# The influence of the exponential demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city


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# Abstract

All over the world, cities are attempting to emit less carbon to limit the possibly detrimental effects of human-induced climate change. One way to limit carbon emissions is by reducing fossil fuel car use and transitioning to forms of low-carbon mobility. Electric vehicles (EVs) are an exponentially popular low-carbon transport solution, providing similar qualities to fossil-fuel cars. The question is whether it is possible to supply the growing demand for public EV infrastructure and simultaneously have a spatial design with every function within a 10-minute walking or cycling distance of each resident. This paper studies this question in the context of the municipality of Utrecht, the Netherlands. To a large extent, policy decisions that are made now shape how the city will operate in the future. This exploratory research identifies leverage points and lock-ins on both a city scale (policy research) and a neighborhood scale (case study). Furthermore, Stakeholder behavior is analyzed by asking the most essential stakeholders how they expect to respond when the research results become a reality. They are also asked to consider policies to prevent lock-ins and utilize leverage points. The goal is to prevent any unwanted outcomes blocking zero-emission mobility. The study revealed that the current strategy for public EV infrastructure locks in the ability to utilize a significant share of the public space for the 10-minute city. The study suggests six strategy changes to improve the odds of simultaneously supplying the public EV infrastructure demand and implementing a ten-minute city by 2040.



*Key words: EV infrastructure, EV charging, 15-minute city, socio-technical systems, systemic design approach, carbon lock-in, leverage points, sustainable mobility, GIS, 3D-stakeholder grid.*

# 1 Introduction

## 1.1 Background

The city of Utrecht currently counts 361.000 residents, making it the fourth most populated city in the Netherlands. Expectations are that this city will grow to 454.000 residents in 2035, a growth of roughly 25% in just 13 years (CBS, 2022). The municipality is aware that this will have major implications for the built environment (Utrecht, 2021b). More people means a higher demand for housing, services and infrastructure, all of which require space.

While the demand for space is increasing in the urban environment, the way people move through the city is also rapidly changing. Efforts are being made by citizens and governments alike to use more sustainable modes of transport. Due to the intensifying time pressure of reducing human impacts on climate change, action must be taken quickly. The Dutch authority on monitoring the urban environment is Plan Bureau Nederland (PBL). PBL reported in 2019 that it is uncertain how future mobility will take shape. They acknowledge that this makes it much more challenging to decide on which investments in infrastructure should be made (Snellen et al., 2019)

Utrecht has determined how many square meters should be dedicated to different functions per 10.000 extra houses as part of their 2040 spatial development strategy (Gemeente Utrecht, 2021). A concept known as the 15-minute city stands at the core of their reasoning. The city of Utrecht has translated the 15-minute city concept to its ambitions. They want all the services a resident needs to live a happy and healthy life within ten minutes of walking or cycling instead of fifteen (Utrecht, 2021b).

Transforming neighborhoods to become more walkable is not something that happens overnight. Changes in the built environment are renowned for taking a decade to complete or more, considering planning, administrative duties, selection of the contractor, and proving adherence to regulations and construction. In the meantime, the demand for transportation, housing and services is ever-growing. One emerging trend to facilitate the need for sustainable transportation and reaching services is using electric vehicles (EVs). The demand for EVs has risen astronomically in the Netherlands. In 2021, 526.000 EVs were registered, while in 2014 there were just

130.000 EVs (CBS & RDW, 2021). That means that in less than ten years, the amount of EVs has quadrupled. Each year, the growth percentage increases, indicating an exponential growth rate. EV policy in the Netherlands is decided per municipality (Laadinfrastructuur, 2019). Even though Utrecht strategizes toward a 10-minute city, the shift from fossil-fuelled cars to EVs persists, requiring infrastructure that takes up valuable space.

EVs and fossil-fuelled cars have both similarities and differences when it comes to infrastructure. Similarities are that both need roads and parking to function. A key difference is that the batteries of EVs are charged at charging stations instead of at gas stations. In the Netherlands, including Utrecht, charging stations are situated in neighborhoods. This way, residents can charge their cars close to where they live. In doing so, parking spots are effectively transformed into electric charging locations. More and more charging locations are needed to satisfy the growing fleet of electric vehicles.

It is still unknown what the influence will be of the increased demand and implementation of electric car infrastructure on the spatial capabilities of Utrecht to become a ten-minute walking city. The discussion can even be broadened to the fundamental question for the municipality of Utrecht if and to what extent car use should be facilitated within its borders when a resident has everything within a 10-minute walking or cycling distance.

## 1.2 Problem statement

Cities are making numerous efforts to reduce carbon emissions. Two ways to do this are applying the 15-minute city concept and creating public EV infrastructure to stimulate EV use. It is still unclear to what extent these two ways contradict each other or create unwanted effects when applied together in the built environment. Such undesirable effects could negatively impact the intended goal of zero carbon mobility. A possible cause of this problem is that different departments develop these efforts with separate governmental strategies. Therefore, the potential effects of applying these strategies simultaneously might not have been identified. Predicting the results of applying these different strategies simultaneously could help to prevent any negative impacts on the desired outcome. This discussion will shape how our cities will operate in the coming decades.

## 1.3 Research questions

The main research question is:

What strategy changes are needed for the city of Utrecht to simultaneously supply the public EV infrastructure demand and to have implemented a ten-minute city in 2040?

Sub-research questions:

1. What is the strategy of the municipality of Utrecht for creating a ten-minute walking city?
2. What is the strategy of the municipality of Utrecht for supplying EV demand?
3. What stakeholders are involved in these strategies?
4. What lock-in(s) and leverage points can be identified in applying both strategies simultaneously in 2040?
5. What happens when these strategies are applied simultaneously to the spatial context of a city district in Utrecht in 2040?
6. What strategic behavior is to be expected of the involved stakeholders when the identified lock-in(s) become a reality?
7. What strategy changes do stakeholders suggest to prevent carbon lock-in and utilize leverage points?

## 1.4 Research goals

The goal of this research is first to aid the municipality of Utrecht in making informed decisions on spatial design and policy-making in the built environment. Furthermore, the study aims to open a broader discussion on the role of motorized vehicles in cities worldwide.

## 1.5 Scope

1.1 Geographic Scope

The study concentrates solely on the city of Utrecht, excluding any analysis of metropolitan or national policies related to EVs. The focus remains within the city's boundaries, providing a localized examination of the spatial effects of EV infrastructure.

1.2 Infrastructure scope

The analysis primarily revolves around above-ground EV infrastructure, including charging points, parking facilities, and roads required. The placement of charging stations depends on the location of underground cables. Therefore, these are included in the research.

The particular focus is on regular charging stations (AC) operating at 11 kW and fast chargers (DC) designated for short-stay locations. Fast-charging locations targeting business parks, logistics centers, or highways are deliberately excluded from this research. Our investigation is specifically directed toward the public charging infrastructure accessible to residents and visitors in urban neighborhoods.

1.5 Policy scope

This research does not delve into the policies related to public transport, nor does it examine the broader effects of public transportation measures on EV adoption or the 10-minute city. The scope is confined to evaluating the spatial consequences of EV infrastructure on implementing the FML concept.

1.6 Effects scope

The study's primary focus is on the spatial effects of EV infrastructure; thus, it does not analyze the feasibility of whether the power grid will have enough capacity to satisfy EV infrastructure demand.

1.7 Stakeholder scope

The study acknowledges that residents play a crucial role in urban mobility and city planning; however, due to time restraints, they are not considered as correspondents in this research. Instead, the focus is on other relevant stakeholders.

# 2 Methodology

## 2.1 Research philosophy

Following the line of thinking of Abson et al. (2017), an epistemological approach to the notion of systems is used, seeing systems "as a lens through which sustainability issues can be addressed. They stress the importance of understanding that "the worldviews and concerns of researchers and other actors involved "influence the research outcomes. Part of this is the researchers' education, having six years of education in sustainability. Added to this is the experience of the researcher as a professional working for two years in the field of public EV charging.

## 2.2 Research aim and type

The aim is to explore the possible implications of simultaneously creating a 10-minute city and satisfying the demand for EV infrastructure in the city of Utrecht. A mixed-methods approach is used in this research which is detailed in the next paragraph.

## 2.3 Research methods

The literature provides a solid basis for understanding why the system's social and technical aspects are to be considered when analyzing socio-technical systems. This research looks at the targeted socio-technical system's system features and spatial components. Therefore, a framework is needed that takes all these aspects into account. The systemic design approach is such a framework (Ospina, 2019). It combines systems thinking with design thinking. Stakeholders' involvement is engrained in the process. The process is iterative, constantly improving the understanding of the system by involving the knowledge and expertise of stakeholders. It includes eight steps that are a constant follow-up of divergent and convergent steps. The structure of the systemic design approach is shown in figure 1.

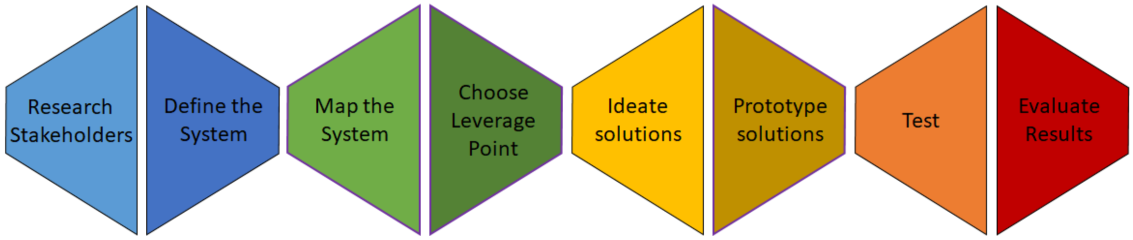



Figure 1: systemic-design framework (Ospina, 2019)

The systemic design approach has been adapted to the research flow diagram in figure 2. The colors of figure 1 are used to show which step of the systemic design approach applies to which step in the research flow diagram. Steps 1 to 4 are done twice, once on the city level and once on the neighborhood level. For each step is shown which methods are used and what sub-research questions are answered.

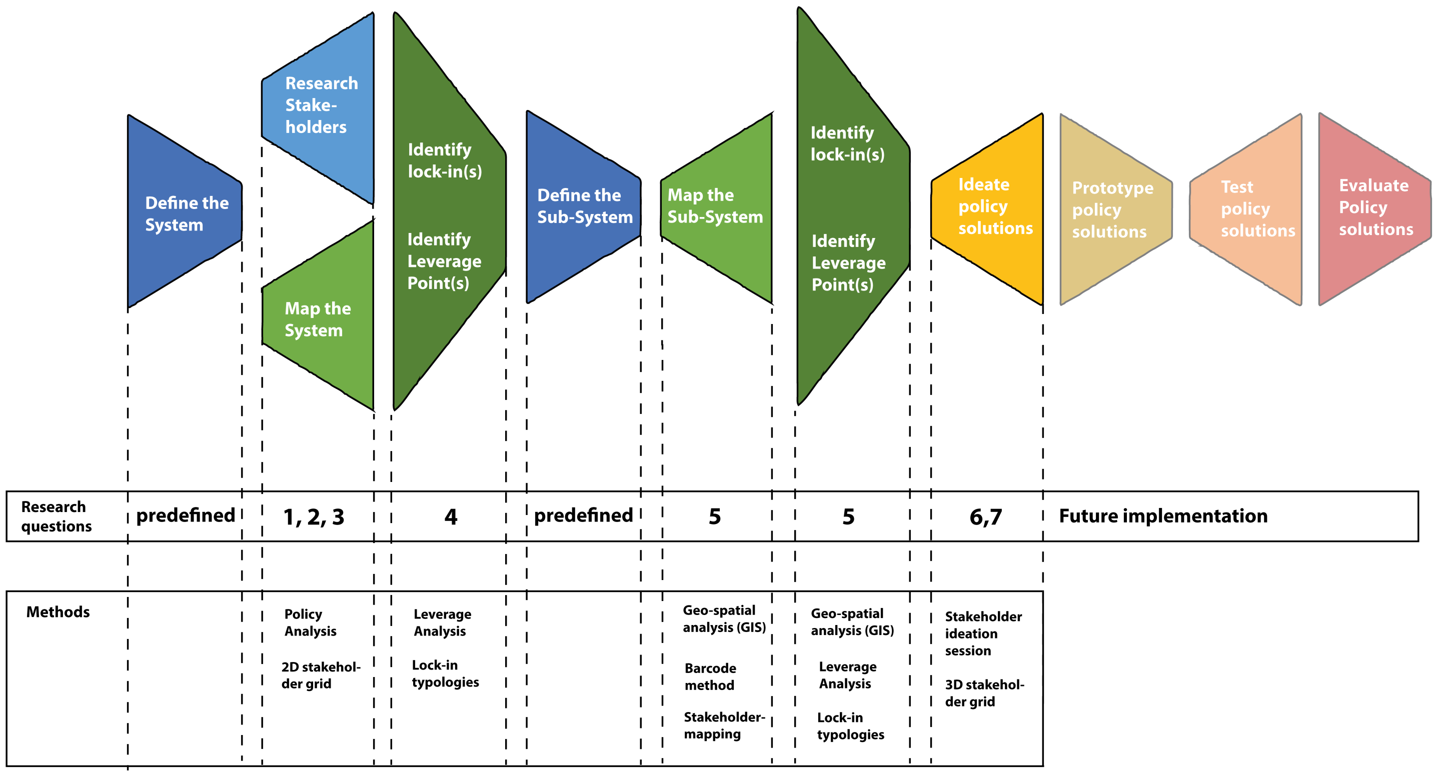



Figure 2: Altered systemic-design framework with the research questions and methods per step (made by author inspired by Ospina (2019)).

The research methods are best explained by dividing the research into three phases. The first phase was on the scale of the city of Utrecht. A qualitative approach was applied through policy analysis to analyze the city's strategies for creating a 10-minute city and satisfying the demand for public EV infrastructure. The policy documents were found by searching for the Dutch versions of relevant terms such as mobility strategy, city planning strategy, sustainability strategy and public EV strategy. Added to this the Snowball method was used, scanning the policy documents for other relevant ones. Different professionals working on the 10-minute city and public EV infrastructure were contacted to verify if all the relevant documents had been analyzed.

The policy analysis consisted of four parts. First, the most important measures, assumptions, visions and forecasts are critically assessed. Second, the stakeholders were derived from the policy documents and categorized in a power-interest grid. Third, the management styles of the two strategies are analyzed based on the literature on adaptive management and transition management. Fourth, the lock-ins and leverage points are identified and categorized using the framework of Seto et al. (2016) and Abson et al. (2017), respectively.

The second phase of the study focused on the neighborhood/district scale. This phase employed a quantitative approach, utilizing a case study of Utrecht Noordwest and GIS analysis to assess the feasibility of accommodating the required functions for a 10-minute city and the necessary charging stations and parking spaces for electric vehicles (EVs) by the year 2040. To conduct this analysis, the most up-to-date GIS data on charging station placement and 10-minute city functions, all of which were published or updated in 2023, were employed.

The analyses involved a process of combining various GIS layers related to public EV charging infrastructure and calculating the square meters it would occupy within Noordwest. Furthermore, the study delved into understanding the potential lock-ins and leverage points, drawing insights from the GIS analysis of the Noordwest district.

For a detailed account of the steps involved in the GIS analysis, please refer to Appendix D. Additionally, all the formulas used throughout the case study can be found in Appendix E. The resulting data from this comprehensive analysis is available in Appendix F.

The third phase involved another qualitative approach, integrating the city and district scales. A selection of stakeholders was invited for a session to discuss the results of the policy analysis and the case study. To do so, first, a data management plan, a human ethics checklist and an informed consent template were submitted and approved by the Human Research Ethics Commission of the TU Delft. These can be found in appendix H. All the stakeholders signed the informed consent forms. Three professionals were interviewed in two sessions.

The first session was with two municipal officers and the second one was with an EV expert working at the active CPO in Utrecht. The EV expert was asked to respond to the findings of the first interview. These interviews were summarized to protect the anonymity of the correspondents. The summaries were checked by the correspondent and provided with feedback for validation. The interview transcriptions and video recordings were used to analyze the expected behavior of the interviewed stakeholders when the findings of the case study became a reality. Their responses were categorized using the 3D stakeholder grid of Murray-Webster and Simon (2007). Furthermore, any alternatives for the projected future were discussed, including an ideation session on realizing these alternative concepts.

The research was conducted over a period of 5 months.

## 2.4 Limitations

This research is prone to different limitations. The policy analysis may not capture the full range of factors that influence the creation of a 10-minute city and the provision of EV infrastructure. Although the policy analysis conducted in this study provided valuable insights into the city's strategies and stakeholder positions, some relevant policies may have been missed or some stakeholders were not fully represented.

GIS analysis is subject to limitations inherent in the data used. The GIS analysis was conducted using available data sources, which may not be fully accurate or up-to-date. The GIS analysis results also depend on the assumptions made about the future uptake of EVs and the availability of charging infrastructure, which may not align with actual future developments.

The formulas used to calculate the expected demand for charging stations are not state-of-the-art. Even if that was the case, future predictions give no certainties. The actual number of charging stations might deviate from the predictions in this study.

Stakeholder involvement may not fully capture the diversity of perspectives and interests. Despite efforts to involve a wide range of stakeholders, it is possible that some voices were not fully represented in the stakeholder session.

The generalizability of findings may be limited to the context of Utrecht. The findings of this study are specific to the context of Utrecht and may not be generalizable to other cities or regions with different socio-technical systems or policy contexts. Further research in other contexts may be needed to confirm or refute the findings of this study.

Despite these limitations, the methodology provides a comprehensive and holistic approach to analyzing the implications of creating a 10-minute city while satisfying the demand for EV infrastructure.

# 3 Literature Review

This section focuses on the most relevant scientific concepts and frameworks that underlie this research. It also summarizes key arguments out of scientific literature for the importance of conducting this research. This section is closed with a theoretic framework in which the connections between the literature review and the research are visualized.

## 3.1 Socio-technical systems

### 3.1.1 Infrastructure as a socio-technical system

Infrastructures are recognized as complex socio-technical systems (Chappin, 2011; de Bruijn & Herder, 2009). The term gives away most of its meaning, seeing infrastructure not only as a sum of technical components but also comprising of social components, which influence each other. As Ingeborgrud et al. (2020) words beautifully:" ... it has become clearer that the complex relationship between technology and society means that this is a socio-technical challenge where technology and society must be tackled in tandem and that there is no simple technological solution to low-carbon energy transitions.". Therefore stakeholder behavior should be considered and not only the physical infrastructure.

### 3.1.2 Transition management and adaptive management

Two schools of thought are frequently addressed to understand complex changes in socio-technical systems: Transition management (TM) and adaptive management (AM). These schools originated from two different fields. Adaptive management was a reaction to the failure to control and predict water bodies. Adaptive management has the philosophy that the ability to predict the future of a system is inherently limited. Therefore, adaptive management emphasizes the need to be able to change course based on gained experience and insights (Pahl-Wostl, 2006). Transition management came from studying historical transitions to better understand transitions to sustainable systems. Transition management has the inherent assumption that transitions can be steered to a desired goal (Kemp et al., 2007).

A critique of transition management has been raised by Bridge et al. (2013) claiming that its methods are focused too much on the national and global scale while neglecting the context on the urban scale. They claim that each context is different and that no one-size-fits-all solution exists. Geels et al. (2018) make a similar remark, mentioning that socio-technical literature is strong on temporal issues but less so on spatial issues, specifically mentioning questions to enrich the current body of literature, such as: "What is the role of local and regional institutions, policies and forms of governance in the emergence and diffusion of innovations?". This research can enrich the socio-technical literature with critical spatial aspects to consider on the urban scale.

## 3.2 carbon Lock-in

### 3.2.1 Definition of carbon lock-in

The fitting term carbon lock-in tells the tale of cities that have been locked into fossil fuel-based energy systems, such as fossil-fuel car infrastructure, through a process of technological and institutional co-evolution (Unruh, 2000). Bridge et al. (2013) mention that mobility is particularly connected to the urban context. It speaks on how the degree of existing fossil-fuel car infrastructure limits possibilities for more sustainable alternatives, creating carbon lock-in.

Lock-ins are mostly seen and studied as a negative phenomenon, inhibiting systems from changing. Important to note is that lock-in is not negative per sé. Lock-ins can have both positive and negative effects (Seto et al., 2016). Klitkou et al. (2015) mentions that "there is a need to distinguish between lock-in mechanisms which favor, respectively, the old fossil-based regime, well-established (mature) renewable technological trajectories, and new technological trajectories." They remark that well-established (mature) renewable technological trajectories can reinforce the development of new trajectories but also act as a barrier due to their financial and physical binding.

Carbon lock-ins are a specific type of lock-in that is negative because these lock-ins prevent systems from decreasing carbon emissions (Seto et al., 2016). Reviewing studies between 2015 and 2021, Buzási and Csizovszky (2022) found that lock-ins and path dependencies are rarely even mentioned in sustainability publications, let alone studied. The authors reason the negative connotation of lock-ins is the cause, with sustainability having a positive connotation. They stress the importance of studying lock-ins in the sustainability domain to avoid long-term harmful consequences.

### 3.2.2 Types of lock-in

The lock-in definition of Unruh (2000) mentions technological and institutional elements. As we are dealing with socio-technical systems, the behavioral aspects are still missing. Seto et al. (2016), a later publication that Unruh co-authored, confirms this. This publication distinguishes three types of lock-in. Figure 3 shows these types and concisely summarizes the key characteristics of each type.

| Lock-in type | Key characteristics |
|---|---|
| Infrastructural and technological | ■ Technological and economic forces lead to inertia<br>■ Long lead times, large investments, sunk costs, long-lived effects<br>■ Initial choices account for private but not social costs and benefits<br>■ Random, unintentional events affect final outcomes (e.g., QWERTY) |
| Institutional | ■ Powerful economic, social, and political actors seek to reinforce status quo that favors their interests<br>■ Institutions are designed to stabilize and lock in<br>■ Beneficial and intended outcome for some actors<br>■ Not random chance but intentional choice (e.g., support for renewable energy in Germany) |
| Behavioral | ■ Lock-in through individual decision making (e.g., psychological processes)<br>■ Single, calculated choices become a long string of noncalculated and self-reinforcing habits<br>■ Lock-in through social structure (e.g., norms and social processes)<br>■ Interrupting habits is difficult but possible (e.g., family size, thermostat setting) |

Figure 3: Types of lock-in and their characteristics (Seto et al., 2016).

The term inertia is mentioned in the table and might be unfamiliar to some readers in this context. Inertia is "a tendency to do nothing or to remain unchanged" (‘Inertia | Encyclopedia.com’, n.d.).

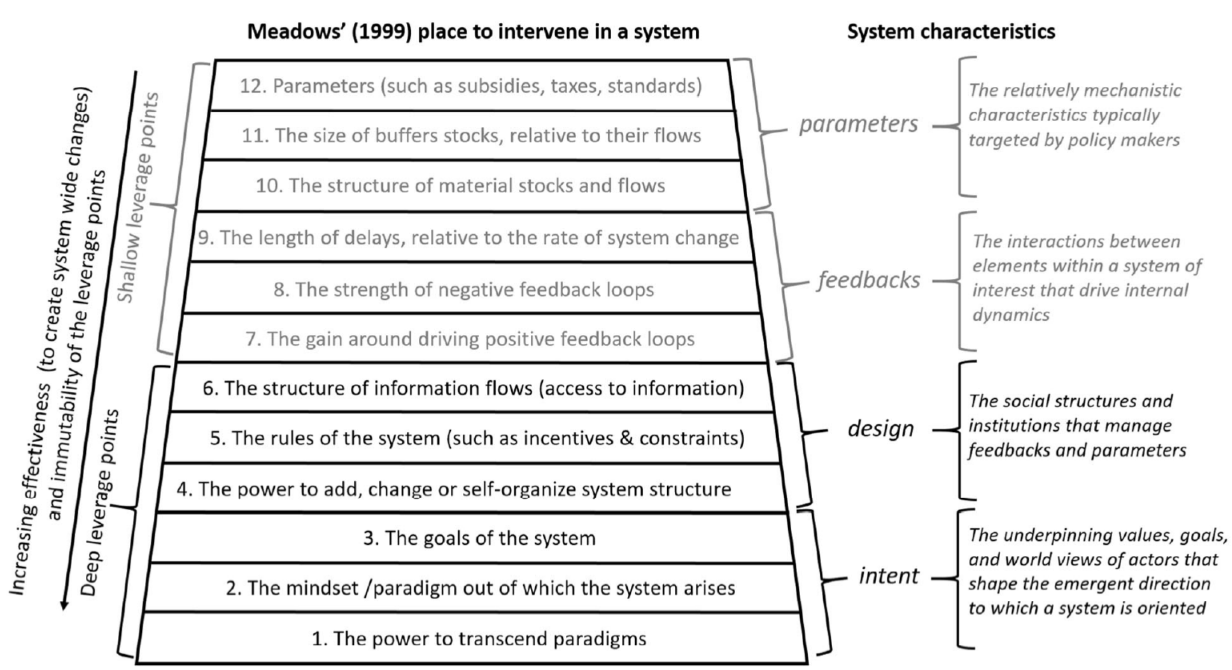
### 3.2.3 prevention of carbon lock-in

The ability to change systems depends on the state of the system. Seto et al. (2016) mention "that Systems can be more plastic, and hence more open to low-carbon-intensive choices, either in emergent realms and sectors where no technology or development path has yet become dominant and locked in or at moments when locked-in realms and sectors are disrupted by technological, economic, political, or social changes that reduce the costs of transition or make relevant actors more willing to incur those costs."

Future carbon lock-in can be caused by EV infrastructure. EVs are not zero-carbon and could be a limiting factor for zero-carbon solutions, such as walking (Henderson, 2020). This research hopes to analyze the concept of “EV lock-in” and if it is something to watch out for, possibly preventing unwanted results in the cities.

## 3.3 Leverage points

Meadows (1999) wrote an essay on 12 leverage points that can change systems that would later prove to be the foundation of the literature on leverage points. These 12 points have a hierarchy of effectiveness, with 12 creating the least impact and one the most. Almost twenty years later, Abson et al. (2017) refined this theory by grouping these leverage points into four groups based on which system characteristics they affect. Furthermore, this article provided a distinction between shallow and deep leverage points. Shallow leverage points are described as relatively easy to implement but cause little change, while deep leverage points are the opposite: they are hard to implement but result in big changes. Figure 4 impressively summarizes all this information.




The four system characteristics represent a nested hierarchy of, tightly interacting, realms of leverage within which interventions in a given system of interest may be made. Deeper system characteristics constrain the types of interventions possible at shallower realms of leverage

Figure 4: Types of leverage points with the associated system characteristics and whether they are shallow or deep leverage points (Abson et al., 2017).

## 3.4 the 15-minute city

### 3.4.1 Definition of the 15-minute city

C. Moreno first introduced the 15-minute city concept(FMC). The paper of Moreno et al. (2021) explains the concept as follows: "The 15-Minute City rides on the concept of "chrono-urbanism", which outlines that the quality of urban life is inversely proportional to the amount of time invested in transportation, more so through the use of automobiles.". They mention that a resident should be able to fulfill six urban social functions within a 15-minute walking or cycling distance to uphold a decent urban life, which are living, working, commerce, healthcare, education and entertainment.

### 3.4.2 Framework of the 15-minute city

Moreno et al. (2021) created the 15-Minute City framework, illustrated in figure 5. It shows all the key dimensions of the concept. Each dimension constitutes the creation of a 15-minute city.

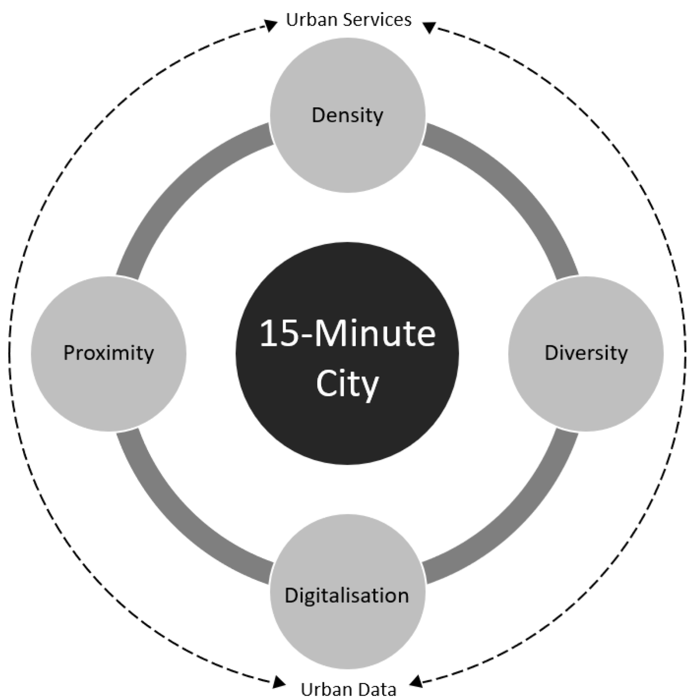



Figure 5: The 15-minute city framework (Moreno et al., 2021).

The dimensions do not speak for themselves. Definitions are necessary to understand their meaning within the context of FMC. Density is not just having as many people in one square kilometer as possible. In FMC, density is "the optimal number of people that a given area can comfortably sustain in terms of urban service delivery and resource consumption." (Moreno et al., 2021). In other words, it is a fine balance where the number of people still allows for economic, social and environmental sustainability.

Proximity lies at the heart of the FMC concept, as it is about how close functions are both in space and time (Moreno et al., 2021; Pozoukidou & Chatziyiannaki, 2021). This is what makes the concept fundamentally different than concepts focused merely on accessibility because that something is accessible does not mean that it is close.

As Pozoukidou and Chatziyiannaki (2021) explains: "FMCs intend to bring activities to the neighborhoods and not people to the activities...".

Diversity has two parts. First, the diversity in functions and second, the diversity in culture and people. Moreno et al. (2021) claim that these parts positively impact each other. They mention that a multicultural component creates a greater variety of products, making the area more diverse and attracting more customers, in turn creating job opportunities.

Digitalization is the dimension that aids in realizing the other dimensions of FMC. Data is used to improve decision-making about the urban environment. Furthermore, different digital platforms are used to assist citizens, such as bike-sharing apps or online citizens participation (Moreno et al., 2021).

### 3.4.3 Implementation of the 15-minute city

The implementation of the 15-Minute City is not meant to be rigid. After asking 120 experts, Pozoukidou and Chatziyiannaki (2021) concluded that:"...FMCs should not be interpreted as a strict system of urban development and planning standards; rather, they are a paradigmatic model for sustainably managing urban development and for thinking about cities." This statement is confirmed by the execution of the concept in different parts of the world. Paris, where the concept originated, aims for a 15-minute city. Other cities followed, such as Portland and Melbourne, aiming for a 20-minute city, each with a different strategy to acquire this goal (Pozoukidou & Chatziyiannaki, 2021).

## 3.5 Connecting EV infrastructure and the 15-minute city

No studies were found on the influence of FMC and EV infrastructure. Ajanovic and Haas (2016) do mention the relevance of multi-modal transport in that: “the final goal is not just to increase the number of EVs but to reduce emissions, cities have to consider also other e-mobility options such as trolleybuses, metros, trams and electro buses, as well as promote walking and biking, especially for short distances.”. One would expect more awareness of the inter-influence as FMC is based on the philosophy that the quality of urban life is inversely proportional to the amount of time invested in transportation, more so through the use of automobiles. Supporting

EVs seem to do the opposite and keep motorized vehicle infrastructure in place.

### 3.6 Conceptual framework

Now that relevant theories have been summarized, the literature review is concluded by explaining how the literature in this chapter is linked to answering the main research question. This is done with the conceptual framework visualized in figure 6.

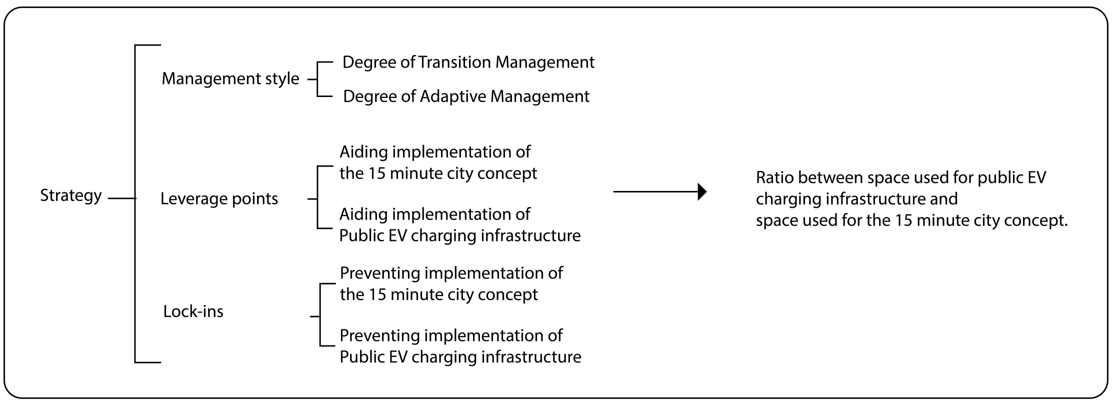



Figure 6: The conceptual framework (by author).

The main research question is:

What strategy changes are needed for the city of Utrecht to simultaneously supply the public EV infrastructure demand and to have implemented a ten-minute walking city in 2040?

The conceptualization of the word 'strategy' is key to answering the main research question. The strategy includes combining the strategies for supplying the EV infrastructure demand and creating a 10-minute city. The conceptual framework illustrates that 'Strategy' is a multi-dimensional construct comprising of different underlying variables. How each variable is organized determines the ratio between the space used for the 15-minute city concept and the space used for public EV infrastructure. In other words, the concepts underlying the construct strategy are the independent variables and the resulting ratio is the dependent variable.

Theoretical frameworks are applied to research the state of the dependent variables. The framework of Abson et al. (2017) is used to analyze leverage points and for the analysis of lock-ins, the framework of Seto et al. (2016) is used. No framework is used in determining the management style. Instead, the analysis is done based on the descriptions given in the literature on TM and AM.

Using the terms 15-minute city and 10-minute city might cause slight confusion. To clarify, the 10-minute city is a spatial strategy by the city of Utrecht that is adapted from the 15-minute city concept. Therefore, in the theoretical plane, the variable is called the 15-minute city. The theory is put into practice under a different name, being altered to the municipality's wishes.

# 4 Policy review

This policy review consists of a collection of different policy documents covering the public EV charging strategy and the 10-minute city strategy. The review aims to capture all the concepts that are part of the strategy as described in the conceptual framework in 3.6.

## 4.1 Public EV charging strategy

EV charging in the public domain is a crossroad of different policy fields. Utrecht has different documents forming a patchwork of relevant assumptions, analyses, wishes and rules for public EV charging. Out of this patchwork, all the relevant information for public EV charging is collected, which together is viewed as Utrecht's public EV charging strategy. Table 1 summarizes the relevant documents and policy fields.

Table 1: Policy fields and documents important to the public EV strategy.

| Policy field | Policy document | Publishing date |
|---|---|---|
| Charging infrastructure | Strategisch plan laadinfrastructuur | 10-2018 |
| | Plaatsingsleidraad en inrichtingskader publieke laadinfrastructuur | 05-2021 |
| | Plan laadinfrastructuur Utrecht 2030 v2 | 09-2022 |
| Parking | Aanpak parkeren openbare ruimte 2021 | 11-2021 |
| | Parkeervisie (na verwerking amendement) | 12-2021 |
| Mobility | Mobiliteitsplan 2040 | 07-2021 |
| | Monitor Mobiliteitsplan 2022 | 06-2022 |

### 4.1.1 A glimpse into the future: mobility in Utrecht in 2040

Utrecht is clear in its vision when it comes to mobility explained in 'Mobiliteitsplan 2040' (Utrecht, 2021a). The focus is on increasing walking, biking, public transport and shared mobility and decreasing the share of privately owned cars. Cars are facilitated in some sense by facilitating the shift from fossil fuel cars to electric. The ambition is not to let car use increase, even though the city will hold more citizens in the future.

The assumption is that when implementing the mobility plan, car traffic will not increase in 2040. The plan is to fulfill the increasing mobility demand with other modes of transport. Additionally, The municipality wants to have a less dominant appearance of the parked car in the public space. Even though major investments in public transport are planned, it is the question whether this assumption is realistic. From 2011 to 2021, the number of cars per 1000 residents was between 290 and 302. This means the increase in cars is rather consistent with the increase in residents. The city expects to have 455.000 residents in 2040 (Utrecht, 2021b). As mentioned in the introduction, the city now holds 361.000 residents. If this trend continues until 2040, with an additional 94.000 residents and around 300 cars per 1000 residents, the city will have to deal with around 28.000 new personal cars within the city.

The municipality expects to have a clear distinction in the future between cars with emissions and cars without emissions. This statement is highly debatable as the production process of electric cars and the needed batteries still have significant emissions. A study of van Gijlswijk et al. (2014) estimated EVs to have 130-160 CO2-eq/km. That is lower than the estimation for combustion engine cars with around 240-260 co2-eq/km, but there is still no evidence that the electric car will become a zero-emission vehicle. Low-emission vehicle seems to be a more fitting term.

**The modal split in 2040** The expected share of different modes of transport (a.k.a. modal split) is calculated separately for two neighborhoods (Leidsche Rijn and Vleuten-De Meern), scope 1, as compared to the rest of the city, scope 2. No reason is given for separating these neighborhoods, but this is probably because these areas are disproportionately more car-dominated than the rest of the city, making a total average unrepresentative.

For both scopes, two forecasts are done. One with and one without executing the mobility plan. The results are summarized in table 2 and table 3. In both cases, the share of car use goes down drastically. Peculiarly, the business-as-usual scenario in 2040 varies only slightly with the scenario with the mobility plan implemented. That is quite unexpected because the mobility plan includes significant measures for decreasing car use and stimulating other modes of transport.

Table 2: Modal split in the City of Utrecht, just for the neighborhoods Leidsche Rijn and Vleuten-De Meern (Utrecht, 2021a).

| | 2015 | reference 2040 | Mobility plan 2040 |
|---|---|---|---|
| Car | 60% | 54% | 53% |
| Bike | 29% | 33% | 33% |
| Public transport | 11% | 13% | 14% |

Table 3: Modal split in the City of Utrecht, except for the neighborhoods Leidsche Rijn and Vleuten-De Meern (Utrecht, 2021a).

| | 2015 | reference 2040 | Mobility plan 2040 |
|---|---|---|---|
| Car | 47% | 37% | 33% |
| Bike | 32% | 39% | 41% |
| Public transport | 21% | 23% | 26% |

**Expected share of E-mobility** Two forecasts are presented in the Mobility plan. One on the National scale and one for the city of Utrecht. On the National scale, it is said that 25% of all private cars will be 'zero-emission' in 2030. This share will increase every year by 5%, reaching 75% in 2040. Interestingly enough, 30% EV is the prognosis for private cars in 2040 in Utrecht. It is not stated why the difference between the share of 'zero-emission' cars on the national scale and EV cars on the city scale is so large. If the number of cars would stay the same as in 2021 (108.447), this would mean there will be around 32.000 EVs in Utrecht by 2040. If the amount of cars continues to rise as it has been over roughly the last ten years, there will be around 41.000 EVs in 2040.

**Public EV infrastructure forecasts** The 'Plan laadinfrastructuur Utrecht 2030'(PLU) (Utrecht Elektrisch, 2023) has the most up-to-date forecasts on the amount of regular charging points. A charging station has either one or two charging points. The expectations are that 4.600 charging points are needed in 2025 and 5.700 in 2030. Figure 7 shows a bar chart of their forecast. The forecast in the 'Strategisch plan laadinfrastructuur'(SL) (Kok, 2018) was much higher for 2030, expecting the demand to be 5.000 points in 2025 and 10.000 in 2030. The PLU explains this difference by the increasing size of batteries needing fewer charging sessions and that charging stations are used more efficiently when there is a higher density. These factors were not taken into account before.

They also present a forecast for fast chargers with a wider target group than expected in 2018. Short-stay locations such as shopping malls and sports facilities are also expected to have sufficient demand for fast charging. Figure 8 shows a bar chart of the amount of expected short-stay fast chargers over time, showing around 250 charging points in 2025 and 450 in 2030.

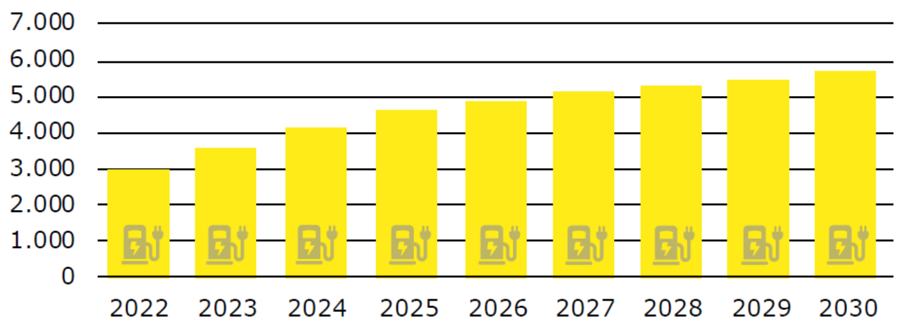



Figure 7: Forecast of the numbers of regular EV stations in Utrecht in different years(Utrecht Elektrisch, 2023).

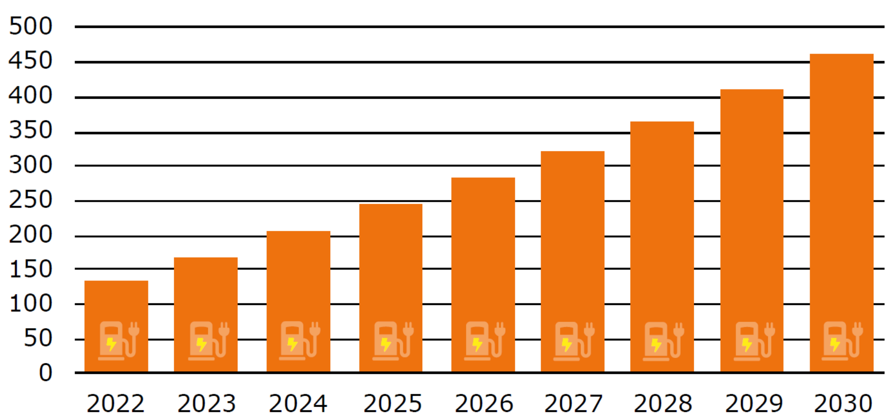



Figure 8: Forecast of the numbers of fast charging EV stations at short stay locations in Utrecht in different years (Utrecht Elektrisch, 2023).

The municipality mentions the uncertainty of the projections. The dependence on consumer behavior is especially highlighted. The share of charging demand fulfilled by fast charging and at the workplace varies widely in projections. Assumptions were made in this regard, but it is stressed that the city's approach should be adaptive to how charging behavior develops in the city (Kok, 2018).

**the effects of public EV charging** are discussed in the 'Parkeervisie' (Utrecht, 2021d). More E-charging stations mean fewer parking options for fossil-fueled cars in areas with high parking pressure. Also, it is stated that more charging stations will not result in more cars. They say that this is because an electric car replaces a fossil-fueled car.

The increasing pressure on the public space is highlighted in many of Utrecht's policy documents (Kok, 2018, 2020; Utrecht, 2021a, 2021c, 2021d). The quality of the public space is expected to become increasingly important as the housing density increases. The municipality is already finding out that E-charging is putting pressure on the space for parking, sidewalks and greenery (Kok, 2018). Increasing pressure on the public space decreases the support of citizens for the placement of charging infrastructure. The goal is to keep supplying the demand for public infrastructure whilst safeguarding spatial quality as much as possible (Kok, 2020).

Another effect might be that EVs will be used as batteries for stabilizing energy systems via public charging stations. This is only briefly mentioned in the 'Ruimtelijke strategies 2040' (Utrecht, 2021b). Many charging stations in Utrecht are bidirectional, meaning EVs can charge at peak moments and discharge at moments of energy scarcity. Non-municipal sources claim the municipality has the ambition to make Utrecht the first bidirectional city in the world (Company, 2021; Solar, 2021; Solutions, 2021). The municipality signed an agreement with several strategic partners, each committing to an important facet to make Utrecht the first bi-directional city (Solar, 2021; Solutions, 2021). This could have huge ramifications for the dependence on public charging infrastructure. The dependence on EVs for stabilizing the energy grid is a possible lock-in that should not be overlooked.

### 4.1.2 Understanding the status quo: measurements on mobility

Each year the mobility plan is monitored with indicators. The latest version of the 'Monitor Mobiliteitsplan' (Stumpel & van Weperen, 2022) has some indicators related to car use and EV infrastructure worth mentioning. These are summarized in table 6.

Table 4: Different indicators on cars that the municipality uses to monitor the 'Mobiliteitsplan' (Stumpel & van Weperen, 2022)

| Indicators | 2020 | 2021 |
|---|---|---|
| private vehicles per 1000 citizens | 295 | 302 |
| Number of shared cars per 100.000 citizens | 1461 | 1958 |
| BEVs (Battery electric vehicle) | 5143 | 7012 |
| Plug-in hybrid vehicles | 2100 | 2412 |
| % of residents with one or more EVs | - | 8% |

Table 5: Different indicators on EV charging that the municipality uses to monitor the 'Mobiliteitsplan (Stumpel & van Weperen, 2022)

| Indicators | 2020 | 2021 |
|---|---|---|
| charging stations per 1000 citizens | 7 | 9 |
| charging points total | 2463 | 3263 |

Table 6: Different indicators on parking that the municipality uses to monitor the 'Mobiliteitsplan' (Stumpel & van Weperen, 2022)

| Indicators | 2020 | 2021 |
|---|---|---|
| paid on-street parking spots | - | 36.676 |
| parking spots for shared cars | - | 500 |
| parking spots in parking garages | - | 4.719 |
| parking spots at P+R the edge of the city | - | 2.100 |
| parking spots for shared cars | - | 500 |
| parking spots at EV charging stations | - | 2.700 |

**A questionnaire on car parking** in 2021 found that 47% of the residents think there are just enough car parking spaces on the street near their own homes. A third find there to be too few and 8% too many.

Every two years, a random sample of Utrecht residents (18 years and older) receive an invitation to participate in the survey. The municipality asks for residents' opinions on many different topics, such as safety, mobility, housing, participation and culture.

Approximately 6,800 people completed the questionnaire. This allows the municipality to make reliable statements at the neighborhood and subdistrict level.(Monitor, n.d.)

#### 4.1.3 What about the measures: decreasing parking in the public space

Several policies have been implemented to have a less dominant appearance share of car parking in neighborhoods in Utrecht.

**Parking norms** Parking norms are decided per area. In earlier times, parking norms were formulated only as the minimum amount of parking spaces in an area per person. Utrecht decided to make the minimum parking norm the maximum parking norm at the same time. They motivate this decision by mentioning that each parking space is an extra reason to use the car instead of another mode of transport. On top of that, they reason that less space reserved for parking equals more space for other functions.

**Decreasing on-street parking** The Parking vision Utrecht, 2021a states that existing parking options outside of the public space are underutilized. Therefore, the city of Utrecht aims to decrease on-street parking yearly with 0.5% to 1% (Utrecht, 2021d). If they succeed and no new on-street parking is added, the number of on-street parking spots will drop from 36.676 in 2021 to 33.344 - 30.301 in 2040. This is between 6.375 (17%) and 3.332 (9%) parking spots less than in 2021, depending on the percentage that on-street parking is reduced yearly. They want to convert the freed-up space into other functions. The city's methods for decreasing on-street parking focus mainly on improving the use of existing parking options. The methods that they apply are (Utrecht, 2021d):

- More efficient use of existing parking spaces on the street and in garages.
- Stimulating car users to park in garages or at the city's edges.
- Stimulate alternatives for (private) cars.

**Paid parking** Paid parking is used in areas with a high density and pressure on the public space (Utrecht, 2021d). It is possible to introduce paid parking in areas with free parking with the intention of making unnecessary parking in the public space unattractive. The municipality recognizes that the income that is generated from paid parking makes it harder to remove parking spots. This income creates a lock-in in parking. If we follow the reasoning of the municipality, one more parking spot is one more reason to use the car, paid parking is a lock-in for car use.

#### 4.1.4 Public EV charging: Utrecht's four principles

Kok (2018) describes how Utrecht started working with four principles that are the basis for how e-charging infrastructure is arranged in Utrecht. These are:

- 1. Charging infrastructure will be rolled out in a data-driven manner;
- 2. Charging will take place outside public spaces wherever possible;
- 3. Charging in public spaces will be clustered where possible;
- 4. Public fast charging can play a role in relieving the burden on regular public charging points.

**1. Data-driven** The municipality outsources most of the process of finding, choosing and installing locations to a Charging Point Operator (CPO). Utrecht applied an 'application-driven' approach before this document was published. That means a citizen first filled out an application for a charging station. Secondly, the CPO checked per case if the request was valid and, if so, chose a fitting location. Thirdly, the municipality reviewed the case and if both parties approved, a new charging station was realized.

From the document of Kok (2018) onward, the municipality started using a 'data-driven' approach. Charging data is collected from existing public charging infrastructure. Examples of data are the degree of occupation and the kilowatt-hour usage of the charging stations. This data is analyzed and forms the basis for choosing where new charging stations are located.

Citizens can still submit applications. These applications serve as extra signals indicating where the demand is high. All the locations are chosen at once per neighborhood as part of the 'Wijklocatieplan'. Citizens get the chance to give feedback via neighborhood meetings and an online map. This feedback is used to make adjustments to improve the 'Wijklocatieplan'.

The data-driven approach made it possible to change the way the city rewards its

CPO. They used to reward the CPO for placing and exploiting charging stations. Now, the CPO is rewarded based on the extent to which the CPO meets the charging needs of EV drivers in Utrecht. In other words, they stopped rewarding the CPO for the means and started rewarding them for acquiring the overarching goal.

**2. Outside the public space** The municipality wants to increase the spatial quality of the built environment so preferably, charging infrastructure is not added to the public space. Charging outside of the public space in parking garages and business parking facilities is preferred for keeping spatial quality up to standards.

It is stated that in 2018 90% of EV charging was done in the public space. The municipality strives to have a more balanced network with around 40% of public E-charging and a larger role for charging plazas and fast chargers. Figure 9 is a forecast of how they expected the distribution to change from 2020 to 2025.

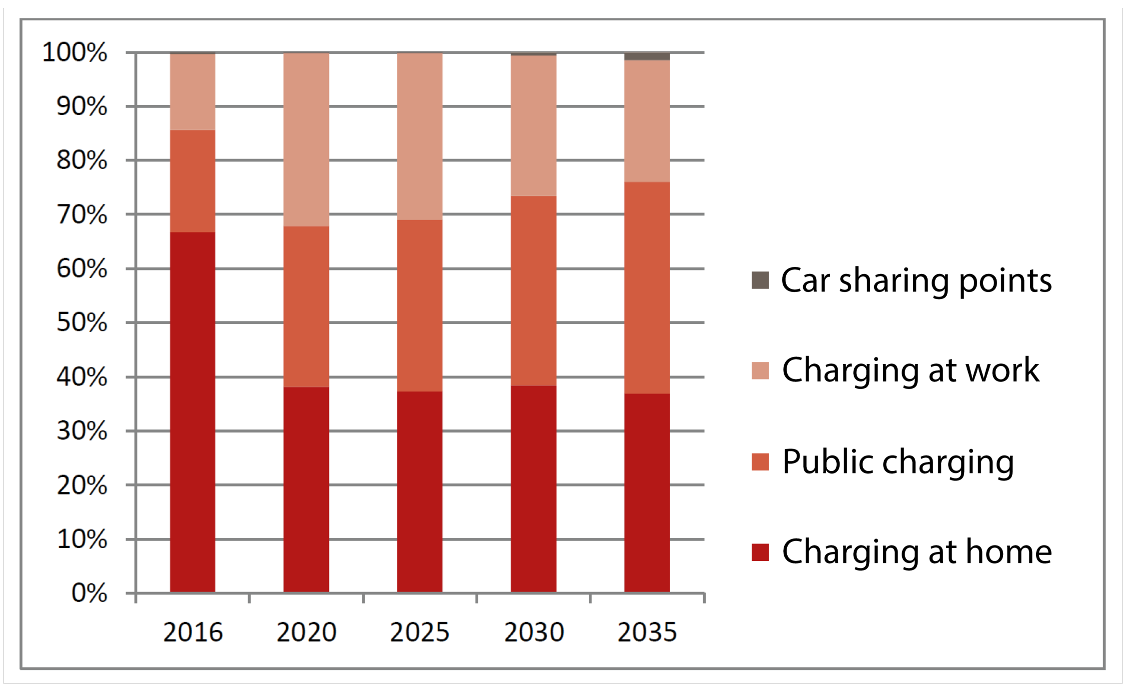



Figure 9: Forecast of where EV charging will take place over time (Kok, 2018). The legend was simplified and translated by the author.

**3. Clustering public charging** charging plazas are multiple charging stations coupled together. Numerous upsides are mentioned for charging plazas instead of scattered locations. These are:

- A more compact design
- Optional to choose locations with less parking pressure.
- Easier to expand with more charging stations.
- Possible to distribute power among charging cars.
- Room to provide space for car sharing and mobility hubs at these plazas combining different modes of transport.

**4. Fast charging as a relief** In 2018, The municipality expected that inner city fast charging would mostly serve frequent drivers such as cabs, busses and target group transport. These fast charging locations potentially decrease the pressure on regular charging stations. As noted earlier, this has been broadened to include short-stay locations.

#### 4.1.5 Public EV charging: Wishes and demands

Kok (2020) outlines wishes and demands for EV charging infrastructure. It includes rules that the concession holder, the CPO, needs to abide by. These rules focus mainly on how a charging location should be designed and arranged (E.G. signs, placement on the sidewalk, and dimensions). Allocating the charging stations within a neighborhood is described as a list of wishes instead of rules.

These wishes are:

- Outside of the public space
- Cluster charging stations
- Use already existing parking spots
- Place at least prominent facades
- Avoid monuments
- Charging stations have some form of back coverage
- Sufficient distance from crossroads
- Minimize sacrificing green space

- Supply short-stay locations solely with fast-charging

Next to wishes, stricter placement guidelines have been set up based on the quality levels of different areas around Utrecht. These quality levels were defined in the policy document “De kadernota openbare ruimte”. Three different quality levels are distinguished: ’Domstadkwaliteit’, ’Domstadkwaliteit bijzonder’ and ’Utrechtse Allure’. Within each of these quality levels, certain functions have specified guidelines for where charging stations are allowed to be placed. Appendix **??** shows the different guidelines per quality level. Locations with specified guidelines include parks, historic village centers and district shopping centers.

Fast charging in the city is expected to occur at destinations near stores and sports facilities, where people park briefly. (Utrecht Elektrisch, 2023).

## 4.2 10-minute city strategy

Currently, the 10-minute city strategy only consists of one policy document, which is the Spatial development strategy of Utrecht for 2040 (RSU), This sub-chapter summarizes the most relevant subjects that are in this document.

### 4.2.1 The vision for 2040: Utrecht closeby

The title of RSU is Utrecht closeby, the 10-minute city. The RSU is the leading vision document for the built environment and the title speaks on the importance of the 10-minute city concept in this vision. The expected cost of the RSU is 7,1 billion giving away the scale of the operation that is ahead. It is explicitly stated that the RSU is not a fixed design for a street or neighborhood but describes the city-wide values and indicative quantifications. The RSU is meant to keep the growth of residents in balance with green, jobs and other facilities, all with a fitting mobility infrastructure and in compliance with the ambitions for the energy transition.

### 4.2.2 City profiles: the values that shape the city

The city has different values they want to safeguard and implement into the structure of the city. These values are expressed in six so-called city profiles. Figure 10 shows the six city profiles the city focuses on. Most of these profiles are quite straightforward. The slow city might raise some questions from the reader. What the municipality means here is that the city should have places that are relaxing, help to discover the city and give room for adventure.

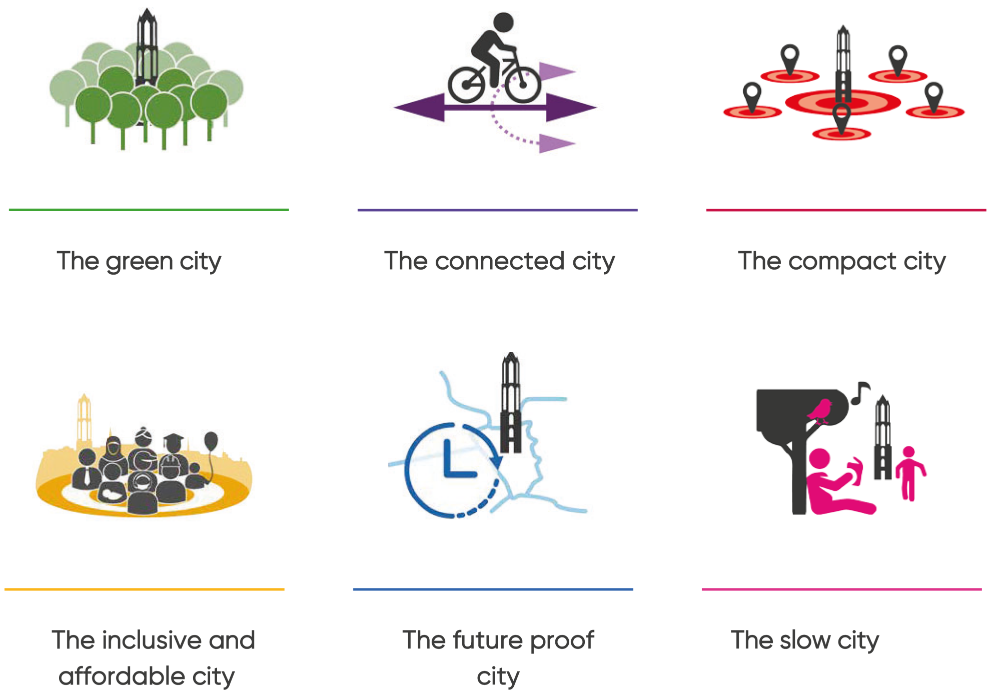



Figure 10: the six different city profiles (Utrecht, 2021b)

### 4.2.3 Proximity: the needs of residents as the starting point

An overview is given in figure 11 of all the functionalities that need to be within a ten-minute walking or biking distance from their residents according to the city of Utrecht.

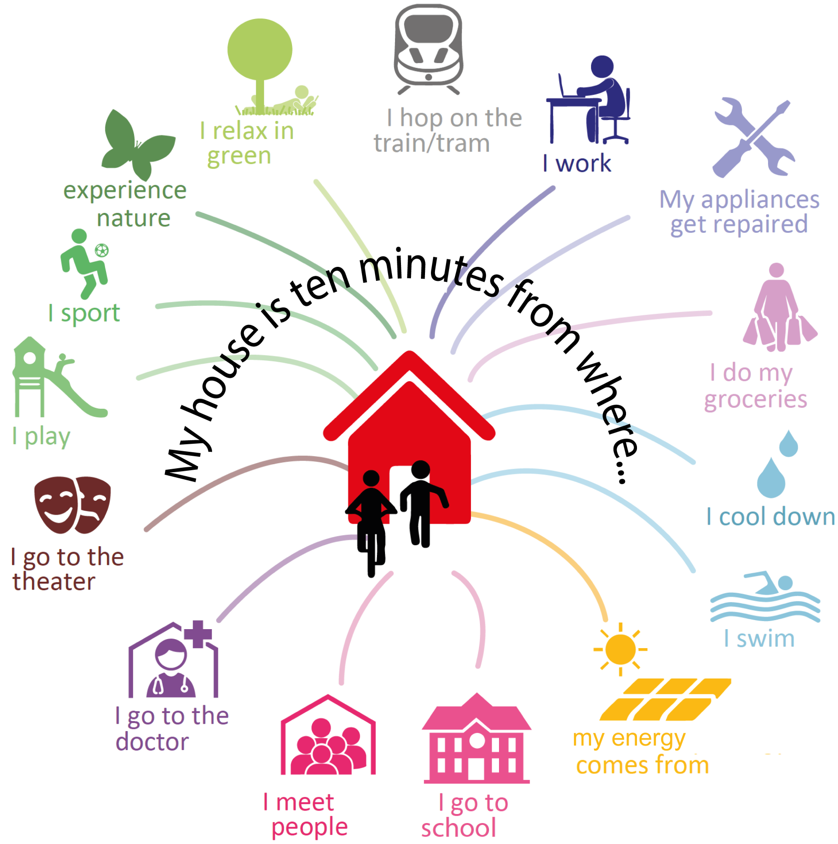



Figure 11: The different functions within 10 minutes walking or biking (Utrecht, 2021b).

#### 4.2.4 Shaping the 10-minute city: the barcode method

The barcode method translates all the functions a resident needs into how much m2 of each of these functions per 10.000 houses. Appendix A is a comprehensive overview of the barcode with all the assigned square meters per function. Notably, mobility is the only function with no square meters assigned to it. The large question mark in the figure seems to indicate that the municipality is unsure about the size that mobility should take up per 10.000 houses.

The RSU mentions the barcode does not apply to every scale and in some locations, it might not be possible to uphold the barcode standards. In these situations, insufficient functions will be compensated elsewhere in the city.

Special attention is given to an 'intelligent' use of space. Less space is needed on ground level when functions are combined. In figure 12 the difference between the barcode and the intelligent barcode is illustrated.


Figure 12: How space can be saved with intelligent configurations (Utrecht, 2021b).

### 4.2.5 Tactics: how to make the barcode work

Different areas require different tactics to acquire the set out square meters in the barcode. The municipality recognizes this and created four tactics, which are shown in 13

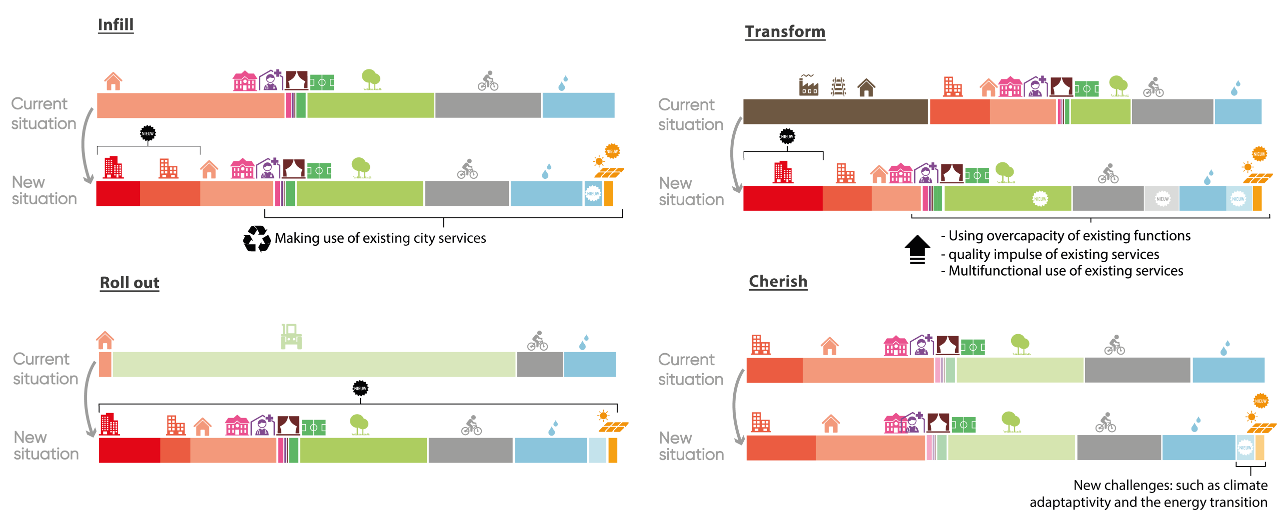



Figure 13: Utrecht's different tactics to get to a 10-minute city (Utrecht, 2021b).

### 4.2.6 shortcomings: understanding the extra dimensions

Even the intelligent barcode is still a simplification of reality. The municipality mentions four dimensions that are important for the barcode. These are:

- Space: some functions can be stacked on top of each other.
- Time: functions might be used for different purposes during the day or week.
- Use: One function might have the capability to fulfill another function at the same time.
- Proximity: That something is close in absolute terms does not mean it is also relatively close.

The RSU lists different ways to include these dimensions in their spatial strategy :

- Changing function
- Densifying
- Stacking functions
- Raise the quality of a function
- Locations with multi-functional uses
- Smart organization of space in the city

### 4.2.7 Densification: a multi-centered approach

The city council decided to densify the city in a specific order. Figure 14 shows this order. Densification and the 10-minute city are intertwined in the strategy of Utrecht. The city aims to create multiple city centers instead of one. Each city center will have a high concentration of functions that should be close to every resident. A future vision is shown in figure 15.

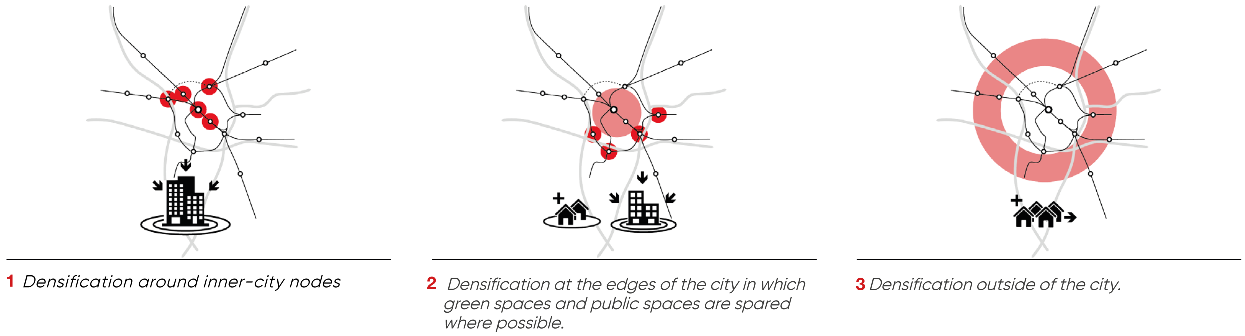



Figure 14: The order in which the city of Utrecht wants to densify (Utrecht, 2021b)


Figure 15: Envisioning Utrecht with different city centers (Utrecht, 2021b).

# 5 Results

## 5.1 Policy analyses

Several analyses are done using the policy review to understand the strategy for supplying EV demand and realizing the 10-minute city. This chapter contains these analyses. These are the stakeholder analysis, management style analysis and the lock-ins and leverage points analysis.

### 5.1.1 Stakeholder analysis

The policy documents give insight into the stakeholders who have a stake in the 10-minute city and/or public EV charging. Table 7 is a list of these stakeholders, what their function is and what stake they have in these strategies. The municipality is mentioned twice with different departments to divide its variety of stakes to some extent. Even these departments are still very big, with the 'Ontwikkelorganisatie Ruimte' having over 700 employees (Utrecht, 2022). These large departments are expected to have many sub-departments with different stakes, sometimes even with interests that contradict each other. Unfortunately, these are hard to capture within the time frame of this research.

The choice was made not to mention residents as one stakeholder but to differentiate residents into the different types of users in the public space. This makes their stakes more clear-cut, although, in reality, residents are much more complex with different opinions.

Just We Drive Solar is the only mentioned car-sharing company that is mentioned even though it is not the only car-sharing company in Utrecht. What makes them unique as a stakeholder is their involvement in pilots for testing discharging. Their knowledge position makes them a more powerful stakeholder than other car-sharing initiatives. Figure 16 shows each stakeholder's power and interest position. Each of the four combinations of power and interest gives a tactic for managing each stakeholder.

Table 7: Stakeholders identified to be involved in the EV and 10-minute city strategies (by author).

| **Stakeholder** | **Function** | **Stake** |
|---|---|---|
| Municipality: Ontwikkelorganisatie ruimte | Spatial development, except real estate. | Increasing the quality and quantity of the public space under increasing density. Contribute to becoming a zero-emission city. Creating a 10-minute city. |
| Municipality: Financiën, Inkoop en Juridische zaken | Financial aspects, such as paid parking. | A healthy financial balance of the municipality. |
| CPO: Equans | Realisation and exploitation of charging stations. | Make a profit on charging stations. |
| Grid operator: Stedin | Operate the grid. | Keep the energy grid stable. |
| We Drive Solar | Car sharing service. Involved in Pilot for discharging EVs. | Make a profit on car sharing. |
| EV drivers | N.A. | Have the ability to charge and park the cars (close to home). Have roads to use their car. |
| Fossil fuel car drivers | N.A. | Keep the ability to park the cars (close to home). Have roads to use their car. |
| Pedestrians | N.A. | Have sidewalks to walk. Have places to rest. |
| Cyclists | N.A. | have the ability to park their bikes (close to their home). Have cycling lanes to use their bike. |

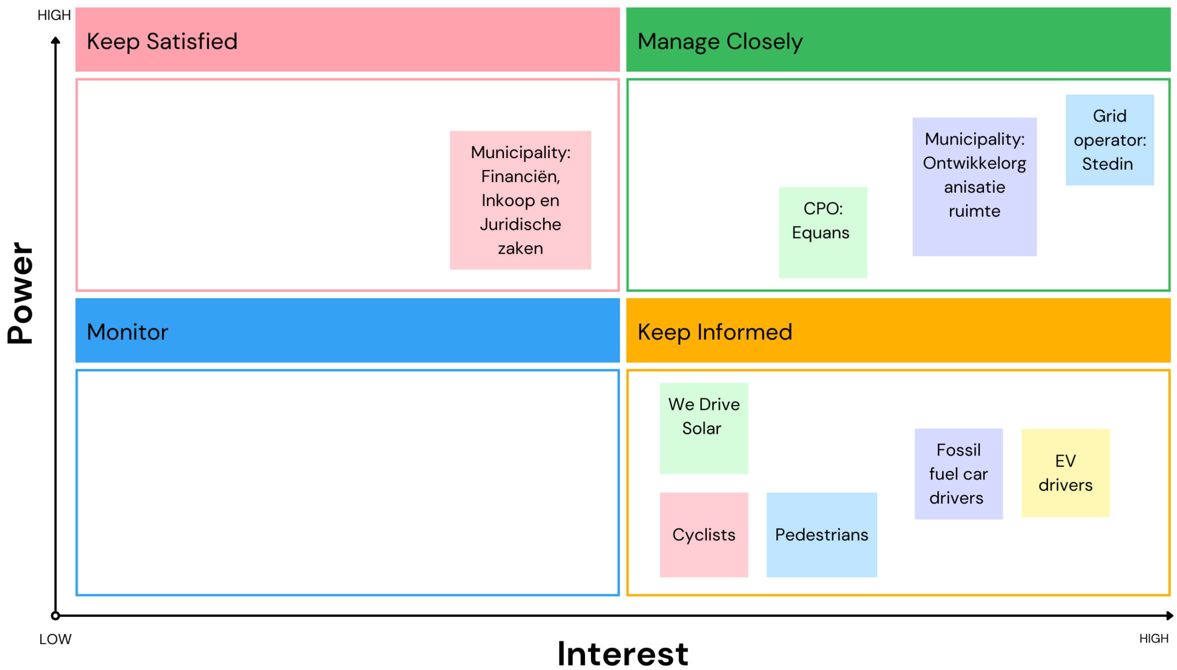



Figure 16: Stakeholders categorized by interest and power both for the 10-minute city and public EV charging (by author).

### 5.1.2 Management style analysis

The management styles used in the public EV charging strategy and the 10-minute city strategy are not simply put in a box of transition management or adaptive management. Each of the two strategies applies a degree of transition management and adaptive management. It is better explained as a scale where the public EV charging strategy is more on the side of adaptive management and the 10-minute city more on the side of transition management.

The reasoning behind the locations on this scale is as follows: The 10-minute city strategy has a clear end goal of becoming a 10-minute city in 2040. The barcode indicates the quantity of space that is needed to accomplish this under different circumstances. These are traits of TM. Still, the strategy has adaptiveness built in by looking at each unique context differently and not holding on to the given quantities when it is not possible.

The public EV charging strategy does not have a clear end goal but is also not entirely adaptive. The charging locations until 2025 have already been decided on. This is more done to keep the pace of keeping charging locations up to speed rather than having this amount of charging stations as a goal by itself. New locations are only realized if the data shows there is enough demand. If the need arises, the municipality can easily lower or increase the amount of charging stations they aim to realize, giving this strategy a highly adaptive character.

### 5.1.3 Leverage points and lock-ins analysis

Now that all the relevant policy documents have been analyzed, the question remains what leverage points and lock-ins can be derived from these documents. Even though sometimes a policy can be categorized as multiple leverage points, the choice was made to assign each policy to only the most fitting leverage point type. Appendix C summarizes the identified policies and the type of leverage point per systems characteristic. What stands out is that Utrecht is already implementing 22 leverage points to steer away from a car-dominant city towards a 10-minute city where, in theory, each citizen can live a happy and healthy life.

Figure 17 shows the number of policies per leverage point type. Leverage point 10.: "The structure of material stocks and flows" is the most frequent type. This makes sense, as this leverage point is about changing the physical structures in systems. When altering the physicalities of the built environment, this is the leverage point that applies. Secondly, leverage point 6.: "the structure of information flows", is noticeable in the usage of forecasts and the communication of wishes by the municipality. Closely related is leverage point 5.: "Changing the rules of the system". Both wishes, forecasts and rules are used frequently in Utrecht's policies. Lastly, the city has clear goals as leverage points, indicating leverage point 3.: "The goals of the system". A caveat is placed here, as the goals of the municipality are not necessarily the goals of the entire system. Still, the municipality plays a major role in city planning and is therefore a leading factor in establishing system goals.

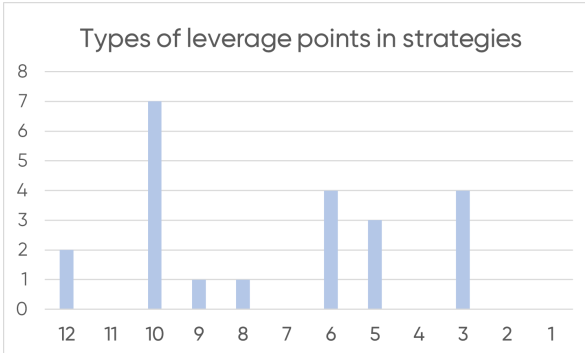



Figure 17: Number of policies per leverage point type (by author).

Figure 18 shows the policies per system characteristic. Parameters and design are the most frequently addressed characteristics. Figure 19 gives the policies per type of change. Interestingly, the amount of policies regarding deep change is the same as those targeting shallow change. Judging from the policy analysis, the municipality has a balanced approach, applying easier methods with a smaller effect and more difficult methods with a bigger effect.

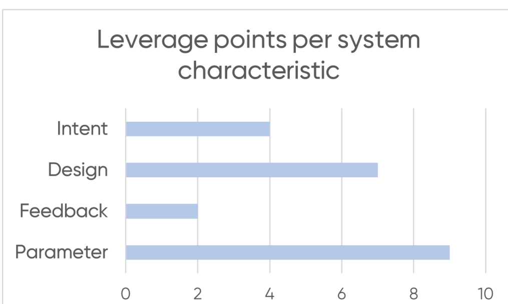



Figure 18: Number of policies per system characteristic (by author).

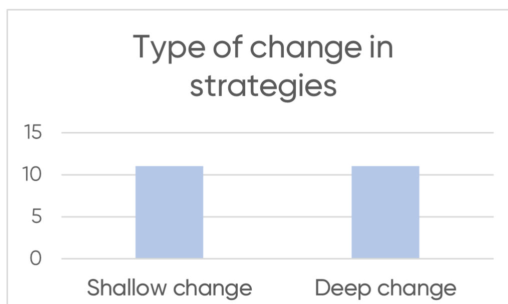



Figure 19: Number of policies per type of change (by author).

Next to the leverage points the municipality implements, two lock-ins have been identified that inhibit the city from its goals, such as a ten-minute city and a less car-dominated public space. Table 8 shows these lock-ins and their lock-in type. Paid parking is an organizational lock-in because it incentivizes the municipality to keep parking spots to continue generating income. The municipality recognizes this lock-in (Utrecht, 2021d). Paid parking is both a leverage point and a lock-in for decreasing parking in the public space.

EV discharging is a lock-in as a dependency on EV discharging means the public EV infrastructure needs to be kept in place to have a stable grid. This increases the difficulty of replacing parking spots with charging stations for other functions that are useful for becoming a 10-minute city. The potential of this infrastructural lock-in is not mentioned in any policy documents. EV discharging is a leverage point for a stable and sustainable energy grid, but possibly a lock-in for reaching the requirements of a ten-minute city. The severity of this lock-in depends on how much EV charging infrastructure will be necessary to supply the EV demand and how much is needed to secure the stability of the energy grid. Another option is using car batteries is an 'in-between' solution for grid stabilization. Ultimately, it all depends on how much additional space is needed to create a 10-minute city. The more additional space is needed, the more inhibiting factors in the spatial realm start to become lock-ins that need to be considered.

Table 8: Identified lock-ins and their types (by author).

| Lock-in | Lock-in type |
|---|---|
| Dependence on EV discharging using public charging stations for stabilizing the energy grid. | Infrastructural |
| The incentive for the municipality to keep paid parking for income. | Organizational |

### 5.1.4 City level: conclusions

The policy documents of the city of Utrecht show a progressive approach to mobility and spatial planning, blending adaptive management and transition management in their strategies. The city wants to change the design of the city from one that is car-dominated to one where walking and cycling come first, public transport comes second and cars in last place. EVs in this hierarchy get special treatment to reduce emissions faster. The municipality has developed the barcode method to quantify the 10-minute city. All functions have been quantified, accept for mobility, which is the function that this research focuses on.

Some assumptions the municipality makes in their policy documents are important to keep an eye on as they could greatly affect how the city will be arranged. The first assumption is that in the future there will be a clear distinction between emission and zero-emission vehicles. EVs are not zero-emission and believing they are might make their role in future mobility larger than it should be, simply replacing a large fraction of fossil fuel cars with EVs.

An assumption that still has to prove itself is that car traffic will not increase until 2040. The past has given no reason to expect this to happen.

Another assumption the municipality makes is that the city will have a 30% share of EV cars in 2040, while the national average is expected to be 75% in 2040. This 45% gap can have huge implications for the built environment and the plans for a 10-minute city.

The city has 22 leverage points in place, with a balance of deep and shallow ones. Special attention should be paid to the lock-ins in parking and discharging. The identified lock-ins make removing charging stations and parking locations harder, ultimately increasing the difficulty of less car-dominated neighborhoods.

In short, the city is working hard to create a sustainable city and a 10-minute city, but some assumptions might be shedding an overoptimistic light on the goals the municipality has formulated.

## 5.2 Case study Utrecht Noordwest

### 5.2.1 Study area

Utrecht is divided into ten districts. Utrecht Noordwest is one of these districts, spanning an area of 453 hectares and containing 24431 houses (Utrecht, 2023). Figure 20 shows a map of Noordwest. The average household size is 1.8 persons (Utrecht, 2023). Similar to the districts Utrecht Noord and Utrecht centrum (the city center), Noordwest is characterized by the high degree of buildings and paved surface area compared to the rest of Utrecht. Noordwest was chosen as the study area because it has a high degree of housing and a low degree of land used for industry purposes compared to Utrecht Noord. Industry areas have a higher percentage of private car infrastructure, making GIS analyses more difficult to conduct.

Figure 20: Satellite image of Utrecht Noordwest (Esri, 2023).

### 5.2.2 Public EV charging

Public EV charging stations require electric cables to function. Regular charging stations need low-voltage cables and fast charging stations need medium-voltage cables. Figure 21 is a map with the locations of low voltage cables and the locations of residential parking to analyze how well these cables are situated to place new charging stations. The map illustrates that there are a lot of parking locations where charging stations are technically viable due to the excellent coverage of low-voltage charging cables.

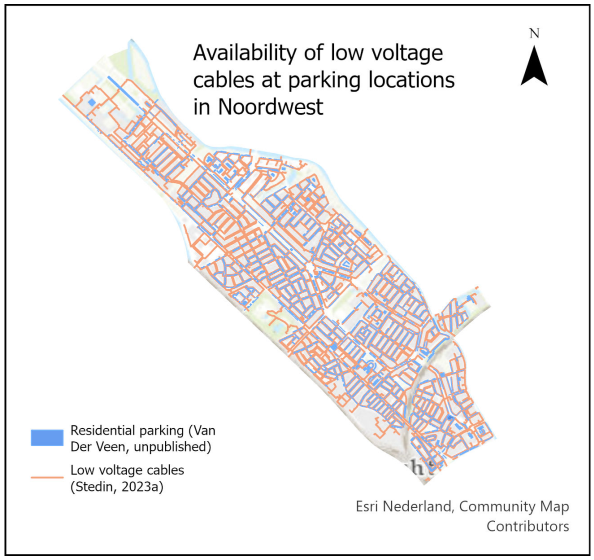



Figure 21: Map showing the availability of low voltage cables at public parking locations (By author).

Currently, there are 191 operational charging stations, 48 are in development and 109 are marked as potential locations. No fast chargers are currently in operation. Six of the 48 locations in development are fast chargers. These locations will be spread out around Noordwest as is laid out in Figure 22. The figure also shows the distribution of medium-voltage cables. There are fewer of these cables than low-voltage cables but they are still plentiful.

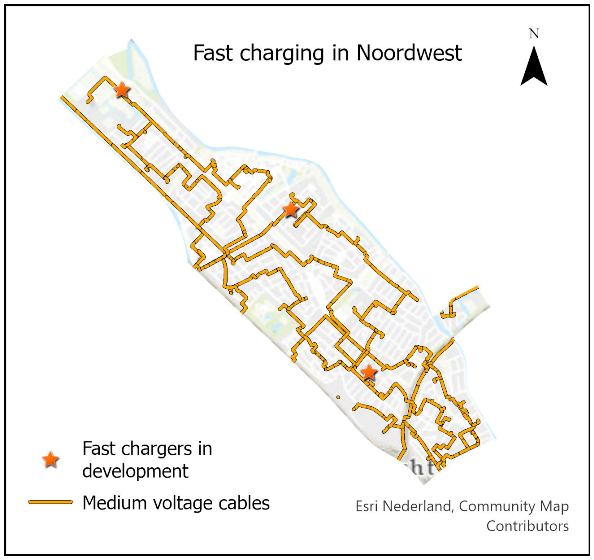



Figure 22: Fast-charging locations in development in Utrecht Noordwest (by author).

The operational charging stations currently use around 6180 m2 of parking space. The average used parking space per charging station is 27 m2. 0.1% of the land area is currently occupied for public charging. Figure 23 shows the distribution of charging stations throughout Noordwest. Noticeably, the charging stations are distributed throughout the neighborhood.

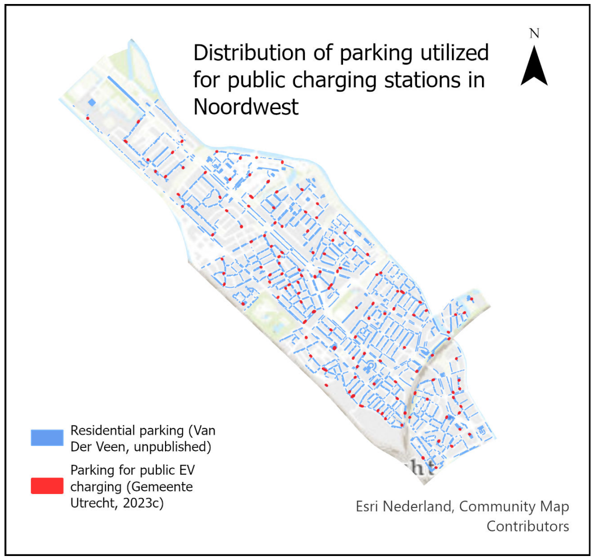



Figure 23: Map showing the distribution of public charging stations in Utrecht Noordwest (By author).

Using the expected population growth, car ownership in Noordwest and the expected share of EVs in 2040, an estimation is made of how much charging stations will be needed in 2040. Around 1500 charging stations are expected in 2040 when no technological advancements are made and fast charging stations are not utilized for residential charging. It is more likely that the amount will be lower, considering technical innovations are quickly evolving. Therefore, it is assumed that the influence of technological innovation will result in 25% fewer needed regular charging stations. Using these assumptions, 1100 charging stations are needed in 2040 in Noordwest. That is an increase of more than five fold of the charging stations that are currently operational. This would require roughly 30.000 m2 of parking space for public EV charging. This is 0.6% of the total area of Noordwest. This number can be lowered if fast charging is set out to play a bigger role in residential EV charging.

### 5.2.3 the 10-minute city

Each citizen has a unique 10-minute city barcode based on where the citizen lives. Figure 24 and 25 show how different the functions are that citizens can reach by cycling and walking, respectively. For some, the city center is within biking reach, having more job opportunities, while others are more on the city's outskirts, having easier access to green facilities. This is not represented in the results because the study area has been set to the borders of Noordwest. Still, Noordwest is a substantial part of most of these residents' cycling and walking 10-minute barcode.

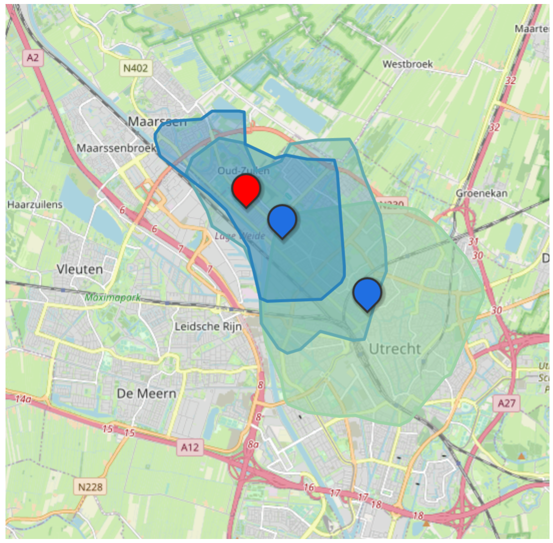



Figure 24: Map showing the 10-minute biking radius from three houses in different parts of Utrecht Noordwest (Open Route Service, 2023).

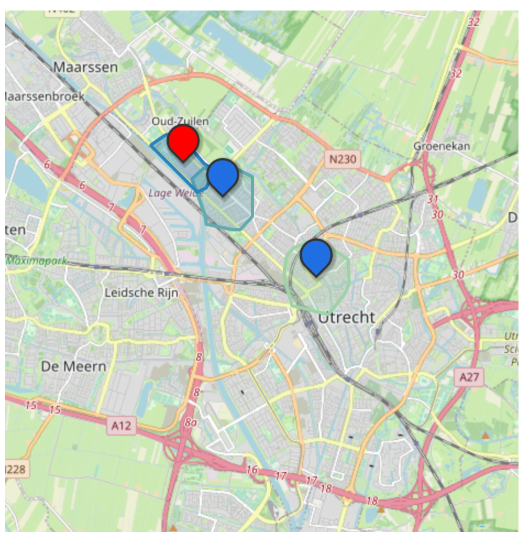



Figure 25: Map showing the 10-minute walking radius from three houses in different parts of Utrecht Noordwest (Open Route Service, 2023).

The guidelines for the square meters per function are set out in the barcode per 10.000 houses. These numbers were converted to the number of houses in Noordwest in 2023 and the number of houses expected by the municipality in 2040. These numbers were compared with the square meters per function currently in Noordwest.

Figure 26 and figure 27 present the data on to what extent the barcode for the present houses is satisfied within Noordwest. The results show that only culture has more square meters than indicated in the barcode. All the other functions are not close to satisfying the indicated square meters in the barcode. The shortage in hectares for all functions is 56% (2034 hectares) in 2023 and 61% (2490 hectares) in 2040.

Figure 26 also shows that housing and infrastructure take a disproportionately high share of space in the district. Infrastructure takes up 18.7% of the district area. 93.3% of infrastructure consists of car roads and parking spots. If the policy to reduce parking by 0.5-1% is successfully implemented from 2023 to 2040, between 0.3% and 0.6% of the land area of Noordwest will be freed to be used for other purposes. This is 0.5% of the square meterage still to be satisfied to reach the 2040 barcode.

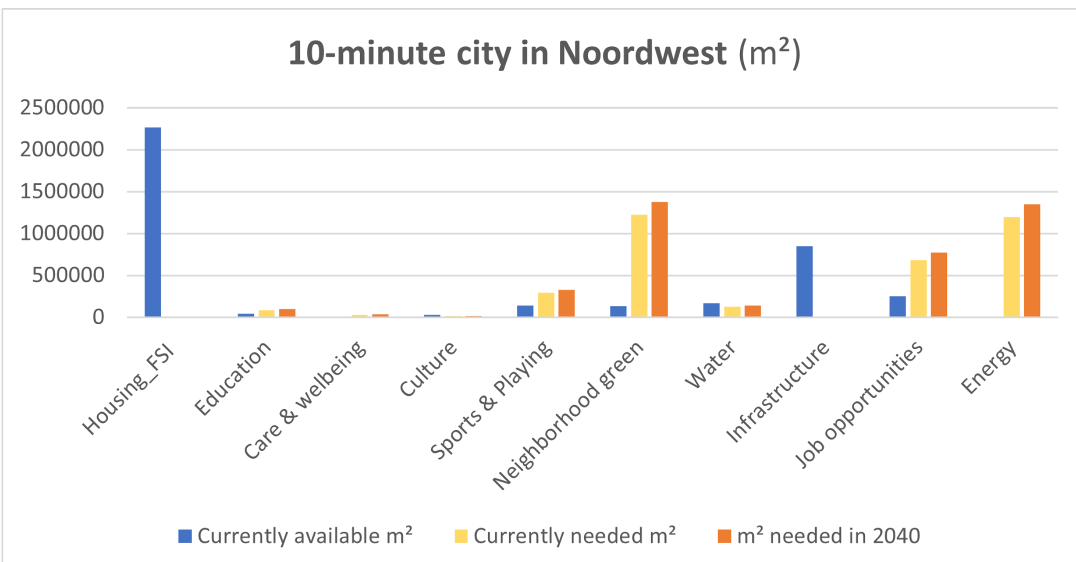



Figure 26: Level of satisfaction of barcode in Noordwest expressed in square meters (figure by author. data source: (Gemeente Utrecht, 2023a)).

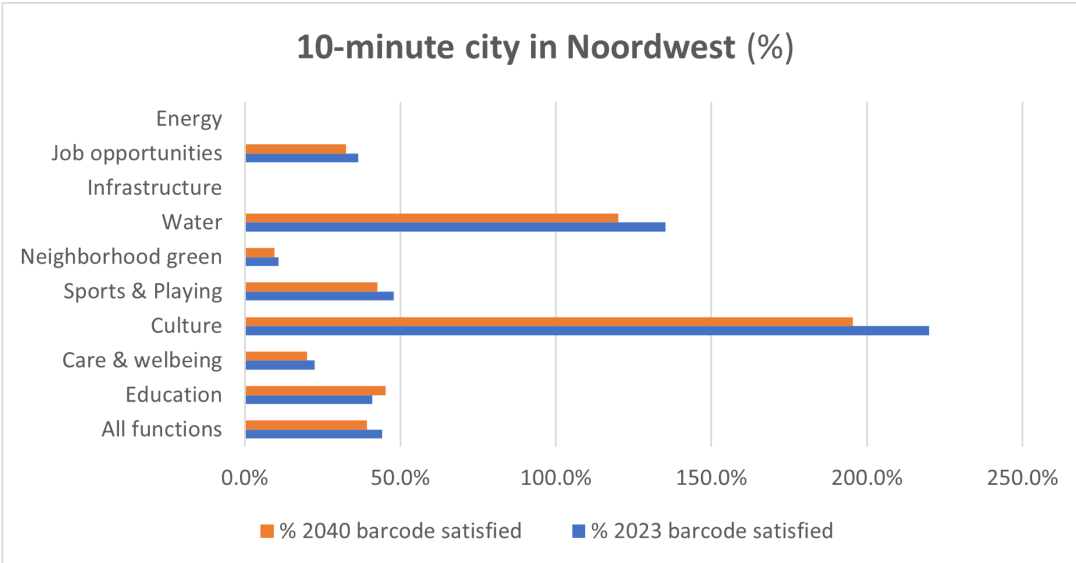



Figure 27: level of satisfaction of barcode in Noordwest expressed in percentages (figure by author. data source:(Gemeente Utrecht, 2023a)).

### 5.2.4 District level: conclusion

The GIS analyses show that Utrecht Noordwest has more favorable conditions for placing charging stations and less so for adding functions for the 10-minute city. The district has nowhere close to the functions set out in the barcode. Although the barcode is more a guideline than a blueprint, it is clear that the district still has a long way to go. As much of Noordwest is occupied with either housing or mobility, it is difficult to envision how 10-minute city principles will be applied to the current typology of the area. Either housing needs to be facilitated with more high-rise constructions or car infrastructure needs to take on a less dominant role in the district. All of which have their implications.

Whether it is possible to decrease car infrastructure depends on the role of the car in the modal share within Noordwest. The rise of EVs and the required charging stations hamper a mobility transition towards more walking and cycling. Moreover, charging stations decrease the chances of becoming a 10-minute city the main reason being that Charging stations are already spread throughout Noordwest and many more are needed to satisfy the rapidly growing demand. The distribution brings comfort to the EV user, but on the other hand, makes it harder to remove car infrastructure in parts of the district and use this space for other purposes.

In short, the danger is that EV cars slowly take over the space used for fossil fuel cars, making it much more difficult to transition to a 10-minute district. Noordwest illustrates that this potential lock-in is real and should be accounted for in policies for public EV charging and the 10-minute city.

## 5.3 analyses stakeholder meetings

Two analyses were derived from the stakeholder meetings: the strategy ideation analysis and the strategic behavior analysis. The strategy ideation was formed by an open discussion on the possibilities of alternatives to prevent carbon lock-in by EV charging. The meetings also gave insights into the strategic behavior of the stakeholders under different future scenarios.

### 5.3.1 Strategy ideation analysis

The ideation session was aimed at creating a 10-minute city in combination with supplying the demand for public EV infrastructure. The correspondents suggested new spatial layouts, which all incorporated the concept of mobility hubs instead of in-street parking. Different types, sizes and placements of these hubs were suggested, summarized in table 9. These scenarios are a simplification to be able to tell the categories apart. These alternatives do not exclude each other and can be combined in the spatial realm to any degree that is suitable for its users.

| **Scenario** | **Description** |
|---|---|
| Business As Usual | Expanding in districts based on kWh usage data. |
| Alternative 1 | Centralized parking hubs at the edges of the city. |
| Alternative 2 | Centralized parking hubs at the edges of the city districts. |
| Alternative 3 | Centralized parking hubs at the edges of (busy) streets. |

Table 9: The scenarios derived from the ideation session with stakeholders (by author).

All the correspondents stressed the consideration of the citizens in transforming existing urban areas. The correspondents have doubts about how far a citizen is willing to walk or bike from a hub their their house. Still, examples are mentioned by the officials of places where traveling by foot or bike to a car is not uncommon either by design or because there is no other alternative.

Giving something back for removing the luxury of having a car close to home was a recurring theme. To do so, residents should be part of a common vision, possibly being stimulated by small initiatives to become interested in larger plans. Increasing functions in and around their streets should be the intention for decreasing on-street parking. Not solely removing but replacing with functions for a healthy and happy life. For this replacement, a gamified approach is suggested, involving citizens in what should be the replacement for the parking spots that will be removed.

Currently, the principal public EV charging placement in Utrecht is charging follows parking. So if parking is not done in neighborhoods anymore, charging will follow. To ensure the longevity of charging stations, urban planners are already involved in advising on what parking spots are least likely to be removed over time. Still, a more integral approach involving all parties responsible for improving the public space is suggested, also speaking of a 'street barcode'. In other words, an integrated approach is needed for a viable mobility plan for realizing the 10-minute city barcode.

All the suggestions from the ideation session are considered to be in the category of deep leverage points focusing on changing design and intent.

### 5.3.2 Strategic behavior analysis

The original intention was only to analyze strategic behavior for the expected result that came out of the research (business as usual). However, strategic behavior is dynamic and depends on what scenario is chosen. With this reasoning, the presented alternatives by the stakeholders are analyzed too. The 3D stakeholder grid categorizes the strategic position of the interviewed stakeholders. The definitions of the 3D stakeholder grid categories can be found in appendix G. Each colored block represents one of the eight categories. The paragraphs are divided into scenarios: business as usual and alternative A, B and C.

**Business as usual**

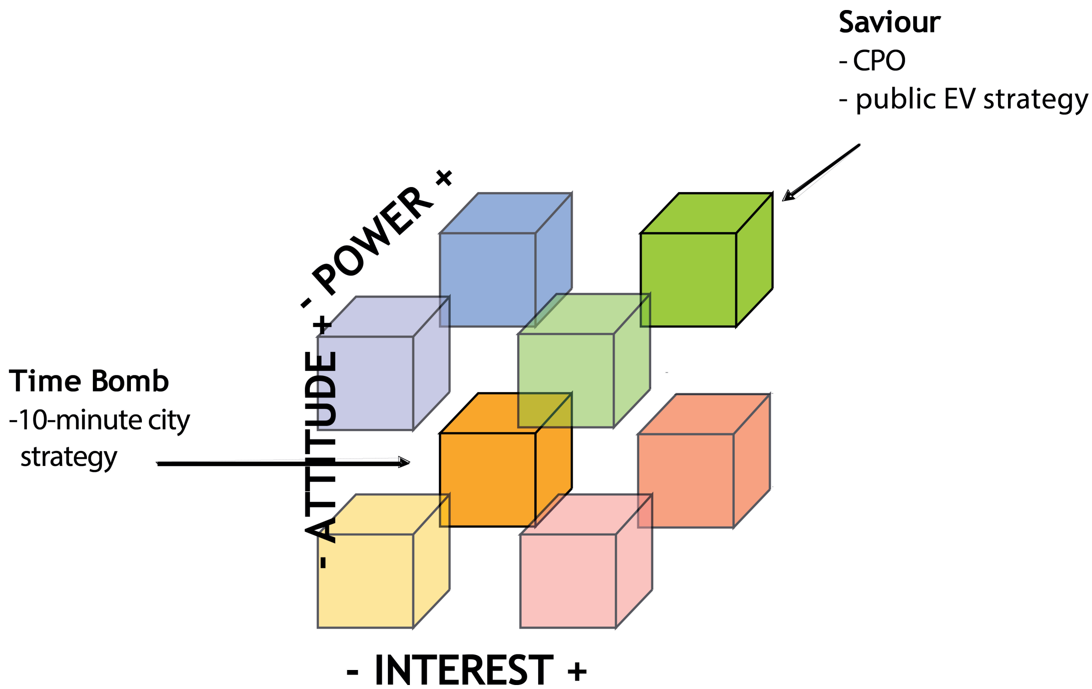



Figure 28: Business as usual: strategic behavior of stakeholders if charging stations will keep their dispersed nature in neighborhoods (Figure made by author inspired by Murray-Webster and Simon (2007)).

Figure 28 gives an overview of the strategic behavior in the business-as-usual scenario. The current EV approach is designed to be prepared for a growth in demand and to be close to residents. The CPO and the Public EV strategy therefore reinforce each other in the business-as-usual scenario. The 10-minute city strategy is still in development, even more so for mobility and is not yet in the phase of implementation on the district level. Therefore, their interest in the public EV strategy is low. However, once the barcode needs to be implemented and the scarcity of space becomes apparent, the 10-minute city strategy can become a blockade to continuing business as usual. The CPO is willing to apply a different strategy for the placement of public EV charging stations and move already placed infrastructure, but will only do so through a gradual approach with a risk versus reward ratio that they deem to be acceptable. This will not be possible if the 10-minute strategy is too late in recognizing the impact of public EV charging stations at in-street parking locations. The CPO will block initiatives if the measures have to be taken all at once posing too much of a risk for profitability.

**Alternative A**

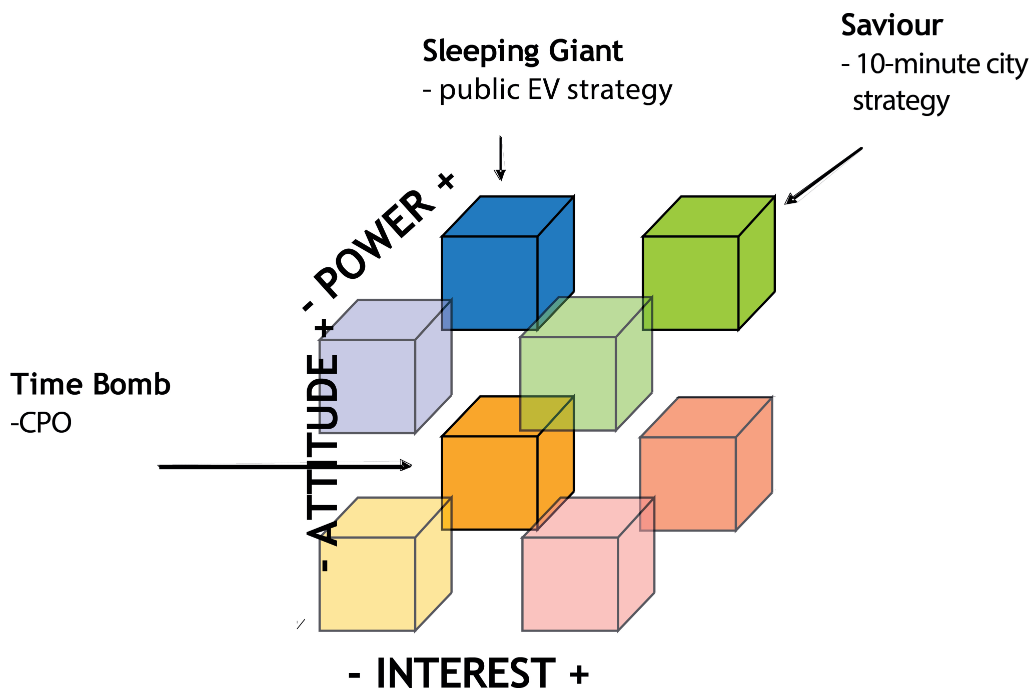



Figure 29: Alternative A: strategic behavior of stakeholders with centralized hubs at city edges (Figure made by author inspired by Murray-Webster and Simon (2007))

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Figure 29 gives an overview of the strategic behavior in the alternative A scenario. CPO is a time bomb in all alternative scenarios as they do not care about how charging infrastructure is implemented as long as the business case is good. If the 10-year contracts are breached for relocation the CPO can prove to be a timebomb if the impact on the overall business is too great. The more gradual the approach the less of a time bomb the CPO will be.

The public EV strategy is a sleeping giant. The philosophy is charging follows parking, so if parking is not realized in centralized hubs, the public EV strategy will not start placing it here. Still, the position of the public EV strategy is powerful. It can steer the rollout of public EV infrastructure with the design of concessions.

The 10-minute city strategy does look at the city scale and is more inclined to use citywide solutions and has a higher stake in the placement of car infrastructure.

**Alternative B**

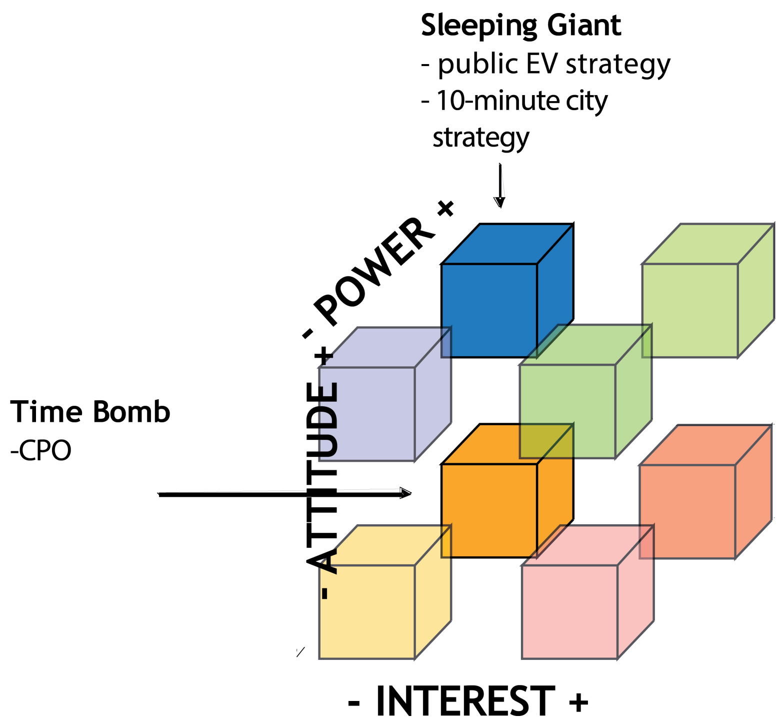


Figure 30: Alternative B: strategic behavior of stakeholders with centralized hubs at district edges (Figure made by author inspired by Murray-Webster and Simon (2007))

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Figure 30 gives an overview of the strategic behavior in the alternative B scenario. Both the public EV strategy and the 10-minute city strategy are sleeping giants in this scenario because both are positive towards this development but are not used to developing district-scale centralized parking with a focus on replacing freed parking space with other functions. Both are positive about such a development, but a more integral approach is needed in collaboration with other municipal departments to make this happen. Also, somebody within the municipality needs to become responsible for the implementation of this new way of working on converting both strategies from sleeping giants to saviours.

**Alternative C**

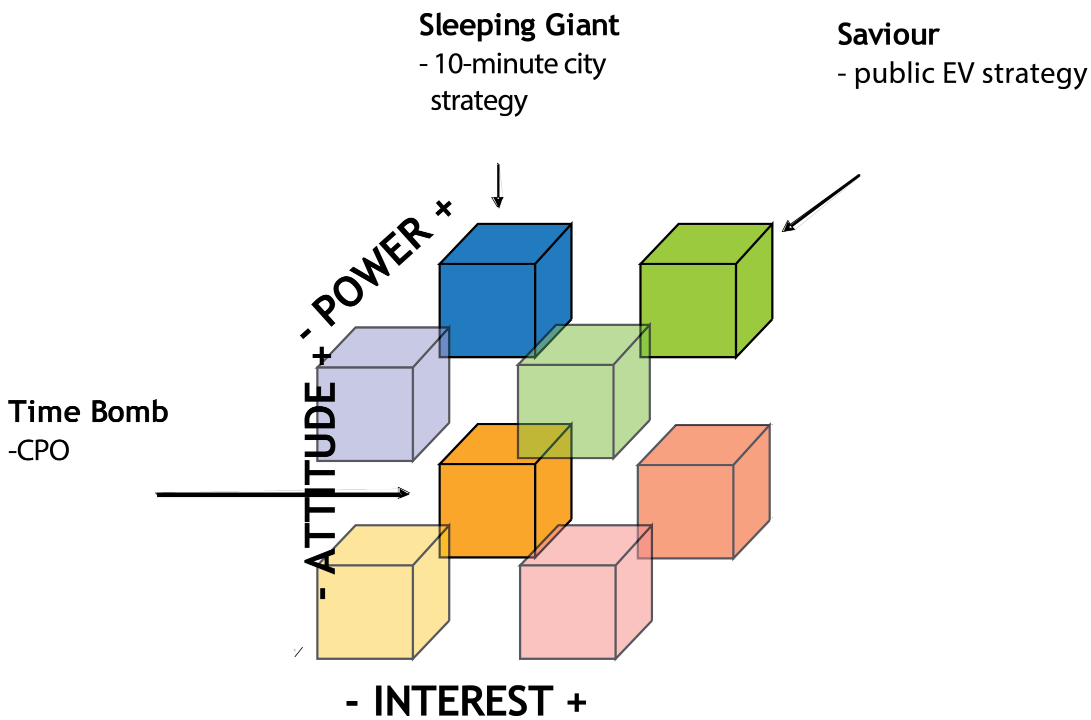


Figure 31: Alternative C: strategic behavior of stakeholders with centralized (car sharing) hubs at street edges (Figure made by author inspired by Murray-Webster and Simon (2007))

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Figure 31 gives an overview of the strategic behavior in the alternative C scenario. Here, public EV strategy is a savor as they are used to think about implementation on a street level, looking at what places in the street are best to place infrastructure. Moreover, EV policy is also in favor of stimulating EV use through the convenience of proximity.

Again, the 10-minute city strategy is still in development and is not yet ready for application on a street level. That does not mean that this will not change in the future.

### 5.3.3 Behavior: conclusion

Noticeably, the improved strategy through collaborative ideation is multi-faceted:

1. A more integral process for alterations of existing public spaces
2. Alternative spatial designs parking at a distance and having the barcode functions close by the residents
3. Creating a common vision with citizens through a collaborative approach

Regarding strategic behavior the CPO should be understood to implement any alternatives. All the selected stakeholders are powerful but have different strengths and interests, making strategic behavior a dynamic phenomenon. The familiarity of a stakeholder with the scope and scale of a scenario, to a large extent, shapes their expected strategic behavior within the given scenario.

# 6 Conclusions

A municipality is a collection of departments in which one department is not always aware of how the policies of other departments influence their own policy goals. With different sustainability transitions well on their way, testing their co-influence is still frequently overlooked. This research has analyzed if Utrecht is doing so with its strategies for public EV charging and the 10-minute city, which could negatively impact its goal of zero-carbon mobility.

In Utrecht, the leading principle for changing the urban landscape is the 10-minute city, taking residents as the starting point of urban development. Through the lens of leverage points, the municipality has a progressive approach, wanting to steer away from a car-dominant city towards a 10-minute city, having a balance between shallow and deep leverage points. However, some of the assumptions made by the municipality on mobility and the role of EVs shed an overoptimistic light on the feasibility of the city's goals.

Remarkably, the barcode developed to estimate the spatial needs of the 10-minute city has no estimations for mobility. A municipal official working on the barcode said that the enormous complexity of mobility is the main reason for not assigning an indicative number of square meters. The case study has given a sense of the scale of the impact of car infrastructure within mobility and the 10-minute city. The share of car infrastructure of the total space consummation by mobility is 93.3% and a total of 18.7% of the land area of Noordwest. This stresses the significance of an in-depth understanding of the role of car mobility within the 10-minute city strategy, specifically the role of EVs, a sustainable fossil fuel car alternative that is already being widely adopted.

The public EV charging strategy is multi-layered, being part of mobility, parking and the placement of charging stations. The overall vision for mobility in Utrecht is to increase walking, biking, public transport and shared mobility while decreasing the share of privately owned cars. EVs get special treatment when it comes to private cars because it is a more sustainable alternative. The municipality claims there will be a clear distinction between cars with emissions and cars without, implying that EVs will be zero emission. Although EVs do not emit emissions while driving, EVs are not produced without emissions. Treating EVs as such, instead of treating them as low-emission vehicles, creates an unfair advantage for EVs compared to modalities with even lower emissions, such as biking and walking. This seemingly small difference in wording can result in a drastically different mobility system and, consequently, a drastically different spatial layout of neighborhoods. This leads to the first strategy change.

**Strategy change 1**

Demote EVs from zero-emissions to low-emissions vehicles in policy documents and describe a clear distinction in EVs, biking and walking in terms of emissions.

The placement of charging stations is decided per neighborhood based on kWh usage data of existing charging locations and feedback from residents. Wishes and guidelines are given to the CPO to decide what parking location best preserves the quality of the public space. The focus is on placing charging stations at park locations that are least likely to be removed. Although charging stations are bundled per district, the effects on the built environment are still discussed on the street level. The complexity of mobility and its effect on the 10-minute city requires the addition of the district-level effects of public charging stations on the urban environment to be included in deciding where public EV infrastructure will be placed. What car infrastructure is least essential to the functioning of the 10-minute city should be included in the decision-making process of the placement of public EV infrastructure. This only strengthens the ability to correctly predict which charging locations are least likely to be displaced, adding to the focus of the public EV charging strategy. This leads to the second strategy change.

**Strategy change 2**

Take a district-level approach to understanding the long-term effects on the urban environment with charging station placement, specifically limiting placement on car infrastructure that is least essential to the function of the 10-minute city.

A more elaborate analysis on the macro level is necessary to decide what selection of car infrastructure is 'non-essential' and needs to be transformed into other barcode functions. How much car infrastructure is deemed non-essential depends on how far a resident is willing to walk or cycle to get to their car. This willingness is not easy to underpin. How residents' willingness is now might be very different from the willingness when residents understand what they will get in return. The municipal officials suggested different design scenarios, which all contained some form of centralized hubs for cars, e-mobility and shared mobility. These varied in distance from the residents, size, the role of shared mobility and what space should be converted to place these hubs. The correspondents stressed the importance of involving residents in small-scale transformations to show the benefits of decreasing the dominance of car infrastructure to gain space for other functions. The EV municipality official suggested a gamified approach during the stakeholder meetings, involving residents in what new functions parking spots in their proximity will have. This approach aims to create a common vision for the 10-minute city, for residents by residents. This leads to the third strategy change.

**Strategy change 3**

Include residents in transformations of on-street parking through a gamified approach, creating a shared vision for the 10-minute city and raising understanding for expanding the distance to car parking facilities.

The parking vision aims to decrease the share of privately owned cars by decreasing parking by 0.5 to 1 percent per year. These parking spots are transformed into other functions that improve the quality of the public space, making steps to a 10-minute city. The municipal correspondents noted that these percentages have lowered in ambition over the years due to the sheer difficulty of the operation. When this policy is translated to the context of Noordwest, an area of between 0.3% and 0.6% of the land area of Noordwest is freed and utilized for other functions if this policy is successfully implemented in the period 2023-2040. That is 0.5% of the square meterage that is still missing in 2023 to fulfill the 2040 barcode. This shows that this policy is insufficient to utilize the full potential that the transformation of car infrastructure can have for the 10-minute city. While parking is a good starting point and could increase through citizens' participation, the focus should be widened to include the transformation of car roads as they occupy the largest portion of space in car infrastructure. This leads to the fourth strategy change.

**Strategy change 4**

Broaden the view of car infrastructure transformation in existing neighborhoods to not only include parking via the parking vision but also car roads, forming a strategy on non-essential car infrastructure in the mobility vision.

The municipality specifically sees public EV charging as an opportunity to stabilize the energy grid. If charging stations are to be an important factor in grid stabilization, the difficulty of shifting from EVs to cycling and walking intensifies. Furthermore, the CPO correspondent points out that charging stations should be used continuously to discharge when the energy grid needs it most. In other words, discharging is a leverage point for a stable energy system but a lock-in for public EV infrastructure and the required car infrastructure in neighborhoods that come with it. This does not immediately lead to a strategy change. It does require close monitoring of how dependent the energy grid will be and how this affects the mobility system.

When comparing the strategies for the 10-minute city and public EV charging, the difference in management style is apparent. The 10-minute city has a clear end goal, wanting to have a 10-minute city realized in 2040. Public EV charging is much more adaptive, having no clear end goal and adapting to the expected demand for charging stations in the near future. The case study exemplifies the effect of the adaptive nature of public EV charging. Clearly, the adaptive demand-driven model currently results in a dispersed network of charging stations. The dispersed character of charging infrastructure is a lock-in that increases the difficulty of transforming car infrastructure to other functions for the 10-minute city. A more steered approach to public EV charging is needed to transform car infrastructure efficiently. This leads to the fifth strategy change.

**Strategy change 5**

Translate the broadened view of car infrastructure transformation to the placement of public EV charging infrastructure, essentially taking a more steered approach to reduce the risk of intensifying car infrastructure lock-in through the use of public EV charging stations.

The 10-minute city strategy department is likely to block further dispersion of charging stations, possibly even displacing charging stations outside of city districts, once the effects are fully recognized. With the 10-minute city strategy still in the early stages of development, it might take years before this recognition. This contradicts the wishes of CPO, which is willing to adapt to different urban layouts but insists on doing this gradually to limit the risk of losing profits. The longer the municipality waits to implement spatial changes, the more drastic they need to become to reach a 10-minute city in 2040 and the higher the chances that CPO will no longer be willing to cooperate. It can not be overstated that the process of ideating, prototyping, testing and evaluating alternatives to dispersed placement of charging stations should start immediately. This should be done in close collaboration with all the stakeholders that have a say in the design of the built environment and those having a stake in the energy system that EVs are coupled to. In other words, the chances of the 10-minute city succeeding depend on how well this cooperation goes and when this cooperation is initiated. This leads to the sixth strategy change.

**Strategy change 6**

Apply a more collaborative approach in existing neighborhoods, integrating stakes of different policy fields and third parties. Do this as soon as possible to prevent the blocking behavior of powerful stakeholders.

The accumulation of the previous paragraphs leads up to answering the main research question, formulating six strategy changes that are needed for the city of Utrecht to simultaneously supply the public EV infrastructure demand and to implement a ten-minute city in 2040.

# 7 Discussion

This research has been the first exploration of the effects of public EV infrastructure on the 15-minute city (FML) concept. The infrastructural scope has been critical in understanding the spatial impact of public EV charging. If only studied from the perspective of the spatial impact of charging stations, the results would have been much less significant. A 'scope of impact' makes much more sense in a socio-technical system. In this case, the scope of impact includes parking and car roads, knowing that public EV charging cannot function without this infrastructure.

Both spatial and temporal issues of socio-technical systems in the urban context have been addressed in this research. Spatial issues, particularly in the urban context, are still lacking in the literature on socio-technical systems. The effect of governance on spatial issues has been pivotal. The question of Geels et al. (2018) on: "...the role of local and regional institutions, policies and forms of governance in the emergence and diffusion of innovations" is partly answered in the context of electric vehicles and the 15-minute city concept (FMC). This research exemplifies that within local governance, the scope of policy fields dealing with innovations in urban design are on different scales. These scales are micro (street level), meso (district/neighborhood level) and macro (city level). This did not immediately become apparent when analyzing policy documents because municipal documents are written for city-wide adaptation, creating the illusion that the scope is on the macro scale. Once analyses include the application of policies in the built environment, differences in scales become much more apparent. A misalignment in the scale of the application of one transition can cause 'blindness' for the development of another transition and vice versa. In Utrecht, the scale of the 10-minute city focuses on the macro scale, while EV public charging is mostly on the micro-scale. Both these developments do not only affect the scale that is focused on but, in fact, affect all scales. If this is unnoticed for too long, it is much more difficult to bend the mobility transition to meet the needs of the 10-minute city.

The increasing difficulty of changing the direction of sustainability transitions mentioned by Seto et al. (2016) and confirmed by this research in the urban context is understudied in transition management. Studies mostly focus on transitioning from unsustainable systems to sustainable systems. This study has enriched the literature by showing the risk of a decline in the plasticity of sustainability transitions over time, posing the risk of lock-ins of sustainability paths chosen. A better understanding of this phenomenon and how it can be prevented is essential for the speed at which carbon reduction is needed to limit climate change. More specifically, for the 15-minute city concept (FMC), a thorough study is needed of FMC in the context of the socio-technical systems it changes and is changed by. This is crucial to gain insight into the feasibility of FMC under different circumstances before lock-ins occur.

The literature pointed out that lock-ins are frequently not addressed in sustainability research as they have a negative connotation, while leverage points have a more positive one. This limits the possibility of understanding the effects of sustainability transitions when they are happening at the same time. Some factors that improve the speed or quality of one sustainability transition (leverage point) hinder the feasibility of another sustainability transition (carbon lock-in). Therefore an integration of lock-ins and leverage points literature is needed in sustainability research to be able to make a fair judgement and make deliberate choices on which system goal is deemed more important.

Integration of lock-ins and leverage points should be done not only in research but also in municipal decision-making processes focussed on the built environment. The stakeholder meetings showed that urban development professionals who had never been in contact with the literature on lock-ins and leverage points could easily understand and apply these concepts. This makes these theoretical concepts useful for both theoretical and practical applications.

Moreover, this research provides proof that successful implementation of multiple transitions at once requires a multi-level governance approach by municipalities, both horizontally and vertically. The combination of policy research (macro level) and GIS (meso and micro level) has been a successful methodological approach for vertical integration. When applying this combination of methods to more than one policy field the horizontal dimension is also achieved.

Through studying the strategic behavior of the selected stakeholders, it became clear that the differences in the maturity of different strategies and commercial interests in public-private partnerships are some of the key drivers in strategic behavior. Although strategic behavior is essential to understanding outcomes, it is difficult to determine strategic behavior many years in the future. The stakeholder meetings correspondents did not show a strong negative or positive attitude toward future scenarios, showing willingness to adapt to different future scenarios. Therefore, it is difficult to apply the third dimension (positive or negative attitude), which is key to the 3D stakeholder grid. It seems that attitude is more of a scale than black or white. Other methods might be more suited to account for the nuances that must be considered in determining what strategic behavior is expected.

The systemic design framework is a valuable tool to put systems research into the realization of innovative spatial design. This research only extends to five out of eight steps of the framework. The research comes to fruition if the municipality continues with the other three steps of prototyping, testing and evaluating solutions. The process is designed to be iterative, going through the steps multiple times and adapting to the insights and effects of implemented solutions. Applying new solutions that, in turn, impact the system, possibly requiring policy changes. This process should include a wider set of stakeholders. Many possibilities have been ideated with just three correspondents, but more perspectives are needed to create a robust strategy. When this iterative process is rigorously applied in collaboration with all important stakeholders in the transformation of existing neighborhoods, it serves as a safeguard preventing transition paths from becoming unwanted lock-ins and, at the same time, steers in the direction of preferred leverage points.

Research is needed about what requirements constitute the successful implementation of mobility hubs if they are to be the concept of choice. First, research is needed to better grasp under what conditions residents are willing to walk or bike to their cars within the desired radius. Second, it's vital to investigate which societal groups, such as disabled individuals or emergency service workers, heavily depend on having a nearby car. Such cases need to be included in the mobility design. Third, hubs should not become the lock-in of the future. If car use declines, so does the necessity for hubs supporting cars. Therefore, forward-thinking should be used to design hubs, ensuring they remain adaptable to changing mobility trends. Possible mobility hub lock-ins and flexible design options should be studied.

Regardless of whether hubs become the primary design choice or not, a close collaboration between system and design research is indispensable. This collaboration is vital for creating resilient cities capable of undergoing the necessary transformations to achieve zero-emission mobility in existing districts.

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# 9 Appendices

## Appendix A 10-minute city barcode

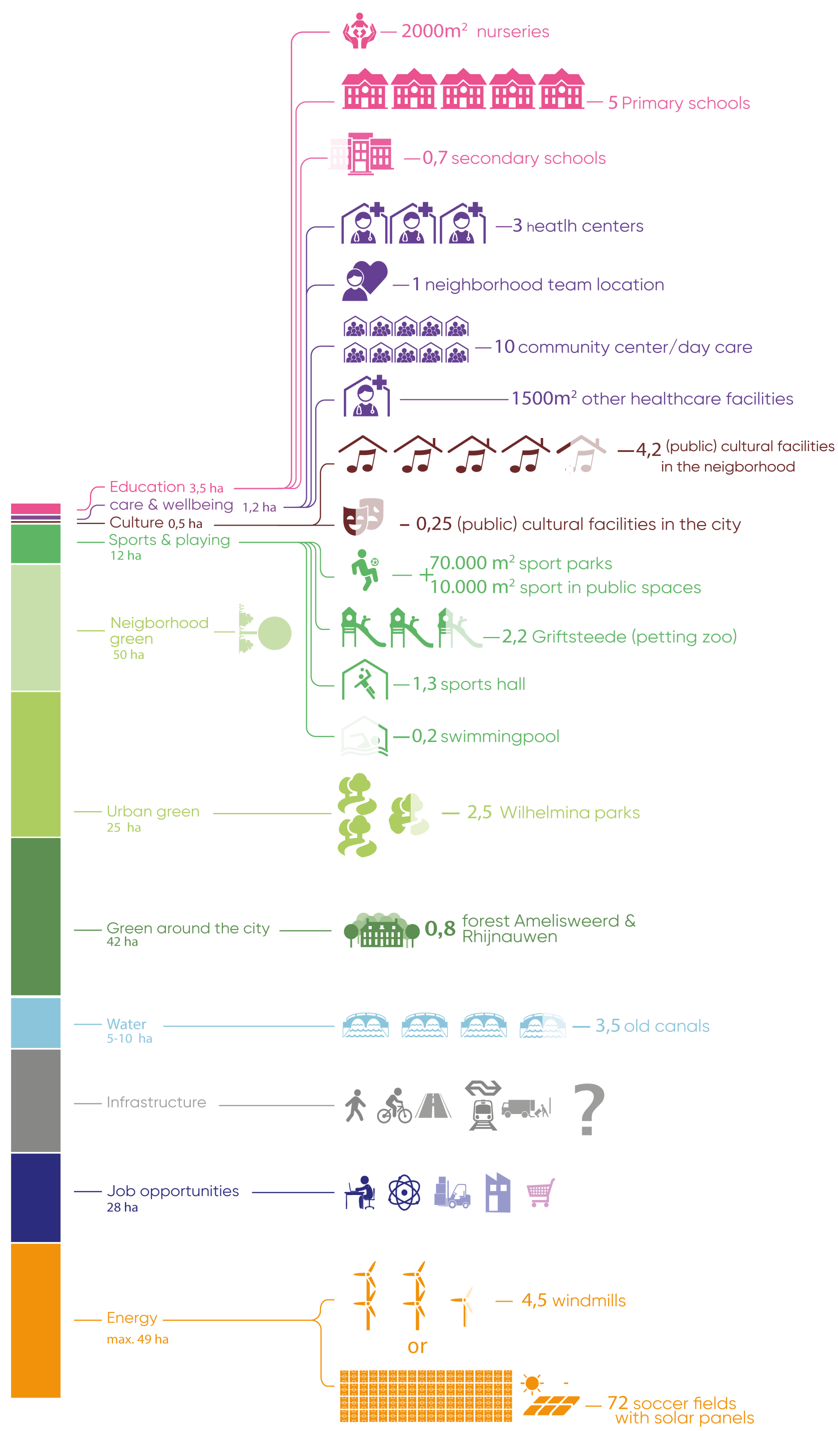


Figure 32: Barcode with the square meters per function (translated and transposed by the author. Source: (Utrecht, 2021b)).

# Appendix B Summaries stakeholder meetings

## B.1 Stakeholder meeting 1: municipality of Utrecht

*This stakeholder meeting was held on 14-9-2023. The meeting started with a presentation explaining some of the theories and findings. Afterward, the participants were asked their stance in the presented future. Without having to ask a question, the officials started thinking of more centralized concepts for cars in the form of hubs. The participant suggested a more integral approach to spatial development in existing neighborhoods, including public EV infrastructure and other functions in the public space. The two officials had not met each other within the municipality.*

**Participants:**

- A municipal official part of zero-emission mobility, specifically EV charging, hereafter referred to as EV official.
- An urban planner working on the development of the barcode for the 10-minute city in Utrecht, hereafter referred to as barcode official.

The EV official mentions that charging professionals are already collaborating with urban planners to place charging stations at locations that are least likely to be removed over time. Placing charging stations on the corner of streets at side facades are preferable but these locations are frequently in use for green patches. These green patches are the first to come back when there is space. So, seemingly less preferable alternatives might be used for the longevity of the infrastructure. Specifically, the placement process does not include the 10-minute city and the barcode. The EV official assumed that the 10-minute city would lead to parking at a distance. The barcode official agrees that parking should be within a 10-minute biking or walking distance following the 10-minute city. The EV official names an example in Merwede Kanaalzone, an industrial district that will be transformed to a neighborhood where the new design is made with the expectation that people will have to park in another neighborhood in a large mobility hub (if they want to keep using the car). The mobility hub will consist of around 4,000 parking spots and is expected to have 2,000 chargers. The EV official mentions that the principle for public EV charging is that charging follows parking. So if parking is done in hubs, charging should be arranged there too. If parking moves to the edge of the city, charging follows. the inner city only has charging on the edges. The EV official says this could be something that is applied to other parts of the city, bundling demand on a district level. The barcode official wonders what the effects of hubs are on citizens' behavior. Is it too much effort and are they unwilling or do they understand the increasing pressure on the built environment? It is recognized that citizens might resist charging at a distance if charging is currently close to their house. The barcode official wonders if some EV drivers are more environmentally conscious and, therefore, more willing to change their habits for a healthier living environment. The EV official wonders how citizens get home from a hub. Biking, walking or something else? Hubs do have the advantage that bundling charging stations gives users a higher reliability of being able to charge when they arrive. One of the official's anecdotes is that some of his friends are known to have problems finding a charging station, leading them to charge far away from their homes. The barcode official gives an explanation as to why mobility is not defined in the barcode. Mobility is the most complex with many factors that account for mobility, such as the different modalities, how many lanes are used, one or two-way streets, et cetera. The debate on whether to facilitate demand or do the opposite to change mobility patterns is constantly happening. Reflecting on the presentation by the researcher featuring the theory on leverage points, the barcode officer has the most interest leverage point within the system characteristic intent. How do we get residents to join a common vision? Ads? Or through smaller initiatives, for example, converting tiles to plants? The barcode officer thinks it is necessary to have a plan to present to citizens to show the benefits instead of leaving it completely up to the residents. The EV official reflects on the way various functions operate within urban streets. They emphasize the importance of considering parking space management and exploring a broader scope beyond charging stations. The speaker recounts giving a recent lecture to colleagues, focusing on the barcode of urban streets. During the lecture, the official pleaded for a more integrated planning approach when redesigning streets. The official highlights the increasing number of functions in existing streets, including charging points, shared vehicles, sharing hubs, cargo bikes, bike racks, green spaces, and play areas, all while reducing 1% in parking spaces. Just like with EV charging, can't we connect these various challenges and envision neighborhood-specific solutions?, the official wonders, also involving the community in the planning process, possibly through a gamified approach, to collaboratively explore alternative functions for each parking space that is to be eliminated. It stands out to the barcode official that the percentage for reducing parking spaces has become less ambitious over time. The EV official agrees and emphasizes that they haven't even begun the process and cites community resistance when proposing relocations or removals. He suggests a more positive approach by explaining that the parking spots will be replaced with green areas, bike racks, shared vehicles, and involving the community in planning. This, he believes, can create a more appealing narrative instead of delivering an unwelcome message. The barcode official agrees that these challenges should be tackled in tandem. The EV official notes that everybody at the lecture loved the idea but that nobody has started to realize it as of yet. Both officials doubt whether it is preferable to have big parking towers with private cars or smaller ones with shared mobility. Another option is to delineate in distance, making smaller shared mobility hubs close to residents and having private parking more at the edges of districts. This can help to stimulate sharing. Typologies with smart placement can combine car-free streets and still keep shared mobility relatively close. But, when sharing is also in hubs at the edges of the district, much less asphalt is needed in neighborhoods, freeing space for other functions. The barcode official says it is possible to remove green at the edges of districts for mobility hubs, but that green needs to come back in the neighborhood elsewhere. It is noted that there is still considerable greenery at the city's edges, which could be considered for this purpose. This does not upset the urban balance. Instead, more space can be freed for greenery when parking is stacked. Incentives like free bike sharing could help kickstart these hubs' use. Both officials underlined that private EVs should have more rights to park close to houses than other cars because this is unfair to people who can't afford an electric car. Whatever vision is adapted, it should be done in phases.

## B.2 Stakeholder meeting 2: CPO Equans

*This stakeholder meeting was held on 15-9-2023, A day after the first stakeholder meeting. Again, the meeting started with a presentation explaining some of the theories and findings. Afterward, the participant was first asked what their stance was in the presented future. The correspondent first gave some developments he expects that will influence public charging. Furthermore, the corresponded reacted to the alternatives the municipal officers gave, what their role is and how they will react if* *this becomes a wish of the municipality.*

**Participants:**

- A professional working at the E-mobility department of Equans, hereafter referred to as EV professional.

The EV professional expects public AC charging to remain important in 2040 in neighborhoods with limited possibilities for at-home charging. The EV professional expects a higher utilization rate of charging stations to around three sessions per charging station per day, currently having a mean of around 0.7 sessions per charging station per day. EVs with bigger batteries will need fewer sessions and are expected to charge once every three to four days instead of daily. EV professional expects that the role of shared E-mobility will be between 5% to 20% of the total car population in 2040. Currently, they see that shared cars have a low utilization rate, resulting in less profitable charging stations at shared e-mobility parking spots. The city's ambition for bi-directional charging will require EVs to be connected as much as possible to be able to discharge when the energy grid needs it most.

The assumption of the EV professional for the 10-minute city is that cars are also reached within 10 minutes of walking. EV professional questions how long car users are willing to walk or cycle from a hub to their houses. The EV professional sees centralized hubs as a quite drastic measure, making it harder to get in and out of the city. If this is to be done it requires the city to be a very attractive place to stay. The car's attractiveness is partly that the user gets to its destination with just one means of transportation, the EV professional says. This is not the case with hubs where taking the bike or walking to reach home is necessary. Taking a luxury away, the EV professional employee says, means you need to have an attractive alternative for that luxury. Hubs also make it harder to implement the neighborhood battery concept. Taking solar energy and using it for EV charging becomes more difficult when EV charging is more centralized, requiring higher grid capacity at these hubs.

The EV professional's stance is that it is not their role to design the public space. They are in agreement that a more integrated approach works best, but they are solely an operator and an investor. From the side of the investor, it is most important that EV professional believes that the design actually will be used enough to be profitable (risk vs. Reward). The CPO has contracts for 10 years of exploitations as a return for their investment. Re-locating charging stations has a big impact on their business case. Extra benefits, for example, extended contracts, will be needed for the CPO if a massive relocation of charging stations is requested during the contract's duration. The EV professional recognizes this as a lock-in for changing spatial design layouts. The downside of more flexibility is an unprofitable business case. Example. The question is raised what party will agree to a highly flexible, unprofitable contract. The municipality could start investing in the infrastructure to gain more flexibility. With the current market model, the EV professional wonders who in the market is willing to realize the infrastructure when the municipality is investing in its own infrastructure. Nevertheless, the EV professional sees possibilities to go to E-mobility hubs. The keyword is gradual. If a hub or small batch of hubs is part of a concession to do a try-out, the risk decreases as well as the impact on the EV professional profitability for the CPO.

# Appendix C Leverage point analysis per policy

## C.1 Parameter policies

Table 10: Policies per leverage point type in the systems characteristic parameters

| Policy | Leverage point type |
|---|---|
| Increasing paid parking. | 12. Parameters (such as subsidies, taxes, standards). |
| Adding bike parking spaces. | 12. Parameters (such as subsidies, taxes, standards). |
| Expanding charging plazas to multi-mode transport hubs. | 10. The structure of material stocks and flows. |
| Clustering charging stations. | 10. The structure of material stocks and flows. |
| Designated parking for car sharing. | 10. The structure of material stocks and flows. |
| Decreasing car parking by 0.5% - 1% per year. | 10. The structure of material stocks and flows. |
| Fast chargers to relieve regular chargers. | 10. The structure of material stocks and flows. |
| Incentivizing parking outside the public space. | 10. The structure of material stocks and flows. |
| Adding public transport. | 10. The structure of material stocks and flows. |

## C.2 feedback policies

Table 11: Policies per leverage point type in the systems characteristic feedbacks

| Policy | Leverage point type |
|---|---|
| Organizing the decision-making process per batch of charging stations instead of per case. | 9. The length of delays, relative to the rate of system change. |
| Rewarding CPO for overarching goal instead of placement of charging stations. | 8. The strength of negative feedback loops. |

## C.3 design policies

Table 12: Policies per leverage point type in the systems characteristic design

| Policy | Leverage point type |
|---|---|
| Wishes placement of charging stations in public space. | 6. The structure of information flows (access to information). |
| Forecast describing the role of public charging in total charging demand. | 6. The structure of information flows (access to information). |
| Forecast 30% private EV in 2040. | 6. The structure of information flows (access to information). |
| map of charging locations based on the expected demand for charging stations in 2025 | 6. The structure of information flows (access to information). |
| Maximum parking norms. | 5. The rules of the system (such as incentives & constraints). |
| Simplifying rules for car-sharing initiatives. | 5. The rules of the system (such as incentives & constraints). |
| Rules for placement in specified areas. | 5. The rules of the system (such as incentives & constraints). |

## C.4 intent policies

Table 13: Policies per leverage point type in the systems characteristic intent

| Policy | Leverage point type |
|---|---|
| Supplying charging infrastructure for EVs, whilst safeguarding the quality of the public space. | 3. The goals of the system |
| Wanting a less dominant appearance of car parking in the public space. | 3. The goals of the system |
| The ambition to not let car traffic increase. | 3. The goals of the system |
| Wanting a 10-minute city to create a happy and healthy life for all citizens. | 3. The goals of the system |

# Appendix D GIS Analysis case study

The GIS analysis consists of two parts:

1. **Comparing the barcode square meters with the current square meters and the expected square meters in 2040.**

   All the shapefile and map files on functions were imported to Arc GIS Pro. The clip function was used to limit the data to the study area using the borders of Utrecht Noord-West. The data was converted to Excel with the convert to Excel function. The dataset with 10-minute city functions in buildings (called "functions polygons") has 40 columns and rows 21387. The sum of the applicable columns was summed to get the square meters per function. The Arcgis data was converted to Excel with the convert to Excel function. The Excel data was used as input for Python. Jupyter Notebook was used to sum up the columns, including the square meters of the different functions. This accumulation led to the square meters per function for the 10-minute city barcode. These were exported back to Excel for chart analysis.

   Two adjustments were made to improve the quality of the 10-minute city data. First, a new layer was created with the polygon tool and a satellite image base map for outside sports, as these are not reflected in the data. The square meters for outside sports were calculated by creating a new row in the attribute table and calculating the geometry. Second, only neighborhood green is used instead of using all green categories in the barcode, as the other categories do not apply to this district.

2. **Calculating the space used for EV charging now and in 2040.**

   The data on parking spaces for EV charging and charging station locations in Utrecht and the data containing all residential parking in the Netherlands were imported into Arc GIS Pro and clipped to the size of Noord-West. Using calculate geometry, the square meters were calculated. The car roads, parking spots, cycling lanes and sidewalks were all part of one layer. This layer had categories, which made it easy to convert these to multiple layers using the select-by-feature option. The category car infrastructure was not divided into roads and parking spots. To get a separate road layer, the erase function was used to cut out the parts of the car infrastructure layer that overlapped with the residential parking layer. The layer containing all the charging stations in Noordwest was converted to three different layers: charging stations in development, charging stations in operation, and planned charging stations. Using different combinations of layers, maps were made with the create and export lay-out functions.

# Appendix E Formulas case study

## E.1 Formulas: public EV charging in Noordwest

### Mean Parking Space Per Charging Station

To calculate the mean of the parking space used per charging station ($P_{\text{mean}}$), divide the number of charging stations in North-West ($CS_{\text{total}}$) by the total area of parking for charging in North-West ($P_{\text{area}}$). It is assumed this mean stays the same in 2040.

$$P_{\text{mean}} = \frac{CS_{\text{total}}}{P_{\text{area}}}$$

**The percentage of EVs in Noordwest in 2040** To calculate the percentage of EVs in Noordwest in 2040 ($\%EV_{\text{NW 2040}}$), divide the currently operational charging stations ($CS_{\text{op 2023}}$) by the current percentage of people with an EV in Utrecht ($\%EV_{2023}$) from Stumpel and van Weperen (2022), then multiply it by the estimated percentage of people with an EV in 2040 Utrecht ($\%EV_{2040}$) from Utrecht (2021a) and the car ownership in Noordwest ($CO_{2023}$). It is assumed that car ownership will stay the same as in 2023.

$$\%EV_{\text{NW 2040}} = \%EV_{2040} \times CO_{2023}$$

**Number of EV charging stations in the Noordwest in 2040** To calculate the number of EV charging stations in the Noordwest in 2040 ($CS_{\text{op 2040 raw}}$), divide the currently operational charging stations ($CS_{\text{op 2023}}$) by the current percentage of people with an EV ($\%EV_{2023}$) from Stumpel and van Weperen (2022), then multiply it by the estimated percentage of people with an EV in 2040 ($CS_{2040}$) from Utrecht (2021a). The assumption of the municipality was used, which expects 30% EV cars in 2040 (Utrecht, 2021a).

$$CS_{\text{op 2040 raw}} = \%EV_{\text{NW 2040}} \times \frac{CS_{\text{op 2023}}}{\%EV_{2023}}$$

An innovation factor (IF) must be applied to account for any innovation in the future, giving a more accurate depiction of the number of future charging stations:

$$CS_{\text{op 2040}} = CS_{\text{op 2040}} \times IF$$

## E.2 Formulas: the 10-minute city in Noordwest

### Parking Space for Charging in 2040

The amount of parking space for charging in 2040 ($PCS_{2040}$) can be calculated by multiplying the number of charging stations in 2040 ($CS_{\text{op 2040 cor}}$) by the main parking area per charging station as it was in 2023 (Mean Parking Space).

$$PCS_{2040} = CS_{\text{op 2040 cor}} \times P\text{mean}$$

### Total parking and car roads Area

It is assumed that the total square meter area of parking and car roads in 2040 remains as it was in 2023.

### Policy on Reducing Parking

The potential of the policy on reducing parking between 0.5% and 1% can be calculated by applying the percentage to the current area for parking and applying both 1% (0.01) as the maximum and 0.5% (0.005) as the minimum decrease in parking, and raising it to the power of the number of years ($n$):

$$P_{2040_{\text{policy}}} = P_{2023} \times (1 - 0.005)^n \ldots (1 - 0.01)^n$$

### Barcode Ratios

To calculate the barcode ratio for 2023 ($BR_{2023}$), divide the amount of houses in Noordwest in 2023 ($H_{2023}$) by 10,000:

$$BR_{2023} = \frac{H_{2023}}{10,000}$$

To calculate the barcode ratio for 2040 first, the amount of houses in 2040 needed to be calculated. To calculate the amount of houses in 2040 ($H_{2040}$), the projected residents in Noordwest ($HS_{mean}$) is divided by the mean household size in Noordwest ($R2040$) collected from Utrecht (2023).

$$H_{2040} = \frac{R2040}{HS_{mean}}$$

Then the 2040 barcode ratio ($BR_{2040}$) was calculated using the following formula:

$$BR_{2040} = \frac{H_{2040}}{10,000}$$

**Satisfaction of the Noordwest Barcode**

To determine the percentage of satisfaction of each of the functions in the barcode in 2023 ($SB_{2023}$), divide the square meters of the function currently present in Noord-West ($FA_{2023}$) by the square meters set out in the Noordwest barcode for that particular function in 2023 ($FAB_{2023}$).

$$BS_{2023} = \frac{FA_{2023}}{FAB_{2023}}$$

To calculate the satisfaction of the barcode in 2040 ($SB_{2040}$), divide the square meters of the function currently present in Noord-West ($FA_{2023}$) by the square meters set out in the Noordwest barcode for that particular function in 2040 ($FAB_{2040}$)

$$SB_{2040} = \frac{FA_{2023}}{FAB_{2040}}$$

# Appendix F  Data results case study

## F.1  Data results: Public EV charging Noordwest

| EV charging Noordwest 2023 | Value |
|---|---|
| Cars per resident | 0.5 |
| Noordwest m2 | 4531445 |
| Charging stations placed | 191 |
| Charging stations in development | 48 |
| Charging stations chosen locations | 109 |
| Mean parking m2 per charging station | 27 |
| Parking m2 for EV charging total | 9437 |
| Parking m2 for EV Charging placed | 5180 |
| Parking | 160352 |
| Car roads | 628423 |

Figure 33: Data on EV charging Noordwest in 2023.

| EV charging Noordwest 2040 | Value |
|---|---|
| percentage with BEV | 1.94% |
| percentage residents with BEV 2040 | 15% |
| Number of charging stations future raw | 1477 |
| correction factor innovation | 0.75 |
| Charging stations future corrected | 1108 |
| Parking m2 for EV Charging | 30036 |
| Parking (remains as in 2023) | 160352 |
| Car roads (remains as in 2023) | 628423 |

Figure 34: Data on EV charging Noordwest in 2040.

| space used by infrastructure | m2 | % of total m2 in Noordwest |
|---|---|---|
| EV Charging current | 5179 | 0.1% |
| EV Charging 2040 | 30036 | 0.7% |
| all car parking | 160352 | 3.5% |
| all car roads | 628423 | 13.9% |
| All car infrastructure | 788775 | 17.4% |
| All infrastructure | 845463 | 18.7% |

Figure 35: The space used by different elements of infrastructure. source:

## F.2 Data results: 10-minute city Noordwest

| Type | Household size | amount of citizens | amount of hous | Barcode |
|---|---|---|---|---|
| Barcode | N.A. | N.A. | 10000 | 1 |
| Noordwest 2023 | 1.8 | 44713 | 24431 | 2.44 |
| Noordwest 2040 | 1.8 | 49478 | 27488 | 2.75 |

Figure 36: The space used by different elements of infrastructure.

| Scenario | Total |
|---|---|
| Barcode | 1492000 |
| Currently available m² | 1610999 |
| Currently needed m² | 3645105 |
| m² needed in 2040 | 4101176 |

Figure 37: The accumulation of square meters of functions the percentage to which the total is currently satisfied in Noordwest.

| satisfaction barcode | All functions | Education | Care & welbeing | Culture | Sports & Playing | Neighborhood green | Water | Infrastructure | Job opportunities | Energy |
|---|---|---|---|---|---|---|---|---|---|---|
| % 2023 barcode satisfied | 44.2% | 40.9% | 22.5% | 219.9% | 47.9% | 10.8% | 135.2% | | 36.6% | 0.1% |
| % 2040 barcode satisfied | 39.3% | 45.3% | 20.0% | 195.4% | 42.6% | 9.6% | 120.2% | | 32.5% | 0.1% |

Figure 38: Percentages showing to what extent the barcode is satisfied in Noordwest.

| Scenario | Housing_FSI | Education | Care & welbeing | Culture | Sports & Playing | Neighborhood green | Water | Infrastructure | Job opportunities | Energy |
|---|---|---|---|---|---|---|---|---|---|---|
| Barcode | ? | 35000 | 12000 | 5000 | 120000 | 500000 | 50000 | ? | 280000 | 490000 |
| Currently available m² | 2267641 | 43571 | 6592 | 26860 | 140570 | 131395 | 165134 | 845463 | 250073 | 1342 |
| Currently needed m² | ? | 85509 | 29317 | 12216 | 293172 | 1221550 | 122155 | ? | 684068 | 1197119 |
| m² needed in 2040 | ? | 96207 | 32985 | 13744 | 329853 | 1374389 | 137439 | ? | 769658 | 1346901 |

Figure 39: The number of square meters that are needed in Noordwest compared to what is needed in 2023 and in 2040.

# Appendix G 3D stakeholder grid categories

- **Saviour** – powerful, high interest, positive attitude or alternatively influential, active, backer. They need to be paid attention to; you should do whatever necessary to keep them on your side – pander to their needs.
- **Friend** – low power, high interest, positive attitude or alternatively insignificant, active, backer. They should be used as a confidant or sounding board.
- **Saboteur** - powerful, high interest, negative attitude or alternatively influential, active, blocker. They need to be engaged in order to disengage. You should be prepared to 'clean-up after them'.
- **Irritant** – low power, high interest, negative attitude or alternatively insignificant, active, blocker. They need to be engaged so that they stop 'eating away' and then be 'put back in their box'.
- **Sleeping Giant** - powerful, low interest, positive attitude or alternatively influential, passive, backer. They need to be engaged in order to awaken them.
- **Acquaintance** –low power, low interest, positive attitude or alternatively insignificant, passive, backer. They need to be kept informed and communicated with on a 'transmit only' basis.
- **Time Bomb** - powerful, low interest, negative attitude or alternatively influential, passive, blocker. They need to be understood so they can be 'defused before the bomb goes off'.
- **Trip Wire** – low power, low interest, negative attitude or alternatively insignificant, passive, blocker. They need to be understood so you can 'watch your step' and avoid 'tripping up'.

Figure 40: The definitions if the different categories of the 3D stakeholder grid as defined by (Murray-Webster & Simon, 2007)

# Appendix H HREC procedure

## H.1 Checklist for human research

**Delft University of Technology**
**HUMAN RESEARCH ETHICS**
**CHECKLIST FOR HUMAN RESEARCH**
**(Version January 2022)**

**IMPORTANT NOTES ON PREPARING THIS CHECKLIST**

1. An HREC application should be submitted for every research study that involves human participants (as Research Subjects) carried out by TU Delft researchers
2. Your HREC application should be submitted and approved **before** potential participants are approached to take part in your study
3. All submissions from Master's Students for their research thesis need approval from the relevant Responsible Researcher
4. The Responsible Researcher must indicate their approval of the completeness and quality of the submission by signing and dating this form OR by providing approval to the corresponding researcher via email (included as a PDF with the full HREC submission)
5. There are various aspects of human research compliance which fall outside of the remit of the HREC, but which must be in place to obtain HREC approval. These often require input from internal or external experts such as Faculty Data Stewards, Faculty HSE advisors, the TU Delft Privacy Team or external Medical research partners.
6. You can find detailed guidance on completing your HREC application here
7. Please note that incomplete submissions (whether in terms of documentation or the information provided therein) will be returned for completion **prior to any assessment**
8. If you have any feedback on any aspect of the HREC approval tools and/or process you can leave your comments here

## I. Applicant Information

| | |
|---|---|
| **PROJECT TITLE:** | **The influence of the exponential demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city** |
| **Research period:**<br>*Over what period of time will this specific part of the research take place* | **From 01-02-2023 until 25-10-2023** |
| **Faculty:** | **Technology, Policy and Management (TPM)** |
| **Department:** | **Industrial Ecology** |
| **Type of the research project:**<br>*(Bachelor's, Master's, DreamTeam, PhD, PostDoc, Senior Researcher, Organisational etc.)* | **Master** |
| **Funder of research:**<br>*(EU, NWO, TUD, other – in which case please elaborate)* | **N.A.** |
| **Name of Corresponding Researcher:**<br>*(If different from the Responsible Researcher)* | **Joey van Loo** |
| **E-mail Corresponding Researcher:**<br>*(If different from the Responsible Researcher)* | **J.vanLoo-2@student.tudelft.nl** |
| **Position of Corresponding Researcher:**<br>*(Masters, DreamTeam, PhD, PostDoc, Assistant/ Associate/ Full Professor)* | **Master** |
| **Name of Responsible Researcher:**<br>***Note:** all student work must have a named Responsible Researcher to approve, sign and submit this application* | **Alexander Wandl** |
| **E-mail of Responsible Researcher:**<br>*Please ensure that an institutional email address (**no Gmail, Yahoo, etc.**) is used for all project documentation/ communications including Informed Consent materials* | **A.Wandl@tudelft.nl** |
| **Position of Responsible Researcher :**<br>*(PhD, PostDoc, Associate/ Assistant/ Full Professor)* | **associate professor** |

## II. Research Overview

***NOTE:*** *You can find more guidance on completing this checklist [here]*

### a) Please summarise your research very briefly (100-200 words)

What are you looking into, who is involved, how many participants there will be, how they will be recruited and what are they expected to do?

| ***Add your text here – (please avoid jargon and abbrevations)*** |
|---|
| All over the world cities are attempting to emit less carbon to limit the possibly detrimental effects of human-induced climate change. One way to limit carbon emissions is by reducing fossil fuel car use and transitioning to forms of low-carbon mobility. Electric vehicles (EVs) are an exponentially popular low-carbon transport solution, providing similar qualities to fossil-fuel cars. The question is though, whether it is possible to supply the growing demand for public EV infrastructure and simultaneously have a spatial design with every function within a 10-minute walking or cycling distance of each resident. This paper studies this question in the context of the municipality of Utrecht, the Netherlands. Policy decisions that are made now to a large extent shape how the city will operate in the future. In this exploratory research, leverage points and lock-ins are identified both on a city scale (policy research) and a neighborhood scale (case study). Furthermore, Stakeholder behavior is analyzed by doing expert interviews with the most essential stakeholders how they expect to respond when the research results become a reality. They are also asked to consider policies |

| |
|---|
| to prevent lock-ins and utilize leverage points. The goal is to prevent any unwanted outcomes blocking zero-emission mobility. Key words: EV infrastructure, EV charging, 15-minute city, socio-technical systems, systemic design approach, carbon lock-in, leverage points, sustainable mobility, GIS, 3D-stakeholder grid. 7 |

b) **If your application is an additional project** related to an existing approved HREC submission, please provide a brief explanation including the existing relevant HREC submission number/s.

| *Add your text here – (please avoid jargon and abbrevations)* |
|---|
| |

c) **If your application is a simple extension of, or amendment to,** an existing approved HREC submission, you can simply submit an HREC Amendment Form as a submission through LabServant.

## III. Risk Assessment and Mitigation Plan

***NOTE:*** *You can find more guidance on completing this checklist [here]*

Please complete the following table in full for all points to which your answer is “yes”. Bear in mind that the vast majority of projects involving human participants as Research Subjects also involve the collection of **Personally Identifiable Information (PII)** and/or **Personally Identifiable Research Data (PIRD)** which may pose potential risks to participants as detailed in Section G: Data Processing and Privacy below.

To ensure alighment between your risk assessment, data management and what you agree with your Research Subjects you can use the last two columns in the table below to refer to specific points in your Data Management Plan (DMP) and Informed Consent Form (ICF) – **but this is not compulsory**.

It’s worth noting that **you’re much more likely to need to resubmit your application if you neglect to identify potential risks**, than if you identify a potential risk and demonstrate how you will mitigate it. If necessary, the HREC will always work with you and colleagues in the Privacy Team and Data Management Services to see how, if at all possible, your research can be conducted.

| | | | ***If YES please complete the Risk Assessment and Mitigation Plan columns below.*** | | ***Please provide the relevant reference #*** | |
|---|---|---|---|---|---|---|
| **ISSUE** | **Yes** | **No** | **RISK ASSESSMENT – what risks could arise?**<br>***Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*** | **MITIGATION PLAN – what mitigating steps will you take?**<br>***Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*** | **DMP** | **ICF** |
| **A: Partners and collaboration** | | | | | | |
| 1. Will the research be carried out in collaboration with additional organisational partners such as:<br>• One or more collaborating research and/or commercial organisations<br>• Either a research, or a work experience internship provider[1]<br>*[1] If yes, please include the graduation agreement in this application* | | **X** | | | | |
| 2. Is this research dependent on a Data Transfer or Processing Agreement with a collaborating partner or third party supplier?<br>*If yes please provide a copy of the signed DTA/DPA* | | **X** | | | | |
| 3. Has this research been approved by another (external) research ethics committee (e.g.: HREC and/or MREC/METC)?<br>*If yes, please provide a copy of the approval (if possible) and summarise any key points in your Risk Management section below* | | **X** | | | | |
| **B: Location** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | *If YES please complete the Risk Assessment and Mitigation Plan columns below.* | | *Please provide the relevant reference #* | |
| **ISSUE** | **Yes** | **No** | **RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!* | **MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.* | **DMP** | **ICF** |
| 4. Will the research take place in a country or countries, other than the Netherlands, within the EU? | | **X** | | | | |
| 5. Will the research take place in a country or countries outside the EU? | | **X** | | | | |
| 6. Will the research take place in a place/region or of higher risk – including known dangerous locations (in any country) or locations with non-democratic regimes? | | **X** | | | | |
| **C: Participants** | | | | | | |
| 7. Will the study involve participants who **may** be vulnerable and possibly (legally) unable to give informed consent? (e.g., children below the legal age for giving consent, people with learning difficulties, people living in care or nursing homes,). | | **X** | | | | |
| 8. Will the study involve participants who **may** be vulnerable under specific circumstances and in specific contexts, such as victims and witnesses of violence, including domestic violence; sex workers; members of minority groups, refugees, irregular migrants or dissidents? | | **X** | | | | |
| 9. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children, own students or employees of either TU Delft and/or a collaborating partner organisation)? *It is essential that you safeguard against possible adverse consequences of this situation (such as allowing a student's failure to participate to your satisfaction to affect your evaluation of their coursework).* | | **X** | | | | |
| 10. Is there a high possibility of re-identification for your participants? (e.g., do they have a very specialist job of which there are only a small number in a given country, are they members of a small community, or employees from a partner company collaborating in the research? Or are they one of only a handful of (expert) participants in the study? | **X** | | The participants are experts in their field and have jobs that only a select few have. This poses a high risk for re-identification. | The participants are made aware of the high risk of re-identification and the risk it holds in the informed consent form. Furthermore only a summary is published and the participants get a change to review the summary before publication to minimize the risk of re-identification. | | |
| **D: Recruiting Participants** | | | | | | |
| 11. Will your participants be recruited through your own, professional, channels such as conference attendance lists, or through specific network/s such as self-help groups | | **X** | | | | |
| 12. Will the participants be recruited or accessed in the longer term by a (legal or customary) gatekeeper? (e.g., an adult professional working with children; a community leader or family member who has this customary role – within or outside the EU; the data producer of a long-term cohort study) | | **X** | | | | |

| | Yes | No | *If YES please complete the Risk Assessment and Mitigation Plan columns below.* | | *Please provide the relevant reference #* | |
|---|---|---|---|---|---|---|
| **ISSUE** | **Yes** | **No** | **RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!* | **MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.* | **DMP** | **ICF** |
| 13. Will you be recruiting your participants through a crowd-sourcing service and/or involve a third party data-gathering service, such as a survey platform? | | X | | | | |
| 14. Will you be offering any financial, or other, remuneration to participants, and might this induce or bias participation? | | X | | | | |
| **E: Subject Matter** *Research related to medical questions/health may require special attention. See also the website of the CCMO before contacting the HREC.* | | | | | | |
| 15. Will your research involve any of the following:<br>• Medical research and/or clinical trials<br>• Invasive sampling and/or medical imaging<br>• Medical and *In Vitro Diagnostic Medical* Devices Research | | X | | | | |
| 16. Will drugs, placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) be administered to the study participants? *If yes see here to determine whether medical ethical approval is required* | | X | | | | |
| 17. Will blood or tissue samples be obtained from participants? *If yes see here to determine whether medical ethical approval is required* | | X | | | | |
| 18. Does the study risk causing psychological stress or anxiety beyond that normally encountered by the participants in their life outside research? | | X | | | | |
| 19. Will the study involve discussion of personal sensitive data which could put participants at increased legal, financial, reputational, security or other risk? (e.g., financial data, location data, data relating to children or other vulnerable groups) *Definitions of sensitive personal data, and special cases are provided on the TUD Privacy Team website.* | | X | | | | |
| 20. Will the study involve disclosing commercially or professionally sensitive, or confidential information? (e.g., relating to decision-making processes or business strategies which might, for example, be of interest to competitors) | | X | | | | |
| 21. Has your study been identified by the TU Delft Privacy Team as requiring a Data Processing Impact Assessment (DPIA)? *If yes please attach the advice/ approval from the Privacy Team to this application* | | X | | | | |
| 22. Does your research investigate causes or areas of conflict? *If yes please confirm that your fieldwork has been discussed with the appropriate safety/security advisors and approved by your Department/Faculty.* | | X | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | *If YES please complete the Risk Assessment and Mitigation Plan columns below.* | | *Please provide the relevant reference #* | |
| **ISSUE** | **Yes** | **No** | **RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!* | **MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.* | **DMP** | **ICF** |
| 23. Does your research involve observing illegal activities or data processed or provided by authorities responsible for preventing, investigating, detecting or prosecuting criminal offences *If so please confirm that your work has been discussed with the appropriate legal advisors and approved by your Department/Faculty.* | | **X** | | | | |
| **F: Research Methods** | | | | | | |
| 24. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g., covert observation of people in non-public places). | | **X** | | | | |
| 25. Will the study involve actively deceiving the participants? (For example, will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study). | | **X** | | | | |
| 26. Is pain or more than mild discomfort likely to result from the study? And/or could your research activity cause an accident involving (non-) participants? | | **X** | | | | |
| 27. Will the experiment involve the use of devices that are not 'CE' certified? *Only, if 'yes': continue with the following questions:* | | **X** | | | | |
| • Was the device built in-house? | | | | | | |
| • Was it inspected by a safety expert at TU Delft? *If yes, please provide a signed device report* | | | | | | |
| • If it was not built in-house and not CE-certified, was it inspected by some other, qualified authority in safety and approved? *If yes, please provide records of the inspection* | | | | | | |
| 28. Will your research involve face-to-face encounters with your participants and if so how will you assess and address Covid considerations? | | **X** | | | | |
| 29. Will your research involve **either:** a) "big data", combined datasets, new data-gathering or new data-merging techniques which might lead to re-identification of your participants **and/or** b) artificial intelligence or algorithm training where, for example biased datasets could lead to biased outcomes? | | **X** | | | | |
| **G: Data Processing and Privacy** | | | | | | |
| 30. Will the research involve collecting, processing and/or storing any directly identifiable PII (Personally Identifiable Information) including name or email address that will be used for administrative purposes only? (eg: obtaining Informed Consent or disbursing remuneration) | **X** | | Yes, the information in the informed consent contains the names of the participants. This is prone to data loss and data leak. | All personal data will be stored in the TU Delft Onedrive to prevent a dataleak containing the retracted statements. | | |

| | | | *If YES please complete the Risk Assessment and Mitigation Plan columns below.* | | *Please provide the relevant reference #* | |
|---|---|---|---|---|---|---|
| **ISSUE** | **Yes** | **No** | **RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!* | **MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.* | **DMP** | **ICF** |
| 31. Will the research involve collecting, processing and/or storing any directly or indirectly identifiable PIRD (Personally Identifiable Research Data) including videos, pictures, IP address, gender, age etc and **what other Personal Research Data** (including personal or professional views) will you be collecting? | **X** | | The professional views of participants will be collected through videorecording. This is prone to data loss and data leak. | All personal data will be stored in the TU Delft Onedrive to prevent a dataleak containing the retracted statements. | | |
| 32. Will this research involve collecting data from the internet, social media and/or publicly available datasets which have been originally contributed by human participants | | **X** | | | | |
| 33. Will your research findings be published in one or more forms in the public domain, as e.g., Masters thesis, journal publication, conference presentation or wider public dissemination? | **X** | | Accidentally revealing participant's identity. It is possible that the participants give opinions that they did not want to share hingsight due to political sensitivity. | All results will be published in an anonymised and aggregated manner. No transcripts are shared in the research only a summary of the interviews that is reviewed by the participants. Furthermore, all personal research data will be deleted after completion of the study. | | |
| 34. Will your research data be archived for re-use and/or teaching in an open, private or semi-open archive? | **X** | | Accidentally revealing participant's identity. It is possible that the participants give opinions that they did not want to share hingsight due to political sensitivity. | All results will be published in an anonymised and aggregated manner. No transcripts are shared in the research only a summary of the interviews that is reviewed by the participants. Furthermore, all personal research data will be deleted after completion of the study. | | |

## H: More on Informed Consent and Data Management

***NOTE:*** *You can find guidance and templates for preparing your Informed Consent materials) here*

Your research involves human participants as Research Subjects if you are recruiting them or actively involving or influencing, manipulating or directing them in any way in your research activities. This means you must seek informed consent and agree/ implement appropriate safeguards regardless of whether you are collecting any PIRD.

Where you are also collecting PIRD, and using Informed Consent as the legal basis for your research, you need to also make sure that your IC materials are clear on any related risks and the mitigating measures you will take – including through responsible data management.

***Got a comment on this checklist or the HREC process? You can leave your comments here***

# IV. Signature/s

***Please note that by signing this checklist list as the sole, or Responsible, researcher you are providing approval of the completeness and quality of the submission, as well as confirming alignment between GDPR, Data Management and Informed Consent requirements.***

**Name of Corresponding Researcher (if different from the Responsible Researcher) (print)**

Signature of Corresponding Researcher: ***Signiture removed for sharing purposes***

Date: 06-09-2023

**Name of Responsible Researcher (print)**

Alexander Wandl

Signature (or upload consent by mail) Responsible Researcher:

Date: 06-09 -2023 ***Signiture removed for sharing purposes***

# V. Completing your HREC application

Please use the following list to check that you have provided all relevant documentation

**Required:**

- **Always:** This completed HREC checklist
- **Always:** A data management plan (reviewed, where necessary, by a data-steward)
- **Usually:** A complete Informed Consent form (including Participant Information) and/or Opening Statement (for online consent)

**Please also attach any of the following, if relevant to your research:**

| Document or approval | Contact/s |
|---|---|
| Full Research Ethics Application | After the assessment of your initial application **HREC will let you know if and when you need to submit additional information** |
| Signed, valid Device Report | Your Faculty HSE advisor |
| Ethics approval from an external Medical Committee | TU Delft Policy Advisor, Medical (Devices) Research |
| Ethics approval from an external Research Ethics Committee | Please append, if possible, with your submission |
| Approved Data Transfer or Data Processing Agreement | Your Faculty Data Steward and/or TU Delft Privacy Team |
| Approved Graduation Agreement | Your Master's thesis supervisor |
| Data Processing Impact Assessment (DPIA) | TU Delft Privacy Team |
| Other specific requirement | Please reference/explain in your checklist and append with your submission |

## H.2 Informed consent form

**The influence of the exponential**
**demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city**
**INFORMED CONSENT FORM**

U wordt uitgenodigd om deel te nemen aan een onderzoek genaamd “The influence of the exponential demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city”. Dit onderzoek wordt uitgevoerd door Joey van Loo, master student van de TU Delft en Universiteit Leiden.

Het doel van dit onderzoek is om ongewenste gevolgen te voorkomen van het gelijktijdig implementeren van publieke EV infrastructuur en de 10 minuten stad en zal ongeveer 1,5 uur in beslag nemen. De data zal gebruikt worden voor de publicatie van een masterscriptie voor de studie Industrial Ecology. U wordt gevraagd om de vanuit het onderzoek geschetste toekomst te interpreteren, om vragen te beantwoorden hoe er door u als vertegenwoordiger van uw afdeling en/ of bedrijf verwacht om te gaan met deze toekomst en om te discussiëren met andere stakeholders over mogelijk strategisch beleid om deze geschetste toekomst te mitigeren.

Zoals bij elke online activiteit is het risico van een databreuk aanwezig. Wij doen ons best om uw antwoorden vertrouwelijk te houden. We minimaliseren de risico’s door de data op te slaan in de beveiligde server van TU Delft. De data zal alleen toegankelijk zijn voor de master student Joey van Loo en zijn supervisor Alexander Wandl.

Het interview zal worden opgenomen en wordt getranscribeerd met automatische transcriptie software via Microsoft Teams. De transcriptie zal daarna worden geanalyseerd op verwacht strategisch gedrag van stakeholders te identificeren en op voorgesteld beleid. De transcriptie en de opname van het interview zullen maximaal 1 maand na het eind van het onderzoek worden verwijderd. Alleen geanonimiseerde data zal worden gepubliceerd. Dit betreft een samenvatting van het interview met een omschrijving van functie en organisatie type van alle participanten. Elke deelnemer krijgt de mogelijkheid om feedback te geven op de samenvatting. Conclusies vanuit de analyse van de stakeholder meeting worden toegevoegd als resultaten en meegenomen in de conclusie en discussie. De master scriptie als mede de samenvatting van het interview worden gepubliceerd en publiek gemaakt aan het einde van het onderzoek.

Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt zich elk moment terugtrekken zonder reden op te geven. U bent vrij om vragen niet te beantwoorden.

Als u vragen of klachten heeft, neemt u alstublieft contact op met:
Joey van Loo, J.vanLoo-2@student.tudelft.nl
Alexander Wandl, A.wandl@tudelft.nl

| PLEASE TICK THE APPROPRIATE BOXES | Yes | No |
|---|---|---|
| **A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION** | | |
| 1. Ik heb de bovenstaande informatie over het onderzoek gelezen en begrepen, of deze is aan mij voorgelezen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord. | ☐ | ☐ |
| 2. Ik doe vrijwillig mee aan dit onderzoek, en ik begrijp dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven. | ☐ | ☐ |
| 3. Ik begrijp dat mijn deelname aan het onderzoek de volgende punten betekent: een online interview van ongeveer 1,5 uur met video-opname en automatische transcriptie. | ☐ | ☐ |
| 5. Ik begrijp dat de studie 27-10-2023 eindigt. | ☐ | ☐ |
| **B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)** | | |
| 7. Ik begrijp dat mijn deelname betekent dat er persoonlijke identificeerbare informatie en onderzoeksdata worden verzameld, met het risico dat ik hieruit geïdentificeerd kan worden wat gevolgen kan hebben voor mijn professionele reputatie. Ik begrijp dat ik de samenvatting van het interview kan inzien en wijzigingen kan voorstellen om identificatie te voorkomen. | ☐ | ☐ |
| 10. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt, zoals naam, mailadres en telefoonnummer niet gedeeld worden buiten het studieteam. | ☐ | ☐ |
| 11. Ik begrijp dat de persoonlijke data die over mij verzameld wordt, vernietigd wordt een maand na het einde van het onderzoek, tenzij de deelnemer expliciet toestemming geeft aan de onderzoeker om deze te behouden. | ☐ | ☐ |
| **C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION** | | |
| 12. Ik begrijp dat na het onderzoek de geanonimiseerde informatie gebruikt zal worden voor de voltooiing van een master scriptie van de studie Industrial Ecology aan TU Delft en Leiden Universiteit. | ☐ | ☐ |
| 13. Ik geef toestemming om mijn antwoorden, ideeën of andere bijdrages anoniem te quoten in resulterende producten. | ☐ | ☐ |
| 14. Ik geef toestemming om mijn de functie en organisatie type te gebruiken voor quotes in resulterende producten. | ☐ | ☐ |
| **D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE** | | |

| PLEASE TICK THE APPROPRIATE BOXES | Yes | No |
|---|---|---|
| 16. Ik geef toestemming om de master thesis inclusief functie en organisatie type en de samenvatting van het interview gearchiveerd worden in TU Delft Repository opdat deze gebruikt kunnen worden voor toekomstig onderzoek en onderwijs. | ☐ | ☐ |
| 17. Ik begrijp dat de toegang tot deze repository openlijk toegankelijk is. | ☐ | ☐ |

**Signatures**

_____________________________ _____________________________ _________

Naam deelnemer Handtekening Datum

Ik, **de onderzoeker**, verklaar dat ik de informatie en het instemmingsformulier correct aan de potentiële deelnemer heb voorgelezen en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

___________________________ ____________________ _________

Naam onderzoeker Handtekening Datum

Contactgegevens van de onderzoeker voor verdere informatie: Joey van Loo, J.vanLoo-2@student.tudelft.nl

## H.3 Data Management Plan

# Plan Overview

*A Data Management Plan created using DMPonline*

**Title:** influence of the exponential demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city

**Creator:**Joey van Loo

**Principal Investigator:** Joey van Loo

**Data Manager:** Joey van Loo

**Project Administrator:** Joey van Loo

**Affiliation:** Delft University of Technology

**Template:** TU Delft Data Management Plan template (2021)

**Project abstract:**

All over the world cities are attempting to emit less carbon to limit the possibly detrimental effects of human-induced climate change. One way to limit carbon emissions is by reducing fossil fuel car use and transitioning to forms of low-carbon mobility. Electric vehicles (EVs) are an exponentially popular low-carbon transport solution, providing similar qualities to fossil-fuel cars. The question is though, whether it is possible to supply the growing demand for public EV infrastructure and simultaneously have a spatial design with every function within a 10-minute walking or cycling distance of each resident. This paper studies this question in the context of the municipality of Utrecht, the Netherlands. Policy decisions that are made now to a large extent shape how the city will operate in the future.
In this exploratory research, leverage points and lock-ins are identified both on a city scale (policy research) and a neighborhood scale (case study). Furthermore, Stakeholder behavior is analyzed by doing expert interviews with the most essential stakeholders how
they expect to respond when the research results become a reality. They are also asked to consider policies to prevent lock-ins and utilize leverage points. The goal is to prevent any unwanted outcomes blocking zero-emission mobility.
Key words: EV infrastructure, EV charging, 15-minute city, socio-technical systems, systemic design approach, carbon lock-in, leverage points, sustainable mobility, GIS, 3D-stakeholder grid.
7

**ID:** 132864

**Start date:** 06-03-2023

**End date:** 29-11-2023

**Last modified:** 06-09-2023

# influence of the exponential demand for EV infrastructure on Utrecht's aspiration to become a 10-minute city

## 0. Administrative questions

**1. Name of data management support staff consulted during the preparation of this plan.**

My faculty data steward, Nicolas Dintzner, has reviewed this DMP on 05-09-2023.

**2. Date of consultation with support staff.**

2023-09-05

## I. Data description and collection or re-use of existing data

**3. Provide a general description of the type of data you will be working with, including any re-used data:**

| Type of data | File format(s) | How will data be collected (for re-used data: source and terms of use)? | Purpose of processing | Storage location | Who will have access to the data |
|---|---|---|---|---|---|
| Interview data: ideas for policies and expected strategic behavior | Audio and video recording, word document | Stakeholder meeting (automated transcription via Microsoft Teams) | collecting expert's perspective on EV and 10-min city policy analysis | TU Delft OneDrive | Joey van Loo (Joeyvanloo@tudelft.nl), Alexander Wandl (A.Wandl@tudelft.nl) |
| Informed consent form | .pdf | pdf document | documentation of participant's agreement to the use and processing of their data | TU Delft OneDrive | Joey van Loo (Joeyvanloo@tudelft.nl), Alexander Wandl (A.Wandl@tudelft.nl) |
| Geoinformation about 10-minute city and public EV charging stations | GIS | GIS maps | Understanding the development of urban areas | TU Delft OneDrive | Joey van Loo (Joeyvanloo@tudelft.nl), Alexander Wandl (A.Wandl@tudelft.nl) |
| Anonymous summary of interviews | word | interview data | collecting expert's perspective on EV and 10-min city policy analysis | TU Delft OneDrive | Joey van Loo (Joeyvanloo@tudelft.nl), Alexander Wandl (A.Wandl@tudelft.nl) |

**4. How much data storage will you require during the project lifetime?**

- < 250 GB

## II. Documentation and data quality

**5. What documentation will accompany data?**

- Methodology of data collection

## III. Storage and backup during research process

**6. Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?**

- OneDrive

## IV. Legal and ethical requirements, codes of conduct

**7. Does your research involve human subjects or 3rd party datasets collected from human participants?**

- Yes

**8A. Will you work with personal data? (information about an identified or identifiable natural person)**

***If you are not sure which option to select, first ask your Faculty Data Steward for advice. You can also check with the privacy website . If you would like to contact the privacy team: privacy-tud@tudelft.nl, please bring your DMP.***

- Yes

**8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply)**

***If you are not sure which option to select, ask your Faculty Data Steward for advice.***

- No, I will not work with any confidential or classified data/code

**9. How will ownership of the data and intellectual property rights to the data be managed?**

***For projects involving commercially-sensitive research or research involving third parties, seek advice of your Faculty Contract Manager when answering this question. If this is not the case, you can use the example below.***

This is an internally arranged TUDelft master thesis project.

**10. Which personal data will you process? Tick all that apply**

- Photographs, video materials, performance appraisals or student results
- Data collected in Informed Consent form (names and email addresses)
- Signed consent forms

Profession/ expertise will also be processed.

**11. Please list the categories of data subjects**

Experts/ professionals. These consist of government officials from the municipality of Utrecht and commercial experts in the domain of public electric vehicle charging.

**12. Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?**

- No

**15. What is the legal ground for personal data processing?**

- Informed consent

**16. Please describe the informed consent procedure you will follow:**

An email will be send to the participants to read and fill in the consent form. At the start of the stakeholder meeting a check is done if the form has been signed. If not this will be done together with the participants to avoid any legal reprecautions.

**17. Where will you store the signed consent forms?**

- Same storage solutions as explained in question 6

**18. Does the processing of the personal data result in a high risk to the data subjects?**

**If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).**
**If two or more of the options listed below apply, you will have to complete the DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to receive support with DPIA.**
**If only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to get advice as to whether DPIA is necessary.**
**If you have any additional comments, please add them in the box below.**

- None of the above applies

**22. What will happen with personal research data after the end of the research project?**

- Anonymised or aggregated data will be shared with others
- Personal research data will be destroyed after the end of the research project

The research will share the Profession and job description if the participants agree.  Other data will be destroyed.

**23. How long will (pseudonymised) personal data be stored for?**

- Other - please state the duration and explain the rationale below

The data will be stored until one month after the research.

**24. What is the purpose of sharing personal data?**

- Other - please explain below

We are not going to share personal data.

**25. Will your study participants be asked for their consent for data sharing?**

- Yes, in consent form - please explain below what you will do with data from participants who did not consent to data sharing

If participants do not give consent their profession and job description they will not be able to participate.

## V. Data sharing and long-term preservation

**27. Apart from personal data mentioned in question 22, will any other data be publicly shared?**

- All other non-personal data (and code) underlying published articles / reports / theses

- informed consent for template
- interview protocols (questions)
- summaries
- GIS data

**29. How will you share research data (and code), including the one mentioned in question 22?**

- My data will be shared in a different way - please explain below

In the appendices of the master thesis.

**30. How much of your data will be shared in a research data repository?**

- < 100 GB

**31. When will the data (or code) be shared?**

- At the end of the research project

**32. Under what licence will be the data/code released?**

- CC BY-NC-SA

## VI. Data management responsibilities and resources

**33. Is TU Delft the lead institution for this project?**

- Yes, the only institution involved

**34. If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?**

Alexander Wandl, Thesis supervisor
(A.Wandl@tudelft.nl)

**35. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?**

NA