

ECCENTRIC

Replication Package EV charging infrastructure

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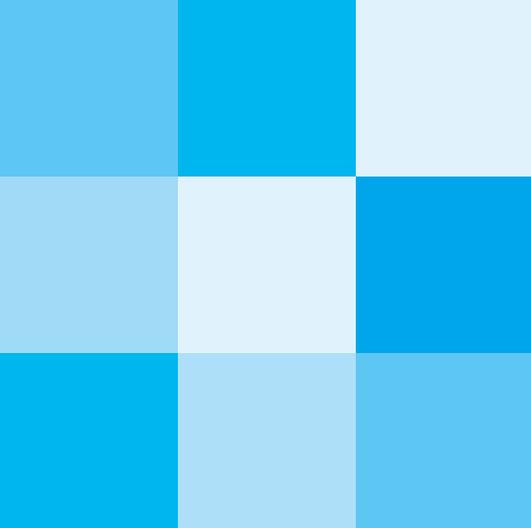
ECCENTRIC **Replication of EV charging infrastructure**

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Abstract

In the CIVITAS ECCENTRIC project, the City of Stockholm worked on projects concerned with public and household charging infrastructure. The implementation of relevant measures has generated a business model for on-street charging infrastructure that is based on a public-private partnership and a concrete process on how to develop and run an information campaign for home charging.

This report presents a replication package, based on the lessons learned during the implementation of two measures on charging infrastructure. The package includes a technical description of the measures and the implementation process. Drivers, barriers, success factors, and foreseeable impacts are presented in a comprehensive manner in order to inspire other cities and provide them with guidance.

The conclusions highlight the role of the city in deploying public and private charging infrastructure. Political commitment is a major driver for large-scale electrification, and interested utility providers and charging operators are key in making this happen. Technical solutions for electrification lay the ground for new business models, which call for regulatory updates in order to allow for the quick uptake that climate targets in Europe necessitate. Lessons learned from measure implementation emphasise that electric mobility must be an integral part of urban planning, in order to ensure cost-efficiency and avoid lock-in effects relating to car dependent mobility.

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List of Acronyms

CO₂	Carbon Dioxide
EU	European Union
EV	Electric Vehicle
e.g.	exempli gratia (for example)
i.e.	id est (that is to say)
MSB	Swedish Civil Contingencies Agency
SUMP	Sustainable Urban Mobility Plan

Executive Summary

European cities are taking the lead in facilitating the rollout of charging infrastructure in various ways. The City of Stockholm, with the co-financing of the ECCENTRIC project, has used and evaluated a set of tools for deploying public and household charging infrastructure. Both types of charging infrastructure are necessary for wide-scale electrification, catering to the needs of various users and clearly communicating a commitment to meet the target of becoming fossil fuel-free by 2040. Measure implementation has generated a business model for on-street charging infrastructure that is based on a public-private partnership and a concrete process on how to develop and run an information campaign for home charging.

To support other cities seeking inspiration and guidance in this field, this report brings together drivers, barriers, success factors, and expected impacts that are transferrable across local contexts in Europe. Conclusions from the project demonstrate how cities can enable electrification by taking an active role in bringing stakeholders together and providing a clear and transparent framework for them to act within. It is made evident that new business models that are being developed for wider-scale electrification make regulatory updates necessary. Electric mobility and the associated infrastructure, may it be public or private, shall be seen as a component of urban planning and shall be taken into account in future development plans.

Introduction

1.1 Purpose of this document

In CIVITAS ECCENTRIC, five cities (Turku, Stockholm, Ruse, Madrid, and Munich) have implemented a total of 51 innovative, sustainable urban mobility measures. The measures address a variety of urban mobility challenges, organised in different thematic clusters. This document is intended to equip practitioners and decision makers with the information needed to replicate measures to roll out charging infrastructure.

Replicability refers to the possibility of transferring results from a pilot case to other geographical areas. These areas, of course, have different local contexts and conditions. When a specific measure has proven to be successful in one area of a European city, it should be possible to transfer it to another city (or another area of the initial city), adjusting its implementation to the local conditions.

Chapter 2 provides a thorough description of measure implementation and concrete recommendations for practitioners. Chapter 3 highlights lessons learned from a strategic perspective and Chapter 4 presents policy recommendations.

1.2 Target group

This document is tailored following the practical needs of project developers and planners or technical staff from cities to develop innovative measures, consider potential barriers, and select appropriate solutions to match their contexts. It provides evidence that particular measures have been successfully implemented in a city and have good replicability potential.

2 Deploying EV charging infrastructure in ECCENTRIC

While home charging infrastructure is the best way to charge electric vehicles (EVs) both from a city and an EV owner perspective, public (on-street) facilities are seen to extend the daily range of the vehicle, decrease range anxiety, and boost opportunity charging. The latter is especially important for business users.

The ECCENTRIC cluster on EV charging infrastructure enabled an efficient and coherent rollout of supplemental EV charging infrastructure to expand driver categories and usage scenarios. The two measures of this cluster were implemented

in Stockholm and addressed public and household charging infrastructure – two types of infrastructure that cater for different user groups and needs. Information campaigns and material to facilitate the installation of and access to both types of infrastructure are at the core of this cluster.

Measure implementation generated a business model for on-street charging infrastructure that is based on public-private partnership and a concrete process on how to develop and run an information campaign for home charging.

Table 1
Measures of this cluster – EV charging infrastructure

Measure	Main focus	City	Partner(s)
STO 6.6 Master Plan for developing EV-charging in Stockholm	Public charging infrastructure	Stockholm	City of Stockholm
STO 6.7 Promote the installation of EV-charging facilities in multi-family houses	Home charging infrastructure; information campaign	Stockholm	City of Stockholm

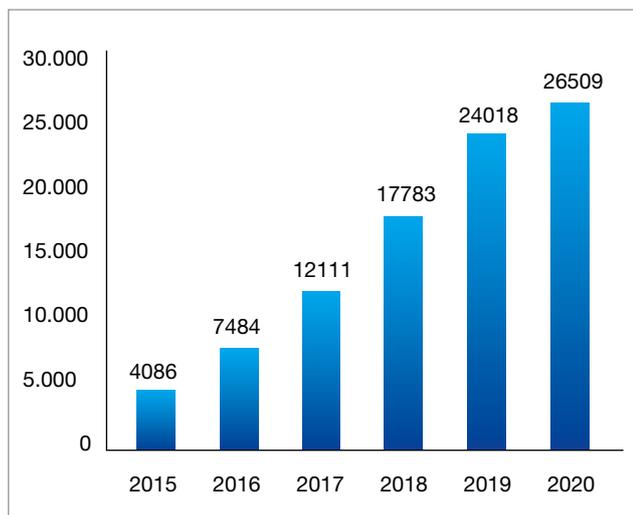
2.1 Master Plan for developing EV-charging in Stockholm

About the measure

The City of Stockholm has a long tradition of proactively working with clean vehicles and fossil-free fuels. When it comes to providing EV charging infrastructure, the role of the city has gradually evolved with a strategic aim to keep streets and sidewalks as free as possible from parked and charging cars. Today, there are about 77,000 on-street parking places in Stockholm (Stockholms stad, 2018a).

Currently, there are over 26,500 chargeable vehicles in Stockholm, constituting about 5% of the total private vehicle fleet (Figure 1).

Figure 1: Chargeable vehicles accumulated per year in Stockholm



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The number of electric vehicles in Stockholm has increased by about 35 percent from 2018 to 2019 (City of Stockholm, 2020). Private EV owners mainly charge their vehicles overnight, at or near to their homes. Many company cars have charging facilities on site.

Charging street:

a strategically chosen street with a cluster of 4-10 charges in a row, normally with a mix of normal and fast charging.

At the same time, craftsmen, delivery and taxi businesses, as well as visitors need access to daytime charging facilities. In addition, there are citizens who cannot charge at home (i.e. not all apartments have access to a parking space or a garage). In order to ensure that the needs of all drivers, including business users, would be met effectively, several working groups and high-level round tables were set up to develop Stockholm's charging strategy. The strategy is based on the following pillars:

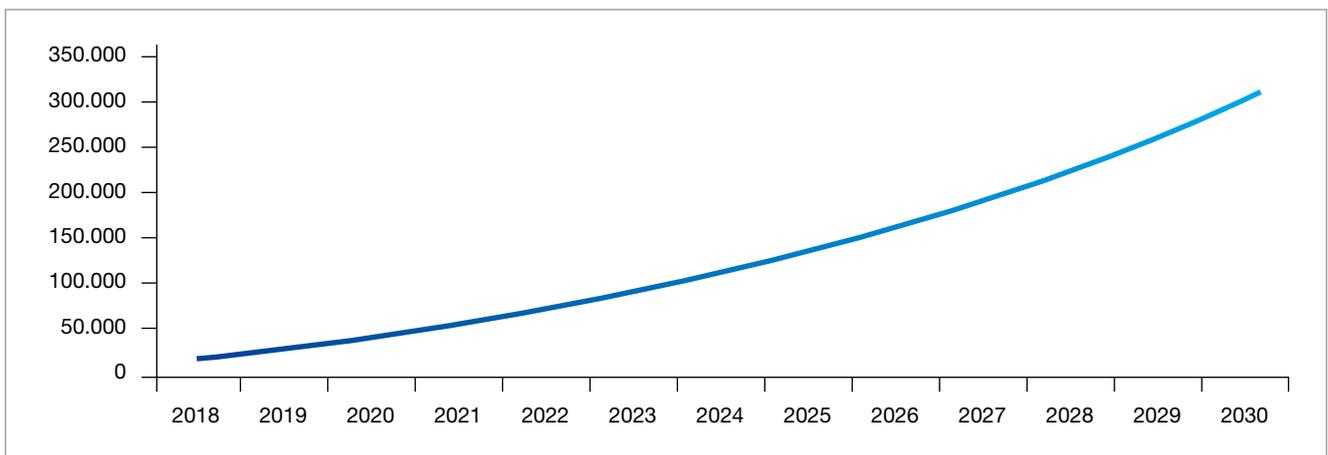
- Offering charging possibilities in city-owned parking facilities off-street (Stockholm Parkering), both for short-term use and with individual contracts for private car owners for long-term use of a specific parking lot.
- Providing know-how and information about charging technology and installation requirements to private parking companies, shopping mall owners, private companies, housing companies, and house owners.
- Providing spots for "charging streets" to utility providers that are willing to finance and operate on-street charging facilities. Charging streets are comprised of normal and fast chargers.

According to the long-term prognosis, chargeable vehicles will exceed 30,000 by 2030 (Figure 2). Private utility companies in Stockholm have shown interest

and readiness in setting up the first fast chargers on-street. The total number of charging points in Stockholm increased from 1034 to 1500 between the years 2018 and 2019 (City of Stockholm, 2020).

Stockholm aims to provide EV users with 4,000 public charging units by 2022, of which half will be on-street and the other half in public garages that are run by Stockholm Parkering.

Figure 2: Long-term prognosis for chargeable vehicles in Stockholm



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Implementation

The implementation of the Master Plan started with the mapping of appropriate spots for “charging streets” in the inner city. Utility providers were not as interested in areas outside of the city centre (e.g. in Liljeholmen-Årsta) because it is normally easier to find appropriate spots there without facilitation from the City.

An online map shows 2,000 appropriate locations, as a result of the mapping, where providers can apply to the City for setting up charging infrastructure. The mapping was based on a number of criteria, including the street and pavement size to allow for sweeping and snow ploughing, the presence of a mixed urban use, and distance to trees and roots (Figure 3).

Figure 3: Criteria for mapping appropriate spots in the inner city



© City of Stockholm

In parallel, the Transport Department has carried out extensive work to interpret the legal framework and associated contracting. Providers must ensure that the equipment is in operation at least 90% of the time or else they can lose their permit. Providers must also agree to comply with international standards on fast charging and the City's standards, such as colour coding for the equipment to blend in with the urban environment. Providers must further be able to offer at least two alternative payment methods.

The final step in implementation has been an effort to coordinate digging works in order to avoid disturbance in the city and minimise costs. To this end, the Transport Department created a map to coordinate actors that are already digging for other purposes at the same spots.

Throughout implementation, the City of Stockholm inspected established charging streets to identify parking errors and improve signage. Some signs were wrongly placed (e.g. in front of residential windows) or very difficult to understand as they contained a large amount of information. Following inspection, signs have been improved. Information about the vehicles that can park on charging streets is now clearer and easier to understand (Figure 4).

The implementation of this measure was a joint effort by the City of Stockholm, the network operator (Ellevio), utility companies (Fortum, Eon, Vattenfall), and a mapping consultant.

The Master Plan for EV-charging is part of the vision of Stockholm to become fossil fuel-free by 2040. On-street charging is expected to serve, among others, the test-fleet of craftsmen and delivery businesses, who are the typical users of opportunity charging during daytime.

The measure is further complementary to home charging, normally taking place at the vehicle's standard parking – at or close to home. In Sweden, national funding supports this type of investment and Stockholm actively works to help housing associations apply for funding and set up charging infrastructure,

Figure 4: Parking sign on charging street



© City of Stockholm

as part of another ECCENTRIC measure. Mapping of available spots and interpreting legislation in order to find the appropriate form of agreement, as well as parking and signage issues, have taken approximately one year of work.

Business model and contractual partnerships

The term “charging streets” was coined by Stockholm City Council. The City owns the land as well as the solution (Figure 5). The utility provider owns the infrastructure and is responsible for its operation, maintenance, and services. The provider is also responsible for collecting data on usage and making it available to the City for the purposes of evaluating the measure.

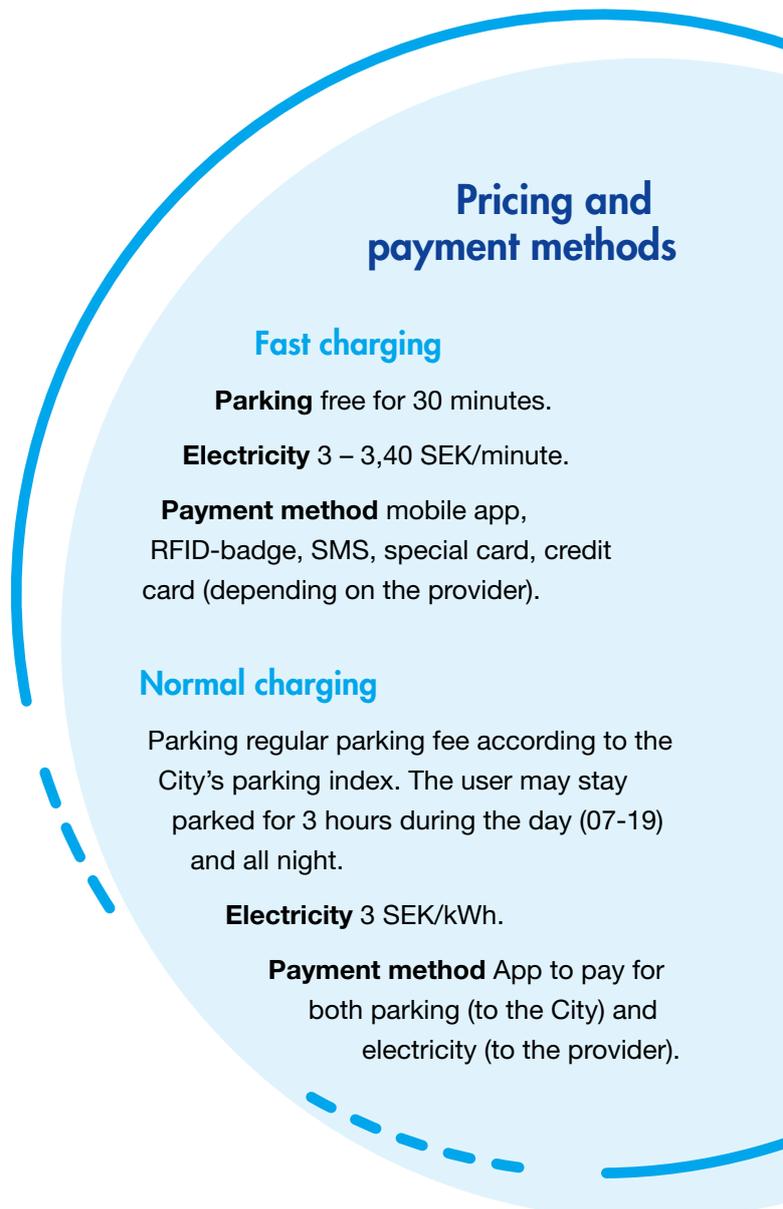
The City of Stockholm and a respective provider are bound by access rights agreements. The access right agreement is valid for ten years and a party can end the contract earlier with a one-year term of notice. To set up charging, a provider can apply for up to 30 spots or a station, which the City may assign on a first-come, first-served basis. Only when all spots are up and in operation, can a provider apply for more.

Utility providers bear all of the costs for setting up, operating, and maintaining the charging installations. The City, on the other hand, covers the total cost of signage and the maintenance of signs. The Eccentric budget covered the costs related to evaluation, data collection and analysis, as well as the communication work around the Master Plan.

Lessons learned

The number of charging sessions in Stockholm increased by 46 percent from 2018 to 2019 (City of Stockholm, 2020). The expansion of on-street charging points and the increased number of chargeable vehicles in Stockholm partly explain this increase.

For Swedish municipalities that are interested in designing a Master Plan, there is a model that is ready to replicate: there is a clear process to identify appropriate locations and an interpretation of regulations that has shown possible alternatives to choose from. This information is publicly available on the City’s website (Stockholm stad, 2018b).



For cities in Europe and abroad, where the regulatory framework might look different, Stockholm has provided a business model, based on the city offering access to land and the utility provider investing in infrastructure and being responsible for operation and maintenance.

Recommendations

- Start with the legal framework, as it is likely to take time.
- If there are uncertainties, choose the type of agreement (with the utility providers) that can be defended at a later stage in the case of an appeal.
- Start with the locations that are interesting for providers.
- Start on a small scale, but plan so that it is possible to expand.
- Think through signage so that it is understandable and blends in with the urban landscape.
- Think through colour identity so that the infrastructure blends in with the urban landscape.
- Consider the residence parking permit and the need for residents to park for longer than three hours.
- Leave enough room to allow for the cleaning of the sidewalks.
- Consider the proximity of the charging streets to coffee and other services.
- Consider an interoperable payment system across all providers.
- Evaluate continuously to refine and improve (e.g. signage, colour coding, etc.).

2.2 Promote the installation of EV-charging facilities in multi-family houses

About the measure

Charging facilities are essential for anyone that is considering to buy an electric vehicle, and overnight charging at or close to home has proven to be the number one choice for most EV drivers. Nearly 80% of the users of public charging in Stockholm have reported that they have access to charging at home (Trivector, 2018). To boost the share of EVs among private users, it is important to ensure overnight charging is available at the vehicle's ordinary parking slot.

The aim of this measure was to inspire and help interested citizens as well as owners of parking facilities by providing facts and practical advice on how to install EV charging facilities in multi-family houses. The intention was to spark the installation of charging points in privately-owned garages and parking spaces in residential areas (Figure 6).

Figure 5: Charging streets in Stockholm



© City of Stockholm

Figure 6: Normal charging in a residential garage



© Bert Ola Gustavsson/ Mosebackemedia

Most citizens in Stockholm live in multi-family houses and often rent an adjacent parking lot. The City of Stockholm has developed checklists and short, informative, and inspiring films to support housing associations in applying for national grants. Success stories from housing associations that had already installed electric vehicle charging have been promoted and seminars have been organised to bring together infrastructure providers and housing associations that are willing to set up charging on their premises. Interested housing associations and landlords can, conversely, use the information material to increase interest among their members and tenants in EVs by offering charging.

During the ECCENTRIC project, the City of Stockholm organised over 30 seminars. Around 3,000 people participated and approximately 5,000 charging units have been installed as a result of the campaign.

Implementation

The first step in the implementation of the measure was to organise the work in groups and assign each of them specific responsibilities for the development of the information material. Four groups, each with

a respective coordinator, were organised along the following assignments: checklists, film, seminar, and communication. Furthermore, a reference group was formed in order to check the quality of and provide feedback on the developed material. The members of the reference group were the Stockholm parking company (Stockholm Parkering), a property manager (Riksbyggen), and member organisations of property and apartment owners (Fastighetsägarna, Bostädsrätterna).

Before the first seminar, the team carried out a rehearsal allowing communicators to give feedback. After the seminar, which took place in Sundbyberg (a neighbouring municipality), the team fine-tuned the programme, including a Q&A session and provided exhibitors with concrete instructions. The City of Stockholm held seminars from 2017-2019 and the information material has been continuously updated.

Follow-up was based on evaluation surveys. Participants and exhibitors gave feedback about the benefits of the campaign and whether they had set up charging infrastructure after attending the seminars. The project team discussed the evaluation results after each stage. According to a follow-up survey that was carried out after the first six seminars (Spring 2017), 200 respondents claimed to have started the process of installing over 1,000 charging units.

Adjustments to the content and format of the seminars were made throughout the implementation period. Housing associations took to the floor to speak about their experiences and best practice examples, giving a peer perspective in the seminar, alongside the City giving advice.

The seminars were free for both participants and exhibitors. Providers were selected on a first-come, first-served basis due to space limitations. A no-show fee was added along the way to prevent no-shows. Clearer rules were also defined along the way to make sure that all voices could be heard. Seminars that were carried out after 2018 included a new target group, namely single-family housing owners.

Information Seminar Programme

17⁰⁰ Exhibition opens,
refreshments and snacks

17³⁰-18¹⁵ Seminar for single-family
houses

18³⁰-20⁰⁰ Seminar for multi-family
houses

The seminars are free of charge

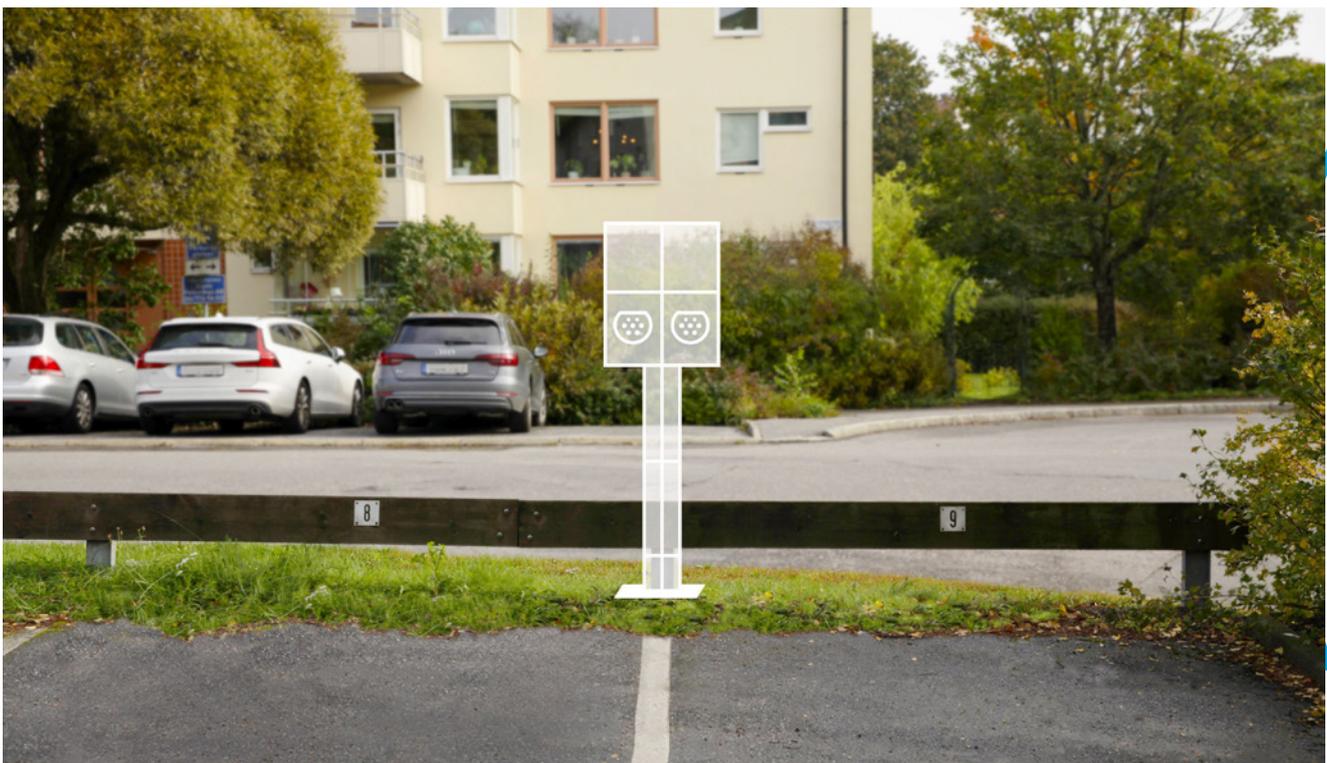
The timeframe of implementation, from preparation to seminar, was approximately half a year. The stakeholders that were involved in the implementation of this measure were property managers (Stockholm Parkering, Fastighetsägarna, Riksbyggen, HSB), member organisations of property owners, multi-family housing associations and single-family

housing associations (Bostädsrätterna, Villaägarnas Riksförbund), as well as utility providers. The City of Stockholm, in particular the Department of Energy and Climate Consulting and the Department of Clean Vehicles, led the work. The measure requires no particular infrastructure.

Business model and contractual partnerships

The City of Stockholm was the solution owner. As a competence centre for questions on energy and in its role as a neutral information carrier, the City decided to run the campaign from start to finish. Only graphic design was outsourced to consultants. The information campaign was financed by the City budget and ECCENTRIC budget combined. Neighbouring municipalities in the Stockholm region have also contributed with in-kind resources. For housing associations that decide to put up charging spots, there are three business models for financing infrastructure investment and electricity costs (Fixa laddplats, 2018).

Figure 7: Illustration of charging infrastructure outdoors



© Fixa laddplats

Lessons learned

The information campaign targeting multi-family houses has already proven to be a successful way to empower landlords and housing associations. The City, as a neutral and impartial source of information, provided inspiration and easily accessible know-how to organise, procure, and install EV charging in garages and parking areas near to the home.

At the same time, the campaign strengthened awareness of the infrastructure that is needed to make EVs a realistic car choice for people who are living in multi-family houses. Providers also found the seminars useful.

As mentioned in the previous section, the success of the campaign builds on three factors: national funding, the organisation of apartment owners in housing associations, and the focus on simple technologies.

Although these are specific to Stockholm, other cities in Europe and abroad can replicate this model. They can do so by taking on the role of a neutral information carrier to facilitate access to funding, empower local actors, and boost charging facilities at the vehicle's ordinary parking location.

Recommendations

- At the design stage of the campaign, think about where private EV owners park overnight. Who has responsibility, mandate and/or owns home parking? In other countries it might not be a housing association, but another property owner of the parking facilities. These stakeholders are often not well-informed.
- Involve the providers. It is important that providers are present during the seminars to show the different charging units that are available in the market and to answer questions.
- Set up clear rules. There might be many providers and it is impossible to accommodate everyone. Selection might be done on a first-come, first-served basis and a no-show fee can ensure commitment. Last but not least, make sure that all of the different voices are heard and that the discussion is not dominated by only a few people.
 - Keep it simple. Providers are technology-ready and might have high ambitions to promote advanced solutions. The City's role, however, is to ensure the spread of easy-to-understand and easy-to-use technologies that can be rolled out in as many places as possible.

Charging at multi-family houses – who pays that?

Business model for investment costs

- The association covers the total cost of the charging station and installation. The cost is reflected in higher parking fees.
- Users pay the total cost of the charging station and installation.
- The association buys or rents a complete charging station, including service. Users sign a subscription directly with the provider.

Business model for electricity costs

- The association may charge for the actual electricity use in kWh or a standard amount for the electricity, in addition to the parking fee. According to the EU, the charging costs should be reasonable.
- The EV owner signs an electricity subscription and pays directly to the electricity provider.
- The association buys or rents a complete charging solution and users get an invoice through a subscription.

Source: Fixa Laddplats Steg för steg-guide, 2018

3 From ECCENTRIC cities to replication in other places

The implemented measures provide concrete processes, a methodology, as well as a business model for cities interested in replication. In order to enable replication, an in-depth analysis was carried out to understand the drivers and barriers that facilitate or obstruct the effective and successful deployment of charging infrastructure in other cities. Finance and governance aspects were included in

this analysis. The key requirements to implement measures of this kind are infrastructure, funding or financing mechanisms, a legal framework, political support, and actors interested and willing to provide and/or invest in charging solutions. Transparency in process and data management is also a key factor for follow-up, especially as regards public charging infrastructure.

3.1 Master plan for developing EV-charging

Drivers

Using the existing structures

The deployment of EVs can make use of the same mechanisms and structures that are in place for regular private vehicles. Street space, financing/insurance, image, and the status quo of motorised individual transport can be used to position the EV in the market and find a place in the political agenda.

Political priority and pressure for action

Political priority is a key driver for the large-scale deployment of public charging infrastructure. Public space, especially in dense inner cities, is scarce and its use is highly contested by different stakeholders and interests. “Charging streets”, which are located in strategic locations and consist of a cluster of four to 10 normal and fast chargers, is a concept that has been coined by Stockholm City Council. The City Council initially aimed to achieve 500 public charging spots on-street by 2020. After a few years, this target was upgraded to 4,000 public spots (off-street included) by 2022. Citizens are increasingly demanding action against pollution in cities and climate change. EVs have cleverly been marketed as part of the solution, even if, in reality, CO₂ savings are only local. This puts pressure on decision makers to legislate and regulate, to facilitate access to new powertrain technologies.

Regional cooperation and coordination

Regional cooperation networks can clarify technical and regulatory aspects that are common for all cities in the same region or the country, and streamline the way a city can act when it comes to deploying public charging infrastructure. The Swedish Association of Local Authorities and Regions (SKL) facilitated the interpretation of the legal framework, issuing a handbook on “Charging for the future” to guide and inform Swedish municipalities that are working with charging infrastructure. The handbook discusses the role of Cities in the rollout of charging infrastructure, and regulatory and technical aspects regarding the placement and form of the charging stations (Swedish Association of Local Authorities and Regions, 2017).

Interested utility providers and charging operators

Interested utility providers and charging operators constitute the third driver. In this model, private actors undertake to cover the cost of investment, installation, operation, and maintenance of the charging points. The role of the City, in this case, is to provide access to strategically-chosen locations and ensure a clear and transparent process that is in accordance with the legal framework.

Growing EV population

While research argues that there is causality between charging infrastructure and EVs (Egnér and Trosvik, 2018), the large-scale deployment of public charging also requires a growing EV population that needs to charge. Chargeable vehicles in Stockholm have increased by nearly 55% since 2017, which also explains the increased demand for public charging facilities.

Barriers

The contested uses of public space

The first barrier in the rollout of public charging infrastructure is the contested uses of public space. With public space being limited not only in Stockholm but also in many European cities, the question of use prioritisation is constant. Stockholm's long-term strategy, which is connected to the Sustainable Urban Mobility Plan (City of Stockholm, 2012), is to remove on-street parking spaces in order to allow for the expansion of bus and cycling lanes. As a result, finding appropriate spaces for on-street charging has been rather challenging, making the large-scale mapping of appropriate parking spaces necessary.

Land use and parking regulations

Besides prioritisation of public space, on-street charging infrastructure is legally complicated as it lies at the intersection of land use and parking regulations. These regulations were developed decades ago, when e-mobility and related infrastructure were not part of transport and land use planning, thereby resulting in many grey zones when it comes to how a city may act. An existing regulatory framework might not prescribe how a business model could be set up. Land use and parking regulations have been the key challenges in Stockholm, requiring considerable time and collaboration between several departments and the Stockholm region in order to find a working solution. In the Swedish context, two different legal ways were identified by which on-street charging infrastructure could be set up: land concession and access rights agreements. Stockholm's on-street charging is based on the latter.

Grid capacity

Old infrastructure and increasing demand in big metropolitan regions, due to a growing population and the building of housing units, poses an imminent challenge to grid capacity. In Stockholm, the grid dates back to the 1950s and the electricity distribution company (Ellevio) is currently upgrading it. The old grid translates into a lack of capacity in some areas, but the renewal process offers an opportunity to prepare for on-street charging at the same time, which is substantially more cost efficient. An additional issue in Stockholm is delivering electricity from the north of Sweden into the city. Until 2030, which is when the grid upgrade will be completed, limited capacity may be noticed on very cold winter days, approximately up to 20 times a year. However, load-balancing equipment will allow for the charging of vehicles whilst managing these constraints.

Urban design norms and rules

Finally, yet importantly, requirements for urban design are especially relevant for cities or areas of a historical character that have stringent rules as to how infrastructure shall seamlessly blend into the urban environment. Besides the aesthetical aspect, there are practical issues to take into consideration, such as access for street sweeping and snow ploughing, and rules on the use of poles for advertising purposes.

Table 2: Drivers and barriers for public charging

Drivers	Barriers
Political priority	The contested uses of public space
Regional cooperation and coordination	Land use and parking regulations
Interested utility providers and charging operators	Grid capacity
Growing EV population	Urban design norms and rules

Success factors

Transparency and clarity

A major success factor in deploying public charging infrastructure is transparency and clarity throughout the process in order to ensure fair competition and commitment. Examples of transparency include organising information meetings with all involved utility providers, making available all relevant information, such as the legal framework and access rights agreement contracts, while managing incoming applications for installing charging facilities.

Flexibility within the business model

Flexibility concerns the type of agreement that binds the involved stakeholders with the physical planning in order to ensure the best possible outcome. Initially, the City of Stockholm signed access rights agreements with utility providers for a period of three to five years. Due to high investment costs and a demand by utility providers, the City now signs access rights agreements for 10 years. A similar adjustment was made to increase the number of spots a provider could apply for, from 10 to 30. Flexibility is also necessary with regard to the physical placement of charging locations. Establishing charging points in areas where a future extension is possible will be cost-efficient in the long run and will minimise traffic disturbance. Lastly, flexibility becomes all the more important for cities that are considering to replicate a business model that has already been implemented in another city.

Visibility of the infrastructure

Beyond its practical purpose, on-street charging infrastructure is a visible action to communicate a City's commitment to electrification to prospective EV users, the industry, and decision makers at the national and EU level.

Interested utility providers and charging operators

Interested utility providers and charging operators constitute the third driver. In this model, private actors undertake to cover the cost of investment, installation,

operation, and maintenance of the charging points. The role of the City, in this case, is to provide access to strategically-chosen locations and ensure a clear and transparent process that is in accordance with the legal framework.

Grid owner on board

Charging infrastructure is heavily dependent on grid capacity and condition. Having the grid owner on board can, therefore, increase efficiency and make the process smoother. In Stockholm, the grid owner has gone from being initially uninterested in on-street charging to actively recommending appropriate locations and launching a new pricing model, based on charging tariffs, for upcoming installations. Taking advantage of the ongoing works on local grid renewal, the grid owner prepares for new charging stations at the same time. Foundations for future charging poles are laid wherever the groundwork matches a mapped location for a possible charging station on-street. As a result, installation becomes cheaper and disturbance for road users decreases.

Ensuring long-term sustainability

A sound business model

A sound business model to ensure the operation, maintenance, and follow-up of the infrastructure is essential. In Stockholm, the business model is based on a public-private partnership, where the City owns the land and the concept. The utility provider owns the infrastructure and is responsible for installation, operation, maintenance, and service. The provider is also responsible for collecting data on usage and making it available for the city in order to follow up usage rates and customer satisfaction. The City of Stockholm and the respective provider are bound by access rights agreements, which are valid for ten years and automatically extended by five years if none of the parties protests. A party may terminate the contract with a one-year term of notice. To set up charging, the provider may apply for up to 30 spots or a station, which the City may assign on a first-come, first-served basis. When the spots are up and running, the

provider may apply for more. Utility providers bear all of the costs for setting up, operating, and maintaining charging installations. The City covers the total cost of signage and the maintenance of signs, as well as street sweeping and the parking control.

A clearly defined process for identifying and assigning locations

The business model includes a clearly-defined process for mapping appropriate spots on public spaces that comply with urban planning and design guidelines (Figure 5). Further, there is a process to handle incoming applications from interested actors, the distribution of charging spots among them, and the follow-up of uptime (i.e. the time during which the charging point is in operation) and data collection.

Environmental aspects

Whereas EVs can clearly eliminate the production of local pollutants in cities, their effect on CO₂ emissions is more complex due to the battery production and electricity mix that vary across countries and manufacturers, and this has to be addressed at a different scale. The commercial promise of sustainably-sourced energy is not enough to claim zero emissions if non-renewables continue to prevail in the overall mix. Local administrations, therefore, need to consider the energy market and power sources when tracing the effects of an EV strategy, which essentially deals with the global challenge of climate change.

Foreseeable impacts

City recognising its own role

Working with public charging infrastructure is, for many cities, an entirely new practice with many grey zones. Taking up a facilitating role in a master plan is therefore a learning process. In the case of Stockholm, the process has helped the City, and especially the Traffic Department, realise its own role and competence in the matter. Cities are key in enabling and facilitating the deployment of public charging through providing land access, clarifying

regulatory aspects and advocating for streamlined guidelines from the regional or national level.

Increased demand among citizens without access to own parking

Residents without access to their own parking facilities have welcomed the rollout of public charging infrastructure. This is especially the case in the inner city, where parking that is adjacent to multi-family houses is less common. These residents have contacted the City, expressing their interest for charging facilities in their neighbourhood. Public opinion has also been positive.

Better understanding of who uses public charging

Data collection from the charging sessions has shed light on the profiles of users of public charging in the city. Among the most common users of public charging in Stockholm are the users of free-floating car-sharing (Aimo), taxis, as well as delivery companies. Such information is particularly valuable for future planning of infrastructure and its provision in the right location for maximum effect.

Charging trend in line with growing EV population

Finally, yet importantly, data collection has shown that many of the charging streets in Stockholm are the most used charging spots in Sweden. Charging sessions have increased over time and are in line with the EV increase in the city (City of Stockholm, 2020).

3.2 Promote the installation of EV-charging facilities in multi-family houses

Drivers

Expertise in energy questions

The major driver for this measure has been the City's expertise in energy-related questions. Stockholm's Environment Department has an expertise centre, which made it natural to take the lead of the design and implementation of this campaign. With the exception of graphic design, which was outsourced, energy and mobility experts in the City ran the campaign. As a neutral and impartial source of information, the City has provided inspiration and easily accessible know-how for organising, procuring, and installing EV charging in garages and parking areas near to the home.

Market availability of technical solutions

Technical solutions for charging as well as billing and distributing the investment and electricity costs must be available in the market. This is particularly important in cases such as in multi-family housing, where non-EV users can reject such an investment if there is no clarity regarding cost division. For housing associations that decide to put up charging spots in Stockholm, the City has defined three business models for financing infrastructure investment and electricity costs (Fixa laddplats, 2020).

Knowledge of the target group

Key in the design of an information campaign is the selection of the target group. The target group should be easily reached and the campaign should have the potential to achieve a high impact. Stockholm chose to work with housing associations, since half of Stockholm's population lives in one. Moreover, housing associations are registered under an umbrella organisation, which makes them easy to find and address.

Barriers

Some target groups are more difficult to reach

While reaching multi-family houses was easy in Sweden due to their organisation in associations, villa owners proved more difficult to reach via email, making it necessary to communicate through advertisements in the local newspapers. This approach can, in comparison, be time-consuming and more expensive.

Regional and national guidelines for fire safety

Guidelines for fire safety in indoor parking garages vary among different regions in Sweden. Stockholm complies with the guidelines of the Stockholm region. These safety guidelines should be streamlined at a national level to avoid local differences. Stockholm has actively pushed the National Board of Housing, Building and Planning to provide these guidelines. In collaboration with the Swedish Civil Contingencies Agency (MSB), progress in this direction is being made.

The human factor

Leading an information campaign requires communication skills, such as the ability to address large audiences. Many of the people that were involved in the campaign in Stockholm were energy experts, but they were not used to speaking in front of large audiences. To dare to be on stage can, therefore, be challenging for experts who have the technical knowledge, but do not normally work with communication tasks.

Table 3: Drivers and barriers for information campaigns for multi-family houses

Drivers	Barriers
Expertise in energy questions	Some target groups are more difficult to reach
Market availability of technical solutions	Regional and national guidelines for fire safety
Knowledge of the target group	The human factor

Success factors

Instruments to incentivise private investments

In Sweden, national funding was available (Klimatklivet) and covered up to 50% of the investment costs, making the implementation of the information campaign very timely. The same funding had also pressed the prices of charging infrastructure downwards. Awareness of existing funding has increased over time, which has further facilitated interest in setting up charging infrastructure at home.

Focus on simple solutions to achieve wide coverage

Defining a reasonable complexity level for the proposed charging infrastructure is necessary. There are plenty of technical solutions in the market for charging and debiting electricity costs to the user, making it difficult for non-experts with limited time (e.g. housing association boards and property owners) to make informed choices. A campaign can, therefore, be more successful if the City advocates those solutions that are good enough for a large number of property owners, and not necessarily the most high-end solutions. The campaign in Stockholm had a clear focus on the rollout of simple infrastructure in many locations, instead of advanced infrastructure in only a few locations.

Ensuring long-term sustainability

A clearly-defined process for running the campaign

While a business model for an information campaign is less relevant, a clear process is necessary. This process shall describe who owns and who runs the campaign. As a competence centre for questions on energy and in its role as a neutral information carrier, the City decided to run the campaign from start to finish. The information campaign was co-financed by the municipal budget and the ECCENTRIC budget, and supported by neighbouring municipalities in the Stockholm region that contributed with other types of resources, such as catering, working hours, and meeting rooms.

A model for cost distribution among EV owners

For property owners or housing associations that decide to put up charging spots, the City has clarified three business models for financing and distributing infrastructure investment and electricity costs (Fixa laddplats, 2020). The division of investment and electricity costs between EV and non-EV owners is a typical question that comes up in any type of shared property where many users are involved. These issues, which are often a strong motivating factor that can block innovation, can easily be overcome if local authorities provide guidelines on possible financing schemes.

Foreseeable impacts

Increased demand for charging infrastructure solutions at home

The City of Stockholm held numerous well-attended seminars and a great number of visitors retrieved information from the associated website. Many housing associations applied for funding and charging infrastructure providers confirmed an increase in demand. In other words, having the campaign strengthened awareness of the infrastructure needed to make EVs a realistic choice for people that are living in multi-family houses. Providers also found the seminars to be useful matchmaking events with future customers.

New service and technology providers emerging

In recent years, new markets and new service and technology providers have emerged. However, despite this increase in supply, demand has grown at a much faster pace, resulting in long delivery times at certain periods.

Easy to replicate

At least five cities in Sweden, in addition to other cities in Europe (e.g. Amsterdam, Turku), are replicating the Stockholm model by carrying out information campaigns that have been inspired by *fixaladdplats*. The material is available online and anyone can use it as long as one understands Swedish, making it possible for any city or region to replicate the campaign locally.

Table 4: Foreseeable impacts of charging infrastructure deployment

Master plan for EV charging	Information campaign
City recognising its own role	Increased demand for charging infrastructure solutions at home
Increased demand among citizens without access to their own parking spaces	The emergence of new service and technology providers
Better understanding of who uses public charging	Easy to replicate
Charging sessions in line with the growing EV population	

4 Policy Recommendations

This section presents concluding policy recommendations for policy and decision makers that are interested in implementing measures related to the deployment of charging infrastructure in their cities.

Electric mobility must be part of urban (mobility) planning

The use of public space is highly contested, and the rise of EVs and charging infrastructure will make it an even more contentious issue in the decades to come. Longer vehicle life cycles, structural changes in the market, and the perpetuation of current car dependency will arguably continue to put pressure on public space unless a more comprehensive view is taken of mobility and urban planning.

Promoting the uptake of EVs for passenger transport is, in essence, promoting motorised individual transport (MIT). Decisive action to counteract this aspect of EV and charging infrastructure deployment is crucial. Particularly important are efforts to reduce the space that is available for MIT, including but not limited to roads, parking, servicing, maintenance, and associated infrastructure.

Public charging in general and charging streets in particular are at the intersection of urban and traffic planning, which is characterised by the numerous voices and interests stemming from the associated departments in the city apparatus and other stakeholders. When planning for the wide-scale deployment of public charging, it is important to think both holistically and strategically.

A holistic approach includes the selection of strategic locations in the city that can be expanded in the future, with minimum possible disturbances on traffic flows and the urban environment. It further includes a seamless integration of the charging infrastructure in the urban fabric in terms of form, colour, and accessibility for basic road maintenance functions, such as cleaning and snow ploughing. A strategic approach takes into account how on-street charging

interacts with future needs (e.g. expansion) or alternative uses of public space (e.g. conversion into cycling lanes), in order to avoid lock-in effects. Put shortly, electric mobility needs to be included as part of a SUMP's list of measures.

Failing to counteract the attractiveness of MIT and the resulting (established) car dependency will neutralise any benefit that EVs can bring in favour of sustainable mobility. The perpetuation of old policies and mobility behaviours blocks the abatement of vehicle kilometres travelled (VKT), keeping congestion at least at the current levels. Local contaminants will not decrease either, because an immediate adoption of EVs and charging technologies is not expected, and none of the Civitas ECCENTRIC measures proves this differently.

From this perspective, efforts and resources related to EV deployment can only contribute to sustainable urban mobility if they are accompanied by parallel and even stronger actions to counteract MIT, car dependency, and VKT. In the long term, failing to fight back local contaminants and congestion today is likely to hinder economic performance and competitiveness in the future, endangering EV technologies themselves

The city as an enabler

Both measures exemplify the role a City can take to facilitate the rollout of ordinary (home) and opportunity charging infrastructure. Business models and processes build on private investment; utility companies bear the investment, maintenance, and operation costs linked to public charging. Housing associations bear the investment and electricity costs for home charging, with the assistance of national

funding. With regards to home charging, there are three ways to distribute these costs among tenants and EV users.

The experience of Stockholm provides a methodological framework according to which a City can enable the deployment of public charging infrastructure by identifying strategic locations, exploring and interpreting the current legislative framework, and providing land access to utility providers in return for data collection and the operation and maintenance of charging points. Stockholm's public charging infrastructure illustrates an example of a functioning public private partnership with a rather low investment risk for the City.

The City might also enable the rollout of home charging infrastructure by reaching out to a large and targeted audience, creating awareness, and facilitating the diffusion of funding that is provided by the national government. The information campaign for single- and multi-family housing associations illustrates a pathway for municipalities to boost and complement the initiatives and work done at the national level. The City, as a neutral and impartial source of information, provides inspiration and easily-accessible know-how related to organising, procuring, and installing EV charging in garages and parking areas near to the home.

New business models for electrification call for regulatory updates

The case of Stockholm further exemplifies that the existing local legal framework does not foresee the development of EVs and charging infrastructure. In this context, local authorities might face considerable barriers in identifying their role and drafting a clear roadmap for the wide-scale electrification necessary to reach their environmental and climate targets. Uncertainty on what a city can and cannot do in order to support a wider EV rollout may block innovation potential, thus further straightening the claim that new business models for electrification require new approaches.

Being aware of this reality while designing charging infrastructure projects can help to allocate sufficient time and resources for this work in the short term. Grey zones may also offer flexibility and an opportunity to bend boundaries. The case of Stockholm is such an example. In the long term, it is necessary to revise local legislation on land use and parking, as well as to, at a European level, provide policy makers with clearer pathways. Similarly, national coordination of fire safety guidelines for the deployment of charging infrastructure in indoor parking might be necessary in order to further streamline the process.

Take advantage of the structures that are in place

Existing economic and social structures can enable the prevalence of motorised individual transport, thereby also facilitating the large-scale adoption of EVs. The predominant position of MIT in public and political discussions should be utilised to speed up actions for new power technologies (e.g. new business models and regulatory updates).

Moreover, car dependency ensures the success of commercialisation strategies. An active and healthy car market facilitates the transformation of associated products and services (e.g. power supply, insurance, financing, maintenance, resale, etc.) to serve new vehicles and their users properly.

5 Conclusions

Cities in Europe and around the world are in search of viable business models for electric urban mobility. The implementation of charging infrastructure in CIVITAS ECCENTRIC has generated valuable lessons and highlighted important factors for urban mobility practitioners and policy makers in other cities.

Stockholm developed a Master Plan for public charging in the inner city, following the mapping of appropriate locations and the interpretation of associated legislation. Private utility companies in Stockholm have demonstrated interest and readiness in setting up and operating charging on-street, which must comply with international standards on fast charging as well as the City's standards on design, data, and payment methods.

A campaign, which included seminars, guidelines, and information material, promoted and facilitated the establishment of charging infrastructure in single- and multi-family houses. The aim of this measure was to inspire and help interested citizens as well as owners of parking facilities by providing facts and practical advice on how to install EV charging facilities in multi-family houses. The intention was to spark the installation of charging points in privately-owned garages and parking spaces in residential areas.

The examples from CIVITAS ECCENTRIC indicate the following:

- EVs and charging infrastructure have to be part of a holistic view of urban and mobility planning. Otherwise, drawbacks and secondary effects can outnumber the benefits. The holistic and strategic planning of electric mobility, in collaboration with urban planning and design experts, is necessary to ensure cost-efficiency and avoid lock-in effects relating to car dependent mobility.
- The existing regulatory framework does not foresee the development EVs and charging infrastructure, making the role and mandate of the City unclear and hindering innovation potential. In this context, cities can use grey zones in a way that enables them to achieve their environmental and urban mobility targets. The City can undertake the role of easing spatial and financial access, collaborating with the private sector, and complementing policy instruments at the national level.
- An increasing demand for electricity, combined with the presence of old grids in cities, may cause capacity issues. Thus, the grid owner is a key partner in developing a master plan and wide-scale electrification.
- New business models emerge, thereby providing a number of solutions for public and private charging infrastructure.

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