in cities where there typical trip distances are long. Metro systems, as with most rail systems, also successfully attract passengers from other transport modes, in particular from private cars. The main driver of metro construction is capacity. It is also perceived as fast and reliable, its electric propulsion does not add to local emissions and the shift of passengers from private cars reduces congestion and therefore emissions from cars.

MRT is most applicable to areas with more than 5 million inhabitants or linear spatial-distribution, for corridors with more than 700,000 trips per day, and with at least USD18.000 per capita annual income at the city level given its high construction and operation costs. Other pre-requisites include competitive fares, steady population growth with economic prosperity, and interconnection of the MRT and other modes (Wright & Fjellstrom, 2003). The main obstacles include: the high capital investment in infrastructure (although offset by long lives and payback rates), maintenance and operation costs (incl. more professional and qualified staff). Due to the high costs, new metro construction is often shared between the public and private sectors.

Examples are manifold. Major systems are the London underground (now more than 150 years old), Paris, New York, Moscow, Washington, Berlin as well as many cities in Asia, including Singapore, Beijing (now the world’s largest system), Shanghai and Dalian. Smaller automatic or driverless metros have been introduced for medium to large cities such as Copenhagen, Nuremberg, Lille and parts of the Paris metro.

Solution 1.4: fossil-fuel switch options for public transport

Primarily driven by air quality concerns a number of public transport operators have switched to Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG). This kind of fuel switch are relatively easy to implement, however there are some constraints, such as the increased cost of the vehicles, depot arrangements for refuelling and maintenance, the availability of fuel infrastructure and maintenance.

Figure 2. CNG bus, Delhi, India (Markus Spring)

An additional driver for utilising these fuels is their lower cost relative to diesel, despite higher maintenance costs. From a CO_2 perspective the benefits of this fuel switch are less certain and can even be higher than efficient diesel engines. Other obstacles include the lower range of natural gas- propelled vehicles, difficulties at higher altitudes, extreme low or high temperatures, and the need for refuelling infrastructure (see cluster 6).

Stockholm (Sweden) and Lille (France) can be considered leaders in using a combination of biogas and CNG (mixed according to biogas availability of the bio gas). This combination, although costly to set up, may become more attractive as measure to reduce greenhouse gas emissions.

Examples are CNG buses in Delhi (India), Berlin (Germany), Lille (France), Hong Kong (China), LNG buses in Guiyang and Xian (China).

Solution 1.5: electric and hybrid vehicles in public transport system

Electromobility has played a part in public transport for many years. Public transport vehicles usually follow fixed routes which makes battery propelled vehicles a feasible alternative to conventionally fuelled counterparts, as routes can be adapted to the vehicles' capabilities. Electric vehicles produce zero local emissions and less noise. Also, hybrid-electric vehicles are more flexible due to their extended range.

Figure 3. Hybrid bus, Germany

Transport authorities and operators can potentially attract more passengers to public transport by using alternatively powered clean vehicles. The scope of this measure is city and metropolitan-wide but works best along main corridors.

The main barriers to full electrification are the considerably higher costs (batteries), lower range, electricity-supply considerations and a lack of choice on the market (size and power). Also, climatic conditions affect the reliability of the technology (e.g. reduced range and shortened battery life in low temperatures).

Electric and hybrid buses are used in some cities in China: electric in Shenzhen and Beijing; hybrid buses in Guiyang. Aachen, Bremen and London are European examples.

Solution 1.6: ITS for public transport

Intelligent Transport Systems (ITS) play an increasingly important role in public transport, both at the driver-vehicle and passenger-service interfaces. One of the most transformational aspects in recent years has been in the provision of real-time arrival and departure time information to passengers, but it is also used to provide other information (such as multimodal travel planning) to help deliver seamless journeys to travellers. Moreover, it also plays a key role in vehicle monitoring (position, service quality and maintenance diagnostics), through on-board GPS (Global Positioning), which is also used to respond to disruptive traffic situations and to provide evidence about accidents.

ITS is applied not only in vehicles but also across whole public transportation systems. The use of ITS raises the attractiveness of public transport and helps to shift passengers from other transport modes. ITS also improves the public transport system's safety and makes its management more effective and convenient.

A main obstacle of ITS is the high initial investment required for a well-functioning and reliable system. Furthermore, data management and the integration of separate data sources in different departments presents a challenge; equally important is the maintenance and operation of technical equipment.

The take up of ITS in public transport in Asia has been faster than in Europe, led by Korea – Seoul's metro is highly ITS enabled, while the Hong Kong Octopus smart card was one of the first integrated fare systems.

Asia's leading position is being challenged, however. ITS technology is used in most major cities in Europe and other developed countries. It is widely used for traffic management and for controlling the traffic lights at junctions (prioritising public transport vehicles).

Solution 1.7: integrated fare systems

Integrated fare systems for public transport are one of the basic conditions required to provide convenient access to a public transport system in a city. They allow passengers to make journeys involving transfers within or between different transport modes (buses, trains, subways, ferries, etc.) with a single ticket, valid for the complete journey, ideally using smart-cards or mobile phones. In addition, public bicycles or car sharing can be included, as can electronic purse applications. Integrated ticketing encourages passengers to use public transport by simplifying the fare structures and making switches between transport modes easier, increasing the efficiency and attractiveness of the services.

Several benefits can be gained from implementing an integrated smart card system, such as loyalty points/programmes and calculating the cheapest-fare option. It also provides important travel data (with data protection for the identity of the passengers), such as passenger flows, peak travel times and interchange details which can all be used to improve the service and provides input for better and more integrated transport planning (connecting bus departure schedules or train timetables).

The barriers are the need for cooperation between a number of different authorities and operators (particularly challenging if private *and* public operators are involved), relatively high investments, and difficulties arising from the choice of system, back and front office procedures, revenue sharing, interoperability, equipment life-cycle and data protection issues.

Integrated fare systems are now commonplace in Europe and are spreading in China; experience can be shared and promoted among other cities along with experience from other parts of the world. Examples: London's Oystercard, which allows travel on all modes of public transport, Paris (with market segmentation and loyalty programmes), Bremen's (Germany) Mobility pass including car and bike sharing, Hong Kong, Beijing, Seoul and Tokyo.

There are now even examples of nationally integrated public-transport fares, such as in the Netherlands (originally the 'Strippenkart', now a smart card) and in Denmark where rail and public transport are combined on one card allowing nationwide travel.

Solution 1.8: integrated planning of the public transport network

The aim of integrated transport planning is to align the public transport network with the overall urban planning layout. Integrated public transport planning often is a subset of sustainable urban mobility planning. Integrating transport with urban planning provides a key opportunity to implement 'Avoid' policies as set out in the previously mentioned ASI policy framework.

Integrated planning is best applied in cities (or areas of cities) with insufficient public transport capacity. The impact of integrated transport planning should be visible in the city by making travel distances between urban functions short, efficient and manageable by walking, cycling and public transport. General demand of public transport, sustainable urban development and development within limited space is a major driver for integrated transport planning.

Fragmented competences, divergent land-utilisation interests and resistance from some sectors of society are among the barriers for successful integrated planning. A joint cooperation mechanism among transport, land use, environment protection departments should be set up and operate efficiently in order to allow integrated planning.

An important example is London, which has one of the largest integrated transport authorities (Transport for London). Based on the Transport for London model, Budapest established an authority (BKK) that oversees public transport, infrastructure and planning in the city. Similar approaches were adopted in Stockholm, Curitiba (Brazil) and Hefei and Yinchuan (China).

Solution 1.9: financing public transport

Public transport systems require high levels of capital investments (for infrastructure and rolling stock/vehicles) and funding (subsidies) to cover operations and service delivery. Authorities and operators must ensure that public transport has sufficient investment capital to maintain a high quality service, manage capacity and affordability and to keep up with increasing demand. Generally speaking, and especially in Europe, public actors assume the responsibility for the provision of infrastructure, while operators are expected to deliver predefined service levels with revenues coming from fares and other sources. In many cases an increasingly small amount of financial support or compensation for special fares (such as school children, and the elderly) is available from the public purse. In Asia and much of Latin America, public transport is expected to run without subsidies. This can be achieved as long as ridership is very high, however it can mean that quality is compromised as more people are expected to be carried at peak times, while less profitable but socially-important routes are not attractive. Europe has recently opened the market to competition; there are several different models that could be transferred elsewhere.

A sound financing model allows for the provision of sufficient capital for infrastructure construction and the system's operation, while striking a good balance between high service level and reasonable pricing will attract more passengers to public transport.

Barriers are funding agencies own insufficient capital (or willingness of decision-makers to assign sufficient budget) and unnecessary subsidies for public transport companies (and hence lack of competition) or effort to improve efficiencies.

Funding is a basic need for PT, subsidies are necessary to ensure the operation and provide high quality service with low cost. Typical cost coverage expectations It should be interesting to learn experience from each other.

Examples are the Transport Tax, Paris, France; Ticket system for PT in German cities and Japanese cities; Beijing, China; Ticket system for PT in Dalian city, China

Solution 1.10: eco-driving for professional drivers

Eco-driving involves teaching bus, subway and light rail drivers to drive more smoothly. This increases fuel economy, reducing fuel use, costs and emissions, and increases passenger-comfort, in turn, attracting more passengers. Additionally, vehicle wear and tear is reduced, decreasing maintenance costs. The barriers are the requirements for continuous training efforts of drivers to maintain the level of eco-driving within public transport fleets, and monitoring/motivating them to continue using these skills.

Examples can be found in various European transport projects, such as ACTUATE and

BENEFIT. Examples of driver trainings are found in Leipzig, Germany, Salzburg, Austria, Parma, Italy and Brno, Czech Republic. Some companies in some cities in China have taught eco-driving to their drivers.

Solution 1.11: bus priority

The aim of bus priority is to increase the average speed of public transport buses in cities and to provide passengers with more reliable journeys. Buses are given priority at intersections with traffic light adjustments and sensors. The impact is a more efficient public transport system and increased ridership. The main driver is a participatory decision making mechanism which ensures acceptance of all stakeholders and sectors of society and the affordability and availability of the technology to do this.

Figure 4: dedicated bus lane

Good maintenance and operation of the system is necessary, which is usually centrally controlled. Objections to bus priority are made as they are perceived to be slowing down private car traffic, however there are many cases where smoother running of buses and improved traffic management in general help reduce overall travel time for all vehicles and eases congestion.

Examples are many but especially in Frankfurt, Germany, Nantes and Lille, France, and in some cities in China.

See also section on dedicated bus lanes in Cluster 2 (infrastructure).

Solution 1.12: bike-sharing and public bicycles

Rental bicycle systems look promising to solve the 'last mile' problem in urban transport systems and provide truly door-to-door travel connections. They also provide a means of transport for populations in high-density residential areas where residents have limited possibilities to safely park and store private bicycles.

Figure 5. Foshan, China

Installations of public bike sharing systems are best combined with public transport hubs.

Solving the 'last mile' problem helps to shift passengers from private cars to public transport and hence reduce pollution in cities.

The drivers of a well-functioning public bicycle system are safe cycling infrastructure and good access to installations. The business model is still developing for these systems and the majority are still organised and paid for by the public sector. An obstacle is potential vandalism and obstruction of the operation and maintenance of the corresponding equipment.

Many cities in Europe have experience in public bicycle as an active mode in public transport. Examples of bike-sharing systems can be found in Paris, Brussels, London, Berlin, Hangzhou (China), which is one of the largest in the world with 60,600 bikes and Changzhou (China).

4.3.2. Cluster 2: transport infrastructure

The transport infrastructure cluster focuses on infrastructure for public transport (tramways and light rail, bus lanes, passenger waiting and boarding areas) and infrastructure for soft modes (e.g. cycle routes, pedestrian facilities).

The objective of this cluster is to summarise the available information and provide recommendations for the design of urban streets (sharing of road space) and designing cycling infrastructure to improve its safety.

SOLUTIONS for	**Type of impact (avoid, shift or improve)**
Dedicated bus lanes	Improve
Intermodal interchanges	Improve
Pedestrian infrastructure	Improve (avoid)
Improving non-motorised infrastructure – improving public space and urban road designs for cycling and walking	Improve (avoid)
Cycle infrastructure I - Innovative safe cycling infrastructure	Improve (avoid)
Cycle Infrastructure II – cycle highways	Improve (avoid)
Infrastructure for car and bike sharing	Improve (Shift)
Pedestrianisation of city centres and streets	Improve (avoid)

Table 3: overview of selected solutions in the transport infrastructure cluster

Solution 2.1: dedicated bus lanes

Dedicated bus lanes allow the speed of buses to be maintained so that they run to schedule, making services more reliable and helping to deliver fuel savings due to smoother driving.

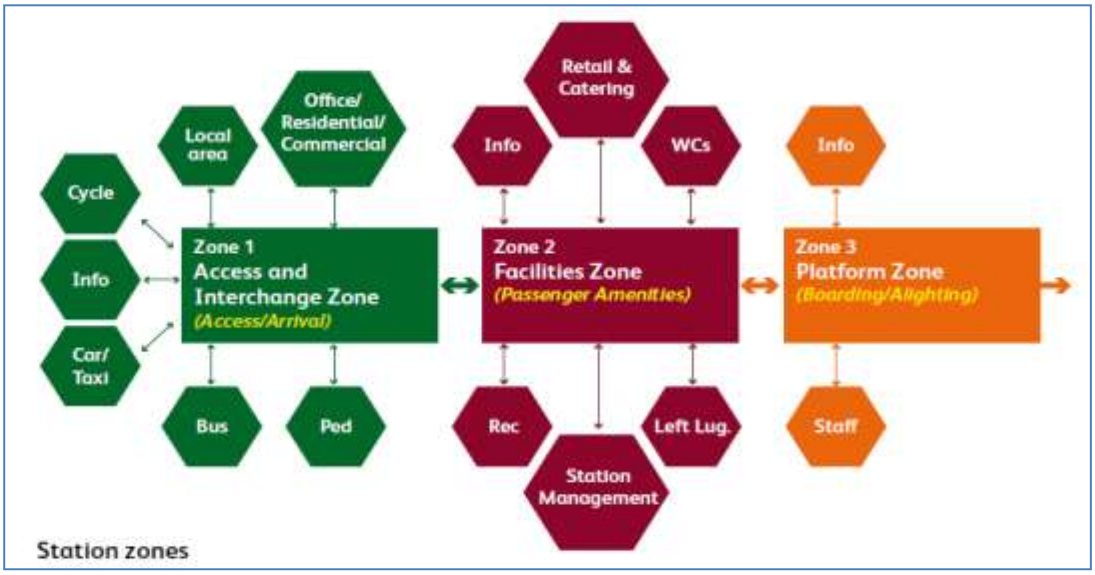
Average speeds are higher for buses on dedicated lanes than for those in mixed traffic, resulting in time travel savings, encouraging more peole to travel by bus. Bus travel also becomes safer for passengers and is usually more comfortable.

Figure 6. Lille, France

The scope of the solution includes dedicated lanes for buses (and emergency and other designated vehicles) separated from other traffic. Sometimes counter flow bus lanes, especially in congested urban areas, have been shown to be effective.

The solution can also be combined with improvements to the public space and improving pedestrian and cycling infrastructure. The efforts for constructing dedicated bus lanes are comparably low compared to rail-based public transport and can help to make travelling by bus more like rail travel.

The barriers for implementation include:



- Lack of space, especially in central and historic urban areas
- Resistance from other road users (allowing taxis and bicycles to use them either at all times or at restricted times of the day has reduced resistance).
- Enforcement of exclusivity (London required a high penalty to stop people using them)
- Public information systems and clear signage to show which vehicles can use the lanes. These are sometimes dynamic signs that change at different times of the day.

Dedicated bus lanes have been implemented in many European cities: London, Berlin, Paris, Nice, Nantes, Lille and Dublin.

Solution 2.2: intermodal interchanges

An intermodal interchange allows people to change from one mode of public transport to another, for example between bus and train, or within modes from one route to another.

Intermodal interchanges provide passengers with convenient journeys. There are a number of different types of interchange, ranging from very large and complex ones that connect international travel (usually rail) with regional and local modes to smaller bus-based route interchanges.

A crucial element of providing successful multi-modal interchanges is to understand the requirements of the users, both existing and potential, and the factors that influence their modal choice.

Sound integrated urban mobility planning helps to define and to implement efficient intermodal interchanges, and to locate them within an overall transport and mobility system in a city.

Barriers include fragmented and uncoordinated transport authorities, and operators of specific modes or routes hampering their functioning and service offer by not integrating their services.

Successful examples are the Moncloa interchange in Madrid, St Pancras International, in London, Gare du Nord in Paris and the Köbánya-Kispest in Budapest. The EU NICHES, NODES and CITYHUBS projects discuss interchanges in more detail.

Solution 2.3: pedestrian infrastructure

The objective of this solution is to improve the safety and comfort of pedestrians and to increase their visibility. The solution helps reduce traffic speeds thereby reducing the likelihood of serious accidents.

Examples of successful solutions include central protective islands on roads, extended pavements or narrowing of the roadway to better protect pedestrians, elevated roadways, and improving the placement of signs and lighting. Each measure can be implemented individually or combined.

Pedestrian infrastructure results in considerably improved safety and comfort of pedestrians, often accompanied by generally improved quality of life in the locality (reduced noise, improved aesthetics).

The technical and financial efforts for such measures are low and highly cost effective. Costs vary according to type of applied measure, the original state of the location and the extent of application. The benefits can be calculated using the accident prediction model.

Many cities in Europe and other parts of the world have implemented such solutions and they can be easily transferred to other cities.

Solution 2.4: improving non-motorised infrastructure – improving public space and urban road design for cycling and walking

This solution aims to provide guidelines and common standards on the planning and design of urban roads and public space to balance the need of users (motorised, mechanised and pedestrian).

Planning and design must be based on liveability and quality-of-life objectives in order to balance all claims for use of the local street space. Creating a culture of shared space and tolerance, and also keeping speeds reasonable for the safety and benefit of all those using that public space are keys to success. The impact includes new infrastructure, the use of (new) materials, colour and design to enhance the urban transport environment.

The solution increases the attractiveness of non-motorised transport and helps balance people's choice of travel mode (level playing field approach) by providing a wider choice of modes for their trips.

Figure 8. Munich, Germany (Harald Schiffer)

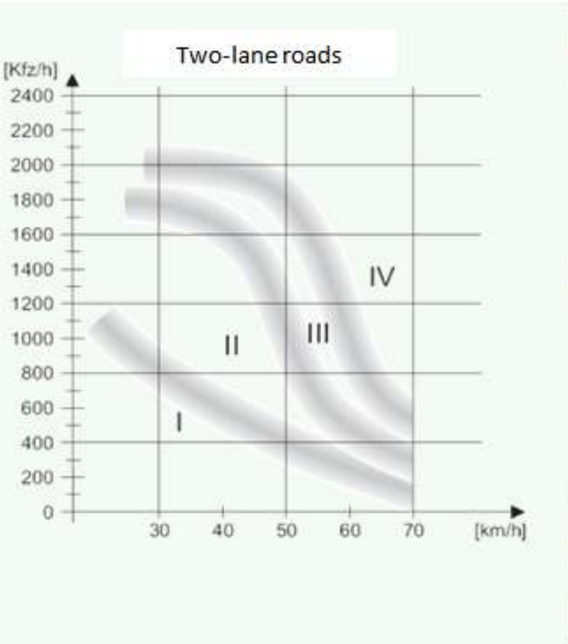
Major barriers for implementation include coordination between interested parties, a lack of capacity to organise them properly at local level, resistance from different modes (and different operators), conflicts between public and private sector interests, and a lack of recognition of vulnerable road users' importance. However these can be overcome; attention to interchange location, design and management is becoming a key success factor for public transport attractiveness.

Examples of successful implementation include the Netherlands, Germany and France (especially when new light rail routes bring public space improvements).

Solution 2.5: cycle infrastructure I - innovative safe cycling infrastructure

This solution helps to increase the modal share of cycling by improving its safety through infrastructure, such as various methods of segregation of cycle lanes from carriageways, lanes using different materials, contraflow lanes, Dutch-style roundabouts, and high and low level cycle signals dealing with left-turning (in the UK, right-turning in Europe) vehicular traffic (the turn that puts the cyclist in vehicles' blind spot and thus at greatest risk).

The measure will result in space being optimally shared between individual/commercial



I	- cycling on the carriageway
II	- advisory cycle lanes which may be used by motor vehicles too, - cycling on the carriageway and shared paths which may be used by cyclists, - cycle paths which may be used by cyclists, - dedicated cycle lanes which may be used by motor vehicles too and and shared paths which may be used by cyclists - advisory cycle lanes which may be used by motor vehicles, too, and existing cycle paths which may be used by cyclists
III / IV	- mandatory cycle lanes which cyclists have to use as well as - mandatory cycle paths

Figure 9: Areas for the pre-selection of suitable forms of cycle facilities types (BAST (2014))

motorised traffic, pedestrians, local public transport and cycle traffic using infrastructure, especially to ensure that speed restrictions and safety concerns are fully satisfied.

Examples of successful implementation include the UK the Netherlands and Germany.

Solution 2.6: cycle Infrastructure II – cycle highways

Cycle highways are part of a cycling network in a municipality or an urban-rural region, linking the major target areas over long distances and consistently providing safe and attractive cycle routes and with high journey speeds.

They help increase the attractiveness of cycling by making crossing a city quicker by increasing cycling speeds in a safe environment, often with better air quality as they are separated from traffic. Other co-benefits include health benefits through increases cycling (fitness).

Some barriers for implementation include lack of knowledge and responsibility at municipal level (e.g. no cycle infrastructure officer). Funding may also not fit with present funding programmes or institutional roles and responsibilities.

Cycle highways can help to shift journeys from motor vehicles to cycles and reduce overall motor vehicle use. They can also be used to revitalise old transport routes such as rail lines, such as in Spain where greenways have been created on unused railway lines. Other examples of cycle highways are in the Netherlands, Denmark, Germany, UK and Spain.

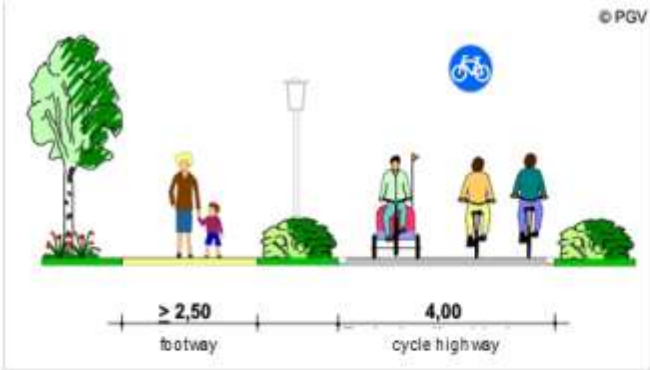


Figure 10. Off-street cycle highway (FGSV (2013))

Solution 2.7: infrastructure for car and bike sharing

The objective of this measure is to make car and bike sharing more attractive by planning and allocating space in highly visible areas of city centres for car and bike sharing stations. Parking spaces may need to be removed in order to do so. The measure increases the opportunity for integrated mobility and reduces the need to own a car in cities.

Some barriers for implementation include:

- The need to remove parking or road space from cars
- resistance from public transport operators if they are not involved in the car or bike schemes
- political or institutional barriers

Brussels (co owned car and bike schemes by the public transport organisation), London, Paris and Berlin are examples of cities that are implementing this measure.

Solution 2.8: pedestrianisation of city centres and streets


Figure 11: Reconstruction of street

This measure aims at improving safety, air quality and the liveability of public spaces.

The measure aims to restrict access of cars and commercial vehicles to areas or roads in a city, allowing public transport, emergency vehicles and deliveries (at certain times). Restrictions can be implemented by infrastructure measures, retracting bollards or electronic devices.

The measure will result in an improvement of the quality of public space, improvement of social inclusion, reduction of noise as well as improvement of local air quality and safety.

Barriers for implementation include lack of political will, poor planning, resistance of uninformed retail owners and commercial actors, a lack of parking in the area, poor communication and stakeholder engagement and poor signage/restriction enforcement

Most major European cities and many market towns and numerous historical cities (especially in Italy) are examples of successful implementation.

4.3.3. Cluster 3: city logistics

While freight is an essential factor for economic activity, it also impacts on the environment, especially in terms of air quality, in particular in cities in emerging countries. More and more attention is being paid to these issues by public authorities and operators, and a variety of new schemes have been experimented to improve city logistics. Three main types of urban freight transport are considered:

1. The delivery and collection of goods for local companies
2. The supply of households, which include individual travel and home delivery and
3. More specific supply chains such as deliveries to public works and building sites, waste handling, maintenance of city networks, postal services etc.

The main focus of Cluster 3 is on ‘city logistics’: effectively acknowledging freight requirements for economic development, while decreasing its environmental and social impacts. This implies decreasing the number of commercial vehicles without increasing other traffic, decreasing commercial vehicles’ emissions (PM, NOx and CO2) and preventing traffic congestion caused by vans and lorries double-parking during delivery. Efficiency in urban logistics is always a compromise between the demand of the economy for freight movement and the limitation of environmental and social impacts. Among the solutions that can be introduced by public authorities are regulations (traffic restriction, low emissions zones), transport pricing and taxes, transport planning and the development of infrastructure dedicated to urban freight (lorry lanes, delivery and loading spaces, urban consolidation centres). Solutions can also be initiated or implemented by private companies, provided that they have a positive return, such as improving their vehicle fuel efficiency, increasing their load factor through the consolidation of urban freight, or improving the efficiency of home deliveries through collective delivery/pick-up depots.

The solutions which are implemented by public authorities mainly aim to reduce the negative impacts of road freight traffic, such as congestion (night deliveries, more use of rail and water) or emissions (low emission zones). Solutions initiated by private operators mainly aim to improve the efficiency of urban logistics (pick up points, cargo cycles). To be sustainable, solutions must comply with both objectives: public authorities and private operators must cooperate to define the best urban freight schemes.

Solution	**Type of impact (avoid, shift or improve)**
Urban deliveries with cargo-cycles	Improve (avoid)
Low Emission Zones (LEZ)	Avoid (improve)
Forums, portals, labels and training programs	Improve
Promotion of off-hour deliveries	Improve (avoid)

Networks of pick up points	Avoid
Larger use of rail and water	Shift (avoid)
Urban Consolidation Centres (UCCs)	Avoid (improve)
Municipal procurement reorganization	Avoid (improve)
Lorry lanes for urban freight transport	Improve
Pricing schemes, taxes and tolls	Improve

Table 4 Overview of selected solutions in the city logistics cluster

Solution 3.1 urban deliveries with cargo-cycles for the last mile

This solution consists of using cycles for deliveries in city centres, where trucks and vans are very slow because of congestion. Bicycles are currently used in many cities for small packages and mail deliveries. For larger volumes of goods and weight (up to 200 kg), tricycles can be used. These cycles often have electric assistance; and can be ridden on normal roads, on bike lanes and even in pedestrian areas (this has to be specifically allowed in local regulations).

Cargo-cycles have clear environmental advantages: they mitigate congestion, pollutant and GHG emissions, and noise. There is also a benefit on employment and on safety. As many initiatives have emerged recently, several cases have been assessed. The use of cargo-cycles generally requires one or several depot(s) in the city centre for the transfer from large vehicles (trucks and trailers) to the cycles for the last mile. These terminals are costly and difficult to accommodate in dense urban areas. Also, for electrically assisted cycles, some legal issues may arise.

The main objective is to avoid adding to congestion, improve productivity and the quality of service. From a public point of view, the objective of mitigating transport externalities (congestion, atmospheric pollution, etc.) by changing from diesel vans and trucks to ‘clean’ cargo-cycles and increasing employment opportunities are also important. Cooperation between the cycle operator and the local administrations is key to the successful implementation of the solution.

This cargo-cycles solution is transferable to major cities, especially to the dense and congested city centres. In Copacabana, Rio de Janeiro, Brazil, where the activity of the many cargo-cycle operators has been assessed by the ‘Associação Transporte Ativo’ (Active Transport Association), the benefit of the cargo cycles was estimated to be important for the economy of the city.

Examples and case studies: Paris, France, there are several cargo cycle companies. Barcelona, Spain the SMILE pilot is developing a viable economic model for operating an off-street transhipment centre that facilitates last-mile delivery and in Donostia/San Sebastian, Spain, a project was developed under the framework of CIVITAS ARCHIMEDES.

Solution 3.2: Low-Emissions Zones (LEZ)

In a low emissions zone (LEZ), access to a certain area (e.g. the city centre) is denied to vehicles which do not meet certain criteria – typically pollutant emissions levels. The LEZs can be very different by their dimension (size), by the type of forbidden vehicles and by the means of control and enforcement. This measure may improve air quality in the exclusion zone, but may also bring with it undesired consequences, for example increased energy consumption and greenhouse gas emissions resulting from longer trips as a consequence of vehicles driving around the zone. This can also lead to higher (re)concentrations of air pollutant emissions outside the zone, affecting the (typically poorer) residents of these areas disproportionately.

The main objective of LEZs is environmental: mitigation of pollutant emissions. The main environmental result is a decrease in particulate matters. The operational costs of LEZs are highly variable according to the type of control and the cost of the changes in the transport market (services and companies), due to the introduction of the LEZ. Its results are very dependent on the efficiency of control and enforcement. The main types of control are video surveillance (London) and 'visual' control by local police (Germany). In Europe, many implementations of LEZs are attributable to violations of the air quality standards prescribed in the EU's Air Quality Directive (96/62/EG).

LEZs' effectiveness is, however, for the most part unproven, partly due to the difficulty in attributing air-quality changes to them alone. A social issue of this solution is that the forbidden vehicles are generally the old ones, mainly belonging to the poor people (cars) or small enterprises. Implementing a LEZ can therefore exclude poorer residents and craftspeople (artisans). When implemented alone, typically LEZs have greater impact upon the fleet composition than on the total traffic volume.

Examples and case studies: LEZs have been widely implemented in Europe (>250 cities/regions), a good overview of which is available at www.lowemissionzones.eu.

The transferability of access restrictions is well known and they have been implemented in many developing and emerging countries. The starting conditions are particularly favourable in Asian cities, as they consistently demonstrate a high interest in reducing local emissions and in environmentally friendly transportation systems. However, as access restrictions have been already implemented in many developing and emerging countries , future activities in this area could indeed focus on the transfer of experience from Asia to Europe or on the integration of already existing schemes into a wider sustainable freight transport policy package.

Solution 3.3: freight forums, information portals, labels and training programmes

Freight forums and portals for sharing experience and information are available on many issues. Many EU research projects on networking cities for improving transport are presented in web portals. For example CIVITAS (www.civitas.eu) is designed to allow cities to learn from each other and facilitate exchange of ideas on green, safe and sustainable transport solutions.

The objective of freight forums, information portals, labels and training programs is knowledge exchange, providing good solutions for cities who do not wish to impose much regulation, but wish to encourage good initiatives, provide incentives for voluntary changes of behaviour and enhance the cooperation between local authorities and urban transport operators

Examples and case studies: Partnership on Good Practices – Toulouse, France (part of the EU SUGAR project http://www.sugarlogistics.eu/pliki/handbook.pdf), Strategic Freight Holders Club in Urban Areas in Norwich, UK.

There are already portals in many parts of the world, like the green freight and logistics program of Clean Air Asia http://cleanairinitiative.org/portal/greenfreightandlogistics, which uses knowledge and partnerships to enable Asia's main cities and national governments to understand problems, identify solutions and implement these effectively. This type of solution can be developed nearly everywhere, for large or specific issues and can be cost effective.

Solution 3.4. pick-up points

Pick up points are secured locations where customers can pick up packages addressed to them (e.g. goods they have bought on the internet). This approach avoids many truck-kilometres and delivery to final customers by reducing the delivery round-distances and by suppressing the need of rescheduling failed deliveries to home addresses. Pick-up points are advantageous for retailers and delivery operators, as well as for customers. There are different kinds of pick up points (parcel lockers, proximity warehouses, convenience stores and local shops serving as networks, etc.).

Customers collect their parcels directly from the pick-up point; in the case of the stores' replenishment in the proximity area, final deliveries can also be done by mean of small vehicles or even with wheelbarrows. The cost of pick up points varies depending on their typology. The use of convenience stores, local shops serving as pick-up points is relatively cheap. However if parcel lockers are needed, some initial investment is required, as well as their management and maintenance and the corresponding technological developments. For example, when the delivery is made, the courier must automatically send an SMS, email, etc. to the final user to announce that the parcel is already in the locker. The customer also needs a password to access to the locker and when the parcel has been picked up, the system automatically sends a message to the transport company.

The main motivation is the reduction of the number of movements and unnecessary deliveries to internet shoppers, which contributes to the reduction of pollution in cities. Pick-up points also have other benefits: they make the supply chain more flexible and increase its efficiency and reliability; time gains for the transporter are clear as there is no need to find the end user and delivery route scheduling are easier as the delivery points are fixed, and finally the parcels can be picked up at any time of the day, increasing customer convenience.

However pick-up points also have some inconveniences: the investment required when constructing a parcel locker is high, especially the infrastructure and information system, loss of direct contact with the customer, and the fact that the Internet consumer needs to pick up the parcel from the pick-up point can be a barrier.

Examples and case studies: Binnenstad service started business in April 2008 in the Dutch city of Nijmegen. This consolidation centre focuses on receivers rather than carriers. After one year already 98 stores joined BSS and this number is still growing. In the Packstation of DHL in Germany, parcels can be received in line with the customers' needs: Packstation system allows the customers to receive and send parcels day and night without the need of waiting for the delivery in person. There are 2,500 Packstations available throughout Germany. Walmart stores in North America have the possibility of working with pick up points: when buying by Internet, the customer has to introduce the zip code, as well as the store pick-up. Some additional information is further needed, for example the email informing the costumer when the parcel is ready for pick-up.

Opportunities and transferability: There are examples of leading cities in Asia (Japan), Europe (France, Germany, UK, Netherlands) and also North America. This solution is transferable to any regions, mainly where e-commerce is developing fast.

Solution 3.5: vehicle and operation regulations on time, weight and size

Weight and size regulations can be enforced by public authorities preventing vehicles of a particular size and weight operating on certain roads. This could also apply to load factors of goods vehicles, but enforcing this last type of regulation is very difficult.

Time regulations can be imposed on goods vehicles in a particular road or urban area, either on vehicle access or on operations (loading and unloading) with two main objectives: to protect residents or to reduce congestion associated with urban freight. These two objectives can be contradictory. Time windows can be implemented to avoid conflicts between residents or tourists on the one hand and freight deliveries on the other. These time windows can lead to traffic congestion in peak hours and to a poor utilisation of vehicles. On the contrary, night deliveries and off-peak hours (combined with low noise delivery equipment) can be an efficient strategy to reduce vehicle-miles and congestion associated with urban freight. Typical times for night deliveries are 22:00 – 06:00. Two types of night regulations may be introduced: (i) time regulations on deliveries and collections to and from a particular building (e.g. retail outlet, office or factory) and (ii) regulations on goods vehicle movement in a part or the whole of an urban area.

Examples and case studies: Dutch cities, NYC, a few other European cities (Dublin, Barcelona, Paris) in a more limited scale.

Opportunities and transferability: Potential take-up cities are large megalopolises with major congestion problems.

Solution 3.6: urban consolidation centres (UCC)

Urban Freight Consolidation Centres are logistics facilities located within or close to urban agglomerations, where separate deliveries are collected in order to enable consolidation of deliveries into the target area: long distance freight can be carried by larger, more efficient trucks or trains and inner-city deliveries by smaller vehicles, using more of their potential capacity. Consolidation centres can lead to reduced delivery times and to a reduction in the total distance of delivery trips, i.e. reduced traffic, emissions, fuel use and noise within the city. They require cooperation,trust between the actors involved and may reduce delivery flexibility and also requires financing for their establishment.

The introduction of this measure should not be limited to environmental considerations (noise, local pollution and CO2 emissions) as it also brings economic advantages, such as reduced delivery times, and lower transport costs. But to date there is not a viable business model, and generally projects are implemented with the help of public subsidies.

Examples and case studies: Urban Consolidation centres have been implemented in many German cities, including Frankfurt, Nuremberg, Berlin and Hamburg, along with London in the UK, Padua in Italy and La Rochelle in France. There is a multitude of evaluations of the many consolidation centre implementations, both ex-ante and ex-post. The majority of these are, however, unreliable. And for those European projects evaluated both ex-ante and ex-post, the promised benefits did not materialise to the extent expected.

Opportunities and transferability: Where both ex-ante and ex-post evaluations have been completed, typically, the centres fail to meet the potential ascribed to them. Possible reasons for this include poor implementation and/or stakeholder resistance. Nevertheless, structural differences between the transport systems in developing and developed cities can also offer new opportunities: logistics concepts which have shown limited success in European agglomerations, such as urban logistics centres, might be effective in other parts of the world, particularly in the Asian region with its much more pressing need to act (GIZ 2010).

Solution 3.7: municipal procurement, delivery reorganization at building level

Procurement decisions have a direct impact on transport, and thus on emissions and congestion. Consolidation of deliveries and working with suppliers to reduce emissions should be a priority for cities. City administrations, for their own supplies, should require environmentally-friendly freight deliveries. This theoretically-simple solution is very rarely implemented. The city can also promote a reorganisation of deliveries within large buildings, including its own. Transport for London, for example, has reorganised its own deliveries, reducing the number of trucks and vans serving its main building.

There are few examples of such a solution: Delivery Servicing Plans in London, projects in Gothenburg, Sweden for clean deliveries in municipal buildings, the Green Link in Paris (delivery of municipal meals to old people's homes with cargo-cycles).

Opportunities and transferability: Potential take-up cities: all of them, to set examples. In practice, cities without severe financial constraints are suited best.

Solution 3.8: rail and waterways for freight deliveries

Increased use of rail and waterways can reduce the number of trucks and vans on the roads in and around urban areas, although generally this must be combined with the use of road vehicles for the final delivery to the consignee.

Two types of rail infrastructure can be used: heavy rail and 'mainly passenger rail' (subways and tramways). For heavy rail, the scheme is the same as for waterways: goods are consolidated in a terminal located outside of the urban area and transported on shuttle trains or barges to an urban distribution terminal. From this urban terminal, goods are transhipped to motor vehicles, preferably low emission ones, for final delivery. Road traffic is reduced according to the distances and to the freight volume involved.

The use of light rail is quite a different option. Tramways offer large capacity, allowing for a decongestion of road infrastructure, without local emissions. But the tram network is rarely suited for freight origins, while the destinations and equipment are not designed for loading and unloading freight.

Figure 12: freight delivery in Utrecht (CIVITAS)

The main objective of public authorities, when trying to boost these non-road modes is to reduce congestion, local pollution and noise from trucks. These benefits need to be offset against increased costs, which may be high as there are numerous management and logistical issues to address. The use of non road-based transport generally implies additional transhipments and a lack of flexibility. In the case of rail, noise emissions can result from freight activities in adjacent communities because of vibrations and also the overlap between the time in which the delivery is made and increase in track maintenance.

Examples and case studies:

- Waterways: in Utrecht (NL), many hotels and restaurants are immediately adjacent to the city's canals and an electrically powered "Beer-boat" delivers beverages and catering products directly from a distribution centre. In Paris, Franprix, a large French grocery retailer, has been supplying 80 stores since September 2012 using a multi-modal transport chain combining trucks and barges.
- Heavy rail: Monoprix, another large French retailer, supplies 90 supermarkets in Paris by train, from an intermodal terminal located 35km south of Paris to a rail terminal located within Paris (Bercy station in the East) and the final deliveries to the supermarkets are made by trucks. Other evaluations carried out for another such project

in the city of Rome show an environmental benefit due to the combined use of rail and clean vehicles for final deliveries.

- Light rail: in Zurich, since 2003, a "Cargotram" provides waste disposal service for bulky refuse around the city. In 2006, an e-tram has been introduced to provide a waste disposal service for electrical and electronic goods. In Dresden, a specific light train using the tramway network connects a Volkswagen logistics centre to a car manufacturing/assembly factory located within the city limits. In Paris, France, the on-going project "Tramfret" looks at using the planned tramway infrastructure, mostly in dense suburban areas, for freight trains.

Opportunities and transferability: The potential gains of implementing a non-road transport solution for urban freight are potentially high if infrastructure (railway, waterway, urban terminals) is available. But, in general, these solutions are costly and some sort of public subsidies are required to cover additional costs, except for niche markets.

Solution 3.9: urban truck lanes

The basic idea of this solution is to introduce truck-only lanes to certain sections of roadway in an urban area. A variation of this solution would allow access to such lanes to other selected types of vehicles, such as busses or high occupancy vehicles, in addition to trucks. Within an urban context, truck lanes may have an impact in reducing traffic delays and improve reliability for goods vehicles on sections of congested urban roads. The following different types of truck lanes exist considering both the exclusive or mixed use of road lanes by goods vehicles:

- Dedicated urban truck lanes – the use of these lanes is restricted to goods vehicles only, which are separated from other traffic through either physical or operational treatments
- No-car lanes – lanes used by both busses and goods vehicles
- High occupancy vehicles lanes – lanes used by buses and cars with specified number of occupants, and certain load factors for goods vehicles.

In addition to the above, bus lanes may also be used, in specific locations, for the (un)loading of goods vehicles but not for travel.

When implemented and operated appropriately, urban truck lanes can increase truck productivity, improve the overall efficiency and safety of the urban transportation system, however insufficient data and lack of experience with their operation make it difficult to accurately determine their impact.

The primary objectives governing the implementation of truck lanes in urban areas can be summarised to the following:

- Reducing congestion, but it is difficult to draw accurate conclusions about how effective and under which circumstances.
- Mitigating impacts of truck traffic, especially in high-truck-volume corridors, by diverting trucks to certain corridors and improving flows.
- Separating trucks from cars, thus improving safety and providing reliability benefits due to reduction in incident-related delay.
- Providing improved travel times and reliability for trucks serving ports and intermodal sites to maintain the economic viability and competitiveness of these facilities.
- Complementing innovative freight-oriented land use strategies (e.g. inland ports or

freight villages). Dedicated truck lanes can be constructed to link facilities such as inland ports to primary port facilities, making operations more economical. However, no research to estimate the degree to which dedicated truck lanes would be beneficial in encouraging these types of freight-oriented land use strategies or on making them more cost effective.

Examples and case studies

- To reduce the effects of the increasing traffic in the commercial centre of Barcelona, the municipality implemented a new street use management scheme. Several multi-functional lanes were used from 8:00 to 10:00 for general or bus traffic, from 10:00 to 17:00 for deliveries, from 17:00 to 21:00 for general or bus traffic and finally from 21:00 to 8:00 for residential car park.
- In an effort to improve traffic conditions and to strengthen commercial transport, Berlin's Senate Department for Urban Development started, in 2004, an initiative focusing on combined lanes i.e. bus lanes extending their use to goods vehicles. The criteria that were considered regarding the use of combined lanes were (i) the high number of trucks on certain roads (more than 2.000 trucks per day and a HGV ratio of more than 5% of all vehicles), (ii) number of busses (less than 200 per direction within the time frame from 6:00 to 18:00), (iii) the high impact on traffic speed during the peak hours and (iv) the existence of bike lanes ensuring their safe movement.
- Padova and other Italian cities also allow goods vehicles to enter bus lanes if they meet environmental requirements (Euro 4, LNG or electric) or if they are part of a "city logistics service". In the latter case, they are recognised by license plate or logo. It is still under discussion whether permits for goods vehicles with high loading factor are legal or not, due to the high uncertainty left by the Italian Road Act.

Urban truck lanes are a solution that can be potentially transferred to other urban areas in the world, if their planning, design, and operation are carefully considered. This solution should be considered as part of wider transport demand management measures and planning.

Solution 3.10: pricing measures for freight

Imposing or modifying taxes and providing subsidies or incentives may have a significant impact on urban freight transport services. Road pricing or fuel taxes will increase the price of urban freight, forcing transport operators to seek alternatives like better consolidation of shipments, to reduce costs, thus addressing major inefficiencies and negative externalities. Subsidies and incentives, provided by local authorities, can also encourage the development of sustainable urban freight distribution operations.

Various forms of taxation policy have been introduced in an attempt to force companies to pay a price close to the marginal social cost. Road pricing is the most promising example of such policies. They are direct charges levied for the use of roads including road tolls, distance or time based fees, congestion charges and charges designed to discourage the use of certain classes of vehicle, fuel sources or more polluting vehicles. Road infrastructure financing and transport demand management are the main objectives governing the implementation of these charges, with the range of approaches including single road pricing (e.g. Norway, France), cordon pricing (e.g. Norway, Italy), network pricing (e.g. Germany) and area pricing (e.g. United Kingdom, Switzerland). While each approach presents advantages and disadvantages, they tend to be selected on the basis of local conditions and political reality rather than economic theories.

The CIVITAS programme has helped provide incentives for city authorities to plan, implement and monitor innovative measures promoting sustainable urban freight distribution across Europe. Otherwise, it is typically difficult to get freight operators, who work on low margins, to spend time and effort working with the public sector in order to achieve city wide objectives such as better air quality.

Road-pricing schemes are primarily used as a means to generate revenue, usually for national road infrastructure (e.g. Norway, France, Germany) or as a transport demand management tool (e.g. United Kingdom, Switzerland) with the objective to reduce peak-hour travel and ease traffic congestion. In many countries, toll roads, toll bridges and toll tunnels are used to repay the long-term debt issued to finance the specific infrastructure, to finance capacity expansion or simply as general income. Road pricing for entering an urban area or pollution charges levied on vehicles with higher tailpipe-emissions are typical schemes implemented to price externalities, with their application being currently limited to a small number of cities and urban roads. Suitable pricing schemes can improve the overall efficiency of urban freight movements and foster the development of more sustainable logistics and distribution strategies. However, in some cases, urban road pricing schemes have proved to be controversial. A number of high profile schemes in the US and UK have been cancelled, delayed or scaled back in response to opposition and protest. Critics maintain that congestion pricing is not equitable, places an economic burden on neighbouring communities, has a negative effect on retail businesses and on economic activity in general, and is “just another tax”.

The opposite of taxation and tolls is the use of incentives to encourage the development of sustainable urban distribution. Direct subsidies by local authorities to transport operators are not widely used in the context of urban freight transport mainly due to budget constraints: the use of indirect subsidies is likely to be the most cost-effective way of encouraging transport operators and their customers to adopt sustainable distribution strategies. Policies such as allowing low or zero emission vehicles, or vehicles operating from Urban Consolidation Centres to be exempt from time window restrictions or congestion charges is likely to be a more effective policy for city authorities than directly investing in urban freight transport operations or infrastructure.

Examples and case studies

- The Norwegian cordon pricing schemes were implemented in the cities of Bergen (1986), Oslo (1990) and Trondheim (1991). All schemes were created to generate revenue, but other indirect benefits were also reported: traffic was reduced by 5% in Oslo while the implementation of the Trondheim Toll Scheme resulted in a 10% decrease in traffic passing the ring in both peak and non-peak hours,
- The Milan Area C was introduced in 2012, replacing the former pollution charge called Ecopass. The objective of this new program is to drastically reduce the chronic congestion in Milan, promote sustainable mobility and public transport and decrease the existing levels of smog that have become unsustainable from the public health point of view. The first results reported indicated a decrease of 32.8% in vehicles entering the area compared to 2011.
- Mileage-based usage fees or distance based charging have been implemented for heavy vehicles based on truck weight and distance travelled in New Zealand (called RUC), Switzerland (LSVA), Germany (LKW-Maut), Austria (Go-Maut), Czech Republic, Slovakia, Poland and in 4 U.S. States i.e. Oregon, New York, Kentucky and New Mexico.
- The CIVITAS programme (http://www.civitas.eu/) provides a good overview of subsidies provided by the European Union to allow city authorities to plan, implement and monitor innovative urban freight distribution measures. However, as indicated earlier, indirect

subsidies prove to be the most cost-effective way of encouraging transport operators and their customers to adopt behaviours that lead to sustainable urban distribution. Examples include exemption from or discounted congestion charges for low and zero emission vehicles in London, allowing vehicles operating from Urban Consolidation Centres to use priority lanes in Norwich and enjoy wider time windows in Bristol and La Rochelle. In Utrecht, low and zero emission vehicles are exempt from time windows and are allowed to use priority lanes.

Opportunities and transferability: Both taxes and subsidies, either direct or indirect, can cause a significant impact on existing urban freight transport operations, encouraging operators to adopt sustainable urban freight distribution strategies. In nearly all large agglomerations, suitable pricing schemes for urban freight transport may yield reliability and travel-time benefits that exceed the cost and foster more sustainable freight services.

4.3.4. Cluster 4: integrated planning and Sustainable Urban Mobility Plans

The need for active participation of all sectors of society in consultation and discussion, relating to sustainable development and the planning of the future of the cities was already formulated in the Brundtland Report in 1987. It was soon recognised that sustainable mobility planning had to complement local Agenda 21 processes to address the impacts of growing traffic in cities.

At the European level several initiatives evolved to promote the broad introduction of sustainable urban mobility planning. Following the Thematic Strategy on the Urban Environment (2006), European cities gathered in the projects BUSTRIP and PILOT to discuss and develop common guidelines, training concepts and outreach strategies. To underline its significance, the European Commission put sustainable urban mobility planning as the first action of the Action Plan on Urban Mobility in 2009. The importance is reiterated in the Transport White Paper 2011, by demanding that "cities should be encouraged to develop Urban Mobility Plans" and examining "the possibility of a mandatory approach for cities of a certain size, according to national standards based on EU guidelines" and thus linking urban mobility plans to regional development and cohesion funds. The 2013 EU Urban Mobility Package puts SUMP at the heart of urban mobility policies and a SUMP coordination platform will steer SUMP activities at the European level.

Key to successful SUMP development is that they must integrate all modes used, they should consider the broader social, environment and economic aspects and they should have a strong participatory nature with a variety of stakeholders, local citizens and key interest groups being consulted.

Sustainable urban mobility planning is a rather diverse process and, although transfer of experiences and good practices exists, take-up in the different parts of the world remains challenging. The European Commission-supported SUMP Guidelines provide European cities and regional/national authorities with guidance for implementing a sustainable urban mobility planning process (http://www.mobilityplans.eu). These guidelines are being adapted to the specific situations in other regions in the world, for example, they are being "tropicalised" by EMBARQ for the Latin-American context. China and the North African countries have also shown interest in transfer of the guidelines.

SOLUTIONS for	Type of impact (avoid, shift or improve)

General preparation of SUMP	Avoid, Shift, Improve
Vision building for future sustainable urban mobility	Avoid, Shift, Improve
Participation (Involving stakeholders and engaging citizens)	Avoid, Shift, Improve
Participatory budgeting in SUMP context	Avoid, Shift, Improve
SUMP audit schemes and quality management	Avoid, Shift, Improve
Measure / measures package selection strategies	Avoid, Shift, Improve
Monitoring and evaluation of SUMP	Avoid, Shift, Improve
Modelling and visualisation tools in SUMP	Avoid, Shift, Improve
SUMP framework conditions	Avoid, Shift, Improve
Capacity building and training schemes in SUMP	Avoid, Shift, Improve
Engaging external support for SUMP development	Avoid, Shift, Improve

Table 5: Overview of selected solutions in the integrated planning and SUMP cluster

Solution 4.1: general preparation of a SUMP

The objective is to create a comprehensive basis for long-term mobility planning in an urbanised area. A Sustainable Urban Mobility Plan (SUMP) is applied for the entire urban area (including peri-urban/urbanised region).

Sound sustainable urban mobility planning has an overall impact on the quality of life. A more efficient transport system raises the attractiveness of the city for investments. It will integrate the urban with the peri-urban area and will create efficient urban network modes, such as TEN-T nodes. Sound planning improves safety and security for travellers and road users. Transport and mobility related investments and implementations receive high level of political and public support.

SUMPs will reduce and even avoid traffic, shift towards the use of sustainable modes and improve the different modes of transport. The drivers for successful SUMPs are existing experiences in improving the transport system in cities, political will of decision-makers, central funding mechanisms, synergies and optimisation of administrative processes, competitiveness of the urban area, public initiative, and legitimisation of infrastructure projects and decisions.

Barriers for implementing an SUMP are lack of capacities, lack of political support, silo thinking of transport professionals and decision-makers with a traditional planning culture, lack of resources, and the absence of legal, regulatory or monetary requirements.

In Europe, some countries adopted comprehensive transport planning policies to guide cities developing and implementing such plans at an early stage. In France since 1982, urban transport plans (plans de déplacements urbains, PDU) have been compulsory for cities larger than 100,000 inhabitants. The objective of the PDU is to ensure a balance between the transport needs of people, environmental protection and health aspects. PDUs usually span a period of 5-10 years, followed by revision and formulation of a new PDU.

In England, local transport plans (LTP) are statutory plans deriving from the Transport Act 2000. They outline the current baseline regarding transport, accessibility and environment, define challenging but achievable objectives, develop a programme for achieving these objectives, and outline funding requirements to be put forward to the national authorities.

Other successful examples (among others): France (Nantes, Lille), UK (Leeds), Sweden

(Lund), Denmark (Aalborg), Belgium (Gent) and Germany (Aachen).

Projects are CIVITAS, CH4LLENGE, BUMP, ENDURANCE; Quest, ADVANCE, ECOMOBILITYSHIFT, PILOT, BUSTRIP, TIDE and PUMAS.

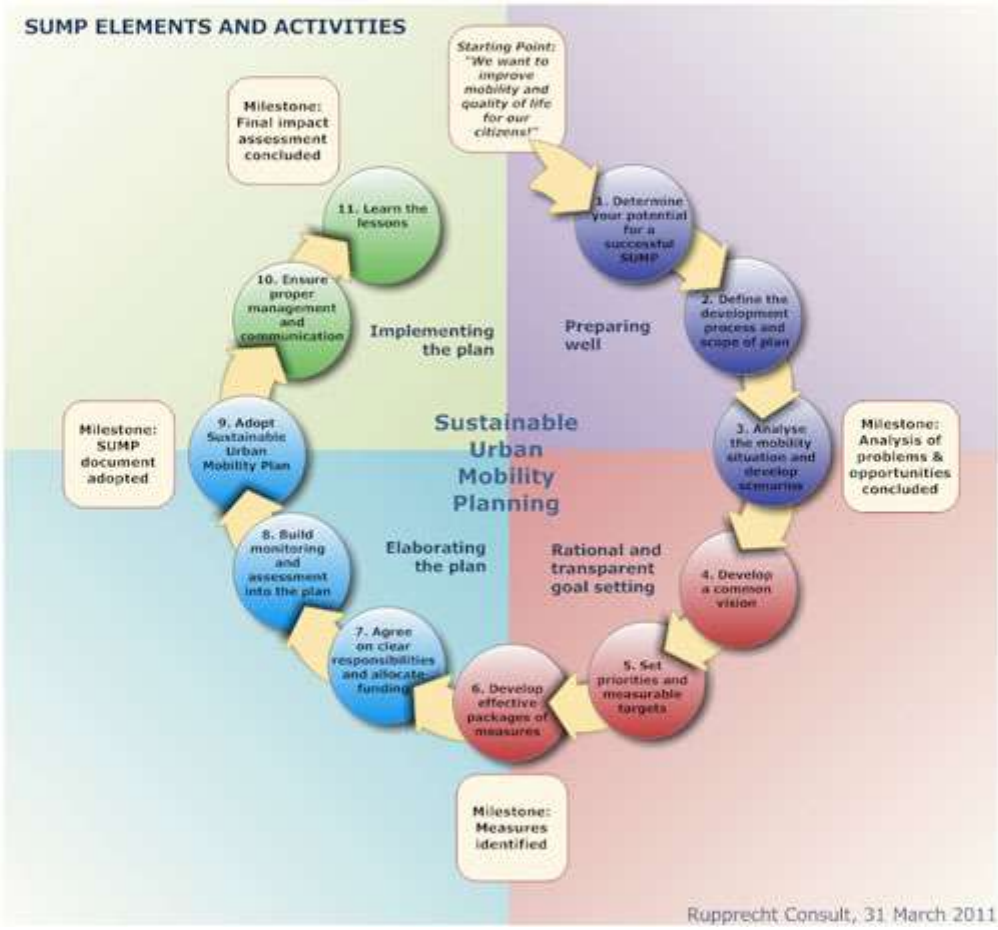


Figure 13: SUMP cycle

Solution 4.2: vision-building for future sustainable urban mobility

Quality of life is a core aspect of our society, especially when considering 'what kind of city do we want to live in?". Citizens are concerned with air quality, road safety and accessibility within their city. They aim for a balance of economic, ecological and social aspects with a long-term perspective.

Citizens increasingly identify themselves with their urban mobility system and want to participate in its future direction. Involving citizens helps to formulate concrete objectives and targets.

The scope of vision building is to define the goals for urban transport/mobility system in a city and its metropolitan region. It can be an efficient marketing tool for innovative transport and mobility measures. Well formulated, a vision has positive impacts on economic growth and jobs and the achievement of a city's climate targets.

Good visualisation and communication to the public supports broad acceptance of a sustainable mobility vision. Experience has shown that high-level political support is often necessary to kick-off an innovative process.

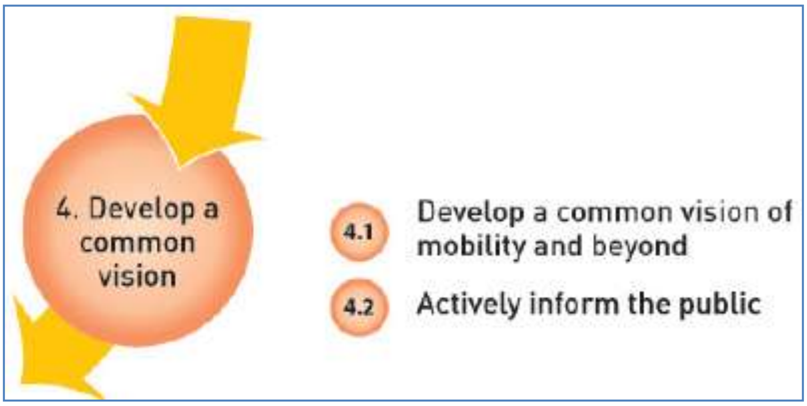


Figure 14: SUMP Guidelines

Barriers for vision building are short-term thinking amongst decision-makers (decisions often depend on electoral cycles). There is confusion about the differences between objectives, targets and measures, and high level objectives are often badly communicated.

Good examples are offered by West Yorkshire (UK), Copenhagen cycling capital, London's Vision 2020 – the Mayor's ambition is to make London the best place to work, live, play, study, invest, and do business – Stockholm, Fossil FUEL Free City by 2050, and the Bogota 8-80 vision.

Solution 4.3: participation (involving stakeholders and engaging citizens)

Stakeholder involvement and citizen engagement is a key component of sound sustainable urban mobility planning. The planning-cycle requires well-structured involvement of the relevant stakeholders throughout key stages of the process. The involvement of citizens seeks to ensure a broad acceptance of transport and mobility measures.

The scope for the participation strategy is city-wide but also geographically delimited areas of the city. The participation of actors from beyond city boundaries is equally relevant. Involving different government sectors helps to work across administrative boundaries.

Participation of stakeholders and citizens ensures better legitimacy for implementing urban transport and mobility measures. Capturing local knowledge ensures a sound decision making basis with resource efficient implementation.

Many stakeholders already have experiences with Local Agenda 21 processes and are familiar with consultative and participatory processes. The successful participation of citizens depends on the appropriate selection strategy of citizens in order to have a representative group.

A lack of interest of citizens and stakeholders in being involved in workshops and round-tables is a major barrier, or getting the right parties involved (local activists can use these process to bend policies to their own agendas rather than for the public good). In turn, unfavourable conditions imposed by decision-makers lower the interest in participation. Certain stakeholder groups may oppose proposed changes and boycott a participatory process. Especially urban freight stakeholders are often difficult to engage in a planning process.

Practical examples are Bath (UK), Gent (BE), round-tables with stakeholders in Berlin, Dresden and Aachen (DE), Barcelona's social pact and Bremen's (DE) planning application.

The projects GUIDEMAPS, ELTIS Plus, Fiets van Troje, and CH4LLENGE have particularly addressed participation in the planning process.

Solution 4.4: participatory budgeting (PB) in SUMP context

Participatory budgeting (PB) is a process of democratic participation in decision-making in which citizens decide how to prioritise and allocate part of a municipal or public budget.

Participatory budgeting allows citizens to identify, discuss, and prioritize public spending projects, and allows them to participate in real decisions about how resources are spent.

Participatory budgeting was first implemented in 1989 in Porto Alegre City (Brazil) and is a leading case study in the world. The Federal Constitution paved the way for implementing participatory budgeting, establishing the democratic basis for resident-participation.

The process of participatory budgeting is quite simple, and yet complex, with three major steps: the Preparatory Meetings, the Regional and Thematic Assemblies, and the Municipal Assembly.

Preparatory annual meetings are hold at subareas of the metropolitan region; during these meetings citizens debate the municipal Investments Plan, the Accounts provided by City Government from the previous year's work, and it will determine who will run for the Participatory Budgeting Council.

In Regional and Thematic Assemblies, the Thematic Priorities for their Region and for the City are decided. For example, in Porto Alegre, the six themes are: 1) mobility and transportation, 2) culture, 3) economic development, taxes tourism and labour, 4) education, sports and leisure, 5) city organisation, urban and environmental development, and 6) health and social assistance. At the regional level, local priorities can be set, councillors are elected, and the number of delegates determined. Decision-makers actively consult the community and answer their questions.

PB is one of the few experiences in the world that really connects Local Government to citizens. Due to the process of analysing the City Budget, people get to know more about political organisation, tax division, and the problems and challenges faced by the local authorities. In addition, citizens become aware of their rights as well as their responsibilities, working together with the government to meet common goals. Participatory budgeting helps prioritise strategies and measures identified in the sustainable urban mobility and transport planning process. The challenge is to involve disadvantaged sectors of society in the process.

PB is already applied in many Brazilian cities, not only in the transport sector. The concept has spread across Latin America, as well as in cities in France, Italy, Germany and Spain.

Solution 4.5: SUMP audit schemes and quality management

The SUMP audit and quality management schemes funded through European projects provide an assessment (snapshot) of the current situation of urban transport policies and their implementation. They envisage concrete improvements to the current planning processes, implementation processes and urban-transport measures selected. The audit and quality management schemes aim at increasing local capacity of transport related staff in public services and at involving stakeholders.

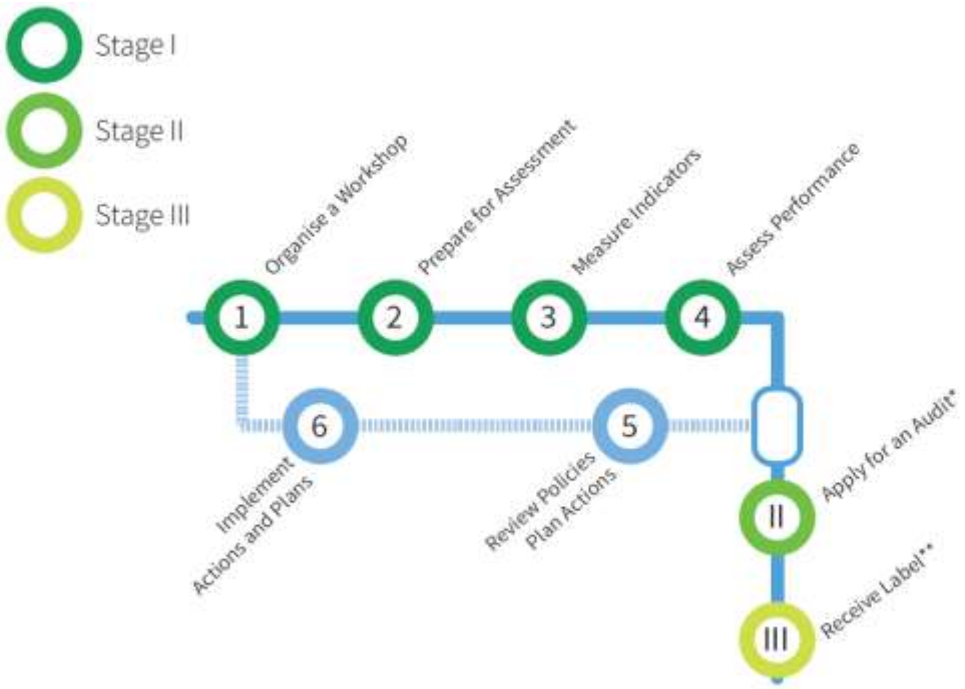


Figure 15: audit scheme of ecomobilityshift

The audit and quality management schemes include elements of auditing (assessing the current situation against a list of indicators), self-assessment (local stakeholders are involved by evaluating the current situation) and action planning (providing solutions to remediate ongoing problems per modal network, in these networks' inter-linkages and in the organisational set-up within the city services).

To a degree, the audit schemes can help to compare the mobility situation in cities and relate to benchmarking activities. The methodologies provide short practical processes that can be concluded within two to three months. In requires the involvement of a trained auditor.

Impacts: after going through an audit and quality management process, public service officials and political decision-makers will have a view of the current status of urban mobility, on fields that require improvement, and on quick-win actions and longer term actions to improve urban transport policies. Local stakeholders will be better informed about urban transport policies and are involved in the decision making.

The main driver is the cities' will to change its urban transport policies. The involvement of local stakeholders creates ownership and legitimation for future action. A trustworthy, local language auditor can create local momentum for change.

The main barrier is the lack of available data which can hamper the audit. Limited experience in stakeholder involvement can create problems in the self-assessment procedure; limiting the quality management scheme to a one-time application will not help. Quality management requires a cyclical approach. The implementation of improvement actions should be followed by actions and by a re-assessment based upon the newly created situation.

The QUEST (www.quest-project.eu) and ADVANCE (audit schemes) projects have successfully involved up to 100 European cities. The ECO-Mobility Shift project (www.ecomobility-shift.org) also engaged in similar activities.

Solution 4.6: measure/measure-package selection strategies

Implementing innovative transport and mobility measures is the ultimate goal of a sustainable urban mobility plan. Part of the planning cycle is to identify suitable measures and establish mutually-reinforcing packages of measures for better economies of scale.

The solution seeks to get an overview of different options that contribute to the vision, objectives and targets of the overall SUMP. Measures and measure packages are implemented within the framework of the plan and have a high acceptance of stakeholders and citizens. It is the basis for decision-making for implementation of transport and mobility measures.

The impact of this solution is the final agreements on the transport and mobility measures to be implemented in the city. The solution is supported through available appropriate tools for measure selection. Experiences and tools for structured measure selection strategies are still limited. Lack of expertise and capacities in this area limits the possibility for structured transfer.

One of the successful case examples is the measure generator, developed by ITS Leeds (www.konsult.leeds.ac.uk/).

Project examples are CH4LLENGE (www.ch4llenge.eu) and CIVITAS (www.civitas.eu).

Solution 4.7: monitoring and evaluation of SUMP

Monitoring and evaluation is a condition for a successful sustainable urban mobility planning cycle. This solution helps to build a suitable monitoring and evaluation arrangement into the SUMP for evaluating the various steps of implementing the plan. Evaluation and monitoring is applied to various steps, such as the vision building, participation, measure selection and implementation, as well as the assessment of the entire plan. It also helps to identify barriers and drivers for measure design and implementation.

The solution employs a wider range of evaluation methodologies, such as impact and process evaluation, allowing the quantification of high level objectives such as climate change or quality of life, as well as specific objectives, such as change in modal split or cost benefit of measures. Measuring progress will help to ‘lift’ the plan to a higher level.

A clear understanding of the necessity of monitoring and evaluation is a prerequisite for assigning resources to such tasks. Access to evaluation expertise, for example through local academic organisations offering such services helps the implementation.

In turn, monitoring and evaluation is often seen as the lowest priority in the mobility planning process. Lack of expertise, lack of structured data and lack of quantified objectives and targets obstruct the evaluation of measures, processes and planning.

Successful examples were demonstrated by Toulouse (FR), Dresden (DE), West Yorkshire (UK) and Gent (BE). Reference projects are CH4LLENGE, CIVITAS, QUEST and ENDURANCE.

Solution 4.8: modelling and visualisation tools in SUMP

This solution supports the acquisition of mobility-relevant data and provides tools for visualising scenarios and planning options. Elaborating scenarios for planning strategies supports participatory decision making.

Modelling and visualisation can be applied at various levels:

* Macro-level for entire city;
* Meso-level for mobility corridors; and
* Micro-level for specific infrastructure design.

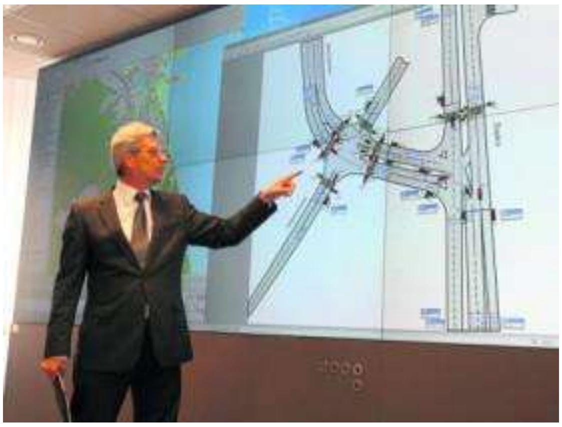


Figure 16: Tristar in Gdynia (Poland)

Modelling generates structured information for defining strategies. It is a decision-support system for measure planning and provides planning options to stakeholders.

Applying visualisation tools in SUMP requires specific technical expertise. The experts need to have good knowledge of the advantages and limitation of tools (software). Modelling software solutions for traffic planning are widely applied and proven. However, as with all models – if the quality of the information entered is not high, the results can be misleading.

Barriers are the lack of understanding of modelling in the context of mobility planning. Modellers often follow a technocratic approach and have exclusive focus on the engineering part of tools.

Examples in modelling have been applied in Gdynia (PL) TRISTAR and Aachen (DE).

Solution 4.9: SUMP framework conditions

Sustainable urban mobility planning is embedded in a wider legal, economic and social context. This measure highlights framework conditions which facilitate and support the SUMP process. In turn, it helps to overcome legal barriers and harmonises them for more efficient planning.

The scope of this measure is to assess legal aspects as well as economic, social and environmental conditions. It puts the conditions into the planning context to immediately identify barriers and drivers of SUMP implementation. Framework conditions are determined at local, regional and national levels, thus the involvement of actors from the various levels is required at the planning stages.

The impact of this measure is a sound legal and financial basis of SUMP.

SUMP is supported through a clear national policy framework and conditionality. European guidelines help national authorities formulate conditions at the national level. Six countries (France, Germany, Italy, Netherlands, Norway, the UK and the region of Flanders in Belgium) have legal definitions of a SUMP, and have national guidelines. However many countries in Europe have inadequate or no national guidance and regulation for an SUMP process.

Examples can be found in the guidelines for preparing PDUs (Plan de Déplacements Urbains) in France and LTPs (Local Transport Plans) in the UK, which have served as examples for the SUMP guidelines (http://www.mobilityplans.eu/). In 2012, Aberdeen City Council won the first annual EU SUMP award, which focused on stakeholder and citizen participation. Aberdeen was recognised for its inventive use of surveys, open workshops, and a strong social media campaign, which allowed citizens and stakeholders to directly engage with and contribute to the SUMP.

Solution 4.10: capacity building and training schemes in SUMP

A sustainable urban mobility planning process requires transport professionals with profound expertise in the planning process. This solution helps to build capacities of transport professionals in starting and implementing a SUMP process. Capacity building helps to inform politicians and decision-makers of the benefits and advantages of SUMP for the city.

Figure 17: AENEAS training workshop

The scope of this solution is across local/regional government institutions, but also service providers who actually develop and implement SUMP. As a result of this solution, transport professionals will know how to start and apply a SUMP and local authorities will have increased capacity for outsourcing tasks (such as the preparation of terms of reference).

Planning expertise is usually available in local and regional administrations. Capacity building can advance this expertise through courses and peer to peer exchange. It is advantageous if education and research institutions providing such services exist in the city.

The barrier for capacity building is often the classical engineering focus of planners and their unwillingness to 'look beyond borders'.

Reference projects are DYN@MO Baltic SUMP competence centre, SUMP capacity building under ELTIS, and SUTP of GIZ in Asia.

Solution 4.11: engaging external support for SUMP development

Local authorities usually have to engage in external expertise for a sustainable urban mobility plan. This solution provides support to local and regional authorities in the tendering and outsourcing of the plan and/or planning steps. It will provide answers to the question of who is doing what in the planning process.

The impact of this solution is the actual development and implementation of SUMP in a city. Local and regional administrations have experience in outsourcing services to external suppliers and service providers.

There is the risk of engaging tenderers with a rather technocratic approach without looking at the required aspects of SUMP. To date, there are only scattered standards on tendering procedures and documentation for SUMP.

Examples are the preparation of PDUs in France, LTPs in UK, Verkehrsentwicklungspläne in Germany, but also planning experience in Brazilian cities.

4.3.5. Cluster 5: network and mobility management

Cluster 5 addresses in general, measures in the areas of parking management, access management, traffic and mobility management and control, traffic information and journey planning systems, cooperative intelligent transport systems (C-ITS) and pricing policies.

Specific emphasis is placed on technological and institutional challenges, and barriers for implementation. The main goal is to provide examples of successful deployment in European Cities and lessons-learnt. The objective of the aforementioned areas for technical and planning measures is to ensure seamless transport, connectivity, more flexible travel, lower environmental impact and support of multimodal mobility behaviour and lifestyles.

Measures analysed in this cluster try to make the best use of available resources in cities and city regions, and help plan and implement additional measures. It is important to ensure that multiple mobility options in urban environments are provided, and not unduly restricted e.g. unavoidable car trips. However, these mobility options should be carried out in a more intelligent way, while considering advantages and disadvantages of different transport modes and the increasing mobility demand in cities and city regions. Network and mobility management has in recent years been in the focus of a number of EU-funded research and coordination projects. Some of them were carried out with international participation such as SIMBA, VIAJEO, NICHES/+ and STADIUM. These projects are already aimed at knowledge transfer and exchange of best practices in network and mobility management applications and planning measures with Asia, Latin America and Africa.

Information and data exchange is the key component for all planning measures in this cluster. Although large volumes of data are collected over the transport network, including data on moving individuals, transferring it into relevant information, making it available and sharing it among particular user-groups is still a major challenge. At the moment, two competing deployment strategies are under debate: open data or big data concepts. Both approaches offer particular advantages and disadvantages. Open data concepts allow a manifold of innovative, low-cost applications, provided by the private sector. However, absent standardisation may limit the scope, coverage and interoperability of these systems. Big-data strategies, on the other hand, allow better coordination and control over data ownership and responsibility of large public providers. This strategy allows the use of data more systematically for traffic and mobility management, and, in particular, traffic control. Privacy and personal security issues are, in both concepts, a major concern, especially with individual and location-based data. They represent a high-value data format for private as well as public sector data providers, but at the same time represent an exceptional surveillance technology.

The speed and uncertainty of technological progress in this area often leads to situations where the involved actor groups lag behind the current state-of-the-art technologies and find themselves often confronted with new realities and actor groups not yet considered. The fast dispersion of smartphone technology may serve as example. In a very brief time, everybody has the chance to become both a data provider and data consumer, or even co-develop service applications by participating in social networks parallel to commercial offers. This multiplicity of options offers cities and city regions a wide range of novel solutions.

SOLUTIONS for	Type of impact (avoid, shift or improve)
Parking Management	Avoid (Shift)
Access Restriction	Avoid (Shift)
Traffic Management	Improve (Shift)
Multimodal Journey Planner	Improve (Shift)
Cooperative ITS (C-ITS)	Improve (Shift)
Car- and Bike-Sharing	Avoid (Shift)

Table 6: overview of selected solutions in the network and mobility management cluster

Solution 5.1: parking management

Parking management, particularly in densely populated city areas is increasing in importance. Growing and shrinking cities and districts in European member states are very often relatively close to each other, allowing for daily commuting from one centre to the other. This emerging type of urban structure, called central/city region, is different from urban sprawl structures in other regions.

In growing districts within the city these regions, in particular the inner city areas, parking stress is heavily increasing, due to the growing number of daily commuters, shopping and leisure visitors. Also, parking-capacity shortage is driven by increasing populations living in attractive inner city districts, further densifying these districts.

Inner-city and surrounding areas in growing city regions are of high interest for real estate investment and urban development measures. This can be observed in Europe and worldwide. Attractive districts are being gentrified, thus an increasing number of inhabitants or households living in these areas can afford a car, for use at least on weekends and for non-routine trips during the week. In very attractive inner city centres the number of apartments for high-income groups is increasing – groups who rarely use public transport. Middle-class income groups are increasingly using public transport for most routine trips, but often still own at least one car per household for occasional use. All these trends lead to the situation that, in most attractive inner-city districts, insufficient parking is available, even for all the residents.

Policy and planning objectives vary among city and city regions in Europe; strategies to tackle the aforementioned problems and trends are manifold. One strategy is to increase parking supply; new or retrofitted buildings must include parking space for residents, in most cases underground. In old buildings, e.g. those constructed before the introduction of cars, ground floor apartments can be converted to parking spaces. However, this strategy is contentious as it diminishes housing capacity. Its costs are high due to the exhaust systems necessary for cars in apartment buildings. Another strategy is to reduce parking demand by planning and investing in car-free areas. One prominent example in Europe is the Vauban Quarter in Freiburg in Germany, www.vauban.de.

Policy and planning solutions in European cities for residential parking range from motivating residents to park their cars outside dense districts and not next to their apartment with pricing schemes. Parking options – easily accessed by public transport – at the periphery are offered for much lower fees than taxes on residential parking in dense areas. A consistent urban planning concept might, for example, ban residential parking in inner-city districts and establish a public transport system so no residence more than 15min from stop.

Policy and planning solutions for commuter parking in European cities are mainly heading to channel commuters into publicly or privately managed parking facilities rather than allowing parking in public spaces. Parking space management is expensive, a fact now widely accepted by the public, and thus the willingness to pay for parking has increased. There are even concepts involving differentiating prices for parking during weekdays, weeknights and weekends. There are already examples for this parking management strategy in the US; in Europe there are still legal concerns with this strategy.

In very many in larger city regions it is still more attractive to travel by car than by public transport. Commuting by public transport often takes more than double the time than by car. Although public transport interchanges are getting more seamless and thus travelling times are dropping, it is unrealistic for public transport to provide the same service as individual cars. Similar access management, parking management and pricing schemes aim to encourage users to take intermodal trips and leave their car at park and ride facilities, and use it for first and last mile trips in less dense areas.

Figure 18: parking management in Palma

Parking management strategies are primarily implemented by city governments. Within city regions, policy coordination among the local governments is crucial. To implement novel parking management schemes, local administrative practices have to change. Parking management schemes cannot, for example, be successful if enforcement strategies are absent. On the other hand, easy access options to buy parking tickets must be provided, for example, by smart phone payment systems.

The implementation of new parking management schemes is not a matter of technological change alone, but also of institutional change, and a significant change of current practices. Parking management strategies and their potential benefits require changing zoning and planning practices as well as changes in organizational and institutional frameworks (such as TDM Programs).

A variety of parking management strategies and solutions have been implemented in European cities as well as in cities worldwide. A good summary of these strategies can be obtained at the following web link: http://www.vtpi.org/tdm/tdm72.htm. Examples of EU projects addressing these issues are the EU-funded projects MOBILIS (http://www.civitas.eu/content/mobilis), ELAN (http://www.civitas.eu/content/elan and CARAVEL (http://www.civitas-caravel.org/)

Solution 5.2: access restriction

Urban access restriction management strategies aim to “restrict and enable” access to city districts or network intersections. These strategies allow congestion and parking stress to be reduced, and can improve traffic safety and network operation. The most far-ranging strategies for access restriction involve allowing entry for individual vehicles, booked in advance, such as in Bergamo and Rome in Italy. Alternatively, entry may be granted to holders of passes e.g. tags on number plates. See also Solution 6.8.

Access restriction schemes (ARS) can be classified in the following 4 types:

Point based access systems (e.g. restriction to cross a bridge or enter a section of the city); charging may differ with vehicle type and vary with time of day.

Cordon based access system: a restriction is applied to crossing a particular cordon, and may vary with time of day, direction of travel, vehicle type and location on the cordon. There could be a number of cordons with different access rules and charging schemes.

Area license or area charging: a restriction is applied for driving within a particular area during a period of time. Access and charging rules may vary with time and vehicle type.

Distance or time based charging: is essentially a restriction based upon charging for the distance or time a vehicle travels along a corridor or in a specific area and may vary with vehicle type, location and travel time. A specific vision is the allocation of network kilometres per user, e.g. with prepayment systems or equal quota per user.

An current European study on urban access restriction and management schemes (http://www.accessrestriction.eu/doc/finalreport/2010_12_ars_final_report.pdf) provides an extensive overview on ARS schemes in Europe. Research carried out in this study led to the identification of 417 European cities which have implemented such schemes.

Figure 19: access restriction in Florence

A large number of access restriction management schemes have been introduced, tested and implemented in European cities and city regions in the past years. One of the most well-known and heavily debated earlier system was the access restriction scheme in Athens, Greece. This scheme was not very successful and had several unintended side effects. Many exemptions had to be made and public debate pointed out inequality due high-income households being able to circumvent the restrictions.

Most access management schemes today are based on road user charging. However, regulatory access restriction schemes are still viable for environmentally-driven access restriction, if, for example critical values for particulate matter or NOx emissions are exceeded. In the Netherlands, a scheme to restrict access of vintage cars has been introduced, while in Switzerland, a quota on the number of heavy trucks allowed on the national road network will be introduced in 2020. Green-corridor concepts foresee intersections where access can be restricted based on environmental factors. However, there are institutional barriers to such concepts at the European level.

Several urban congestion and area charging schemes implemented in European cities in the past years have been successful, especially those following a transport-demand management approach. They have generated significant benefits including increased network reliability, reduced delays in travel times and reduced congestion and related environmental impacts. Examples:

- The Norwegian cordon pricing schemes implemented in the cities of Bergen (1986), Oslo (1990) and Trondheim (1991). All schemes were created for generating revenue but other indirect benefits were also reported. More specifically, traffic was reduced by 5% in Oslo, 10% in Trondheim.

- The London congestion charging scheme was introduced in 2003. Operated on behalf of the urban authority by a private company. Since its implementation, traffic entering the zone has decreased by 18%, delays by 30%.

- Following the example of London, the Stockholm congestion charging scheme was adopted in 2007 with the objective of reducing traffic to and from the city by 10-15% during peak hours, increase the level of access to Stockholm city and reduce emissions. Since its implementation, light goods vehicle traffic has reduced by 22%, heavy goods vehicle traffic declined more than 10%. Today there is 20% less traffic in and out of inner city during peak hours, 10-14% less emissions and 30% lower travelling times.

- The Milan area charging scheme was introduced in 2012 replacing a former pollution charging scheme, Ecopass. The objective of the new scheme is to drastically reduce chronic traffic congestion and the number of days particulate matter and NOx exceed critical values. The first results reported a decrease of 32.8% in vehicles entering the area compared to 2011.

Similar to parking management, decisions on access restriction schemes are very political. Therefore policy implementation is very dependent on appropriate windows of political opportunity. There is typically much resistance to congestion or area charging, citing negative economic effects, in particular for retail businesses and for economic activity in general. For most of the cases listed above there are convincing narratives on institutional barriers and political constraints. For example, the Major of London who introduced the congestion charging scheme, Ken Livingstone, later confessed that he had a very hard time introducing congestion charging in London’s city centre. Most political advisers were fully convinced that he would risk his re-election with this initiative. Milan’s city government spent much time in court to fight legal action by a large private parking facility operator. But in most cases like London, Milan and Stockholm, public opinion was in favour of congestion or area charging schemes.

Solution 5.3: traffic management

Figure 20: traffic management in Palma

Traffic management and control has the goal of maximising the effectiveness of existing infrastructure, ensuring reliable and safe transport, addressing environmental goals and ensuring fair allocation of infrastructure space to users. This covers planning and preparing for expected traffic volumes, continuous monitoring and, if necessary, taking corrective measures by directly influencing traffic.

Common barriers include existing planning and funding practices that favour capacity expansion over demand management (even when it is more cost effective and beneficial overall), institutional and political opposition to change and resistance from special-interest groups that benefit from existing inefficiencies. There is a wide variety of traffic management measures being implemented in European. Examples of projects addressing these issues are MIMOSA (http://www.civitas-mimosa.eu/main/) and Easyway (http://www.easyway-its.eu/).

Solution 5.4: multimodal journey planner

Multimodal journey and mobility planning apps can be considered transport-related ICT, allowing users to plan and monitor their trips.

The speed of innovation in this field is very fast. Large companies and investors like Google and others are driving innovation and generating location-based data. This data is valuable in gaining consumer profiles and in order to personalise marketing. Although this data is very sensitive regarding privacy and surveillance aspects, as most users have to share their data.

Figure 21: SUPERHUB project

Personal travelling companions are available as mobile applications, facilitating personalised travelling information, including different transport modes and other information like accommodation or restaurant opportunities along the route. This additional information may not be relevant for all travellers, but is good business for the provider, who charges hotels and restaurants for providing their service. Mobile apps can provide personalised travel suggestions, offering a wide range of transport alternatives and, in case of delays or disruptions, provide alternative routes. These companions can encourage the use of climate friendly modes by informing users on their carbon footprint or even facilitating rewards.

Many cities in Europe have already introduced comprehensive multi-modal journey and mobility planning systems that cover either the city or the city region. The 'Destineo' journey planner (www.destineo.fr) was first created as a co-financed European ITISS project in late 2004 in partnership with the Pays de la Loire Regional Council and the local transport authorities. The first version of the Destineo system was brought into service in September 2006. The Destineo journey planner is available as website and mobile application, providing a multi-modal journey planner with real-time traffic information, a journey time and cost calculator, information about all modes of transport, timetable search and visual maps. The site also displays information on accommodation and restaurants. The service is also accessible to partially-sighted and non-sighted users via a braille keyboard or synthetic voice reader.

Many other examples of comprehensive multi-modal journey planning services can be given, i.e. from Sweden (www.trafiken.nu) of from Austria (www.anachb.at).

There are two approaches regarding the implementation of multimodal journey planning systems; large systems approaches (big data) and open data. Large systems approaches have been commissioned by cities or city regions, e.g. Lyon (France) or Torino (Italy) or nationally in the Czech Republic or Austria. There is, however, a trend towards the open data strategy (http://www.posse-openits.eu/en/). Data owners (city governments, network and fleet operators, service providers etc.) provide data in a standardized data exchange format so it can be used by private sector companies to develop applications.

In both cases there must be good cooperation between all actors involved. This cooperation is easier to achieve in cities or city regions where data owners are public companies closely related to city governments.

Solution 5.5: Cooperative Intelligent Transport Systems (C-ITS)

The term Cooperative Intelligent Transport Systems (C-ITS) is a term for the next-generation of Intelligent Transport Systems (ITS). The deployment of new transmission technologies like wireless (WIFI), near field communication (NFC) in the past years, as well in satellite-based and other location systems are improving the possibilities offered by intelligent or smart transport systems.

C-ITS can be implemented at the local, regional, the national and international level. Such systems allow constant tracking and tracing of freight, enhancing GPS-based road user charging and, most significantly, are set to shortly allow semi-automated autonomous driving. Currently in the USA, the use of autonomous driving systems has been proposed on large and heavily congested radial roads. However, such systems are still very costly because of the requisite combination of satellite, infrastructure, car-side sensors and positioning systems.

Institutional barriers are the main reason why this technology is not being taken up faster. In Europe, legislation is concerned with liability issues.

Several projects address development and testing of such C-ITS systems in Europe, (e.g. EasyWay (http://www.easyway-its.eu/, Conduits (http://www.conduits.eu/) and SARTRE (www.sartre-project.eu). In the future (10-20 year), it may be feasible, probably only on particular intersections, such systems be active.

Solution 5.6: car-sharing and bike-sharing

Car sharing is a model of car rental for shorter periods than typical at conventional car-rental, called car clubs in some countries (UK). It allows car use without ownership. According to the Transportation Sustainability Research Center at U.C. Berkeley, as of December 2012, there were an estimated 1.7m car-sharing members and users in 27 countries worldwide, including so-called peer-to-peer services.

Figure 22: cambio car-sharing

In most European countries, early car sharing schemes in the 1990s started from grassroots movements. With the fast growth of car sharing initiatives in the first years they started to organize themselves as commercial or cooperative companies. Due to this success, traditional car rental companies entered the market, introducing their own car sharing services and now car manufacturers have introduced car sharing services (e.g, car2go by Daimler, DriveNow by BMW and Quicar by VW) with different concepts and strategies. The market has consolidated: Mobility (Switzerland) is the largest European system, Green wheels (NL) and Zipcar (US based) had 767,000 members and offers 11,000 vehicles throughout North America and Europe, making it the world's leading car sharing network. Car2go is available in 17 cities worldwide, with over 275,000 customers in January 2013.

The main factors driving the growth of car sharing in urban areas are the rising levels of congestion and parking stress, the increasing cost of individual vehicle ownership, and a convergence of business models to pool and share cars. For future applications, many car sharing companies are now investing in electric car fleets respectively in plug-in hybrid electric vehicles (PHEV).

Bike-sharing systems, as previously mentioned, offer new mobility options, in particular for the first and the last mile, for spontaneous day-to-day travel, for multimodal commuters in city centres and peripheral areas, and for leisure cycling in the city and the city region. An increased integration of bike sharing services into local public transport provides the "missing link" in transport networks and secondly eases the burden of public transport at peak times.

Numerous cities of different sizes have implemented bike rental systems as a sign of pedestrian and cycling friendly transport policy. Often, rental bike systems have been used as a starting point for radical change in urban and transport planning, being observed with interest by the media and the public. The systems serve both residents who have difficulty storing a bicycle at home and commuters' last mile.

In Paris, the bike rental system Vélib has a fleet of 20,600 bikes and 1,800 stations. They have been used in particular to replace short trips (even on public transport) freeing up for longer distance travellers. Many additional (private) bicycles can now be seen on the streets, where before few could be seen. Similar effects have been achieved by bike sharing systems in Barcelona (introduced in 2007) and London (2010), Hamburg and a number of medium-sized European cities. The European countries with the most bike sharing systems are Spain (132) and Italy (104). The bike sharing systems with the highest market penetration are both in France, the Parisian Velib' with 1 bike per 97 inhabitants and Vélo'v in Lyon (founded 2005) with 1 bike per 121 residents. Velib' is the largest bike sharing initiative outside of China, where bike-sharing systems are spreading rapidly across cities.

No bicycle-sharing initiative has yet been able to operate on revenues from membership fees and user charges alone. Therefore, bicycle-sharing facilities use co-funding from public sources. Bike-sharing schemes may be managed by city governments, non-profit organisations or in public-private partnership. There are also some public transport providers running bike sharing systems (i.e. Mainzer Verkehrsgesellschaft in Mainz, Germany, and the regional association CUB in Bordeaux, France). Technology in public bike sharing solutions is moving fast, with e-bikes for sharing or cyclo-logistics (bicycles to transport goods or children) now being implemented into bike sharing schemes (http://www.velobility.net/de/home.html).

4.3.6. Cluster 6: clean vehicles

The global vehicle fleet continues to be dominated by internal combustion engines; even under progressive scenarios this is likely to remain the case over the short to medium term due to the slow vehicle fleet turnover rate, and yet-to-be-solved technological problems in making alternative (in particular electric) powertrains fully competitive with internal combustion engines. In addition, many cities in Asia and Latin America will see their vehicle fleet grow in the coming decades. There are a number of options to limit the growth of vehicle ownership and to foster the adoption of cleaner vehicles in cities, ranging from electric cars (full-electric or hybrid-electric) and two-wheelers, to various alternative liquid/gaseous fuel options, such as CNG, LNG and biofuels. In addition, due to technological advances, conventional gasoline and diesel vehicles' fuel efficiency can be improved and their exhaust emissions reduced. This thematic cluster considers clean vehicles in the broader sense, along with readily available fuels and technologies that offer substantial greenhouse gas emissions reduction potential, and possibly other energy efficiency-related options. SOLUTIONS takes into account the total Well-to-Wheel CO2 emissions to ensure overall sustainability of any solutions suggested for transfer. Also, the project considers vehicles' whole life-cycle, including any necessary infrastructure.

The suitability of different clean-vehicle technologies depends not only on local circumstances, but also on the national framework. The measures analysed in this cluster include a wide range of technology options and vehicle categories in order to offer appropriate clean-vehicle solutions to the variety of cities in SOLUTIONS's regions. It is important to consider the various technologies' and fuels' prerequisites, their feasibility in the local framework and any side effects that may result from their application. The risk of negative effects can be reduced if municipalities build on experience gained by other cities - as promoted in the SOLUTIONS project - as this allows investment costs and possible side effects to be estimated. The cluster Clean Vehicles also builds upon several European electric mobility projects' findings and on the European Green Cars Initiative. Crucially, as part of a few of the European clean vehicles projects (e.g. NICHES/NICHES+ and CIVITAS), some cities implemented measures similar to those selected for SOLUTIONS.

Innovative solutions identified in the clean vehicles cluster

In the Clean Vehicles cluster, a total of ten innovative transport solutions from around the world have been selected (see following table), based on their potential to address the pressing need to reduce local air pollution, especially in Asian cities, and to limit transport-sector oil consumption.

Electric vehicles (EVs) can be differentiated according to their degree of electrification (listed here from lowest to highest): hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs). When operating electrically, EVs emit no local pollution (particulate matter, NOx, CO2) and much less noise than conventional internal combustion engine (ICE) vehicles, making electric vehicles the cleanest vehicles currently available. However the emissions of the electricity supply should not be ignored. In urban traffic (characterised by frequent stops and deceleration) electric vehicles have a significant fuel-efficiency advantage over conventional equivalents due to regenerative braking. However, electric vehicles' well-to-tank (i.e. from electricity generation) emissions must be included in an analysis of their greenhouse gas emissions. If the electricity generation is dominated by fossil fuels, electric vehicles charged with this electricity may not save much CO2 compared to diesel or gasoline vehicles.

Also included in the measures to be analysed are options such as CNG, LPG and advanced conventional-vehicle technologies, in order to account for the different conditions in different regions. Besides covering different technologies, the selected solutions also include different modes such as cars, two-wheelers, tricycles or delivery vehicles, as well as different target groups such as taxi service providers, municipal fleets, and commercial and private vehicle owners.

Solution	Type of impact (avoid, shift or improve)
Registration restrictions/number plate auctions	Shift (Improve)
Management of electric two-wheelers	Shift (Improve)
Fuel economy/CO_2 standards	Improve
Fuel switch in taxi fleets: EVs	Improve
Fuel switch in taxi fleets: LPG/CNG	Improve
Emission-based vehicle taxation	Improve (Shift)
Clean vehicles in municipal fleets	Improve
Information and promotion of clean vehicles	Improve

Infrastructure for clean vehicles	Improve
Fleet renewal schemes	Improve (Shift)

Table 7: overview of selected measures in the clean vehicles cluster

Solution 6.1: registration restrictions/number plate auctions

This measure aims to limit a city's vehicle fleet by linking car-ownership to possession of some form of permit. In addition to, or instead of, setting a limit on the number of vehicles, a fee for vehicle ownership can be charged, potentially differentiated by emissions/fuel-economy.

The measure limits vehicle ownership in a city, while permit fees create an additional disincentive for vehicle ownership, which, if differentiated by vehicle emissions, may also encourage the adoption of cleaner vehicles. As such schemes make car ownership less attractive in general, they may also increase the use of more sustainable modes such as public transport and non-motorised modes. Permit distribution by auction will favour wealthy vehicle owners, however. To counteract this, permits may be distributed by lottery with the fees linked to income.

Figure 23: number plates in Beijing

Such measures can be expected to be met by strong opposition from the public. This can be overcome through the provision of sufficient and comfortable alternatives to private cars. Also, ensuring the measure's success depends on the municipality preventing its circumvention.

Examples and case studies: Singapore implemented a vehicle quota system in 1990. In order to register a vehicle, owners must bid for a licence, valid for 10 years and limited in number. Today, Singapore's vehicle ownership rate is very low compared to similar cities. Likewise, Shanghai and Beijing have also implemented quota systems to limit the growth of car ownership (Böhler-Baedeker and Hüging, 2012).

Solution 6.2: management of electric two-wheelers

Electric two-wheelers (motorcycles, scooters, pedelecs[3], mopeds etc.) have many positive characteristics compared to petrol equivalents (more so over cars), including less local air pollution and noise, lower CO2 emissions, improved safety and increased mobility for low-income citizens. This measure aims to replace fossil-fuelled two-wheelers (or passenger cars) with electric two-wheelers. An electric two-wheeler plan can be written, based on an examination of the role and implications of electric two-wheelers in the entire local transport system, with appropriate goals. Measures which could be included in the plan include banning non-electric PTWs, dedicated parking and charging areas for electric two-wheelers, separate lanes for (electric) two-wheelers, special waiting areas at intersections for motorcycles or excluding (electric) two-wheelers from city tolls.

[3] Pedal assisted electric bikes

Electric two-wheelers may be a sustainable alternative to their still dominant gasoline-fuelled equivalents. In contrast to electric cars, two-wheelers' electrification is relatively easy and they require less charging infrastructure. To date, small scale projects have demonstrated that there is potential for electric two-wheelers. Significant market shares have been achieved in China, but in many citieselectric two-wheelers' benefits were diminished , because of insufficient regulations and enforcement, along with deficient integration into the transport system..

Figure 24: electric two-wheeler in Foshan

The idea behind sustainable management of electric two-wheelers is to foster their deployment in light of growing overall numbers of PTWs and their negative side effects. To this end, measures which are tailored to local characteristics must be identified. It is important to differentiate the various types of powered two-wheelers, such as electric bikes, electric mopeds or electric motorcycles and it might be necessary to address these types separately. To ensure the success of the measure it is important that the regulations for (electric) two-wheelers are enforced properly. Currently, motorised two-wheelers are often not sufficiently included in transport planning and regulations. There is often a lack of knowledge on the impact of different policies and measures that address two-wheeler traffic.

Examples and case studies: In many Chinese cities, electric two-wheelers have gained a considerable modal-share, often fostered by a ban on fossil-fuelled two-wheelers. Barriers include vehicle standards and traffic regulations which may be absent or not properly enforced. In addition, proper classification of PTWs as basis for appropriate regulations is often absent. Due to safety and congestion concerns, ninety Chinese cities have banned electric motorcycles. In the past, some cities have implemented isolated measures regarding electric two-wheelers such as an integrated city-wide electric two-wheeler plan. Safety issues associated with electric two-wheelers can be reduced by improved general regulation of two-wheeler use. In Malaysia (Kuala Lumpur) and Taiwan (Taipei), motorcycle lanes and waiting boxes at junctions have been successfully introduced to reduce accidents (Hook and Fabian, 2009).

The city of Murcia (Spain) installed public charging stations for electric two-wheelers to encourage the deployment of electric motorcycles and electric bikes (Eltis 2012). In Rome about 400 electric scooters and suitable recharging infrastructure were introduced within the CIVITAs programme. Also, Rotterdam and Barcelona installed charging infrastructure for electric scooters and bicycles. In Barcelona, the first electric scooter sharing project was launched in 2013. Electric bikes and pedelecs were covered in the MOLECULES project. The city of Naples (Italy) promoted electric two-wheelers by cooperating with manufactures to offer purchasing discounts for electric scooters and pedelecs (Edegger et al. 2012).

Solution 6.3: fuel economy/CO2 standards

Vehicle standards aim to improve the fuel economy of the new vehicle fleet and to reduce the emissions per vehicle-kilometre. It is an effective approach to accelerate technology innovation, as adopting advanced technologies is prerequisite to achieving stringent targets. The setting of long-term targets offers certainty to vehicle manufacturers; crucial to them in order to make investments in new technologies (Schipper, 2007). For policy-makers, the key benefit of vehicle standards compared to other mechanisms is the need to deal with only a relatively small number of car manufacturers, whereas other policies usually target a vast number of individuals.

Worldwide, different kinds of vehicles standards have been implemented: vehicle fuel efficiency standards are based on the fuel consumption per distance travelled, as implemented in Japan. The European Union adopted vehicle standards based on the CO2 emissions per kilometre travelled. The Californian standard takes all GHG emissions into account. Another option is to implement vehicle standards based on the energy intensity (MJ/km) of the vehicle (Creutzig et al., 2011).

Even though the different kinds of standards are based, in principle, on the same objectives, the design of the standards can lead to different effects. Fuel efficiency standards for car manufacturers aim to ensure a supply of efficient vehicles and, even more importantly, aim for a standardised level of fuel consumption in the vehicle fleet. Standards based on fuel volume (/km) may exclude alternative fuels such as electricity. An energy-intensity based standard would allow the inclusion of alternative fuels, but similar to a volume-of-fuel based standard, different fuels' GHG intensities are not accounted for, in which case, the upstream emissions must be regulated separately. Establishing GHG emission standards directly limits new vehicles' exhaust GHG emissions, including CO2, along with the whole suite of GHG emissions from the rest of the vehicle, such as refrigerants from the air conditioning system and other powerful GHG gasses. The standards may even extend beyond the exhaust emissions to encompass the life-cycle GHG emissions generated in the production of the vehicle and fuel. This requires more detailed assessment and administrative capacity compared to fuel efficiency standards. As vehicle manufactures can neither influence upstream emissions of fuels nor the electricity generation mix, this kind of standard might be inadequate as soon as vehicle technologies and fuels diversify (Creutzig et al., 2011). Consequently, careful selection of the measurement basis for the standard is crucial.

Figure 25: fuel station in Cologne

The adoption of fuel efficiency or GHG emission standards will bring significant environmental and social benefit, as it will effectively increase fuel efficiency and reduce GHG emission of the new-car fleet. The regulation may also bring some economic impacts, especially for the automobile industry, as advanced technologies are required to achieve the targets. From a societal perspective, individuals mostly do not act responsibly when making purchasing decisions. Consumers rarely evaluate the trade-off between higher initial cost for efficient vehicles and the benefit of fuel saved (Turrentine and Kurani, 2007). This can be mitigated to some extent by vehicle standards.

Fuel economy standards can be differentiated by weight and can be applied to different vehicle categories. Thus, fuel economy standards can address passenger as well as goods transport. To ensure equal conditions for all manufacturers, standards should apply to all vehicles entering the fleet, whether locally produced or imported. Fuel economy standards are usually implemented at national level. However, some cities or regions for instance in Asia have the possibility to implement their own standards. Otherwise, cities can request or opt for standards on national level.

One of the key shortfalls of standards as the sole policy measure to reduce fuel consumption is related to the rebound effects it initiates (Schipper, 1993). Vehicle efficiency standards reduce the cost of driving and promote increased travel (Plotkin, 2009). However, the rebound effect can be minimised by appropriate fuel pricing (Gerard and Lave, 2003). Efficiency targets should be combined with demand-side polices in order to ensure the supply of more efficient vehicles matching consumer demand. This highlights that only integrated policy packages, including standards and fiscal measures, will achieve substantial results.

Examples and case studies: Governments around the world have successively introduced and revised vehicle standards at national level. To date, among the top 15 vehicle market regions, 8 regions (79% of world vehicle sales) have established either fuel consumption or GHG emission standards for passenger cars and/or light-duty vehicles - the major fleet component in urban areas - for 2015 and beyond. Depending on the stringency of standards, the estimated extent of GHG reduction differs from region to region.

The US was the first country to introduce vehicle fuel economy standards. In 1975, just two years after the first oil crisis, the US CAFE standard was introduced, which requires car manufacturers to meet sales-weighted average fuel-economy standards for light vehicles sold in the United States. In an analysis of a policy which aimed to bring forward attainment of the 2020 target (35 mpg) to 2016, the US Environmental Protection Agency (EPA) came to the conclusion that, on average, the price increase for model year 2015 cars and light trucks would be paid back from reduced fuel costs in 56 or 50 months (assuming manufacturers pass on costs to consumers and fuel prices of US$2.26 in 2016 and $2.51 in 2030, respectively). Economy-wide net benefits (using a 7% discount rate) from lower fuel costs, reduced oil dependence and avoided external costs are estimated by NHTSA to be US$15.2b for cars and $26.4b for light trucks (NHTSA, 2008).

The EU has moved from voluntary arrangements with the automobile industry to binding regulation. The Regulation EC 443/2009 is based on a target of 120 gCO2/km for the European car industry by 2015: a target of 130 gCO2/km is to be reached by improvements in vehicle motor technology, with a further 10 gCO2/km to be obtained by using other technological improvements such as the use of biofuels or more efficient ancillaries and tyres. The regulation also includes a medium-term target of 95 g CO2/km by 2020, which is still under negotiation.

Solution 6.4: fuel switch in taxi fleets: EVs

Electric vehicles are very suitable to be used as taxis and tricycles. Motorised tricycles play a major role in Asia as cheap alternative to taxis for shorter distances. The distances that taxis and tricycles cover are usually within the driving range of regular electric vehicles. Furthermore, charging can be easily provided during waiting times at major taxi stands. Substitution of fossil-fuelled taxis and tricycles with electric vehicles can reduce local air pollution and noise, and depending on the electricity mix, it can also contribute to greenhouse gas mitigation. Especially two-stroke engines, often used to power tricycles, contribute considerably to local air pollution. Establishing a fleet of electric taxis and tricycles requires significant upfront costs for the vehicles and their charging infrastructure. A city can encourage adoption of electric taxis or tricycles by providing financial incentives (e.g. subsidies, loans) for these vehicles, by providing necessary infrastructure or by tightening local emission standards. Sometimes it is also necessary to adapt local regulations to facilitate the use of electric vehicles.

In Asia, the adoption of electric taxis or tricycles is mainly driven by the intention to reduce local air pollution. In Europe and Japan, electric taxis are often seen as tool to support the wider adoption of electric vehicles. Existing experience shows that these taxis are well accepted. However, barriers include limited driving range, limited charging infrastructure and need for specialised maintenance workshops are often perceived as a disadvantage by taxi drivers. Due to lower fuel costs, electric vehicles are cheaper to operate and thus can increase drivers' profit margin. In addition, electric taxis and tricycles are often used in areas where use of conventional vehicles is prohibited.

Examples and case studies: In 2010, Shenzhen (China) began the establishment of a fleet of electric taxis. The fleet has grown to 800 taxis, operated by a dedicated electric taxi company, a joint venture between an electric vehicle manufacturer and a local public transport company. These taxis are cheaper for passengers and drivers alike. However, the availability of charging infrastructure is still an issue (Shengyang et al. 2012). Other cities where electric taxis operate on a smaller scale include Mexico City, Kanagawa Prefecture, Dublin and London.

The city of Kathmandu, Nepal successfully replaced diesel-fuelled three-wheelers with electric ones. A pilot project undertaken by the municipality proved the applicability and economic feasibility of electric three-wheelers, which encouraged the private sector. In 1996, an incentive, in form of a 75% customs-duty discount, was provided by the city and subsequently, in 1999, diesel fuelled three-wheelers were banned from the valley area. In 2001, more than 600 electric three-wheelers were in operation in Kathmandu (Tejas Ghate et al., 2013). The Philippines is in the process of replacing (target of 200,000) fossil-fuelled tricycles with electric ones; produced domestically and available under a lease-to-own programme. Furthermore, in a pilot project, 20 electric tricycles equipped with lithium ion batteries were trialled in the City of Mandaluyong. Due to reduced fuel costs, the income of some drivers participating in the pilot project has doubled.

Solution 6.5: fuel switch in taxi fleets: CNG/LPG

In a number of cities, the use of taxis fuelled by CNG (Compressed Natural Gas) or LPG (Liquefied Petroleum Gas) has been implemented primarily to reduce local air pollution. CNG and LPG are advantageous compared to other conventional fuels as they cause less tailpipe air pollutants and produce less noise. CNG vehicles emit 20% less nitrogen oxide than petrol vehicles. However, the CO_2 benefits vary greatly and may be even higher than an efficient diesel powered vehicle.

Cars or tricycles that run on LPG or CNG can reduce local air pollution, noise and GHG emissions compared to petrol or diesel equivalents. Lack of refuelling infrastructure and fear of the conversion or replacement cost often limit the use of CNG and LPG. Thus, to foster the introduction of LPG or CNG in the local taxi fleet, a combination of different instruments might be necessary, such as a) financial incentives for the vehicles/fuels (e.g. in form of subsidies, loans for vehicle conversion, tax rebates etc.), b) provision of sufficient refuelling stations (CNG) and c) restrictions on conventional taxis. Loans can help vehicles or fleet owners to bear the initial conversion cost of switching to LPG or CNG. Sufficient refuelling infrastructure is key for the measure's success; this can be installed through public-private partnerships to limit the cost to municipalities.

Figure 26: CNG fuel station in Delhi, India

Examples and case studies: In Delhi and Ahmedabad, taxi and auto rickshaws have been successfully converted to run on CNG. The measure was mainly driven by air quality problems in these cities. The city Ahmedabad ensured an adequate CNG supply, an adequate number of filling stations and the availability of conversion kits for vehicles. In addition, monetary incentives where offered to rickshaw drivers along with soft loans (Tejas Ghate et al., 2013). Similarly, Madrid has installed CNG/LPG refuelling stations and provided grants to taxi drivers to convert their vehicles.

Solution 6.6: emissions-based vehicle taxation (annual & purchase/registration tax)

Emissions-based vehicle taxation aims to create disincentives for the acquisition and use of heavily polluting vehicles, while creating incentives for less polluting vehicles. Larger, more polluting and fuel-consuming vehicles are charged higher tax rates than less polluting vehicles. For example, acquisition taxes can be levied through a feebate system where cleaner vehicles benefit from a rebate, financed by higher taxes on more polluting vehicles. Tax exemptions can also be allowed for specific technologies.

The share of clean vehicles in the overall fleet is increased and the fuel economy of the fleet is improved, leading to energy savings and emissions reductions. Also, the downsizing of vehicles and alternative-fuel vehicles are promoted. Furthermore, a general increase in vehicle taxation can reduce overall car ownership. Proper design of the vehicles evaluation scheme is key for the measure’s success. The assessment criteria are best designed in a way that they are also able to reflect alternative fuels. In addition, the size of the tax difference between lowly and highly emitting vehicles must be appropriate level to have an effect on purchasing behaviour.

Examples and case studies: The Kanagawa Prefecture in Japan provided a tax exemption for purely electric vehicles to encourage their market penetration. Similarly, in Norway electric vehicles are exempted from VAT and receive other monetary and non-monetary advantages (Vaggen Malvik et al., 2013). In France, a bonus-malus system encourages the adoption of cleaner vehicles, while in many other European countries vehicle taxation is differentiated according to emissions.

Solution 6.7: clean vehicles in the municipal fleet

Municipalities can encourage the use of cleaner vehicles through the way they manage their own fleets, specifically by introducing clean vehicles in the fleets of the municipality and municipal enterprises. This requires energy efficiency and environmental performance to be considered for vehicle purchases. For example, municipal procurement guidelines may oblige departments and municipal enterprises to purchase fuel-efficient, low-emission vehicles. Especially where municipal enterprises operate local public transport, waste collection or street cleaning services, procurement guidelines are applied to large vehicle fleets. An accounting system which is structured in a why that long-term savings remain with the investing department can increase the ambition to use clean and fuel-efficient vehicles. This is especially important as investment costs for fuel-efficient or alternatively fuelled vehicles can be higher than for conventional vehicles. To avoid investment costs, alternatively, municipally-owned vehicles can be substituted with alternatively-fuelled car-sharing vehicles.

Figure 27: electric fleet of Aachen's energy provider

Through this measure, the share of clean vehicles in the municipal fleet increased and the municipality can serve as role model for private enterprises. By demonstrating the applicability of clean vehicles, the city can share its experience with new vehicle technologies. Besides emissions reduction, the operation of cleaner vehicles can also result in long term cost savings.

Examples and case studies: The city of Grenoble, France, replaced around a quarter of its fleet with CNG vehicles. Several European projects supported the use of clean vehicles in municipal fleets: within CIVITAS ELAN, alternative fuels were used for waste disposal vehicles in Zagreb. CIVITAS TELLUS introduced clean vehicles to Rotterdam's municipal fleet. In the project TURBLOG, Utrecht tested an electric 'beer boat'. Stockholm, Sweden has added 200 clean cars to Stockholm's municipal fleet and the city of Stockholm introduced clean vehicles as part of the EU CIVITAS TRENDSETTER project.

Solution 6.8: information and promotion of clean vehicles among the general public and private companies

Information on clean vehicles is provided to the public, e.g. in form of a campaign. In addition, advantages for the use of clean vehicles are created, for example through reduced public parking fees or reduced road tolls. Ideally, local activities are linked to nation-wide schemes, such as a vehicle labelling system based on CO2 emissions, local air pollutants or fuel economy.

Such measures aim to increase the share of clean vehicles in private and commercial fleets. The public's knowledge of clean vehicles is improved and advantages are created. This can lead to wider use of clean vehicles. Manufacturers or NGOs can support campaigns for cleaner vehicles. Alterations in national or regional regulations might be necessary to allow cities to provide specific advantages for clean vehicles, which can be a barrier.

Examples and case studies: In Norway, several incentives for electric vehicles are provided: they can drive on bus lanes, parking is free in all publicly owned parking spaces and they are exempt from road tolls (Håvard Vaggen Malvik et al., 2013). Electric cars are exemot from paying the congestion charge in London, UK for example. Several European projects have promoted the use of clean vehicles: CIVITAS Trendsetter – clean vehicle use in private companies, NICHES – deployment of clean vehicles in the private sector and ECOSTARS – clean vehicles for local fleet operators.

Solution 6.9: infrastructure for clean vehicles

When alternative fuels are to be introduced or their deployment is to be increased, often additional infrastructure such as CNG refuelling stations or EV charging facilities are needed. However, as long as the number of vehicles that run on these fuels is still low, private investors are often unwilling to install respective infrastructure, as the installation might not be profitable in the initial phase. On the other hand, without sufficient charging infrastructure vehicle owners are usually reluctant to purchase vehicles running on alternative fuels. This so-called 'chicken and egg dilemma' can be addressed by the city in providing or supporting the initial infrastructure development.

Figure 28: CNG fuel station, Delhi, India

By providing support for the installation of refuelling/charging stations, the city can reduce the barriers for the adoption for alternative fuels/energy carriers. The city can install its own charging facilities or provide the necessary land. Close cooperation with electricity suppliers or car dealers can speed up the installation of recharging/refuelling facilities. In Stockholm and Lille similar experiences have been made with the establishment of biogas fuel stations.

Examples and case studies: Several cities in Europe foster the adoption of electric vehicles by supporting the installation of charging facilities. Rotterdam, for instance, offered subsidies for charging station construction and installed charging facilities on public ground. London has done the same. CNG infrastructure for buses can be shared with private vehicles and municipal fleets under some conditions.

Solution 6.10: fleet renewal schemes

The measure deals with the provision of monetary incentives for citizens to exchange their old, petrol fuelled car/motorcycle with a new, clean one (electric/hybrid etc.). Monetary incentives are of specific importance for those technologies that are not yet cost-competitive. Especially electric vehicles, which have very high initial investment costs compared to conventional vehicles, benefit from monetary incentives.

The measure aims at increasing the adoption rate of clean private vehicles. The impact of the measure is twofold. Firstly, it will increase the number of clean vehicles on the roads, thus reducing the overall environmental impact, and on the other hand it will boost the car/motorcycle market; suffering significant losses during the economic crisis. At best the measure should be implemented at national level or linked to national policies. Also, PPPs could be a means of promoting it. It could be combined with taxation measures and/or low emission zones to increase its effectiveness.

Examples and case studies: Similar measures have also been applied in the past in several countries as an incentive for switching into vehicles equipped with catalytic converters. In most cases, they were very successful and the private vehicle fleets were renewed in a few years. Today, several countries provide monetary incentives, in form of tax exemption or subsidies, for electric vehicles. Norway, for instance, exempts electric vehicles from high taxes on automobiles. The UK and the Netherlands provide subsidies for EV purchase.

5. Conclusions

The six cluster leaders of the SOLUTIONS project have selected and described 58 individual urban transport and mobility solutions with a high transferability potential. The selection of measures confirms the richness of practical experience, which exists in Europe, Asia and Latin America.

Experiences from projects and initiatives have shown that transferability of measures from one to another city depends on numerous conditions. While single (mostly technical) measures are relatively easy transferred between cities, policy measures require more careful analysis of the conditions in the donor and recipient city. A separate working paper on the transferability methodology has been developed as an input into the feasibility studies. A guideline for the transferability of solutions will also be developed at a later stage based on the experiences in the Take-up Cities.

Single solutions cannot stay on their own and they are always interrelated with other measures within and across clusters. This working paper helps SOLUTIONS cluster leaders and take-up coaches to visualise the relationships between independent measures and where packages of measures would be desired or even needed.

5.1. Prioritisation of measures

The transferability of measures is very context-specific. Technical solutions are often easier to transfer than policy and planning-related measures. Solutions under transport infrastructure and network management are more communicable than, for example, sustainable urban mobility planning measures.

The selection is a result of considering the relevance of the proposed solutions for achieving high impact on the urban transport and mobility system and an analysis of the potential transferability of specific solutions. The analysis was based on the outcomes and results of different European and global transport projects in which the SOLUTIONS partners have been involved.

The measures which are described in this paper will be presented to the SOLUTIONS Take-up Cities for further consideration in their aspiration to take-up successful sustainable mobility solutions from cities who have great experiences in successfully implementing such measures.

In the course of the SOLUTIONS project, the proposed measures will be further prioritised and their transfer potential further researched. By testing transfer in pilot cities, the research will have an empirical component. The transferability guidelines, as one result at the end of the project, will compile the lessons from the transfer tests.

5.2. Match-making with leading and take-up cities

The call for leading and take-up cities included a category on the six clusters in order to find out the primary competences of leading cities and the interest/needs of the take-up cities.

The selected leading cities have experience in measures across all clusters. Particular competences exist in public transport and SUMP, followed by clean vehicles and network and mobility management. As observed in many other projects, city logistics is a more difficult topic to cover.

The following table presents the results of the selected leading cities:

City	Size	Region	Clusters
Aalborg City Council	100k-500k	**DK** Europe	Public transport SUMP Network and mobility management Transport infrastructure
Barcelona Municipality	>500k	**ES** Europe	Public transport SUMP City logistics
BKK Budapest	>500k	**HU** Europe	Public Transport SUMP

Bremen City Council	>500k	**DE** Europe	Public transport SUMP Network and mobility management Clean Vehicles
Hangzhou Municipal	>500k	**China** Asia	Public Transport Network and Mobility Management Clean Vehicles
URBS Urbanizacao Curtiba	>500k	**Brazil**, Latin America	Public transport SUMP Transport infrastructure Clean Vehicles

The interest of the selected take-up cities is mainly on public transport, clean vehicles, SUMP and city logistics. Measures under the cluster of transport infrastructure and network and mobility management are considered as cross-cutting solutions, supporting the introduction of public transport, city logistics and clean vehicles (infrastructure implications, ITS and ICT applications charging stations, installations of vehicle sharing, etc.).

The following table presents the results of the selected take-up cities:

City	Size	Region	Clusters
Belo Horizonte	>500k	**Brazil**, Latin America	Public Transport SUMP City logistics Clean vehicles
Guiyang	100-500k	**China**, Asia	SUMP Clean vehicles
Kochin	>500k	**India**, Asia	Public Transport SUMP
Leon City Council	>500k	**Mexico**, Latin America	Public Transport
Kocaeli Metropolitan Municipality	>500k	**Turkey**, Med	Public Transport SUMP City logistics

The catalogue of solutions will be discussed with both groups of cities in a match-making workshop. The result of this workshop will be teams for structured take-up with a clear list of measures and measure packages for transfer.

5.3. Inputs to training materials and guidance for transferability

The whole set of the identified solutions will be input to the development of training packages for the training cities. The selected training cities will list clusters relevant for building capacities of their transport professionals. Also in this group, public transport is considered the cluster with the highest need for training offers and the further developments in SOLUTIONS will reflect and build on this.

The following table presents the results of the selected training cities:

City	Size	Region	Clusters
Casablanca organizing Authority of Urban Mobility	>500k	**Morocco**, Med	SUMP
City of Durango	>500k	**Mexico**, Latin America	Public transport SUMP Network and mobility management
Direction Regionale du Transport de Sfax	>500k	**Tunisia**, Med	Public transport
Greater Amman Municipality	>500k	**Jordan**, Med	Public transport SUMP
Hanoi Transport Development and Strategy Institute TDSI	>500k	**Vietnam**, Asia	Public transport SUMP City logistics Clean vehicles
La Serena Minister of Transport and Telecommunications	100-500k	**Chile**, Latin America	SUMP
Matale Municipal Council	>500k	**Sri Lanka**, Asia	Public transport SUMP
Sao Jose Dos Campos	>500k	**Brazil**, Latin America	All
Xian Municipal Transportation	>500k	**China**, Asia	Public transport Clean vehicles

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7. List of acronyms

AG	Advisory Group
BHLS	Bus with a High Level of Service
BRT	Bus Rapid Transit
CNG	Compressed natural gas
EC	European Commission
ERTICO	European Road Transport Telematics Implementation Coordination Organisation S.c.r.l.
EU	European Union
FP7	EU's Seventh framework programme for research and technological development
ITS	Intelligent transport systems
LNG	Liquefied natural gas
LPG	Liquefied Petroleum Gas
LTE	Long-term evaluation
LTP	Local Transport Plan (UK)
M	Month
MRT	Mass Rapid Transit (a high capacity rail based system)
MS	Milestone
PC	Project Consortium

PDU	Plan Deplacement Urbaine – Local Mobility Plan (France)
PMG	Project Management Group
PPP	Public Private Partnership
PU	Public
RTD	Research and Technological Development
SUMP	Sustainable Urban Mobility Planning/Plan
TEN-T	Trans-European networks