GREEN CHARGE

greencharge2020.eu

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Recommendations and Guidelines for Integrating Electric Mobility into SUMPs

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2020 CiViTAS
Cleaner and better transport in cities

About GreenCharge

GreenCharge takes us a few important steps closer to achieving one of the dreams of modern cities: a zero-emission transport system based on electric vehicles running on green energy, with traffic jams and parking problems becoming things of the past.

The project promotes:

- **Power to the people!**
  The GreenCharge dream can only be achieved if people feel confident that they can access charging infrastructure as and when they need it. So GreenCharge is developing a smart charging system that lets people book charging in advance, so that they can easily access the power they need.
- **The delicate balance of power**
  If lots of people try to charge their vehicles around the same time (e.g. on returning home from work), public electricity suppliers may struggle to cope with the peaks in demand. So we are developing software for automatic energy management in local areas to balance demand with available supplies. This balancing act combines public supplies and locally produced reusable energy, using local storage as a buffer and staggering the times at which vehicles get charged.
- **Getting the financial incentives right**
  Electric motors may make the wheels go round, but money makes the world go round. So we are devising and testing business models that encourage use of electric vehicles and sharing of energy resources, allowing all those involved to cooperate in an economically viable way.
- **Showing how it works in practice**
  GreenCharge is testing all of these innovations in practical trials in Barcelona, Bremen and Oslo. Together, these trials cover a wide variety of factors: vehicle type (scooters, cars, buses), ownership model (private, shared individual use, public transport), charging locations (private residences, workplaces, public spaces, transport hubs), energy management (using solar power, load balancing at one charging station or within a neighbourhood, battery swapping), and charging support (booking, priority charging).

To help cities and municipalities make the transition to zero emission/sustainable mobility, the project is producing three main sets of results: (1) **innovative business models**; (2) **technological support**; and (3) **guidelines** for cost efficient and successful deployment and operation of charging infrastructure for Electric Vehicles (EVs).

The **innovative business models** are inspired by ideas from the sharing economy, meaning they will show how to use and share the excess capacity of private renewable energy sources (RES), private charging facilities and the batteries of parked EVs in ways that benefit all involved, financially and otherwise.

The **technological support** will coordinate the power demand of charging with other local demand and local RES, leveraging load flexibility and storage capacity of local stationary batteries and parked EVs. It will also provide user friendly charge planning, booking and billing services for EV users. This will reduce the need for grid investments, address range/charge anxiety and enable sharing of already existing charging facilities for EV fleets.

The **guidelines** will integrate the experience from the trials and simulations and provide advice on localisation of charging points, grid investment reductions, and policy and public communication measures for accelerating uptake of electromobility

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Executive Summary

E-mobility is one of the key elements for decarbonising the transport sector, but the ambitious European targets require a profound change in the wider transport and energy system. Sustainable Urban Mobility Planning (SUMP) is a key participatory planning framework – integrating and focussing different mobility-related planning activities towards a common vision. As cities develop or revise their SUMPs, it is important to include emerging services and technologies such as charging and energy infrastructure in public space, new city logistics modules and electrification of public transport, taxis and car sharing cars. This document supplements the existing SUMP guidelines with the insights of the GreenCharge project, which focusses on 1) vehicles with the greatest use to maximise decarbonisation and emission reduction, and 2) on the role of municipalities to encourage the uptake of good practice e-mobility solutions.

Simply electrifying vehicles will not solve the mobility problems facing cities and rural areas. Congestion, parking, road safety and connectivity are other challenges facing the transport sector. With SUMPs, priority is put on reducing transport needs, shifting to active modes, strengthening public transport and electrifying the fleets with greatest use: buses and municipal fleets, commercial vehicles and taxi and car sharing fleets.

Cities must be easily accessible, and rural areas must be connected. The reduction of traffic jams requires new services and technologies to be as convenient as car ownership, but to take up less space. The gap between individual transport needs and public transport supply can be bridged by Mobility as a Service (digitally mediated public transport, carpooling, car and bike sharing, ride pooling, on-demand shuttles or micro-mobility). Multimodal solutions need appropriate infrastructure, including mobility hubs and digital access.

Neighbourhoods are the starting points for our mobility. A diverse range of transportation options must provide residents with an attractive alternative to owning a car. Car sharing plays an important role, but reducing the space consumed by private car parking is a prerequisite for the establishment of sustainable mobility options and for the installation of curbside charging infrastructure. Comprehensive parking management, one of the most important fields of action for a mobility transformation, is a starting point for a fair distribution of space.

Both pull and push measures are necessary to achieve a lasting shift in mobility behaviour, but this won't happen without strong political leadership and a participatory process within an SUMP. With a range of good practice examples, GreenCharge encourages broad uptake of the lessons and results that have shown success or promise of success.

The central roles of municipalities in this transformation process are to foster the SUMP process and to practice what they preach. This starts with electrifying their own fleet and integrating sustainable mobility options – like using public transport or bicycles - in their own daily practices. Another important role for municipalities is to provide a planning and legal framework and public space to create a sustainable urban mobility environment. This can include the integration of car sharing into housing developments, improvements for walking and cycling and in the environmental quality and climate resilience of street space.

The GreenCharge pilots described in this document include software solutions for charging at home and at work and the integration of car sharing. All pilots aimed to optimise energy use and improve charging management and smart booking systems. The GreenCharge examples are supplemented by an example from the See4City project of charging at points of interest. All examples provide cost-efficient charging solutions for electric vehicles and enable increased consumption of locally produced solar energy. Accompanying aspects are presented, including the promotion of car sharing and walking in the city of Vienna and making cycling safer and more attractive. In all cases, the electrification of transport is presented as an integrated component of the wider transformation of mobility.

Table of Contents

Table of Figures

List of Tables

List of abbreviations

BMVI	Bundesministerium für Verkehr und digitale Infrastruktur
CEP	Courier express and parcel services
COP21	Conference of Parties (21st United Nations Climate Conference 2015 in Paris)
CS	Carsharing
CVD	Clean Vehicles Directive
EDG	European Green Deal
ESR	Effort Sharing Regulation
EGD	European Green Deal
EU ETS	European Emission Trading System
GDRR	General Data Protection Regulation
GHG	Greenhouse Gases
Gt	Gigatonne
ICE	Internal combustion engine
IEA	International Energy Agency
NDC	Nationally Determined Contributions
NECPs	National energy and climate plans
NZE	Net Zero Emission
PV	Photo voltaic
RED II	Renewable Energy Directive (revised)
SDG	Sustainable Development Goals
SECAP	Sustainable Energy and Climate Action Plan
SoC	State of Charge
STEPS	Stated Policies Scenario
SULP	Sustainable Urban Logistic Plan
SUMP	Sustainable Urban Mobility Plan
TFC	Total final consumption
UVARs	Urban vehicle access regulations
V2G	Vehicle to Grid

1 Introduction

Across Europe, local authorities and their private operating partners are striving to create sustainable solutions for passenger transport and freight that foster accessible, safe and affordable mobility, while aligning with European Green Deal emissions reduction objectives (EGD), Sustainable Development Goals (SDG11) and the Habitat III New Urban Agenda.

1.1 European initiatives to reduce GHG emissions

Novel GHG-reduction levels were set out in the European Green Deal (EGD) in April 2021 by the Council and Parliament in order to meet the overall goal of limiting the temperature rise to max. 1.5° in year 2100. The emission reduction objectives are based on the calculated CO2 budgets set out by the Paris Agreement COP 21 and new EU CO2 reduction targets of -55% from 1990 until 2030 and climate neutrality by 2050.. The EU Commission presented with its Climate package concrete actions make the EGD more than a narrative. The frame is set by the EU Commission but member states are now in the driver seat to design their own national instruments and programmes to reach their targets.

The Effort-Sharing Regulation (ESR) set national emission targets for the sectors transport, buildings, agriculture and waste, that are not yet included in the EU Emissions Trading System (EU ETS). In contrast to sectors in the EU ETS, which are regulated at EU level, Member States are responsible for national policies and measures to limit emissions from the ESR-sectors. This will change with the revision of the EU ETS when ESR will be incorporated into the EU ETS from 2025. ESR2 will be an upstream system and the certificates from ESR2 will be fully auctioned but member states shall reserve 50% for low income households.

In December 2021, the European Commission published new transport initiatives for more sustainable mobility – ranging from Trans-European Networks (TEN-T) and long distance travel to urban mobility solutions. The new Urban Mobility Framework sets out European guidance on how cities can cut emissions and improve mobility, including via Sustainable Urban Mobility Plans. The main focus will be on public transport, walking and cycling. The proposal also prioritises zero-emission solutions for urban fleets, including taxis and ride-hailing services, the last mile of urban deliveries, and the construction and modernisation of multimodal hubs, as well as new digital solutions and services.

The Sustainable Development Goals (SDG) of the United Nations frame future sustainable development in altogether 17 areas. Area 11 is related to “make cities and human settlements inclusive, safe, resilient and sustainable”. It aims at increasing the share of people with convenient access to public transport and open public space within walking distance.

For the transport sector, a EU core goal is consequently to reduce transport needs in the first place, in the second to promote public transport and to shift road traffic to environmentally friendly modes of transport, especially rail. In addition, emissions are to be reduced through a drive system shift to zero-emission power trains.

To achieve the ambiguous goals of urban transitions in transport and mobility, resistance and conflicts must be overcome. It also requires long-term planning certainty, stable policy goals and funding in an ever changing political and economic environment.

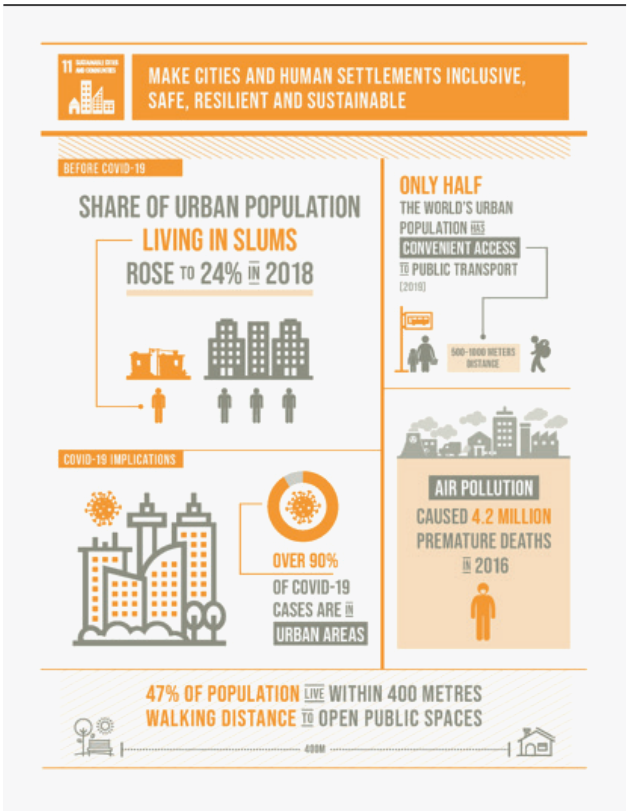

Figure 1: Sustainable Development GOAL 11, source: https://sdgs.un.org/goals/goal11

1.2 SUMPs as a tool to achieve climate goals in urban transportation

Sustainable urban mobility planning (SUMP) is a strategic and integrated approach to ensure the much needed societal, and political consensus on how to deal with the complexity of urban transport to achieve the required emission reductions and help a transition towards a future proof urbans transport and mobility system.

Due to the increasing urgency of climate protection, the energy issue is assuming ever greater importance in the urban planning processes.

This recommendations builds upon the series of topic guides related to the subjects of urban mobility planning that are available at the Commission´s Urban Mobility Observatory ELTIS (eltis.org). During the course of the GreenCharge project the following Topic Guides with direct relevance were published in September 2019:

- Electrification - planning for electric road transport in the SUMP context (SUMPs-Up)
- Linking Transport and Health in SUMPs (PROSPERITY)
- Guidelines for the harmonization of energy and mobility planning (SIMPLA)
- Integration of shared mobility approaches in Sustainable Urban Mobility Planning (PROSPERITY)
- Intelligent Transport Systems (ITS) and SUMPs – making smarter integrated mobility plans and policie (ERTICO-ITS & CERTH)
- Mobility as a Service (MaaS) and Sustainable Urban Mobility Planning (ERTICO-ITS & CERTH)
- UVAR and SUMPs Regulating vehicle access to cities as part of integrated mobility policie (ReVEAL)
- New recommendations for developing electric charging infrastructure (Sustainable Transport Forum (STF))

Already in the SUMP guidelines on the integration of electromobility in the urban planning process, it was emphasized that electrification does not follow the simple scheme of substituting combustion engine vehicles by electric motors. It was outlined that a number of issues must be tackled, including the provision of charging infrastructure the cooperation with a wide range of stakeholders, the procurement of new fleets by public authorities and transport operators, adapting parking regulations and the management of regulations and privileges for EV users[1]. This core idea of embedding electromobility in a wider context is the guiding principle for decarbonizing transport.

What is a SUMP

"A Sustainable Urban Mobility Plan is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles."

SUMP design principles

- Plan for functional urban areas
- Cooperation across institutional boundaries
- Involvement of citizens and stakeholders
- Assessment of current and future performance
- Long-term vision and clear implementation plan
- All transport modes in an integrated manner
- Monitoring & evaluation

www.eltis.org

1 Topic guide: Electrification in Sustainable Urban Mobility Planning, 2019

2 E-mobility - which role does it play in sustainable mobility planning

Electric mobility is widely understand to be essential for the energy transformation in the transportation sector. But what is in there for municipalities?

Clean air – less noise – energy transition

The benefits from e-mobility are emission reduction in air pollutants, carbon free energy sources and noise reduction. The role it plays especially in terms of climate action can´t be underestimated. Therefore it goes beyond purely mobility related issues and requires sparring with the energy and environment sectors.

The urban mobility environment has a very high potential to shoulder the burden for emission reductions. The challenge is to rally all stakeholders behind that common goals in a timely manner. Electrification of private cars and commercial fleets is more than just a shift in energy source. It also needs a different planning of mobility as a whole to accommodate a shift towards sustainable modes and the new requirements for e-mobility. Electric mobility will reduce emissions, but it must also be considered that Electromobility electromobility brings an additional land demand into the planning process due to the need for charging infrastructure and thus increases the land competition for the limited urban space. In consequence it needs a new urban space distribution between all stakeholders to give more room for active modes and to enable mobility and urban logistic services as well as providing charging opportunities.

SUMPs aim to integrate the competing goals of mobility requirements under the overarching goals of urban development and climate protection and to lead them to consensus and implementation in a structured process. Urban mobility planning traditionally aims at reducing traffic jams, lower emissions of air pollutants, reduce noise and eliminate

Figure 2: SUMP implementation guide 2019, ©Rupprecht Consult

climate-impacting effects. By doing so, successful pathways along the conversion of the commercial fleet are increasing the share of active modes in the modal split by fostering walking and cycling. Motorised transport should be reduced a much a possible and the remaining part needs to be transformed to electric traction or in case of heavy duty vehicles to alternative fuels.

In the 2019 SUMP Guide on electrification planning relevant steps were identified which are especially relevant for electromobility also for planning of charging infrastructure as a prerequisite for a wider uptake of e-mobility.

Public transport plays a key role for a sustainable transport system. Electrifying busses has a positive effect on reducing emissions that equals the effect of electrifying 100 cars.

When transport and private mobility is to be electrified it also places an additional conflict in respect to public space consumption and changed mobility behaviour for charging. These challenges have to be addressed in urban planning. Actions to electrify the urban mobility system should focus on a cascading decision in respect to utilization rate and charging requirements.

3 Legal framework

In December 2020, the EU set ambitious Union commitments to reduce greenhouse gas emissions further by at least 55 % by 2030 as compared with 1990, to increase the proportion of renewable energy consumed, to make energy savings in accordance with Union level ambitions, and to improve Europe's energy security, competitiveness and sustainability.

This section elaborates the European regulatory framework that will affect the energy transition in mobility.

3.1 Clean Vehicles Directive 2019/1161

Clean Vehicles Directive 2019/1161 promotes clean mobility solutions in public procurement tenders and creates a strong demand growth and further deployment of low- and zero-emission vehicles. It defines when a vehicle is "clean" and "zero-emission", and sets specific targets for Member States on the share of clean and zero-emission vehicles in public vehicle procurement and public transport contracts from mid-2021.

A vehicle is "clean" if it uses alternative fuels such as electricity, hydrogen, biofuels, synthetic and paraffin fuels or gas (CNG, LNG, LPG, biomethane). Plug-in hybrid buses are also "clean".

Vehicles are considered "emission-free" if they do not have an internal combustion engine - or the internal combustion engine emits less than 1 g CO2/km or 1 g CO2/kWh. Since this is factually excluded, only buses with purely electric drives (battery, trolley, fuel cell bus) are emission-free in the sense of the directive.

The Clean Vehicles Directive sets minimum quotas for two multi-year periods. The following requirements apply to most Western European countries:

First period (2 August 2021 to 31 December 2025): 45 percent of the new vehicles to be procured should be "clean" buses, at least half of which should have an emission-free drive.

Second period (1 January 2026 to 31 December 2030): the quota for clean vehicles increases to 65 per cent, again at least half of which are to have zero-emission propulsion.

The quotas of the second period will apply beyond 2030 unless new quotas are adopted. However, there are exceptions: In the bus sector, only city buses are covered; coaches are excluded. For own-account transport, the requirements only apply if the respective transport company is considered a sectoral client. The quotas specified in the directive also do not relate to each individual contract, but to the average of the contracts awarded in the member state.

Vehicle type	Clean vehicles		Procurement quotas: 1st reference period 2nd August 2021 – 31 December 2025	Procurement quotas: 2nd reference period 1st January 2026 – 31 December 2030
Passenger car	50g CO_2/km	From 2026: 0g CO_2/km	38,5 %	
Light duty vehicle	50 g CO_2/km		38,5 %	
Heavy duty vehicle	Alternative fuels (electric, hydrogen, LNG, synthetic fuels, bio-based fuels)		10 %	15 %
Busses			45 %	65 %

Table 1: Overview of public procurement quotas, Source: German Federal Ministry for Transportation and digital Infrastructure (BMVI)

3.2 Renewable Energy Directive 2018/2001

The revised directive RED II sets only one overall binding target at the EU level: 32% renewables by 2030. Starting in 2021, the member states must "jointly ensure" that the EU-wide RE expansion target of 32% is achieved by 2030.

To do so, member states must set national contributions as part of their respective climate and energy plans (NECPs) and continue to meet their national renewable energy expansion targets from the predecessor 2020 Directive. The Commission will review and, if necessary, tighten the target by 2023.

With the revision of the Renewable Energies Directive, the EU is giving itself a new common framework for promoting renewable energies. The share of renewable energies in the EU's final energy consumption is to increase to at least 32 percent by 2030. In addition to joint support schemes in the electricity sector, the directive also provides for measures in the heating and transport sectors, which together account for two-thirds of energy consumption.

For example, member states are to increase the share of renewables in the heating and cooling sector by 1.3 percentage points annually from 2021. In the transport sector, fuel distributors will be required to increase the share of electromobility and renewable fuels (electricity-based synthetic fuels) to 14 percent by 2030. The share of "first-generation biofuels" produced from crops will be limited by the new directive.

3.3 Building energy efficiency directive 2018/844

The directive rational is tapping the potential for decarbonisation that the EU building stock offers: approximately 40% of energy consumption and 36% of CO2 emissions in the EU originate from buildings. The new version of the Buildings Directive provides for further development of the long-term renovation strategies previously regulated in the Energy Efficiency Directive[1].

The building directive stipulates that in new or extensively renovated residential buildings with more than ten parking spaces, all parking spaces will in future be equipped with empty conduits for electric cables. In non-residential buildings, at least every fifth parking space must be equipped with empty conduits and at least one charging point must be installed.

From 2025, every non-residential building with more than twenty parking spaces must be equipped with at least one charging point.

The building directive provides for exceptions for buildings owned and predominantly used by small and medium-sized enterprises. Violations are punishable by fines.

1 Climate Adapt: https://climate-adapt.eea.europa.eu/metadata/publications/directive-eu-2018-844-amending-directive-2010-31-eu-on-the-energy-performance-of-buildings-and-directive-2012-27-eu-on-energy-efficiency

Charging infrastructure on private land should be made accessible to the public wherever possible, thus making a valuable contribution to demand-driven charging. Especially at night, charging infrastructure on customer parking lots, e.g. of retailers, and on municipal properties can offer added value for residents without their own parking space.

4 Transport transformation to reach climate targets

To reach a net zero target for transport in 2050 and the intermediate goals of CO2 emission reduction of 55% by 2030 (EDG) it requires decisive actions in all sectors. The transport sector is the one that missed any reduction target in the EU – thus special efforts are required to reach the necessary reduction in CO2 emission.

The IEA Report (2021) outlines that to meet the net zero emission scenario requires the key milestones of 20 % EV share in existing fleet and no new ICE cars sold from 2035 and 60% fleet share by 2040. In 2020 fuel use consisted of 90% oil based in the transport sector. Rising from 1.5 % in 2020 energy use in transport will be 60 % by 2050. Hydrogen and alternative fuels based on hydrogen will make up 30 % and bioenergy for the remaining 15% rising from almost zero and 4%[2].

To achieve this goal, it is important to intensify knowledge transfer and the exchange of good examples for decarbonizing transport and the mobility environment in urban contexts. The goals and fields of action provide a new framework for this change.

Cities account for 72% of all GHG emissions in the EU (EEA, 2020) and the mobility sector for 1/3 of these emissions. City authorities are in the driver seat to

2 IEA (2021): Net Zero by 2050 – A roadmap for the Global energy Sector, Special Report, revised version Mai 2021

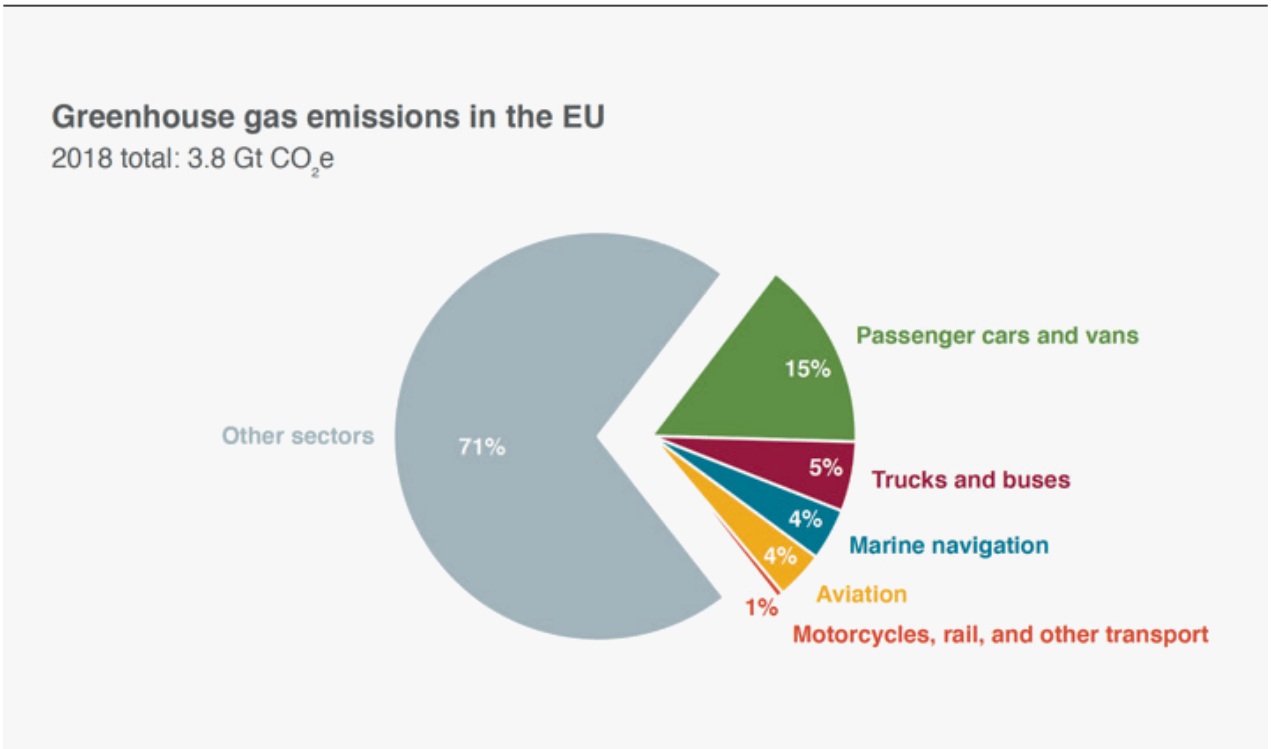

Figure 3: Share of EU-27 economy-wide greenhouse gas emissions in 2018 by transport subsector, including domestic and international components. Land use, land-use change, and forestry are included in the other sectors category, ICCT 2021

set the framework for reaching the emission reduction targets and develop strategies for all sectors in combination.

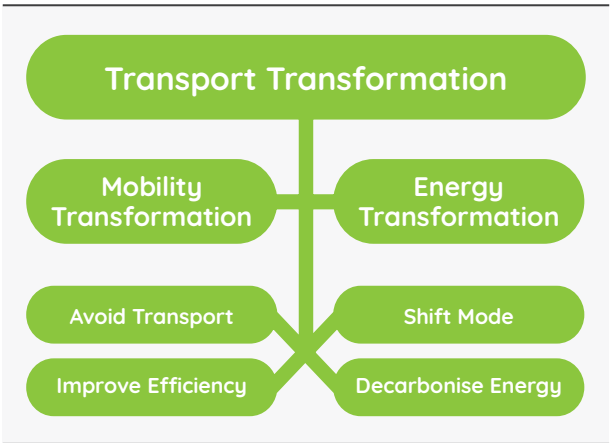

Figure 4: building blocks of sustainable transformation in the transport sector

The path to emissions reduction and more futureproof cities is well known:

1. Avoid transport needs
2. shifting to sustainable modes
3. efficiency improvements
4. renewable energy sources

4.1 The role of municipalities in achieving climate targets

With sustainable urban mobility planning, municipalities have an instrument in their hands to reduce the use of private cars and promote active and shared modes of transport. In this way, cities play an important role in the market take-off of electromobility. Cities and municipalities can play a pioneering and exemplary role in shaping the mobility transition: They are in direct contact with their citizens and the local economy and can promote and implement behavioural changes and technological innovations in a variety of ways, for example in their own administration or in municipal assets.

This includes promoting the development and expansion of infrastructure, for example charging stations, but also the expansion of distribution networks. Direct control by the municipalities is not possible in all areas, and municipal resources are also limited.

Municipalities can influence electromobility in various roles:

- Municipalities are enablers through strategic planning by designing and interlinking mobility plans (SUMPs), sustainable urban logistics plans (SULPs) and sustainable environmental and climate action plans (SECAPs) and referencing any measurement to a greater vision also as presupposition for accessing funding.
- Municipalities are consumers and are procuring zero emission logistic services for their own needs.
- Municipalities serve as role models by converting their own fleets and, where possible, making their charging infrastructure available to the public.
- Municipalities are networkers and strategists, bringing together the various stakeholders and using their platforms to plan according to need and develop strategies for building charging infrastructure and last-mile logistics.
- Municipalities are multipliers, passing on information from networks and other levels of collaboration to others for adoption.
- Municipalities are providers of information and services for specific information or offer advice, especially in cooperation with municipal companies or by setting up advisory programs.
- Municipalities are interfaces between national regulation and the local level, i.e. they implement legal options and specifications in statutes and - depending on the framework conditions - are also approval authorities.
- Municipalities are property owner and can dedicate public space for alternative mobility services and charging infrastructure

4.2 City authorities as strategic players

Cities are not only places where pollution takes place, but city government is also a key player in implementing policies and a strategic actor in mitigating climate change and developing adaptation strategies.

However, although some capital cities are already experiencing peaks in car ownership, this is not necessarily true for smaller cities or rural areas[3].

3 Jones et al, 2018, CREATE project summary report, 2018: http://create-mobility.eu

In general, the number of passenger cars increased between 2015 and 2019 by 1.8% in Europe. The only country with a slight decrease is France with -0.3% over the period[4].

The increase in vehicle registrations is a growing problem for urban development. Vehicles themselves create dependencies. The car's promise of freedom has turned into a path dependency. Maintaining a car is expensive, so we shy away from the additional costs of other modes of transportation and do not try new forms of mobility. At the same time, the car creates a sense of personal convenience because it is always available and requires no additional effort[5]. They are a barrier to more active modes of transport. They decrease quality of public space and road safety for other people, as well as consume valuable space in cities at an ever increasing pace. These trend has to be reversed urgently. Increasing car ownership is never part of the solution.

> We do not have a problem of knowledge but a crisis of ambition and implementation.[6]

City authorities need resources, expertise and knowledge to reach a reduction in car ownership. It's a highly political topic and discussed very emotionally that is beyond its physical function and existence. It is necessary to look at cross sectoral issues and different policy areas to identify troubled spots and solve them with elements that fit into larger policy directives.

In the upcoming debate on how to achieve the climate protection targets with measures in the field of mobility, the financing of public transport must be given special priority and various financing options must be discussed in an unbiased manner.

To understand that public transport is the backbone of sustainable mobility in cities and rural areas plays a major role in reaching the SDE goals as well as the emission reduction targets. In order to achieve the climate targets and for better accessibility of rural areas, broad investments for public transport on rail and road and an increased service level are crucial. Fields of actions are investments in supply, infrastructure, digitization, modern vehicles and qualified personnel, as well as marketing and communications and attractive fares. The Corona pandemic must not change this.

But the pandemic led to significant changes in mobility behaviour and avoidance of public transport requiring additional funding for local public transport to keep and strengthen its position in the mobility environment thus helping to meet the sectoral climate targets for transport. Municipalities and regional authorities must be put in a position to make further investments in the local public transport infrastructure, to significantly increase and permanently finance the high quality of public transport service. To invest sustainably in public transport not only infrastructure and modern vehicles matter but also digitization, qualified personnel, marketing and communications as well as attractive fares.

4.3 Municipal fields of action

The fields of action in which the city administration can intervene determine the focus of sustainable urban mobility planning. Therefore, a transparent and thoughtful prioritisation of the fields of action is essential for further acceptance and also the linkage with other planning areas.

The first step is to identify the problem. What obstacles does the city face when aiming for decarbonisation of transport? How can private car ownership be reduced and how can charging be integrated without compromising sustainable transport modes?

Integration of different planning sectors with SUMPs

SUMPs focus on sustainability in the urban mobility environment. They need to go beyond the classic aspects of walking, cycling, urban logistics and parking management as fields of action - within a holistic approach to promote each other. This requires bringing together planning areas that have mostly acted separately up to now. This requires careful planning, because the integration of different planning areas makes any planning process more complicated and requires resources and additional time.

4 ACEA, 2021: Vehicles in use Europe https://www.acea.auto/files/report-vehicles-in-use-europe-january-2021-1.pdf
5 Ketterl,C. et.al, 2021 in B.A.U.M. INSIGHTS 1/21
6 Hoffart,F. & Kempfert,C. 2021

Nevertheless energy sector coupling becomes increasingly important as the energy consumption of all mobility types put pressure on the public grid. New mobility forms, based on electric propulsion should therefore be integrated into a system of load balancing and be part of a strategic development with the grid operator.

Especially the year 2021 made it absolutely imperative that climate resilience of cities it the new urgency in urban planning. The last years have seen heat waves, torrential rain and floods. Therefore public space must not only accommodate traffic but play its role by contributing to cooling down the urban hot spots by vegetation and large trees. Streets must also contribute to the regional water balance by retaining rain water and groundwater infiltration.

These aims often hamper charging infrastructure in public street space. The below picture of a residential street shows the optimization for rainwater retention and infiltration, shading and space for safe walking and cycling.

At the same time it illustrates the dilemma of narrow urban streets: difficulty to implement charging infrastructure in residential streets that just have sufficient room for walking and cycling as well as need to provide space for trees and green. The competing user demands require prioritization and strong political support because such conflicting demands often cannot be fully solved to the consent of all stakeholders.

Therefore the sourcing of private grounds like publicly accessible parking spaces from supermarkets, gyms or larger garages in neighbourhoods should be included in charging concepts and play a major role in it.

4.3.1 Enabling active modes of transport - Cycling and walking

Active modes are the most climate-friendly form of mobility and an important component of intermodal mobility solutions. Cycling and walking is becoming increasingly important in both urban and rural areas. With the ever growing share of electrically supported bicycles, there is a growing potential for the use of bicycles for commuting also in a regional context – an alternative to the use of a private car.

Cycling network

The attractiveness and safety of cycling are the decisive factors for a further increase in the share of cycling in the transport environment. The development of a cycling infrastructure that is as continuous

Figure 5: residential street in the City of Bremen – space competition for redesigned under climate resilience aspects – trees, safe walk and cycle conditions, unpaved strip for rainwater infiltration, Source: Glotz-Richter

as possible with urban-rural connections beyond the municipal boundaries and the linking with other modes of transport are particularly in focus.

In addition to the new construction, conversion and expansion of comprehensive, preferably separated and safe cycling networks, a cycle-friendly environment also includes independent cycle paths as well as parking facilities and cycle parking garages.

Cross-border connections in particular require a long implementation period. In strategic planning, this long-term continuity must be taken into account when planning funding and resources.

Forecasts must take into account the increasing cargo bike traffic and its potential to reduce car traffic. In order to promote this trend, its special requirements, such as parking areas, must also be included in the planning.

Disused railway lines and agricultural roads can serve as extensions of inner-city cycle connections. These longer route connections increase the attractiveness for bicycle commuters and recreational athletes. A structural upgrading of such connections creates a comfortable and safe cycle path infrastructure and can be an attractive alternative to the construction of completely separate cycle paths, both in terms of lower land consumption, the otherwise necessary interventions in nature and the environment, and the expenses for land acquisition.

Due to the standard range of batteries of electrically assisted bicycles, there is no general need for additional charging infrastructure in public. On tourist routes, restaurants and cafés can offer charging facilities to their customers to increase attractiveness.

Walking

Walking is an everyday activity and a unique primary indicator for quality of live[7]. It has been a widely overlooked and neglected part of mobility planning. Recent attention to the linkages between the "walkability" of urban areas and perceived quality of live has brought much-needed attention to this inherently climate-friendly, emission-free and inclusive mode of transportation. Several pioneering examples from Paris, Rotterdam, Lisbon and many other cities have demonstrated the positive impact on modal shift and decreased car use.
The International Charter for Walking (Walk 21, 2006) recommends for SUMPs to ensure safe and convenient access on foot for as many people as possible to as many places as possible, especially public transport and public buildings, as well as barrier free design of public spaces and access to facilities and services. This includes a favourable street design, including reallocation of space for pedestrian use and car-free environment adapted to climate resilience with trees and green areas, places for social interaction and safe intersections. It may be necessary to re-organise or even reduce car parking as the ever growing car sizes causes increasing problems in narrow urban streets. As with bicycle planning, high-quality pedestrian networks supported by public transportation and convenient access encourage active mobility in general and walking in particular.

Improving Safety

Inappropriate speed is one of the most common causes of accidents in urban and suburban areas. The speed of motor vehicles is a decisive factor in the number and severity of property damage and personal injury, the perception of safety, especially among cyclists and pedestrians, and has significant spatial and functional separation effects. It also affects environmental and climate protection (emissions, energy consumption and noise).

Possible options for action in this context include enabling and testing locally adapted speed regulations without proof of a special hazard situation to reverse the car-oriented legislation.

Bicycle and pedestrian safety and attractiveness need to be brought into political focus. Safe pedestrian connections and protecting vulnerable road users from consequences of high speeds in mixed traffic through separate or more protective infrastructure are a key to safety and attractiveness of active modes and deserve special attention.

Electromobility and all forms of automated transport also benefit from generally lower speeds, as they consume less energy and increase range. Automated transportation also needs lower speeds in

7 J. Walker et.al., 2019: Supporting and Encouraging Walking in Sustainable Urban Mobility Planning, October 2019

mixed traffic to cope with environmental complexity. As transportation systems transition to automated on-demand services, a generally more moderate speed of 30 km/h helps all mobility participants.

4.3.2 Attractive public transport

Buses, city trains and light rail are the workhorses of the public transport network. Their traffic frequency is the heartbeat of a city. Collective and electrified transport powered by renewable energy is the most important tool for reducing climate-relevant emissions and offers an inclusive transport option. All active transport modes, such as cycling and walking, as well as mobility services, rely on an adequate public transport system, which is an essential part of the urban mobility system.

Public transport must make a significant sectoral contribution to climate protection. In Germany, this means around 60 % more service and a doubling of public transport passengers by 2030 to make its contribution to the climate protection target.

While light rail vehicles and trams are already fully electric, buses are predominantly powered by diesel engines. A gradual replacement of the bus fleets with electric buses, at least at the procurement rates set in the CVD emissions, will accelerate the conversion of the existing fleet and contribute to climate protection and the quality of the urban environment. Electrification of the bus fleet is extremely costly and involves not only the vehicles and infrastructure, but also the upgrading or complete redesign of bus depots.

The European H2020 project ELIPTIC (Electrification of Public Transport in Cities) has shown with its "Factor 100" campaign that the electrification of one 18-meter city bus results in CO2 reductions equivalent to those that could be achieved by electrifying 100 cars - mainly due to the much longer operating time. But despite the 100-fold impact, there is not 100-fold funding in the various national funding programs.

In order to compensate for the pandemic decline in ridership and attract a larger share of customers, the attractiveness and reliability of the service must be increased. This can be achieved by increasing the frequency of service and extending the operating hours as well as by linking different mobility offers, both in ticket booking and combination options. Another success factor for public transport is general barrier-free access and improved inclusion, as well as ensuring that stops and stations are not scary places, especially outside peak hours. Sharing options such as car, bike or scooter sharing have the task of accompanying the public transport system. They can partially fill the gaps caused by limited operating hours or area coverage.

Sharing offers are closely linked to parking space management, as they are mostly offered in public street space.

4.3.3 Electrification of municipal fleet

Municipalities are important employers, owners of real estate and customers of services. This also applies to their subsidiaries and participations. The actions of municipalities therefore have an impact on the market, in the form of savings in the procurement of goods and services, but also in the form of setting an example. Preaching sustainability and taking no action themselves will not accelerate the transition.

Preferring active modes of transport such as cycling and walking for employee mobility, combined with bike and car sharing, are essential measures to reduce the municipal vehicle fleet, bringing immediate financial benefits and positive public recognition. Only the remaining fleet needs to be electrified and at least meet the requirements of the CVD.

This means that electrification will be gradual. To maximise the impact of a partially or fully electric fleet, both the vehicles and the charging infrastructure can be opened for car sharing after office hours. The possibility of opening the municipal charging station to the public after office hours should also be considered.

The aforementioned possibilities have a huge signalling effect for the economy and can motivate companies to also provide charging stations for their employees or to consider opening their charging infrastructure to the public.

4.3.3.1 Concept for fleet-electrification

Electromobility concepts are an instrument for making electromobility more permanent in administrative units and municipal companies and gather political support for shouldering the additional cost. It enables the elements of mobility management to be combined with the new direction of procurement.

It is helpful to conduct a fleet analysis, a demands analysis, and a differentiated cost analysis before electrifying the vehicle fleet. This enable to combine the electrification with the introduction of a mobility management.

Dedicated fleet managers or special caretakers are helpful in this regard, as they provide technical support for the development of such a concept and are indispensable for its subsequent implementation.

In addition to the ecological motivation for electrification, the external impact of fleet electrification represents the most important argument with regard to the defense of additional costs and employee acceptance. The need for non-technical or fiscal measures is derived from this and should be an important component of an electromobility concept.

On the basis of the concept, a procurement plan can set clear targets regarding the electrification rate of the vehicle fleet and generally give priority to the procurement of e-vehicles.

The objectives of the procurement plan can also be a general vehicle reduction or a weighing of ecological and economic factors in the procurement of new vehicles based on a fleet analysis.

In some cases, it may be better to lease e-vehicles, because the technology of the vehicles is currently developing rapidly and this gives the opportunity to test the vehicle and the technology first and then to evaluate the new vehicle.

4.3.3.2 Training employees

Special training courses can reduce employees' barriers to using electric vehicles. In preparing employees for Electromobility, three main categories have proven effective. The first category can be summarized as "instruction and test drive. This involves an introduction to the topic of e-vehicles, including car-sharing use and the charging process, and above all practical testing and test driving. The second category includes the "Train the Trainer" format as an external training for the multipliers and vehicle coordinators in the individual departments. These then train their own employees and then hand over the training to fleet management, which takes over the training when it is needed later. As a third category, information days have the function of offering a larger group open-topic opportunities to try out and ask questions. In this way, fear of contact with the new technology and, in combination with mobility management measures, emotional resistance can be reduced.

4.3.3.3 Mining green sources of energy

The use of renewable energy sources for the municipal electric fleet can be the simplest and most commonly chosen alternative of purchasing green electricity without a new installation quota. Additionally it could be the more complex, but cost-wise advantageous own generation of renewable energy. Depending on local conditions, this can be done using photovoltaics, waste-fired power plants, a mix of photovoltaics, wind power, biogas or hydropower.

For municipalities it has shown that publicly owned companies have the capacity and agility to adapt new energy concepts[8] and provide them in line with municipal policy.

The past years have shown a dynamic development in the large-scale application of proven renewable energy technologies, but also smaller-scale, innovative concepts for local energy production. These are mostly specifically adapted to local conditions and show the great potential that still lies in the development of new technologies and special use cases.

In addition to the well-known energy producers, new players are also appearing on the market, such as housing associations, companies from the technology sector, etc., which offer local energy and heat production for their clientele with local and new solutions and keep the added value in-house. Municipalities can either provide support or act as a player themselves.

4.3.4 Impose parking management

Public space is a limited commodity and many sectors want to participate in using it. Space allocation is therefore the ultimate design tool to create discrimination-free access to the precious resource of public space.

Parking management is so important and difficult to implement because it is directly linked to car ownership. On street parking happens in public street

8 APSE, 2015

space and car owners are used to use it for free. Changing parking regulations can become very political especially as people are often very emotional about it[9].

In many urban areas with high parking pressure, the electrification of mobility means that on-street parking must be solved the in the first place. If cars are parked illegally on the pavement or elsewhere, the first step is to enforce legal parking. This will create space at the roadside for the provision of charging infrastructure and increase safety and unhindered access for pedestrians.

Figure 6: illegal parking is barrier to safety for road users and blocks cycling and the deployment of charging infrastructure for electric mobility, Source: Michael Glotz-Richter

The installation of charging infrastructure in public street space adds an additional function to a municipal asset that is already burdened with functions and expectations. Efficient parking management, interventions and policy frameworks are therefore a prerequisite for the introduction of charging infrastructure and at the same time a prerequisite for reducing the number of cars in cities.

However, it also enables and requires the introduction of mobility services such as car or bike sharing and bicycle parking as an alternative mobility option to the private car. Shared mobility has a higher usage rate than private cars, which stand idle for almost 23 hours a day.

The CIVITAS project SUNRISE[10] showcased the gains and conflicts that arise when reorganising street space. Enforcing parking regulations or introducing new ones as well as banning car-traffic in particular sensitive streets cause great resistance and conflict in the neighbourhood. The project showed the beneficial effects of broad involvement of citizens and integration of ideas from different parts of society.

Figure 7: SUNRISE public participation and co-creation as initial phase to parking management, Source: Michael Glotz-Richter

4.3.5 Urban vehicles access regulation

Access regulations have a history as a measure to preserve historic city centers, control emissions or reduce congestions. Over time different kinds of access regulations have emerged and support different policy objectives. Within the Topic Guide

9 Civitas Project Park4SUMP

10 CIVITAS Project SUNRISE, https://civitas-sunrise.eu/s

on UVARs (Urban Vehicle Access Regulations), the relation between access regulation and SUMPs has been examined[11]. Embedding UVARs in a SUMP context ensures an integrated transport policy approach that supports overall objectives and can increase the uptake of such UVAR systems. In reaching emission reduction goals UVARs might present a suitable push-measure that can be very different in nature. They can be low- or ultra-low emission zones, pedestrian or limited traffic zones, traffic routing or specific vehicle bans, delivery time windows or urban road tolls or combinations of it.

Although UVARs show immediate positive effects in protected areas, the impacts on suburban and peripheral urban areas of the functional city need to be considered to avoid negative effects. Often a stepwise introduction is favourable. In the first step, older ICE- and heavier vehicles might be banned from a relatively small area. The restrictions will then be extended to more recent vehicles and or geographical coverage increases over time. Phasing also gives vehicle operators time to adapt, and tackles the worst offending vehicles first. Long term developments might aim for a total phase out of vehicles with internal combustion engines. Such a phased approach can be communicated early to give ample preparation time to stakeholders and enable them to adapt to their choice of compliance.

While European cities seek to become climate neutral within the coming years UVARs might become more regular, in order to push modal shift and e-mobility.

4.3.6 Planning of charging infrastructure for electric vehicles in public space

Municipalities are owner of public street space. Therefore they have a special responsibility for providing access to public space in a sustainable manner. Besides fostering active and shared modes, municipalities have a steering function that enables them to promote sustainable mobility patterns and also to designate areas for charging infrastructure.

The planning steps outlined below are based on the German guideline DIN SPEC 91433:2020-08 “Guideline for search area and site identification as well as recommendations for notification and approval procedures in charging infrastructure planning”. This guideline was commissioned by the German Institute for Standardization (DIN) as part of the EmoStar²K project funded by the German Federal Ministry of Economics and Technology (BMWi) and developed by a consortium under the leadership of the Reiner Lemoine Institute (DIN SPEC 91433, 2020).

A stepwise guide to develop a municipal charging infrastructure plan (based on DIN SPEC 91433) is outlined in Annex A.

4.4 Housing sector

New housing developments, quite unlike existing buildings, can easily be thought together with mobility alternatives instead of providing private parking spaces.

The ideals of post-war urban development and private prosperity have become the legacy of today. Urban sprawl has created areas where public transport or other public services cannot be sufficiently provided. There is a negative correlation between urban density and the use of private vehicles[12].

Generally with new developments for car-free living resemble old quarters in terms of concept of urban space: it´s not made for parking. Therefore the desired mobility environment facilitates access to climate-compatible means of transport at the place of residence and offers various mobility options (plus infrastructure) as an alternative to the car.

In new construction projects, in contrast to existing neighbourhoods, the supply of parking spaces and mobility options can be planned simultaneously. The toolbox for alternative mobility offers public transport subscriptions, car sharing and bicycle parking facilities. Additional offers such as cargo-bike sharing and various ticket options are also plausible.

Car-free or living with less private car concepts have shown to work also beyond pilot phases and are still conceived as high quality urban quarters.

11 Cré; I.; 2019: UVAR and SUMPs Regulating vehicle access to cities as part of integrated mobility policies

12 P. Newman, 2015; G. Boisjoly & A. El-Geneidy, 2021

4.4.1 New residential developments

New housing projects are often accompanied by a fixed number of required car parks per residential unit. The construction costs for parking facilities can be substantial, especially if they are to be designed as underground garages. Savings in construction costs by cutting the number of car parking is the seed budget for alternative mobility options. It depends on property developers and investors to take up new mobility concepts and their attractiveness to tenants and potential buyers.

4.4.1.1 Car-free developments

New housing developments offer the opportunity to pick up the new residents right at their new stage of life, when the psychological readiness for change is also highest, and to anchor sustainable mobility patterns in their lives. A car-free living environment that offers alternative mobility options and provides access to multimodal trip planning facilitates lifestyle changes. Perceptions of safety, especially for children, quality of living environment and attractiveness for pedestrian traffic are very positive, as evaluations of car-free neighbourhood developments show[13].

However, project developers are often reluctant to reduce parking spaces because they fear a conflict with the market attractiveness of properties. This is where the governing hand of municipal policies is needed.

4.4.1.2 Integration of car sharing

Urban areas can benefit from the positive effects of car sharing, especially if they work with larger housing associations. These do not suffer so much from parking restrictions, but often supply rental housing for residents with lower incomes. For them, car sharing offers a low-cost alternative to owning a car. These combinations offer favourable conditions for the introduction of e-car sharing.

From the point of view of car sharing users, aspects of ease of use and reliability are the most important. To be a real alternative to owning a car, reliability is crucial - meaning that a car is available when it is needed. This is where the advantage of station-based car sharing with its reservation options becomes apparent. Proximity to the station is also important - this is where municipalities come into play, as they can make street space available for car sharing in urban neighbourhoods.

Housing associations can provide CS on private land, offer a fleet mix for different needs, and often have the opportunity to combine charging infrastructure with their own photovoltaic system.

In many cities, it is mandatory to build a certain number of car parking spaces or pay a fee or, alternatively, offer mobility services to residents. These mobility services can include the construction of a car sharing station on the property as well as car sharing memberships for the residents or public transport subscriptions. The combination of housing and PV in a prosumer combination can generate incentives for investors and residents.

Using car sharing instead of having a private vehicle means a significant behaviour change for most people. Therefore it is important to facilitate access to car sharing, communicate the financial benefits, and ally people's concerns about costs and difficulties in organizing their mobility needs.

13 TUHH, Ottensen macht Platz, 2021

Figure 8: Neighbourhood car sharing stations (mobil.punkt) – also with electric cars, source: Michael Glotz-Richter

Figure 9: Car sharing station in a new development in Bremen, source: Michael Glotz-Richter

The expansion of e-mobility is primarily linked to the corresponding charging infrastructure.

This means sustainable planning includes sufficient structural and technical reserves for later expansions, especially for new buildings, renovations, development and compliance with fire protection. In terms of technical integration, sufficient grid capacity and combination with local renewable sources (photovoltaics) for the lowest possible carbon footprint must be included in the planning.

Investments in a sustainable e-mobility infrastructure can increase the value of a property and form the basis of a sustainable energy supply.

4.4.2 Old quarters – it´s all about parking

Residential areas, especially in historic downtowns, are not designed to accommodate these huge volumes of cars, which have also increased in size over the years. A common problem is the difficult parking situation in residential areas. E-mobility will not change this. On the contrary, it will further increase parking pressure if certain parking spaces are used for charging.

Suitable charging concepts must take into account the very limited street space on the one hand and traffic conditions on the other. Beyond the use of electric vehicles, these neighbourhoods have great potential for climate-friendly mobility that can be tapped with integrated charging concepts.

At the same time, there are significant conflicts in the use of limited street space, which represent a major obstacle in the ramp-up of electric mobility. In many streets, the current parking facilities do not meet the current requirements of the road traffic regulations. In such streets, therefore, the installation of charging facilities must be accompanied by a reorganization of parking in the street space.

The ramp-up of electromobility goes hand in hand with a reorganization of street space in urban neighbourhoods. And in many cases, public street space will not be sufficient to accommodate all cars. A better multimodal use of road space and new mobility offers can fill the gap.

The climate protection contributions are made up of the behaviour changes resulting from the reorganization of the road space and the switch from car ownership to sharing services, and the ramp-up of electromobility.

Car sharing, especially station-based car sharing, has been shown to reduce the number of private cars. It is therefore one of the flanking measures of e-mobility in existing residential areas. Multimodal networked car sharing helps to switch to buses, trains, walking and cycling is encouraged.

A considerable expansion of the electric charging infrastructure is necessary for the ramp-up of electromobility. In these neighbourhoods, there are special requirements, as there are hardly any private car

parking facilities / charging options. The assumption of 60-85% charging in on private ground for Germany as a whole is not feasible here; a significantly higher charging point density in public space must be envisaged.

The zero-emission hubs project therefore plans a dynamically growing range of charging points via terminal-based master-slave solutions. Up to 12 charging points can be served via one terminal, which also enables load balanced charging management. In the future, this approach can also be linked to dynamic parking pricing (curbside management), if it is legally feasible according to national law.

Other ideas, such as open charging in private areas with limited access, such as overnight charging in corporate parking or supermarket lots can alleviate the shortage of space and allow dual use of charging points.

4.5 Freight transport

Commercial vehicles place a lot of strain to the urban environment by their place and parking requirement, noise, emissions and safety issues. Electrification of these vehicles, promotion of charging infrastructure and introduction of supportive policies such as access restrictions, giving priority to electric vehicles, can turn city logistics emission-free. However, electrification only helps with the emissions aspect of transportation. In urban areas, other measures are needed to further advance climate protection and sustainability. So further insights into how to reshape the last mile logistic will be feed into the discussion by several project outcomes like ULaadDS[14] and others.

Figure 10 left: mobil.punkt with on-street car sharing in Bremen and Bergen, source: Bremen - Michael Glotz-Richter, Interreg ShareNorth

14 Urban Logistics as an on Demand Service, https://ulaads.eu/

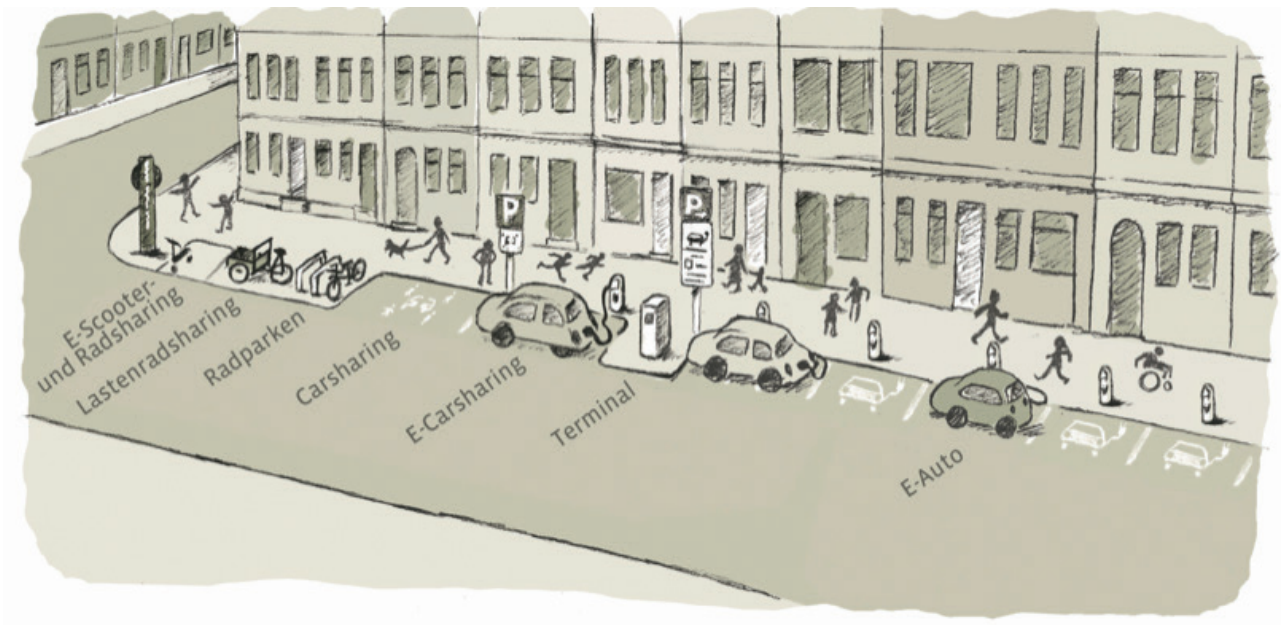

Figure 11: ideal status of a future mobility station in dense urban areas: ZEROEMISSIONHUB©- combination of different shared mobility options and charging for private cars with an growing charging infrastructure that adapts to increasing demand

4.5.1 Cargo bikes

A fairly new development is the use of cargo bikes for last mile logistics in combination with micro-hubs throughout the city. The hope is, that these vehicles will replace delivery vans and in the best case also private cars.

In many cities schemes for shared cargo bikes are set up on a project basis. At the moment it is too early to judge if private cargo bikes or sharing schemes will contribute to the reduction of car trips or even replace a private car.

4.5.2 New delivery systems for last miles

Delivery traffic has increased globally by 17% annually since 2014[15] adding to air pollution, noise and usage of traffic space in urban areas. In order to comply with the limits while meeting transport demand, new solutions in commercial transport need to be considered to ensure efficient and low-emission traffic even in densely built-up areas. In addition to local and global emissions, the increase in traffic volume also leads to congested cities and traffic jams, which in turn increases travel times and could affect the speed or timeliness of a delivery. With the demand for fewer delivery trucks and reduced delivery traffic, the demand for new logistics concepts is evident.
In recent years there have been numerous studies and research projects on the use of cargo bicycles in inner-city deliveries[16]. These studies have shown the positive effects of this form of delivery in their trial phase. The fine distribution of goods on the "last mile" by means of cargo bicycles makes a significant contribution to promoting climate-neutral effects in the area of inner-city delivery. The positive effects are less congestion at peak times due to a reduced number of delivery vehicles in the inner-city area. By using e.g. three cargo bikes, which also require less space than conventional delivery vehicles, two vans can be replaced in relation to the delivery volume.

The European Cycling Logistics Foundation calculates a potential to replace vans in 32 % of delivery trips and 50% of service trips.

Fontaine et. Al (2020) points out that the choice of vehicles for the fields of application is initially made between two-, three- and four-wheeled cargo bikes with or without electric drive. E-bikes with up to 250 watts continuous power and a maximum design speed of up to 25 km/h are not subject to any type approval. Bikes with that exceed these specifications are in the L category (EU RL 168/2013). For L category vehicles different conditions of use apply. Some countries restrict them from using cycle paths and require a driving license. However, many cities have an insufficient bicycle infrastructure that does not offer enough space for cargo bikes in the future, especially in the case of potential substitutions. In addition to flowing traffic, the parking space for cargo bikes is also a factor. Multi-track vehicles therefore require more space for parking[17]. In very densely built-up areas, problems can also arise because the turning circle is comparatively larger.

Research by Fontaine et al. (2020) found that the introduction of delivery by cargo bike for 37% of all parcels in the city of Regensburg reduced the total number of trips by delivery truck and replaced them with a greater number of trips by cargo bike plus the feeder trips to supply the micro-depots. The study found that the total trip distance increased slightly, although the total travel time decreased. As a result of the lower mileage of the ICE vans, CO2 emissions decreased, while emissions from charging the cargo bikes were relatively low.

But not only the vehicles themselves offer a climate benefit but also the delivery concepts. The last mile is the most costly and time intensive part of the delivery chain.

Many projects are testing new last mile delivery systems in form of cooperative micro-hub solutions like in Malaga (project MEISTER) or even white label micro-hub trials like in Bremen (project ULaaDS) from where vehicles like cargo-bikes or small vans deliver the packages to the doorstep of the customer or business.

The whole concept of the last mile delivery is tied around a network of micro-hubs from which the cargo-bikes delivery within a radius of around 5 km.

15 Bowes, 2019
16 Ewert & Deniz, 2020
17 Wrighton & Rzewnicki, 2020

Freight transport in the CEP sector is already practiced by large companies such as DHL, UPS, DPD and Hermes with e-cargo bikes. E-cargo bikes also play a role in intralogistics such as internal transport in factories, distribution centers, airports or hospitals. The third sector is services involving B2C or B2B transports.

While these concepts focus on bundling deliveries to avoid parallel routing of different CEP-services, crowdsourced services focus on cutting costs by shifting the physical part to local couriers. Crowdsourced delivery is mainly seen in food delivery and is carried out by local start-ups. However, established giants such as Walmart, Aldi, FedEx and DHL are also experimenting with this model[18].

4.6 Public transport and Mobility as a service

Public transport is one of the most important fields of action for municipalities with the greatest impact on climate-relevant emissions, main control field as well as sink for tax money. The comparison of the best benefit for emission reduction shows that spending public funds on e-buses has the same positive effect as electrifying 100 private cars.

Efficient and sustainable urban transport is unthinkable without public transport (PT). Public transport is particularly space-efficient and thus an important tool against congestion. Since collective means of transport are much more space-efficient, the use of alternative and sustainable energy sources there makes much more sense and increases the positive environmental effect compared to private motorized transport.

EU Regulation 2019/1161 sets the framework for the introduction of clean and zero-emission vehicles and services in public procurement. Therefore, all public transport providers need to start converting their fleet to clean and eventually zero-emission vehicles. While some cities are fortunate to have trolley buses and the necessary infrastructure, other cities need to start from scratch in electrifying their bus fleets.

This is a major effort for the public sector to provide sufficient funding for the necessary vehicles and services, but also to retrofit operations and bus depots for the new fleet and train staff to operate the high-voltage vehicles.

However, the strengthening of the public transport sector also has implications for complementary mobility services. Mobility as a Service (MaaS) is a term used to describe digital transport service plat-

18 Dolan, 2021

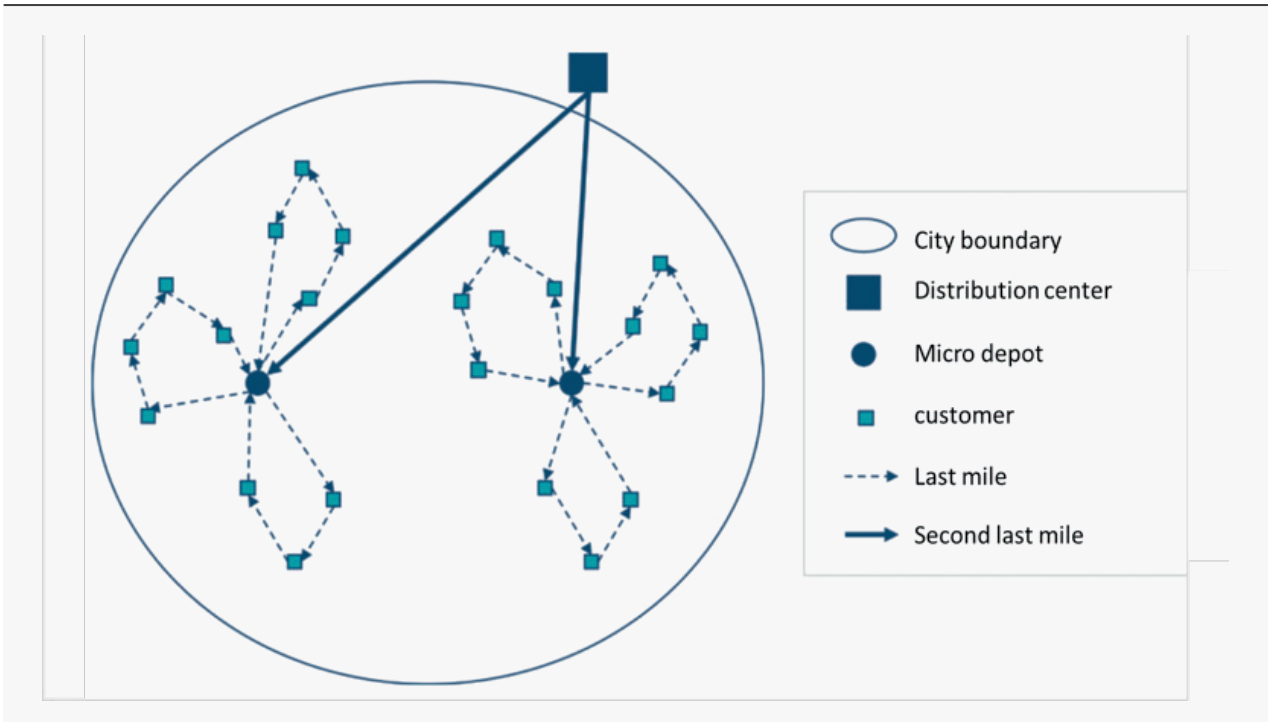

Figure 12: concept of last mile delivery with micro depots, based on Fontaine et.al., 2021

forms that allow users to combine different mobility services. They enable multimodal trip planning using public transport in combination with other services such as cab, ride-sharing or car-sharing, real-time information and ticketing.

Embedding public transport, e-charging and alternative mobility options into a MaaS system exposes the public transport system to competition, but also allows other mobility services to be used as complementary offerings for underserved areas or times.

Numerous MaaS applications have become established in recent years. Their potential is still not fully exploited, but increasing awareness and user-centric design are contributing significantly to their popularity. For example, Jelbi in Berlin, IMOVE in Manchester, UbiGo in Gothenburg, Whim in Helsinki and many others have emerged and continue to expand their services. Data integration and payment options are always the most difficult tasks to solve. Platforms like trafi, FluidHub, Moovit, gimble, Mobilleo and many others offer customizable solutions for cities.

There are many regionally based and sometimes public agency led solutions like Yelbi, SHIFT, Ubigo, Mobilleo and many more operating in different cities. Others are promoted by the car industry (e.g. Moovel) or the digital industry (Google). This makes public transport more attractive and often provides an alternative mobility solution instead of a private car.

Additionally, employers can strongly influence the mobility patterns of their employees through mobile working, parking management, company cars and job tickets. Employers can provide their workforce with a fixed amount of money, which they individually can choose to spend on various mobility services as needed. This way company car policies become rather flexible mobility policies using mobility platforms as enabler.

Taking this concept into services for company workforce in form of a mobility budget enables the turnaround in the car fixation as part of payment with tax benefits.

The mobility budget might nudge people to use public transport or other modes that they have never thought about before because their financial burden for their car also tied them to it.

Introducing a mobility budget in a company payment and incentive scheme is a rather complex process. But many good examples show that it´s worth taking up the effort. Software solutions help HR, fleet and mobility managers to manage the mobility of their employees with a flexible monthly digital mobility budget, accounting for it in line with tax requirements, and incentivizing sustainable mobility patterns. Employees, on the other hand, receive a mobility benefit from their employer that can be used for all types of mobility worldwide.

In small companies the mobility budget can consist a mix of shared company EVs, scooters and e-bikes as well as support for ride hailing and public transport tickets. Larger companies may additionally offer a down- sizing of company cars and hand out the savings in form of public transport ticket, taxi vouchers or sharing vouchers for the saved amount.

Some mobility budget provider offer full fleet conversion towards e-mobility including procurement of vehicles, charging infrastructure, sharing platform and mobility platform and accounting. Often it is a whole range of service provider that add their solution to build the customized service for a company. New ideas are constantly emerging and the market is very dynamic.
As the user perception is most important, a ‘guaranteed ride home’ scheme can offer supplementary security, like an insurance it comes into places for ride-sharing schemes, when there are unforeseen incidents (e.g. sickness requires to stay at home and the ride-share solution needs to be replaced by another solution like taxi).

New sustainability consciousness also fostered by EU regulation about company Taxonomy reporting requirements help companies becoming more agile in their transformation process towards climate neutrality.

Companies like Frosta, NTT Data or SAP are already focusing on promoting multimodality in their workforce. In the meantime, more and more services are emerging - bonvoyo, belmoto, mobiko, moovster, rydes, Wegfinder and 1st Mobility are just a few examples. Many more are to be seen in the coming years.

5 Best practice examples from GreenCharge and beyond

This chapter focuses on best practice examples as inspiration for other cities. Increasing the modal split towards active transport modes and strengthening public transport are the overarching goals for achieving climate targets, which need to be underpinned by pull and push measures. In detail, there are many different approaches to specific problems. New challenges, ideas and projects are coming to light almost daily. Digitization is an important driver for better access to alternative mobility options, and its role in making multimodal travel convenient, reliable, and seamless cannot be underestimated.

5.1 Different use cases for electric vehicle charging

5.1.1 Charge at home

This sector is strongly influenced by the legal framework but offers also the largest potential for urban transformation and monetary gains for electric mobility. Municipal action is required in setting the framework, communication and supporting actions. The actual planning and implementation of charging infrastructure and the combination with decentralized energy production is a private actor decision that can be supported by subsidies/ funding or legal requirements.

Combination of heating and electricity and mobility in a holistic, sector-coupled energy management in the neighbourhood.

The Røverkollen housing cooperative is situated outside of Oslo, and within the CIVITAS GreenCharge project, developed a charging solution with a particular focus on providing cost efficient home charging facilities for inhabitants living in blocks of flats. The housing cooperative includes a total of 246 apartments distributed over five blocks. It also has a stand-alone four-storey parking garage with 230 parking places where most residents have their own parking spot.

With support from the City of Oslo, Green Charge has facilitated the installation of 61charging points in the garage and 4 outside for visitors together with a 70 kWp solar PV panel and a 50 kWh stationary battery. To enable charging of up to 230 EVs inside the garage, GreenCharge has developed a smart energy management control that ensures optimal timing of the charging taking both the EV users' needs and the energy peaks into account. The aim is to reduce the peaks and still get the EVs charged according to needs. The system is based on information provided by the EV-user through our GreenCharge app: SOC at arrival, requested SOC at departure and estimated time of departure.

5.1.2 Booking of shared charge points

Furthermore, Røverkollen housing cooperative facilitates four publicly available charging points outside the garage. Here, GreenCharge demonstrates booking and roaming. The innovative aspect of this

Figure 13: Roverkollen charging inside garage and PV panels on four storey garage, source: Roverkollen housing cooperative

Figure 14: PMC solar carport with buffer storage and smart charging at the IFAM in Bremen, source: PMC

pilot is twofold: The charging time can be booked in advance to arrange for more predictable access to charging; and the charge points owned by the housing cooperative is shared with the public to arrange for a higher utilisation and return of investment.

The price models used penalise blocking of the booked charge points. EV users have to pay if they do not cancel bookings in time or if they do not leave the charge point when the booked timeslot has expired.

5.1.3 Charge at work

Commuters with no charging option at home rely on alternative options and charging at the workplace is the most intriguing option. Here a combination of locally produced energy an ample charging time can be combined to a sustainable package. Within the GreenCharge project this combination was developed by the Personal Mobility Center Nordwest EG (PMC). PMC is a cooperative of institutions that mediates and operates the “electric mobility system” with e-vehicles of the members in connection with electricity storage and adapted charging infrastructure in/on buildings as well as on parking lots/parking spaces. PMC developed a charging system for the employees of their members that combines local PV production, a buffer storage and a sophisticated load balancing and charging software that provides booking of charge points. The developed application is fully DSGVO compliant by separation of technical data as well as user data. A completely self-sufficient software platform is created for each client, which can be installed on public or private clouds (company internal) and supports the integration into existing authentication systems (LDAP/RADIUS). A platform-independent web application for using the software without installation/rollout enables “Booking” of the energy demand necessary for the next trip including departure time to optimize network utilization. The application allows the optional integration of parking space sensors to detect blocked charging stations and enables the shared use of charging points adjacent to multiple parking spaces in the way that after reaching the “charging destination”, the charging process can be terminated by other users. A prioritization of charging by visitors or VIPs (constant charging power, highest priority) is possible. A display of current charging power/vehicle status as well as vehicle SoC estimation without the need for in-vehicle systems (no data loggers or car-sharing computers) is implemented.

In future the integration into building energy management / energy smart neighbourhood to dynamically limit the load of the charging park is envisaged.

5.1.4 Charge at points of interest

Charging at point of interests like tourist attractions or event locations are of special interest as there is a need for special business models. These special locations experience demands only for a period of time like holiday seasons or when events take place. To compensate for the fluctuating or seasonal use of these charging stations, it is advisable to equip them with additional functions to make them economically interesting.

Within the Interreg Project SEEV4-City the Johan Cruijff ArenA Amsterdam became a pilot for showcasing the combination of photovoltaic, energy storage and a V2G charging unit.

The JC ArenA is designed for up to 68,000 visitors. It´s electricity demand equals 2700 households. Demand peak at events is 3 MW. The installed photovoltaic capacity of 1 MWp produces around 8% of that demand. The remaining energy is provided by externally produced wind energy. A local battery storage system of 3 MW/2.8 MWh enables balancing of power and increase self-consumption. The results show that it can serve as a model for other stadiums as well as for use of 2nd live batteries[19]. The ArenA ex-storage building system stores energy from the solar roof panels or from the grid during low-demand periods and feeds out in case of an outage or high demand on grid operators requests as well as supplies the arena during events when self- consumption is high. By this the maximum load on the public grid is reduced and grid stability is strengthened while generating additional benefit for the JC ArenA. Technically this is possible by bidirectional converters that are connected to battery racks and balanced by a battery management system.

There were 14 EV chargers with 22 kW each, summing up to a maximum demand of 308 kW. These peaks will be managed by a smart management system which can flexibly set the peak limits. The local energy infrastructure is laid out for a maximum of 210 A which lowered the installation and cabling cost significantly. Additionally, a V2X unit was installed to add the car batteries to the energy supply system of the battery storage system. It is planned to install more V2X units in future times.

19 SEEV4-City-Johan-Cruijff-ArenA-Operational-Pilot-Final-Report.pdf

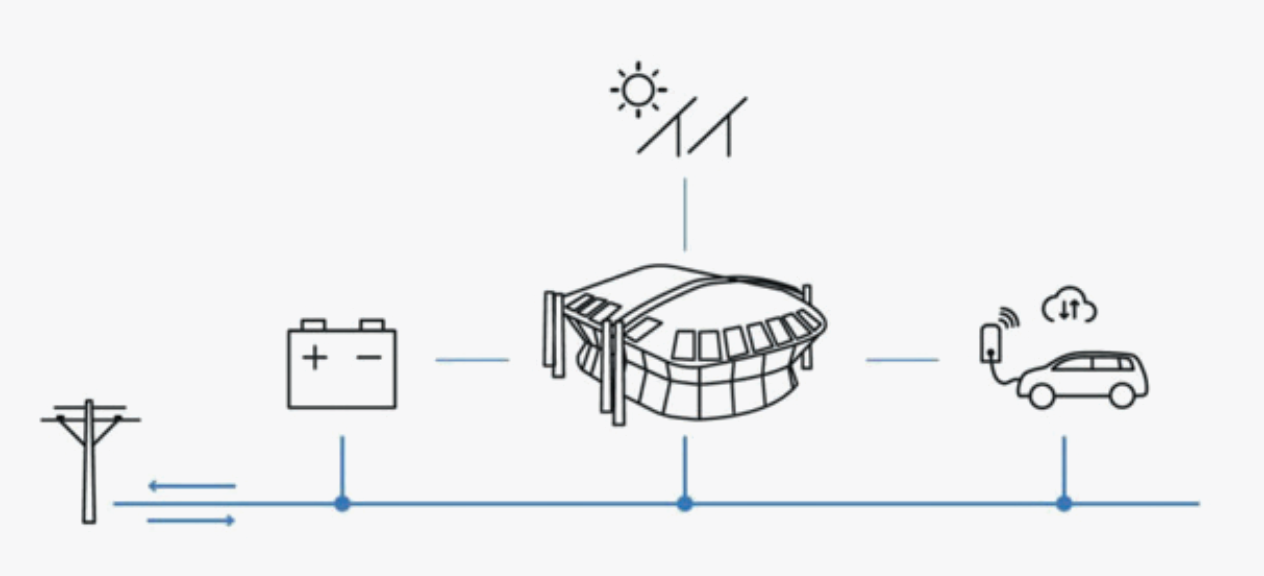

Figure 15 SEEV4City – Smart, clean energy and electric vehicles 4 the city, source: seev4-city.eu

The installation includes:

- 1 MWp PV-installation consists of 4,000 solar panels with 270 Wp each
- Battery storage 3MW/2.8 MWh and back-up diesel generator 0,7 MW
- V2X unit
- Grid service on TSO request (FCO service)
- Load Management, peak shaving, backup power, optimized PV integration

The final report from SEEV4-city outlines that the total energy demand in year 2017 of 8,610 MWh has a gap to the total PV production (857 MWh) of 7,753 MWh in that year.
648 MWh (76%) was used locally (8% of total demand), and 203 MWh was exported to the public grid.

Energy production is highest in summer while demand is highest during the winter period and a daily production curve is to be taken into planning as well. The mismatch is partly buffered by the local battery storage system and the remaining short-term surplus is fed into the public grid. Within the project self-sufficiency increased by 1.2% to 9% and the self-consumption increased to 88%.

Several services have been implemented to increase self-consumption and to increase revenues: V2X charging, grid service on TSO request (FCO service), load management, peak shaving, backup power and optimized PV integration. The project proofed ready for transfer and upscaling also in parts of the tested services as they can be implemented in combination but don´t have to.

They conclude[20]: The extent to which these solutions can be adopted elsewhere and used at scale depends largely on influencing factors such as:

- Costs associated to installation and possible investments related to grid capacity,
- Pricing structures and related legislation regarding tariffs,
- Developments regarding EV adoption and availability of similar services,
- Characteristics of suitable locations.

5.2 Fostering active modes of mobility

Active modes have been successfully introduced in some European cities to enhance quality of urban life with less pollution and noise, increased accessibility and social inclusion. A collection of inspirational projects from Finland, UK, Germany, France and Belgium are described in “Reclaiming city streets for people”[21]. The combined experiences in all cities after the reallocation of the street space the predictions of traffic chaos did not come true but after an initial habituation phase the traffic volume “evaporated”.

A Portfolio of Measures of how to introduce successfully walking and cycling to reduce congestion has been developed within the project FLOW[22]. Walking and Cycling became even more important during the Covid-19 pandemic and many ad hoc projects enabled safe and convenient walking and cycling in an unprecedented way in many cities[23].

The city of Vienna goes a step further and combines the vision of walkable cities with climate resilience aspects. A shopping street in the city center was transformed into a car-free zone, where 33 parking spaces were eliminated.

5.2.1 Walking

As early as 2014, the city of Vienna joined the concept of the legible city and installed a pedestrian guidance system. The results of various measures led to a city of short distances, in which almost one third of all people make their daily journeys predominantly on foot.

The guidance system, which currently has 25 pillars and is also available as an app, provides a quick and informative overview for better and faster orientation, especially for those unfamiliar with the area, and shows the special features of the surroundings. The map printed on the information pillar indicates, among other things, distances or walking times to the surrounding public transport stations, car-sharing locations, city bike stations or public toilets.

In addition, “shortcuts” - for example, passages through courtyards - are displayed for pedestrians. They are supplemented by information on whether they are barrier-free. The information pillar is free of advertising and is illuminated from the inside at night.

Another focus is on repurposing land and promoting a high quality of public space by converting parking lots into temporary event spaces (Schani-gardens) or turning streets into pedestrian zones.
One of the most recent examples of converting a street into a pedestrian zone is Zollerngasse in

20 SEEV4-City: Final report JC ArenA
21 EC, Reclaiming city streets, 2014
22 FLOW Project, 2016
23 Combs, T., Pardo, C.F., Streetplans, Epiandes, MobilityWorks, & Datasketch (2020). The “Shifting Streets” Covid-19 mobility dataset. Available from http://pedbikeinfo.org/resources/resources_details.cfm?id=5235

downtown Vienna. It is a typical small two-lane street with narrow sidewalks and many stores.

Figure 16: Vienna Zollerngasse before transformation, © Korbwurf / janusch.co

In order to improve the quality of the public space, reduce the heat in summer and make it a lively public space, a bundle of measures was implemented. A total of 33 parking spaces were removed (20% of the additional street area) and 8 large 25-year-old trees with 10 m height and 4 m canopy will be planted in the middle of the street in autumn 2021. A complete redesign of the sidewalks and new street furniture will transform the street into an open space to walk and enjoy. Additional green space and a drainage system will be installed to facilitate stormwater retention and infiltration and support the “sponge city” principle. Cooling fountains with a stream-like film of water on the street alleviate hot summer days.

5.2.2 Cycling

Cycling infrastructure ranges from designation of cycle streets, where cyclists have priority over cars. Cyclist can ride side by side and may not be overtaken. Cycle streets are mixed traffic roads and are marked not only with regular traffic signs but it´s recommended to add broad street-marks.

Figure 17 Vienna Zollerngasse after transformation, © Korbwurf / janusch.co

Figure 18: cycle street in Germany, Bremen ©Michael Glotz-Richter

Safety can be enhanced by high visibility of special cycle provision. Red road coverings have no regulatory function but experiences show that drivers behave more cautiously when street marks underpin the traffic signs.

Figure 19: safe cycle crossings, © activmobil BW

Figure 20: safe crossings, cycling model quarter in Bremen, © City of Bremen

These provisions for giving cyclists priority on streets can be extended to smart traffic lights that detect pedestrians and bikes and give them priority over car traffic. This avoids annoying waiting time and can lead to faster and smother rides than using a car.

5.2.3 Car-free residential quarter

As an example, the car-free residential quarter Stellwerk60 in Cologne was initiated by citizens and realized with private project developers. It is located on a former railroad yard, close to the city centre and offers 440 apartments and houses for about 1500 residents. The neighbourhood offers a mix of houses and apartments for rent or ownership. First occupancy took place in 2006 and completion in 2013. 80% of the residents live car-free. A self-administered cargo-bike- and trailer-sharing is open to all residents and for the one´s that need a car, a simple parking garage is available at the edge of the complex. Underground and city-trains are in close vicinity.

Figure 21: Stellwerk60 – car-free-living in Köln, credit: H.G. Kleinman

Complementing the residential view of mobility, the choice of mode of transport for commuting is also closely linked to the residential environment. For this reason, corporate mobility management ideally begins at the employee's place of residence. This is where the choice of mode of transport or the route chain to the company or to customers is decided. Employers can have a lasting influence on the mobility behaviour of commuters and business travelers if they are aware of the potential for change and promote it with good offers and incentives.

5.2.4 Carsharing for residents

Carsharing can play a crucial role in completing a public transport system and provide an alternative to owning a private car. The car sharing policy in the city of Bremen showed that one carsharing car replaces 16 private cars that have been sold or not been purchased[24].

Integrating carsharing into housing developments places the mobility service at the source and can complement the full range of mobility options, from walking to biking to public transportation, and provide an alternative to owning a private car.

As carsharing has become more popular in recent years, it has been shown that carsharing users are more likely to use public transportation and walk and bike more than non-carsharing users.

Living without your own car is only possible if you can rely on easy-to-use and safe mobility alternatives. Therefore, in addition to easy access to carsharing cars, efficient public transportation and safe infrastructure for pedestrians and cyclists are essential. As stated in the policy recommendations of the Interreg CARE-North project for the North Sea region, walking and cycling should be an attractive and accessible alternative to car transport and should not compete with each other for space in urban areas. Future investments in public infrastructure - for example in Mobihubs - should therefore be considered from the perspective of pedestrians and cyclists[25].

Findings from a comprehensive study from the STARS H2020 project (Shared mobilityopportTunities And challenges foR Euopean citieS) showed that a combined service consisting of station based and free floating carsharing is the most successful business model.

In order to create an optimal policy framework for car sharing, car sharing itself should be included in other policy areas as it involves different topics such as mobility, public space, new housing developments and even social cohesion and work. Integration of car sharing in all these fields avoids conflicting legislation. For instance, fiscal policy can have an immense positive or negative impact on car sharing (e.g. company/salary cars), parking standards and car sharing go hand in hand.

Figure 22: carsharing station in Bremen, Source: Glotz-Richter

Gothenburg reduced its car traffic by more than 10% in 2013 and increase the use of public transport through their carsharing policy[26].

Positive effects on car ownership have also been achieved in Bremen through the car sharing action plan, where one car sharing car replaces 16 private cars.

24 Team red, 2018
25 STARS policy brief 2018
26 C. Baranzelli et.al. 2019

6 Recommendations for integrating e-mobility in SUMPs

Sustainable urban mobility plans define objectives, measures and sub-measures and open up the process of cross-sector collaboration. It is a very time-consuming process and involves broad public participation, but enables municipalities to build on shared visions and goals.

Years down the road, a partial adaptation of the SUMP focus will be necessary to make urban transport and mobility fit for the challenges of climate change and adaptation, and to give active transport modes space in cities. Goals that were almost unthinkable years ago could come into focus, such as improving accessibility in public spaces. In recent years and under the impact of the pandemic, it has become even more important to address demands for an attractive urban environment and to use public space for people, not just vehicles. Charging infrastructure is an additional special requirement that adds to the already existing pressure on public space. Therefore, wherever possible, the facilitation of e-mobility should be implemented primarily on private property and only in very limited and particularly appropriate settings in public street space.

Historically grown neighbourhoods with narrow street spaces require special attention. Here, there is often no private parking and e-car owners rely on publicly accessible infrastructure - at the same time, redesigning street space for pedestrians, cyclists, sharing options, logistics solutions, and climate adaptation is as necessary as providing for some charging infrastructure. Since street space is limited, new solutions for dealing with car ownership and parking are absolutely necessary as part of SUMP e-mobility strategies.

E-mobility planning means first and foremost defining which urban areas could contribute to climate resilience, and only the remaining areas are considered in order of speed - walking first, biking second, shared transport third, which should be electrified, and only in the last part can public charging be considered.

Charging applications consist mainly of charging on private property, such as charging at home or at work. Only a small proportion of 10 to 20% of all charging currently relies on publicly accessible infrastructure. This is true for long-distance trips and for e-vehicle owners who do not have private parking.

The potential of private charging infrastructure varies by country and region. In densely populated urban areas with low private charging potential, providing publicly accessible charging infrastructure is the biggest challenge for municipalities. For these urban areas, different models are currently being tested in various cities on project basis to find solutions that are best suited to the specific situation.

Commercial fleets face quite different challenges. These special requirements should be considered separately and might lead to different business models for charging infrastructure.

Areas of action for city authorities and recommendations to enable transition:

- Public transport – electrification of vehicles with high utilisation rate and most transport volume should be made the highest priority for cities attention
  - Recommendations for electrification of public transport
    - Develop nationwide funding schemes that offer a level playing field for all actors
    - support procurement coorperations across regional public transport providers to shoulder the CVD-requirements in parallel to converting depots and operations
- Shared vehicles – carsharing and taxi-fleets provide complementary services to public transport and have special charging requirements that often need municipal attention to support the e-transition
  - Recommendations for taxi and carsharing services
    - Set up a dialog with local carsharing and taxi providers to define their special needs
    - Define a charging strategy together with providers
    - Identify funding schemes that support e-transition

- Lead by example – high priority should be given to the electrification of municipal fleets, open municipal charging infrastructure to the public and integration of carsharing options to reduce the fleet size
  - Recommendations for e-transition in municipal fleets
    - Set up a competence team that offers conceptual advice and technical expertise for different parts of municipal fleets
    - Design a common procurement procedure to use scaling effects
    - Develop a funding scheme on national level that enables a better planning for fleet operators

- Public charging –long range transport, private EV owners without private parking in dense urban areas, urban logistics require infrastructure in public space or access to private property with publicly accessible charging infrastructure
  - Recommendations for development of a public charging infrastructure plan
    - Develop a plan based on demand scenarios and special local requirements
    - Communicate the plan to inform the public and investors
    - Use the plan to market the charging locations
    - Evaluate whether concessions should be granted for specific use cases

- Dual use concepts - utilizing the space potential of publicly accessible private areas, of e.g. supermarkets, for the provision of charging infrastructure in order to relieve public roads from this land consumption. Here is the possibility of other time regimes and their enforcement, which are not as possible in public space.
  - Recommendation for the inclusion and use of private land potential in infrastructure planning
    - Include property owner in a focussed dialog about dual use cases
    - Develop suitable business models to attract private property owner to offer their space for charging infrastructure
    - Consider a consulting programme for property owners

- Parking management - legal enforcement and monetization of the use of public space is a prerequisite for opening up public space for charging infrastructure and alternative mobility services
  - Recommendations on enforcement of parking management
    - Parking management is the presupposition for installing charging infrastructure
    - Seek political support for parking management enforcement
    - Educate the enforcement personnel
    - Communicate the benefits of parking management intensively
    - Price models used should arrange for the best possible charging behaviour,

- Smart energy use – with a fully electrification of the transport sector, the use of energy for charging must be adapted to the energy availability at the charge point locations. Local renewable energy sources and local energy storages may also be used to fulfil high energy demands. EVs has the benefit that they may not have to be charged immediately. If the EV user define the charging can be done at any time as long as the demand is met.
  - Recommendation for smart charging
    - Establish expertise on smart energy management or collaborate with such experts. It may for example be useful to participate in pilots and projects to learn.
    - Install local renewable energy sources in the vicinity of charge points or collaborate with owners of such sources in the neighbourhood.
    - Collaborate with electric mobility providers and providers of smart energy management systems to utilise the charging flexibility.

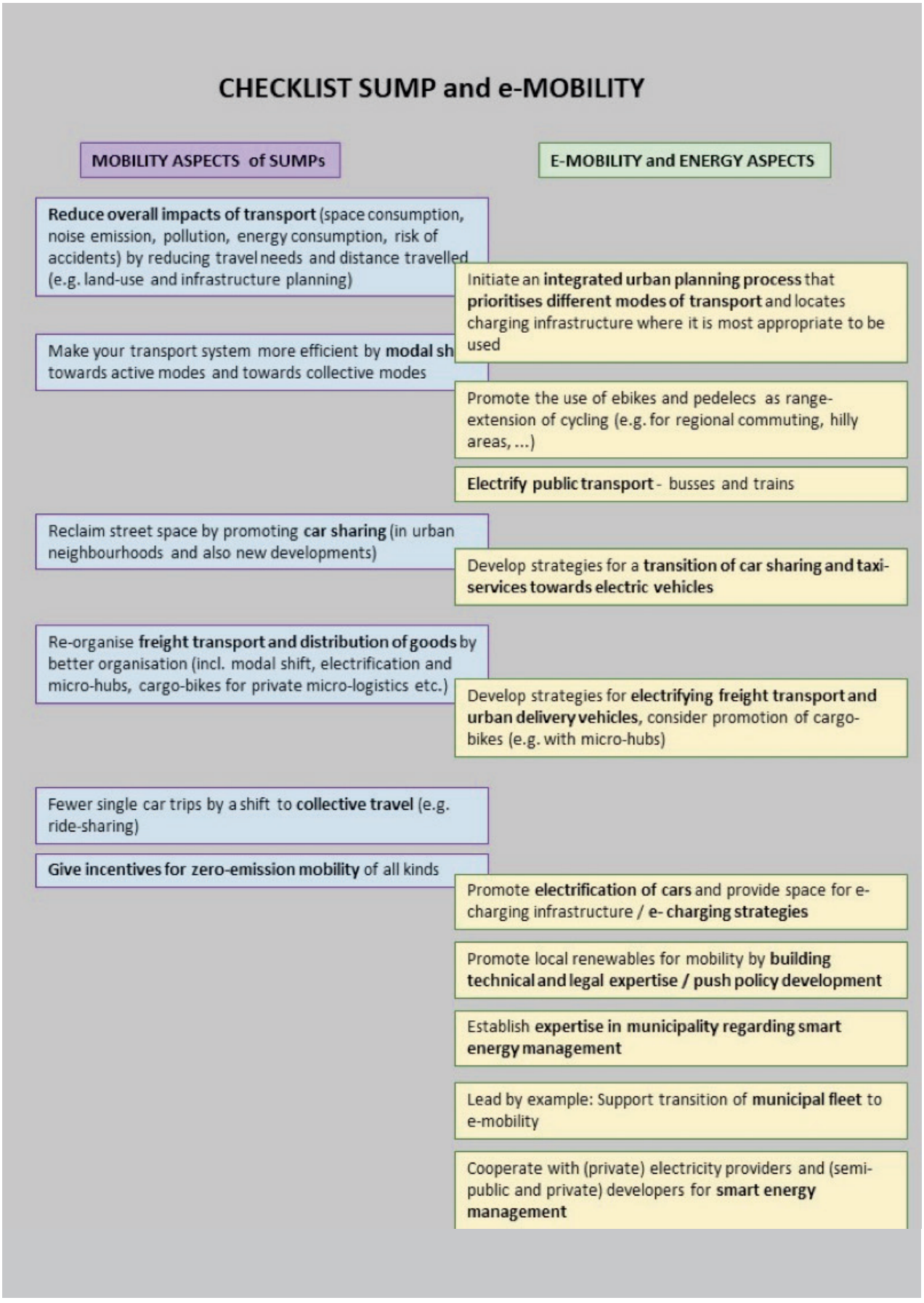

Figure 23: Checklist on how to integrate e-mobility into SUMPs

7 Related projects

MEISTER

MEISTER is a CIVITAS sister project to GreenCharge and aims to change the paradigm in the electromobility market by providing interoperable platforms and services for easy, convenient, and barrier-free access to charging, billing and smart grid service, whilst also increasing the use of renewable energy sources and self-generation methods to power electric vehicles (EVs).

The project demonstrates and establishes innovative business models that will help cities, charging infrastructure operators and e-mobility service providers to reduce costs for EV infrastructure deployment, thereby facilitating large-scale EV usage/ownership.

https://civitas.eu/projects/meister

SUMPs-Up

SUMPs-Up is one of the three projects related to sustainable urban mobility plans under the European Union's CIVITAS 2020 initiative.

It brings together eight partner organisations and seven partner cities, all of whom are seeking to help European cities to introduce cleaner and more sustainable mobility.

The project assisted planning authorities to overcome the barriers that prevent or make it difficult to implement SUMPs: capacity building, tailored information, and support during development and implementation phases to equip them with the necessary knowledge and skills to do so. The objective was to enable mobility planning authorities across Europe to embrace SUMP as the European-wide strategic planning approach, especially in countries where take-up is low and the negative effects of transport are severe.

https://sumps-up.eu/the-project/

PROSPERITY

PROSERITY is one of the three projects related to sustainable urban mobility plans under the European Union's CIVITAS 2020 initiative.

It set out to cultivate a culture shift in mobility planning at all levels, with a focus on stimulating SUMPs at the city level via national SUMP Task Forces. To facilitate this, PROSPERITY provided mechanisms and tools to help national and regional agencies take a leading role in SUMP development through SUMP support programmes.

Targeted knowledge transfer and capacity building helped build mutual understanding of the SUMP process and boosted cooperation across various levels of governance, whilst targeted dissemination promoted SUMPs and their value. Together, these laid the basis for (further) SUMP adoption in 13 EU Member States.

The core of PROSPERITY's activities was a series of National SUMP Support Programmes (NSSPs), whose development PROSPERITY assessed. Implemented at the national (and regional) level, NSSPs provide assistance and incentivise local authorities to implement SUMPs.

https://civitas.eu/projects/prosperity

- **SUITS**

SUITS is one of the three projects related to sustainable urban mobility plans under the European Union's CIVITAS 2020 initiative.

Its objective was to address a long-term reduction in urban road congestion as a major challenge for modern cities. The key driver and change agent for sustainable development in transport is the city with its local authorities, stakeholder organisations and citizens.

Almost half (44%) of all EU urban citizens live in 'medium-sized' city regions of less than 500,000. SUITS focus lay on the specific needs of small and medium sized cities and to address existing capacity shortfalls in order to maintain and normalise sustainable mobility in policy making and transport planning and to improve the quality of urban life.
The SUITS project shared best practice and developed a range of materials to enable, in particular, small and medium-sized cities to increase capacity to finance and implement sustainable transport measures or Sustainable Urban Mobility Plans (SUMPs) that support mobility transformation.

https://www.suits-project.eu/project/

- **SUNRISE - Sustainable Urban Neighbourhoods**

SUNRISE is a CIVITAS project with the mission is to develop, implement, assess and facilitate co-learning about new, collaborative ways to address common urban mobility challenges at the urban district level through "neighbourhood mobility labs" and thus to lay the foundation for a Sustainable Neighbourhood Mobility Planning concept.

SUNRISE has its own empirical programme, that is, a carefully planned set of interventions in six "action neighbourhoods" within their respective city. Concretely, one neighbourhood each in the cities of Bremen, Budapest, Jerusalem, Malmö, Thessaloniki, and Southend-on-sea will run a highly participatory "co-creation" process with their residents and stakeholders to identify local needs, to develop new transport solutions, to implement and to evaluate them – all with the guidance and assistance of the support partners urbanista, Rupprecht Consult, POLIS, TU Wien, Edinburgh Napier University – Transport Research Institute, Zaragoza Logistics Center and Koucky & Partners.

All cities are strongly committed to sustainable mobility and co-creation principles. They all have city-wide mobility strategies (esp. SUMP), yet realise that large innovative potentials are untapped at the neighbourhood level which requires the proactive involvement of local communities for lasting and publicly embraced solutions to urban mobility challenges.

https://civitas-sunrise.eu/

- **Park4SUMP**

The project aim is to help partners cities to integrate parking management into their (future) SUMP, by doing so free an average of 10% of public space currently used for parking by means of participatory planning and invest at least 10% of parking revenues into sustainable transport, active modes such as walking and cycling.

Park4SUMP aims at stimulating further innovation in parking management and turning parking policies from being reactive and operational as today to become more strategic, effective and holistic and develop a more human-centred neighbourhoods.

https://park4sump.eu/

8 Annex A – Guide to developing a charging infrastructure plan

This guide reflects the recommendations given in the German guidelines (DIN SPEC 91433, 2020) developed within the project EmoStar²K.

Step 1: Defining goals and developing a strategy

Long-term planning targets in respect to emission reduction on municipal level are set by the requirements of the National Policy Frameworks adopted under AFID and, more generally, in the National Energy and Climate Plans adopted in accordance with EU Regulation on the governance of the energy union and climate action (EU)2018/1999. For municipal authorities, such long-term electrification strategies set the minimum targets that should be integrated in their Sustainable Urban Mobility Plans .

At the beginning of the process, a municipal policy objective should be set, for example in the form of municipal climate protection or mobility strategies. Here, both the mobility turnaround (avoidance of traffic and shift to public transport) and the energy turnaround in transport (replacement of fossil fuels) must be taken into account. Possible subgoals should then be classified in terms of “political feasibility”, “financial cost”, “ mobility impact” and “environmental impact”.

A good mobility strategy that takes into account the different modes of transport and the different energy sources in a temporal context, helps to estimate infrastructure requirements and thus also to use available efficiently use existing resources.

Step 2: setting the organizational frame

Many stakeholders can be involved in the planning and implementation of charging infrastructure in public spaces like road traffic authority, civil engineering office, heritage protection authority, department of public order, grid operators, district council etc. If there is a large number of stakeholders, there should be an overall coordination that organizes the planning and approval processes on the municipal side and acts as a central point of contact for questions relating to charging infrastructure.

The coordinating body can also be located at a higher administrative level (district or state level) to ensure a coordinated approach beyond the municipality and to keep the effort low. Responsibilities and process flows for the swift handling of applications for approval of charging infrastructure in public spaces should be defined.

In addition, a compilation of the form and content of the applications as well as the criteria for granting them at a central location represents a major time-saver for applicants and approving bodies.

Likewise, within the scope of the municipality’s possibilities, the digitization of the application process should be examined and the integration into the local area atlas should be assessed.

Step 3: Identifying charging requirements

Public space is limited and there is strong competition for space. The charging infrastructure concept to be developed be demand-driven and not only consider charging points in public space, but also publicly accessible charging points on private ground as well as private charging points (as far as known). In this context, a consideration should be made according to use cases, as in this way the interactions of charging points with different charging capacities can also be taken into account e.g. petrol station-like charging hub (use case “petrol station in town”) could provide the same amount of propulsion energy as a large number of charging points with low charging capacity (use case “roadside”). The charging infrastructure concept should be tailored to the region and reflect the current State of the art. The result of the charging infrastructure concept is a need for charging points of the different power classes, the selection of suitable locations and an expected demand for the future.

Step 4: Development of demand scenarios

Basis for future development of urban charging infrastructure are scenarios for traffic development as a basis for the derived charging requirements for electromobility, ramp-up curves for electromobility in road traffic depending on the underlying scenarios, usage behavior and preferred (charging) use cases corresponding to the usage groups of electric vehicles, as well as the derived charging infrastructure requirements differentiated by space, type and quantity.

The scenarios for demand-driven supply range from a nationwide distribution with charging points of low charging power to a gas station-like system of charging hubs with high charging power. Here, there is also a dependence on the settlement structure, urban or rural, and the transport links. In addition, it is important to consider the different mobility and charging needs for different trip purposes.

One way of estimating future developments is to assume the most economically viable solution, since costs incurred for investment and operation will in most cases be passed on to the end users at the latest once the funding programs for LIS have expired.

The most efficient charging infrastructure is the one that gets by with a minimum amount of installed power, but still allows the mobility needs of the users to be met. This can be ensured by focusing on the parking duration and the distance to be covered. For this purpose, seven different use cases were used to estimate the respective energy and power requirements as well as the number of connection points needed, thus supporting the development of a charging infrastructure concept.

	Location type						
	@home		@work	@public			
Use case	Home with private parking lot	Residential complex with private parking space	Company parking lot, own site	Road side	shopping center, parking garage, retail store, public parking lots	Petrol station	High way service stations, freeway parking lots
Ground property	Private ground	Private ground	Private ground	Public ground	Public and private ground	Private ground	Public and private ground
Charging duration	8 h	8 h	8 h	1 – 8 h	1 – 2 h	≤ 30 min	≤ 30 min
Type of operation	AC	AC	AC	AC + DC	AC + DC	AC + DC	DC

Table 2: overview of use cases for charging infrastructure, (DIN SPEC 91433, 2020)

Step 5: Charging infrastructure concept

Public space is limited and there is strong competition for space. The charging infrastructure concept to be developed be demand-driven and not only consider charging points in public space, but also publicly accessible charging points on private ground as well as private charging points (as far as known). In this context, a consideration should be made according to use cases, as in this way the interactions of charging points with different charging capacities can also be taken into account e.g. petrol station-like charging hub (use case "petrol station in town") could provide the same amount of propulsion energy as a large number of charging points with low charging capacity (use case "roadside"). The charging infrastructure concept should therefore be tailored to the region and reflect the current State of the art. The result of the charging infrastructure concept is the target number of charging points of the different power classes, the selection of suitable locations and an expected demand for the future.

Step 6: Adopt action plans

At present, no one can say with certainty what the charging infrastructure landscape of the future will look like. Likewise, the ramp-up of electromobility cannot be predicted exactly. For these reasons, charging infrastructure planning must be kept flexible. Therefore, as early as the Therefore, a process should be developed during the creation of the concept that determines under which conditions, which type of charging infrastructure should be retrofitted and at which intervals this must be tested. Real usage data of the existing charging infrastructure is suitable as one criterion, which is why the availability and provision of this data should already be ensured when granting the special use permit for charging infrastructure or in the charging station operator contract.

Action plans should then be developed and adopted. These should be based on the formulated objectives:

- Develop measures to support/implement charging infrastructure projects in private and public spaces (e.g., information provision, effort reduction, financial support, etc.);
- Establish goals for the measures, interim goals as appropriate;
- Determine review method and frequency of targets (are targets still appropriate?
- Determine responsibilities and stakeholders;
- Establish time schedule;
- Establish success control mechanisms
- Create strategy for subsequent expansion of the charging infrastructure network.

Step 7: Determination of search areas and suitable locations

First, a decision should be made regarding the goal of the charging infrastructure to be established, as the approach to search space identification depends on this. Basically, there are three different objectives:

a) Demand-oriented charging infrastructure.
Here, the charging infrastructure is built based on forecasted charging requirements. This leads mostly to a concentration of charging infrastructure in metropolitan areas and usually leads to a higher utilization rate.

Once the charging requirements have been determined, they must be located. The areas in which a high charging requirement is assumed or which are of strategic importance for the charging infrastructure concept are defined as search areas. Within these search areas, a search is then conducted for suitable locations

b) Area-wide charging infrastructure
In this case, the focus is on ensuring a minimum level of mobility for electric vehicles, often in connection with services of general interest.

c) Minimizing investment costs for power supply.
In this approach, particular emphasis is placed on existing capacities in the power grid and the associated cost-efficient infrastructure. If positioned appropriately, this can minimize the investment costs for the charging infrastructure owner and the grid operator, and thus the electricity customers.

Often, mixed forms of positioning objectives are useful, such as using parts of the charging infrastructure to be built to meet demand and another part to cover the remaining uncovered areas.

A series of possible indicators that can be used in the search space identification are listed. Their use should depend on the availability of data and their usefulness for the use case under consideration. the use case under consideration.

population	Mobility	Infrastructure	Further indicators
Population density Sociodemographic and socioeconomic indicators Settlement structure	- Vehicle registration numbers - Modal split - Commercial traffic - Source-destination data - Trip purposes - traffic volumes - traffic models - Public transport and alternative mobility offers	- publicly accessible existing charging infrastructure - Private inventory charging infrastructure - Utilization of the Inventory charging infrastructure - Location of power grid and facilities of the power supply - free capacities of the power supply infrastructure - mobile phone coverage - number of parking places - Utilization of parking spaces	- Tourism - Job density - Points-of-Interest (definition according to use case) - Land prices - Land ownership - land use - Accessibility, Accessibility

Table 3: possible indicators for search areas, (DIN SPEC 91433, 2020)

The site search is the process of identifying a specific installation site for the charging infrastructure and parking spaces for charging electric vehicles within a defined search area. search area and thus follows the search area identification. The definition of location criteria and the identification of suitable locations is carried out by the charging station operator or owner taking into account the municipal requirements and possibly the requirements of the network operator.

Location potential increasing criteria are:
- Land availability for charging infrastructure;
- Parking space availability;
- Expansion possibilities;
- Opportunities to use charging time/dwell time (e.g., shopping, cafes, etc.);
- Accessibility;
- Visibility and publicity;
- Existing vehicles to be used;
- Existing public transportation, car sharing, etc. opportunities;
- Available grid capacity;
- Grid accessibility.

Site potential lowering criteria are:
- Soil media resulting in higher construction costs;
- Noise control (especially for high power chargers);
- Historic preservation;
- Contaminated sites (demolitions or soil contamination);
- Underground utilities (e.g., telecommunications, water, gas, etc.);
- Bike paths;
- Trees;
- Special parking areas;
- Street accessories/furnishings;
- Impairment to the safety and ease of street traffic;
- Existing or planned charging infrastructure.

Prior to searching for locations in the public realm, possible locations on private property that are or can be made publicly accessible should be sought to address existing competition for space in the public realm.

The voltage level to which the charging infrastructure must be connected, depends on the expected power demand. Connection to the low-voltage grid is sufficient for most cases. In any case, the grid operator should be involved in the planning of charging points at an early stage, as he can check the compatibility of the can verify the compatibility with the grid.

Step 8: Approval procedure of charging infrastructure in public space

From a municipal perspective, it is helpful if a special use permit is required for the economic use of public street space. The criteria for approval can be, for example, requirements of the traffic safety obligation, of the cityscape, uniform operability or better findability. Likewise, locations with a high expected demand can be given special consideration. Last but not least, there is also the possibility of charging fees here.

For the evaluation of the municipal electromobility strategy as well as for the planning of the further expansion of charging infrastructure, it is imperative to include a reporting requirement from which the utilization of the charging infrastructure can be read.

A clear, understandable and illustrated presentation of the ancillary conditions saves both applicants and the approving body work and time. Permission for special use can be granted as an administrative act or with a contract under public law. Coordination of the ancillary conditions with surrounding municipalities and districts should be checked.

The traffic and construction requirements for charging infrastructure in public spaces should be clearly communicated and the approval mechanism should be based on a digital process that enables the administration to handle this additional task effectively.

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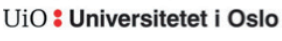	University of Oslo (UiO) NO-0313 Oslo Norway www.uio.no	**Contact:** Geir Horn geir.horn@mn.uio.no
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