TOPIC GUIDE:

DECARBONISATION OF URBAN MOBILITY

European Platform on Sustainable Urban Mobility Plans

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About

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Introduction and target group

Decarbonisation of urban transport will enable cities to mitigate the climate change impacts of urban mobility. It requires a set of measures that will significantly impact personal behaviour and living patterns. Effective greenhouse gas (GHG) reduction requires changes in how we live, particularly regarding the role of the private car. These changes will require political commitment, at least public acceptance, and have to be based on constant and decades-long dialogue with a broad range of stakeholders. Setbacks along the way are inevitable. Decarbonisation of urban mobility is one of the most challenging areas in the fight against climate change. While some progress has been achieved in many cities, the broader picture so far shows a steady increase in the absolute and relative GHG emissions from transport (including urban transport).

This guide aims to help planners and decision-makers responsible for tackling climate change and for developing transport plans, at all levels, to understand which measures to introduce within Sustainable Urban Mobility Planning (SUMP) and the types of impact that are to be expected from those measures, to achieve the relevant GHG emissions reduction targets. It focuses on personal mobility.

This guide is based on the methodology of the general SUMP guidelines[1] with a focus on climate change mitigation. Where necessary it refers to the general SUMP guidance material. The guide presents or refers to available state-of-the-art knowledge in this field.

Planning for mobility and decarbonisation towards climate neutrality is not always in harmony. The SUMP has to address a wider range of challenges and objectives, including social, economic and environmental objectives such as accessibility, traffic flow, congestion, noise, traffic safety, etc., and it would promote measures to enhance mobility services and provide for a wide range of mobility options. In contrast, decarbonisation requires a focus on transport measures packages that are effective and efficient to reduce GHG emissions. This guide takes the assumption that considered planning options along SUMP development should be aligned with climate objectives. A planning option (or package of measures) would need to be adapted accordingly, or they would need to be dropped and replaced by other means to coherently ensure all SUMP objectives.

The guide is developed for urban and regional mobility planners, or spatial planners who can influence the structure and morphology of cities and their functional urban areas. The guide will be of particular relevance for planners in larger cities and urban. The core information provided and the calculation schemes do on the other hand also apply to any urban agglomeration size[2]. Beyond the relevant professionals in public administration, the guide also aims to provide valuable information to a wide range of interested stakeholder groups, including schools, universities, real estate developers and managers, public transport authorities and companies, commuters, civil society groups with a mission to reduce the carbon intensity of urban mobility and transport in general. Last but not least decision-makers at all levels should benefit from the guide and be able to find relevant examples and understand the core elements in planning the decarbonisation of urban mobility.

1 Rupprecht Consult (editor), Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition, 2019, https://www.eltis.org/sites/default/files/sump_guidelines_2019_interactive_document_1.pdf

2 The present Guide recalls to SUMP geographical scope principles to cover relevant Functional Urban Mobility (FUA) (see further details in the relevant chapters).

1. Planning urban mobility decarbonisation

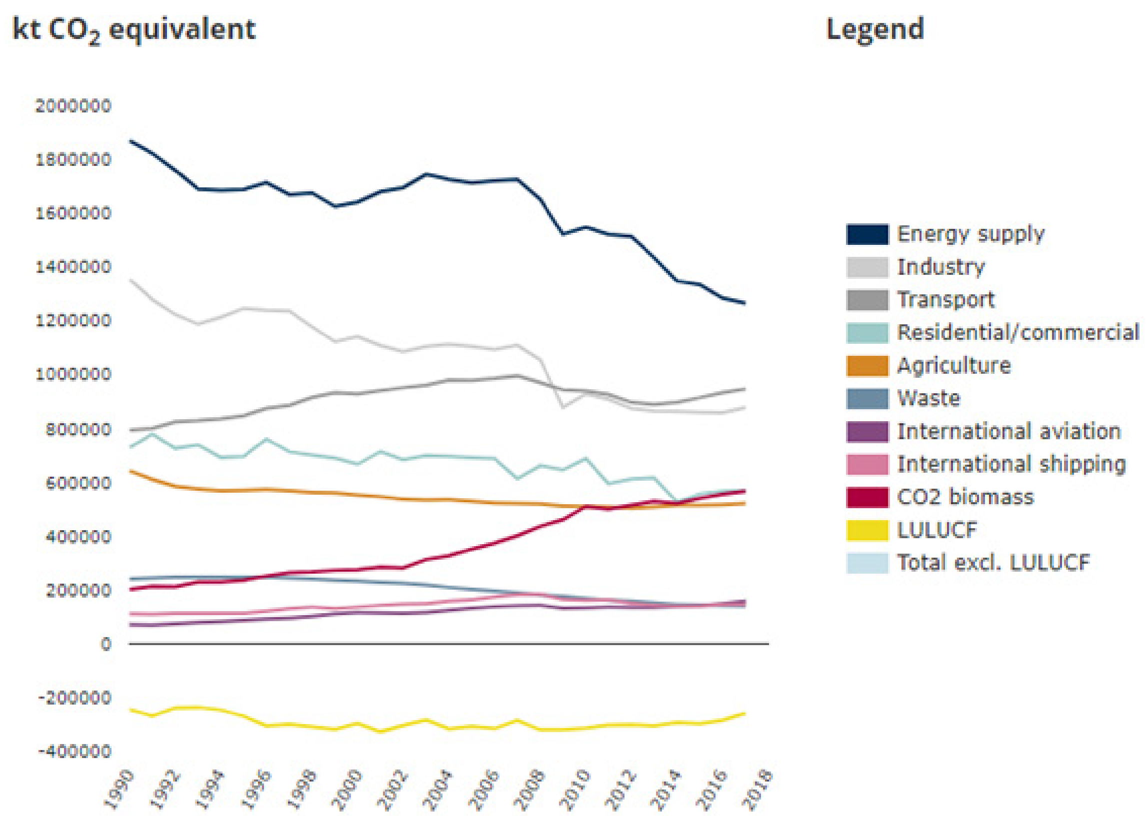
1.1. Climate change mitigation and mobility challenges

The European Commission has set out a target for all sectors to be climate neutral (net zero) by 2050, including surface and air transport[3]. This is particularly challenging, as currently transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities. The transport sector has not seen the same gradual decline in emissions as other sectors: emissions only started to decrease in 2007 and remain higher than in 1990 (see graph Figure 1).

According to Eurostat, CO2 emissions from transport accounted for 25.8% of all GHG emissions in the EU in 2019[4]. Within this sector, road transport is by far the biggest emitter accounting for more than 70% of all GHG emissions from transport.

With the global shift towards a low-carbon, circular economy already underway, the European Commission's low-emission mobility strategy, adopted in July 2016, aims to ensure Europe stays competitive and able to respond to the increasing mobility needs of people and goods.[5]

Figure 1. Total greenhouse gas emissions trends by aggregated sector in Europe (source: European Environment Agency[6])



3 See page 4, chapter 2, point 10 of the "Sustainable and Smart Mobility Strategy" (SSMS) of 9.12.2020: "The European Green Deal calls for a 90% reduction in greenhouse gas emissions from transport, in order for the EU to become a climate-neutral economy by 2050" and page 72, point 285 of the Commission staff working document accompanying the SSMS: "Based on the analysis underlying the 2030 Climate Target Plan and in line with Communication on the European Green Deal, in order to reach the objective of a climate-neutral economy by 2050, a reduction of 90% in transport CO2 emissions must be achieved, relative to 1990 level."

4 'Shedding Light on Energy in the EU: How Are Emissions of Greenhouse Gases in the EU Evolving?' Shedding Light on Energy in the EU, https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-4a.html.

5 European Commission, 2016, A European Strategy for Low-Emission Mobility https://eur-lex.europa.eu/resource.html?uri=cellar:e44d3c21-531e-11e6-89bd-01aa75ed71a1.0002.02/DOC_1&format=PDF

6 Total greenhouse gas emission trends and projections in Europe — European Environment Agency. (n.d.). Retrieved October 10, 2022, from https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-6/assessment-3

The Commission noted, in announcing the Mission for 100 Climate Neutral and Smart Cities by 2030, that "our urban areas are home to 75% of EU citizens. Globally, urban areas consume over 65% of the world's energy, accounting for more than 70% of CO2 emissions. It is therefore important that some cities act as experimentation and innovation ecosystems to help all others (or: to help all other cities) in their transition to become climate-neutral by 2050."[7]

The scale of the challenge is unprecedented, but many cities have already re-engineered themselves to reduce their reliance on private cars, typically from a peak of 50% car use around 2000 to as little as 30% in 2018[8] and, in the case of Vienna, a more ambitious target has been determined in the near future[9].

Meeting the carbon-neutral mobility challenge will require a similar shift in policy strategies and professional and public mindsets, but on a larger and faster scale, working with a wide range of organisations and sectors. As set out in the EU Sustainable and Smart Mobility Strategy of 9.12.2020, a "shift (of) the existing paradigm of incremental change to fundamental transformation" is needed[10]. This shift requires the development of a long-term transition strategy, implemented and updated through different SUMPs (i.e. normally with shorter-term implementation focus vis-à-vis those longer-term ones). Developing a long-term carbon-zero transition strategy will need to recognise the following:

- Currently, travel behaviour is commonly measured by trip rates and trip modal shares; but carbon emissions[11] are directly linked to the number, length of trips and emission rates of different modes – the less frequent but longer car trips contribute disproportionately more carbon than the more frequent, shorter ones.[12]
- Carbon neutrality represents a fixed end goal, but there are many different strategies and mixes of policy measures among sectors that can be adopted to achieve that common end goal – according to local conditions and capabilities.
- While targets focus on end goals, the important factor to limit climate change is the total CO2-equivalent emissions in the atmosphere, so early actions to reduce emissions have a greater cumulative impact than later ones.
- The preferred transition strategy should be implemented through more specific policy measures, throughout several SUMP cycles.
- The role of modelling switches from forecasting futures ('predict and provide') to assessing which strategies and policy mixes will deliver the desired end state ('vision and validate').

Carbon reduction as a goal cannot be considered in isolation from other transport and environmental objectives (safety, biodiversity, air quality, etc.), and should adequately consider transport-related social challenges. The transformation to carbon-zero requires both, the mobility transition (e.g. shift to biking, walking, public transport) and the energy transition (e.g. electric vehicles) of the transport sector – all to be done as fairly as possible i.e. also considering social aspects of the change.

Planning the transition may be based on a comprehensive local climate strategy (including one based on the Sustainable Energy and Climate Action Plans (SECAP) methodology proposed by the Covenant of Mayors may cover a period of 20 to 30 years. The mobility component may then be specified through a transport sector plan, delivered through a succession of SUMPs – that usually cover a time span in the range of 10 years.

In the case where an overarching climate strategy or general local climate regulation does not exist, the contribution from urban mobility has to be determined directly through the development of a long-term carbon mitigation mobility strategy, delivered through a series of SUMPs.

Decisions and actions taken at the SUMP level are critical and are the main drivers to translating long-term climate mitigation strategies and goals into concrete measures to reduce GHG emissions from transport, enabling a city to achieve the full climate change mitigation potential of a transport system. Once each measure is selected, its overall impact depends largely on the fact that it is part of a plan, i.e., its full benefits will

7 European Commission, 2022, "Commission announces 100 cities participating in EU Mission for climate-neutral and smart cities by 2030" https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2591

8 https://nws.eurocities.eu/MediaShell/media/CREATE-ProjectSummaryReccommendations.pdf

9 https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008443.pdf

10 See page 4, chapter 2, point 9 of the "Sustainable and Smart Mobility Strategy" (SSMS) of 9.12.2020

11 The terms "carbon emissions, GHG emissions, CO2-equivalent emissions and CO2 emissions are used in interchangeable manner in this guide

12 As explained later in this guide, it should be noted though that 1) the shortest trip are the easiest to shift towards non-motorised mobility/public transport, and 2) journeys in urban areas with ICE vehicles (not ZEV) emit twice as much CO2 and far more local pollutants in the most sensitive areas. Therefore a simple vehicle x km factor might not represent correctly the impact.

only be achieved when the set of complementary actions and factors foreseen in the plan are also implemented.

A robust SUMP process developed consistently with the relevant long-term climate change mitigation strategies, and in synergy with cross-sectoral, especially spatial development planning, can optimise mobility patterns and promote the usage of public transport and smarter mobility solutions. For example, it provides an opportunity to locate residential/productive areas, hospitals and schools within 15-minute neighbourhoods, or on major public transport corridors, and to promote organisational arrangements for study and work (e.g. telework) that reduce the need for travel and redistribute demand peaks. The combination of such measures has the overall effect of reducing the frequency, length and duration of trips and promotes the use of softer modes, through the development of micro-mobility options including walking, cycling and usage of "last-mile" connections for passenger and freight traffic based on electric propulsion where appropriate.

1.2. Strategies to deliver climate mitigation

An effective mix of strategies and policy measures to reduce/eliminate carbon emissions can be developed by using the 'Avoid –Shift – Improve' paradigm.

Avoid

Spatial and land-use planning and carbon-reduction business service delivery models are key cornerstones, having possibly the biggest long-term potential for GHG emissions reduction. The effectiveness of the transport system and hence its impact on climate change mitigation and adaptation is greatly influenced by long-term decisions taken regarding the patterns of land use which it serves:

- Location and access (to the strategic / higher rank public transport networks);
- Land use designation (quantum, density, mix of functionalities); and
- Design (urban street typology).

The potential for climate change mitigation at this level of decision-making is significant by reducing the frequency and length of trips and promoting non-motorised or public transport modes which are more suitable for certain trip lengths and spatial configurations. Therefore, the SUMP[13] should be carried out in parallel and synergy with the land use/spatial plan where possible.

In addition, more public and private sector organisations are signing up for carbon reduction targets and auditing their operations. Those that are adopting 'Scope 3'[14] accounting are measuring the transport carbon that their activities generate – and taking responsibility for reducing them. This may involve developing new service delivery models that move some services fully or partly online (e.g. teleworking), or through localising physical service provision.

To harmonise quantification of emissions from transport operations by private and public sector organisations, the European Commission has adopted the CountEmissions EU proposal[15] for a regulation as part of the Greening Freight Transport Package of July 11th 2023[16]. CountEmissions EU provides a common semi-voluntary methodological approach for entities to calculate the greenhouse gas emissions of their transport services. The proposed methodology is based on the recently adopted EN ISO 14083 standard for the quantification and reporting of greenhouse gas emissions arising from the operation of transport chains of passengers and freight. Reliable data on door-to-door emissions will enable operators to benchmark their services and allow consumers to make informed choices on transport and delivery options.

Shift

An essential role is played by the modal split, i.e. the higher the usage of public transport and other modes with lower emissions and energy consumption per pass-km - including walking, cycling, etc. - in comparison to private cars, the lower the level of emissions and energy consumption of the transport system operation overall.

While land use policies play a significant role in influencing modal choices, the focus here is on the characteristics of the transport systems provided (rail, bus, walking, cycling…), in terms of the density and quality of networks, service frequency and fares; and, in the case of car use, the cost and availability of parking spaces, and any disincentives to car driving (e.g. access restrictions or road pricing). The balance between these influences the modal choice i.e. the shift from more to lower carbon intensive-modes (e.g. from private cars to public transport or active modes), as per the considerations above.

13 Here it refers to SUMPs where it also applies to a wider type of Plans – Transport and others.

14 See chapter 3.1, page 20 in the explanation of the EIB carbon footprint methodology

15 https://transport.ec.europa.eu/document/download/6fd194f0-1618-45c8-822e-1b13e808eb23_en?filename=COM_2023_441.pdf

16 https://transport.ec.europa.eu/document/download/c1472590-4276-49b8-9194-8300f6197e2c_en?filename=COM_2023_440.pdf

1. PLANNING URBAN MOBILITY DECARBONISATION

Improve

Promoting the renewal and technological transition to low and zero-emission vehicles can also contribute to the reduction of emissions, same to improving the traffic regime. The choice of a technical solution for urban mobility investments may equally contribute to reducing the carbon footprint.

Implementing fully the whole "package" of measures developed in the SUMP (including the softer ones) is essential for the achievement of the agreed climate change targets. The impact of the implemented package needs to be fully monitored, both to learn lessons about any implementation issues (process evaluation) and to assess the overall effectiveness in reducing CO2 emissions (and other high-level policy objectives). This information then feeds back into the long-term carbon reduction strategy, which may need modifying to meet the final zero-carbon target.

Box 1. The eight SUMP principles to mitigate climate change

The SUMP Guidelines spell out eight principles that build the core of every Sustainable Urban Mobility Plan which are equally and easily applicable also to mobility decarbonisation throughout the SUMP cycle. 17

(1) Plan for sustainable mobility in the entire 'functional city': A large number of trips within a city are relatively short whereas trip connections between a city and its surrounding area (esp. commuter traffic) are significantly longer and responsible for a high amount of CO2 emissions in absolute terms. This is one of the primary reasons18 why mobility planning for climate change mitigation has to consider the entire "Functional Urban Area" (FUA).

(2) Cooperate across institutional boundaries: A coordinated approach across spatial, administrative and public-private boundaries is important for climate change mitigation to touch upon the dimension of urban governance: services location, generation and distribution of energy, digitalisation, data, etc.

(3) Involve citizens and stakeholders: The transition toward decarbonisation of urban mobility will demand fundamental changes in urban mobility patterns and behaviour. Citizens and stakeholders need to be encouraged to raise their concerns, share their ideas and actively contribute throughout the planning process to ensure acceptance and support to minimise political risks and facilitate implementation.19

(4) Assess current and future performance: Decarbonising mobility requires detailed knowledge of the current amount and sources of GHG emissions in the functional urban area. A baseline against which progress can be measured and assessing future performance means conducting a thorough ex-ante estimation of whether a proposed set of measures can realistically deliver the desired GHG reduction at the required speed.

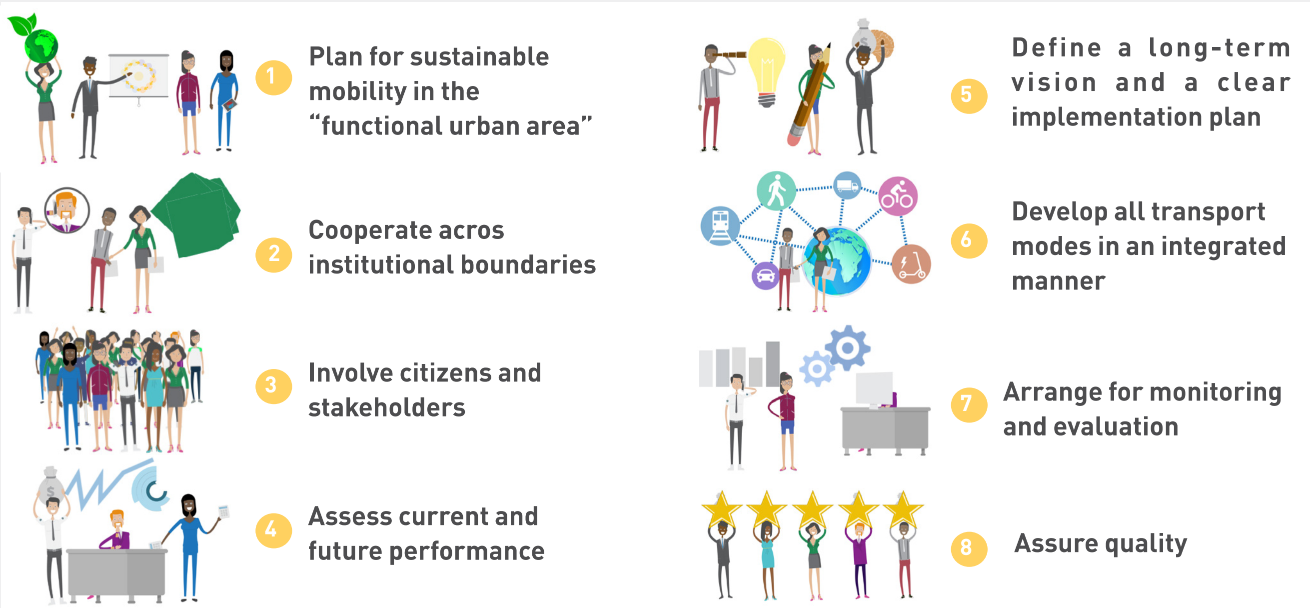
(5) Define a long-term vision and a clear implementation plan: Climate-neutral futures and timelines may be different for cities. This makes it necessary to articulate an explicit societal vision of what the future city would look like to be and translate this into a clear implementation plan.

(6) Develop all transport modes in an integrated manner: The Avoid-Shift-Improve approach plays an important role in the climate-neutral development of all transport modes. Cities can promote telework and teleservices to avoid certain trips altogether while shifting many car-based trips to low/zero-carbon modes and still improve their strategy for mobility electrification.

(7) Arrange for monitoring and evaluation: The effects of all SUMP measures have to be closely monitored to detect early on whether the impacts are sufficient to decarbonise urban mobility by the specified date. This will allow for the adjustment of measures to remain on track or to adapt the strategy to new climate goals, accounting for the continual evolution of climate change.

(8) Assure quality: Following the recommended steps of the SUMP cycle while providing the necessary resources (staff and funding) plus quality control mechanisms will assure the quality of the SUMP to achieve mobility decarbonisation.

Figure 2. The eight SUMP principles (Source: SUMP Guidelines, 2019)



17 Rupprecht Consult (editor). 2019. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition. https://www.eltis.org/sites/default/files/sump_guidelines_2019_interactive_document_1.pdf

18 Others include the importance to secure political support from local authorities in the wider area and to facilitate appropriate data collection and analysis, measure planning and implementation.

19 As an example: Ensuring the delivery of benefits for non-resident commuters from suburban or rural areas in terms of time/money saved will help gathering a critical mass of support and avoiding a typical win-lose antagonism.

2. The path to Decarbonisation of urban mobility

2.1. A succession of SUMPs on the transition path to net zero

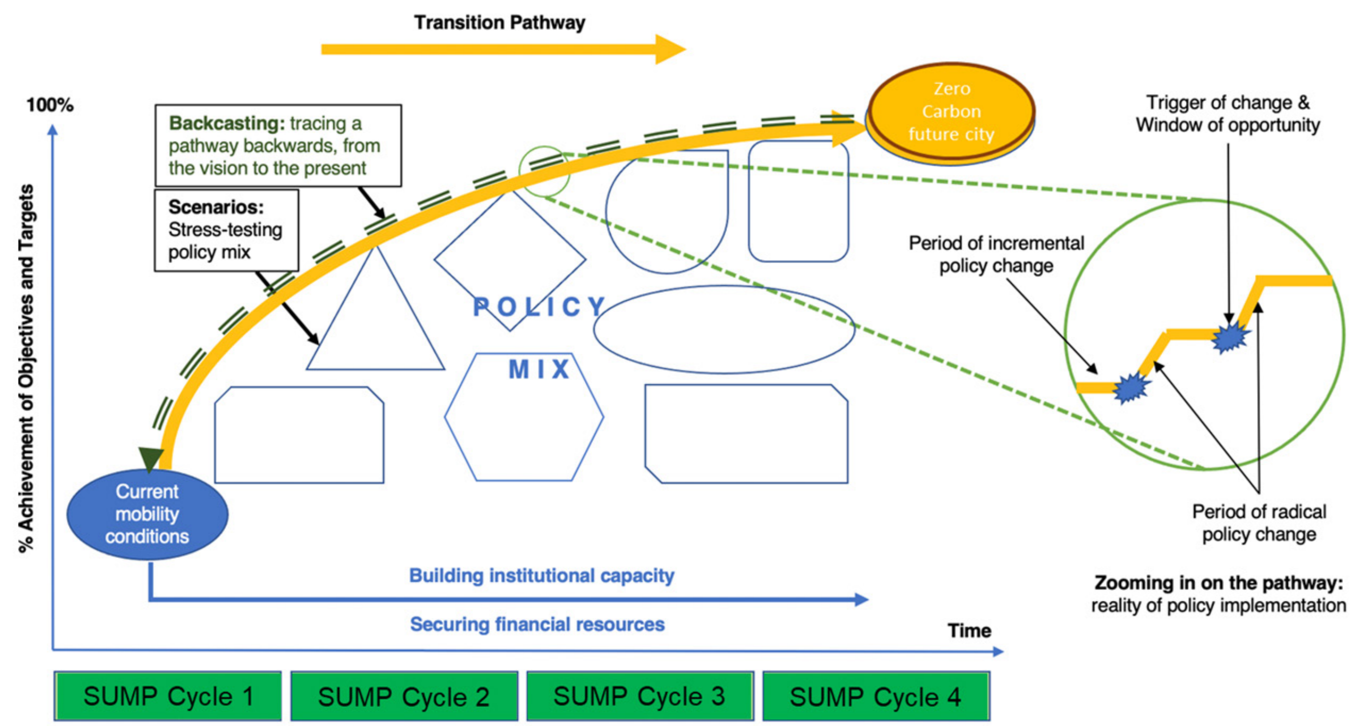
In most cities, the path towards zero carbon emissions from urban mobility will span over more than one SUMP period. The "European Green Deal" has determined the net zero carbon objective across all sectors until the year 2050. The "fit for 55" package has determined interim objectives until 2030 of a net 55% carbon reduction across all sectors against 1990. The 55% objective is supported by a package of legislative and political measures across relevant sectors. The general net zero objectives cannot be achieved in every sector individually. In the transport sector (urban mobility applying on a pro-rata basis) the basis is not 100% of 1990 but more than that and would thus have to go down from that level to 45% in 2030, which will only be achievable where substantial progress has already been made. Meeting the 2030 target requires an ambitious reduction of private motorised transport in urban areas from an average of 44% modal share in 2019 to 20% in 2030.

The sustainable urban mobility transition in European cities could lead to net benefits of up to €177bn by 2030. Of these net benefits, saved costs from reduced CO2 emissions, pollution, noise, and fatalities (externalities) amount to €79bn in 2030. This means that on average, each euro invested in the transition can generate up to €3,06 by 2030[20].

The actual impact of certain policy areas can be determined from a longer-term perspective. The achievement of a long-term zero-carbon transition strategy can be viewed in the following terms in Figure 3.

Starting from the current position of an urban mobility system that is highly carbon-dependent in the bottom left, the goal is to arrive at the top-right part of the figure, when the target of 100% carbon-free urban mobility has been reached. This will require the development of a mix of strategies, introduced at different times and with varying durations of implementation. Recognising that progress may well be a 'bumpy road', depending on political and funding cycles.

Figure 3. Developing a full-length Transition Strategy (Source: UCL, 'SUMP-Plus')



20 Borgato, S., Fermi, F., Chirico, F., & Bosetti, S. (2021). Study on costs and benefits of the sustainable urban mobility transition-D3: Final Report EIT Urban Mobility-Mobility for more liveable urban spaces. EIT Urban Mobility. https://www.eiturbanmobility.eu/wp-content/uploads/2021/10/Final-report_Long-version.pdf

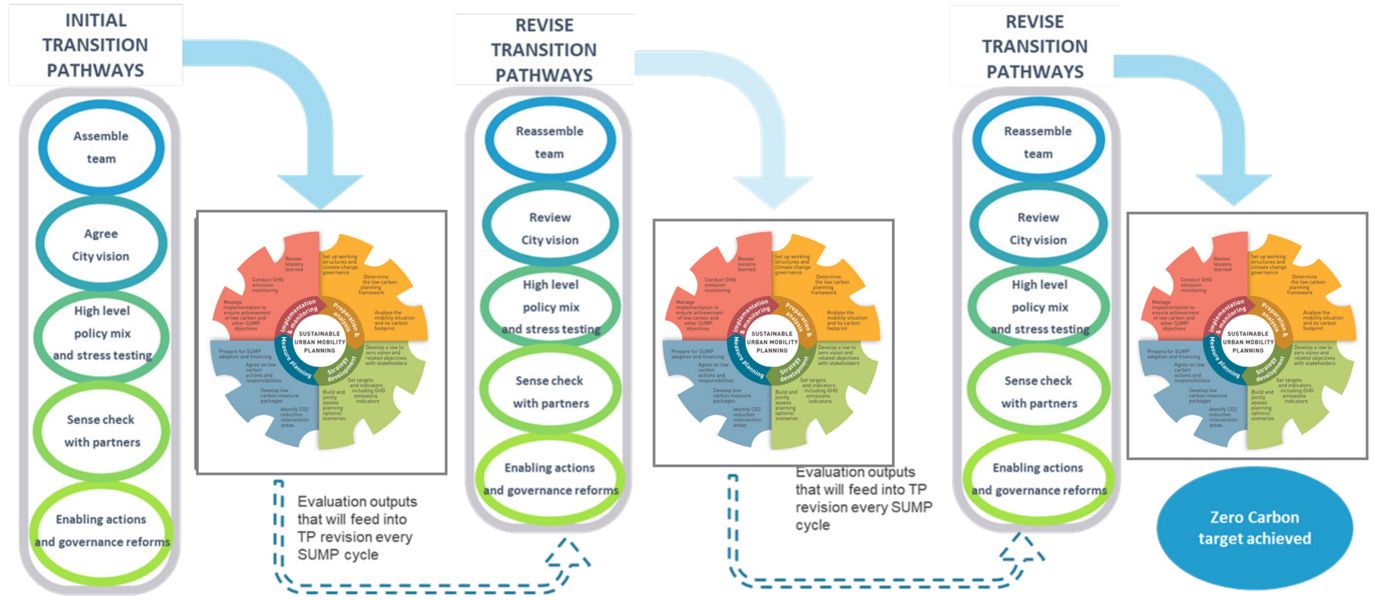


Figure 4. Interrelationships between Transition Strategy and SUMP cycles (Source: UCL, 'SUMP-Plus')

Over time, in most cases, there will need to be a build-up of institutional capacity and financial resources.

Achieving the long-term carbon goals will require a symbiotic relationship between the formulation of this long-term transition strategy and its implementation, via a sequence of SUMP cycles, as illustrated in Figure 3.

The initial development of a long-term transition strategy feeds into the start of a SUMP cycle, during which the high-level strategies are turned into specific policy mixes that drive the selection of actual measures (e.g. a strategy to reduce car use by 10% is translated into specific active travel and public transport improvements, and traffic restraint policies, such as parking restrictions). The resulting (groups of) measures are implemented, monitored and evaluated. Their effectiveness is fed back into the high-level transition strategy, which may well need to be modified. Where a long-term transition strategy has not been developed or clear mobility goals toward climate neutrality target not yet envisaged, the SUMP preparation process already represents a step in this regard and a tool for carbon emissions reduction.

The process for developing a long-term transition strategy, made up of the Avoid-Shift-Improve components is comprised of several steps and will require extensive stakeholder engagement, for several reasons:

- They are experts in their own fields (e.g. from electricity distribution to bus service operations);
- There will be a need to have a common understanding and agreement on targets and measures and general support;
- The implementation of many of the measures (e.g. online service delivery) will fall onto other stakeholders.

3. Sustainable urban mobility planning steps for climate change mitigation planning

The established SUMP concept provides the short- to medium-term planning and implementation framework to reduce the carbon footprint of urban mobility. Where possible, this should be based on the development of a long-term climate change mitigation strategy (also referred to as "long-term transition strategy" or "Transition pathway") across sectors or specifically for urban mobility (see chapter 2). In other words, linking climate change mitigation planning with their SUMP should help cities to plan and deliver specific low and zero-carbon emissions mobility solutions.

To do this systematically, it is necessary to "weave" climate change mitigation strategies into the established SUMP process.

This chapter provides guidance, including suitable methods, tools and activities, on the way toward achieving a sustainable and low-carbon city. It aims at complementing what is detailed in the general SUMP guidelines with a focus on integrating climate change mitigation strategies and goals in the SUMP process. It constitutes stand-alone guidance on the topic and therefore, a coherent complement to the general SUMP guidelines.

Because cities might be at very different starting points, there is no single ideal way to tackle this. It is highly dependent on the specific situation and the status of the local SUMP, the existence and quality of local climate action plans and the availability of a long-term mobility transition strategy.

- If your city does not yet have a SUMP but is in the process of kicking it off, it is a great opportunity to also integrate climate change mitigation planning and delivery, from the start. This guide will offer a practical framework for such a combined approach.
- If your city already has a SUMP in place, climate change mitigation planning can still be integrated. A reflection and update of a SUMP, considering evaluation results, public acceptance issues and recent developments is always a good idea.

Figure 5. SUMP Cycle integrating guidelines to decarbonise mobility

- If your city already has a climate action plan established, then this guide can support the integration of carbon reduction goals for mobility into your SUMP processes.

The SUMP cycle is a simplified and idealised representation of the overarching SUMP planning logic, broken down into four separate phases with smaller steps within each. It has proven very helpful for planners to structure and keep track of a complex process. The four phases are:

1. Preparation and analysis,
2. Strategy development,
3. Measure planning, and
4. Implementation and monitoring.

Depending on the local and regional situation, certain steps and activities can be adapted and skipped (if equivalent results are already available, e.g., from a related planning process) or repeated at a later stage. Such adaptation to the specific situation must be carried out by the local and regional actors themselves.

3.1. Phase 1: Preparation and analysis

Set up working structures and climate change governance

The urgency of working across sectors and boundaries, as described in step 1 of the general SUMP guidelines21 increases when preparing a low-carbon SUMP. Some stakeholder engagement activities will be required to develop a long-term transition strategy (as mentioned in chapter 2), so it may be that many of the same people and groups can be invited to collaborate in the development and implementation of the SUMP.

Practitioners need to define a core working structure and set up a strong basis for cooperation between different departments within the city and, if encouraged by national policy or if governance structures exist, between local authorities at the Functional Urban Area (FUA) level. Even if the SUMP cannot be established for the entire FUA, the reduction of the GHG footprint of mobility requires a detailed understanding of transport and urban development interdependencies at the level of the FUA. Climate change mitigation requires relevant stakeholders and municipalities to at least cooperate within the respective area to gather and analyse data.

The existence of institutional fora, where such regional issues can be discussed may provide an initial institutional basis for that. In most cases, there is no need to establish such structures from scratch. Rather, identify and connect with related existing activities, platforms and associations. They might not always already have a focus on mobility but they can open the door and provide a basis on which SUMP-related topics can be productively discussed.

Vertical integration

Cities are in charge of important levers to speed up climate change mitigation, especially in the area of mobility and spatial planning. However, many other levers are beyond the sphere of influence of cities. The decarbonisation of all aspects of life, including mobility, has to be addressed at all geographical and political levels, the higher the stronger its impact. Urban Mobility practitioners need to consider higher integration with the regional and national level which includes coordination, negotiation, lobbying or conflict regulation. By bringing key representatives on board from the start, practitioners may ensure stronger political support from the start at both the local, FUA, regional and national levels, facilitating an alignment of objectives, goals and measures.

Depending on the intensity of cooperation required and the incentives provided at the regional and national level, practitioners could aim for a formal cooperation agreement beyond the city level, formal agreements on association or cooperation with each municipality within the FUA.

Involving the public, citizens and mobility users

More than most other sectors decarbonisation of urban mobility impacts the live styles of citizens and requires behavioural change (work, leisure, shopping, family life, etc.). Citizens and grass root community organisations already active in requesting and promoting those changes need to take part in the process from the start. These actors can contribute actively throughout the Climate Action Planning and the SUMP process. Involving them from the start will ensure their buy-in to the project and facilitate the acceptance of less popular measures.

Horizontal integration

Setting up working structures and cooperation mechanisms is also necessary at the local and regional level with other departments, such as land-use planning, energy, environment, etc. These cooperation mechanisms will be used throughout the planning process as they will bring together a plurality of competencies and secure a diversity of capacities and

21 Rupprecht Consult (editor), Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition, 2019, https://www.eltis.org/sites/default/files/sump_guidelines_2019_interactive_document_1.pdf

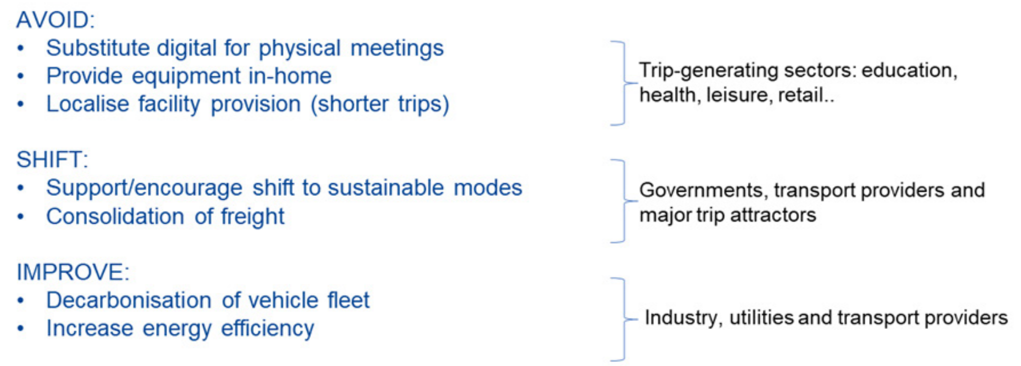


Figure 6. Multi-sector collaboration following the Avoid-Shift-Improve strategy (Source: UCL, 'SUMP-PLUS')

resources. Interested private sector and stakeholders could also be involved from the start. They can be beneficial for creating public-private partnerships early on to gain support and encourage innovative pilot measures. Working closely with the private sector, including electricity generators and distributors (TCOs/DCOs), electromobility providers and charging point operators, potentially ride-sharing companies and fleet managers, as well as key trip-generating sectors, will enable practitioners to follow an integrated approach for their SUMP and have an impact on land use to promote decarbonized mobility.

In practice, cooperation can manifest in different ways, for example, through regular meetings, the exchange of newsletters, work shadowing, written cooperation agreements, the establishment of data sharing IT infrastructure, data standard conventions, the creation of a joint glossary etc. In all of these cases, there is a component of trust between human beings. The importance of personal encounters should therefore not be underestimated.

Once the vertical and horizontal working structures and collaborations have been discussed and set, practitioners may be able to assess the capacities and skills already available, but also identify the gaps they have and may need to fill by hiring additional staff or learning new skills that are indispensable for climate mitigation planning. At the end of this first step, clear organisational arrangements should be in place.

Examples of some of the stakeholder groups that need to be involved in the implementation of Avoid-Shift-Improve strategies are illustrated in Figure 6.

Practice Example

Setting up working structures and climate governance: Budapest, Hungary – revision of the SUMP under development based on the city's SECAP and with institutional, professional and public consultation

A revision of the Budapest Mobility Plan 2019 is currently under development, based on the city's SECAP adopted in 2021. The revised SUMP will put more emphasis on environmental aspects, which are the main evaluation criteria for the assessment of mobility development projects included in the plan. To do so, BKK (Budapest Centre for Transport) has invested in internal capacity building and upskilling processes of its staff which resulted in the creation of an expert team working together with a newly formed department to develop the revised SUMP. Cross-sectoral collaborative structures have been set in three levels according to responsibilities and level of involvement in the plan revision:

Institutional consultation: The Balázs Mór Committee is a regular expert consulting forum established by BKK's CEO, the largest public transport company in Hungary. The committee consists of representatives of the stakeholder organisations that had taken part in the preparation and implementation of transport development projects: Municipality of Budapest/Mayor's Office, Ministry of Innovation and Technology, Centre of Key Government Investments, Municipality of Pest County, Budapest Közút Zrt. (Road Manager), BKV Zrt., National Infrastructure Development, MÁV Zrt., MÁV-HÉV Zrt., MÁV-START Zrt., Budapest and Pest County Chamber of Engineers.

Professional consultation: The Balázs Mór Club is the middle level of partnership, which is a professional consultation forum with NGOs, planners and other external/internal experts.

Public consultation: BKK used a questionnaire to survey the opinion of Budapest residents regarding the uncovered problems and the objectives. The most important result of the survey was that more than 87% of respondents agreed with the most important strategic goals defined by the BMT: that the number of environmentally friendly means of transport should be increased by 2030.

Source: Stakeholder workshops held in preparation for this topic guide and BKK, 2019.
BKK. (n.d.). Budapest Mobility Plan. Retrieved October 10, 2022, from https://bkk.hu/en/strategy/budapest-mobility-plan/

At the European level	At the national and regional level	At the city level
• EU Green Deal and EU Climate Law • Fit for 55 package • EU Smart and Sustainable Mobility Strategy • Energy Governance Regulation • 2030 Climate & Energy Framework • EU Taxonomy and its Delegated acts • Climate Financing Plans	• National Energy and Climate Plans (NECP) & National and/or Regional Adaptation Strategy • National and regional climate change mitigation policies • National and regional land use plans • National and regional environmental plans • Sustainable Energy Action Plans (SEAP) • Sustainable Energy and Climate Action Plans (SECAP) or other national and regional energy plans	• City's environmental, climate or resilience or adaptation strategy

Table 1. List of existing plans that can be assessed

Determine the low-carbon planning framework

This step is one of the key steps of the process to fully integrate climate change mitigation planning in your future SUMP as it is an opportunity to assess all relevant planning from multiple sectors, and align with their goals and objectives as well as timelines. This step will result in having a comprehensive understanding of the strategies already in place in terms of climate mitigation at the local and national levels while also considering strategies of other sectors such as land use and energy.

Define the geographical scope

A low-carbon SUMP should cover the functional urban area as longer trips in the FUA may represent few of the total urban trips but produce higher amounts of CO2 than shorter urban trips. In addition to securing political support from local authorities in the area, defining the FUA as the main scope of your SUMP will ensure appropriate data collection and analysis and measure planning and implementation at the FUA level. Therefore, a SUMP that covers the entire urban agglomeration will be much more effective at reducing GHG emissions than one that covers only part of it.

Based on the traffic analysis, the functional urban area can cover an area where the large majority of commuting trips take place. Other threshold criteria can be applied depending on the specific focus and indications. Practitioners could identify within these boundaries the modes that would be potentially impacted by the SUMP and would have a relevant impact on GHG emissions as a result of their respective modal share.

Assess existing plans

The SUMP needs to be coherent with and contribute to other key plans and strategies from the EU, national, regional and local levels that have an impact on urban planning, land use planning, air quality, environment, energy, innovation and research & development. These plans should cascade the objectives of the main international agreements, such as the Paris Agreement, into more sectoral and area-specific targets, namely for GHG reductions. The National Energy and Climate Plans (NECPs) sets the frame of minimum objectives[22]. Regional or local Climate Action Plans under whichever title may specify the objectives and some core measures[23].

Certain plans could be assessed (Table 1.)

Align with existing plans

Existing plans need to be aligned in two important ways. Firstly, they need to be free of contradictions or, ideally, mutually reinforcing and informing. This is not always the case, for example, if a housing shortage is being tackled with new single-family homes outside existing strong public transport corridors. Secondly, existing plans need to be synchronized in the sense that they work towards compatible time horizons because only plans that are coordinated can be coherent.

To align the work within the city and the timelines for the preparation of the two plans, SUMP & Climate Action Plan, bringing departments together is crucial. This could be informed by a long-term transition strategy as presented in chapter 2 of this guide. In case it does not exist the SUMP could precede the long-term strategy, which in any case will have to ensure close to zero emissions by 2050. By doing so, the departments will be able to carry out baseline emission inventories jointly in the next step and therefore combine competencies and save resources. To get political support and long-term planning, the goal is present the two strategies as interlinked, serving the wider objectives for decarbonisation and improving the quality of life for citizens in the city.

By aligning these plans, practitioners will have a solid knowledge baseline to then set up a strategic framework to create an implementation plan for climate goals in SUMP.

22 It is however noted that some of those NECPs might not already be aligned with EU climate neutrality target and this will be object of upcoming revisions in near future.

23 If you see inconsistencies in regional or local climate action plans, give some recommendation and try to change those documents.

Analyse the mobility situation and its carbon footprint

It is recommended that the analysis phase of SUMPs is concluded and summarised in the form of a substantiated SWOT analysis (i.e. Strengths, Weaknesses, Opportunities and Threats), including a particular focus on the GHG emissions aspects.

The analysis should address, among others, the following questions, which are of particular importance regarding climate change mitigation[24]:

- What has been the evolution of transport-related GHG emissions in recent years? How are emissions expected to evolve in the following years in the base scenario (i.e. scenario without considering SUMP planned measures?
- What is the availability of motorized individual traffic (ownership, car sharing, etc.)?
- What is the availability of public transport, bike and pedestrian infrastructure and sharing services?
- What is the average trip distance?
- What are the primary energy sources for the transport system? What has been the evolution in recent years and how are they expected to evolve in the base scenario?
- What are the main drivers for the historical increase and decrease in GHG emissions? What is the modal split development?
- Which transport functionalities, Origin/Destination (O/D) relations and categories are the most important in terms of emissions? Which transport subsectors have made significant progress in terms of the reduction of emissions?
- What would be the most competitive and sustainable alternatives? If the case, why are they not used to a greater extent?
- Are the current policies in place effective for climate change mitigation, and if so, which ones are more relevant for transport/mobility? Which additional ones could be recommended?

There are several available recognised references in terms of guidance, tools or methods for the evaluation of GHG emissions for transport. While slight differences might be identified in their reporting purpose or scope covered, generally the principles for this calculation can be summarised simply:

> **Emissions (in TCO2) = Transport activity data (e.g. veh-km, train-km, tonnes-km, ...) x Emission factor gCO2/veh-km, train-km, tonnes-km, ...)**
>
> **(Emission factor in turn is a function of Energy consumption – litres/km or kWh/ veh-km, train-km, ... x CO2/litre or CO2/ kWh)**

This step presents simple but robust calculation methods of GHG emissions focused on transport strategies (including SUMPs). The calculation is based on EIB Project Carbon Footprint Methodologies[25].

As per above, fundamental factors to accurately estimate GHG (CO2 e)[26] emissions are traffic data - current and predicted – including, particularly, modal shift assumptions/predictions.

A sound analysis of transport demand for SUMP would generally include the preparation of an appropriate

24 The analysis of current traffic/demand of transport systems covered might inform a number of those questions.

25 The reference in the Commission Notice — Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (OJ C, C/373, 16.09.2021, p. 1, CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XC0916(03))

26 In accordance with the referred methodology, emissions of greenhouse gases other than carbon dioxide CO2 (i.e. methane CH4 and dinitrogen monoxide N2O) in transport are not included because their impact is regarded negligible. For calculation purposes, the GHG emission factors can be considered as CO2e.

multimodal traffic model[27], reproducing the status of traffic on the different transport networks covered (flows by different modes, vehicle categories, vehicle routes, flow, capacity ratio, level of congestion, etc.). Many of the current traffic models already include a module for the calculation of CO2 emissions, both at the level of the project corridor and area (plan).[28] Annex 6 "GHG Emission calculation in SUMPs" describes the "core" considerations for the calculation of GHG emissions in the SUMP preparation process.

For smaller cities and cities which do not yet dispose of an ex-ante estimation of transport demand, it is recommended in general to develop such a tool possibly in conjunction with a group of surrounding/bordering other cities in the context of an FUA. In the interim period, a simpler transport demand assessment could be considered, based on readily available and ad-hoc collected data (e.g. starting from origin-destination, etc.), so that analyses, hypotheses and measures are developed based on actual data and not purely on qualitative assumptions.

Overall, cities implementing a SUMP to decarbonise their mobility need to have a minimum amount of data available to assess the current situation. Cities can make the best use of existing information available beyond the border of their cities, for example, available at the regional or national level, to cope with data availability and scarcity.

3.2. Phase 2: Strategy development

Develop a low to zero vision and related objectives with stakeholders

The SUMP vision will be aligned to the low carbon planning framework, as referred above, to the long-term transition strategy and/or relevant goals in the sector/country and will be translated into general and specific objectives. The vision might look also into the long-term goals (i.e. till 2050) and shorter terms ones (e.g. within the time horizon covered by the SUMP measures implementation).

Therefore, the SUMP-related objectives for climate mitigation would derive from both the analysis undertaken in both policy level strategies (including climate change strategies available at different administrative/sector levels referred to in the previous chapters) as well as the transport-specific analysis carried out.

Those objectives can be quantifiable to the extent possible and appropriate and translated into indicators (see below) within the relevant time horizon.

- Climate change mitigation (i.e. decarbonisation) objectives and their related KPIs - in particular those on GHG/CO2 reduction - should be included among the set of strategic objectives driving the choice of measures identified in the SUMP.
- SUMP objectives can also be transparently cross-referenced with those specific to the environment deriving from the SEA process.

In alignment with SUMP principles, it is expected that those climate mitigation objectives will provide complementarity and consistency with other main objectives of the SUMP, for example, aiming at increasing the use/share of Public Transport.

Box 2. Path to decarbonisation

Often specific mobility planning interventions (e.g. a new tramway) dominate the agenda in the political process. Nonetheless, decision-makers need to keep in mind mitigation targets going beyond the planning interventions and the path to decarbonisation. This means to think in a succession of SUMP cycles. The following questions are intended to explain this sequential process:

Where are we now? Identifying the actions and measures already taken and implemented in the city and at the FUA level to decarbonise mobility. Evaluate how these actions and measures are going and how impactful they are to achieve the goals.

What will our plans achieve before 2030? Identify clear goals to achieve and which can be monitored during the SUMP implementation.

Where do we want to be in 2030? Identify overarching goals from the region, national or European level and identify how the city's vision can align with those overarching goals. Ambitious targets in SUMPs, an appropriate set of measures, and a solid monitoring structure are essential to define, approach and verify the path.

27 It is noted that transport models developed and/or used in the context of the overall SUMP preparation process (i.e. understanding and assessing transport demand of different modes and respective impacts including its forecasting) might benefit from already existing models at regional or national level as well as other mobility data/surveys of the area.

28 In certain cases, e.g. for smaller area plans such as those concerning mainly the optimization of circulation schemes or the deployment of "softer measures", notably intelligent transportation system ("ITS")/traffic management, it is recommended to use microsimulation models. These models enable a more detailed and accurate modelling of traffic behaviour and traffic/circulation characteristics, such as "stop&go" situations that strongly affect the level of emissions. The models are rapidly expanding their possibilities and could be used more frequently. Their principal limitation is that usually they do not enable modelling of public transport, so they will always have to be used in combination with more traditional models for this purpose.

Practice Example

A low to zero vision and related objectives with stakeholders: Vienna, Austria: The use of a strategic framework to achieve long-term climate-related smart city goals

The City of Vienna aims at finding a way to achieve its climate neutrality with the implementation of a strategic framework. This strategy pursues three main objectives: quality of life, resource conservation and innovation.
The City of Vienna focuses on a high quality of life, life satisfaction and social inclusion by adapting its policy designs and administrative activities. With the help of resource conservation, per capita greenhouse gas emissions are to be reduced by 50% by 2030 and by 100% by 2040. In the same period, the per capita final energy consumption is to be reduced by 40% by 2030 and by 70% by 2040. The share of journeys in Vienna by eco-friendly modes of transport is to rise to 85% by 2030 and well over 85% by 2040.
The city of Vienna also sees its opportunity for climate neutrality in the area of innovation. One objective of this strategy is to be an innovation leader in 2030 and to be Europe's digitalisation capital in 2050.

Figure 7: Vienna's strategic framework

Source: Scholz, A., City of Vienna, 06.04.2022, "Objectives for sustainable Mobility in Vienna", presented during the "Assessing Climate Actions & Monitoring in the framework of the SUMP process focussing on climate mitigation policies and measures" workshop organised by Rupprecht Consult & EIB JASPERS

Set targets and indicators including GHG emissions indicators

Setting targets and indicators for GHG emissions refers to the methodologies, considerations and calculation principles presented in the Annex 6.

The indicators related to the most relevant objectives, in particular those deriving from high-level policies (i.e. long-term carbon-zero transition strategies at national/regional or sectoral level as available), should be considered as SUMP KPIs.

Since the objective is to decrease absolute emissions when compared with current levels, it is recommended to incorporate the following core indicators:

1. **Current Absolute Emissions** = total emissions produced in the base year, associated with operations of all the modes considered relevant within the considered boundaries.
2. **Absolute Emissions** = total emissions produced in the selected SUMP Scenario/Option, also associated with operations of all modes considered relevant within the considered boundaries –for a given/selected future time horizon (year). Based on these two indicators, the main indicator of (relative) Emissions for the SUMP can be calculated:
3. **Current vs Plan Emissions**[29] = difference between Current Absolute Emissions and Absolute Emissions for the defined SUMP time horizon and scenario/option.

This last indicator in particular could become one of the key KPIs of the SUMP. The target value for this indicator should be derived from the relevant national (for example Denmark: 70 % reduction until 2030[30]) and European level policy choices ("fit for 55", see chapters 1.1 and 3.1) or other sectoral or regional/local policy decisions that might be developed in the context of long-term transition strategies. In the case of GHG emissions, the main references at the national level are climate strategies

29 This is the proposed revised way of calculating relative emisisons for plans (SUMPs) in comparison to the standard methodology for projects as per the EIB carbon footprint manual.

30 The Climate Act, approved by the Danish Parliament in June 2020, sets legally binding targets of a 70 % reduction in GHG emissions by 2030 (compared with 1990) and climate neutrality by 2050 at the latest. In addition, the government must set sub-targets every five years.

and/or legislation and the National Energy and Climate Plans (NECPs), which could have been "cascaded" down to the sectoral and local levels. A further step in this direction could be based on the reverse extrapolation of the level of GHG emissions to the 1990 levels, to ensure the SUMP objectives are defined based on the comparison with 1990, i.e. the base year of the Paris agreement (as well as EU and national objectives).

Further work might be needed to establish the appropriate value for the KPIs at the SUMP level from the above-referred climate targets. These values may have been defined in consultation with national authorities where GHG reduction targets per sector and specific administrative divisions are set. Where this is not the case, the team working on the SUMP should aim at engaging with local authorities to agree on a methodology to determine objectives and appropriate target values. This could include a simple "pro-rata" split of a combination of different factors such as surface area, population, density, GDP (total/pro-capita), the sector's or area's current and forecast contribution to GHG production, etc.

Another element to consider in a more detailed level of analysis is what could be referred to as micro-areas[31]. The main objective in a micro-area is to eliminate direct emissions from traffic (e.g. NOx, particulates etc.), independently from the "global" GHG impact (e.g. in certain "protected" pedestrian areas, historical centres, nearby hospitals, schools, etc.). This level would not be covered by the indicators and would not be considered when selecting the SUMP scenario/option but would play a role in guiding the selection of the lowest impact measures for these specific cases.

The total set of SUMP indicators should include also those associated with a wider set of objectives, in particular those deriving from high-level policies. Some examples of SUMP indicators (KPIs), including those relevant to urban mobility decarbonisation and climate change, include:

Table 2. Set of indicators for a decarbonised urban mobility

Strategic/general objective	Measurement / indicator calculation	Definition of target values and sources (other plans, Laws, Policies, etc. – EU/national/regional/ metropolitan/...)
1. Climate change mitigation	1.a. % of reduction of emissions of greenhouse gases, measured in tons of CO2 equivalent	
	1.b. Reduction of energy consumption	
	1.c. Use of renewable energy or share of renewable energy in transport	
2. Climate change adaptation	2.a. Climate risk reduction (qualitative assessment)	
3. Compliance with the environmental thresholds	3.a. Polluting emissions of NOx, CO, PM10 and PM2.5, etc.	
	3.b. Noise and vibration	
	3.c. Potential additional elements	
4. Safety	4.a. Fatalities	
	4.b. Serious injuries	
5. Metropolitan accessibility	5.a. % travel time reduction between municipalities by PT	
6. Financial sustainability	6.a. % increase in ratio income from tariffs/ O&M costs for public transport services	
	6 b. optional: Total transportation costs for citizens / commuters	

31 For example a stretch of road or an area along which certain car emission categories (e.g. below Diesel Euro 5) are not admitted or a low emission zone with the same type of restriction.

Practice Example

The use of Indicators in a SUMP toward climate mitigation: Barcelona, Spain and its implementation of the SUMI indicators.

During the SUMI project (2017-2019) an indicator focusing on Greenhouse gas emissions of passenger and freight mobility within urban areas has been defined. The indicator is evaluated in terms of well-to-wheels GHG emissions per capita (t CO2 eq/ cap per year) and can be estimated by filling out the related calculation spreadsheet[1]. The key data for the estimation of the parameter is related to transport performance by mode (i.e., in terms of distance driven by transport mode and vehicle type) and vehicle fleet composition by mode and fuel technology, complemented with the related energy consumption factors and CO2 emissions coefficients by fuel type.

The estimation of GHG emissions is based on carbon content related to energy consumed by fuel type, taking into account mobility in the urban area. With this respect, energy consumption factors and vehicle fleet composition are applied to transport performance to estimate the overall energy consumption by fuel type. The emissions are estimated taking into account both passenger modes[2] , freight road transport modes (HGV and LDV) and specific fuel technologies considered for the vehicle fleet[3].

The indicator related to GHG emissions has been successfully estimated during the project by 14 urban areas, out of the 46 urban areas testing the whole SUMI indicator set. Among them, the metropolitan area of Barcelona filled the required input based on data reported in the Metropolitan Plan For Urban Mobility 2019-2024[4]. The document includes information on vehicle fleet composition and transport performance, resulting from a transport network modelling tool which was used for the evaluation of the measures of the Metropolitan Plan. AMB developed an integrated model of intra-urban mobility to assess population exposure to traffic emissions and health impacts. The model was used in the Strategic Environmental Assessment of the Barcelona Metropolitan Mobility Plan (PMMU). For the calculation of the SUMI indicator, some difficulties were reported about having updated data on vehicle fleet composition in circulation and disaggregating some vehicle categories (for instance, LGV vehicles categories). Nevertheless, the current monitoring system of LEZ (ZBE Rondes Barcelona) and the data of the Working Day Mobility Survey (EMEF) would allow for improving the availability and reliability of data about this issue.

The energy consumption factors and CO2 emissions coefficients by fuel type used for the estimation were the default values available in the calculation spreadsheet. The availability of transport models has been reported as a key aspect of cities to provide the required information for the GHG emission indicator. In this sense, several cities – especially smaller ones – tend not to have access to these tools and therefore concrete suggestions could be developed for possible proxy data sources and/or support cities to strengthen their ability to work with geospatial data and transport models, ideally through a kind of toolbox (e.g. simplified aggregated models) of preferably use of open source solutions, open data and EU-wide geodata repositories (in coordination with national and regional data authorities).
The experience of the metropolitan area of Barcelona underlined also the importance of updating regularly the available transport network modelling tool and recalculating the assessment indicators. With this respect, the fine-tuning of the indicator calculation methodology is currently taking place in the SUMI2 project, taking into account the SUMI project's Final Recommendations. The revision of the indicator is expected to be completed by the beginning of 2023.

Source: F.Fermi (TRT Trasporti e Territorio)
Image: SUMI

1 https://transport.ec.europa.eu/other-pages/transport-basic-page/greenhouse-gas-emissions-indicator_en
2 Car, bus, coach, PTW/Motorcycle, Motorised 3-wheeler, metro/tram/trolleybus, light rail, train, Inland waterways ferry
3 Gasoline, Diesel, CNG, LPG, Ethanol, Bio-Ethanol, Bio -Diesel, Hydrogen, Electric vehicles, and Hybrid-Electric vehicles
4 http://www3.amb.cat/repositori/PMMU/APROVA/4%20PMMU_EAE_aprovinicial.pdf

Build and jointly assess planning options/ scenarios

To reach identified objectives, a series of possible measures (i.e. constituting different planning options[32]) could be identified and developed at the level of:

- Organisation: ticketing, traffic associations, harmonization of time schedules, a new approach to coordinating public transport, systemic changes to project planning process, etc.;
- Operation: elimination or introduction of new stops and stations, re-routing of lines, changes in operational concept, rolling stock, traffic management, parking pricing, etc.;

32 Here "planning options" is used while it is also acknowledged the use of "scenarios" in this process of defining planning concepts for SUMP. Since the term scenarios often includes forecasting related factors (e.g. different macro-economic scenarios); planning options is the term used here to refer to alternative and comparable concepts defined exclusively by a combination of organisational, operational and infrastructural measures.

- Infrastructure: extension, capacity increase/decrease, increase/decrease of (design) speed, rearrangement of stops and stations, etc.

These measures could be subject to a qualitative and interdependency comparison to identify a set of reasonable measures. They should be grouped to define operational options, i.e. planning options which could be assessed against the SUMP-defined objectives.

Therefore, this will require the assessment of the planning option(s) in relation to the relevant climate change mitigation objectives (i.e. KPIs for specific time horizon(s) as described above). The assessment of GHG emissions reduction for a certain year(s) in relation to the current/reference year will require assessing/forecasting the relevant transport activity data at the time horizon specified. Those calculations and analyses should be based on a sufficiently robust and adequately representative traffic model and/or based on an adequate transport demand assessment for the specified time horizon(s).

If the minimum established targets of the related KPI(s) (i.e. a certain level of GHG emissions reduction as per the KPI "Current vs Plan Emissions) is not reached by the considered planning option, a new round of measures assessment can be undertaken. This could include more stringent measures increasing the use of lower emission modes, starting from a higher modal shift from private cars to public transport and low/zero emission modes, and policies to set the right incentives / remove barriers for the purchase/lease and use of zero-emission vehicles. In many cases, stricter measures may be needed, including implementation of active travel, public transport priority corridors, reallocation of road capacity reducing the space used for on-street parking, etc. SUMPs will also need to consider policy measures to avoid traffic working with stakeholders outside the transport system to reduce the number/length of the trips.

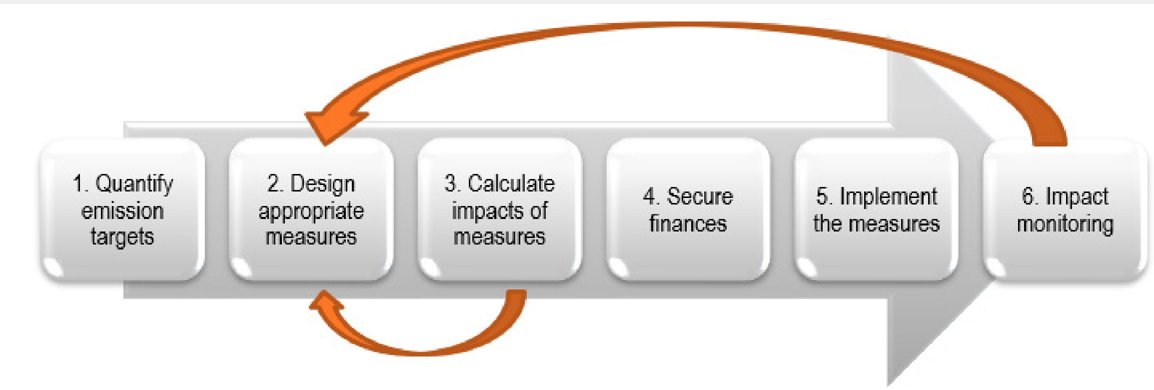
The final choice of the SUMP "planning (operational) option (scenario)" among the X admissible ones (if more than one) will be made including other criteria related to the (main) SUMP objectives and other identified KPIs, (such as safety, financial sustainability, improvement of accessibility/reduction of overall travel times, etc.), see also table 2 above.

Box 4. Use of backcasting approach to set targets and to select options/scenarios

To plan for decarbonised mobility to address the climate crisis, cities will need to switch planning approaches and outcomes: from extrapolating existing mobility trends and increasing road capacity ('predict and provide'), to starting with the end vision, including net zero transport carbon emissions and using backcasting to identify sustainable policy packages that will deliver the intended outcomes ('vision and validate'). The main question to be answered by practitioners will be what measures and measures packages can most efficiently reduce CO2 emissions in mobility to the required level. This could, for example, translate into setting an allowable annual CO2 budget that is reduced over time, leading to the decarbonisation of mobility by a set target date.
For that, a procedure is suggested that can be described as a six-step model:

Figure 8: Sequence of a backcasting process to select options/scenarios

Source: INFRAS, 2021, Overview of Urban Mobility Climate Strategies and Climate objectives in Urban Mobility Plans (SUMPs)



3.3. Phase 3: Measure planning

Identify CO2 reduction intervention areas

Overall, studies have found that cities can avoid a great amount of 'their' greenhouse gas emissions through action at the local level[33]. The most important areas of intervention at the city level include a better integration of land use development and transport to avoid traffic; the incentivisation of work organisation systems that allow decreasing the number of commuting trips (e.g. telework); the promotion of alternatives to the individual car through improved public transport, the (substantial) improvement of cycling conditions and other forms of active mobility, the pricing of inner-city car use, the re-allocation of road and other transport dedicated urban space to other than car modes and all types of smart mobility to shift traffic; and the support of vehicle fleet electrification and other measures to improve transport, i.e. to reduce the carbon footprint of individual motorised transport. Beyond safe and comfortable infrastructure for active mobility, a high-quality public transport service is key to attracting passengers to sustainable mobility options. This comprises reliable and effective/efficient services, barrier-free stations and vehicles, but also affordable fares and adequate levels of (tailored) information. Social tickets or free public transport for school kids provide mobility for population groups that cannot rely on car usage.

New mobility services such as shared vehicles and shared rides have emerged in many cities. New mobility services are often perceived as unnecessary, disturbing the traffic flow, or competing with existing public transport offers, specifically when they operate in areas with already high service quality. These and shared mobility solutions may have the potential though to close service gaps in areas with low public transport coverage, enhance the flexibility of public transport, and increase public transport trips.

Ride sharing (i.e. the joint use of minibuses) can complement public transport in areas and times in which fixed transport offers and timetables may not be efficient, or shared micro-vehicles could serve as first- and last-mile connections in districts where the density of public transport stops are low. Thus, integrating the most often privately operated new mobility services with existing mobility systems can strengthen public transport as an alternative to private motorised transport.

Parking regulations and the conversion of car parking slots into parking zones for shared micro-vehicles which are mandatory to use are a means to limit the cluttering of vehicles on sidewalks.

Pricing inner-city private car use is one of the most common approaches to reducing motorised individual transport and generating revenues for the city budget. Parking management is a widespread measure among European cities.

As a measure for a city to support the energy transition, benefits for electric vehicles (e.g. free parking, where cars with combustion engines have to pay) could be added.

A growing number of cities recognised the need to provide more space for active mobility and public transport. Re-allocating space from car use towards safe active mobility (i.e. the provision of protected bike lanes) and speeding up public bus transport is a means to increase the competitiveness of sustainable mobility. The reallocation of scarce public space at the expense of car infrastructure can imply time-consuming

Box 5. Electrification of vehicles as a city's intervention area

Cities could support the electrification of individual vehicles through public procurement, e.g., through a strategy to electrify bus fleets or vehicle fleets of city administrations (as determined by the Clean Vehicles Directive yet beyond the ratios required there). Vehicle fleets which are run based on local concessions or other forms of public authorisation, e.g. taxi fleets and vehicles used for ride-sharing services, may equally be subject to electrification requirements. Finally, cities can support the electrification of private vehicles through the provision of publicly accessible charging points or the procurement of charging point operator (CPO) services. This can be supported by facilitating the exchange between key players, including energy providers, energy network operators, large housing companies, or supermarkets, whose parking spaces could be equipped with semi-public charging points. Local authorities can also encourage private homeowners to combine PV-powered electricity production with charging rights or charging points, which may then also be offered to third-party charging. Since the installation of roadside charging infrastructure can lock in urban spaces that are dedicated to car use, charging infrastructure development plans need to be aligned with urban road use planning.

Source: Directive (EU) 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles

33 Not all measures can be decided and implemented at the local level and the remaining emissions are within the competence of the national (and European) level. The largest share of costs related to car use and ownership, for example, is usually determined at the national level. This includes vehicle-related taxes or fuel taxation. Complementary measures at the local level comprise parking management – including adequate pricing both for short-term parking and residential parking permits. Moreover, national-level laws may reduce a city's room for manoeuvre; for example, cities in some member states are not allowed to raise congestion charges or to introduce zero-emission zones.

decision-making, planning, and construction processes that may be contentious; but the H2020 'MORE' project has developed processes and tools for stakeholder co-creation of street designs that enhance public acceptability[34].

An ambitious reduction of transport-related CO2 emissions will not be achieved without an energy transition in urban mobility. Although a phase-out of private vehicle use in cities is highly desirable from a climate and quality of life perspective – including e.g. private cars' severance effect and impact on the safety of circulation - cars will remain part of the mobility system in the coming decades. This means that the remaining car fleet needs to gradually shift to zero tailpipe emission (to be necessarily complemented by reducing the carbon footprint of the required charging power generation). While the main framework conditions for the switch to e-vehicles are set at the national and European levels (fleet emission standards, taxation, premiums), more and more cities contribute to accelerating this shift through local measures. City governments can actively push for changing framework conditions at the national level and publicly announce to their citizens their willingness to introduce Internal Combustion Engine (ICE) car bans. Due to the long product lifetime of motor vehicles, this decision could be announced forcefully and several years before the planned introduction to allow citizens to factor in an ICE vehicle ban when purchasing a new car.

A longer list of types of individual measures/actions to contribute to achieving decarbonisation objectives is introduced in chapter 4.1.

Therefore, it is a particular step in the planning process to further develop the different types of infrastructure, financial, technological, regulatory, behavioural as well as soft measures that were initially identified in the planning option/scenario assessment. There are various approaches to bundle climate measures:

- The combination of push and pull measures is one important approach. The aim is to improve the effect of pull, i.e. supply-side measures (e.g. improved public transport services), by combining this with more restrictive 'push' measures, but also to prevent potential rebound effects. Push measures such as traffic restraints are often disliked by both policymakers and the public but can gain acceptance as part of a package. A good example of such a package is the combination of a cycling expansion infrastructure program with an enforced parking regulation in public spaces. This could be complemented by traffic calming measures and non-mobility-related measures such as planting trees in former parking spaces.
- Another approach is to focus on ensuring the complementarity of measures introduced in the same area of a city, to provide synergies and enhance effectiveness, by combining major policy measures identified as 'core' measures with smaller-scale 'supporting' measures. The following graph shows an example of an express bus corridor as a core measure in combination with local measures for cycling, walking and micro-mobility, e.g. by providing high-quality cycle parking along the route of the bus. This example shows that packages can also have a concrete spatial orientation in a district or along a road corridor.

Develop low-carbon measure packages

Once the preferred planning option/scenario is identified, the related package of measures needs to be further developed as an iterative process.

No measure on its own will be sufficient to achieve emission reduction. Most cities plan for several climate policy measures and need to think about how these different measures might interact. The key to developing a package is to identify which climate mitigation policy measures will support each other's effects and climate impact.[35] A portfolio of measures and their impact on climate change is detailed later in this guide.

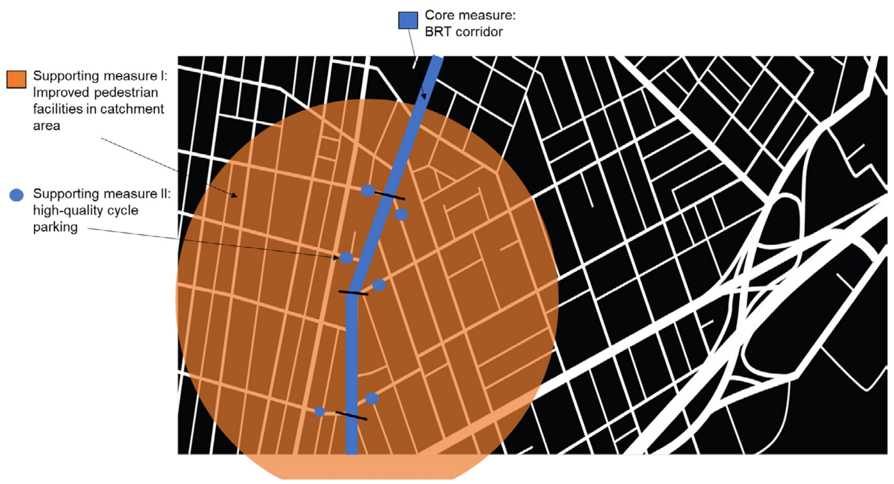


Figure 9. Example of concrete spatial co-location and synergy of measures
Source: SUMP-PLUS

34 MORE Project. (2022). Better Streets for Better Cities: Summary and Key Recommendations - MORE. https://www.roadspace.eu/results/better-streets-for-better-cities-summary-and-key-recommendations

35 May, A. (2016): Measure selection: Selecting the most effective packages of measures for Sustainable Urban Mobility Plans

3. SUSTAINABLE URBAN MOBILITY PLANNING STEPS FOR CLIMATE CHANGE MITIGATION PLANNING

Practice Example

Practice Example 4. Example of measure packaging in Vitoria Gasteiz, Spain: Combination of "Superblocks" with public transport expansion & good communication and participation

Vitoria-Gasteiz is implementing a superblock scheme to transform the city into a more liveable and safer place. Firstly, the city introduced speed-reducing measures, roadblocks and changes in traffic circulation. Furthermore, road space was redesigned to encourage active and sustainable travel. Pavements were widened and pedestrian priority zones, cycle lanes and bus/tram priority lanes were installed, and the city is planning more developments in the future. Some kiss-and-ride spaces are planned to be introduced in school areas as well. Also, the city plans to introduce parking charges (fixed price, based on emission standards and from on-street to off-street). Vehicle access (in certain areas) is planned to be restricted based on the emission level of the vehicles and the trip purpose of the road user, more specifically delivery vehicles and through-traffic will be regulated. Travelling, parking and planning conditions in the superblocks will also be regulated using permits. Lastly, to mitigate the impacts of the interventions, exemptions will be introduced and mobility options will increase.

UVAR group		UVAR	
Spatial interventions			
1	Speed reduction	a	Speed reduction
2	Traffic filter	a	Recirculation
		b	Roadblock
		c	Capacity restraint
3	Reallocating parking space	a	Parklet
		b	Drop-off zone shared mobility
		c	Logistics bay (mini-hub)
		d	Kiss and ride (K&R)
4	Reallocating road space for pedestrians	a	Widen pavement
		b	Pedestrian priority street or zone
5	Reallocating road space for cycling	a	Cycle lane
		b	Cycling street
6	Reallocating road space for public transport	a	Bus/tram priority lane
Pricing aspects			
7	Road charges/tolls	a	Charge applied to a perimeter or an area
		b	Charge applied to specific points
		c	Distance-based charge
		d	Time-based charge
		e	Permit charge
		f	Charge based on emission standards (pollution charge)
8	Parking charge	a	Dynamic price (real time)
		b	Fixed price
		c	Charge based on emission standards (pollution charge)
		d	Workplace levy
		e	From on-street to off-street parking
Regulatory measures			
9	Regulation by emissions	a	EURO standard
		b	Zero-emission vehicles
10	Regultion by vehicle type and dimensions	a	Vehicle type
		b	Dimensions
11	Regulation by trip purpose	a	Delivery and logistics
		b	Through traffic ban
12	Regulation by permit	a	Permit to travel
		b	Parking permit
		c	Planning permit conditions
13	Regulation by safety requirements	a	Vehicle safety features
Complementary measures			
14	Complementary supportive measures	a	Financial incentives
		b	Exemptions
		c	Increased mobility options

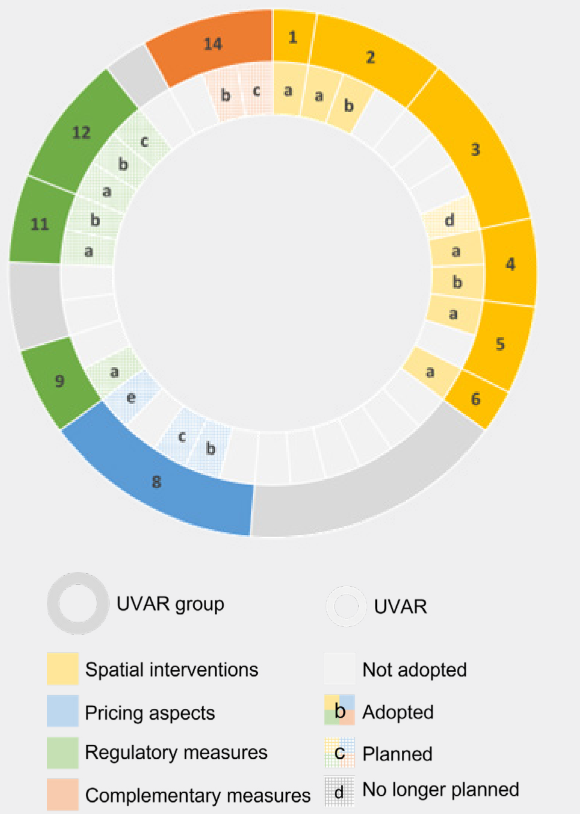


Figure 10. UVAR in Vitoria-Gasteiz (source: ReVeAL project, 2022)

Source: Versigghel, J. 2022, UGent, ReVeAL project, D2.5. Change processes in pilot cities, Introducing UVAR measures in pilot cities

Agree on low-carbon actions and responsibilities for package implementation

Following the agreement on measure packages, operational planning must break the packages down into actionable tasks for each of the departments and institutions that are in charge of their implementation. Based on detailed action descriptions, practitioners will identify cost estimations, clear responsibilities, implementation priorities and timelines to be agreed upon with other actors. This will help practitioners allocate their resources according to the needs during the implementation.

The timing of the implementation of a policy measure is often linked to the introduction of other measures and factors, as indicated in the Figure 11.

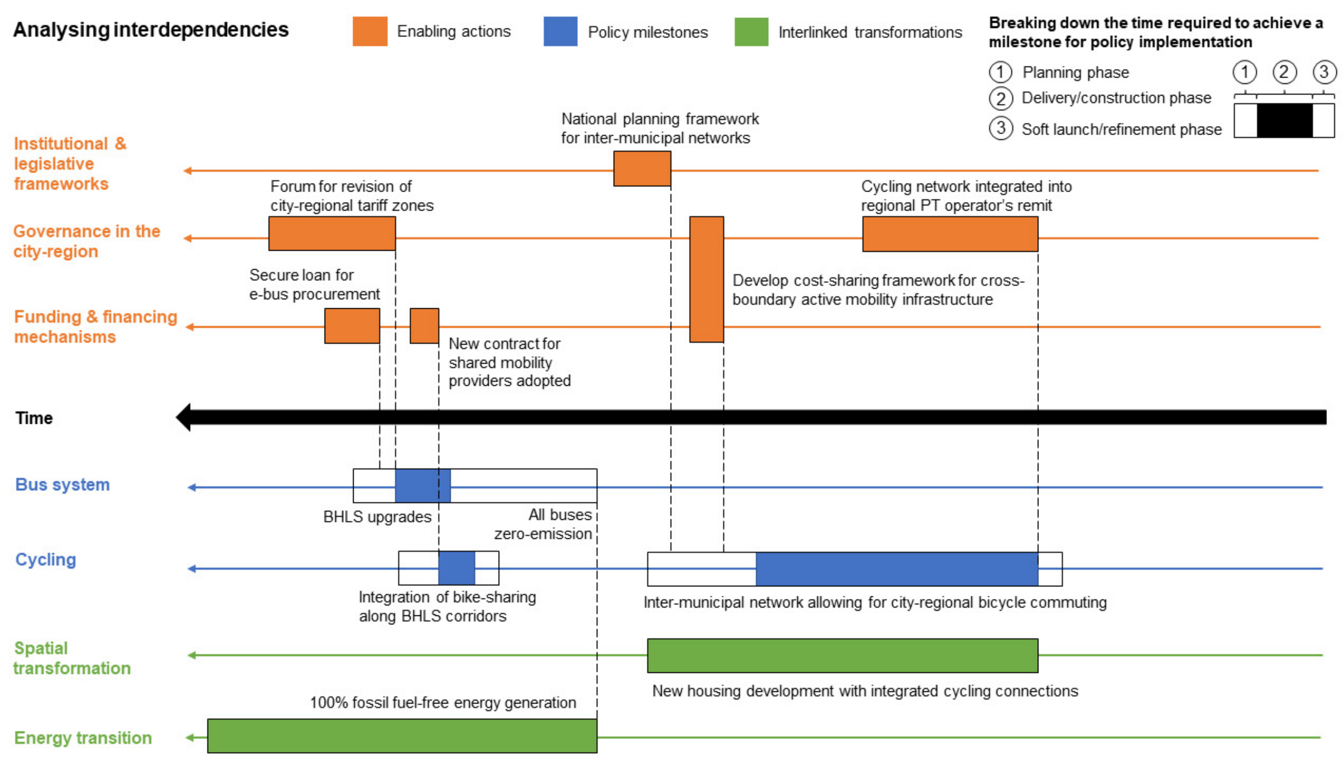
This figure shows interdependencies between enabling actions, such as legislation, some SUMP transport policy measures, and measures in other sectors that are required to deliver the carbon reduction targets (e.g. fossil-free electricity generation and better co-coordinated housing policies).

Based on the institutional cooperation agreed upon during the definition of long-term transition strategies (see chapter 2) and at the beginning of the SUMP process in Phase 1, involved actors should agree on responsibilities, timelines and resources available to use all available skills and capacities, as well as ensuring that skills within each department are used accordingly. A template action table can be found in Activity 8.3 of the SUMP guidelines[36].

Each measure package and measure could be clearly defined to develop a thorough financing plan. Practitioners should start by identifying all the available funding and financing streams available within the institutions and departments cooperating on the development of this SUMP, as well as assess the abilities of the organisations involved to access or capture these funding streams. Ideally, each measure could be linked to a specific regulation or administrative process to ensure its implementation.

Clear communication with the most affected stakeholders, often the general public, and key political decision-makers is essential to ensure further support for the acceptance of certain measures and to anticipate potential blockages. Practitioners can continue communicating regularly on the vision, objectives and measures selected to strengthen wide political and public support around decarbonised mobility. Communication on less popular measures should be particularly emphasised, through increased awareness of the topic and its impact at different levels as well as including citizen collaboration and participation during their implementation.

Figure 11. Policy measures' timing of implementation. Source: 'SUMP-PLUS'



36 Rupprecht Consult (editor). 2019. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition. https://www.eltis.org/sites/default/files/sump_guidelines_2019_interactive_document_1.pdf

Practice Example

SUMP adoption and financing actions in Baden-Württemberg, Germany, where approved mobility plans can receive higher funding rates

The state of Baden-Württemberg (Germany) has concluded in 2021 that the targets defined in the Federal Transport Infrastructure Plan 2030 will not be met. The state has therefore developed a climate protection scenario for 2030, showing a way by which the ambitious climate protection goals can be achieved while satisfying the local mobility needs. The scenario includes a transformation target for the mobility sector by reducing GHG emissions by up to 55% by 2030. The goals focus on increasing alternative modes of transport, such as active modes (walking, cycling) and doubling the public transport connections. In addition, the number of cars is to be reduced by one-third.
The climate protection scenario for 2030 includes 10 ambitious measurable goals for Baden-Württemberg, such as specific climate-related requirements to make a SUMP a "climate mobility plan", 2.000.000 climate-neutral cars and 1.000.000 charging stations and 500 lively and traffic-calm town centres. To establish and disseminate the development of "Climate Mobility Plans" in all of the state's cities and districts, the state government has taken different approaches. It has set up a new state/regional municipal transport funding act (LGVFG), with a 320 million euros annual budget to, fund local transport projects.Funding rates for individual transport projects may increase to 75% instead of 50% for particularly climate-ambitious projects/measures. The state can also provide a financial incentive for cities to develop their SUMP by funding 50% of external costs for "climate mobility plans" which have to include traffic models, through a separate financing scheme.

Source: Fedderke, S. State of Baden-Württemberg, 15.09.2021, "Webinar on Climate Change Mitigation through Sustainable Urban Mobility Plans" organised by EIB/JASPERS

Prepare for SUMP adoption and financing

After preparing a thorough cost estimation and the elaboration of a financial plan at the SUMP level, practitioners need to develop definite concrete financial plans for all actions. This financial scheme can then be included in the SUMP itself or part of a separate process.

As decarbonisation of urban mobility requires practitioners to prepare, long, medium and short-term investment plans to finance different types of measures, a specific emphasis needs to be put on funding opportunities for climate change mitigation and their economic impacts. Climate change mitigation and decarbonisation processes implemented by the SUMP can grant access to specific financial opportunities associated with climate action. Planning for contingencies to help achieve resilience against potential changes in the funding stream can be secured by finding different streams.

As the decarbonisation of transport may require the implementation of innovative measures or living labs, existing funding schemes may be inadequately aligned to the needs of pilot measures, which are seen as key to building acceptance to change and participation. Going beyond the awareness level towards action, a continuous dialogue among stakeholders and sectors can prove to have tremendous benefits in gaining political buy-in for controversial measures, prioritisation and packaging of measures, as well as in evaluating their impacts. By creating a common understanding of the fact that climate change affects everyone and that all should act together in coordinating efforts, funding streams can be channelled effectively. In addition, securing public-private partnerships or using innovative procurement processes may help to fill a gap in funding/financing of innovative and pilot measures.

Finding funding for decarbonized mobility will be easier for SUMPs defined at the FUA level and where different departments and institutions have been cooperating from the start. The main reason is the financial volume, also due to a larger number of users. To finance pilots or test innovative solutions, practitioners may use a public-private partnership to fill the gaps in funding. Several challenges often arise for smaller cities to achieve long-term financial support to ensure their strategic planning which is why they should be embedded in a process covering the wider functional urban area they are part of.

3.4. Phase 4: Implementation and monitoring

The fourth phase focuses on implementing the measure packages and related actions defined in the SUMP, integrating systematic monitoring, evaluation and communication.

Manage implementation to ensure achievement of low carbon and other SUMP objectives

Once the measures' package has been agreed upon and the SUMP is adopted, the implementation phase starts. Each measure package has been broken down into clear actions which now need to be defined as clear implementation tasks and taken over by the relevant departments. The implementation of the SUMP is not usually performed by the core "SUMP team", but by the responsible technical departments. Having involved stakeholders from different departments from the start, they will be able to follow and guide the implementation of these measure packages, following a coherent approach. Therefore, institutional cooperation with other departments and local authorities is key to managing successful implementation.

In addition, specific coordination with the overarching climate change mitigation strategy needs to take place under this step, to ensure the integration of decarbonisation processes within the SUMP implementation.

A crucial part of the implementation is the procurement of goods and services necessary for the measures and actions. Tendering for innovative products or "green procurement" will be essential in the implementation of decarbonised mobility to enable innovative products and services to be implemented while minimising the negative social and environmental impact of certain measure implementations. Additional information on procurement can be found in the SUMP topic guide on procurement[37].

Different implementation strategies can be adopted at this stage in relation to certain policy measures, depending on local requirements. They can take the following shapes:

- Full-scale implementation. This introduces popular measures or measures well-known for their impact at their full scale, without implementing testing or scaling up phases.
- Pilots. This introduces test measures to determine whether widespread adoption of the measures is likely to achieve the GHG emissions objectives and targets previously agreed upon and/or to achieve public acceptability. It remains essential to have a concept of how to make this measure permanent.
- Living labs. This key implementation strategy aims to boost the uptake of innovative sustainable urban mobility solutions that accelerate the decarbonisation of mobility to scale by engaging directly with citizens, the local community and all stakeholders in a real-life environment. This strategy works best for controversial measures or very innovative measures to test public acceptance and their impact.
- Instant implementation. This works best for measures and measure packages that require light infrastructure for which their decarbonisation impacts are certain and that are well accepted by the public.
- Pop-up implementation. This has been a successful approach during the pandemic as it enabled cities to test certain measures, e.g. bike lanes, for a certain time without lengthy consultation processes or building physical infrastructure. This strategy works best for measures requiring light infrastructure or more tangible measures with a quick and visible impact. It remains essential to have a concept of how to make this measure permanent.

Practice Example

Managing implementation to ensure achievement of low carbon and other SUMP objectives: Helsinki, Finland and its on-demand autonomous electric boat service

Helsinki has ambitious goals when it comes to implementing low-carbon mobility solutions. One example is the on-demand autonomous electric boat service, Callboats. The electric boats can be booked on demand in a user-friendly way via a specially developed app and provide connections from the southern Helsinki city area to offshore islands (Harakka and Pohjoinen). The electric boats have been designed and engineered to be particularly environmentally friendly, being powered by the sun during the day, while not emitting harmful exhaust gases during their operation. The Callboats have been designed for a minimal environmental impact. The slender hulls cross the water effortlessly without waves leaving the marine environment unharmed.

Figure 12. Helsinki on-demand autonomous electric boat service (Source: Callboats)

Source: Callboats, 2022, https://callboats.com/

37 Rudolph, F., Werland, S. 2019. Public procurement of Sustainable Urban Mobility Measures. https://www.eltis.org/sites/default/files/public_procurement_of_sump_v2.pdf

Communication about the measures plays a key role in the success of their implementation. Practitioners who have first implemented more visible and tangible measures through the improvement of traffic safety or the implementation of traffic calming in school areas have found it easier to convince citizens to implement other measures related to GHG emission reduction. Framing the measure positively can also help and can prevent more negative narratives. Practitioners can also highlight the costs of inactions and paint an attractive picture of a future with a more people-centric mobility system.

GHG emission monitoring process

Continuous monitoring is essential for the successful implementation of decarbonised mobility. Monitoring is designed to increase the efficiency of the process, respond rapidly to any problems arising during implementation and ensure the high quality of measure implementation. The monitoring of measure implementation processes and impacts throughout this phase of the SUMP has multiple benefits. Preliminary results can help practitioners move forward in implementing and readjusting the course of action to achieve the objectives and targets set and communicate the results to the public and stakeholders. This could further solidify buy-in of measures and show the positive impacts that citizens can achieve by changing their behaviour.

Decarbonisation of urban mobility should be measured through the monitoring of GHG emissions and reductions deriving from measures put in place, alongside the other indicators defined earlier in the process and agreed on with the collaborating institutions. The monitoring of GHG emissions has to accord with the calculation methods developed during the analysis of the mobility situation and with the targets and indicators set during the strategy development phase, and should therefore aim at collecting data needed for such calculations (see chapter 3.2 and Annex 6). Ideally, practitioners should

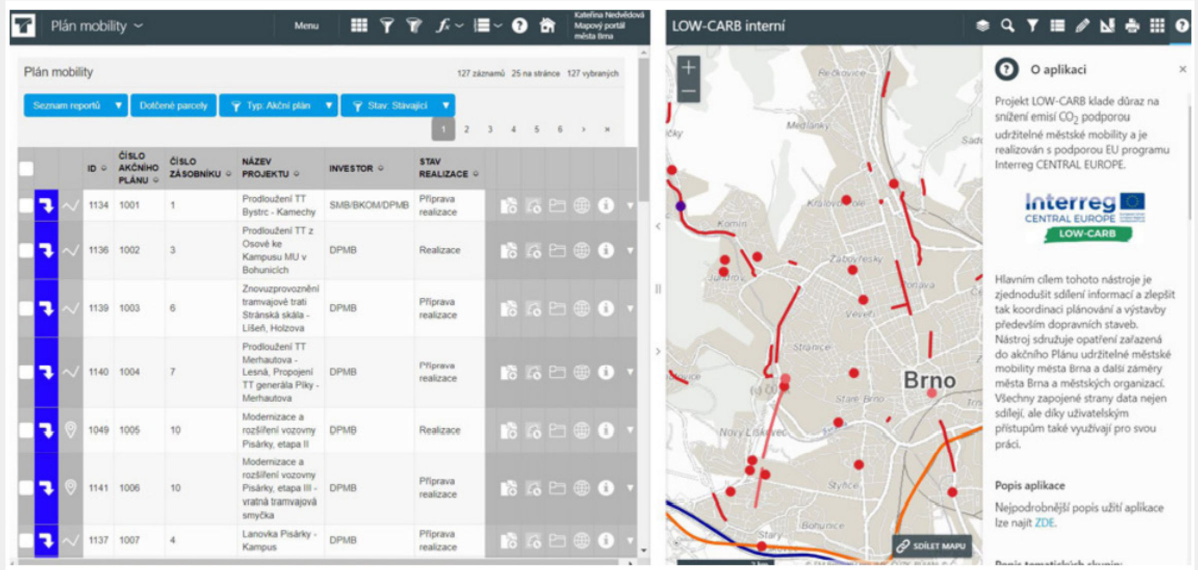
Practice Example

Monitoring of GHG emissions in SUMP implementation: Brno, Czech Republic and its system for monitoring and implementation

The City of Brno in cooperation with the company T-MAPY, and as part of the Interreg Low-Carb project, has developed a monitoring tool that helps both the coordination and engagement activities of a SUMP development. It can help planners monitor numbers, types, scales and duration of measures within a SUMP or action plan.
This tool is essential to evaluate and monitor whether SUMP process objectives have been achieved on time and within budget by mapping the measures in a GIS suite. This tool was therefore valuable for multiple phases of SUMP development from the measure selection process during the SUMP's preparation, the implementation phase of each measure, and the evaluation of measure package impacts.
The tool can also be used to display selected measures and demonstrate the cumulative intended impacts of the whole measure package. This provides both a quick overview and gives detailed insights into the measures. From here, results can be further analysed according to strategic or specified objectives.

Source: Interreg Low-Carb, MAPPING MEASURES OF A SUMP: A GIS tool for monitoring and evaluating mobility measures

Figure 13. Example of measure mapping using the monitoring tool (source: Interreg Low-Carb)



follow a dynamic monitoring process with multiple interim goals to validate the progress of implementation, based on the key indicators.

In more practical terms, practitioners can more easily allocate resources from different departments to gather data and monitor the implementation of measures based on the cooperation agreements validated at the beginning of the SUMP process. Alternatively, practitioners can find multi-purpose data to reduce the resources necessary. Working at the FUA level is also beneficial for monitoring as it allows practitioners to allocate certain staff and resources from different municipalities in the evaluation process and improve the data quality in the process. In the end, measuring evaluation and monitoring should benefit practitioners by helping them justify staff and budget for the evaluation, which also is part of the evaluation plan.

Review and lessons

The SUMP process is a cycle because it presents a continuous development of policy and its implementation. As one cycle is completed, it is important to take a look at what went well and what did not. This review process is essential to continue improving the process, and to identify further steps and improvements.

During this final step, practitioners need to check the outputs of the SUMP and evaluate to what extent they meet the targets of the overarching climate transition strategy. They have to determine whether the decarbonisation of mobility is on the right path and identify further actions. It is essential here to review the results and compare them with the targets previously defined and identify what is left to do in the following SUMP cycles.

It is also a time to review the governance capabilities, capacities and resources of the "SUMP team" and to determine whether new organisational arrangements, legislation or funding streams are necessary to implement some of the future policy measures. Climate action is an evolving topic and institutions constantly improving on how to tackle climate change, new funding and resources may be allocated to departments and institutions in the future, which may contribute further to decarbonising urban mobility.

This review process is essential to ensure the alignment of the SUMP with the long-term transition strategies and to enable the creation of a new SUMP that continues (or realigns if needed) on the relevant transition pathway (see Chapter 2).

3. SUSTAINABLE URBAN MOBILITY PLANNING STEPS FOR CLIMATE CHANGE MITIGATION PLANNING

4. Portfolio of effective measures and their potential contribution to mitigating climate risks of transport

4.1. Types of individual measures

Measures to support the decarbonisation of urban mobility can be categorised in different ways. This guide has focussed on the distinction between measures aiming at avoiding transport, shifting from private cars and improving, i.e. reducing the carbon footprint of urban mobility. All policy/financial/organisational, operational and infrastructural measures contribute to avoiding, shifting and improving urban mobility.

The SUMP sets several goals and identifies key areas of action that have different implications for cities. Relevant types of actions should both be sustainable and smart to contribute to achieving decarbonisation goals. The final zero emission objective (to be reached as early as possible, latest close to 2050) requires a diverse set of actions. Types of action include better integration of land use and transport planning to avoid traffic caused by the many decades of spatial disintegration, and different work organisation/business models that decrease the number of commuting trips in a reference period (e.g. - among the others – telework a certain number of days per week and/or per year). Consistent data management and governance at the highest possible level create conditions for the optimised use of available data to enable smart solutions and applications in all types of action to support decarbonisation. New technologies and business models such as telework, online shopping, and e-health can decrease the total number of trips and bring significant savings in terms of emissions. Offering infrastructure (for instance by developing extra cycling space), vehicles and interconnected transport services should provide viable and attractive alternatives to the use of the private car in daily commutes, and commercial or leisure traffic. Boosting the uptake of zero-emission vehicles and renewable/low-carbon fuels and related infrastructure should finally contribute to reducing the carbon footprint of remaining trips/transport modes.

New technologies or business models for urban mobility can also help shift demand to options with a lower carbon footprint. For example, applications allowing the shared use of bicycles, electric cars or electric mopeds can provide solutions for many mobility needs and help avoid the need for car ownership. The integration and interaction of land use and transport planning can influence the use of private transport, hence GHG emissions, in existing and planned development. The urban form of a city has a direct effect on which measures would be more effective to achieve climate neutrality. A city's compactness and population distribution influence the potential for the development of a sustainable public transport network and also for the shift to active modes such as walking or cycling. Planning future urban development taking into account public transport needs (i.e., Transit Oriented Development, TOD16) can ensure that mass transit solutions have the critical mass required to provide an alternative to car use. Improving walkability and providing safe and segregated cycle lanes in a city can encourage more active transport. It is important to design decarbonisation policies that are coherent with the diverse city typologies. Local authorities should be aware of commuters coming every day from residential areas located outside of the administrative boundaries to coordinate the decarbonisation measures with the surrounding local administrations and propose alternative travel means while working with employers to incentivise new behaviours.

The term "types of action" used in the list includes measures, policy approaches, investment projects etc. as referred to in different parts of this guide and in local and academic practice. The list aims at highlighting and categorising actions under the control at the local level. It is based on several sources of information. Sources include an analysis of local climate action plans undertaken by an EIB/JASPERS commissioned preceding study (INFRAS), by the University College of London (UCL) in the context of the Horizon Europe project SUMPs Plus[38],and a list of "solutions factsheets" developed by the NetZeroCities[39] consortium.

It reflects current actions already taken by cities to tackle decarbonisation and therefore should be updated regularly to best reflect innovations. It does not aim at being exhaustive. An exhaustive overview is practically impossible because of the steadily evolving experience and practice in local administrations, local initiatives, academia, the dynamics of the private sector etc. It aims through at highlighting a diverse set of possible actions. It should ideally establish the basis of a living document which may be regularly updated to provide the latest developments and good practices and include links to relevant documents and examples.

38 https://sump-plus.eu/

39 NetZeroCities Mobility & Transport Factsheets, https://netzerocities.app/resource-2488

The types of actions included in the list are not weighted in terms of their potential impact on decarbonisation because this impact will differ in relation to the degree of ambition and implementability at the local level. Chapter 4.2 highlights actions considered to achieve a potentially big impact. Whatever the expected potential individual impact is though, isolated implementation, not based on a comprehensive urban mobility plan, may even lead to counterproductive impacts in other parts of the urban and regional area. The list should therefore not be used as a box-ticking type of planning and approval exercise.

While all actions have the potential to make tangible contributions to mitigate climate impacts of urban mobility many do also contribute to several other strategic transport objectives. Several SUMP guides have emphasised specific aspects of the actions in the list, which all form part of the compendium of SUMP Guidance produced under the umbrella of DG MOVE. .

The order of actions presented starts with different types of comprehensive planning, smart city, data governance, spatial, mobility, climate action and other general planning approaches, ideally at the level of the functional urban area or at least covering the core city.

It continues in the order of types of actions which can all be determined at the local (ideally metropolitan/ agglomeration, i.e. FUA) level and in an order of gradually increasing implementation challenges and financial weight. Categories include:

Cross-sectoral, spatial and sectoral planning. The integration and interaction of land use and transport planning can influence the use of private transport, hence GHG emissions, in existing and planned development. The urban form of a city has a direct effect on which measures would be more effective to achieve climate neutrality. A city's compactness and population distribution influence the potential for the development of a sustainable public transport network and also for the shift to active modes such as walking or cycling. Planning future urban development taking into account public transport needs (i.e., Transit Oriented Development, TOD16) can ensure that mass transit solutions have the critical mass required to provide an alternative to car use. Improving walkability and providing safe and segregated cycle lanes in a city can encourage more active transport. It is important to design decarbonisation policies that are coherent with the diverse city typologies. Local authorities should be aware of commuters coming every day from residential areas located outside of the administrative boundaries to coordinate the decarbonisation measures with the surrounding local administrations and propose alternative travel means while working with employers to incentivise new behaviours. In this sense, different work organisation/ business models that decrease the number of commuting trips in a reference period (e.g. - among others – telework a certain number of days per week and/or per year) would also play an important role.

Policy/regulatory, illustrating the types of actions decisive policy action may implement, including speed limits, vehicle access regulation focussed parking policy etc. Legislative measures, such as the constitution of Zero Emission Zones, can drastically limit the access of internal combustion vehicles to urban areas and encourage the exchange of fossil fuel against an e-car.

Educational /capacity building. It includes all behaviour change, information and awareness campaigns as well as other programmes promoting changes in mobility behaviours.

Financial/fiscal. It includes measures such as congestion pricing, parking prices, support schemes etc.

Mobility services including multimodal ones. For urban freight, green last-mile delivery options are available, including distribution by electric vans or cargo bikes. New technologies or business models for urban mobility can also help shift demand to options with a lower carbon footprint. For example, applications allowing the shared use of bicycles, electric cars or electric mopeds can provide solutions for many mobility needs and help avoid the need for car ownership.

Mobile assets include public transport vehicles, service vehicles, captive fleets (Taxi, Uber etc), automated vehicles, micromobility and freight. For public transport, a transition to fully carbon-neutral busses and urban trains (while improving the quality of service) could provide an alternative to passenger cars, while contributing to the reduction of CO_2 emissions.

Infrastructure investments for public transport, including all types of conventional public transport systems, smart mobility hubs, bus and cycling lanes, e- and H2-charging options etc.

4.2. Big levers for climate mitigation

The definition of measures based on a SUMP guarantees that challenges and options are understood systemically as urban mobility requires a holistic and comprehensive approach. It is important to think and act based on a combination of measures, which complement each other.

Certain combinations of measures or approaches have been proven in many different cases to reduce transport-related carbon emissions significantly. These are understood as "big levers". Some approaches have proven to be more effective in reducing carbon emissions than others. Their effectiveness can be maximized if they are pursued as part of a wider overall strategy like a SUMP.

This subchapter, therefore, presents seven approaches, common to most cities, considered to have an important impact on reducing carbon emissions from urban mobility and to be implementable through local decisions. Their effectiveness depends on local circumstances. Therefore, approaches should not be taken by practitioners as a checklist to be done, as local realities differ.

Re-organisation of space[40]

This approach highlights measures that work towards re-organising urban space to modes that further contribute to the decarbonisation of transport as well as other measures contributing to a long-term change in people's movement and engagement with public space. While the re-organisation of space may seem like secondary measures resulting from other mobility measures in some cases, it can also work as a catalyst or have a complementary effect on specific measures. For example, the reallocation of urban space from car use to active modes can both be a result of restricted car use or as a means towards its restriction.

Improving public / collective transport[41]

This approach highlights the need for measures to maximise local public transport's potential by creating an accessible service that is a fast, reliable, accessible and convenient alternative to the private car. It also highlights the need for additional collective transport, through shared and on-demand mobility measures while planning to restrict the use of private vehicles. For public/ collective transport to contribute to decarbonising urban mobility, all transport modes need to be integrated into planning, from buses to sharing options that can easily step in to fill supply gaps. Public and collective transport must continue to be the backbone of mobility in cities and its region. This usually works best if put in place in conjunction with the following point on private car usage.

Facilitating active mobility[42]

This approach highlights the measures that aim to get people out of cars and walking and cycling instead. This approach covers various topics such as safe and secure infrastructure for active modes. Active modes are an essential part of all journeys and thus enabling safe active mobility is fundamental to achieving integrated mobility systems and ensuring its uptake in detriment to polluting modes. Active mobility is a simple and cost-effective way of achieving the decarbonisation of mobility as well as contributing to achieving noise reduction and the recommended physical activity levels for personal health and well-being. It also makes urban mobility systems more inclusive by having the potential to reduce inequalities due to its accessibility, affordability and social equity.

Re-organisation of urban logistics[43]

This approach emphasises measures regarding the implementation of sustainable urban logistics solutions. The competitive nature of the sector often leads to fewer interventions from city authorities and therefore policy response is often slow and fragmented leaders to few improvements made to the current state of cities' urban logistics systems. Decarbonising measures for urban logistics promote the use of cleaner freight vehicles but also the further implementation of last-mile logistics. The latter may require land use interventions to manage delivery spaces and make way for inter-city last-mile logistical hubs.

UVAR and other types of restrictions on private vehicles[44]

This approach aims at bringing to light the different restrictions on private vehicles cities may implement but also how cities should consider the possible synergies or contradictory effects of private vehicle restrictions would have on the use of other modes. It is essential to think of rebound effects – and prepare to counteract them – when planning private vehicles restriction. As mentioned above this should be done in conjunction with PT improvement and e.g. with the rest of the measures on facilitating active mobility. (See box on Urban Vehicle Access Regulation p37-38)

Fewer and cleaner private and company cars[45]

This approach highlights the measures that contribute to reducing the use of private and company cars as well as replacing all vehicles with cleaner alternatives. This

40 As part of the category "cross-sectoral, spatial and sectoral planning" of annex 6.3

41 As part of the categories "cross-sectoral etc, educational etc, , mobility services, mobile assets and infrastructure" of annex 6.3

42 As part of the categories "cross-sectoral etc, educational etc, , mobility services, mobile assets and infrastructure" of annex 6.3

43 As part of the categories "cross sectoral etc, educational etc, , financial/fiscal, mobility services, mobile assets and infrastructure" of annex 6.3

44 As part of the category "policy and regulatory" of annex 6.3

45 As part of the category "policy and regulatory" of annex 6.3

approach includes measures to adapt the urban grid to provide alternative fuelling charging infrastructure, to promote the implementation of mobility management at company levels as well as measures to discourage car ownership (e.g. car clubs, residential parking restrictions, Zero-Emission-Zones).

Activity re-organisation[46]

Traffic and travel patterns are strongly affected by the organisation, location and timing of the activities and services that generate the need for travel. Avoid strategies, in particular, can be supported by collaborating with trip-generating sectors to substitute some digital for physical communications, by localising provision and re-timing start and finish times (e.g. implementing telework, improving freight efficiency, reducing freight emissions, etc.)

Table 3 below provides a comparative overview of these seven big levers structured by the following four characteristics[47]:

- Measure examples: it aims at highlighting the measures that fall under this approach. All measures can be listed, independently of their type (e.g. operational, organisational or infrastructural) or of their contribution to avoiding, shifting or improving mobility.
- Importance of systems thinking and risk of isolated approach: it aims at highlighting the importance of developing measures through a systemic approach, keeping in mind the potential rebound effects of any measure implementation, as well as possible synergies that may exist between one or more approaches. For the latter, the risk of developing an isolated approach is provided to illustrate the risks practitioners can face in implementing isolated approaches.
- Real-world example: it aims at presenting a real-world example of this approach that practitioners can refer to as a best practice for this approach implementation.

Table 3. Description of the big levers for CO2 reduction

Approaches	Measure Examples	Importance of systems thinking & risk of isolated approach
Re-organisation of space	• More space for active mobility (from parking, road lanes etc) • 15min city • Urban development along PT corridors (Transit-oriented development) • Integrated land use and urban planning • Integrated land use and transport planning	A part of the reorganisation of space can only happen if commuters are attracted to collective and active modes to the detriment of private vehicles. As a specific measure to implement the many actions listed in annexe 6.3 the reorganisation of delivery zones and timed access may contribute to achieving the necessary shift.
Improving public / collective transport	• New/improved services • Increase capacity • Better connection between suburban/rural and urban area • Clean buses • eTicketing • Shared (micro)mobility • Multimodal ticketing & charging • CCAM • MaaS for multimodal integration	Public transport has an inevitable "first and last mile" problem. This makes it necessary to consider multimodality, in particular the connection between walking and cycling. The attractiveness of public transport is always relative to the attractiveness of other modes, especially the car. This requires access regulation and other "push" measures as complementary elements.
Facilitating active mobility	• Cycling • Walking • Micromobility • Integrate e-bike charging infrastructure	Active modes currently have limited urban space compared to other modes which would require a shift in the distribution of urban space for mobility, especially to increase accessibility to active modes and ensure the safety of vulnerable users.
Re-organisation of urban logistics	• Smart logistics hubs • Drones and droids delivery systems • Electrified urban freight delivery (e-vehicles) • Zero emissions last mile delivery (cargo bikes)	A sustainable urban logistics system is directly linked to and dependent on the organisation of space (e.g. location of sources and destinations), the availability of clean energy or the regulation of access for such vehicles.
UVAR and other types of restrictions on private vehicles	• Low Emission Zones • Ultra Low Emission Zones • Zero Emission Zones • Superblocks • Spatial interventions • Parking fare structure - facilitating residents (and possibly rotation), impeding long-term • Congestion parking schemes • Road pricing	Good practice examples of access regulations show that they are best combined with a range of complementary measures to avoid negative equity implications (e.g. exemptions), facilitate trip alternatives and, overall, boost their effectiveness. Access regulations should therefore always be designed as bundles of mutually reinforcing measures.
Fewer and cleaner private and company cars	• Vehicle Charging Policy with clean energy incentives • Adaptation of local building code requirements • Dis/incentives for company cars • Public zero-emissions vehicle fleets • Mobility management • Parking policy and management • Car sharing	Restricting private car use at both the individual and company level can only be effective transport modes are offered as an alternative. The attractiveness of cleaner vehicles is also relative to the available charging infrastructure in the public and company spheres. As a specific measure to implement the many actions listed in annexe 6.3 policies in the B2B sector to encourage shift among employees may contribute to achieving the necessary shift.
Activity re-organisation	• Telework • Reorganisation of local health, commercial etc services • Differentiation of school opening hours • Mobility restrictions	Reorganisation of activities can only take place through cross-sectoral agreements to ensure an integrated approach As a specific measure to implement the many actions listed in annexe 6.3 the adaptation of delivery times to reduce congestion may contribute to achieving the necessary shift.

46 As part of the category "educational/capacity building" of annex 6.3

47 The table highlights the comprehensive and holistic nature of the approaches selected, equity has been not declared as a separate approach as it is an overarching imperative that should be integrated to all approaches.

4. PORTFOLIO OF EFFECTIVE MEASURES AND THEIR POTENTIAL CONTRIBUTION TO MITIGATING CLIMATE RISKS OF TRANSPORT

Urban vehicle access regulations

Urban vehicle access regulations refer to the regulation (or restriction) of motor vehicle access to an entire city or to certain parts of it. This can take the form of banning or charging a fee to (certain types of) vehicles, taking away space from cars to give to sustainable modes or changing the road layout to ensure that drivers behave as desired. Such restrictions in urban areas are referred to in general terms as urban vehicle access regulations (UVARs). Common types of UVAR include:

1. Low or zero-emission zones (access according to emissions)
2. Limited traffic zones (only certain vehicles)
3. Congestion charge zones (entry on payment)
4. Pedestrian zones (pedestrian – and perhaps cyclist – only)
5. Changes in road layout to i) allocate space away from car driving or parking to walking, cycling or public transport, or ii) ensure that car drivers behave as desired (e.g., drive slowly)

Why UVARs?

There are many good reasons to regulate urban vehicle access in cities.

- Pollution kills over 7 million people each year[48], especially the vulnerable, the elderly and those with pre-existing health conditions. It also causes lung disorders such as asthma in children and costs us 4.8% of global GDP[49].
- Congestion in cities makes journeys and deliveries less reliable; in Europe, congestion costs 1% of GDP[50].
- Urban quality of life can be improved by converting road space into recreation or commercial space. In the 1970s the central squares of many European cities were filled with parked cars. Now, that space is used for outdoor dining and recreation.
- Space allocation is a question of equity; people with limited incomes often have no car. This means the vulnerable in society subsidise the use of road space for those who drive.

The need to reduce climate emissions towards the Paris Agreement is also an increasing driver of UVARs. While national policies can improve the general conditions for lower-emitting options, UVARs can help facilitate faster change in urban areas.

But as "stick" measures such as UVARs are much less popular than "carrot" measures among citizens, it's important for each city to find the right measures, approach and complementary measures for its local context. The EU ReVeAL project[51] helps by structuring the measures, systematising the process and providing guidance on implementation.

Building blocks, measure fields and cross-cutting themes

To understand what a complete UVAR "package" consists of, ReVeAL analysed a wide range of UVAR schemes to identify their constituent components. 33 UVAR building blocks were identified that can be combined to create an UVAR package. The building blocks are categorised into three measure fields: 1) spatial interventions (e.g., a pedestrian zone), 2) pricing aspects (e.g., a congestion charge) and 3) regulatory measures (e.g., a low-emission zone). Building blocks can be combined within or across the measure fields to create an UVAR package.

For each building block, ReVeAL developed a fact sheet providing a definition, a description of its use, building blocks it works well with, an example, implementation tips and links to the ReVeAL guidance.

48 World Health Organisation. (n.d.). Air pollution. from https://www.who.int/health-topics/air-pollution#tab=tab_2

49 World Bank Group, T. (2022). The Global Health Cost of PM 2.5 Air Pollution A Case for Action Beyond 2021 INTERNATIONAL DEVELOPMENT IN FOCUS. https://doi.org/10.1596/978-1-4648-1816-5

50 Christidis, Panayotis & Rivas, N.I.. (2012). Measuring road congestion. 10.2791/15282.

51 Civitas ReVeAL - Regulating Vehicle Access for Improved Liveability. (n.d.), from https://civitas-reveal.eu/

ReVeAL also identified four cross-cutting themes that are relevant to all UVARs. Complementary measures ensure access of people, goods and services, while maintaining the goals of the UVAR and minimising equity issues or undesirable impacts. User needs and public acceptance acknowledge the needs of citizens and try to develop a shared commitment to a common goal, knowing that understanding the purpose of the UVAR makes people more willing to adapt their behaviour. Governance and finance look at decision-making processes, regulatory structures and how to finance UVARs and ensuring compliance makes sure that people are aware of the scheme and follow the rules put in place.

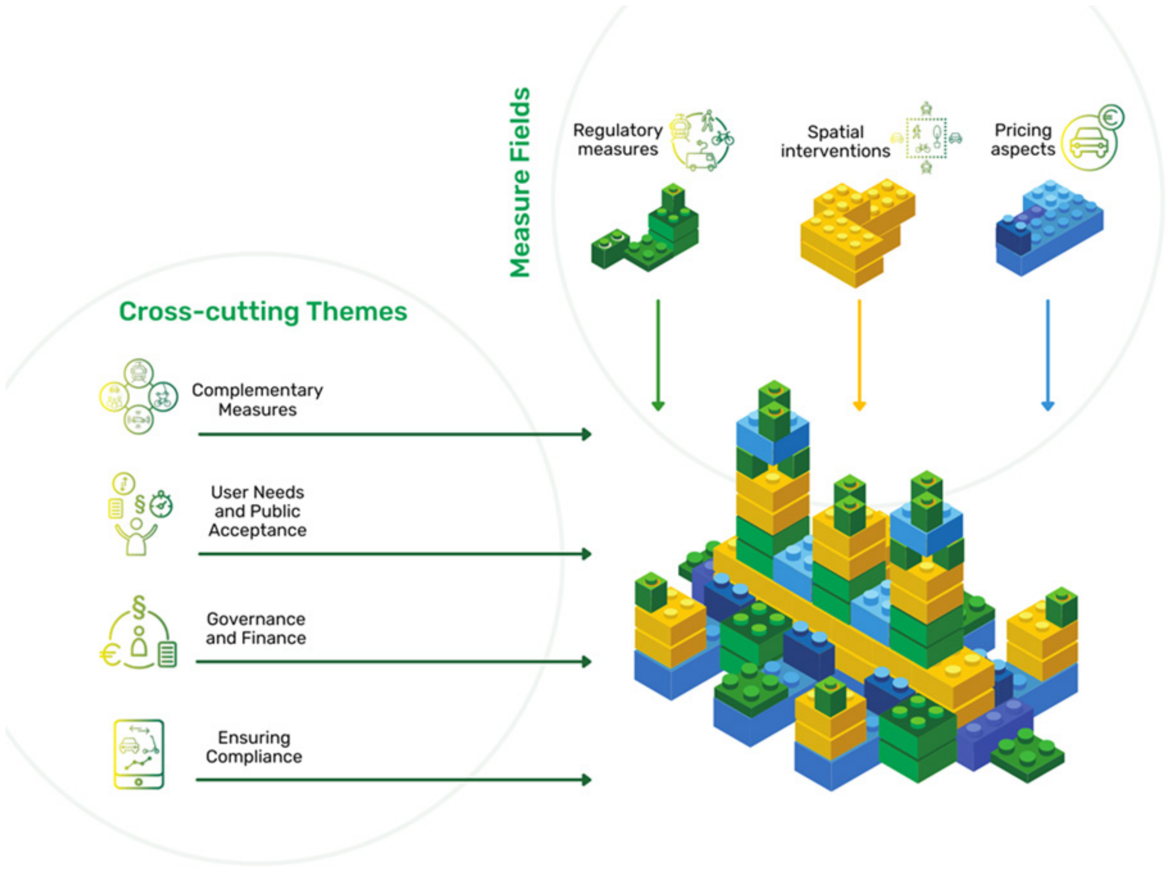


Figure 14: The ReVeAL project structures UVARs into categories of measures (measure fields) and cross-cutting aspects that are relevant to UVARs from any measure field (image: ReVeAL project).

For more details, check out the ReVeAL toolkit:

1. The ReVeAL building block fact sheets
2. Online UVAR guidance addressing cross-cutting themes that are relevant for all or several UVAR building blocks
3. The online UVAR decision support tool, which supports cities' critical thinking around UVAR packages. Using a short questionnaire, it offers a prioritised list of 5-10 UVAR building blocks to explore, an example for each building block and guidance for developing an effective and equitable package of UVAR measures.
4. ReVeAL recommendations for cities

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5.2. Contributions to the Stakeholders' consultation

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6. Annexes

6.1. GHG Emissions calculation in SUMPs

The traditional data gathering needed for the analysis stage of SUMPs should be sufficient for the needs of the climate change mitigation analysis, i.e. including a complete set of data on demand and supply.

As per the basic principles presented in chapter 3.2, the emission factors of different transport modes (and vehicles) covered in the SUMP can be determined based on detailed data for the characteristics and composition of each mode, which is also further dependent on the vehicle fleet, both for private and public transport (buses, rail, etc. – depending on the context this might be based on a specific survey or might be already available from existing studies and/or official statistics[52]). Data should also include vehicles used for freight distribution and their operational modalities and limitations. The characterisation of the current fleet for GHG emissions includes aspects such as the following (up to the available extent and relevance): vehicle category, type of fuel, year of production, EURO class, energy efficiency, etc.

Practitioners will also need to define the realistic and planned evolution of the fleet (and/or of these emissions characteristics). This evolution should reflect on the most recent forecasts regarding rollout of electric vehicles and/or other low and zero-tail-pipe emission vehicles, including an estimate of the share of veh-km run with such vehicles. For electric-powered modes and vehicles, it will generally be necessary to determine the so-called grid factor for the country or the reference project/area if specific solutions for electricity production are envisaged.

This information should be complemented with existing inventories of GHG emissions for transport in the area to its possible extent and other relevant data available.

The methodology presented below is based on the approach for the quantification of GHG emissions for transport projects presented in the EIB Project Carbon Footprint Methodologies (the currently recommended source in different EC Guidelines), but extending this methodology to the case of entire SUMPs/transport networks. This approach represents a simple but robust calculation method, considering the tank-to-wheel[53] component of emissions[54] associated with operations of all the modes considered relevant within the considered planning/SUMP boundaries.

As indicated above, for calculating (disaggregated) emissions data from specific transport and hub operations, the Commission launched a proposal for regulation on the accounting of greenhouse gas emissions of transport services (CountEmissions EU)[55]. Therefore, the calculation and reporting of the GHG emissions of a single transport service (or its leg) by any public or private sector organisation will have to follow the rules set in the CountEmissions EU regulation once the regulation will enter into full application.

52 Example of sources: relevant publications at national level for calculation of GHG emissions of transport investments, COPERT (Emissions calculation tool produced by EEA), EIB Project Carbon Footprint Methodologies provides some default reference values for EU, etc.

53 For electric vehicles also a country grid emission factor for electricity consumption is considered (distinguished by country and by type of grid – Low Voltage/Medium Voltage/High Voltage – figures expressed in grams CO2 per kilowatt hour / tonnes CO2 per GW) to take into account the GHG emissions from electric mobility, which depend on the electricity production mix of the country. These emissions would not strictly be a well-to-wheel factor, but one step upstream from the tank-to-wheel approach. Default electricity grid factors are based on historic data and given the steady decarbonisation of electricity production, the actual emissions from electric transport would be lower in the future.

54 Applying "well-to-wheel" or "tank-to-wheel" means in practice using different emission factors that might be applied in the same formula/calculation principles; using tank-to-wheel for calculation within SUMPs is consistent with their boundaries/area of competence (affecting solely/primarily the tank-to-wheel part). Nevertheless, the well to wheel emission factors could be used (when available) in SUMPs calculations. In any case, it is recommended to clearly report on what is covered by emissions calculations ("well-to-wheel" or "tank-to-wheel").

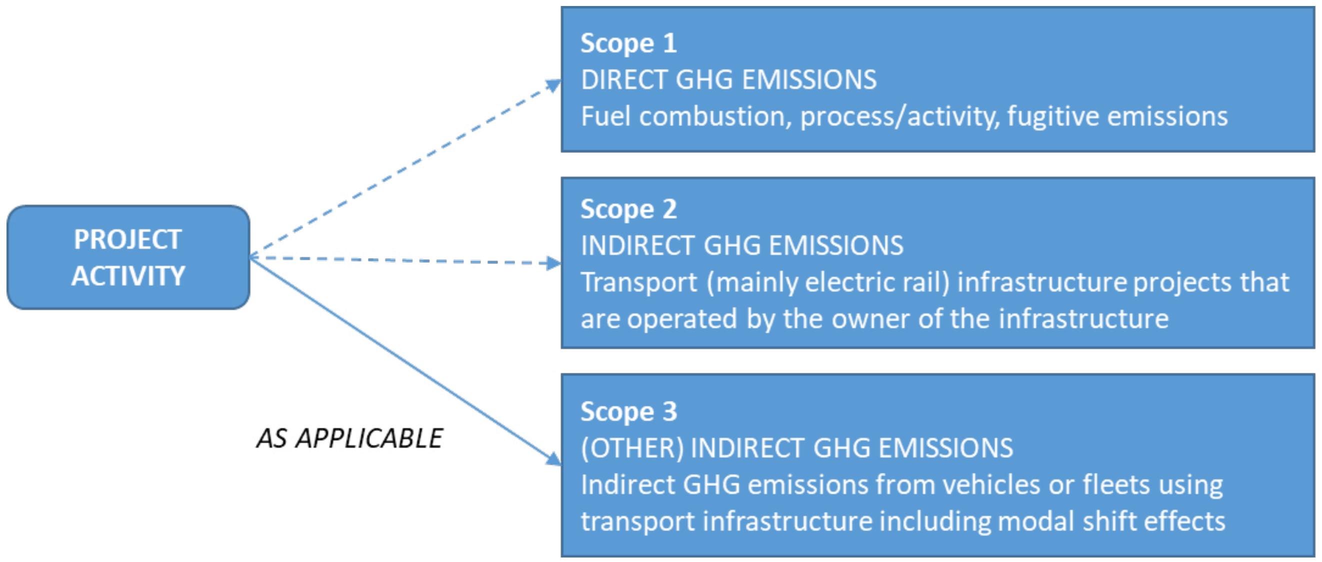
55 At the time of finalizing this guide (February 2024) a General Approach on the proposal has been adopted by the Council on 4 December 2023 (ST 16145 2023) and is being discussed in the European Parliament.

Box 5. Best practice/tools/methods/lessons learned for data collection & GHG emissions calculations

The European Commission's Technical guidance on the climate proofing of infrastructure in the period 2021-2027[56] refers to the assessment of GHG emissions of projects and allows for the assessment of:

- **Absolute emissions**: total emissions produced by the project in a typical operating year (tCO2e);
- **Relative emissions:** incremental emissions (increase/reduction) between investment and non-investment options considered in the CBA in a typical operating year (tCO2e).

The full details on the principles of this assessment are described in the above references, below the focus is on its



application in transport:

Figure 15. GHG emissions calculation – project boundaries (source: own based on EIB Carbon Footprint Methodologies)

Project boundaries

Scope 1 - Direct GHG emissions: emissions physically occurring from sources that are operated by the project within the project boundary - e.g. emissions produced by the combustion of fossil fuels (normally not applicable in transport infrastructure projects as there are not usually direct emissions associated with the operation of the infrastructure).

Scope 2 - Indirect GHG emissions: account for GHG emissions from the generation of electricity produced outside the project boundary (i.e. at the power plant level) that is consumed by the project. These indirect emissions are attributed to the project as the level of consumption is determined by the project (and can be reduced through various measures e.g. energy efficiency).

Scope 3 - Other indirect GHG emissions: consequences of the activities of the project but which occur from sources not operated by the project.

The current practice is that GHG emissions assessment of transport infrastructure projects mainly refers to the consequences of the project's activities (Scope 2 and Scope 3 - indirect GHG emissions), i.e. the relative impact of vehicles using the physical transport infrastructure. The related relative GHG emissions are calculated based on the displacement of passengers from one mode of transport to another (modal shift effects), changes in travel patterns (alternative routes, time of travel) and the induced increase in traffic (passengers and freight). If the project also includes the replacement of rolling stock, the related savings in emissions should also be taken into account.

56 Commission Notice — Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (OJ C, C/373, 16.09.2021, p. 1, CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XC0916(03))

This can be both direct - e.g. Scope 1 when replacing obsolete buses running on combustion engines with new vehicles, or indirect – e.g. Scope 2 when replacing obsolete trams with new rolling stock.

Specific considerations should be developed to consider in the calculations the impacts of "softer" measures such as those on organizational measures and minor operational changes (e.g. they might be contributing to a share of modal shift, limitation and redirection of mobility patterns, etc.). This is particularly relevant in the case of SUMPs.

Calculation principles for transport projects

For each project option, multiply the yearly transport activity data by the respective emission factors:

- Road modes: transport activity in total vehicles-km by the emission factors which are: dependent on fuel consumption and therefore on the vehicle category, engine technology57 (including ZEV technology), speed, road condition and road geometry58, inter-alia.
- Public Transport: transport volume is the service production (vehicle-km or train-km) for consumption/emissions:
  - Rail modes and trolleybuses/electric buses:
    - The power consumption rate per electrical vehicle or train (in KWh/veh-km or KWh/train-km);
    - The CO2e grid emission factor (tCO2/KWh).[59]
  - Buses:
    - Same calculation as for road modes.

GHG emissions Calculation – the approach for SUMP

The climate change impact of a SUMP in terms of GHG emissions can be calculated with an analogy to that of a project. Therefore, the assessment of the input data on transport/demand activity will generally require a multimodal traffic model60 which estimates the flows and conditions of circulation on the entire network considered in the reference area of the SUMP, also referred to as "boundaries" (see previous chapters).

The first step is therefore to correctly identify the boundaries. Once these are defined, the second step is to identify the relevant modes that pertain to the SUMP and the related area – and that would be potentially subject to changes due to the SUMP.

The calculation method should follow the same logic as for a single project carbon footprint estimate:

For all private modes (including private vehicles, taxis, mopeds/motorcycles, taxis, freight, and car-sharing): for each link of the network in the SUMP area, data to be used are still those concerning flows, circulation regime (depending

$$\underset{\substack{\text{(private modes}\\\text{component)}}}{\text{Plan Emissions Volume } (t\,CO_{2e}) \text{ in a given year}} = 365 \times \underset{\substack{(n = \text{number of links}\\\text{in the Plan Area})}}{\sum_{i=1 \text{ to } n}} \text{Traffic volume sect. } i \text{ (AADT, veh/day)} \times \text{Length of road sect. } i \text{ (km)} \times \underset{\text{(dependent on fuel consumption)}}{\text{Emission factor } (Tn\,CO_{2e}/vehkm)}$$

57 For electric vehicles see rail modes and relative footnotes. The same apply to Hydrogen-Fuel cells vehicles for hydrogen generated through electrolysis. For Methane Steam reformer – generated Hydrogen the full LCA emissions have to be taken into account (deducing the CCS/CCU rate, potentially). For Hydrogen generated through biogas solely the fugitive emissions counts. – for more details refer to the Renewable energy Directive Delegated acts on Hydrogen and RFNBOs.

58 The calculation should also take into account the presence of electric vehicles in the road traffic mix. For these the total consumption of electric energy should be calculated and transformed into CO2eq emissions through the electric grid emission factor (same steps as for electric buses).

59 unless specific arrangements to use greener electricity through purchase / storage are in place

60 The level of complexity for the multimodal traffic model might go from more simple demand assessments to more advance 4-stage demand models depending on the scope and conditions defined for the transport demand assessment of the given SUMP.

on the level of traffic model accuracy/detail - V/C ratio, average speed, fleet composition – type, age, fuel/technology)[61 62]:

For public transport: for each considered mode/type, data in terms of total yearly production (veh-km, train-km),

$$\underset{\substack{\text{(Public Transport component)}}}{\text{Plan Emissions Volume } (Tn\ CO_{2e}) \text{ in a given year}} = \sum_{i=1 \text{ to } z} \text{Total Service production (Veh-km or Train-km)} \times \text{Energy consumption (Trams/Trolleybuses: KWh/veh-km or KWh/train-km) Buses: litres/veh-km} \times \text{Emission factor (Trams/Trolleybuses: } Tn\ CO_{2e}/KWh \text{ Buses: } Tn\ CO_2/litre)$$

(z = number of (relevant) PT modes considered in the Plan/Area)

fleet composition (type, age, consumption) and fuel/technology should be used – for the totality of each (relevant) public transport mode considered in the Plan and reference area:

(data on a yearly basis)[63]

The following main indicators can be defined and calculated at the SUMP level (see also definitions and details in section 3.2):

- **(SUMP) Current Absolute Emissions** = total emissions produced in the base year, associated with operations of all the modes considered relevant within the considered boundaries.
- **(SUMP) Absolute Emissions** = total emissions produced in the selected SUMP Scenario, also associated with operations of all modes considered relevant within the considered boundaries –for a given/selected time horizon (year).
- Based on this these two indicators, the main indicator of (relative) Emissions for the SUMP can be calculated:
- **(SUMP) Current vs Plan Emissions** = difference between Current Absolute Emissions and Absolute Plan Emissions for the defined SUMP time horizon and scenario/option.

SUMP (relative Emissions) calculated as Current vs Plan Emissions represent (should represent) the main climate change mitigation indicator, providing an estimate of the extent to which the SUMP:

- Accommodates the needs and trends in future mobility; and
- Ensures that this future demand does not increase emissions, but rather ensures a decrease in absolute emissions when compared with current levels, as per objectives set at the SUMP level, in line with policy targets (see specific sections in the Guide). This would not have been possible by using a SUMP Relative Emissions indicator calculated along the lines of that for a project (i.e. only considering the difference between emissions levels in future scenarios – i.e. with and without the project).

Further details and recommendations on defining related SUMP indicators on GHG emissions are provided in Chapter 3.2.

61 In the formulas hereunder, "Plan" is equivalent to "Strategy" or SUMP.

62 As mentioned, transport models might already provide the calculations of the CO2 emissions of the transport systems covered for time horizon and option/scenario considered.

63 Total public transport service production is normally a combination of road-based and rail-based services (veh-km & train-km).

"Mobilise your City (MyC)"[64], which has worked with more than 100 cities of the developing world has provided a simplified calculation tool, still in line with the principles presented above, which allows for evaluating the current mobility CO2 footprint and the impact of proposed measures. Their MobiliseYourCity Emissions calculator is based on an Excel tool.

The calculation tool and user manual are listed and hyperlinked below:

- MobiliseYourCity GHG Emissions Calculator (Tool)[65]
- User Manual for the MobiliseYourCity GHG Emissions Calculator[66]

In the above cases where more basic calculator tools are utilised for emissions calculations, it is recommended that in any case an accurate data set and quantitative analysis is developed in due time, including if possible and relevant a traffic model, covering the adequate reference geographical area e.g. the FUA. Such an approach will facilitate future calculation of GHG emissions on a common basis, and will additionally allow the assessment of GHG emissions of planning options (ultimately measures packages) to be compared to the GHG emissions reduction target(s) set.

6.2. Count Emissions EU

The Count Emissions EU initiative sets out a common framework for greenhouse gas emissions accounting of passengers and freight transport services across the entire multimodal transport chain. The increased transparency on the performance of various services should lead to incentives for market players to reduce greenhouse gas emissions and make transport more efficient and sustainable.

CountEmissions EU adopts a semi-voluntary (binding opt-in) approach: an entity which decides to disclose its GHG emissions calculations should do so according to the rules set out in the Regulation. It is designed to support other, specific measures taken by industry and public authorities to facilitate the green transition. These measures include establishing greenhouse gas transparency clauses in transport contracts, providing information on greenhouse gas emissions of a given service to passengers, or setting climate-related criteria for green procurement procedures and green transport programmes.

The core element of the initiative is the methodology based on a newly established international standard CEN ISO 14083. It represents the latest scientific state of the art, is well recognised by the businesses and it is currently the only methodology specifically dedicated to quantifying emissions in the transport chains. CEN ISO 14083 requires emissions calculations for transport operations to be based on the 'well-to-wheel/wake' approach: in this way, fuel production and distribution, as well as the emissions produced when the vehicle is moving, all have to be taken into account in the calculations. The Count Emissions EU refers also to the development of two input databases: a central EU database of greenhouse gas emission factors and a core EU database of default values for greenhouse gas emissions intensity.

In the present Topic Guide, the assumed GHG emission factors are based on the "tank-to-wheel" approach for transport projects and transport plans. This type of calculation takes into account only those emissions associated with operations of all the modes considered relevant within the considered planning/SUMP boundaries, these being the sole components that can be actually affected and influenced by the SUMP process. Concerning aggregated calculations (i.e. not accounting GHG emissions of a transport service) this methodology will remain applicable and valid also when the referenced databases from the CountEmissions EU initiative (with emission factors on "well-to-wheel/wake") become available, using those (well-to-wheel/wake) factors instead of the (tank-to-wheel) factors currently used and referred to in this Guide.

64"Mobilise your City" are supporting cities and countries outside Europe, with technical assistance to develop scalable solutions to improve mobility in complex developing country environments. It is a consortium based on support from the European Commission's Directorate-General for International Partnerships (INTPA), the French Ministry of Ecological Transition (MTE), the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the French Facility for Global Environment (FFEM) and the Agence Française de Développement (AFD). Main implementing partners, the Agence Française de Développement (AFD) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

65 Mobilise Your City. (2022). MobiliseYourCity Emissions Calculator. https://www.mobiliseyourcity.net/mobiliseyourcity-emissions-calculator

66Mobilise Your City. (2020). User Manual for the MobiliseYourCity Emissions Calculator. https://www.mobiliseyourcity.net/user-manual-mobiliseyourcity-emissions-calculator

As such, both approaches are substantively coherent in the sense that the Count Emissions EU includes both tank to wheel and fuel production/distribution (well to tank) components for the calculation of the emission factors. Whilst the inclusion of the well-to-tank component could be "plugged" into the SUMP calculations to produce the related "upgraded" result, this would not practically affect SUMP-related KPIs, as the main indicator referring to the different between the current and SUMP scenarios would remain unchanged. Of course, this would not be the case should wider scope interventions be taken into account in the planning exercise, although that would generally be beyond the scope of the SUMP and external to it. Note that such calculations are undertaken as part of the Cities Mission Climate Action Plans of which the SUMP is one input to such a calculation which covers multiple sectors.

For further reference on work currently being done on this please refer to the impact assessment supporting the proposal for a Regulation of the European Parliament and of the Council on the accounting of greenhouse gas emissions of transport services (CountEmissions EU) and to the study supporting the impact assessment.