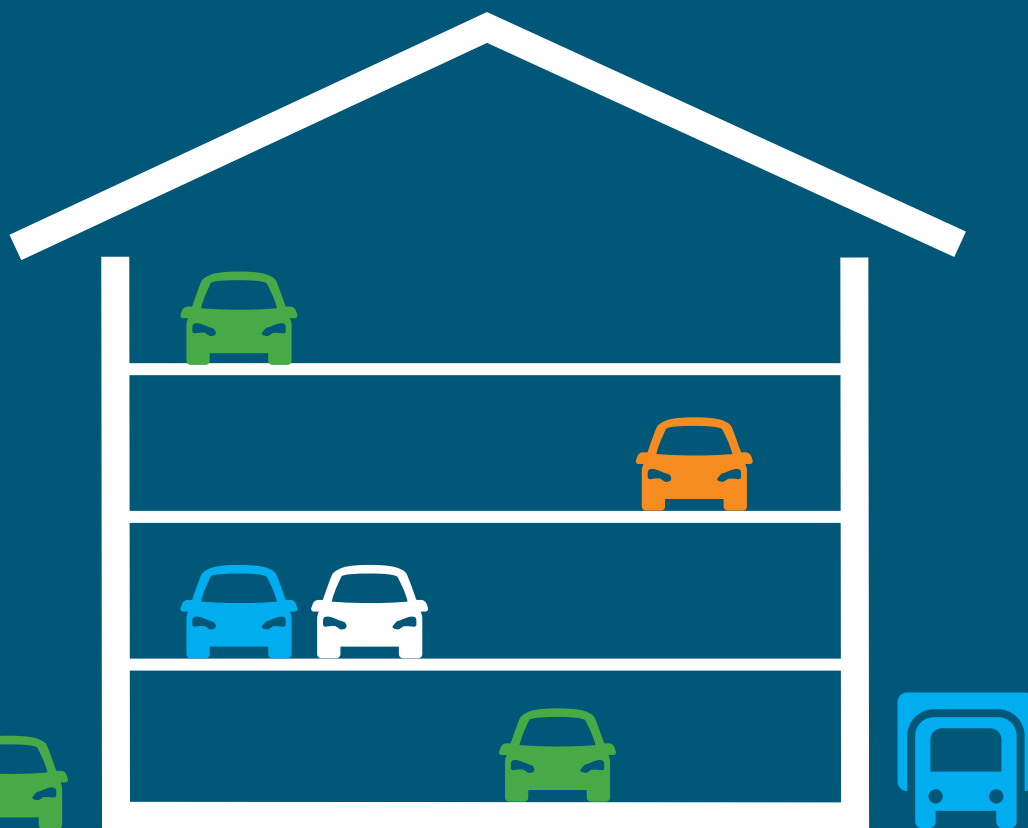


PARKING IN CITIES



CONCITO

DENMARK'S GREEN THINK TANK

Parking regulation in municipal climate and mobility action

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Preface

Parking in an international context

From the mid-20th century and onwards, car-centric urban planning became the norm in much of the world beginning with the United States. The traditional dense, mixed-use urban landscapes were expanded and/or replaced by suburbanization, functional separation, and intricate highway systems. Stretching the urban fabric increases the energy demand for transport, overall resource use, and cost for everything from paving to pipes. Car ownership and driving is – or is at least perceived as – a prerequisite for everyday life in a situation where transportation alternatives are sparse or seem less attractive in comparison.

Parking infrastructure is often taken for granted and seen as matter of fact as sanitation or streetlights. It is regularly provided at no or highly reduced direct cost to car owners. The costs are instead borne by all (taxpayers paying for public parking, customers paying for shops’ parking, employers paying for employee parking, etc.). This has been described at length by American engineer, professor of urban planning at UCLA, Donald Shoup as a classic tragedy of the commons-problem. The most comprehensive and well-known critique of the current parking paradigm is found in his opus magnum “The High Cost of Free Parking” (Shoup, 2005). The book commences with an outline of the history of automobility and parking and concludes with highly practical recommendations and guidelines for parking policy reform directed at politicians and planners. His primary recommendations are to remove minimum requirements for new development, charge fair market prices for curb parking, and direct the revenue generated from parking to local neighborhood and community. Good compromises require negotiation of the different and often opposing interests with a sensitivity to context. There is no one-size-fits-all.

Nevertheless, it is indisputable that parking is a prerequisite for cars. In some ways it is more fundamental than roads since most cars are only actually driven a fraction of the time. If there was nowhere to park the car 90% of the time where it sits idle, there would be no cars on the streets. More parking means more cars and vice versa. If cities are serious about wanting to reduce their CO₂-emissions, particle pollution, noise pollution, and overall dependency on cars, there is no way around the need to restrict automobility to some extent. Parking policy is an effective place to start.

Danish perspectives

At CONCITO, we are first and foremost concerned with climate action and with reaching politically agreed climate targets, mostly in Denmark but also in the EU (European Union). We work from a multilevel governance perspective and believe that everybody from individuals to local governments and international bodies of government have their part to play in the green transition. The focus of this analysis is parking and how parking policy can be leveraged as local climate policy in Danish municipalities. The effects of the suggested tools are likely transferable across contexts, although the scale of the impact may vary. Other recommendations are more specific to the Danish political and legal context but may still serve as comparative sources of inspiration and reflection.

In Denmark there are about 470 cars for every 1.000 inhabitants which is low in an EU-context where the average motorization rate is 570¹. The number of cars has been growing steadily from 2 million in 2010 to more than 3 million in 2024. The increase in numbers has occurred both in rural areas and the most urbanized areas where transportation alternatives such as cycling infrastructure and public transportation (bus, train, metro and/or light rail) are widely available. This demonstrates that providing alternatives is not sufficient for reducing automobility. With Copenhagen as the only exception, biking has been in decline for 10 years and the cost of public transportation has increased both in absolute terms and relative to the cost of car ownership. In Denmark as is the case in many places, the climate benefits from fuel efficiency gains and a burgeoning electrification have been outweighed by the growth of cars in numbers and size. Danes drive more than ever, and the number of passenger kilometers continues to increase year on year. Unless more measures are applied, full electrification is not expected until 2050 at the earliest, mostly thanks to the EU 2035 ban on the sale of emission cars.

Even as Denmark is often highlighted in an international context as a paragon of sustainable mobility, the picture looks different on the ground, especially considering the trajectory of trends. Automobility can be the most sensible means of transportation for certain destinations and regions. However, even for shorter distances of 5 km and under, the car is still the preferred mode. Conversely, in the biggest cities, a significant proportion of cars are only used infrequently, such as on the weekends, but still have access to free or reduced cost residential parking on streets and in public spaces. These two examples of mobility culture in Denmark bring to light how parking policy can be leveraged to increase modal shares of sustainable mobility for short trips and to reduce the number of “ghost cars” in cities, which can allow for improved availability of parking or the possibility to reallocate public space to different purposes.

¹ <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20230530-1>

Summary and recommendations

In dense urban areas, space is scarce and must be allocated efficiently. Municipalities can manage how much space is dedicated to car use at the expense of other land uses by implementing an active parking policy. This policy involves prioritizing which types of car-based errands and which motorists are desirable in the city. In existing urban areas, the influx of cars can be regulated by the number of parking spaces, time restrictions, and fees. In new urban areas, low parking norms can be used to create districts with limited car traffic.

Danish and Norwegian analyses show that parking conditions at the destination are to some degree deterministic for the choice of transportation. If parking is easy and convenient, twice as many people will commute by car compared to when it is difficult and expensive. Similarly, Norwegian analyses demonstrate that in situations where it is equally fast to drive in a car and to take public transportation, twice as many will opt for public transportation if the destination requires paying for parking. Thus, parking restrictions are a very efficient means of action to limit car traffic.

Generally, it is not possible to quantify the effects of individual parking legislation since the effect will depend on the conditions for car traffic and access to parking in the area in general. However, this analysis attempts to provide qualitative estimates and directions of the effects of parking. The purpose of the parking initiatives mentioned is to reduce car traffic and car ownership. The most important actions and their effects are summarized in the table below.

Table 1: Primary parking initiatives and a qualitative assessment of their climate impact

Initiatives	Who is impacted	Climate impact	Comments
Reduce the number of parking spaces	All car owners/drivers	+++	Areas can be used for walking and cycling infrastructure, bus lanes, green areas, and other purposes
Time-limited parking	Car owners/drivers that park for an extended period: commuters and inhabitants	+	Creates more car traffic per parking space but also transfers car trips to other modes of transportation
High cost of parking	All car owners/drivers - primarily long-term parking and low-income groups	++	Reduces inflow of cars and improve access for cars with important errands
Low max norms for new buildings	Primarily new inhabitants but generally all car owners/drivers	++	Requires regulation of adjacent areas to avoid spill-over-effect
High cost of residential parking	Residents	++	Can generate more inflow traffic if it is not accompanied by other initiatives
Parking in construction	Residents, urban life in general	÷÷÷	Parking underground or in a parking house emits significant amounts of CO ₂

Recommendations for municipalities

CONCITO recommends that municipalities use parking policy as a tool to limit CO₂ emissions from car traffic. A parking policy should include a coherent prioritization of the use of public parking areas.

Answers to the following questions will provide a good starting point for defining the necessary measures in the parking policy:

- Are there urban areas in the municipality where public transport is or is planned to be so good that there is no need for many parking spaces for cars?
- Are there urban areas where the distance between homes and travel destinations is so short that transportation can mainly be managed on foot or by (electric) bicycle?
- Are there parking areas that can be freed up for other urban activities (bicycle lanes/bus lanes, leisure areas, green spaces, etc.) with the right measures?
- Which parking areas should be filled up first (parking garages, street parking, large collective spaces/houses on the outskirts of the center)?
- How should new urban areas be planned to reduce the need for cars?

A cohesive parking policy can implement the prioritization necessary when the municipality wants to limit car traffic in central parts of the city. The parking policy must use different measures (reducing the number of parking spaces, time limitations, fees, and residential licenses) in different urban areas to create coherence in the restrictions with clear signals to motorists. It is important that the parking policy is simple so that it is easily understood by motorists. It should be easy both to understand what is allowed at a specific location and the intention of the parking policy should be communicated to motorists. The latter can help avoid some search traffic if one cannot find a loophole to park for free.

The parking policy should cover all urban areas where the demand for parking is greater than the supply. Otherwise, parking is pushed to neighboring areas. It might also be relevant to implement mechanisms that ensure that it is possible to administratively increase restrictions when and if there are more cars in an area. It can be an ambition that motorists should be able to find a parking space in an area (e.g., commercial district). If the growth of the number of cars makes it impossible, the parking policy can be designed such that it is possible to increase restrictions. For example, from time restrictions to paid parking or increasing the price of parking. In this way it is possible to continually ensure that it is precisely as easy or as difficult to park, as is desired from the municipality's perspective.

Parking policy should also actively address parking norms of newly built areas and apply low max norms. One should also consider the CO₂ -emissions of the construction of parking facilities in the overall assessment of parking solutions.

Recommendations for the national government

To give the municipalities greater freedom to introduce appropriate parking regulations, CONCITO recommends that the national government will adjust the following regulation:

- **Minimum parking norms:** Removal of requirements for minimum norms for parking as well as removal of requirements for compensatory mechanisms.
- **Income:** Abolish deduction of municipal funds based on parking income.
Land use: Multi-functional use of parking spaces ought to be permitted and the value of free parking at the workplace ought to be taxed as a fringe benefit.
- **Construction:** The complete CO₂ -emissions from the construction of parking facilities should be considered in life cycle analyses. Incentives to further construction with reduced emissions per square meter.

In the section "Legislation", these recommendations are elaborated.

Introduction and problem definition

Motorized transportation provides a flexible and individual mobility which is considered as very attractive by most people, especially those with the economic means and other prerequisites for owning and/or operating a vehicle. It also has a range of negative, well-known effects, including noise, air pollution and climate impact.

Furthermore, car traffic greatly impacts the urban fabric and design. To accommodate car traffic in areas which in many instances were built before the popularization of the car either means that there is going to be very little space for other activities and mobility forms or that significant, large constructions of subterranean roads and/or parking which are both expensive and, in the construction, phase emit significant amounts of CO₂. For this reason, municipalities stand to benefit from regulating the scope of car traffic, especially in urban areas.

The transition to electric cars will improve air pollution, reduce greenhouse gas emissions (GHG), and reduce noise, if cars drive slowly. However, congestion and the urban functioning will continue to be challenged by car traffic even if it is with electric vehicles.

Since the 1960's cars have been allocated a lot of space in urban areas. Front garden and even rows of houses and buildings have been removed to create space for growing automobility. Outside of urban areas the expansion of motorways has favored car traffic and has resulted in the car frequently being the fastest means of transportation measured from door to door. Combined with the flexibility and comfort of cars it is no wonder that cars have become the favored means of transportation for the majority. For many decades, a high cost was imposed on car ownership and driving in Denmark which resulted in lower levels of car ownership compared to similar countries. The relative cost of owning and driving a car has dropped the past decade, which has resulted in a steep increase in the number of cars. This is due to the combined effects of lower registration fees and a general increase in average wealth in the population.

Centralization because of the municipal reform must also be presumed to have had an impact; when distances between children and their school become greater, children are less likely to bike to school. This impacts daily transportation of both children and adults, health, and autonomy negatively. Cycling is in decline across the country, but especially for children in rural areas [1].

If we continue to expand the main roads every time congestion occurs, it will result in more cars. More cars create more congestion as is seen for most larger cities and their suburbs, which cannot be reduced by expanding the roads (there is not more space) and results in more parking demand in urban areas.

Accessibility for cars in the densest urban areas is often limited due to the physical structures of the dense city, and this impacts car ownership. In the dense urban areas, it is difficult to drive a car and to park it. Simultaneously, the conditions of public transportation and cycling have improved. Collectively, this means that the population in dense urban areas, has fewer cars, and drive less than similar groups that live more spread out. The table below demonstrates how large a fraction of families² in the entire country, Copenhagen, and Western Jutland own a car. Generally, in Denmark, we have a high degree of car ownership. Approximately 2/3 of all families have access to a car (63%), while families without a car only account for 37%. In Copenhagen, the distribution is reverse where 2/3 of families do not own a car, nor have access to one.

² Statistics Denmark defines families as "one or more persons living at the same address and having certain mutual relations. A family can consist of a single person or a couple with or without children under 25 living at home <https://www.dst.dk/da/TilSalg/Forskningsservice/Dokumentation/hoekvalitetsvariable/familier/familie-type>

Table 2 - Car access of families based on region (CAR800, DST, 2022)

	Denmark	Copenhagen	Western Jutland
Families without car access, %.	37%	67%	26%
Families with car access, %.	63%	33%	74%

It is this mechanism which can regulate car traffic in urban areas. If the municipality makes it difficult to be a motorist, while simultaneously making the alternatives more attractive, car ownership - all things considered - will decline among the population groups which are less dependent on car ownership. This will result in a reduction in car traffic and there will be fewer cars which sit unused most of the day and of the week.

A significant fraction of the cars in urban areas only rarely drive because they are not used for the daily commute. When people without a pronounced need for driving still wish to own a car, there are many different valid reasons and justifications but also downsides. Accessibility to parking can impact one's consideration of whether it is required/makes sense to own a private vehicle in an urban area.

The more cars are present in an urban area, the more car journeys are taken. This is partially because the car is quick and flexible outside of the limited fractions of the day with congestion issues. Besides, it is cheap to drive in the car once it has been purchased. Especially electric vehicles are cheap to run, even though they cost more up front.

This brief introduction of the development and role of car traffic in urban areas serves to conclude that there is a real and legitimate need for municipalities to regulate the number of cars through parking policies, infrastructure as well as conditions for other means of transportation. This is both in consideration of mobility and land use. In this analysis, the focus is only on parking regulations.

Land use for parking

Car traffic takes up a lot of space from road infrastructure alone. Parking also takes up significant space in most urban areas. Most cars are parked on private land such as driveways and garages when they are "home". Further 20% park in connection to housing at shared facilities. Only 12% of cars are parked on public land when they are "home" [2]. It is often the latter portion which creates problems in urban areas because an increasing number of cars in dense urban areas are unable to find sufficient parking spaces on public land.

Areas for parking are also located at workplaces, retail, cultural and other institutional facilities. As a result, there are much more than one parking space per car in urban areas. In study from the Norwegian Transport Economic Institute [3] it is assessed, that in Norway there are 4-6 parking spaces per car.

There are no aggregated numbers on the total land use for motorized road transport. Neither how large areas that are used for parking in urban centers. In a study of 18 central/arterial roads in Berlin, it was investigated how traffic was divided between different modes of transportation [4]. The current use of the traffic area has been compared with alternative ways to distribute the area. In table 3 it is shown how the area should be distributed if it had to correlate to either the passenger traffic work or the number of trips.

Table 3: Distribution of the traffic area (in %) based on means of transportation on 18 selected streets in Berlin distributed based on different principles: 1) the current distribution of the traffic area, 2) distributed based on passenger traffic work, i.e. how many people are transported relative to the area, and 3) number of trips.

	Car driving	Parking	Cycling	Public transportation	Walking
Current distribution	32	22	8	7	31
Divided by passenger traffic work	33		14	47	6
Divided by number of trips	34	4	16	18	29

Regulation of car traffic

The cities' opportunities to regulate the amount of car traffic is currently highly linked to parking regulation. There are plans to allow the municipalities to introduce (smaller) zero emission zones, but it is currently not possible for the municipalities to institute congestion charges (or more generalized road pricing), as exists in many other European cities.

Most trips will end in a parking space. For that reason, it is obvious that the accessibility of parking is decisive for how many people choose to conduct a given trip. Regulation of parking is an important tool in differentiating which types of car traffic the municipality wants to prioritize in different areas of the city. In many locations it is desirable to keep commuters out since they only to a limited extent generate revenue in a city center. In other locations, it is desirable to prioritize residential parking. And in other places, vans and trucks which deliver goods and services are the main priority.

Besides from parking, planning of road infrastructure naturally impacts the volume of car traffic. The national government mandates the overall transport infrastructure - roads, rails, airports etc. Furthermore, the national authorities determine taxes on purchase and ownership of cars as well as fuel taxes. Those are the framework conditions which at large determine car ownership and how much people choose to drive in Denmark. Municipalities determine the municipal roads and the conditions for parking on public land.

Parking on public land exists in many places where it is not possible to park on your own land. This is often elderly housing and frequently multistorey apartment complexes or attached houses. Typically, it is buildings which were constructed before the dawn of motorized transportation and the private car. Therefore, they are not planned without the extra space required for cars. The number of cars in these areas often surpass the number of parking spaces. This results in much time spent by the residents in the search of an available parking space. This can result in residents with cars either spending an undue amount of time driving around and searching for parking, or for those for whom it is possible, they might refrain from using the cars for errands and at certain times when longer search times are experienced. Such a situation can also result in some residents purchasing a parking license in a private parking facility to get access to a predetermined parking space at all hours of the day. Such a solution will often cost 10-100 times as much as a residential parking permit. Many would prefer to "pay" with the extra time spent searching for public and much cheaper parking.

Types of parking regulation

Legislation

Parking is primarily regulated through two types of legislation. Partially through The Road Act which addresses the road authority's right to regulate and charge for parking on public roads and spaces. Partially through The Planning Act and The Building Act when it comes to conditions of the built environment. Additionally, there is The Traffic Law which contains safety-oriented legislation. Furthermore, in the legislation which regulates cross-municipal subsidies it is stated that a municipality may only charge for parking to the extent that it covers the expenses from regulating and monitoring parking. If the charged amount surpasses a certain threshold, the municipality is required to pay back some of its cross-municipal subsidies to the national government.

Regulation through The Road Act concerns existing urban areas and public roads in general. This legislation enables the municipalities to regulate parking through time limitations and payment as well as permitting advantages for special groups such as residents, zero and low emission vehicles, and especially persons with disabilities.

A municipality's parking guidelines for new construction will often be part of the municipal planning process. In local planning, the municipality's parking policy is translated into specific parking conditions in connection with new construction or transformation of urban areas. Typically, you will work with either minimum or maximum standards for how many parking spaces must be established for several homes or square meters of new construction for different purposes. According to the Planning Act, minimum standards must ensure sufficient parking, which is not further defined, while maximum standards must limit the parking area and car ownership in the area.

Today, it is not possible to finance parking across municipal boundaries. This would create stronger incentives for park and ride facilities in suburban municipalities. For example, financed through parking revenues in the center municipality. This has previously been recommended by KORA [8]. However, it will often prove difficult in practice, as no municipality wants to act as a "parking lot" for a larger catchment area.

CONCITO recommends that legislation should be adjusted so that parking and car use are not disproportionately favored compared to other modes of transport². For example, the value of parking at the workplace should be taxed as an employee benefit and the building regulations can be adjusted so that the full carbon footprint of parking facilities counts 100% regardless of the type of parking. Today, integrated garages count 50% and integrated carports 25%. An adjustment will ensure that it is not more attractive to build with parking to reduce CO₂/m².

The table below contains CONCITO's proposals for legislative changes affecting parking.

Table 4 - Proposed legislative changes for parking.

Legislation	CONCITO's proposed amendments
The Danish Construction Act §7, paragraph 1 (LBK no. 1178 of 23/09/2016)	Remove all requirements for minimum parking standards and establish the necessary legal basis in the Planning Act [7]. The note that satisfactory parking areas must be ensured is deleted. Instead, it can be stated that areas must be secured to cover the need for mobility in a satisfactory manner, also in relation to climate, environmental and health considerations. There should be no differentiation between car parking, bicycle parking, public transport, and other modes of transport in favor of cars.

Danish Building Act §7, paragraph 2	Allow multifunctional use of parking areas and remove any barriers to converting areas zoned for parking for other purposes. Today, areas zoned and approved for parking cannot be used for anything other than parking.
Construction Act §22, stk. 6 & Parking Fund Circular (CIR no. 10 of 17/10/1994)	It must be possible to completely waive the requirement for parking on your own property without compensatory measures such as paying into a parking fund or establishing replacement parking on another property. Disabled parking is exempt, while car sharing may be exempt.
Building regulations (BR18)	All forms of parking should count 100% in the CO ₂ - calculation ₂
The Danish Tax Assessment Act §16, paragraph 10 (LBK no. 1735 of 17/08/2021)	The value of free access to parking at the workplace is taxed as an employee benefit unless the car is an actual work tool.
Act on municipal equalization and general grants to municipalities (LBK no. 63 of 19/01/2021)	Offsetting of municipalities' block grants from parking revenues is dropped (§15 (3) & (4), §15a, §17d (1) & (4)). Instead, it is stipulated that parking revenues can only be used for mobility-related costs (operation or construction).
Road rules	Enable differentiation of payment according to the footprint of the car and leave larger bays (wider than 2.5m) on public roads up to local political decision instead of locked in by the Road Rules. ³

Existing urban areas

In existing urban areas, the municipality can regulate parking on public roads and public areas. The municipality cannot regulate parking on private areas but can designate private areas for other uses so that they can eventually change use. However, the use of private areas for parking during a transitional period can be difficult to regulate. Municipalities can regulate parking in public areas in the following four ways:

- Through number of parking spaces
- By giving rights to special groups, e.g. residents, business spaces, car sharing, etc.
- By time limit
- When pricing

Typically, when the number of cars exceeds the number of parking spaces in an area, it becomes difficult to find a parking space and the municipality will regulate parking. The regulation will exclude some types of parking, and therefore there will be spaces for more of the prioritized cars. Parking policy is therefore generally to prioritize between different types of trips and drivers, so that you primarily support the trips and drivers that the municipality wants in the area in question.

Available parking

It is obvious that if the municipality closes parking spaces in an area, for example to establish a bicycle path or a bus lane, it will become more difficult to find parking in the area, and this will lead to two effects. Firstly, there will be more cars circulating to find a parking space, and secondly, some drivers will choose other means of transportation or other destinations for their trip. Overall, fewer parking spaces will mean less car traffic. The size of the effect depends on local conditions.

³ In 2010, for example, the VD changed the guiding dimensions for a parking space from 230 in width to 250 cm: <https://fdm.dk/node/1390>

Restrictions on time

Time limits are used to ensure circulation in parking spaces. This is typically used by retailers to prevent parking spaces from being taken up by commuters who don't generate much turnover. Time restrictions are also used in residential areas in combination with residential parking to ensure space for residents' cars. Time restrictions can apply during the daytime, in shorter time windows or virtually around the clock. The specific conditions in the area will determine what is an appropriate regulation. For example, if there are many cultural institutions in the area, free parking in the evening will not ensure that residents can find a space, and it may be appropriate to allow time restrictions to apply until 23:00. In the area in front of a daycare center, you can establish a maximum of 15 minutes of parking in a period between 7:30 and 9:00 am, when most parents drop off their children. In this way, you can prioritize parking space for different drivers and trip purposes throughout the day in a detailed way.

The effect of a time limit will be that more car trips can use the same parking space during the day. The shorter the time interval, the more trips a parking space generates. This type of regulation will therefore favor drivers with short errands and potentially create more car trips in the area than in a situation with free parking. Time limits should therefore not be introduced to limit car traffic, but to create flexible utilization of parking spaces.

Rights for special needs group

The most used regulation is to establish either time limits or payment in combination with resident licenses. This means that residents with a permanent residence in the area can park without restrictions for a fixed, typically symbolic, fee, while drivers coming from outside the area are either only allowed to park for a limited time and/or must pay for parking. The effect of this approach will be to reduce parking for longer periods of time, typically commuters, while providing residents with better parking options. The price of resident parking is often low and only covers the cost of administering the scheme. Parking regulation means that parking in the area must be controlled. This will mean municipal costs to enforce and administer the parking restrictions. The payment for resident parking is unlikely to cover the real cost of losing the opportunity for other uses of the space that the car occupies in the street.⁴

Other groups that can be favored in parking regulation are typically disabled people, who are allocated a parking space at their address if they have a disabled car. Disabled parking spaces are also established in different parts of the city where there is an assessed need.

In recent years, some municipalities have also chosen to prioritize car sharing and electric cars. Car sharing both with and without a fixed parking space can be prioritized. On the one hand, this means that car-sharing vehicles are always available where the users live and that they have easier parking conditions than individually owned cars. On the other hand, it means that there are fewer parking spaces for the other cars. All of this makes car sharing a more attractive option.

Several cities are introducing free parking for electric cars and/or reserved spaces for electric cars. This naturally provides an incentive to switch to an electric car if you frequent these areas. However, it is a favoritism that must have an end date as the share of electric cars increases. In terms of promoting the transition to EVs, it is more important to ensure that charging points are i) properly located and ii) accessible. Parking regulation is especially relevant in relation to the last point, to ensure that charging stations are not blocked by cars that are not charging (whether they are EVs or not). This

⁴ For example, a resident license in the City of Copenhagen for 2023 costs between DKK 515 - 5,530 depending on the car's fuel consumption [5], while a private parking space costs between DKK 1,000 - 3,000 per month depending on the area (see prices on Lokalebasen.dk).

could be done with a 3–4-hour time limit (but only during the daytime, allowing residents to charge overnight and leave the car until 8 am the next morning).

Paid parking

Paid parking will generally limit long stays in the area in question. Paid parking is typically introduced where it is not possible to find a free space despite time limits on parking. When introducing paid

parking, some drivers will opt out of the area to save the payment and spaces will become available in the area. The fee can be in- or decreased on an ongoing basis to ensure that people with errands in the area can always find a space. In theory, the right price is one that always leaves at least one available space. Paid parking will mean that drivers with better finances and/or a higher willingness to pay will perceive paid parking as less of a barrier than drivers with lower incomes. This kind of regulation will impact lower income individuals and households more.

However, in most cases, paid

parking is a very small cost compared to the cost of owning a car. It is therefore unlikely to break the budget. Despite this, many drivers will go to great lengths to avoid paying to park. Therefore, this measure will result in lower car use in the area in question. In large cities, the city will often be divided into zones with increasing parking rates towards the city center, where demand and willingness to pay is highest, exemplified by the zone map from Copenhagen (see figure 1). Prices vary from free on weekends to DKK 41/hour during the daytime in the red zone (see table 5).

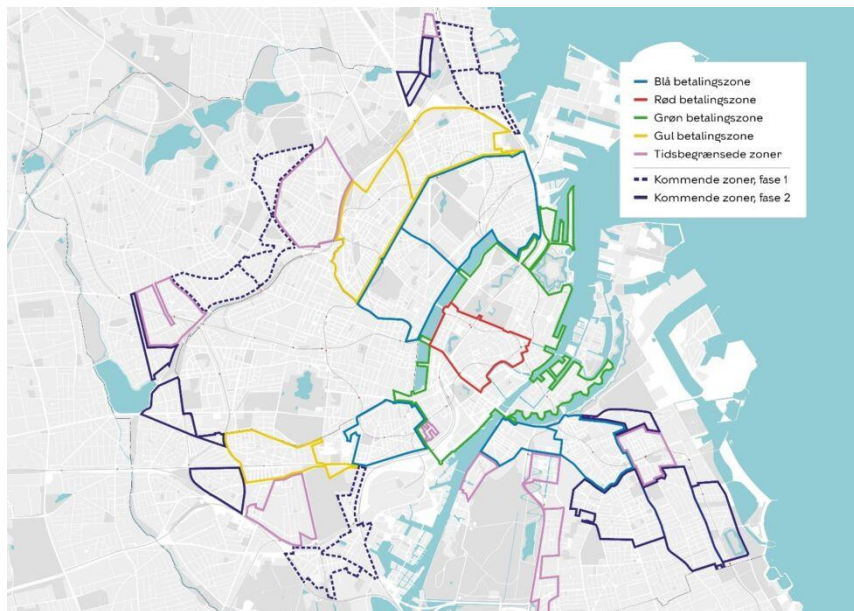


Figure 1: Parking zone map of Copenhagen (Technical and Environmental Administration, City of Copenhagen)

Table 5 - Parking prices by zone and time in Copenhagen (Technical and Environmental Management)

Prices in 2023 in	Red zone	Green zone	Blue zone	Yellow zone
The payment zones	Price per hour	Price per hour	Price per hour	Price per hour
Day (08-18)	41 kr.	24 kr.	15 kr.	12 kr.
Evening (18-23)	16 kr.	16 kr.	16 kr.	12 kr.
Night (23-08)	5 kr.	5 kr.	5 kr.	5 kr.
Saturday from 17:00 to Monday 08:00	Free of charge	Free of charge	Free of charge	Free of charge

There has been a political debate about whether municipal paid parking can be considered a form of alternative tax collection. For this reason, there has been a lot of opposition to paid parking from previous governments, and municipalities have paid a large part of the revenue from parking to the state. The rules state that paid parking may only be introduced for the sake of mobility in the area. Therefore, the municipality cannot introduce paid parking solely to generate revenue.

Other ways to reduce parking in urban centers

Park-n-ride facilities

An alternative is to establish parking spaces outside the urban area with good public transport connections, making it possible for drivers to park their cars outside the city and take public transport to their destination in the city center. On the face of it, this is a great initiative, but in practice it often proves to be less effective. There are several challenges:

- Finding sufficient land near good public transport. Often, there are not large areas of land available at stations that can be used for parking – and if they are available, they are typically better spent on building housing or workplaces near stations.
- To ensure that travel time does not increase overall with a public transport solution. It takes time to switch from car to public transport and the frequency of public transport must be so high that the overall travel time does not increase with public transport. This can also be achieved if there are or will be significant congestion problems for car traffic that are not addressed.
- Finally, in some cases, there are different municipalities and thus different interests in establishing parking. The central municipality will have a strong interest in cars being parked outside the city, while the surrounding municipalities do not have the same interest in large parking facilities near public transport. As the rules stand today, it is not possible for the central municipality to finance parking in the neighboring municipality.
- In many cases, there are relatively few spaces that can be allocated near public transport in peripheral urban areas. Therefore, the effect on car traffic is also relatively limited.
- However, if you want to reduce parking capacity in the city center, it can be crucial to provide other mobility options, such as park-and-ride facilities.

There are good examples of public transport parking. Abroad, it is often in connection with toll rings or very significant congestion problems on approach roads. On a slightly different scale, you can see effective park-and-ride spaces at both Korsoer and Nyborg stations as well as at Koege Nord. In all cases, this involves paid parking at the destination and/or access to efficient public transport.

Double use

When there are 4-6 parking spaces/car [4] that can't be utilized at the same time, initiatives are often underway to better utilize parking capacity. Businesses may have parking facilities for their employees that are utilized during the day, but not during the evening and night. Similarly, residential parking will be fully utilized during the evening and night, and there will be available spaces during the day. It sounds simple to double utilize parking capacity by allowing residents to park in corporate parking areas. However, such initiatives are often met with resistance because businesses want to ensure that all spaces are available early in the morning. Since it is not attractive for residents to have to move their cars every weekday at 7 am, for example, it is rare in practice that double utilization can solve major problems. Moreover, double utilization of parking will not contribute to reducing car traffic, but only reduce the parking area.

Parking in connection with new buildings

Most municipalities have standards for how many parking spaces must or can be provided in new developments. How parking is organized has a significant impact on car ownership, especially in large urban development areas.

Min or max norms?

In many cities, there has been a tradition of having minimum parking standards for new developments. Typically, the norm has been to provide one or even 1–2 parking spaces per new home. The intention is that the developer must provide sufficient parking space as part of the new construction, so that neighbors/municipalities do not have to deal with the problem afterwards. With minimum standards, the developer is free to provide more parking spaces if they believe it will make the development more attractive.

Several cities, also abroad, have switched to maximum standards. Here, a developer is only allowed to build a maximum of ½ or 1 parking space per home in a new development. In this way, the municipality ensures that there will not be a very high car ownership in the newly built area.

Parking in construction as add-on (additional purchase)

In dense urban areas, parking is often required to be constructed either above or below ground. This makes the establishment of parking quite costly, and you will often find that the developer will be very satisfied with low parking standards and preferably maximum standards when parking is to be established in construction.

When parking is provided in developments, it makes sense to separate the cost of the home from the parking. Previously, the provision of parking was an integral part of the cost of construction and was reflected in the price and/or rent of the homes. When parking construction is a significant cost, as is often the case in urban areas, it is reasonable to separate the two economies. Thus, a new resident can choose to buy/rent an apartment with or without a parking space. That way, the driver pays the full amount for the parking space and the residents who choose to live without a car can avoid paying for parking. If you have a car in such a newly built area, you will have to buy or rent a parking space, as there will be no other place to park your car. There will be no access (or space) for residential parking on public roads in such areas.

Parking standards also apply to urban functions other than housing. There are usually parking space standards for commercial buildings, retail, institutions, etc. that similarly aim to ensure adequate, but not oversized parking facilities.

Svendborg Municipality has collected parking norms from different cities Funen [6]. You can see how the norms differ by function, city size and density, which shows the desire to control the amount of car traffic and ownership.

Parking in construction

In many cities, there are large empty parking lots in both basements and houses. If off-street parking is available, drivers prefer this solution. This is partly due to the hassle of getting in and out of the parking facilities, and partly because it is usually more expensive to park in facilities than on the ground. However, it is a poor use of the existing infrastructure not to fill the parking facilities once they are built. For example, even on Black Friday in 2018, Aarhus Municipality had 1,500 available parking spaces in underground parking garages with public access, all within reasonable walking distance from the shopping streets in the city center.

The tool to fill parking facilities is, of course, to limit surface parking and possibly make it cheaper to park in facilities to the extent possible. Often private operators have these facilities under construction, and of course they cannot be regulated by the municipality. In fact, you can be accused of “cartel formation” if you agree on prices between the public and private parking providers.

In many new, dense urban areas, municipalities require parking to be constructed, i.e. parking basements or parking garages. The obvious reason for this is to remove parked cars from the surface to create greener urban spaces and a much better and safer urban environment in the area. However,

parking in construction has the effect of emitting significant amounts of CO₂ during the construction phase.

Analyses have been conducted to determine the CO₂ emissions from the construction of a handful of parking garages in Sweden [9]. According to SBUF (the Swedish Construction Industry Development Fund), a traditional parking garage emits 6 tons of CO₂ e/parking space. A brand-new wooden parking garage, a pilot project in Malmö, has managed to reduce emissions to just over 4 tons of CO₂ e/parking space. According to their report, construction emission reductions of 40–60% are possible, but it requires choosing all the right materials, construction equipment, etc.

Emissions from underground parking facilities will be higher, as excavation and earth moving, possible foundations and a higher material consumption for concrete, which cannot be replaced by wood or similar in the same way as with buildings, must be considered. A Swedish report from IVL [10] states that one underground parking lot emits approx. 10t CO₂, but it has not been possible to find the basis for this calculation.

Unfortunately, in Denmark, it has only been possible to find data for excavation and removal of soil. For example, in Copenhagen, 1500 parking spaces were built in an underground parking garage. This led to the excavation of more than 400,000 tons of soil, and the excavation and removal of soil emitted about 1,000 tons of CO₂, or about 650 kg CO₂ e per parking space for the earthworks.

We therefore conclude that a reasonable estimate for the construction footprint of a parking lot in construction is 4–10 tons, depending on whether it is above or below ground.

Currently, the area for parking in facilities is partially counted in a building's total area. At the same time, over the lifetime of a building, the parking area has a low CO₂ footprint/m², as it is typically not heated and maintained to the same extent as the residential/commercial area. It can therefore reduce the building's CO₂ footprint per m², which creates an inappropriate incentive to include parking in new buildings.

Planning for car-free urban areas

There are several experiences with planning urban areas for no or much fewer cars in several of our neighboring countries [10, 11 & 12]. In Germany and the Netherlands, the approach is usually to establish a limited parking area far away from the homes and in return to build more green spaces in the area where parking should have been. In Sweden, this approach is often supplemented with all residents being members of a car-sharing club (carpool) from the start, and car-sharing cars and corresponding bikes are placed centrally, right at the entrance to homes, making car-sharing and bikes the easiest choice. There have also been experiments with giving a monthly pass for public transport to newcomers in such a residential area to encourage them to try out public transport – and not just get a car before testing out shared mobility and public transport options.

Experience shows that there is a high demand for living in such almost car-free residential areas, contrary to what both municipalities and developers had expected.

The effects of parking restrictions on car use and climate

What are the impacts of parking restrictions on the amount of traffic?

There are strong correlations between parking availability, distances to many activities and the quality of public transport, among other things. Therefore, it is difficult to take one element such as parking and assess the effect of this one parameter.

Based on data from DTU's transportation survey, the choice of mode of transportation for commuter trips is dependent on the availability and cost of parking at the workplace (see Figure 2). If it's easy and free, the majority will drive, while many more will choose both active and public transport when it's time-limited, there's a lack of space and/or paid parking is available. Of course, the location of the workplace and the distance between home and workplace determine whether it is possible to use active or public transport at all. For example, 65% of Copenhageners who work in Copenhagen, where distances are short and parking is limited,

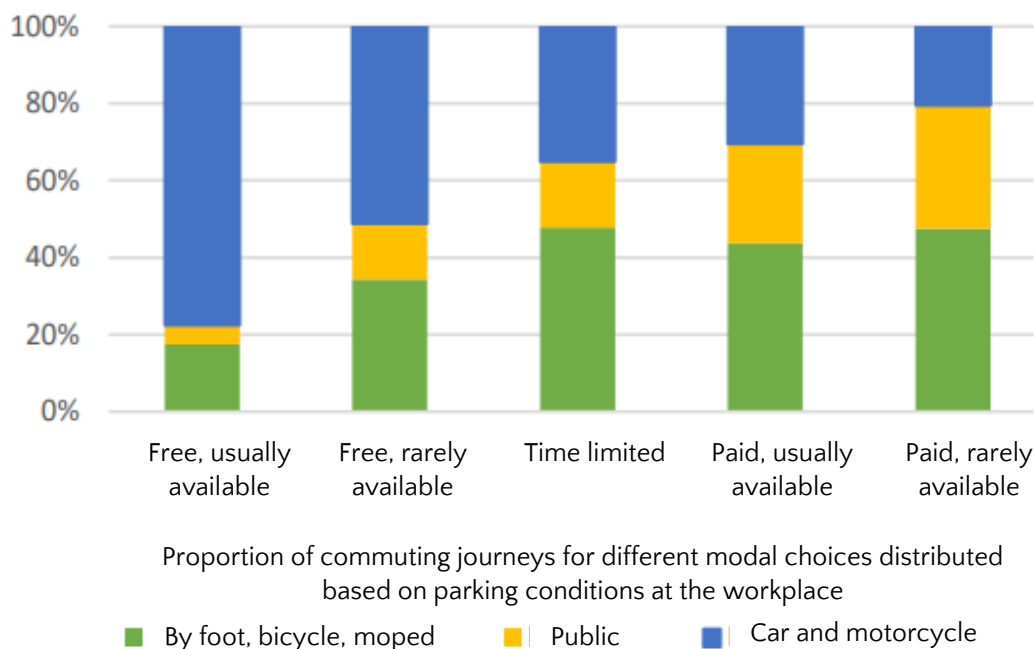


Figure 2: Choice of mode of transport on the journey to work depending on parking conditions at the workplace. The figure is based on the Danish transport survey (2016-2019)

A Norwegian study by the Institute of Transport Economics shows the same effects (see Figure 3). The difference is that more people in Denmark cycle.

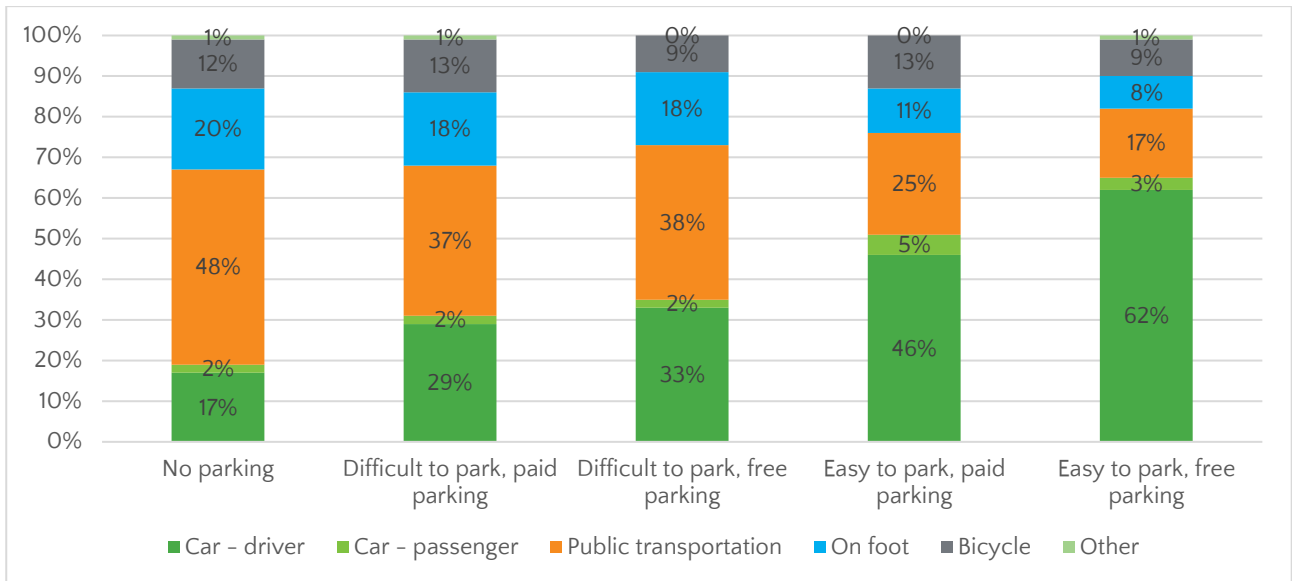


Figure 3: Choice of mode of transport for the journey to work depending on parking conditions at the workplace. The figure is based on the Norwegian Travel Survey (2013/14).

It is clear to see that car use in commuting is more than twice as high if parking is easy and free at the workplace compared to the situation where it is difficult and must be paid for. It is therefore clear that limited parking options at the destination of the trip means that car traffic to that area is significantly reduced.

Based on the same transport habit analysis, the TØI report shows a correlation between the use of public transport and parking conditions at the home (see Figure 4).

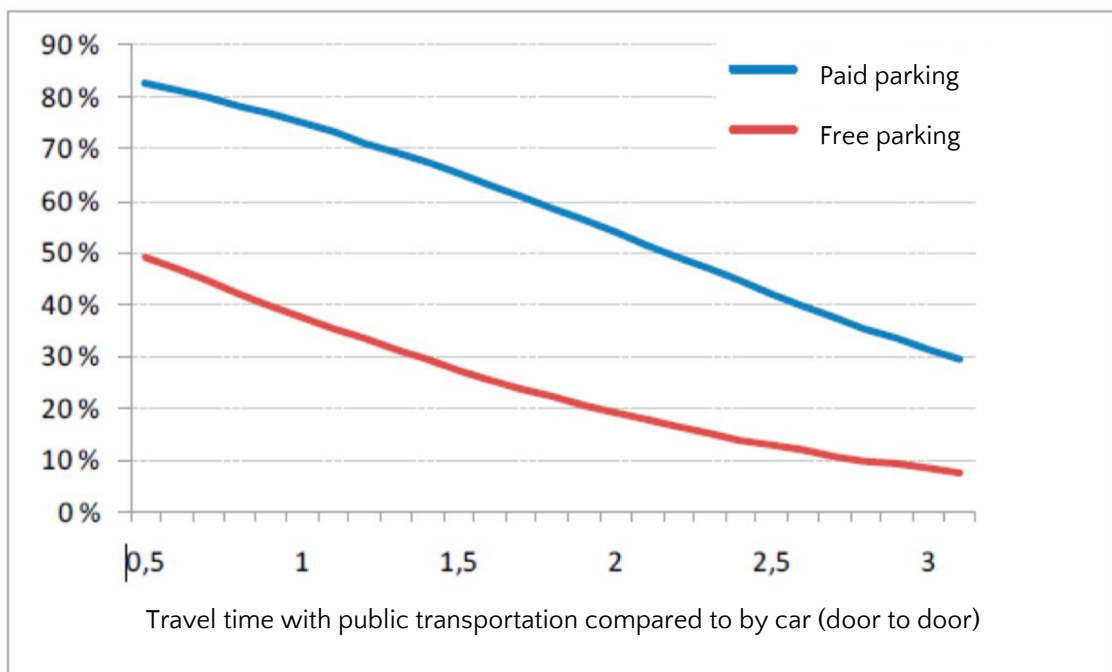


Figure 4: Probability of traveling by public transport depending on the relationship between travel time by car and public transport and parking conditions (Travel Survey 2013/14 Norway [3])

You can see from the figure that if it is equally fast to make a given trip by car or by public transport (x-axis = 1), about 40% will use public transport if parking is free, while about 75% will use public

transport if there are parking fees. The difference between public transport use is maintained even though it takes twice as long to use public transport as it does to drive. This underlines how effective a tool paid parking is in limiting car traffic to a given area.

Parking conditions of housing

The easier it is to park at home, the easier it is to have a car and take the car. This is illustrated in the following by data from DTU's transport survey (2016–2019), where the effect of parking conditions at home on mode choice is examined, broken down into 19 types of access to parking. Data is available both for trips (see figure 5) and for the total amount of transportation (% of distance travelled in km) (see figure 6).

Effects of parking conditions of housing - distributed based on share of trips (%)

The lowest overall share of car trips is found in the categories where parking is paid or time-limited (4 and 9). In comparison, car trips make up the largest share of the modal split where there is on-site parking (18 and 19).

The average share of walking is around 30%. The share is highest where it is most difficult to park (9 and 13), while it is much lower where it is easiest to park (18 and 19). This may be because the places where it is most difficult to park are in the most urbanized areas where more of the daily activities are within walking distance, while the places where it is easy to park are often in more sparsely populated areas where distances are greater and/or walking is not attractive.



Figure 5 - Modal split for number of trips by parking conditions (DTU: Transportvaneundersøgelse 2016-2019)

In general, the share of bike trips is higher when the share of car trips is lower. This may indicate that it is more likely to be the shorter trips where the bike can replace the car. When there is a higher share of public transport, it is more likely to be the longer trips.

A cautious conclusion might be that people don't automatically take the bike even when short distances make it possible, but that difficult parking conditions create a stronger incentive to choose other means of transportation than the car.

Effects of parking conditions of housing - distributed based on person kilometers (traffic work)

When comparing the statistics for the effect on parking of the number of trips and trip lengths, the difference is that there are many more short trips than long trips. This explains why walking and cycling take up less space in the statistics based on person-kilometers, as they represent many trips, but only a few kilometers overall. For many of the categories, well over half of the total number of kilometers are driven by car, either as a driver or as a passenger. There are more trips as a driver. In comparison, there is a higher proportion of kilometers driven as a passenger. This may be cases where several people drive longer trips together, e.g. to visit family/friends, go on vacation, etc.

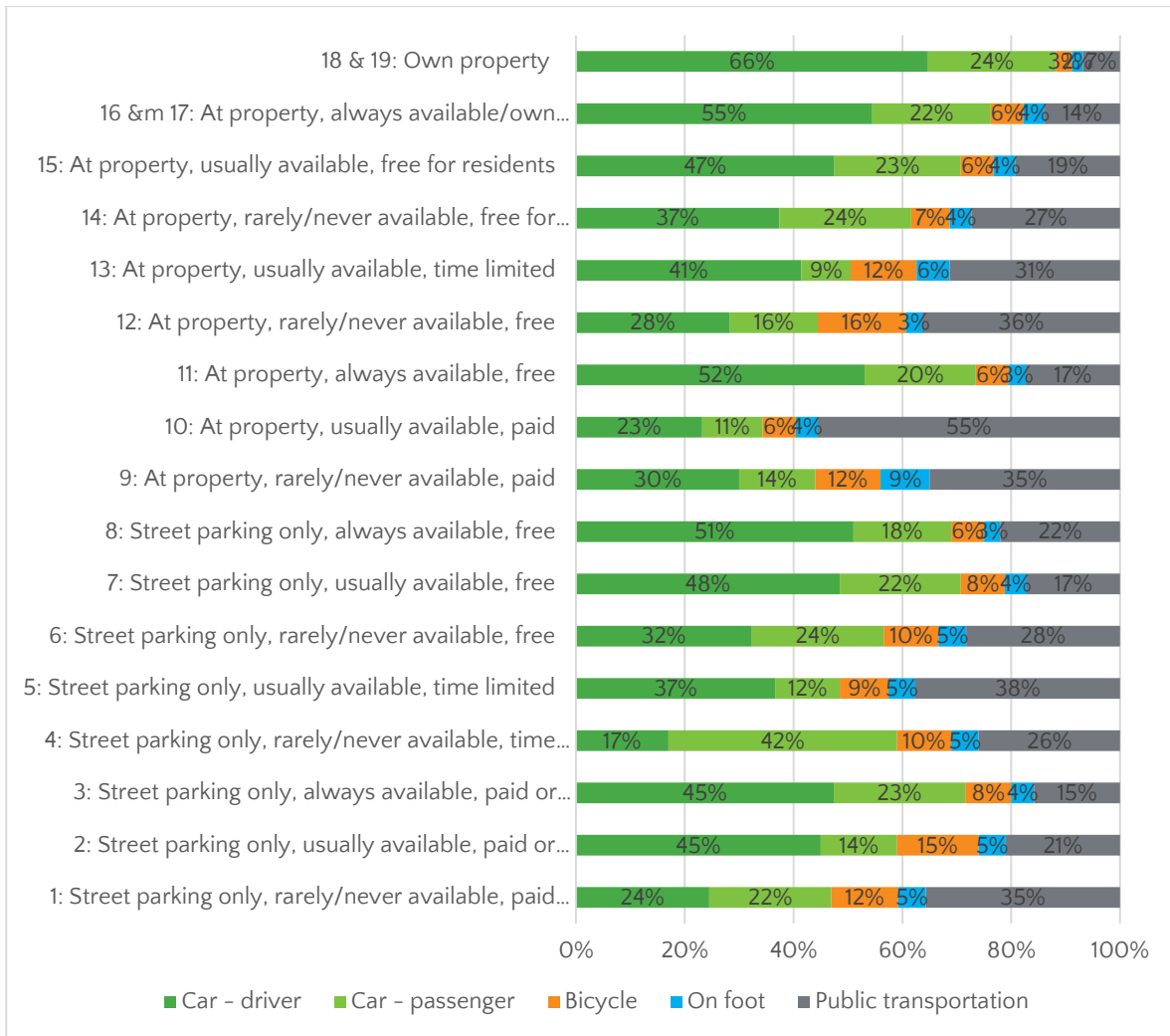


Figure 6 - Modal split by person-kilometers by parking ratio.

(DTU: Transport habit survey 2016-2019)

The lowest share of driving by car is again found when it is paid parking at the home where there is usually space (10) or rarely space (9), paid parking/license on the street where there is rarely/never space (1) or time-limited parking at the property where there is rarely/never space (12).

Most car driving is found where parking is easy (18 and 19). Those with the most difficult parking conditions travel greater distances by public transport. The effect is greatest where there is paid or time-limited parking (10, 5, 9, 12, and 1).

Where parking is on the street, but space is rarely available and parking is free, 28% of the distance is traveled by public transport. Where parking/parking license is paid for, it is only 15% (3) to 21% (2). This suggests that even though parking is inconvenient, some people prefer to make the longer trips by car or are unable to use public transport to meet this need.

If parking at home is expensive and inconvenient, far fewer trips will be made by car. Especially short car trips will be replaced by cycling and walking, with the strongest effect for the bicycle for medium/long trips. In this way, difficult parking conditions can provide a societal and personal health benefit when the incentive to walk and cycle is increased.

It seems more difficult to replace the car when it comes to very long trips, where public transport does not displace the car in the same way. More kilometers are driven as a passenger, indicating

lower car ownership and/or a greater tendency to carpool if you live in a place where parking is difficult.

However, the potential seems great, especially with paid parking, even if space is usually available (10), where 55% of kilometers were driven by public transport. Compared to only 19% if parking was free (15). There is likely some degree of self-selection in the figures, as people who have a harder time finding a space drive less by public transport (9). This suggests that if you need your car, you keep it and use it, even if space is hard to find. In other words, people seem more likely to spend their time rather than their wallet on parking.

The type and density of development (degree of urbanization) has the greatest overall effect, as people with access to parking space on their own property drive more frequently and for longer distances. Thus, the planning and design of residential areas has a large effect on an individual's choice of transportation mode.

Finally, it should be mentioned that the data shown above reflects some self-selection: if you want/need to have your own car, access to parking will probably also play a role in your choice of housing. However, an analysis of the transportation choices of residents of affordable public housing in San Francisco [13] has shown that access to parking matters a lot, even when correcting for such self-selection. This conclusion is made possible by the fact that this study found a population whose housing situation was the result of a lottery - there is a severe housing shortage in San Francisco, so many people sign up for a wide variety of housing and take what they can get. The researchers concluded that "we examined 107,310 applications to 59 housing lotteries held between July 2015 and June 2018, and found no evidence that people factor in parking, walkability, or transit when they enter a lottery".

Where do the CO₂ -reductions come from?

Climate benefits can be achieved through the derived effects of restrictive parking policies. The primary benefits are that a restrictive parking policy leads to lower car ownership among residents and less driving by commuters and visitors. Fewer cars also mean fewer emissions from the construction, operation, and maintenance of parking facilities, whether underground, in-building or on-street. Climate impacts come from the transfer of trips from the car to other modes of transportation, as well as any reduced car ownership, which in turn reduces the number of trips.

Table 6 - Summary of the main parking initiatives and their qualitative climate impact

Initiative	Who is affected	Climate impact	Comments
Reduce the number of parking spaces	All drivers	+++	The area can be used for bicycles, bus lanes, green spaces, etc.
Time-limited parking	Long-stay drivers: commuters and residents	+	Creates more car traffic per parking space, but also shifts car trips
High payment	Everyone - primarily long-term parking and low-income groups	++	Will reduce inflow
Low max norms for new construction	Primarily the new residents, but also all other drivers	+++	Requires regulation in neighboring areas

High price for resident license	Residents	++	Can generate more commuter traffic if not accompanied by other measures
Establishing parking in construction	Residents in the area, city quality	÷÷÷	Parking in a basement or structure emits significant amounts of CO ₂

Other important aspects to consider with regards to parking regulation

Land use

Parking and car traffic take up a lot of street space. If there was less parking, it would free up space for other purposes. This could be outdoor seating for restaurants and cafés, trees and shrubs, recreational areas, space for goods delivery/businesses, etc. that contribute to the life of the city. It is not quantified, but there are potentially huge gains to be made in terms of tax revenue, ecosystem services, health, quality of life, etc. The most effective approach is for municipalities to focus on land use-efficient planning and be guided by principles such as proximity to stations and transformation rather than new construction on virgin land and sprawl-type development.

Health

Through a restrictive parking policy, where parking is both expensive and inconvenient, it will create an incentive to replace short trips with cycling. This has a very positive health benefit both for the individual and in socio-economic terms. Although the conditions for cycling are most favorable in the largest cities, there is great potential if people in smaller towns and villages started cycling more on short trips.

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