



Transport Strategy Refresh

Background paper – Car Parking

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Introduction

Car parking is essential to car-based travel, with cars stationary 95 per cent of the time (Barter – Reinventing Parking, 2013). Occupying at least 12 square metres but as much as 35 square metres per space, parking can account for significant portions of urban land. Car parking policy is relevant to many issues in Australian transport and urban planning— concerns about urban intensification; housing affordability; the liveability of dense urban areas; traffic and congestion; and the sustainability of cities. Parking policy influences transport, housing, and urban design but is sometimes overlooked in debates about cities and their future: it is “expected but unnoticed” (Ben-Joseph 2012).

Car parking is an important part of Melbourne’s transport and planning challenge. Conventional car parking policies have long shaped the city’s urban form and transport patterns. A legacy of 20th century approaches to parking policy mean the real cost of parking is rarely paid for upfront, nor is the actual use of or demand for car parking space often monitored. As a result, a growing body of research indicates that car parking is oversupplied and is neither priced nor used efficiently. Demographic changes, car sharing, ride sharing and automated vehicle technologies mean uncertainty over future demand for parking and how best to manage it. Newer approaches to parking policy and to the use or re-use of parking space including for public open space in cities worldwide are the subject of enthusiasm, but also of concerns that change may disadvantage or disrupt communities. An evidence base can help inform public discussion about the trade-offs. This discussion paper acknowledges however that car parking is characterised both by strong beliefs, and by gaps in this evidence base.

The City of Melbourne is in a unique position to reflect on parking policies, and consider the advantages and disadvantages of further change. The City has introduced progressive changes to both on-street and off-street parking policies since as early as the 1970s. Unlike most of metropolitan Melbourne, and most Australian cities, parts of the City of Melbourne have maximum rather than minimum requirements for off-street parking. Much of its on-street parking is managed by pricing and timing mechanisms – underscoring more efficient management and use of parking space. The City has a comparatively large population of households without cars; and of trips by non-car modes. City of Melbourne transport policies have long encouraged sustainable and efficient transport modes. While much of the City’s accessible urban form and infrastructure dates to a period of development before cars and car parking, other characteristics of the municipality have been shaped by its car parking policies. The City of Melbourne also has the advantage of extensive parking data, which (although not comprehensive) are in advance of most other areas and give a better evidence base for parking policy decisions than is typically the case worldwide.

At the same time, the City of Melbourne has a comparatively high dependence on parking revenue as a revenue source, both from fees and from infringements. Like many cities, the City of Melbourne seeks to balance potentially competing goals with its parking policies: generating revenue, managing car traffic, placing a value on the use of public space, and keeping the city accessible and attractive to visitors. Its policies vary across different parts of the municipality, and are not underpinned by a comprehensive parking plan. This discussion paper summarises parking concepts, academic research on parking, experiences and ideas from other cities, and data on parking in the City of Melbourne. It contains the following:

- A glossary / explainers of some common parking concepts and terms;
- A review of the evidence base around parking in academic literature and in the City of Melbourne specifically: its extent and use; and its role in traffic, housing, and retailing.
- A summary of car parking policies and their influence: how parking is typically managed, examples of parking policy and practices worldwide, and how City of Melbourne policies fit in these contexts;
- Summary of parking policy recommendations, ideas and challenges for the City of Melbourne.

Summary of key findings and recommendations

The evidence base around car parking

How much car parking space is there?

- It is common to underestimate the size and extent of car parking as a land use. Parking bays occupy 12-35 square metres of space. A parking space is bigger than a bedroom, and about a quarter the size of a typical Melbourne tram.
- The City of Melbourne has at least 217,090 parking spaces, most of which are off-street, and many of which are residential. Off-street parking accounts for 12% of floor space in the City of Melbourne and is the third-largest land use.
- Total parking floor space in the municipality is the equivalent of 225 MCGs, or 3.6 Hoddle Grids.
- The City of Melbourne has better data (CLUE, and on-street parking records) than most cities or most parts of the Melbourne metropolitan area. Knowledge of the extent of parking space is excellent for some areas and parking types, but poor for others.

How much car parking space is actually used?

- In most cities, there are significant gaps in knowledge around how much car parking spaces are actually used. Knowledge of car parking use is often anecdotal.
- Data is excellent for on-street bays with sensors in the City of Melbourne. Average occupancy of on-street parking in the City of Melbourne is around 47.3%, varying from 30-70%.
- On-street occupancy varies by location, time, and day. It is highest on Sunday when parking is unmetered.
- Based on surveys and estimates, between 26% and 41% of residential apartment parking spaces in the City of Melbourne are thought to be vacant/unused.
- Data is lacking or poor for other parking types including private parking and unmetered on-street parking.

How much does a car parking space cost, and who pays for it?

- Few parking spaces are paid for: researchers often argue that policies that treat parking as infrastructure that seems free to the user disguise its real costs and the real demand for it.
- The costs of parking include land and construction costs; the externality costs of traffic including cruising for free space; subsidies to car use over other transport modes; and the opportunity costs of the land itself.
- Most (95%) parking trips in metropolitan Melbourne are free to the user. The City of Melbourne has a higher share of paid parking trips: accounting for a third of paid parking trips in Melbourne. 42% of parking trips to the City of Melbourne involved payment.
- Many parking trips to the City of Melbourne were paid for by an employer or through a salary arrangement.
- On-street parking costs \$5.50 per hour in the CBD, \$3.20 in some other locations, and 0.80 per hour in all-day parking areas.

- Residential on-street parking permits cost \$30 - \$120 per year.
- Estimates of off-street parking construction costs are between \$40,000 and \$126,000 per bay.

What role does car parking have in transport and traffic?

- Ample free parking increasing the likelihood of car ownership and use. More and lower priced car parking increases car use and congestion even when there is access to other transport.
- There is strong research evidence that workers are significantly more likely to drive when subsidised parking is provided, and that changes to parking provision or pricing changes commuter transport patterns.
- The search for parking adds to traffic through cruising – some estimates say 30% of traffic is the search for parking space.
- Analysis of the role of parking in traffic patterns in Melbourne would be possible, but requires sophisticated analysis that has not yet been undertaken.

What role does car parking have in retailing?

- Retail traders' concerns often underscore opposition to changes to parking.
- Although beliefs are strong, there is weak or contrary research evidence that parking influences retailing viability.
- Available studies suggest that the number of drivers, and influence of parking, is overestimated by traders. Some studies suggest retail spending is higher by pedestrians and cyclists.
- There are few observed behavioural studies or large scale sources of evidence, and the available evidence on retail and parking may not be transferable to specific locations and retailing types.
- Travel survey data shows the City of Melbourne is the top metropolitan destination for social/hospitality trips, and fourth for retail trips. Three-quarters of retail trips, and 70% of social trips, to the City of Melbourne were by non-car travel.

What role does car parking have in housing?

- Parking - and minimum off-street parking requirements for it - add to housing construction costs, and limit housing choice and affordability through direct and indirect means. 'Bundling' parking with housing is considered problematic: where it is difficult to buy or rent housing without car parking. 'Unbundled' parking is residential parking sold or rented separately.
- Off-street residential parking adds around \$40,000 - \$80,000 per space in the City of Melbourne. Rental costs of off-street parking space are around \$70-\$95 per week.
- Residential parking space adds to purchase and rent costs, but is also a housing feature/amenity that some households will pay a premium for, and the bank/financial practices encourage.
- 40-60% of City of Melbourne households do not own a car, and around a third of residential apartment parking spaces in the City of Melbourne are vacant / unused.
- An identical number (around 13,000) of on-street residential parking permits are issued to residents of older housing. 15% of on-street parking use in the City of Melbourne is residential parking (storage). The majority (94%) of use of on-street parking for residential parking is by residents of detached houses and terraces.

Car parking policies: roles and impacts

Competing roles for parking policies

- Most car parking depends on government policy or subsidies. In theory, on-street and off-street parking should be integrated: in practice most are fragmented. Most cities balance competing goals and mechanisms for car parking (restraint, regeneration, revenue).
- The City of Melbourne is not unusual for having competing interests in parking: restraining traffic, increasing visitors, and revenue.

Categories of parking policies: Conventional, management, market

- Researcher Paul Barter characterizes three basic approaches to parking policies - two mainstream approaches ('conventional', and 'parking management'), plus 'market-based' approaches.
- Conventional policies or 'predict and provide' use minimum off-street parking requirements, with on-street parking treated as free infrastructure.
- Management policies use precinct-based parking strategies, with competing parking demands balanced by tools such as timing and pricing.
- Market-based approaches have no off-street requirements, are flexible and unplanned supply, and rely on pricing signals (Japan is a rare example).
- Parking policy typologies have a historical trajectory. Most cities adopt conventional policies in response to rapid motorisation, then move away from them over time.
- The City of Melbourne sits part way along trajectories of parking policies. Parts of the City of Melbourne have had parking management since the 1980s, while others retain conventional parking policies. Most of Metropolitan Melbourne still uses conventional parking policies.

Off-street parking requirements

- Research indicates that off-street parking requirements oversupply parking, add to housing costs, promote inefficient land use. They have a limited empirical basis. Impacts are thought to be worse in older, denser areas.
- Off-street parking requirements removed or replaced with maximums in London, Berlin, Hamburg, and several other European cities. They are used variably in Asian cities. Japan has few or no off-street requirements. Several North American commercial city centres have removed off-street requirements.
- Parking maximums are a tool in transport management approaches, but their impact is less clear.
- In Victoria Minimum parking requirements have been standard since the 1950s. Parking overlays allow for local variation but only the City of Melbourne uses these to a significant extent.
- The City of Melbourne removed parking minimums from the CBD and replaced them with maximums in 1975-1983. Other parts of the City of Melbourne had parking maximums extended e.g. West Melbourne in 2012.
- Elsewhere in Victoria disputes over off-street requirements is a major planning issue (underscored by lack of on-street parking management). The City is in a position to coordinate with and provide an evidence base for other inner city municipalities, and act in an advocacy role for other inner city councils in moving away from conventional and discredited off-street parking policies.

On-street parking management

- Conventional parking policies combine off-street requirements with free on-street parking. As an alternative: some locations (e.g. Tokyo) have essentially no on-street parking.
- More commonly: on-street parking management seeks to avoid parking under-pricing and over-supply (and over-pricing, under-supply). Uses different tools: timing, pricing, permits and exemptions. These reflect a hierarchy of parking users while discouraging long-term storage. On-street parking is a form of Transport Demand Management: discourages single occupant vehicles. Examples: Vienna, Berlin.
- The City of Melbourne uses many on-street parking management practices: varying time limits, price scales, and pricing. Management and enforcement varies by area. Paid parking and timing restrictions are strongest in the most central areas.
- On-street management in the City of Melbourne is guided by policy but is not clearly tied to a hierarchy of users or to an overall parking strategy or transport / land use strategies. The City has the potential to extend management into other parts of the municipality, and to act as an evidence base / advocacy role for other inner city municipalities.

Dynamic pricing

- Dynamic pricing varies parking prices by location and time, in response to usage patterns and with occupancy targets. It aims to maximise efficiency and to reduce cruising.
- A key example is SF Park San Francisco: prices are adjusted very two months, with a 60-80% occupancy target. Over time a small number of peak locations reduced in price, while most reduced. Cruising reduced by 50%.
- A local example is the Gold Coast pilot scheme: Park in Centre Schemes (PICS), with prices adjusted quarterly.
- The City of Melbourne informally adjusts hourly limits to even out occupancy, and has three broad zones of on-street parking fees. It does not have dynamic pricing. Data and technology commitments are a limitation. There is also no clear council policy on occupancy targets.

Management and spending of parking revenue

- Ring fenced / hypothecated spending of on-street parking fees can be used for local improvements or for metropolitan transport projects
- Examples of ring fencing and spending include: Barcelona (bike sharing program), Gold Coast (local improvements including landscaping), Perth (free city buses), Pasadena (historical district renovations), Beijing (sanitation).
- Showing how parking revenue is spent is important to political support. Voluntary local parking districts for use of fees also increase support. E.g. Beijing.
- Congestion levies are taxes on off-street parking, used to offset congestion impacts. E.g. Nottingham: congestion levy used to pay for light rail; Sydney Parking Space Levy (introduced 1992) used to finance public transport and park-and-ride parking.
- The City of Melbourne operates its own public on-street parking and leases two garages. Parking revenue goes to general revenue. Melbourne's inner city congestion levy – a State Government Policy – was introduced 2006 and extended 2015. It applies to long-term off-street parking spaces. Research suggests the levy has been passed on to short term users, and encourages employer-subsidised parking. Most of the levy goes to general revenue, with a payment to the City of Melbourne.

- Lack of transparency is an issue. Spending of the congestion levy is not as clearly tied to transport improvements as in other examples. The City of Melbourne needs to clarify whether parking fees and levies are to decrease congestion, recoup costs, or to finance transport projects.

Capping or converting parking space

- Large-scale examples of cities reducing parking space include Zurich, which froze existing parking supply in 1996. Oslo: recently (2017) introduced policy to remove over 20,000 spaces particularly from residential areas, replaced by trees, landscaping, bike lanes. Copenhagen policy since 1970s has been to reduce parking spaces by 2% per year, replaced by bike and other infrastructure. London recently (2017) announced a ban on new parking.
- Small scale, voluntary examples of replacing on-street parking include Parklets, Park(ing) Day, Better Block, Complete Streets. New York, San Francisco, Bogotá, Munich. In Hackney, London, one on-street space per street can be nominated for conversion by residents.
- The City of Melbourne has no formal policy on limiting or targeting the number of parking spaces, on or off-street.
- Several parks in the City of Melbourne have expanded via on-street parking conversion. The City has been gradually reducing metered on-street parking in the CBD for a range of purposes. There is potential for adopting, trialing and monitoring the range of small scale voluntary schemes for replacing on-street parking with other uses.
- There are examples of converting off-street parking structures: housing, 'end of trip' facilities, both retrofitted, and future-proofed (e.g. Minneapolis policy). One well-known example of conversion of excess off-street parking to apartments within the City of Melbourne. More common has been the recent conversion of parking within commercial structures, to end of trip facilities including bike parking and showers.
- There are servicing, structural, and pricing barriers in the conversion of off-street parking space to other uses. These could be identified and addressed. There is also an opportunity to influence the design specifications for parking, to better future-proof new parking spaces.

Residential parking policies

- 'Unbundling' of residential parking policies allow households to choose to own or rent more or less parking. Overlaps with 'precinct parking': where residential parking is off-site. Used in pedestrianized developments. Examples: Los Angeles, Japan, Gottenburg, San Francisco, Freiburg.
- Removal of off-street requirements for housing, e.g. London, has been introduced to better match underlying demand and to reduce direct and indirect costs of parking minimums. Some studies suggest car ownership and use is reduced. Others emphasise that car ownership is better matched to preferences, and oversupply is reduced.
- Residential permits usually introduced to control commuter parking. Long-run issues: subsidises on-street car storage. Permits are usually very low priced relative to on-street fees or to land costs. e.g. London, Amsterdam. Sydney and Adelaide policy limits on-street permits to housing without off-street parking. Canberra has no residential permit parking.
- The City of Melbourne has a commitment to supporting car free or reduced parking residential development. Some but not all areas have no off-street requirements. Parking maximums were expanded to West Melbourne in 2012, avoiding nearly 20,000 excess spaces. Changes to off-street parking are underscored by strong on-street management and enforcement.

- The City of Melbourne has a very low rate of car ownership and some areas of the city have a significant excess of parking in apartment buildings – an affordability issue. The growth of peer-to-peer parking applications, where unused spaces can be rented out, may see less partitioning of residential parking in future. Barriers to unbundled management of residential parking include zoning, property title systems, financial practices, congestion levy, and owners corporation practices.
- Residential on-street permits in the City are well managed and likely deter commuter users in fringe areas. They are also under-priced, a significant use of on-street space (15%), and are limited to a privileged minority of older and lower density housing. The majority (94%) of on-street residential parking in inner Melbourne is storage of vehicles of residents of detached houses and terraces. There is a disparity between high rates of vacant, expensive off-street apartment parking; and low-priced on-street parking rights for other residents.

Emerging technologies

- Current and emerging vehicle technologies have a strong impact on how parking is used and paid for.
- Car sharing operates in over 1,000 cities worldwide. Parking space can be allocated, or free-floating / dockless. An alternative or complement to car ownership, car sharing reduces car use by reducing sunk costs to users. These are for-profit operations but are heavily reliant on local parking policies. Parking policies for car share have been a response to rapid changes. Researchers argue they should be more consistent.
- City of Melbourne supports car sharing through on-street spaces, and encourages a share of spaces to be off-street.
- Emerging car parking sharing applications: peer to peer applications to allow renting of excess space. Local examples include Parkhound, Parkey, Kerb, Spacer. A trend in motorising Chinese cities: “airparking”, “Parking Panda”. Car park sharing uses existing space more efficiently. It may not be consistent with reducing commuter traffic.
- Electronic parking information, enforcement and payment systems used by governments and parking operators. Reduces cruising time and increases efficiency and transparency. The City of Melbourne uses parking sensor and guidance systems in several areas. This underscores its open data provision. Coverage is not comprehensive.
- The way car parking space is allocated and priced has a significant role in shaping the form in which new transport technologies progress.
- Future uncertainty: deliveries, ride sharing, ‘valet’ parking, autonomous vehicles, mobility as a service, road user pricing. It is difficult to predict future disruptions but the City has an opportunity to facilitate consistent and fair systems of access and pricing for parking.

Summary of policy recommendations for the City of Melbourne

- Make a clear statement of parking strategy and hierarchies in relation to transport and land use goals
- Place a clear value on parking on-street space as public space
- Make on-street parking spaces available for different uses and users, based on clear values and guidelines
- Trial and monitor methods for converting more on-street parking space to public open space
- Introduce simple or trial versions of occupancy targets and dynamic pricing

- Gradually reduce reliance on on-street residential parking permits
- Free up ways to make better use of excess apartment parking
- Reduce barriers to the re-use of off-street parking space for retail, housing and end-of-trip purposes
- Facilitate local parking policies and initiatives that build shared understanding with the community
- Improve the congestion levy and its transparency – as well as of other parking-based revenue
- Prepare for future disruptions with fairer policies now: charge for street use not just parking
- Extend parking data collection and coordination
- Take on an evidence and advocacy role with other municipalities

Thought bubbles / policy provocations for the City of Melbourne to consider

- A fully market based system?
- A cap on or reduction of overall parking numbers?
- Open up apartment parking via shared parking arrangements?
- Rather than offering low-priced residential on-street parking permits, offer incentives to *not* use street parking?
- What about facilitating greater public ownership of parking and how its value is allocated, e.g. 'giving streets' schemes?
- Is it possible to make parking more fun, more attractive- or at least less aggravating?

Figure 1: One reason car parking is important is that cars are stationary most (95%) of the time

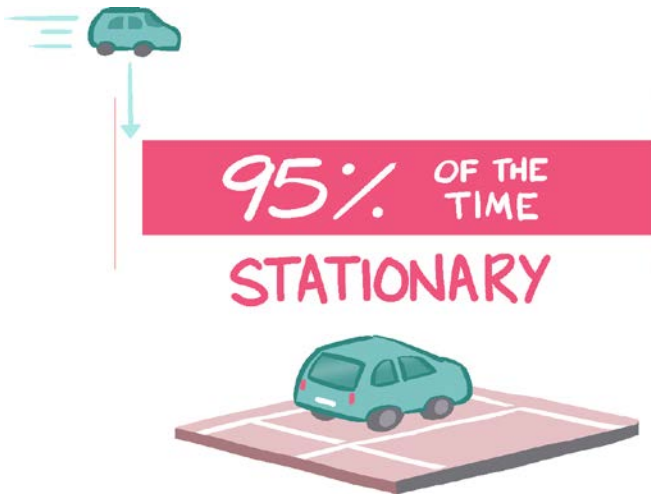
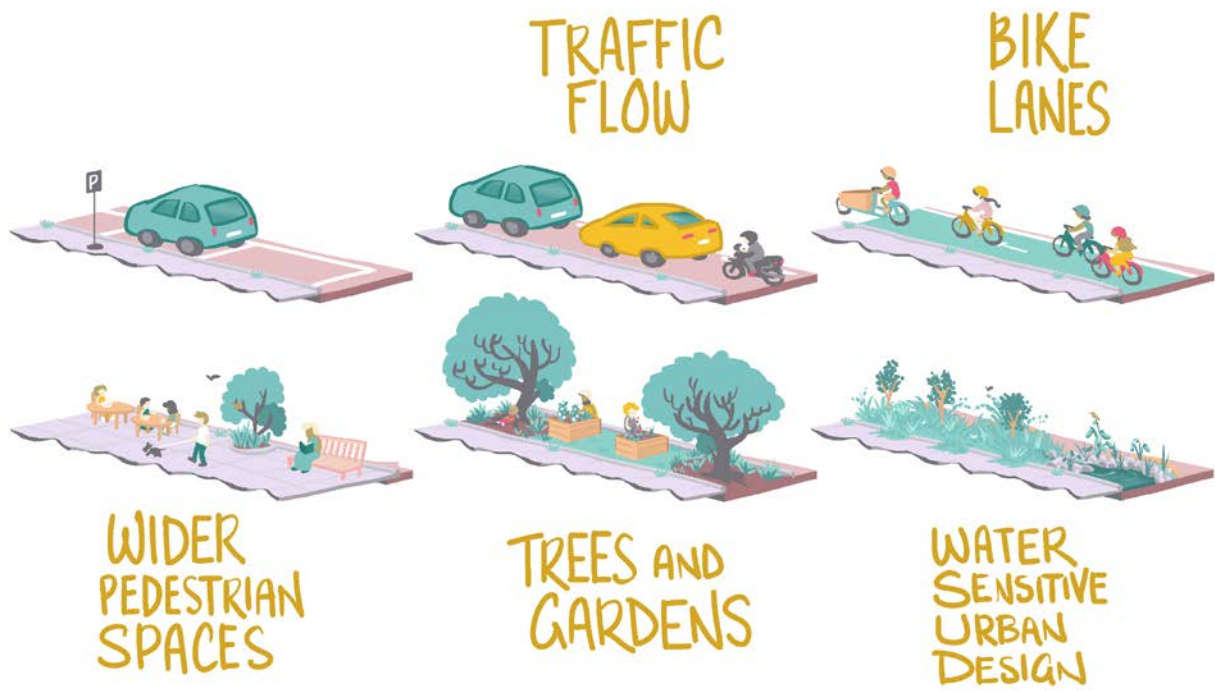


Figure 2: Another reason parking is important is that parking is a significant land use: one which is traded off against other forms of transport or other potential land uses



Glossary / Explainers: Car parking concepts and terms

- **On-street parking:** refers to parking on public road space, also known as curb or curbside parking. On-street parking is regulated by local governments using time limits, pricing (meters), and allocations to special users (e.g. permits). On-street parking is a question of road space allocation: it is traded-off against road traffic lanes, bike lanes, footpaths or potentially street trees and public open space. It is typically intended for short term destination parking (e.g. for retailing), but is also often allocated to residents for longer-term car storage.
- **Off-street parking:** is parking that can be either privately or publically owned, but is not (as the name indicates) located on the street. It takes the form of surface 'lots', multi-storey parking garages, and the basements or podium levels of private buildings. Some off-street parking is dedicated commercial parking space open to the public. Other private off-street parking is for customers, residents, or workers at a specific site. Through minimum parking requirements, new developments have often been required to provide their own off-street parking. Off-street parking is traded off against other land uses or uses of floor space, for example retail or housing space.
- **Minimum parking requirements:** or ratios, are parking policies that are a common part of planning processes worldwide. They specify an amount of off-street parking to be provided in new developments: for example, the number of spaces per square metre of office floor space. Minimum parking requirements were introduced across Melbourne in the 1950s. Today, standard minimums are set in 52.06 of the Victoria Planning Provisions, which municipalities may vary with parking overlays. The only municipality in Victoria with substantial areas without minimum parking requirements is the City of Melbourne. Minimum parking policies are often viewed critically by researchers, and some cities have moved away from them over time.
- **Maximum parking policies:** Rather than a minimum amount of off-street parking spaces (see above), maximum parking policies specify the maximum amount of parking spaces allowed in new developments. Parking maximums have been introduced in high-demand cities worldwide, including parts of the City of Melbourne, typically in efforts to manage congestion. While a significant tool in parking management, research is mixed on their effectiveness - suggesting it is more important to remove minimum parking requirements.
- **Commercial parking:** Refers to commercial for-profit parking garages. In many locations, including in the City of Melbourne, commercial garages compete with on-street parking. Commercial parking garages sometimes function as spillover from curb parking. Some researchers recommend pricing of the two to be integrated, to minimise 'cruising' for lower cost or free on-street parking.
- **Cruising:** refers to the practice of drivers searching for a free or low priced on-street parking spot, often in preference to paying for commercial parking. Sometimes cited as a significant contributor of inner city traffic. **Demand:** In conventional parking policies, parking demand has meant the peak use of free parking for a given use or site. In newer ideas of market or dynamic pricing, demand refers to drivers' willingness to pay for a space at a given time.
- **Dynamic pricing:** Refers to parking pricing that changes depending on demand and occupancy levels, by location and time of time.
- **Loading bays:** Parking space reserved for eligible vehicles (trucks, taxis etc.) for short-term use for the delivery of goods or people.
- **Occupancy:** refers to the proportion of parking spaces that have cars parked in them, within a given area. Dynamic pricing sometimes aims for 85% occupancy: that is, keeping 15% of spaces always available on a given street or block.
- **Precinct parking:** typically means parking used by several different sites or buildings in an area, rather than an individual site. It can also mean residential parking provided off-site, for example in

a dedicated garage, within walking distance. Precinct parking garages have been used in pedestrianised neighbourhoods, such as the Vauban development Freiburg, Germany.

- **Residential parking permits:** are special rights to on-street parking space issued to residents. Permits are usually (as in the City of Melbourne) limited to housing dating to before a certain time (e.g. 2005). Permits are normally low priced (e.g. \$30 per year for the first permit). In some contexts, residential permits are used to limit commuter use of on-street parking. Some studies are critical of the amount of subsidy given to residents by residential permits, for example in inner London.
- **Sensors:** The City of Melbourne employs in-ground parking sensors to detect on-street car parking occupancy and monitor compliance with parking restrictions.
- **Storage:** Some researchers distinguish parking (short term space for car users to access destination parking, for example for under 4 hours); from the use of space for car storage (longer term parking or car storage – over 4 hours).
- **Supply:** Some measures of parking supply refer to site-based parking supply (the number of spaces in a building). Others refer to parking in a given area or precinct, including the total on-street and off-street parking. Conventional policies try to increase supply, whereas newer policies try to increase turnover and availability.
- **Turnover:** refers to the availability of a parking spot, and the number of cars accessing the space during a day. Parking management policies try to increase turnover and the availability of parking space, using time restrictions or pricing, particularly for destination parking. This is an alternative to policies that seek to increase overall numbers of spaces.
- **Unbundled parking:** Residential parking spaces are often 'bundled' (sold or rented) on-title with apartments. The occupant usually has no choice but to buy or rent the space, regardless of whether it will be used. 'Unbundled' parking is residential parking sold or rented in a separate market to housing. This enables residents to decide on their willingness to pay for a parking space.

The Evidence base around car parking

How much car parking space is there?

While car parking is a significant urban land use, it is common to underestimate its size and extent. This is a problem because underestimating parking space means a risk of having too much of it at too little a price, at the expense of other possible uses for the space. Space for on-street parking is space not used for road traffic lanes, bike lanes, footpaths or potentially street trees, commercial space (outdoor dining) or public open space. Off-street parking is space not used for other developments, for example retail or housing space.

The size of each car park. Individual parking spaces occupy at least 12.7 square metres of land or floor area - the minimum dimensions for a 90 degree parking space in the Victorian planning provisions are 4.9m long by 2.6m wide (12.7 square metres), plus a 6.4m wide access space (Figure 6). Including access ways, the 2017 Austroads Guide to Traffic Management Part 11 (Parking), based on quantity surveyor data, allows 32-35 square metres of floor area per parking bay. The land per parking bay varies by whether the space is on-street or off-street, basement or other.

Total amounts of parking space in cities. Website “What the Street” (<https://whatthestreet.moovellab.com>) maps space for different transport modes in cities such as Los Angeles, which has over a thousand hectares of surface car parking. Another study found that Los Angeles County, with over 200 square miles of parking (518 square kilometres), was 14% parking (Chester et al 2015). Mapping exercises have shown surface car parking to be as much as half of the ground space of central commercial areas, as in Albuquerque New Mexico and Buffalo New York (Shoup, 2005, p 131). In “Rethinking a Lot” Eran Ben-Joseph estimated while there were at least 800 million parking spaces in the USA (around 3.2 spaces per vehicle), but found that people typically noticed parking only in the briefly frustrating moment of looking for a space.

Data on parking is not often available. Although many parking debates centre on fears of parking loss or that there is not enough parking, in many cases it is not known how much car parking there actually is. Mapping the number and extent of parking space in a city is often a difficult task relying on aerial photography, given that records are spread across several different types and sources and often incomplete. For metropolitan Melbourne as a whole, there is little if any knowledge of the total number of parking spaces or amount of parking space as land or floor area. Data on the amount of car parking tends to be better for on-street spaces with parking meters, and in certain municipalities – including the City of Melbourne. The City of Melbourne collects on-street parking data from in-ground parking sensors; and off-street data through its CLUE (Census of Land Use and Employment) dataset. The City’s parking datasets, although not comprehensive, are ahead of most other areas. Zurich is unusual for having kept comprehensive parking data for over a century, making possible its policies for stabilising or reducing overall car parking numbers.

A ‘Future Melbourne’ focus group (Global Research for the City of Melbourne 2017) found some people think the City of Melbourne does not have enough car parking space; while others think it has too much: “an almost even split between people desiring less car parking – or none at all – in the city, and those who believe that there is currently insufficient spaces around the city” (p17). The split in perception highlights the difficulty of getting the ‘right’ amount of car parking.

The City of Melbourne is in a better position to assess its extent of parking space, by having more extensive, although not comprehensive, datasets on car parking than most municipalities. Parking spaces fitted with smart-sensors offer better data than that available for other types of on-street parking. The CLUE land-use data has some coverage of commercial garages and of parking associated with other uses. Central city coverage is better than other parts of the municipality; while the City of Melbourne’s parking data is in turn significantly more detailed than other parts of Melbourne.

Number of off-street spaces in the City of Melbourne. There were a total of 193,311 off-street spaces in the City in 2015 (Phillip Boyle & Associates 2017). Based on 2016 CLUE data, off-street parking in the City of Melbourne included 68,300 garage spaces, 49,500 residential parking spaces, and 75,800 parking spaces associated with other private uses (for staff, customers or visitors). There were a total of 193,600 off-street

spaces in the City in 2016 (City of Melbourne CLUE Profile 2016)(Figure 3). In 2016 CLUE data, off-street car parking was the third largest floor space user in the City – after residential accommodation and office space – with off-street parking occupying 4.1 million square metres or 12% of total floor space in the municipality.

Change in off-street parking by type. Between 2015 and 2016 the total number of off-street parking spaces in the City of Melbourne increased by a small amount. Commercial and other private spaces decreased over this time, while residential parking spaces increased (Figure 4). A Phillip Boyle & Associates study found that between 2006 and 2015, there was a substantial (16,616 or 54%) increase in off-street residential parking spaces in the City of Melbourne. The report also found that, if standard Victorian parking minimums had applied, an additional 19,000 off-street residential spaces would have been built.

Number of on-street spaces in the City of Melbourne. Based on City of Melbourne open data (City of Melbourne data portal, “on-street parking bays”) there were 23,490 public on-street parking spaces in the City of Melbourne in 2017. Of these 4,414 had in-ground sensors; 7,600 had meters but not in-ground sensors (12,014 metered spaces in total); and a further 11,476 had time or other restrictions but not meters (Figure 3). Some unmarked on-street parking areas are unknown. At any given time, a proportion of on-street spaces are not available to public parking (for example for construction). Metered spaces in the CBD are reducing over time – replaced through a range of policy actions, including for bike lanes, trams stops, street trees, widened footpaths, and conversions to loading zones (Figure 5).

Total parking numbers and spaces. In total there are at least 217,090 parking spaces in total within the City of Melbourne, comprising 193,600 off-street and 23,490 on-street spaces. Off-street parking accounted for 4.1 million square metres of floor space. On-street parking – if averaged to 21.2 square metres (the average floor space of off-street space in the city) – would account for half a million square metres of public space in the City. In total the City of Melbourne has around 4.6 million square metres of car parking. This is the equivalent of 225 MCGs worth of car parking (Figure 6), or 3.6 Hoddle Grids (Figure 7).

Figure 3: Car Parking Spaces in the City of Melbourne, by Type, 2016-2017

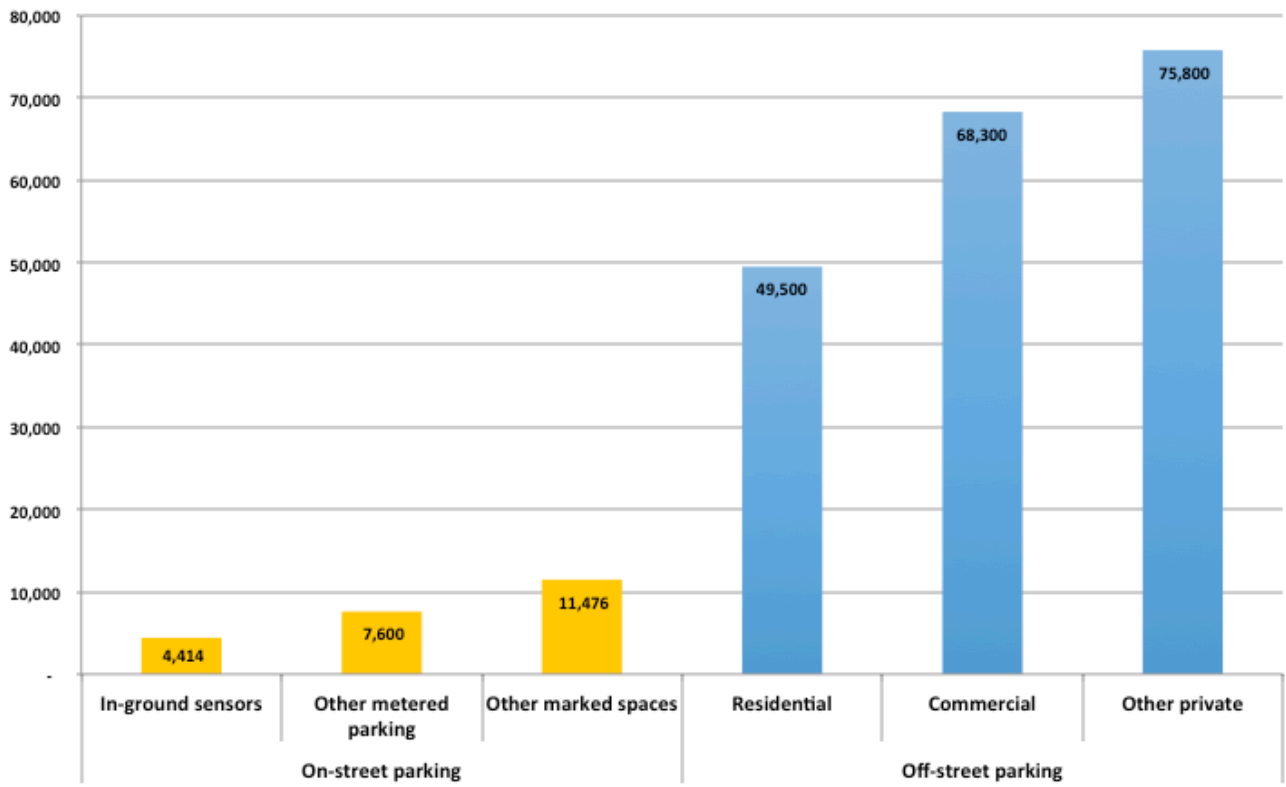


Figure 4: Change in off-street parking in the City of Melbourne, by type, 2015-2016

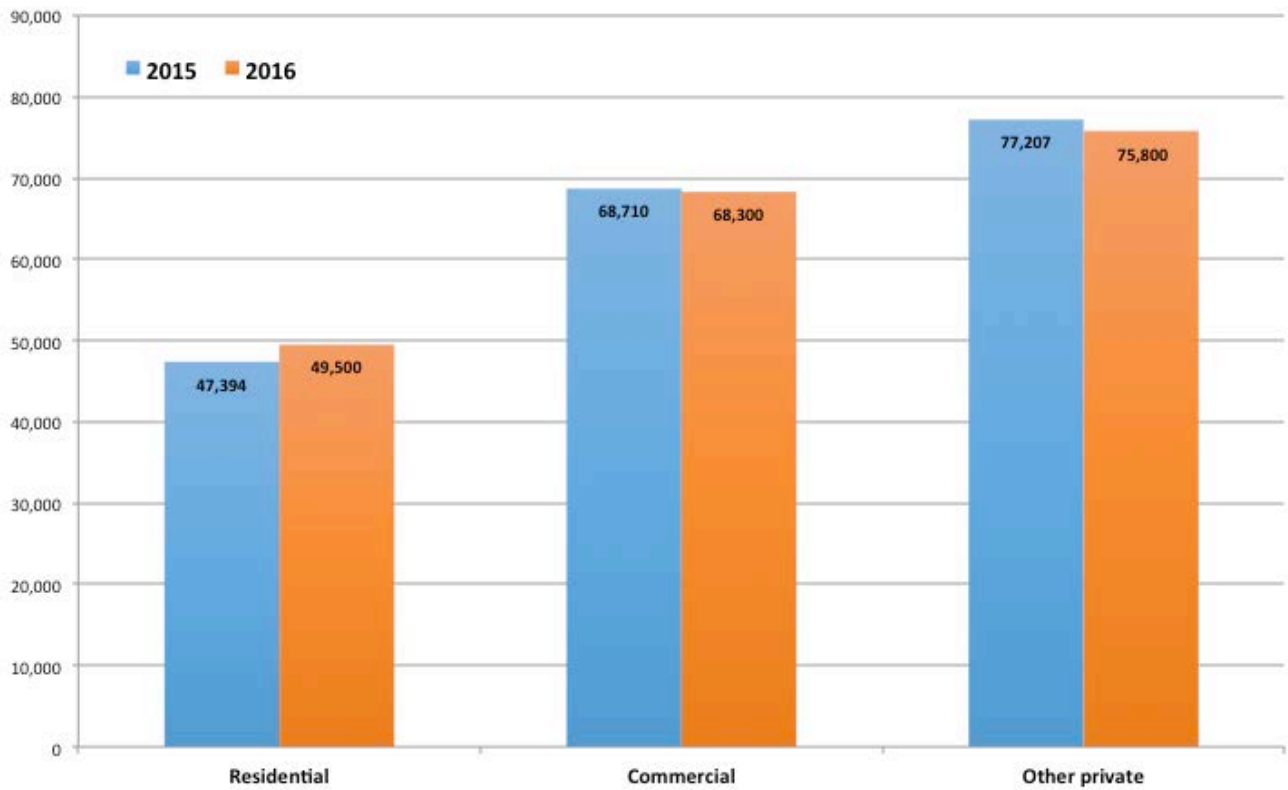


Figure 5: Change in metered on-street spaces, CBD and rest of municipality, by year

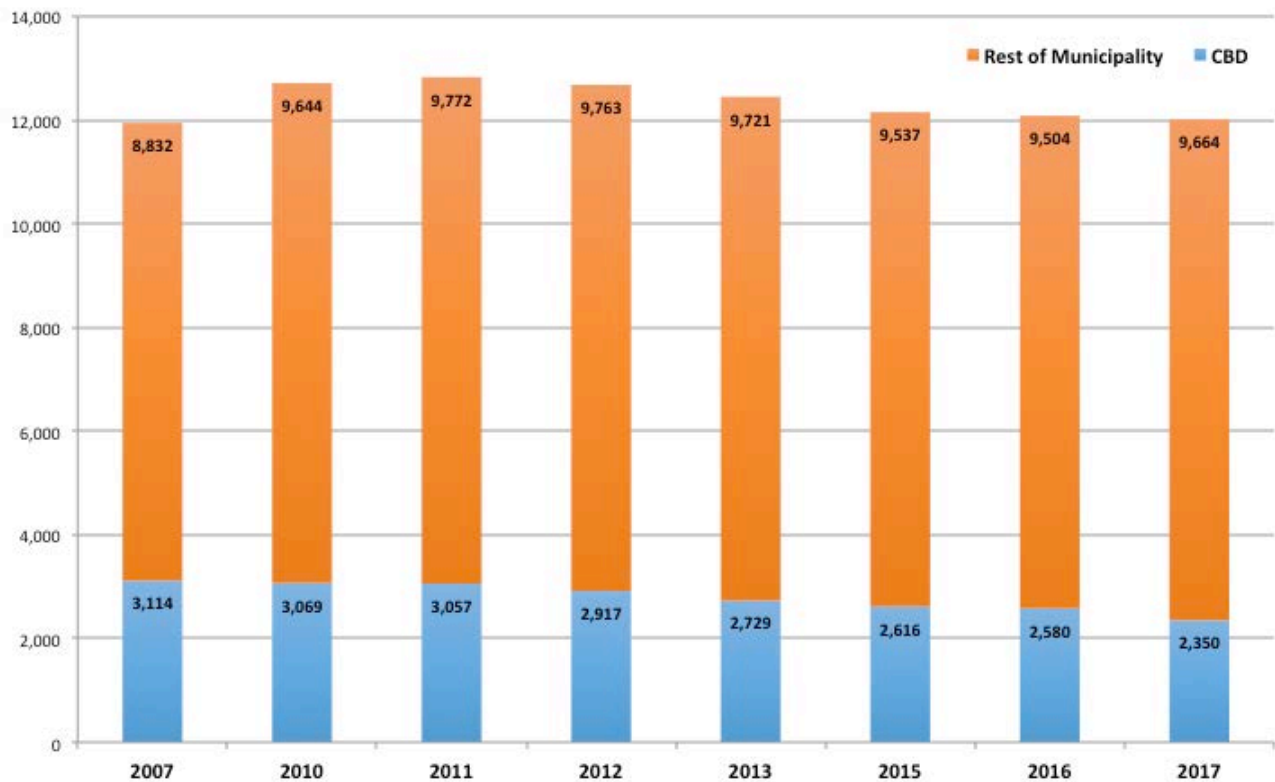


Figure 6: Size reference for car parking floor space in City of Melbourne: MCGs

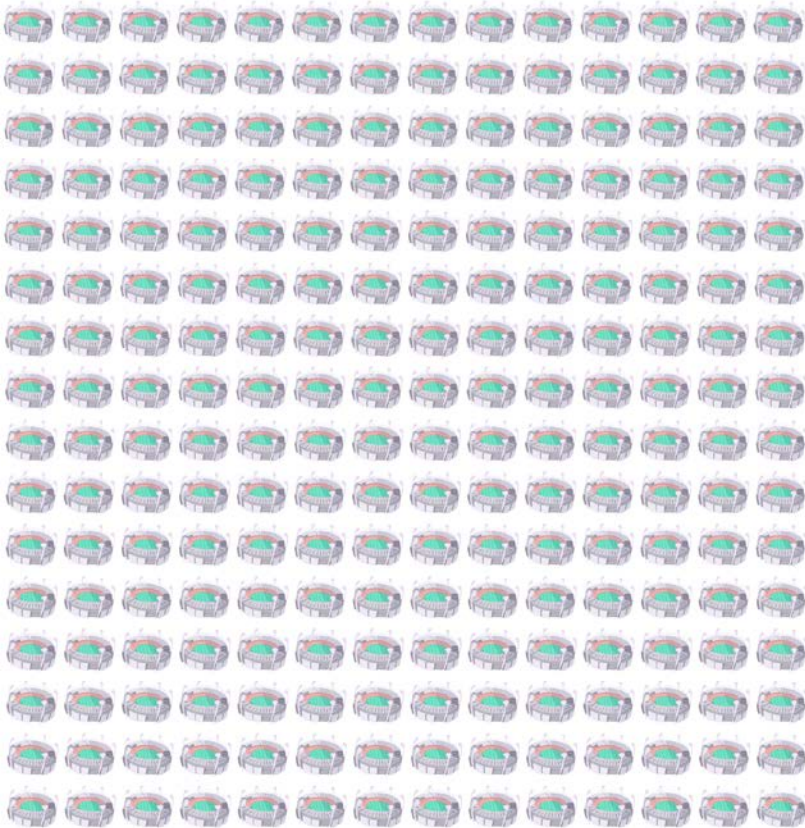
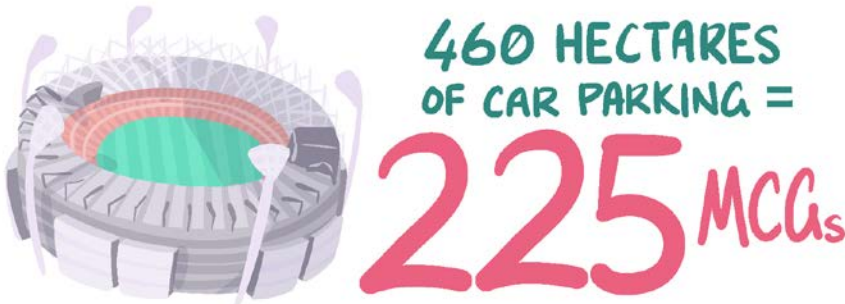


Figure 7: Size reference for car parking floor space in City of Melbourne: Hoddle Grids

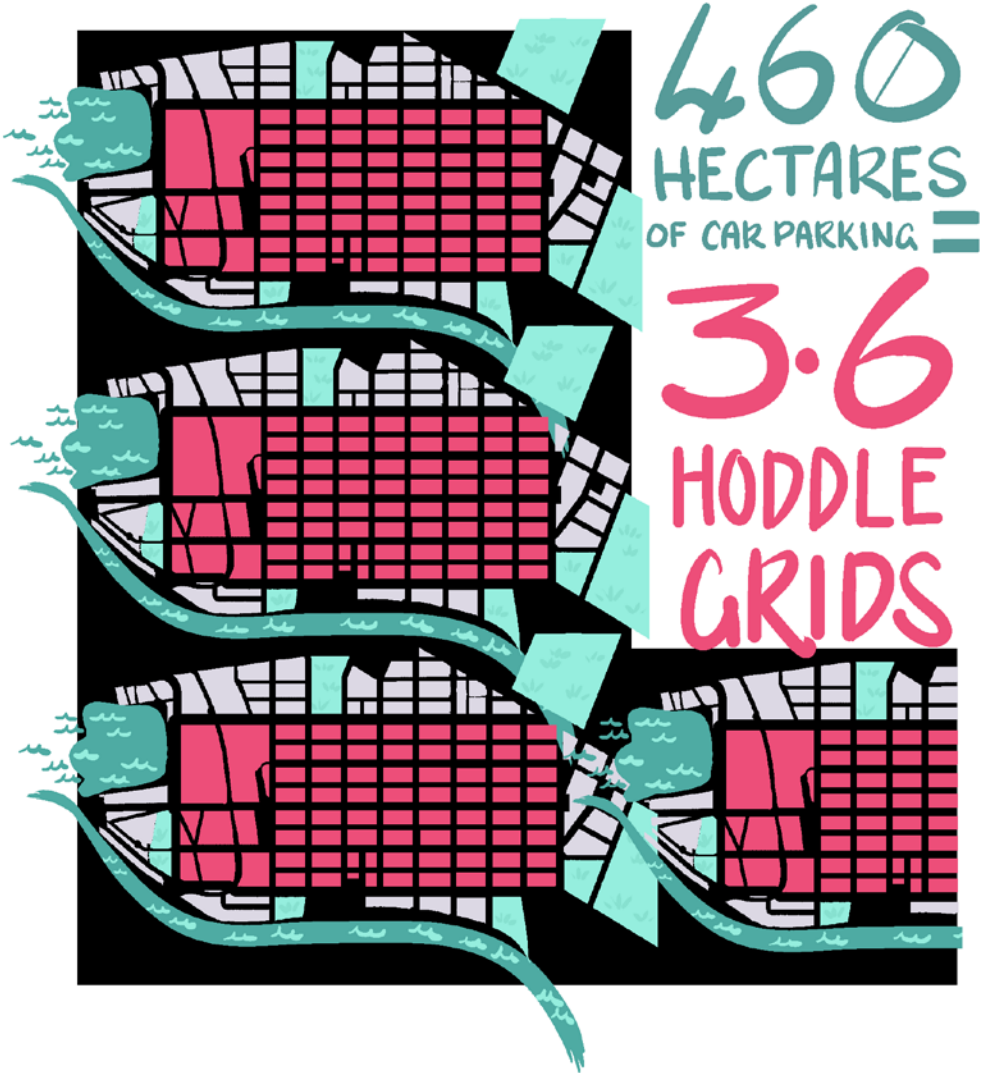
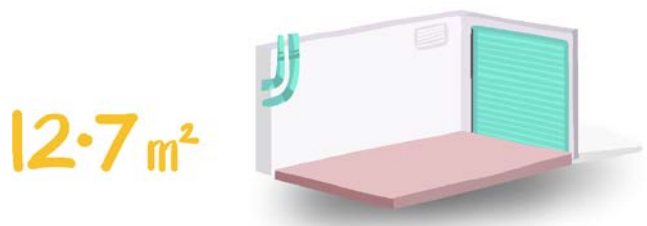


Figure 8: Size references for minimum car parking dimensions – (proposed) minimum bedroom size, and a Melbourne B-class tram (capacity approx. 70-120 people).



How much car parking space is actually used?

Data gaps around use and occupancy. Traditionally, parking demand and minimum parking policies (see ‘parking concepts and terms’) have been based on observing the maximum number of cars at a site during a peak time, based on free parking availability. In most cities, very limited other parking occupancy data has been collected, and there are significant gaps in knowledge around the extent to which car parking spaces are actually used. In many contexts, knowledge of car parking use is simply anecdotal. This is important because without understanding how much car parking is used, it is more difficult to make policy decisions about its supply.

Occupancy targets. Recently, parking management ideas have encouraged targets for occupancy rates. Donald Shoup and others propose a target of 85% occupancy for on-street parking— aiming for 15% of spaces on a street to be available at any given time. The idea is to get more use out of parking spaces while also keeping spaces available to those who need them. To do so, prices change by locations and times, aiming to even out occupancy. Parking management ideas tend to require better data on car parking use, including via technology.

Occupancy of City of Melbourne on-street spaces with sensors. The City of Melbourne has extensive occupancy data for metered its on-street parking spaces that have in-ground sensors. The overall average occupancy of on-street parking spaces (with sensors) in the City of Melbourne is 47.3%. Average occupancy rates vary by area, day, and by time of day. There is not a formal parking strategy targeting occupancy rates for the City of Melbourne’s on-street parking spaces. Occupancy is managed by time limits and hourly fees in different locations, but is not dynamic in response to demand.

Partly because parking is free and unmetered on Sunday, average on-street occupancy rates in the City of Melbourne are highest on Sundays (54.8%). A McIvor (2017) study of 4,000 City of Melbourne bays in 2014 found that hourly occupancy varied from 30-70%. This study recommended extending metering to Sundays and to other times, to even out the costs of parking in the City using dynamic pricing methods. On-street parking occupancy rates also vary by time of day and has two peaks: a morning peak around 10am; then a drop off in the afternoon and a second smaller peak in the evening. On average there are around 45,000 parking transactions per day in the city.

Limited data on occupancy of other parking types such as commercial garages. While knowledge of on-street occupancy for bays with sensors in the City of Melbourne is high, occupancy of on-street spaces without sensors, and of off-street parking, has much less data coverage and/or availability. This is true both in the City of Melbourne and in other cities. Cities such as San Francisco, that own or coordinate both off-street and on-street parking spaces, are exceptions. Although the City of Melbourne contains private parking garages with 68,300 spaces, there is no public data on occupancy rates in these commercial garages. Data availability on private spaces may improve via the take-up of parking applications; or via coordination with other municipalities and with private providers. Or, commercial barriers to the sharing of such data may also simply remain in place.

Some estimates of residential apartment parking occupancy. For off-street residential parking, knowledge of how much residential parking is used is limited to specific studies. A Phillip Boyle study for the City of Melbourne in 2017 based on 2015 CLUE data estimated that there were 13,000 surplus residential car parking spaces in The City of Melbourne: based on comparing Census data on car ownership in apartments with CLUE data on spaces. A submission based on a study undertaken by Southbank BUG of 3 apartment buildings on Kavanagh Street in Southbank found that overnight, 41% of the 620 apartment car parking spaces were unoccupied. Online survey data (Taylor, 2018 under review) on residential parking use found 26% of apartment building spaces in inner Melbourne municipalities were unused. From these three sources (varied but incomplete), between 26 and 41% (on average 32%, or a third) of car parking spaces for apartments in the City of Melbourne are vacant overnight. This is significant given that the best use of space is a growing consideration in a dense urban setting such as the City of Melbourne. Some apartment dwellers may rent their spaces out during the day, using informal arrangements or via third-party applications. Data on this, or on private garage occupancy rates, are not currently available or integrated with City of Melbourne

data. A combination of planning permit requirements, and owners corporation rules – real or asserted – typically limit the use of apartment parking space only to car parking and limit either its alternative use (such as for storage), and its secondary use (such as sub-leasing). Further data on and understanding of these barriers would be useful.

Figure 9: On-street parking occupancy by day of week (December 2017)

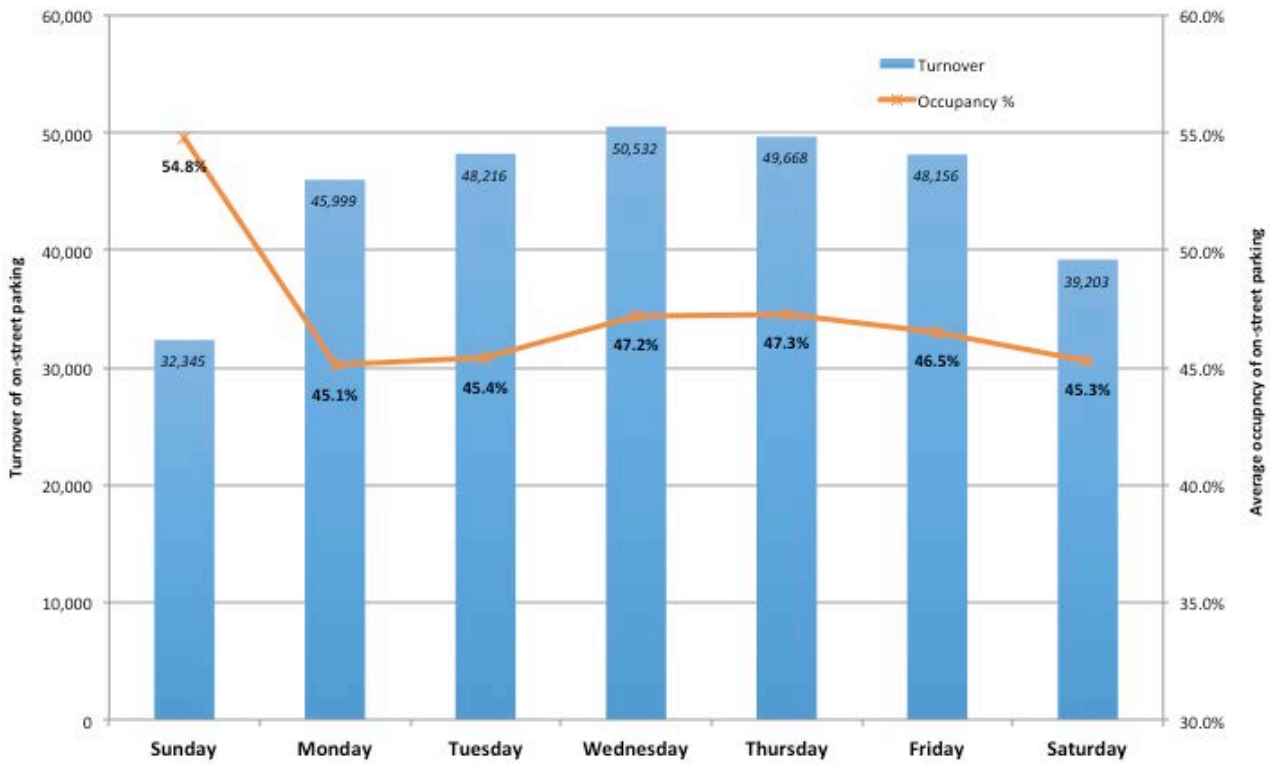
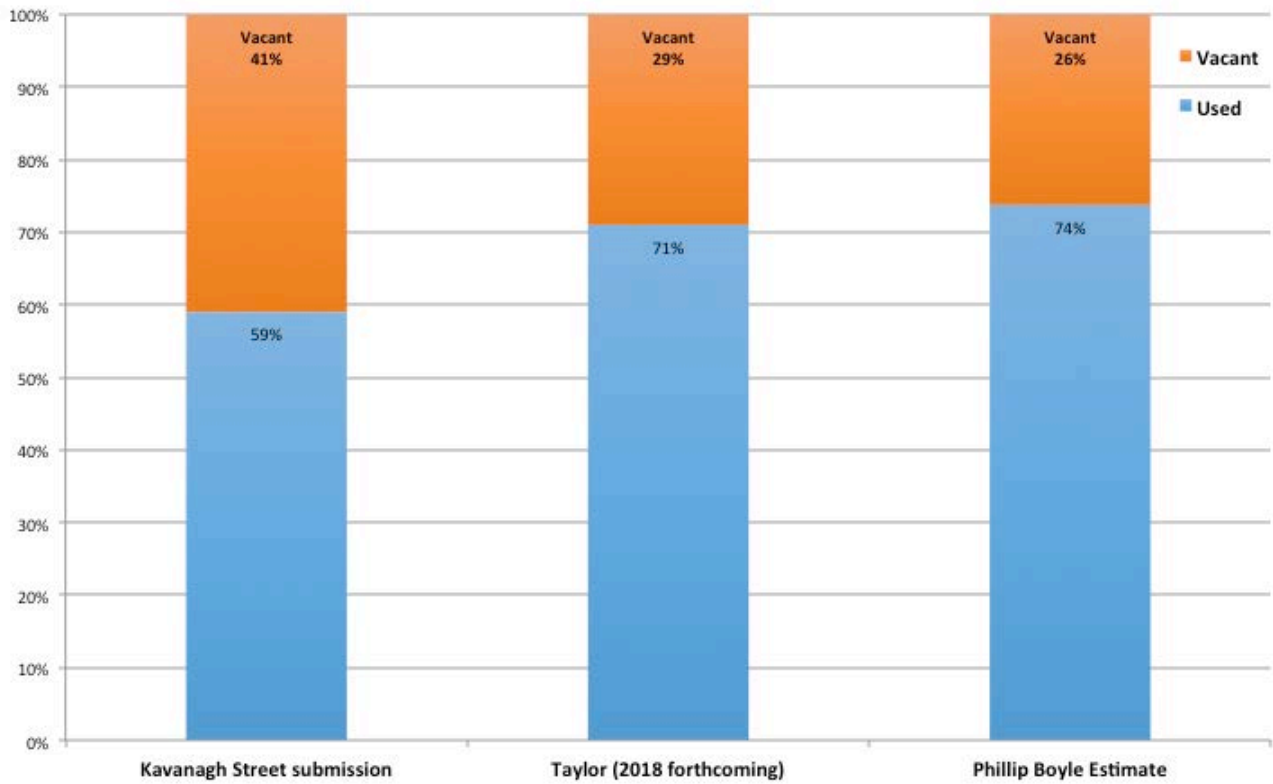


Figure 10: Estimates of vacancy rates in apartment car parking, City of Melbourne (3 sources – online survey, site survey of 3 buildings, Census data)



How much does a car parking space cost, and who pays for it?

Parking as a right or as a market. Researcher Paul Barter (2010, 2015) distinguishes attitudes toward car parking as infrastructure (a right, provided for by government), and as a market good. In the USA and Australia, few parking spaces are paid for in a market: an estimated 99% of parking in the US is free to the user. Shoup (1999, 2005) and others (e.g. Litman 2006; Manville 2017) argue that policies that treat parking as infrastructure and as ostensibly free to the user disguise its real costs and the real demand for parking. Litman (2014) argues travel patterns would change substantially if charges, including parking, reflected the cost of providing the infrastructure.

The costs of parking include land and construction costs; the externality costs of traffic including cruising for free space; subsidies to car use over other transport modes; and the opportunity costs of the land itself. These cost types can be divided into two basic meanings: financial (land, upkeep, enforcement); and economic (the opportunity cost of land, pollution, cruising costs). See Figure 11.

While many researchers argue that parking costs should be more often paid for by users rather than absorbed into land and development costs, and through broader costs such as traffic, they also acknowledge the barriers to charging for this when parking has so often appeared free. Button (2006) contrasts an ideal of parking pricing with real-world or 'second best' realities of parking prices including institutional structures: saying that "in most circumstances...the 'right conditions' where everyone pays the true cost of their parking do not exist". The outrage Melburnians express over paying \$1.50 an hour for parking (as was seen in a conflict over parking meters in Yarraville in 2015) indicates how, unlike food or housing costs, parking tends to be considered public infrastructure or a right, rather than a market good.

In comparison, Japan is unusual for having a longstanding demand-based approach to parking. More commonly, a price for parking space is introduced after or on top of embedded supply-based parking policies, and is disruptive both practically and symbolically – space that once appeared free moves to a market, and winners and losers result.

Paying for parking use in the City of Melbourne. A fairly large share of car parking in the City of Melbourne has an out of pocket price paid for it (42%, including trips to a residence, where parking is rarely paid for out of pocket). Patterns of the price paid for parking in the City of Melbourne are different to other parts of the metropolitan area. Across Melbourne overall, Victorian Integrated Survey of Travel and Activity (VISTA – Department of Transport 2017) survey data for Melbourne for 2012-14 showed 95.8% of parking trips were free to the user (Figure 12). Of the small portion of parking trips in the metropolitan area ending in paid parking, trips to The City of Melbourne accounted for a disproportionate share, 32.1%. Of parking trips to the City of Melbourne, 42% involved payment. This is higher than other inner city councils: for example Port Phillip (21%), Yarra (16%), and Stonnington (5%). Of parking trips to the City of Melbourne, 16% paid a short-term parking fee and 9% a daily parking fee. It was also common for drivers to the City of Melbourne have had their parking paid for by their employer (8%), or through a salary arrangement (4%).

Currently, metered on-street parking run by the City of Melbourne charges out of pocket fees of \$5.50 per hour in the CBD, \$3.20 in some other locations, and \$0.80 per hour in all-day parking areas. Commercial parking garages offer low daily 'early bird' parking (around \$20 per day) but are more expensive (around \$15-\$20 per hour) for casual parking.

The cost of parking land and construction. The *Austrroads Guide to Traffic Management (Parking)* gives a guide price of land and construction for parking spaces in Australia (Table 1). These costs per space range between \$50,000 and \$126,000 per bay, varying by the angle of parking space and by whether it is surface level, basement, or podium parking. Surface parking has lower construction costs but higher land costs; basement parking has higher construction costs but lower land costs. In 2015, on average, spaces inside the Hoddle Grid had a \$7,000 of revenue per year and outside \$2,400 (City of Melbourne Car Share Policy 2015).

The broader economic costs and benefits of parking in the City of Melbourne are harder to estimate. The opportunity costs embedded in a parking space are difficult to quantify both because of the absence of a

market for street space but also because some uses for land (including parking, and public open space) are considered infrastructure and not valued in monetary terms. Figure 11 illustrates some of the hidden and opportunity costs of car parking space.

Some benchmarks of the value of parking space or equivalent sized spaces are available (see box 'Putting a price on parking'). These vary widely, and reflect differences in how parking space is thought of, and how space is valued in differing policies and contexts.

In figures: Putting a price on parking

Metered on-street parking in the City of Melbourne: \$5.50 per hour in the CBD, \$2.30 or \$0.80 elsewhere.

Commercial parking garages: approx. \$20 early bird daily parking, \$16 per hour for casual parking.

Residential parking permits in the City of Melbourne: \$30 per year for the first permit, and \$120 for the second.

Car share companies: pay a fee per space – for this to be cost recovery, Council estimates were \$5,400 per space per year inside the Hoddle Grid and \$3,800 outside (actual fees paid are partial cost recovery).

Typical sale price of individual off-street car parks in Melbourne CBD: \$30,000 - \$60,000.

Monthly car space rental in CBD on secondary market provider sites: approx. \$300-\$400 p.m. (\$70-\$95 p.w.)

In figures: Comparing the price of parking

Daily MYKI (zone 1 & 2 full fare): \$8.60

Medium coffee: \$4.10

Median weekly rent, 2-bedroom apartment in CBD: \$575 p.w. (\$29,986 p.a.) (approx. 60 sqm)

Commercial rents in the Melbourne CBD: average around \$3,500 per square metre per year: around \$44,000 - \$75,000 p.a. for a parking space sized area.

The value of a street tree in the City of Melbourne: between \$21,522 and \$181,002.

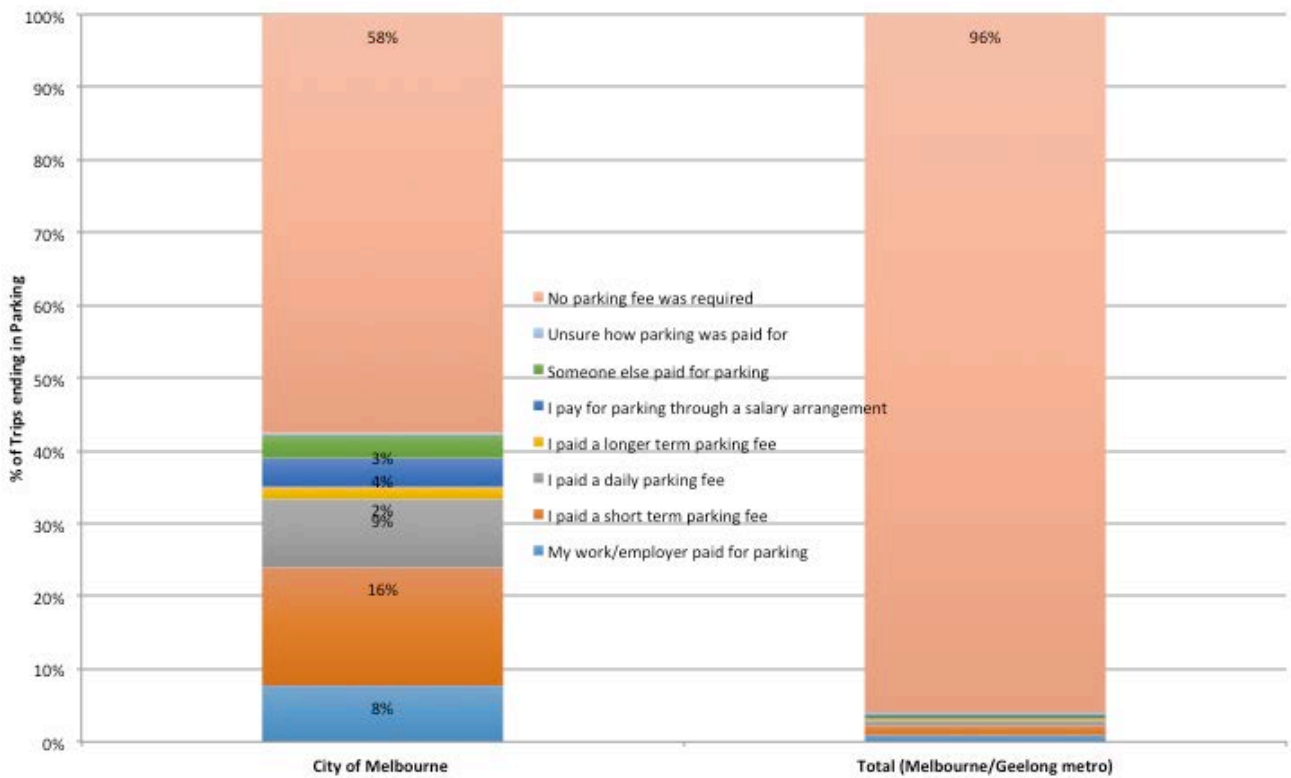
Sales prices for vacant resident land across metropolitan Melbourne: average around \$700 per square metre. This would be \$9,000-15,000 for land the size of a parking space.

Melbourne CBD land prices: are as high as \$10,000-\$25,000 per square metre. This would be around \$191,000 - \$315,000 for an area the size of a parking space.

Figure 11: The hidden and opportunity costs of car parking



Figure 12: Trips ending in parking: who paid for parking (City of Melbourne compared to Metropolitan Melbourne) (VISTA survey)



Description: A column graph with a 100% scale shows two stacked columns, on the left the City of Melbourne, and on the right the Total (Melbourne / Geelong metro). The columns are stacked with categories of “who paid for parking”. On the right for total (Melbourne/Geelong) only the column “no parking fee was required” is the only readable category (96%). On the left for the City of Melbourne: my work/employer paid for parking 8%; I paid a short term parking fee 16%; I paid a daily parking fee 9%; I paid a longer term parking fee 2%; I pay for parking through a salary arrangement 4%; someone else paid for parking 3%; unsure how parking was paid for 0%; no parking fee was required 58%.

Figure 13: Trips ending in parking: where vehicle was parked (City of Melbourne compared to Metropolitan Melbourne) (VISTA survey)

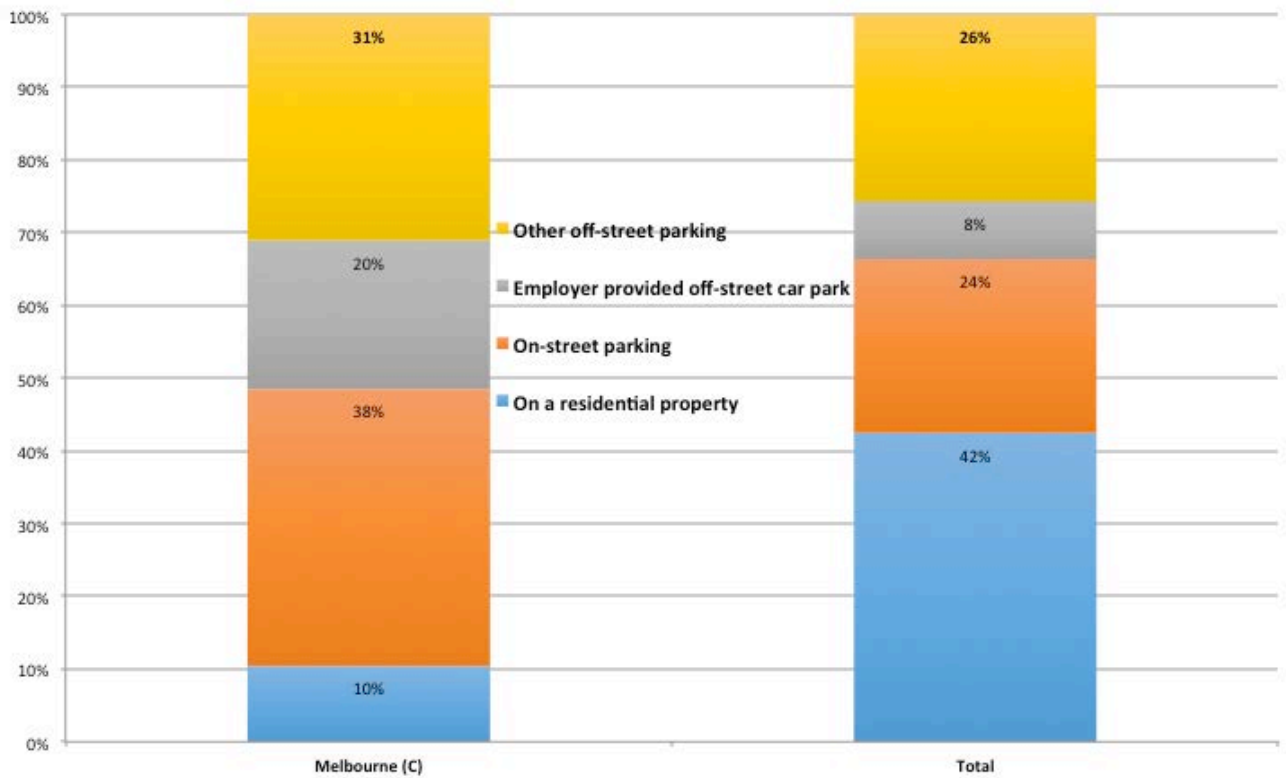


Table 1: Land and construction costs per parking bay, by construction type

Type of parking	Land per bay	Land cost per square meter	Floor area per bay	Construction cost per bay	Estimated total cost per bay
Off-street surface (at-grade)	35m ²	\$70,000 - \$122,500	35m ²	\$3,500	\$73,500 - \$126,000
Deck - 2 level	16m ²	\$32,000 - \$56,000	32m ²	\$31,000	\$63,000 - \$87,000
Deck - 4 level	8m ²	\$16,000 - \$28,000	32m ²	\$34,000	\$50,000 - \$62,000
Basement - 2 level	8m ²	\$16,000 - \$28,000	32m ²	\$39,000	\$55,000 - \$67,000

Source: Austroads Guide to Traffic Management Part 11 (Parking), 2017 edition, p142

What role does car parking have in transport and traffic?

Several studies illustrate that parking availability and price influences decisions to drive, as well as car ownership. The availability and price of car parking at destinations has been identified as a factor in transport mode choice, with ample free parking increasing the likelihood of car ownership and use (Manville 2017, Milosvljevic & Simicevic 2016). Greater extent and lower price of car parking increases car use and congestion even when there is access to other modes (Guo 2013a, 2013b; Hagman 2006; McCahill and Garrick 2010; Pandhe and March 2012; Weinberger 2012).

Commuters and free parking. Some of the stronger evidence around the role of parking in influencing car use is for commuter (worker) parking. In a 1997 study of California 1,684 employees, Shoup found that when an equivalent cash-out option was given to workers instead of 'free' worker parking, solo car driving reduced by 17%. Reducing subsidies to employee parking increased carpooling and public transport use; as well as walking and cycling. Conversely, automatically subsidizing parking increases car use for commuters. Pandhe and March (2012) in a survey-based study of workers in Melbourne CBD, found provision of employer-paid parking influenced the decision to drive (2012): 35% of drivers would shift to trains were parking not provided. For similar reasons, provision of bicycle parking including end-of-trip facilities (showers and lockers) has been shown to increase bicycle use by commuters (Beuhler 2012).

Marsden (summarizing other studies) – parking pricing (based on the US primarily) show that in general, people are more sensitive to paying parking charges, than to the costs of petrol or car ownership. Other studies show changes in car use for commuting from introducing car parking charges or reducing subsidies to driving. Workers respond to parking pricing by: changing parking destination, transport mode, or departure time. Often there is a switch in transport mode – however some changes may reflect different parking behavior, for example parking further away and then walking. For example the centre of Edinburgh, Scotland has been part of a controlled parking zone since 1974. Resident parking in the area is based on payment. A study by Rye et al (2004 – cited in Marsden 2006) found that in the area surrounding the controlled parking part of Edinburgh, some evidence suggested that 28-42% of parking was by commuters. A study of the potential effects of expanding the zone noted that some but not all commuters were prepared to walk further for free parking. Commuters are also more likely to search for a space close to work, even when search time is involved.

Spillover from paid parking. Because changing parking location is a primary response of commuters to parking changes, Marsden emphasizes “the need for an area-wide strategy if the problems are not simply to be moved elsewhere”. Anecdotally the introduction of paid parking in government areas in Canberra has seen spillover of workers to nearby residential areas, who then walk. There is a split in the City of Melbourne between tightly managed, slightly managed, and adjoining areas with fewer parking costs or controls. There is not clear evidence of to what length workers will go to avoid paid parking areas. The fact that Canberra has no residential permit parking may have exacerbated spillover effects there as compared to Melbourne.

Cruising. As well as total car traffic, parking has a role in adding traffic from drivers searching for parking. Shoup (1999; 2006) argues drivers are more likely to 'cruise' if on-street (curb) parking is cheaper than off-street parking, amongst other factors. Other studies confirm drivers favour on-street parking over off-street parking garages, and cruise in search of free parking rather than paying for private off-street parking (Arnott 2006; Kobus et al 2013). As cruising for 'free' or cheap parking adds to traffic and its associated pollution, this is one reason Shoup argues for a market price for both on and off-street parking (as well as for parking information). A 2006 study found that in congested downtown American areas, it took 3.5-14 minutes to find on-street parking space; and that between 8-74% of traffic was cruising for parking. Another meta-study (reviewing 16 studies) found on average 30% of traffic is looking for a parking space.

What role does car parking have in retailing?

Retail parking has long been a major concern of planning and transport policy. Retail traders' concerns often underscore opposition to reduction of parking space allocation, or to the introduction of pricing. Marsden (2006) noted that despite a lack of evidence, parking policies in the UK are framed in a way sensitive to the idea that parking pricing will negatively impact retailing visits. City of Melbourne policy seeks to balance short term destination parking (for retail and other destinations), against other objectives. Time-limited parking is used to encourage high turnover (assumed to be good for retailing), although this might also be considered bad for traffic generation (except in limiting cruising). All car parking policy decisions involve such trade-offs, real and imagined.

Few studies of retailing and parking. Although beliefs are strong, data and empirical analysis on retailing and parking is not. Marsden (2006) observed differences in the strength of research evidence around commuter responses to parking changes; as compared to evidence on changes to parking for retail, hospitality or leisure destinations. Evidence on the role of parking and changes to it for retailing and leisure destinations is much more limited, especially in the lack of observed behaviour studies around parking and retailing. In a review of the literature Marsden found either little evidence for, or contrary evidence for, the idea that parking restraint makes areas less attractive for retail. But he also pointed out that more context-specific and disaggregate studies are needed – that it isn't clear when and where parking changes do or do not influence retailing.

Hensher and King (2001) undertook a study of casual visitors to the CBD of Sydney. The Hensher and King study was based on 660 respondents and on their stated preferences: the background to this study was the lack of information in Australia regarding changes to parking pricing or access. The findings indicated that parking price increases would lead to relocation of parking from the CBD to other areas close to the CBD. Some drivers were more price sensitive, and some were more likely to shift to public transport or to lower priced fringe parking. The findings showed no reduction in total journeys to the CBD in response to parking performance.

Still and Simmonds (2000) – modeled relationships between parking provision and economic vitality and found a very weak relationship. However a modeling exercise found where strong parking restraint is implemented in the city centre but not elsewhere, this could have negative impacts. A study by Lockwood (2003) correlating parking and centre performance found no systematic relationship for the amount or convenience of parking. This did not examine the quality or type of retailing. Another study of 3000 visitors to 11 shopping centers in London found that walkers spent on average £91 per week (higher than bus users, £63, and car drivers, £64).

Locally, Yen et al (2015) found that restaurant precincts in Brisbane, store owners significantly over-estimated the proportion of customers coming by car, while underestimating pedestrian and other traffic. Lee and March (2010) found in a study of Lygon Street in Carlton (in the City of Melbourne) that while bike parking was allocated a small amount of space, it generated more significantly spending per hour (\$31) than car parking (\$6).

Concerns about retail parking loss. Several examples highlight the intense fears of traders around changes to parking. In suburban or other areas, timing restrictions (as opposed to changes to parking numbers or location, or introduction of pricing) may be more politically acceptable. Anecdotally, precinct-based measure of retail parking availability often do not persuade traders that parking is available: partly because of an expectation that workers and visitors, should simultaneously park directly in front of a destination. This was illustrated in a study of changes to parking for the 96 tram upgrade (Legacy and Taylor 2018). Melbourne's LXRA level crossing removal projects have a mandate for no net loss of car parking. In the Mentone project this implied a five storey car park be built to replace parking. Occupancy studies of the area showed occupancy rates of 40-70%. In media coverage, some traders doubted these studies, calling for more parking spaces, as "he and his staff battled for a car spot each day when they turned up for work" (Mordialloc Chelsea Leader November 17th 2017).

The strongest evidence from literature is that retailers often express intense fear of any change around car parking provision. It is not clear what if any information is persuasive in questions of retailing and parking,

given the strength of assumed knowledge of customer parking preferences and habits. Temporary (trial) changes are pointed to as one option for improving buy-in, for example as in Parklet and Park(ing) Day programs. Parklets are parking spaces converted to public open space, temporarily or sometimes permanently. Park(ing) Day is an annual event where parking spaces are converted to alternative uses.

Importantly, the City of Melbourne already has many of the policies recommended in research literature: it has few free or unrestricted retail parking areas, so does not face the same challenges as suburban areas with regards concerns about retailing. Historically CBD traders have been very active in seeking to add commercial or high-turnover parking to the CBD, in efforts to compete with suburban malls (the politics of this in the 1950s is described in Graeme Davison's "Car Wars", 2004). Retailing challenges may be stronger in other retailing areas in the city – strip centres such as North Melbourne – where destination space competes with residential on-street storage (including permits).

Data on retail and hospitality trips in the City of Melbourne. Based on VISTA travel survey data, 73% of trips to the City of Melbourne with the purpose "buy something" (shopping) were by non-car travel, while the remainder more commonly used on-street parking (14%) than off-street parking (11.7%). For "social" trips (including hospitality), 69% were by non-car means, while 14% used on-street parking and 15.5% used off-street parking (Figure 14). Trip types most reliant on on-street parking were pick-ups and deliveries of items and of people.

Of trips ending in off-street parking use in the municipality, the largest users were work related trips (22%), social (18%), "go home" (residential) (15%), and "buy something" (9%) (Figure 15). Across metropolitan Melbourne, 18% of all trips to "social places" were to the City of Melbourne; and 5% of trips to shops. The LGA was the top destination for social trips, and fourth for shopping trips. Across all trip types, 82% of trips to the City of Melbourne did not involve car parking; while 7% used on-street parking and 11% used off-street parking. In comparison, across the Melbourne metropolitan area only 28% of trips did not end in car parking; 22% in on-street parking; and 50% in off-street parking.

The City of Melbourne is the top destination for social and hospitality trips, and an important but not dominant destination for shopping trips. Most (around three quarters) of travel for these purposes does not rely on car parking – unusual in the context of metropolitan Melbourne, where the majority of trips are by car and result in parking. However of the share of trips by car to the municipality for retail and social purposes, both on and off-street parking are used roughly equally. Major uses of on-street space in the city are instead work and residential trips, followed by social trips. On-street parking is also important for pick-ups and deliveries. Competition for parking space by users is likely to vary time of day and location.

Figure 14: (VISTA survey) – Trip purpose by type of parking used

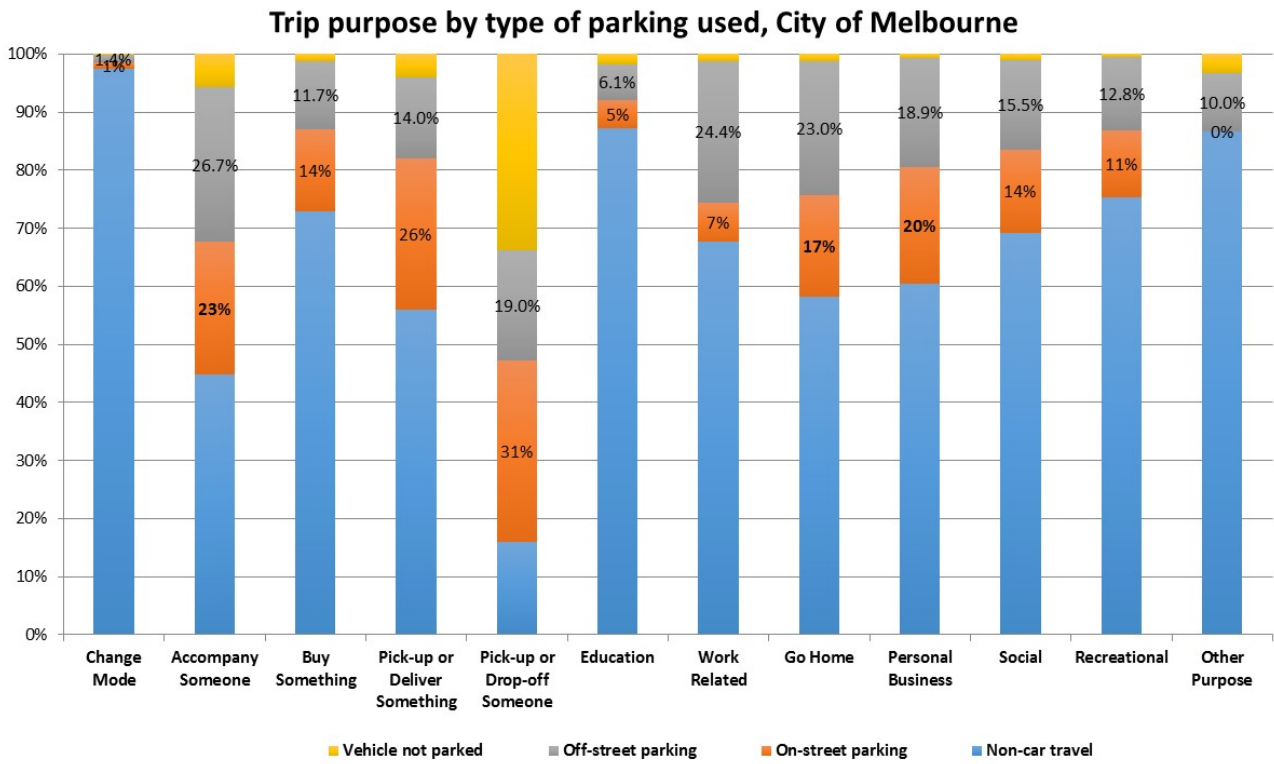
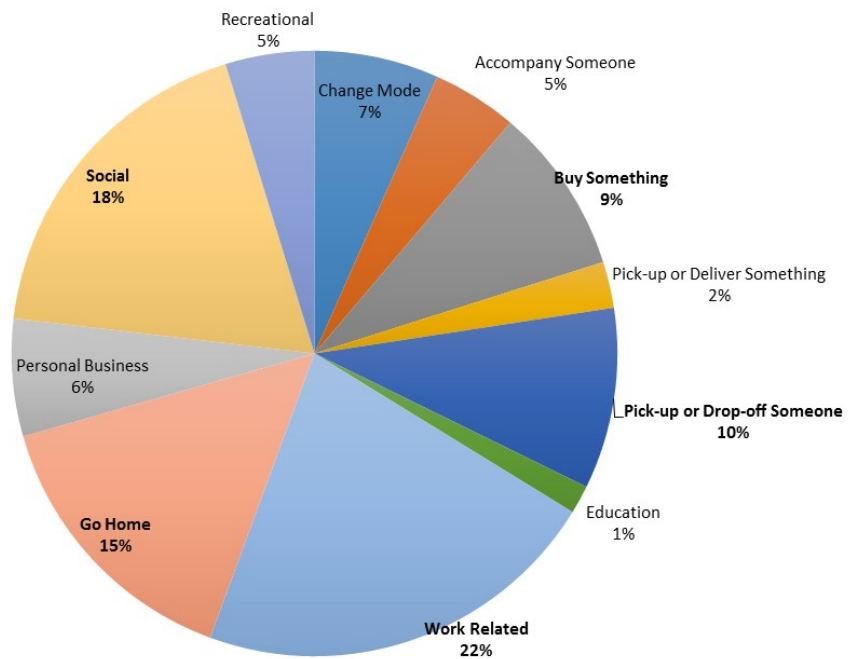


Figure 15: (VISTA survey) – Share of on-street parking use by trip purpose

Share of on-street parking use by trip purpose, City of Melbourne



What role does car parking have in housing?

Parking in the context of housing involves different questions to destination parking, including: parking as a housing cost; as an amenity (including for resale); car ownership versus use; the role of on-street parking rights; and the use of parking space (particularly garages) for other housing purposes such as storage.

Residential parking and affordability. Parking (and minimum off-street parking requirements for it) add to housing construction costs, and to housing choice and affordability through direct and indirect means (e.g. Guo and Ren 2013; Jia and Wachs 1999; Manville 2013). In Australia, Austroads estimates land and construction costs per parking space at \$50,000 - \$80,000 for basement or podium parking. Another study cited residential parking costs at around \$40,000 per space in the City of Melbourne (Phillip Boyle & Associated 2017). 'Bundling' car parking with new housing is considered problematic as some households would otherwise trade-off parking for affordability and other housing attributes against parking costs (Figure 16).

Residential parking as an amenity. Residential parking space is also a housing feature/amenity that some households will pay a premium for. Guo and Ren (2013) found while parking adds to housing costs, higher income households pay a premium for parking even or especially in areas of high accessibility. Stubbs (2002) also found many UK households prefer to purchase residential parking for its on-sale value, even if not for their own use. In Australia, finance and banking practices similarly encourage car parking as an amenity in the sale and resale of apartments.

Vacant or unused residential parking the City of Melbourne. It is difficult to distinguish residential car parking that is unwanted, from parking that is simply unused. Nonetheless of 49,500 off-street residential spaces in the City of Melbourne, a Phillip Boyle study for the City of Melbourne in 2017 estimated that 13,000 were surplus (not used for overnight parking – based on comparing car ownership with residential off-street parking spaces). The City of Melbourne has a low rate of motorization by world standards, and the number and proportion of zero car households has grown four-fold since the 1990s. As at 2016, 47% of households in the City of Melbourne did not own a car - and 61% of those in the CBD. Survey data (noted earlier) also suggest an estimated 30%-40% of apartment parking spaces in the City of Melbourne are unused – which would imply slightly higher than 13,000 excess spaces.

The Phillip Boyle study noted that the City of Melbourne “did not (and does not) strictly enforce ‘minimum’ requirements but allowed (and allows) lower level of provision including zero car spaces”. They found that through this approach the City avoided 19,000 above-demand car parking spaces (between 2006 and 2015). In 2010, parking minimums were removed and replaced with maximums in a larger area, extending into West Melbourne. The City of Melbourne has begun to avoid more of the excess residential parking facilitated by minimum parking policies. Residential parking provision seems however to still be above low car ownership levels; partly through legacy construction and legacy policies; and partly through ongoing construction and financing practices.

Use of on-street residential parking and permits. Most housing across metropolitan Melbourne has off-street parking. Exceptions are older, pre-planning terrace and other Victorian-era housing including within the City of Melbourne, and apartments in the CBD (the City of Melbourne) (Taylor 2016). Outside of the City of Melbourne new housing either meets parking minimums, or is the subject of considerable debate and dispute (for example Brunswick’s Commons and Nightingale buildings). In much of Melbourne residential parking policies are complicated by the availability of free street parking, to which existing residents exert a real or asserted right (Taylor 2014). VISTA data on residential parking use indicates 94% of on-street residential parking is by residents of detached and terraced housing – apartments have the onus to provide on-site off-street parking, which typically has much tighter controls on its use (such as through owners corporation rules).

The City of Melbourne has on-street parking management limiting or eliminating possible ‘spillover’ residential parking. This is through parking pricing and enforcement, and the use of residential parking permits. City of Melbourne residential parking permit policy has similarities to other inner city residential parking schemes in its low price, and eligibility restrictions based on dwelling age. Residential parking permits in the City of

Melbourne vary by area. In Carlton, North and West Melbourne residents can apply for 2 parking permits plus visitor vouchers. Only residents of homes built before 2005 or 2008 (varying by area) are eligible for on-street parking permits. Fees are \$30 for the first annual permit, \$120 for the second, plus \$30 for visitor vouchers. There is no resident permit parking scheme in the CBD or Docklands. In other areas eligibility for residential parking permits excludes homes built before 2010 or 2011. Around 13,000 residential parking permits (referred to in the Phillip Boyle 2017 report as 'kerbside vehicle storage' - Figure 17) are issued in the City of Melbourne each year. This terminology highlights difficulties with residential permits. On the one hand permit systems manage non-resident parking, reducing commuter parking and limiting 'spillover' from development. On the other hand, permits give preference to existing residents over others; and tend to be extremely low cost relative to their underlying value as urban space (Marsden 2006; Guo 2013; Van Ommeran et al 2014; Molenda & Sieg 2013).

Provision of on-street permits also seems to encourage car ownership (Weinberger et al. 2009; Weinberger 2012; Manville 2016; Guo 2013); and the use of off-street parking space for other housing-related uses, shifting car storage to public space. Dutch, UK and US studies show households underutilize private parking where on-street parking is available: garages in particular seem to be used for car storage only around half the time. A study of households in Los Angeles found that 75% of garages were filled with household goods rather than cars (Arnold et al 2012 p44-47). Increased car ownership and pressure on street space (and footpath space) has also defined the parking experiences of many German cities. This is true even in areas with declining populations or stable populations, and limited if any new development (Topp 1991). Marsden (2006) argues that to tackle parking and associated amenity issues in inner urban areas residential on-street parking is a key issue - whereas much parking policy focuses on destination parking, partly for political reasons: noting that "the two principal barriers to tackling residential parking policies are enforcement costs and community acceptance" (p455).

In the two Phillip Boyle reports the estimated number of unused residential parking spaces in apartment buildings in the City of Melbourne (13,000 around with an average cost of around \$40,000); is essential identical to the numbers of on-street residential parking permits (13,000) issued. On-street parking permits grant the right to use on-street space for car storage: anecdotally many of these are cars are driven comparatively rarely (Figure 17). Residential permits on the one hand serve to limit traffic, and commuter traffic in particular, by replacing 'parking' with 'storage'. They are also a sizeable use of on-street space: in the City of Melbourne, 15% of users of on-street parking were residential / home (the third largest user category). Their user cost is extremely low compared to the cost of off-street space to residents of apartments (mostly, and increasingly, ineligible for on-street permits). Past experience shows on-street residential parking permits are highly valued by residents with rights to them, although this valuing does not extend to financial value – permit holders are very averse to paying for permits and certainly to paying above a nominal annual fee. This political reality is common to studies elsewhere – for example New York (Guo and McDonnell 2013), and the Netherlands (Van Ommeren et al 2014).

In figures: Car parking and housing

Median weekly rent, 2-bedroom apartment in CBD: \$575 p.w.

Monthly car space rental in CBD on third party provider sites: approx. \$300-\$400 per month (\$70-\$95 p.w.)

Land and construction cost of off-street residential parking space: \$40,000 - \$80,000

Share of households in the City of Melbourne paying more than 30% of income on housing (2016 Census): 34.6%

Share of households in the City of Melbourne with no car: 46.4% (61.1% of households in the Melbourne CBD have no car)

Estimated excess (vacant) residential parking spaces in apartment buildings in the City of Melbourne: 13,000

Price of residential parking permits in the City of Melbourne: \$30 per year for the first permit, and \$120 for the second.

Share of on-street residential parking use by residents of apartments, Melbourne (VISTA survey): 6%

Figure 16: Parking and housing - explainer of 'bundled' and 'un-bundled'

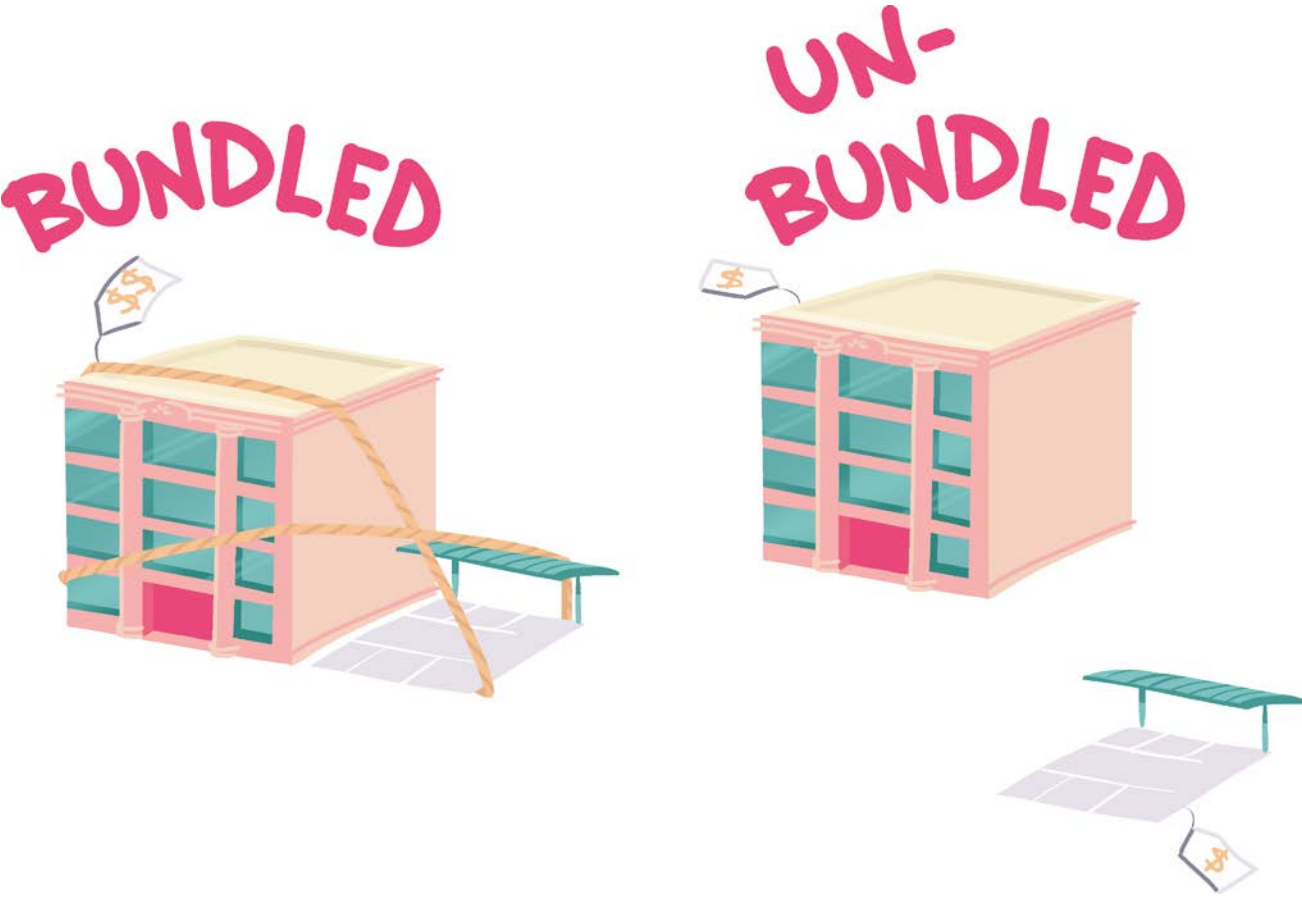
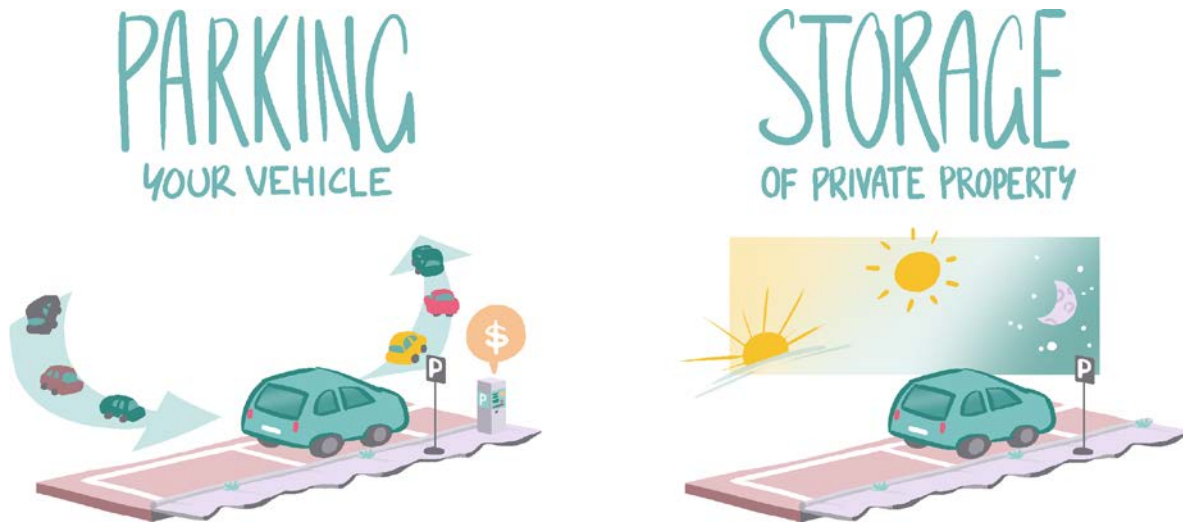


Figure 17: Parking and housing - explainer of 'parking' and 'storage' (including residential parking)



Summary: Strength of evidence around car parking questions

Table 1 – Summary of strength of the evidence base around parking

Parking Question	Likely answer	Strength of evidence
How much parking space do we have?	<p>Parking bays occupy 12-35 square metres of space. (On average, 21sqm)</p> <p>In some cities car parking areas can occupy a third or half of land area.</p> <p>A parking space is bigger than a bedroom, and about a quarter the size of a typical Melbourne tram.</p> <p>The City of Melbourne has at least 217,090 parking spaces, most of which are off-street (193,000) and many of which are residential.</p> <p>Residential off-street space is increasing while on-street metered spaces are decreasing.</p> <p>Off-street parking accounts for 12% of floor space in the City of Melbourne.</p> <p>Total parking floor space in the municipality is the equivalent of 225 MCGs, or 3.6 Hoddle Grids.</p>	<p>Knowledge of the extent of parking space is excellent for some areas and parking types, but poor for others.</p> <p>The City of Melbourne has better data (CLUE, and on-street parking records) than most cities or most parts of the Melbourne metropolitan area.</p>
How much parking space is used?	<p>Average occupancy of on-street parking in the City of Melbourne is around 47.3%, varying from 30-70%.</p> <p>Occupancy varies by location, time, and day. It is highest on Sunday when parking is unmetered.</p> <p>Between 26% and 41% of residential apartment parking spaces in the City of Melbourne are thought to be vacant/unused.</p>	<p>Knowledge of on-street parking occupancy (use rates) is excellent for metered on-street spaces with sensors in the City of Melbourne.</p> <p>Estimates are reasonable, but patchy, for residential parking use (survey data, CLUE data combined with Census records).</p> <p>Data is lacking or poor for other parking types including private parking and unmetered on-street parking.</p> <p>Other cities often rely on isolated surveys or anecdotal evidence only.</p>
How much is paid for parking?	<p>Most (95%) parking trips in metropolitan Melbourne are free to the user. Similar to US studies.</p> <p>The City of Melbourne has a higher share of paid parking trips: 32.1% of</p>	<p>Good data for on-street parking meters.</p> <p>Strong but sample-based data (VISTA) on the proportion of trips paid for and where.</p>

Parking Question	Likely answer	Strength of evidence
	<p>paid parking trips in Melbourne. 42% of parking trips to the City of Melbourne involved payment.</p> <p>Many parking trips in the municipality were paid for by an employer or through a salary arrangement.</p> <p>Currently on-street parking costs \$5.50 per hour in the CBD, \$3.20 in some other locations, and 0.80 per hour in all-day parking areas.</p> <p>Residential on-street parking permits cost \$30 - \$120 per year.</p> <p>Estimates of parking construction costs are between \$40,000 and \$126,000 per bay.</p> <p>Typical sale prices of individual car parks in the CBD are \$30,000 - \$60,000.</p> <p>On average on-street spaces in the City of Melbourne generate \$2,400-\$7,000 in revenue per year.</p>	<p>Strong estimates of land and construction costs, but based on typical projects not specific to City of Melbourne locations.</p> <p>Commercial and secondary data on parking sale prices are patchy.</p>
<p>What role does parking have in traffic?</p>	<p>Strong evidence that changes to parking provision or pricing changes commuter transport behaviour.</p> <p>Workers significantly more likely to drive when subsidised parking is provided. More likely to ride when bicycle parking and facilities are provided.</p> <p>Parking pricing or controls can displace commuter parking to other locations unless a large area is managed.</p> <p>The search for parking adds to traffic through cruising.</p>	<p>The role of parking availability and price in encouraging driving (and conversely, of pricing deterring the decision to drive) has strong empirical evidence, especially for commuters.</p> <p>Data on cruising traffic is commonly cited but weaker.</p> <p>Analysis of parking and congestion patterns in Melbourne would be possible, but require sophisticated analysis which has not yet been undertaken - or at least, not published.</p>
<p>What role does parking have in retailing?</p>	<p>Weak or contrary evidence that parking influences retailing viability</p> <p>Available studies suggest that the number of drivers, and influence of parking, is overestimated by traders.</p> <p>Retail spending is higher by</p>	<p>Poor or mixed. There are strong beliefs around the importance of parking (supply and/or turnover) for parking but limited behaviour studies or large scale evidence.</p> <p>Studies that do exist indicate that the importance of cars and parking is often</p>

Parking Question	Likely answer	Strength of evidence
	<p>pedestrians and cyclists.</p> <p>Change to retail parking is politically fraught.</p> <p>City of Melbourne retail parking and turnover is highly managed in the CBD. Traders in other centres may compete with long-term parking.</p> <p>The City of Melbourne is the top metropolitan destination for social trips, and fourth for retail trips.</p> <p>Three-quarters of retail trips, and 70% of social trips (including hospitality), to the City of Melbourne were by non-car travel.</p> <p>The most significant users of on-street parking in the municipality were: work related trips, residential (storage), social trips, and picks up and deliveries.</p>	<p>overestimated by traders.</p> <p>However these studies may not be transferable to specific locations and retailing types. Detailed trials are lacking.</p> <p>VISTA data provides strong survey-based data on the comparatively low use of parking for trips including retail and hospitality to the City of Melbourne.</p> <p>It is not known, however, which trips were not undertaken or went to different locations due to parking differences.</p>
<p>What role does parking have in housing?</p>	<p>Off-street parking adds to new housing costs directly and indirectly</p> <p>Residential parking adds around \$40,000 - \$80,000 per space in the City of Melbourne</p> <p>Off-street residential parking is also a desirable feature, including for banks and for re-sale value.</p> <p>40-60% of City of Melbourne households do not own a car, and around a third (estimated 13,000) of residential apartment parking spaces in the City of Melbourne are vacant / unused</p> <p>An identical number (around 13,000) of on-street residential parking permits seem to be issued to residents of older housing.</p> <p>The majority (94%) of use of on-street parking for residential parking is by residents of houses and terraces.</p> <p>15% of on-street parking use in the City of Melbourne is residential parking</p>	<p>Strong evidence from empirical studies on the influence of parking and parking requirements on housing costs and diversity.</p> <p>Very good data on residential parking spaces from CLUE.</p> <p>Data is reasonable. but patchy for estimates of residential parking occupancy (survey data, CLUE data combined with Census records)</p> <p>VISTA has good but survey-based data on on-street parking use (used by a small subset of the households in the survey).</p> <p>Information is lacking on the role of parking in housing choice.</p> <p>No detailed information on residential permit users.</p> <p>Several strong studies confirming that residential on-street parking is mainly for storage, and that seeking to change or charge for residential parking is</p>

Parking Question	Likely answer	Strength of evidence
	(storage).	politically very difficult.

Car parking policies: roles and impacts

Competing roles for parking policies

Most car parking depends on government policy or subsidies in one form or another: worldwide very few examples of market-based car parking provision exist. Unlike several other utilities (electricity, water, telecommunication) car infrastructure including car parking has largely resisted trends toward market liberalisation over previous decades.

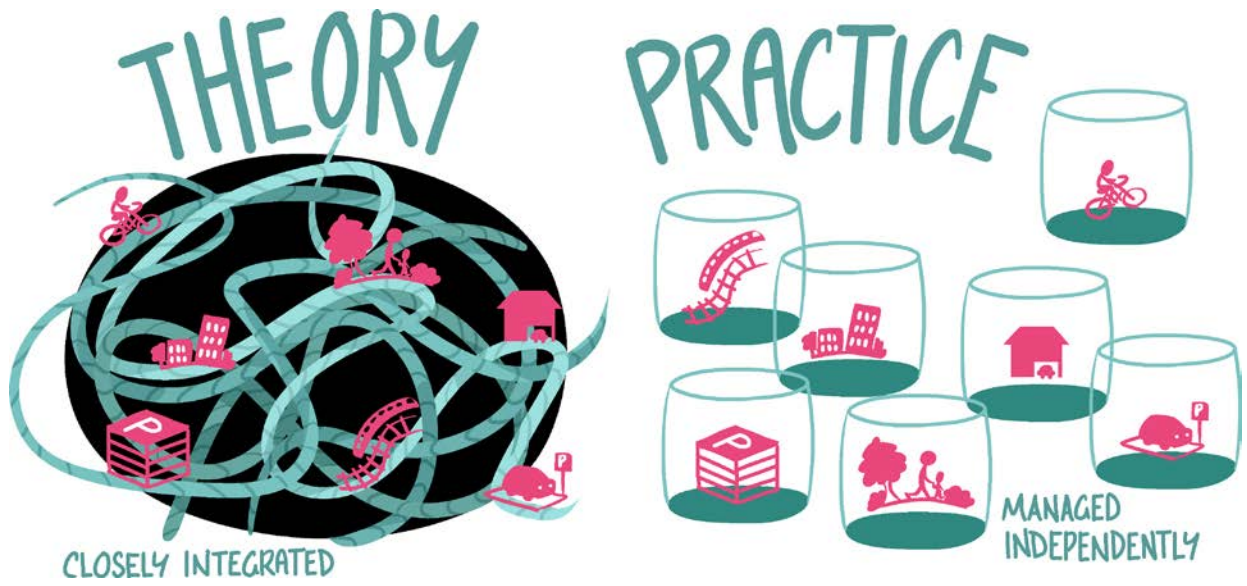
Since rapid motorisation of the mid-20th century governments have long been heavily involved in car parking - both through the provision of public space, and the regulation of private development. Broad aspects of policy involvement in parking are: off-street parking rates (minimums or maximums), design and other standards; the provision of on-street space; pricing, timing, and special rights to on-street parking space. Councils have also been involved in acquiring and demolishing land for car parking.

In theory, each element of parking policy is closely integrated – in practice, on-street parking is often independently managed of off-street parking (Figure 18). Marsden (2006) observed there are competing goals for car parking policies. He observes tensions between three potential objectives of parking: regeneration (e.g. seeking to provide more parking to attract visitors), restraint (e.g. managing car use through parking, to encourage environmental quality, other transport modes), and revenue (generating revenue from parking to cover its cost or to fund other activities).

Another parking discussion paper (Mississauga 2017) points out that parking is not just end-of-trip infrastructure but influences building, management, and human travel behaviour. These roles of parking policy are often operated separately within governments. This is largely true of the City of Melbourne: parking is an element of local law enforcement; engineering; planning; building; and transport (amongst others).

Within the City of Melbourne, interests in revenue are balanced against transport goals and retail goals. Even revenue and enforcement are in some tension, with better technology increasing legal payments but reducing income from infringements. Policies for open space access and quality for residents and visitors are in competition with public space used for car parking. The interests of retailers in deliveries and customer turnover are not always the same as the parking interests of residents. Broad categorisations and chronologies of types of parking policies help explain different types of policy approaches, and to identify common principles.

Figure 18: Parking policy has many competing goals. In theory these are closely integrated, in practice they are usually managed independently.



Categories of parking policies: Conventional, management, market

Barter (2010) characterizes three basic approaches to parking policies - two mainstream approaches ('conventional', and 'parking management'), plus 'market-based' approaches. In a later study Barter (2015) suggested slightly different typology for parking: with three types, based on two criteria: whether parking is precinct based or site based ("parking facilities serve their district" vs. "every site should be fully served by on-site parking"); and whether parking is regarded as a market good or as infrastructure.

Parking policy typologies have a historical trajectory. Informal, unregulated parking has usually accompanied rapid motorization, leading to pressures to control parking. In the characterization of Mingardo et al (2007) based on European cities, minimum parking requirements (conventional policies) are followed by an initial pricing of parking, and by a third more strategic phase of parking management. In some cities, parking restraint follows on from parking management. London, Helsinki, Oslo, Zurich and Vienna have moved toward discouraging car parking: IDTP (2011) tracks Europe's shift over time from encouraging car parking to regulation. In other cities, such as San Francisco, parking policy is shifting toward more market-based making use of technology. See Figure 19 for an illustration of differences between basic categories of parking policy approaches.

In **conventional**, or conventional site-focused, parking policies:

- Parking assumed to be public infrastructure
- On-street parking is seen as a 'commons' (usually free to the user)
- Scarcity is the problem, and policies seek to reduce 'spillover'
- Use site-based requirements: minimum parking policies try to get each site (development) to handle its own parking by providing 'enough' parking
- Parking usually appears free to the user

Such approaches became widespread over the 20th century. One reason for the amount of parking, and our expectation it should be free, is conventional parking policies. Conventional parking policies appeal politically, but research is highly critical of them - for oversupplying parking, and for disguising and displacing its costs. They have been phased out in some cities, including parts of the City of Melbourne.

In **management**, or area management, parking policies:

- Parking is broadly thought of as infrastructure, but is managed and planned at an area level
- The parking problem is approached as one of meeting broader policy goals, sometimes competing. E.g. to reduce car use impacts, increase retail viability
- These use a variety of tools (including timing, pricing, planning, day-to-day management) to match parking to wider goals
- Sometimes use parking maximums instead of parking minimums.

Elements of parking management have typically been adopted in inner city areas (including in the City of Melbourne). They are widespread in European cities.

In **market-based**, or responsive, parking approaches:

- On-street parking is part of broader parking market
- In some cases, there is no or close to on-street parking (private garages dominate)
- In other cases on-street parking is dynamically priced to match price to demand by location and time of day
- The amount of parking is driven by willingness to pay
- The parking problem is seen as a mismatch of demand and supply, and the underpricing of parking
- Governments remove obstacles to market choices

Some existing examples of market based parking exist (e.g. Japan). Market-based parking is otherwise mostly examples of cities seeking to reform parking to reflect market ideas. Dynamic pricing is often dependent on technology.

The City of Melbourne sits part way along these categories or trajectories. The introduction of CBD parking maximums in 1970s and 1980s signalled the City of Melbourne moving away from conventional parking. Parts of the city clearly have parking management, and others do not. There are elements of market-based parking, and pressures or opportunities for more of this via new technology. The potential for the City of Melbourne to move more toward either a comprehensive market-based, or parking-restraint, policy is partly constrained by its position within the broader metropolitan area. The vast majority of municipalities elsewhere in Melbourne (with the exceptions of the City of Port Phillip; City of Yarra; and sections of some other inner municipalities) still employ conventional parking policies and assumptions.

Figure 19: Three basic categories of parking policies: Conventional, management, and market/responsive based approaches



Parking Policy and Practice Examples: Melbourne in Context

Minimum to maximum off-street parking policies

Minimum off-street parking policies require a set number of off-street car parking spaces to be provided with new developments. Such planning policies are widespread in North America (Manville 2013; McDonnell et al 2011; Shoup 2005); and used variably in European cities (Guo & Ren 2013; Mingardo et al 2015). The work of Barter (2012) charts the differing use of minimum parking policies in Asia; while some rapidly motorizing Chinese cities are currently taking up minimum parking requirements (Wang & Yuan 2013).

Minimum off-street parking policies try to predict and provide (require) an amount of off-street parking suitable for the intended use. They are also closely concerned with *on*-street parking: assuming that if new developments provide sufficient parking of their own, spillover onto on-street parking will be managed. Criticisms of minimum off-street parking policies include that they oversupply parking; disguise and disperse the costs of parking space; undermine alternative transport; add to housing costs; and promote inefficient land use. Sometimes the area set aside for car parking is greater than the use itself. See for example work by Shoup (1999); Litman (2006); and Manville (2017). Minimum parking ratios are also typically either copied from other jurisdictions; invented based on rules of thumb; or based on observed demand surveys with low predictive power – a “pseudo-science of planning for parking” (Shoup 2005 p. 75).

Litman (2006) argues that parking requirements impose car-oriented patterns even on more accessible areas. Barter (2010) citing Ferguson (2004) suggests the effects of parking requirements in denser, pre-car areas, are more damaging. This implies that The City of Melbourne, a denser area built before cars, is likely to have had worse impacts from conventional parking strategies and to benefit more from their removal. In this respect it is positive that the City of Melbourne has removed off-street requirements in significant parts of the municipality.

There are few direct defences of minimum off-street parking policies in academic literature, although some view parking requirements as efficient outcomes of political demand for such controls (Levinson 2005); and others warn against oversimplifying the effects of removing parking minimums (Engel-Yan et al 2007) especially in areas with limited transport accessibility. Stubbs (2002) found wide variation in underlying demand for parking in the UK; and others (Guo and Ren, 2013; Li and Guo, 2014) found spatial differences in the effect of removing London’s residential parking requirements. Barter (2010) stresses that the removal of off-street requirements should be supported by the active fostering of commercial parking markets.

In Asia, Barter (2011) noted that Tokyo, Singapore, and Hong Kong have extremely low or no minimum parking standards. In Europe minimum parking policies vary and have in some countries been substantially reviewed and lowered, or replaced with maximums. For example residential minimum parking requirements were removed across Greater London in 2004, and partly replaced by parking maximums (Guo and Ren 2013). This followed an earlier removal of requirements for other use types. Berlin and Hamburg in Germany removed parking minimums in the 1990s. Several American cities – in downtown areas primarily, for example Buffalo New York or in parts of New York City – are moving away from minimums, as is tracked at the blog “Strong Towns” (<https://www.strongtowns.org/parking>) where cities are urged to “take the pledge to remove minimum parking standards”. In these and other cases, however, Paul Barter on the “Reinventing Parking” blog (<http://www.reinventingparking.org/2013/09/which-cities-have-abolished-parking.html>) notes that often (as in Melbourne) minimum off-street parking requirements are removed in the city centre only and not in a comprehensive way.

In place of off-street minimums, parking *maximums* have been introduced in high-demand cities, including parts of the City of Melbourne, usually in efforts to manage traffic congestion. While a significant tool in parking management, research is mixed on their effectiveness - suggesting it is more important to remove minimums.

In Germany, minimum parking policies are set at the state level, but cities vary these standards based on local circumstances. Some locations have adjusted rather than removed minimum requirements - for example since 2015 in the German state of Baden-Wuerttemberg, off-street parking requirements (Landesbauordnung) for car

parking can be substituted with bicycle parking – 4 bicycle spaces in place of 1 car parking space. Freiburg, a city which achieved high rates of public transport and cycling use, achieved significant changes to urban form and transport patterns while retaining off-street minimum parking. In Freiburg’s Vauban district, a largely pedestrianized car-minimal area, off-site precinct-level parking was provided in separate garage structures, at close to the standard minimum rates. In addition, residential parking purchase is opt-in and unbundled.

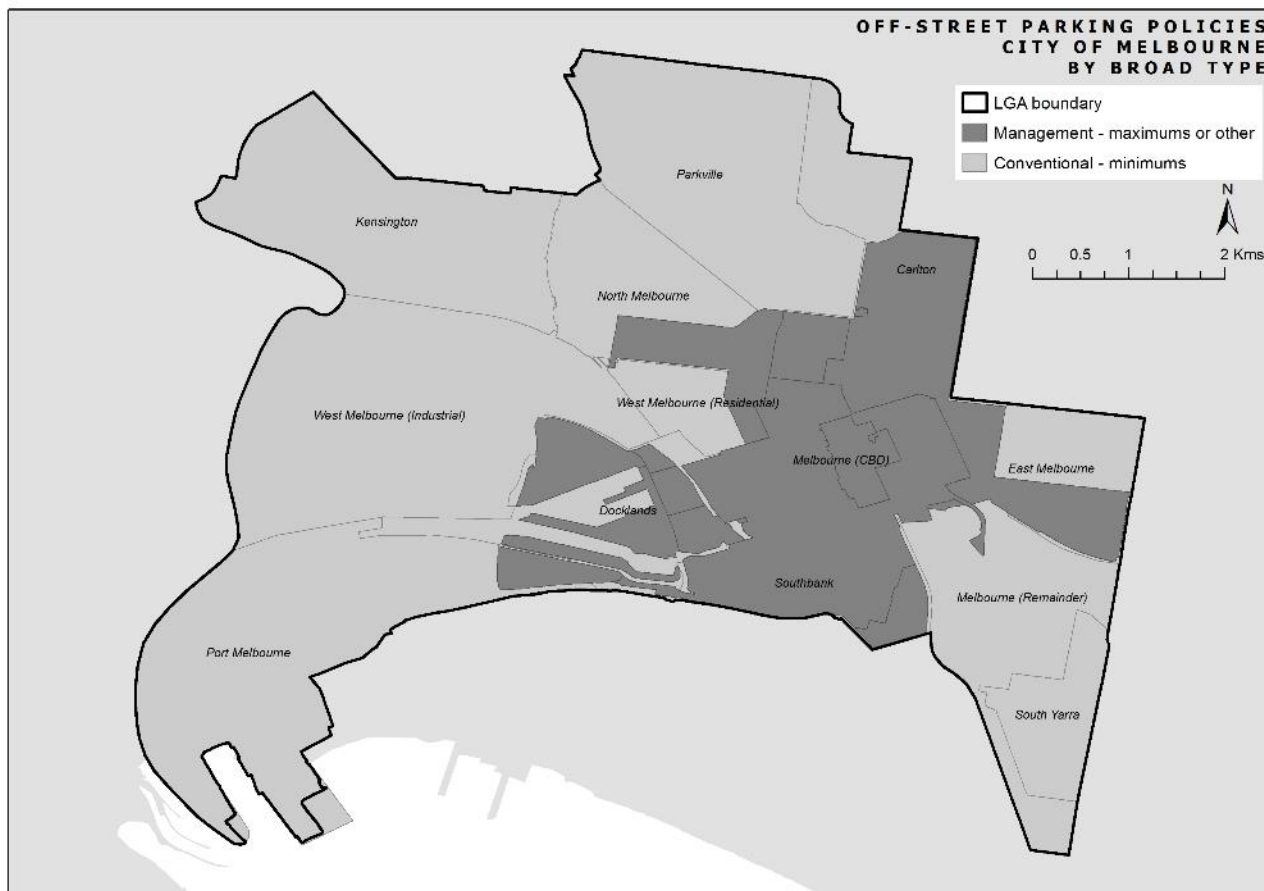
In most of metropolitan Melbourne, minimum parking policies have been standard practice since the 1950s (Taylor & van-Bemmel-Misrachi, 2017). Reflecting Shoup’s critique (2005 p27) that parking rates appear precise but are largely copied from other jurisdictions, Melbourne’s original parking policies were copied from American standards. Today, standard minimums are set in 52.06 of the Victoria Planning Provisions. A ‘waiver’ system allows for reduction of minimums in special circumstances. Disagreement over these provisions, worsened by a lack of coordination between off street and on-street management, is a focus of Victoria’s thousands of annual planning appeals (Taylor 2014).

Victorian Municipalities may vary minimum rates with parking overlays. The only municipality in Victoria with substantial areas without minimum parking requirements is the City of Melbourne, in the central city and certain other areas (Figure 20). These areas have maximum rather than minimum parking policies – shown in the map at

Figure 20. The CBD and Carlton overlays date back several decades to when the Melbourne CBD adopted parking maximums in 1983 planning strategy (or possibly earlier, in 1975). Parking maximum policies were extended in 2010-12 through Amendment C133, extending parking maximums to part of West Melbourne over an area of 4.8 square kilometres. Maximum off-street parking policies, albeit higher, also apply in Docklands. The City of Melbourne therefore has multiple off-street parking policies – with both parking minimums and maximums in different areas, and for different use types. In this and other ways the City of Melbourne has become increasingly distinct from the rest of metropolitan Melbourne in parking policy terms. While ratios vary, the central areas of Sydney and Melbourne are some of the only known locations where housing may be built without a default requirement for off-street parking (Young 2008).

Within the City of Melbourne there is potential to extend parking minimum removal (and/or introduction of maximums) across the municipality (into North Melbourne, Kensington, South Yarra etc.) especially given the importance of comprehensive policies (as in London and Berlin). In addition it is important to coordinate off-street changes with on-street parking management, as the City of Melbourne has largely done. The City is also in a position to coordinate with and provide an evidence base for other inner city municipalities, and act in an advocacy role for other inner city councils in moving away from conventional off-street parking policies in line with the research evidence and with practice elsewhere.

Figure 20: Off-street parking policies in the City of Melbourne, by broad type (minimum or maximum) (based on parking overlays)



On-street parking management

Changes to off-street parking requirements are (or should be) accompanied by changes to on-street parking. This could mean either (as in Tokyo for example) by essentially no on-street parking, and reliance on private off-street parking markets. Or (more commonly) the implementation on-street parking management. On-street parking management can serve different objectives, which are not always aligned: optimizing parking space, or as a tool in transport demand management.

To optimise parking space, on-street parking management uses several policy levers – timing restrictions, pricing, and permits / exemptions – to balance competing interests in parking and space. Implicitly or explicitly, parking management is based on a preferred hierarchy of parking users. For example short-term timing and pricing preferences a high turnover of visitors to shops, over long-term commuter parking. Allocated spaces or permits keep spaces available for groups that most need parking – for example disabled parking spaces, and delivery spaces. On-street parking management tries to limit over-supply and under-pricing of parking, as well as under-supply and over-pricing. Forms of access to and pricing of parking run on axes of “increasing focus on parking management” (Mississauga 2017):

- Access to parking: first come first served, allocated, time-based, market based
- Pricing of parking: flat, incremental, dynamic, flexible

Parking is also a tool in Transport Demand Management (TDM). TDM refers to strategies to redistribute transport patterns by time, mode and place. TDM usually encourages alternatives to single occupant vehicle trips, particularly at peak times, with the goal of improving liveability or reducing pollution and emissions. Parking related policies used as part of TDM measures include:

- Cash in lieu or bicycle parking facilities in lieu of off-street parking
- Discounted or free parking space for car sharing
- Car parking spaces replaced with bicycle parking or shared bike scheme parking
- Spaces allocated to car pooling or ride sharing
- Replacing parking with shuttles, last mile, and targeted ‘para transport’
- Encouraging shared parking: identifying predictable patterns of under-use of parking. Shared use (e.g. office and residential parking, with different times of demand) can reduce required spaces by as much as 40%.

Examples given of cities with effective on-street parking management include, in North America: Waterloo, Ontario; Calgary, Alberta; and Arlington, Virginia. In the UK, Nottingham, Cambridge, and Edinburgh are examples of cities with parking management. The IDTP (2011) reviews European cities that have changed parking policy around different social goals, sometimes driven by EU air quality rules: Amsterdam, Antwerp, Barcelona, Copenhagen, London, Munich, Paris, Stockholm, Strasbourg, and Zurich. These cities are approached as only partial successes in parking management - most still have minimum parking policies, and charge too little for parking. With air quality as a priority, EU cities often give priority parking to electric vehicles and restrict city centre parking based on vehicle emissions standards.

Vienna has introduced parking management over past decades – the process has extended gradually across different districts, on an opt-in (popular vote) basis and with key expansions in 1993 and in 2012. Vienna uses short term parking fees and enforcement of timing restrictions; and higher residential parking fees. Income from parking funds transport projects, and the scheme has been accompanied substantial reductions to public transport pricing as well as supportive provisions for car sharing.

German cities vary in parking policies, and with examples of strategic parking management in Berlin, Frankfurt, Hamburg, Potsdam, Munich and Stuttgart. Freiburg introduced parking fees, and parking information systems (garages and on-street), alongside exclusions of vehicles from the central historic core (as in many German cities), accompanying improvements to tram and train services and frequencies; and bicycle parking. Off-street parking policies in Freiburg have not been substantially lowered, but off-site parking provision in garages is used.

The City of Melbourne uses many on-street parking management practices. It manages on-street parking pricing using varying time limits (1 hour, 2 hour); and three rough price scales per hour. It has a high share of the (little) paid parking in Melbourne. It has extensive paid parking and timed parking areas in most of the municipality, and a high level of enforcement (by contrast in European cities on-street parking management has been bought in to improve enforcement of otherwise high rates of illegal parking, primarily on footpaths). The City has no control over public transport pricing and is not directly involved in public transport provision, except in design. Some but not all aspects of TDM are used in the City of Melbourne, and the extent of on-street management and enforcement varies by area.

Dynamic pricing

Many cities have historically used 'first come first served' parking. When user pricing of parking has been used, flat rate or escalating parking prices have been common. Some cities are moving away from 'first come first served' parking or flat rate parking pricing, and are exploring dynamic or flexible pricing. Dynamic pricing has been made more feasible with new technology.

Dynamic pricing refers to parking where hourly fees vary by time and location, with prices adjusted based on occupancy targets and on observed usage patterns. The goal is to minimise both under priced and overpriced parking, keeping turnover of spaces matched to demand. Flexible pricing is fully market-based, with multiple providers.

The model of parking proposed by Shoup is demand-based 'performance' parking, as follows:

1. Remove minimum parking policies
2. Set the right price for 'curb' (street) parking (dynamic pricing - adjusted by availability and time of day)
3. Return the parking revenue to pay for public services (hypothecation)

A well-known implementation of dynamic pricing is SF Park in San Francisco. SF Park adjusts prices each two months, to even out occupancy aiming for a target of 60-80% per street. Off-street garages are part of the same tariff system. Patterns of usage and charging in SF Park since its introduction show a small number of locations increasing in price to reflect peak demand, with a greater number of meters reduced to a minimum rate – prices adjusted without increasing overall levels. The system extensive requires data collection and smart parking information systems to advise drivers of available parking and rates. Another evaluation found the program had moved slowly to its occupancy target; and that cruising for under-priced street parking had decreased by 50% (Millard-Ball et al 2014). Political disruptions also occurred around changes to San Francisco parking policy, with winners and losers from the changes (Henderson 2009).

In Australia, the Gold Coast's "Park in centre schemes" (PICS) allows for prices to be adjusted up or down on a quarterly basis, in 20 cent increments, based on observed demand. The range of parking fees on the Gold Coast are currently \$1.90 per hour to \$3.70 per hour. The dynamic pricing scheme has been piloted in two locations, beginning late 2015.

While the City of Melbourne informally adjusts its hourly limits to even out occupancy, using time restrictions and accompanying enforcement to encourage turnover, its pricing system is not dynamic. There are broad zones of fees (\$5.50 per hour in the CBD and \$3.20 in city fringe areas).

Data and technology commitments are a potential limitation to the introduction of flexible pricing; as is a lack of clear council policy on occupancy targets; and lack of integration of pricing between on-street parking and off-street garages.

Management and spending of parking income

Where public parking revenue goes, and how it is spent are important features of parking policies. Common parking policies highlighting this include different business models (such as leasing public parking to private operators), the ring-fencing (hypothecation) of parking fees, local improvement schemes, and congestion levies.

The City of Melbourne operates its own public on-street parking and leases two garages. Alternative models are private municipal contract, public sector ownership with private sector management, public-private partnerships. For example parking in Chicago Illinois, covering both on-street parking and 4 garages, was leased to a private operator for \$1.6 billion US in 2008.

Ring-fenced use of parking revenue – also known as hypothecated or earmarked pricing – is the use of parking fees for specific projects. In some examples, revenue from parking goes to support sustainable transport projects across a city. In others, in so-called ‘parking improvement districts’, revenue goes to specific locally visible projects such as landscaping, street furnishings or, in developing contexts, basic infrastructure such as sanitation.

Examples of ring fencing of public parking revenue include Barcelona where 100% of parking revenue goes to the city’s bike sharing program. On the Gold Coast, in accordance with its 2015 parking plan, 50% of new on-street meter revenue is allocated for local improvements including landscaping and public transport. In Perth, parking revenue is used to fund free city buses. The Pasadena, California, historic district used \$1 million annual parking revenue for street trees, furniture, policing, and footpaths. Other US cities with ‘Parking Benefit Districts’ include Austin, Houston, and San Diego.

Shoup et al (2017) looked at a pilot study in Beijing using market prices charged for on-street parking to finance sanitation services in a developing context and amidst rapid motorisation. In Beijing the space contrast between public space used for parking, and very small underground housing, is particularly stark. As car parking effectively privatizes the benefits of public space to a limited number of users, the use of parking revenue to benefit a broader range of users is seen as a means of compensating the public. The study of the Beijing pilot noted equity pay-offs - around of third of households in the study area were non-car owners, and car owning households earned three times that of non-car owning households.

Showing how parking revenue is spent is seen as important to political buy-in (a point stressed by Shoup and others, including the IDTP in a review of European schemes). Of Pasadena, Shoup argued that “everyone who lives, works or owns property in the district can then see the benefits paid for by the parking revenue” (Shoup et al 2017). Research and practice examples also stress the importance of local-level control – including optional schemes by district. Using parking revenue to upgrade local infrastructure or for preferred projects can offset the local costs of parking and enforcement.

Congestion levies are taxes applied to off-street parking – typically to private parking at workplaces or in commercial garages. Usually this is hypothecated in that income is tied to specific funding to offset congestion impacts. In Nottingham, UK, funds from a congestion levy on parking are used to pay for light rail.

Research on Sydney’s Parking Space Levy (Ison et al 2014), introduced in 1992, showed that while the scheme had succeeded in funding public transport and commuter parking projects, that it had no impact on parking numbers (partly through the extent of exemptions introduced). The study stressed that the scheme “had more than [a] single objective which makes it more difficult to assess whether its implementation has been a success”. The same is true of road pricing policies – objectives to decrease congestion, to recoup costs, or to finance infrastructure are not always aligned.

Melbourne’s congestion levy on long-term commercial parking spaces was introduced in 2006, and is a State Government policy. Research indicated that the levy had been passed on to short term parking users in commercial garages, rather than discouraging long-term parkers (commuters) or reducing parking spaces (Hamer et al (2011, 2012). The design of the system is also thought to discourage parking payment by

employers. The boundary within which the levy applies is largely within the City of Melbourne, but was expanded into adjoining areas in 2015.

In Melbourne, different fiscal and political structures in Australia are barriers to new parking fees or charges with ring-fenced revenues. So too is the complexity of designing and implementing such schemes, including the difficulty of coordination between levels of government. A further issue the limited transparency about the use of existing schemes such as the Growth Areas Infrastructure Charge (GAIC), and the Melbourne congestion levy. Spending of income from the congestion levy is not visible or local or clearly tied to transport improvements as in other schemes, and the scheme has not had a clear impact on congestion. While ostensibly to fund sustainable transport, most of the income appears to be absorbed into general revenue. A levy on off-street parking without integration with on-street parking fees is also problematic from the perspective of recent parking research and practice. Potentially there is an opportunity to publically clarify the use of funds from the congestion levy, as well as to examine the design of the policy in order to be better integrated with City of Melbourne policy objectives around transport. Grattan Institute analysis argued similarly (Terrill et al 2017), as well as for increasing the Melbourne levy to Sydney levels.

Capping or converting parking space

Some cities have pursued policies of either stabilising or reducing the total number of parking spaces.

Zurich (1996) and Hamburg (1976): froze existing parking supply in the city centre. Zurich policy is particularly strict. Having begun in 1989 with parking maximums, Zurich introduced parking restraint in 1996 through a “historic compromise” on parking. The measure was voted in. Parking in the central city of Zurich was capped at the 1990 level, and any new parking would mean existing surface parking would be removed and converted. Most have been converted to public squares. A 2010 referendum found 55 % of the city’s population favoured the parking restraints (Garrick & McCahill 2012). Zurich is unusual for having an inventory of parking back to 1909.

Either in combination with capping or reducing parking on a larger scale (above) or in small scale, trial projects, there are examples of cities replaces on-street parking space with other uses. Most typically this has meant bicycle lanes, parks, street furniture, public squares, and landscaping.

Oslo has begun removing free on-street parking particularly from residential areas – over 20,000 spaces targeted for removal as at 2017. Parking has been replaced by trees, landscaping, and bike lanes. Remaining parking is metered, or is allocated to electric vehicles, with residential permit parking available but with a relatively high fee to users. Since the 1970s Copenhagen policy has been to reduce parking spaces by 2% per year, replacing space with bike lanes and open space and with the principle of “treating street space as a valuable public asset, by reclaiming it from cars” (IDTP 2011). Paris has reduced parking numbers since 1993, and introduced paid parking to most areas. As at late 2017, London announced a ban on new parking construction.

Barcelona’s new Super Block or Superilla program, is strategically reallocating street space to public space. The Super Blocks confine through-traffic to outside of sets of blocks. Internal blocks are traffic free or traffic calmed, and gradually converted to other uses. The program is designed for experimentation and adaptation and begins with street furniture and landscaping. There is no on-street parking, and dead-end streets provide access to underground parking spaces. Copenhagen and Antwerp have also replaced parking spaces temporarily or permanently with trees, benches, other obstructions to encourage the safe use of public space by children and pedestrians.

Pop-up, temporary, and trial programs have proven more feasible or politically acceptable in other cities. Parklets, Park(ing) Day, Better Block and pop up parks have proliferated on parking spaces over the past decade or so – Park(ing) Day began in 2005, and the Complete Streets guide dates to 2011. Hackney – a borough of London – is introducing a Parklet program where one on-street space per street can be nominated for conversion by residents.

In some cases on-street parking space is not removed but is physically redesigned. Extensive surface-level impermeable car parking spaces are linked to worsened urban design and urban heat islands, runoff, and reduced efficiency. For example Davis et al. (2010) found environmental impacts from large amounts of surface parking, including pollution runoff. In a study of Davis California, a US city with high cycling levels and comparatively low car ownership, Thigpen and Volker (2017) found that only 2 in 7 spaces were occupied and that residential parking was over supplied. The authors identified this as an opportunity for “repurposing the paving”: to redesign public street spaces both for ecosystem reasons and for fiscal reasons.

The removal of on-street parking to increase pedestrian space had an earlier historical phase in many European cities. Most Germany and Dutch cities throughout the 1970s pedestrianised their inner retailing cores, removing parking and cars from streets (often combined with construction of off-street parking garages). Similar trends were taken on, at least in small numbers of streets, in Australian cities. Current practices in road space allocations – usually seeing the removal and conversion of on-street parking space – combine informal, ‘guerrilla’ projects and those guided by policy such as the Complete Streets guide. Well-known examples include those in New York (The Plaza Program), San Fransisco, and Bogotá. In Munich, bike parking has replaced some car parking (with 10 bike spaces per car space).

Melbourne has several examples including Yarraville, and recent programs within the City of Melbourne. Parking space in Lygon Street was converted to bicycle parking via a voluntary pilot program for local traders to nominate space for alternative uses. The City of Melbourne has undertaken, and continues to undertake, projects to expand park space via the removal of on-street parking. A current example is Gardiners Reserve in North Melbourne.

Some recent examples have emerged of off-street parking structures being converted to alternative uses, including housing, commercial use, and 'end of trip' facilities (for example bicycle parking and showers). In other cases new structures are designed with retrofitting in mind. Both kinds (retrofits and 'future proofed' garages) are largely demonstration projects. Multi-story concrete parking can potentially be adapted or redesigned, however building requirements often mean this space is difficult to adapt to services for other uses, partly due to low ceiling heights.

Examples with media coverage include the 4th and Columbia Tower in Seattle (with four floors of above ground parking designed for later alternative use); and the SCADpad studio projects which showcase parking redesigned as 'micro apartments' (<http://www.scadpad.com/>). Within the City of Melbourne, one existing example of excess parking converted into an apartment has been showcased (within QV). More commonly, conversion of garage space in the city has been of commercial parking to 'end of trip' facilities or to retailing space. For example the former RMIT parking garage on Cardigan Street in Carlton, now a bicycle parking facility with locker and shower provision; and the 161 Collins building. Changes to office rankings through the 'WELL' rating are thought to have incentivised provision of end of trip facilities over parking.

In Minneapolis, USA – new regulations on parking structures encourage designs that allow conversion into commercial or residential uses in future. These also allow trade-offs: if parking is allowed above ground, the code mandates design elements and active uses at street level. Despite the move, the City of Minneapolis cites comments from developers that designing for conversion would be cost-prohibitive. Midway elements suggested include having spaces for ride sharing and pick-up rather than parking (storage). Also in Minneapolis, opponents of development cite possible conversion of parking space as an issue (Minn Post 2017).

Residential parking policies

Policy shifts around residential parking include removing parking minimums; and the use of ‘unbundled’ parking; precinct-level parking; and changes to residential parking permits.

‘Unbundled’ residential parking is parking sold or rented in a separate market to housing. This means household can choose to own or rent more or less parking, and to pay accordingly. Mississauga (2017) lists three forms of unbundling:

- Parking spaces included or not included in base rent/purchase;
- Building managers or (or owners corporations or equivalent) providing discounts to renters or owners who do not want the standard parking;
- Building managers or (or owners corporations or equivalent) creating a secondary market for spaces by renting unused spaces as a separate commodity.

In Greater London following the removal of minimum parking policies, residential parking was built at around half the previously required rate, indicating minimums were above market demand (Guo and Ren 2013). Manville and Shoup (2010) found in an area of Los Angeles that the removal of parking minimums saw residential parking supplied at around half the previously required rate, with parking often unbundled and provided off-site. Barter (2012) notes Japan has few parking minimums and essentially no free on-street parking; with an active private market for parking in residential areas. Japan also has a reverse of typical residential parking processes in that rather than a requirement to supply parking for possible cars, those buying a car have to prove they have parking space at home for it. This space does not have to be physically within the home, but within a defined walking distance of it.

Precinct-based parking overlaps with unbundled parking. Residential precinct parking typically means parking used by several different sites or buildings in an area, rather than an individual site. It can also mean residential parking provided off-site, for example in a dedicated garage, within walking distance of residences. Austrian researcher Hermann Knoflacher (2006) argued for “a new way to organise parking” - that residential parking, should be precinct-based and that residential parking should be located the same distance from a house as the public transport stop. Precinct parking garages are often used in pedestrianized neighbourhoods, such as the Vauban development in Freiburg, Germany (Broaddus 2010). A substantial new development planned for Freiburg will also employ precinct-level parking structures, accompanied by car share schemes.

In precinct-based parking, off-street requirements may still apply or not, but parking is permitted to be in a separate building and may be encouraged to be separately sold and managed. The actual reduction of parking in the case of Freiburg was minimal, although the effects on urban design were strong. A key advantage is in allowing for housing for households without cars, and for residential areas with minimal impact from cars. Precinct parking is usually accompanied by unbundling, either in the initial sale / rent or an ongoing separate market. Some studies suggest unbundling reduces car ownership or use, while others indicate that it simply improves parking allocation. The two objectives are not always aligned. For example Antonson et al (2017) found in a study of precinct based parking in a Swedish city, Gothenburg, that overall car ownership did not decrease. However, parking better matched actual and preferred car ownership levels. In that case unbundling was ongoing – residents could lease parking space from the owners cooperative as preferred. A study in San Francisco – where new laws require unbundling and car share provision – found that car ownership and use, and car share membership, decreased significantly in buildings with unbundled parking (Ter Shure et al 2012). A study comparing Vauban with another Freiburg eco-suburb, with conventional parking provision, found that residents of Vauban owned fewer cars and drove less (Broaddus 2010).

Off-street residential parking is complicated by the availability of free or nominally priced on-street parking. Residential parking permits are special rights to on-street parking space issued to residents. They vary widely by specific local governments. In some contexts (including Melbourne and surrounding local government areas) rights to on-street permits are limited to older housing built before a certain time. City of Sydney and City of Adelaide policy is to only issue residential permits to homes without off-street parking. Canberra has no residential permit scheme – to avoid giving the sense of a right to public on-street parking. This comes with issues of managing commuters, but has other advantages.

The purpose of residential parking permits is mixed. Residential permits are used to limit commuter use of on-street parking, and as a first step in introducing parking management to areas including those with illegal parking. The long-term effect of residential permits is however that some residents are afforded valuable rights - permits are normally nominally priced, with the permit fee a small fraction of equivalent on-street parking fees, or of the underlying value of the land. In higher value areas (for example London or Amsterdam – see a study by Van Ommeren et al 2014) residential parking permits are incongruously low priced, encouraging low cost car storage at the expense of streetscapes and local economies. Some research is also critical of the amount of subsidy given to residents by residential permits, and the equity issues involved when parking is subsidised but not housing or other services. There is mixed community acceptance of pricing of on-street residential parking: Guo & McDonnell (2013) found around half of a surveyed New York neighbourhood would support above-nominal pricing of on-street parking. Residents more often agree with pricing when the purpose is to deter other users (not to rationalise residential use of street parking). Recent Changes in Oslo have increased residential permits to around \$400US per year. Reverse auctioning or uniform-price auctioning of on-street parking permits have been proposed for residential parking permits, but not apparently implemented.

The City of Melbourne has a long commitment to reducing car parking spaces in residential buildings: to “promote car free or reduced rate residential developments due to the excellent accessibility of public transport and other alternative transport modes”. A Phillip Boyle study (2017) of the amendments extending the parking maximums policy found the central city and amendment areas still saw increases in parking, but at a much lower rate than other parts of the City of Melbourne. Had the City of Melbourne followed standard residential parking minimums, an additional (and excess of market demand) 19,203 car parking spaces would have been added since the amendment. The study pointed to other benefits including reduction in red tape; and increasing housing choice. It is not clear what effect maximum parking policies have had.

The City of Melbourne has some separate markets for residential parking, primarily in the CBD, and some are emerging through peer-to-peer parking rental operators. In other sections of the city’s housing, there are barriers to unbundling housing and parking: property title systems, financial practices, the congestion levy, and owners corporations rules or attitudes (toward security for example). There are parts of the City of Melbourne that retain minimum off-street parking requirements, and some where maximums have replaced minimums but where existing dwellings have partitioned car parking titles. A Phillip Boyle (2017) study of residential parking in West Melbourne argued for encouraging precinct-based parking: reallocating surplus space in residential apartment buildings. It suggested partitioning parking oversupplies parking, with excess residential space and office space unavailable publically but with similar numbers of on-street residential permits issued.

Within the City of Melbourne, new precinct-based parking structures are unlikely, as Victorian zoning tends to discourage single-use parking structures. However there do seem to be possibilities for making better use of excess off-street residential parking. Unbundling and shared markets could require policy changes, or changes to established practices (owners corporation and real estate agents), but may be prompted by the spread of peer-to-peer technology for leasing parking space.

In the City of Melbourne on-street permits are well managed, and are likely to deter commuter users of on-street parking in city fringe areas, but they are under priced (as are most residential permit schemes). It is not clear whether permits are to control commuters; or as a necessity to residents; or as a subsidy. Their use and pricing largely may simply reflect historical decisions and the political difficulty of taking away perceived rights. From a parking policy perspective it would be of value to be more explicit about the broader value and the subsidy offered via residential permits.

Emerging technologies and shared markets

Technology has a critical and rapidly changing role in parking, in several different ways:

- Underscoring parking information, enforcement and payment systems;
- Facilitating emerging car park sharing applications; and
- Creating new patterns of car and parking use (car sharing, ride sharing, and autonomous vehicles).

Electronic parking guidance systems are established technologies for reducing cruising time for parking. They provide real time guidance on parking availability. Smart meters are real-time, sensor-based technology for monitoring car park usage and payment. Alternatives, as in Amsterdam, use photo-based car scanning systems or LIDAR-based scanning of parked cars. Electronic parking guidance, enforcement and payment systems are used by governments and/or major commercial car parks and require substantial investment in infrastructure. They are used in very high demand areas, including most of the City of the Melbourne.

Car park sharing applications have emerged largely outside of government and of major car parking operators. They are typically mobile applications that allow people with access to car parking space to rent it out on a short or long term basis to those searching for car parking. The price is driven by supply and demand. Local existing and emerging examples are Parkhound, Parkey, Kerb, Spacer, and the NRMA parking app. Car park sharing is a trend rapidly motorising Chinese cities. Around 10,000 existing parking spots in Qingdao, Shandong Province, have been converted to shared spaces through online platform “Airparking” to share or book a parking space. Other Chinese cities with the concept are Shanghai, Beijing (“Parking Panda”), and Hefei (China Daily 2017; Shoup et al 2017). The significance of car park sharing applications is their re-allocation of unused parking space, consistent with market-based and flexible parking ideas where shared parking is assumed to be a norm. Car park sharing is not always consistent with parking management ideas and with reducing commuter traffic. Technology is making it easier to park, and to put underutilised spaces on the market – and brings implications and uncertainties for parking management in the City of Melbourne.

Over recent years local governments have responded to the emergence of car sharing operators. These include commercial operators (Flexicar, GoGet, and others) and also peer-to-peer car sharing (where private vehicles are available for rental – described as “like Airbnb, but for cars”). Car sharing operates in over 1,000 cities worldwide, and is growing. It functions as an alternative or complement to car ownership. While not eliminating car use, car sharing reduces car parking space demand and reduces car use in part by shifting from sunk costs (for example, car purchase and registration) to upfront user costs. Car sharing schemes are heavily reliant on local parking policy settings. Research by Kent and Dowling in Sydney (Kent & Dowling 2013, 2016) found that car sharing policies were fragmented by local government areas, and that planning policies both encouraged and restricted car sharing. Allocated or ‘docked’ parking spaces for car share vehicles are highly valued in inner city areas, although the politics of public attitudes to these spaces are complex. Local governments vary in the fees charged for allocated car share spaces, and in the requirements applied. Dockless or free-floating car sharing has only been piloted in Australian cities but is used elsewhere for example Berlin and Portland, Oregon.

Like the sharing economy for accommodation, policy on car sharing has had to emerge in response to rapid changes and pressures. Kent and Dowling (2015) argue that car sharing policies, and the success of car sharing schemes, need to be considered within the broader context of transport planning. The City of Melbourne policy has a car sharing policy and actively supports car sharing on-street, while encouraging a share of spaces to be provided off-street in private garages. Operators pay a fee based on partial cost recovery of meter revenue, varying by location. There are about 350 on-street spaces allocated to car sharing. As with other uses of on-street parking, this fee and its basis is not fully transparent – although the City’s car 2015 share policy set out some assumptions based on average meter revenue. Car share companies pay a fee per space in the City – for this to be cost recovery Council estimates were of \$5,400 per year inside the Hoddle Grid and \$3,800 per space outside. Actual fees are partial cost recovery of meter revenue only.

The way car parking space is allocated and priced has a significant role in shaping the form in which these new technologies progress. The way parking policies adapt to car sharing, ride sharing and other recent

trends in turn reflects existing inconsistencies in parking policy and in the pricing of road space and use more generally. With the expectation that autonomous vehicles will increase in prevalence, there are different theories as to whether this will mean no need for parking; parking in different locations; or an increase in traffic. These technologies bring uncertainty over future car ownership and parking. Policies for access to and pricing parking for shared vehicles are precursors to how cities may be impacted by autonomous vehicles or, in the short term, to the expanded role of 'last-mile' deliveries and of ride sharing use. Likewise parking pricing is a both a component of, and alternative to, road user pricing (see related discussion papers). Parking policies will need to keep track with mobility as a service – either in facilitating fair and transparent systems of access and pricing; or in appropriately regulating them. Repositioning charging for 'parking' as charging for the private use of curb - public space – would be one way of anticipating further technological changes such as autonomous vehicles.

A recent ADVI (Australia and New Zealand Driverless Vehicle Initiative) paper on parking argued that emerging vehicle technologies “bring substantial changes to the parking ecosystem” (ADVI 2017). Valet parking is likely to be a first step; followed by the transformation of parking infrastructure to different land uses. Conversion of on-street spaces to other land uses such as footpaths and nature strips; and of privately owned spaces to housing or retail uses; is anticipated if driverless vehicle technology is adopted. The ADVI stressed, however, that careful planning and preparation is required to limit potential congestion peaks. They also recommend adopting future-proof design codes; and facilitating improved parking space data.

The City of Melbourne will have to balance investing in further technology of its own, and the opportunities to better integrate with private providers and with other government agencies. The City of Melbourne already supports data sharing through its open data policies, underscored by its parking sensors. Integrated payment systems – as in Helsinki and Munich – integrate payment for car sharing and parking, and bike sharing, with ticketing for public transport on a metropolitan basis. Working with other local governments and with state government transport policy would be required.

Summary: City of Melbourne parking policies in context

Table 2 – City of Melbourne policy in the context of parking policy and practice elsewhere

Parking Policy Area	Example policies and practices	City of Melbourne
Competing roles for parking policies	<p>Most car parking depends on government policy or subsidies</p> <p>In theory, on-street and off-street parking should be integrated: in practice most are fragmented</p> <p>Most cities balance competing goals for car parking (restraint, regeneration, revenue)</p>	<p>The City of Melbourne is not unusual for having competing interests in parking: restraining traffic, increasing visitors, and revenue (which the City is unusually reliant on).</p> <p>Parking policy and enforcement is spread across multiple agencies of the municipality.</p>
Categories of parking policy	<p>Conventional (predict and provide: minimum off-street parking, on-street parking treated as free infrastructure)</p> <p>Management (precinct-based parking, with competing parking demands balanced by tools such as timing and pricing)</p> <p>Market-based (no off-street requirements, flexible and unplanned supply, reliance on pricing signals)</p> <p>Parking restraint: some cities (London, Oslo, Copenhagen) actively discourage parking.</p> <p>Most cities adopt conventional policies in response to rapid motorisation, then move away from them over time.</p>	<p>The City of Melbourne sits part way along trajectories of parking policies.</p> <p>Parts of the City of Melbourne have had parking management since the 1980s (the CBD), while others retain conventional parking policies.</p> <p>The City could move toward a comprehensive market-based, or alternatively to a parking-restraint, policy approach.</p> <p>Either is constrained by broader context: most of Metropolitan Melbourne still uses conventional parking policies.</p>
Off-street parking requirements	<p>Off-street parking requirements removed or replaced with maximums in London, Berlin, Hamburg, other European cities.</p> <p>Used variably in Asian cities. Japan has few or no off-street requirements.</p> <p>Many North American commercial city centres have removed off-street requirements</p> <p>Off-street requirements thought to oversupply parking, add to housing costs, promote inefficient land use. They have a limited empirical basis. Impacts are thought to be worse in older, denser</p>	<p>In Victoria Minimum parking requirements have been standard since the 1950s. Parking overlays allow for local variation but only the City of Melbourne uses these to a significant extent.</p> <p>The City of Melbourne removed parking minimums from the CBD and replaced them with maximums in 1975-1983.</p> <p>Other parts of the City of Melbourne had parking maximums extended e.g. West Melbourne in 2012, Docklands.</p> <p>Elsewhere in Victoria dispute over off-street requirements is a major planning</p>

Parking Policy Area	Example policies and practices	City of Melbourne
	<p>areas.</p> <p>Parking maximums are a tool in transport management approaches, but their impact is less clear.</p>	<p>issue (underscored by lack of on-street parking management).</p> <p>The City is in a position to coordinate with and provide an evidence base for other inner city municipalities, and act in an advocacy role for other inner city councils in moving away from conventional and discredited off-street parking policies.</p>
On-street parking management	<p>Conventional parking policies combine off-street requirements with free on-street parking</p> <p>As an alternative: some locations (e.g. Tokyo) have essentially no on-street parking</p> <p>More commonly: on-street parking management seeks to avoid parking under-pricing and over-supply (and over-pricing, under-supply). Uses different tools: timing, pricing, permits and exemptions.</p> <p>Reflects a hierarchy of parking users: e.g. ensuring disabled parking, deliveries, short term shopping, while discouraging long-term storage.</p> <p>On-street parking as Transport Demand Management: discourages single occupant vehicles. Tools: bicycle and share car parking; shuttles and 'last mile' transport; shared parking; pricing aligned with public transport fares. Examples: Vienna, Berlin.</p>	<p>The City of Melbourne uses many on-street parking management practices: varying time limits, price scales, and pricing (with a high share of the little paid parking in Melbourne).</p> <p>Management and enforcement varies by area. Paid parking and timing restrictions are strongest in the most central areas.</p> <p>The City has the potential to extend management into other parts of the municipality, and to act as an evidence base / advocacy role for other inner city municipalities.</p> <p>The system of timing, pricing, and allocations (e.g. deliveries, shared cars) of on-street parking in the City of Melbourne is guided by policy but is not clearly tied to a hierarchy of users or to an overall parking strategy or transport / land use strategies.</p>
Dynamic pricing	<p>Dynamic pricing varies parking prices by location and time, in response to usage patterns and with occupancy targets. Aims to maximise efficiency and to reduce cruising.</p> <p>SF Park San Francisco: prices adjusted very two months, with 60-80% occupancy target. On-street and off-street garages. Over time a small number of peak locations reduced in price while most reduced. Cruising</p>	<p>The City of Melbourne informally adjusts hourly limits to even out occupancy, and has three broad zones of on-street parking fees. It does not have dynamic pricing – pricing is not directly reflective of usage patterns / demand.</p> <p>Data and technology commitments are a limitation. There is also no clear council policy on occupancy targets. On-street and off-street parking systems are also not integrated within the City.</p>

Parking Policy Area	Example policies and practices	City of Melbourne
	<p>reduced by 50%.</p> <p>Gold Coast pilot scheme: Park in Centre Schemes (PICS). Prices adjusted quarterly.</p>	
<p>Management and spending of parking revenue</p>	<p>Chicago leases its on-street parking and 4 garages to a private operator</p> <p>Ring fenced / hypothecated spending of on-street parking fees can be used for local improvements or for metropolitan transport projects</p> <p>Examples: Barcelona (bike sharing program), Gold Coast (local improvements including landscaping), Perth (free city buses), Pasadena (historical district renovations), Beijing (sanitation).</p> <p>Showing how parking revenue is spent is important to political support. Voluntary local parking districts for use of fees also increase support. E.g. Beijing.</p> <p>Congestion levies are taxes on off-street parking, used to offset congestion impacts. E.g. Nottingham: congestion levy used to pay for light rail; Sydney Parking Space Levy (introduced 1992) used to finance public transport and park-and-ride parking.</p> <p>Need to clarify whether levies are to decrease congestion, recoup costs, or to finance projects.</p>	<p>The City of Melbourne operates its own public on-street parking and leases two garages. It does not have parking improvement districts, and parking revenue goes to general revenue.</p> <p>Local fiscal and political structures are barriers to new ring-fencing policies for parking revenue.</p> <p>Melbourne's inner city congestion levy – a State Government Policy – was introduced 2006 and extended 2015. It applies to long-term off-street parking spaces.</p> <p>Research suggests the levy has been passed on to short term users, and encourages employer-subsidised parking.</p> <p>The City of Melbourne benefits financially from this levy.</p> <p>Lack of transparency is an issue. Spending of the congestion levy is not as clearly tied to transport improvements as in other examples. A levy applied only to off-street parking is inconsistent if the goal is reducing congestion.</p> <p>Opportunity to clarify costs and benefits of the levy, and how funds are used, and to better integrate the design of the congestion levy with City of Melbourne transport objectives in future.</p>
<p>Capping or converting parking space</p>	<p>Large scale examples - Zurich: froze existing parking supply in 1996. Any new off-street parking sees surface parking removed and converted, mostly to public squares. Referendum based.</p> <p>Oslo: recent (2017) policy to remove over 20,000 spaces particularly from</p>	<p>No formal policy on limiting or targeting the number of parking spaces, on or off-street.</p> <p>Several parks expanded via on-street parking conversion – current example is Gardiners Reserve. Also, Elizabeth Street park trial. The City has been</p>

Parking Policy Area	Example policies and practices	City of Melbourne
	<p>residential areas, replaced by trees, landscaping, bike lanes.</p> <p>Copenhagen: policy since 1970s to reduce parking spaces by 2% per year, replaced by bike and other infrastructure.</p> <p>London recently (2017) announced a ban on new parking.</p> <p>Barcelona Super Block / Superille program.</p> <p>Small scale, voluntary examples of replacing on-street parking. Parklets, Park(ing) Day, Better Block, Complete Streets. New York, San Fransisco, Bogotá, Munich.</p> <p>Voluntary and trial projects converting on-street parking increase support and allow for reflective policy. E.g. Yarraville pop up park. Hackney, London – one on-street space per street can be nominated by residents.</p> <p>Pilot examples of converting off-street parking structures: housing, ‘end of trip’ facilities. Retrofitted (e.g. SCADpad) or future-proofed (e.g. Minneapolis policy).</p> <p>Vienna, Zurich, Berlin – restrictive parking policies tend to be voted in, majority of non-car owners.</p>	<p>gradually reducing metered on-street parking in the CBD for a range of purposes.</p> <p>Lygon Street Carlton – on-street car parking converted to bicycle parking as part of a voluntary local program for traders.</p> <p>Popular votes are not part of local political culture. The City has very low levels of car ownership for Australia, and understanding overall levels of public support for parking changes would be valuable.</p> <p>Potential for adopting, trailing and monitoring the range of small scale voluntary schemes for replacing on-street parking with other uses.</p> <p>One well-known example of conversion of excess off-street parking to apartments within the City of Melbourne – the QV building.</p> <p>More common recently has been the conversion of parking within commercial structures, to end of trip facilities including bike parking and showers. This apparently reflects recent office space rankings that prioritise end of trip facilities more than car parking. e.g. RMIT Cardigan Street, 161 Collins.</p> <p>There are servicing, structural, and pricing barriers in the conversion of off-street parking space to other uses. Low ceiling heights are most commonly cited.</p> <p>The City could play a role in incentivising conversion of parking space, based on demand.</p> <p>Also an opportunity to influence the design specifications for parking, to better future-proof new parking spaces.</p>
Residential parking	Removal of off-street requirements for housing e.g. London, to better match underlying demand and to reduce direct and indirect costs of parking minimums.	The City of Melbourne has a commitment to supporting car free or reduced parking residential development. Some but not all areas have no off-street requirements. Parking

Parking Policy Area	Example policies and practices	City of Melbourne
	<p>'Unbundling' of residential parking: households can choose to own or rent more or less parking. Overlaps with 'precinct parking': residential parking is off-site. Used in pedestrianized developments.</p> <p>Examples: Los Angeles, Japan, Gottenburg, San Fransisco, Freiburg (Vauban).</p> <p>Some studies suggest car ownership and use is reduced. Others emphasise that car ownership is better matched to preferences, and oversupply is reduced. Urban design and walkability benefits.</p> <p>Residential permits usually introduced to control commuter parking. Long-run issues: subsidises on-street car storage. Permits usually very low priced relative to on-street fees or to land costs. e.g. London, Amsterdam.</p> <p>Sydney and Adelaide policy limits permits to housing without off-street parking. Canberra has no residential permit parking.</p> <p>Oslo recently raised residential permit fees to \$400 US.</p> <p>Suggestions for permit fees to be based on reverse auction system.</p>	<p>maximums were expanded to West Melbourne in 2012, avoiding nearly 20,000 excess spaces.</p> <p>Changes to off-street parking are underscored by strong on-street management and enforcement.</p> <p>Some areas have separate markets for unbundled residential parking, others do not.</p> <p>Some areas of the city have a significant excess of parking in apartment buildings.</p> <p>The growth of peer-to-peer parking applications, where unused spaces can be rented out, may see less partitioning of residential parking in future.</p> <p>However precinct parking – separate structures - are discouraged by zoning. Barriers to unbundled management of residential parking include property title systems, financial practices, congestion levy, and owners corporation practices. The City of Melbourne could play a role in identifying and reducing barriers to unbundled or shared residential parking.</p> <p>Residential permits in the City are well managed and probably deter commuter users in fringe areas. They are also under-priced and are limited to older housing, which may have off-street parking. On-street residential storage competes with other goals: retailing turnover, or expansion of green space.</p> <p>The number of residential on-street permits is similar to the number of excess apartment spaces – there is potential to investigate shared and unbundled systems.</p> <p>Also potential to be clearer about the subsidy and role of residential parking permits.</p>
New technologies	Electronic parking information, enforcement and payment systems used by governments and parking operators.	The City of Melbourne uses parking sensor and guidance systems in several areas. This underscores its open data

Parking Policy Area	Example policies and practices	City of Melbourne
	<p>Reduces cruising time and increases efficiency and transparency.</p> <p>Emerging car parking sharing applications: peer to peer applications to allow renting of excess space. Local examples include Parkhound, Parkey, Kerb, Spacer. A trend in motorising Chinese cities: “airparking”, “Parking Panda”. Car park sharing uses existing space more efficiently. It may not be consistent with reducing commuter traffic.</p> <p>Car sharing operates in over 1,000 cities worldwide. Parking space can be allocated, or free-floating / dockless. An alternative or complement to car ownership, car sharing reduces car use by reducing sunk costs to users. These are for-profit operations but are heavily reliant on local parking policies.</p> <p>Parking policies for car share have been a response to rapid changes. Researchers argue they should be more consistent.</p> <p>Some cities integrate pricing / ticketing of public transport with car share and bike share schemes.</p> <p>Future uncertainty: deliveries, ride sharing, ‘valet’ parking, autonomous vehicles, mobility as a service, road user pricing.</p>	<p>provision. Coverage is not comprehensive.</p> <p>City of Melbourne supports car sharing through on-street spaces, and encourages a share of spaces to be off-street.</p> <p>As with residential permits and on-street parking, the fee and its basis not transparent.</p> <p>The way car parking space is allocated and priced has a significant role in shaping the form in which new transport technologies progress.</p> <p>It is difficult to predict future disruptions but the City has an opportunity to facilitate consistent and fair systems of access and pricing for parking.</p> <p>This applies to new forms of car use – car sharing, ride sharing, autonomous vehicles, ‘last mile’ deliveries – as much as to the private vehicles around which conventional parking policies were designed.</p> <p>A key challenge is balancing investment in new City infrastructure, versus better coordination with other operators of parking and transport systems.</p>

Next steps: Car parking in the City of Melbourne

Many 20th century cities have been built around providing car parking; while older areas have been remodelled to accommodate parked cars. Worldwide, cities are experimenting with shifts to off-street parking requirements; parking pricing and technology; design; residential parking provision; and the re-use of parking space. Some changes have been prompted by liveability concerns, others by technology and demographic shifts.

This discussion paper has highlighted the interrelationships between different aspects of parking and parking policies (on and off street, public and private); the role of parking in transport, retailing and housing; the space and underlying value of parking; its politics; and the evidence as well as gaps in evidence from research both in Melbourne and overseas. Categories of parking policies, and how the City of Melbourne fits with parking policy examples worldwide, were also highlighted.

Drawing on this, the following are some recommendations for parking policy and practices in the City of Melbourne. Several of these involve trade-offs and leadership decisions. Other recommendations are simpler, and relate to data collection, small-scale trials, and advocacy. Following the recommendations are 'thought bubble' or 'provocation' ideas to consider.

Policy recommendations for the City of Melbourne

Make a clear statement of parking strategy and hierarchies in relation to transport and land use goals

- Research literature, and the policies of other cities worldwide, highlights basic differences in policy assumptions around car parking. Conventional 'predict and provide', management, market-based, and restrictive parking policies each have policy rationales and involve costs and benefits, real and perceived. While some cities are actively restricting parking in favour of other uses of public space; others are moving to market based models to emphasise efficient use of parking space; and many more retain conventional policies. How the City of Melbourne approaches car parking should be based on a clearer statement of parking strategy and its rationale.
- There are several valid options but the chosen option should be clearly tied to a car parking strategy, and to a transport strategy and Future Melbourne policies.
- For example the current placement of timed, priced, and allocated on-street parking in the City of Melbourne is not clearly tied to a hierarchy of users or to an overall parking and transport strategy.
- The City needs to state and maintain a clear hierarchy of parking space including provisions for priority parking users such as disabled motorists, delivery vehicles, and residential parking permit holders.
- The City should simplify and standardise parking policies, hierarchies and pricing mechanisms across the municipality wherever appropriate. While local needs and patterns differ (most obviously between purely residential areas and the CBD), parking policies should still have an integrated purpose and not be based only on entrenched policy anachronisms. This should be examined and justified to ensure a place specific but equitable response.

Place a clear value on parking on-street space as public space

- Car parking is never 'free' – it has direct and indirect costs for the city and its population that are rarely reflected in the price of parking to the user. The extent of land used for parking, and the opportunities lost to use this space for other purposes, is one such cost.

- Developing a clearer statement of the value of on-street parking space – as has happened for example with valuing street trees in the municipality – would help clarify decisions around on-street parking allocation including for alternative uses such as outdoor dining, green space, and tourism uses.
- Valuing approaches could be based on financial costs (direct infrastructure costs), economic value (supply and demand), or economic costs (taking into account broader costs and benefits of a use): these are options to be researched and considered by the City of Melbourne.
- While the land value of a space would not always be explicitly charged, having a reference value would help clarify decisions in road space allocation: which uses of space are considered public infrastructure, and which are private or market goods. Current policy seems to be fragmented: this is the case in many cities, but is also an opportunity for leadership by the City of Melbourne.

Make on-street parking spaces available for different uses and users, based on transparent values and guidelines

- The value of on-street parking space (not just revenue forgone) could more clearly underscore decisions to re-use or lease parking space – for example in policies for access to spaces by car share companies.
- On a similar basis the City could potentially trial leasing on-street spaces on an opt-in basis to retailers, hospitality, community groups, or others, for parking or for other purposes including public open space.
- Temporary use would be preferable, at least at the outset, to monitor the effects of such changes.

Trial and monitor methods for converting more on-street parking space to public open space

- Increasing green space and public open space within the City may be achieved via the reallocation of on-street parking. This has already been demonstrated in parts of the City of Melbourne for example through the gradual reduction in metered spaces in the CBD for bike lanes, street trees, and other uses.
- The City should build public engagement and learn from its past and current examples of green space expansions or new green spaces on parking space. It should clearly document the effects, and public experiences, of these changes and use them to inform policy development.
- Any changes to on-street parking for green space or other public uses should be expressed in comparative terms: a percentage change within the area. Parking should be viewed on a precinct basis – removing a small number of on-street spaces will have a small impact on supply if substantial off-street parking is nearby.

Introduce simple or trial versions of occupancy targets and dynamic pricing

- The City of Melbourne could pursue the full technological commitment required for dynamic pricing (where parking prices are adjusted by time and location, based on usage patterns).
- A more achievable goal, given the extent of data and integration required for dynamic pricing (and the risks of committing to the system), would be to develop a clearer policy of evening out metering charges across the City and to introduce simpler versions of dynamic pricing.
- A trial area of actual dynamic pricing is also a possibility.
- There is currently no clear council policy on occupancy targets - there should be. Typical ranges used elsewhere are 60-80%.

- A flexible pricing scheme, adjusting rates across a broad area, based on observation of occupancy patterns on a monthly or quarterly basis, would be consistent with best practice.
- The City should consider lower meter fees in a greater range of areas, and higher peak fees in high-demand locations. This should be undertaken with occupancy targets in mind.
- Occupancy data suggests that parking (largely free) is underpriced on Sundays. The City should extend metering to Sunday, with corresponding decreases at other times.

Gradually reduce reliance on on-street residential parking permits

- The provision of underpriced on-street permits for relatively small group of users, accounting for a relatively large portion of street parking in high demand areas, is difficult to justify except on grounds of community expectation based on historical decisions.
- The City already denies on-street permits to residents of newly constructed buildings and in key areas (CBD, Docklands). While this will gradually shift patterns of residential parking storage on-street, in the foreseeable future it also embeds 'insider' groups.
- An equity and evidence based approach to the allocation of rights to on-street parking space is preferable.
- Identifying policy options that understand and anticipate the longstanding reliance on residential permits by these groups, while moving toward a long-term reduction both in the use of these permits and in the amount of subsidy offered, is recommended.
- Financial incentives, grandfathering, and alternative parking options are noted in a 'thought bubble' below.

Free up ways to make better use of excess apartment parking

- The City of Melbourne appears to have a significant oversupply of parking in residential apartment buildings. Apartment parking is also the form of parking that has grown most in recent years. While financial and other processes encourage the bundled sale of parking spaces with apartments, around a third or even 40% are unused.
- The City of Melbourne should consider ways to encourage or facilitate the integration of this excess private residential parking into the broader parking supply.
- The growth of peer-to-peer parking applications, where unused spaces can be rented out, may see less partitioning of residential parking in future without government involvement.
- However the City of Melbourne could play a role in identifying and reducing barriers to unbundled or shared residential parking. For example in identifying and addressing owners corporation practices, and the design of the congestion levy.
- As on-street residential parking use is often associated with excess household storage needs (pushing cars out of garages), excess apartment parking could also be made available for storage or other housing-related purposes. Barriers to this should be identified along with key stakeholders - for example owners corporation managers.

Reduce barriers to the re-use of off-street parking space for retail, housing and end-of-trip purposes

- Dedicated off-street parking facilities represent a design issue, especially in terms of potential future mobility patterns and urban design issues in the CBD.

- Conversion of existing off-street parking structures may happen through commercial demand – for example there is current demand for converting parking space to end-of-trip facilities, retail space, and storage. It is recommended the City of Melbourne monitor such current trends in commercial conversions, and identifying barriers or issues.
- In future, the City could play a role in incentivising conversion of existing off-street parking structures. Identifying particularly problematic standalone buildings or locations that limit other City policies.
- There is also an opportunity to influence the design specifications for new parking, to better future-proof new parking spaces via ceiling clearances and other service provisions. This is happening in Fisherman’s Bend and could be extended to the whole municipality. This could happen through Victorian planning guidelines and through local design overlays.

Facilitate local parking policies and initiatives that build shared understanding with the community

- The City of Melbourne has a low rate of car ownership and use, particularly in some parts of the municipality. Half or more of its households do not own cars.
- While plebiscites are not part of the local political culture, it would be valuable to learn about the extent of public support for different parking policies and changes.
- Parking and retailing is a sensitive issue. There is an absence of clear or at least public evidence of the relationship between parking and city retailing, but strong beliefs about it.
- Targeted analysis, local trials, or other approaches to changing parking policy or provision may help better engage with stakeholders and improve understanding of parking policy issues.
- The City of Melbourne should provide more opportunities for community input on parking space, beyond protesting its perceived loss.
- Local-specific policies, initiatives and trials that reflect differences across the municipality would be preferable (see ‘thought bubbles’).

Improve the congestion levy and its transparency – as well as of other parking-based revenue

- The congestion levy is a state policy applied to off-street spaces and is to be used to limit or offset congestion.
- There is an opportunity to clarify costs and benefits of the levy, and how its funds are used for sustainable transport.
- While the levy is State policy, the City of Melbourne could seek to better integrate the design of the congestion levy with City of Melbourne transport objectives in future.
- Other opportunities to ring-fence local parking revenue for use in transport projects should be pursued where possible.

Prepare for future disruptions with fairer policies now: charge for street use not just parking

- The way car parking space is allocated and priced has a significant role in shaping the form in which new transport technologies progress.
- The City should continue to extend its support for shared vehicles, shared parking, and other programs that are likely to support reduced private car ownership and use.
- However these policies should be part of a broader reform of how on-street parking space is paid for. Developing more transparent, faster, and more efficient pricing of parking is needed.

- For example the City should continue to identify opportunities to integrate its pay by phone systems with other municipalities and parking providers.
- Pricing and accommodation for emerging short-term parking needs (ride sharing, autonomous cars) should be anticipated. In addition, 'valet parking' is anticipated as a first stage of vehicle automation. A timing and pricing system that anticipates this is desirable.
- Explore systems for efficient monitoring of and, where appropriate, charging for short term space use by delivery vehicles, commercial vehicles, and emerging short term parking users - valet, ride sharing and autonomous vehicles). This could be on an opt-in basis.
- The City should also coordinate this work with an advocacy role in seeking a fairer system of road user charging (see associated discussion papers).

Extend parking data collection and coordination

- The City of Melbourne has better data (CLUE, and on-street parking records) than most municipalities or most parts of the Melbourne metropolitan area.
- Knowledge is excellent for some parking and types and locations, but poor for others. Extending data collection will improve the evidence base for parking policies, as well as the potential to leverage innovation from the private sector.
- Better integration of city parking data with other municipalities, with private parking providers, and with new applications for sharing parking space would further improve knowledge of parking supply and demand in inner Melbourne.
- On-street and off-street parking systems are not integrated within the City and ideally should be. The barriers appear to be private sector.
- This may or may not happen progressively, if application take-up spreads and as other inner municipalities install in-ground parking sensors. If not, the City should actively address barriers.

Take on an evidence and advocacy role with other municipalities

- The City of Melbourne's parking policies have a clearer evidence base than those used in other Melbourne and regional Victorian municipalities.
- Over time, more municipalities in Melbourne are likely to face similar development patterns as the City of Melbourne has. Conventional parking responses will come under further strain. Along with the City of Port Phillip, the City of Melbourne is in a position to coordinate with and provide an evidence base for other municipalities, particularly those in the inner city of Melbourne (IMAP).
- Where appropriate it could also act in an advocacy role for other inner city councils in moving away from conventional and discredited off-street parking policies and to shift state based policies as required.

Thought bubbles / policy provocations for the City of Melbourne to consider

A fully market based system?

- The City of Melbourne *could* move toward a comprehensive market-based parking system, as per research (Shoup, others) arguing the market provides a fairer, more sustainable and more efficient allocation of parking space. It could do so by expanding its own paid parking technology, or by integrating with private and peer-to-peer parking providers.

- In a fully implemented version, it could withdraw altogether from the provision and management of on-street parking, either leasing this service to one or several private operators, or instead facilitating the greater utilization of excess off-street parking.

A cap on or reduction of overall parking numbers?

- The City of Melbourne *could* move toward a restrictive parking policy emphasising the alternative value of public street space, as per examples (Copenhagen, Oslo, London, Zurich).
- One option would be to commit to an annual reduction in the amount of parking space, as has been achieved for example in Copenhagen. The City could also cap its total number of parking spaces and relate any new off-street parking built to a one-to-one reallocation of on-street space, as in Zurich.
- Spatial areas within which caps would apply would need to be defined (for example, suburbs or city blocks).
- Parking space reductions could also be based on monitoring occupancy levels.

Open up apartment parking via shared parking arrangements?

- The number of residential on-street parking permits issued by the City is very similar to the estimated number of excess apartment spaces (estimated at around 13,000). There is potential to investigate shared and unbundled systems to align these two issues: to encourage use of excess off-street spaces over on-street permit spaces.
- The perceived loss of on-street rights is sensitive. However, this could free up on-street space for public uses such as green space as well as making use of otherwise unused off-street space.
- The City of Melbourne could pilot this idea with a small number of suitable buildings: working with interest groups to examine access, management, security and owners corporation issues. Identifying residential permit use in similar areas to where excess apartment parking is located would be preferable.

Rather than offering low-priced residential on-street parking permits, offer incentives to *not* use street parking?

- It is desirable to explore options to price on-street parking permits based on demand: for example, through reverse auctioning.
- As an alternative, residents who are not entitled to, or do not use, residential parking permits could be offered a rates discount. This would partly respond to the perception that on-street parking rights are paid for by rates.
- Residential parking permit holders could also be offered an option to purchase a larger number of visitor 'scratch' permits, or electronic equivalents, in lieu of longer term storage permits.
- Grandfathering could be achieved by gradually increasing residential permit costs for new residents (based on property sale or lease): this way existing users are not disadvantaged, but new permits gradually come to reflect their real value in particular areas.
- Permit holders could be offered financial incentives or discounts to participate in trials of using off-street parking instead of on-street parking. For example, permit holders could trial using shared apartment parking (of which there is an excess).
- To be effective these ideas would need to be opt-in, monitored trials.

- Closer enforcement of permit schemes would also be necessary – perhaps via greater digitization of the permits.

What about facilitating greater public ownership of parking and how its value is allocated, e.g. ‘giving streets’ schemes?

- To encourage local awareness of parking as a shared space and asset, rather than a perceived private property right, one option might be an opt-in model where a set number of spaces per street, block or suburb are available to be converted to other public uses (nominated by residents or traders).
- Parklet permits are permissions to use on-street space in specific situations, typically for traders. The City of Melbourne could consider broader options for these programs.
- Parking fees could likewise be optional at the local or street level, with fees collected and spent locally. A scheme themed as for example ‘giving streets’ could give residents the opportunity to donate parking revenue to charities and non-profits.
- This could prioritise streets with low rates of car ownership.

Is it possible to make parking more fun, more attractive- or at least less aggravating?

- The City could start design competitions for the creative use or design of different types of parking space.
- Site-based signage could facilitate input on parking: for example, asking “what would you put here?”, “why do you park here?”
- Consider street-based or block-based competitions either for the best design of parking space, the ugliest parking space, the best re-use of parking space, or for the generation of parking revenue for charity or non-profit causes (e.g. ‘local friends of’ groups).

Challenges

Challenges and limitations to the above need to be acknowledged.

A key challenge to parking policy is a lack of clarity about what parking space is, and what role the City (or government in general) should have in its provision. Is on-street parking a public good, or a market good? Is its value as space, or as parking as a service? Should the City expand its paid parking, or withdraw from parking altogether? Should private markets for parking, including peer-to-peer markets, be encouraged or not? Potentially, the city could concentrate on the urban realm and in future, withdraw from on-street parking.

The City of Melbourne will need to clarify to what extent it wants to retain its role in parking, and to what extent its on-street parking policies align with broader ideas about markets. These parking strategies need to be based on a clear understanding of how each open can potentially support or hinder broader policy outcomes sought for the city.

These basic challenges underlie all decisions around parking policies. Communicating these trade-offs and the evidence around them is particularly challenging in a public forum. A challenge is to accept that policies – including parking policies – can rarely achieve multiple goals. As with road user pricing, the design of the policy depends on the goal, and there are inherent trade-offs. For example, congestion levies on parking cannot be equally effective at discouraging congestion and funding infrastructure. Opening up excess residential parking space may solve some issues (underutilised space, housing market inefficiencies), but worsen others (commuter-generated traffic).

A challenge for the City of Melbourne is its reliance on income from parking revenue and infringements, and the number of employees directly employed in parking enforcement. This revenue makes many of its other projects possible, but can undermine some of its other policies.

Clearer use of parking revenue to directly benefit transport projects (including via hypothecation) is recommended by research, however complex local fiscal and political structures are barriers to ring-fencing policies for parking revenue in Melbourne.

Data and technology commitments are a limitation to the introduction of dynamic pricing; as is a lack of integration of pricing between on-street parking and off-street garages. The City of Melbourne is not necessarily in a position to coordinate parking data and policy across private and government agencies, and there is the risk of ongoing fragmentation in some areas – as for example in parking payment systems and disability parking permits. A key challenge is deciding between investment in new infrastructure for the City itself, versus seeking better coordination with other operators of parking and transport systems.

While the City of Melbourne can effect significant change around parking its position is still constrained by broader context. Most of Metropolitan Melbourne still uses conventional parking policies, and State policy is a major driver of transport and planning outcomes within the municipality. Nonetheless, parking policies are a powerful tool and the City of Melbourne has considerable autonomy in applying them. The City of Melbourne has significant potential to take leadership in the area of car parking policy, which could be a catalyst not only for gains in urban life within the City itself but for more efficient, sustainable management of parking space across the broader metropolitan Melbourne region.

References

- Antonson, H., Hrelja, R., & Henriksson, P. (2017). People and parking requirements: Residential attitudes and day-to-day consequences of a land use policy shift towards sustainable mobility. *Land Use Policy*, 62, 213-222.
- Arnott, R., Spatial competition between parking garages and downtown parking policy. ISSN: 0967-070X , 1879-310X, *Transport policy* , Vol.13(6), p.469
- Austroroads Guide to Traffic Management Part 11 (Parking), 2017 edition, p142.
- Australia & New Zealand Driverless Vehicle Initiative (ADVI) (2017), Thought Leadership Paper: Driverless Vehicles and Parking, 23 May 2017.
- Baldwin Hess, D.B., (2017): Repealing minimum parking requirements in Buffalo: new directions for land use and development, *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*.
- Barter, P. A. (2009, September). Three paradigms in parking policy and their relevance to Australian cities. In 32nd Australasian Transport Research Forum (ATRF). SkyCity Auckland Convention Centre, Auckland, New Zealand, October (Vol. 29).
- Barter, P.A., (2010) Off - Street Parking Policy without Parking Requirements: A Need for Market Fostering and Regulation, *Transport Reviews*, 30:5, 571-588, DOI: 10.1080/01441640903216958
- Barter, P. (2011) Parking Requirements in Some Major Asian Cities, *Trans. Res. Record* 2245(-1): 79-86.
- Barter, P., (2013), ""Cars are parked 95% of the time". Let's check!", *Reinventing Parking* - <https://www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.html>
- Barter, P. A. (2015). A parking policy typology for clearer thinking on parking reform. *International Journal of Urban Sciences*, 19(2), 136-156.
- Ben-Joseph, E. (2012) *ReThinking a lot : the design and culture of parking*, MIT Press, 2012.
- Broadus, A. (2010). Tale of two ecosuburbs in Freiburg, Germany: Encouraging transit and bicycle use by restricting parking provision. *Transportation research record: Journal of the transportation research board*, (2187), 114-122.
- Buehler, R. (2012). Determinants of bicycle commuting in the Washington, DC region: The role of bicycle parking, cyclist showers, and free car parking at work. *Transportation research part D: Transport and Environment*, 17(7), 525-531.
- Button, K. (2006). The political economy of parking charges in "first" and "second-best" worlds. *Transport Policy*, 13(6), 470-478.
- China Daily (2017), Parking lots are new stars o the sharing economy, *China daily* November 13th 2017.
- City of Melbourne Census of Land Use and Employment (CLUE) Profile 2016, City of Melbourne.
- City of Melbourne (2018), open data portal, "On-street parking bays", <https://data.melbourne.vic.gov.au/Transport-Movement/On-street-Parking-Bays/crvt-b4kt>
- City of Melbourne (2017), on-street parking occupancy data (provided).
- McCahill, C., & Garrick, N. (2010). Influence of parking policy on built environment and travel behavior in two New England cities, 1960 to 2007. *Transportation Research Record: Journal of the Transportation Research Board*, (2187), 123-130.

- Chester, M., Fraser, A., Matute, J., Flower, C., & Pendyala, R. (2015) Parking Infrastructure: A Constraint on or Opportunity for Urban Redevelopment? A Study of Los Angeles County Parking Supply and Growth, *Journal of the American Planning Association*, 81(4), 268-286.
- De Groote, J., Van Ommeren, J., & Koster, H. R. (2016). Car ownership and residential parking subsidies: Evidence from Amsterdam. *Economics of Transportation*, 6, 25-37.
- Garrick, N., and McCahill, C., (2012), *Lessons from Zurich's Parking Revolution*, City Lab.
- Global Research for the City of Melbourne (2017), *Future Melbourne 2026: Transport Reinvestigation – Analysis of public comment to inform the City of Melbourne's revised Transport Strategy*, November 2017.
- Guerra, E. (2016). Planning for cars that drive themselves: Metropolitan Planning Organizations, regional transportation plans, and autonomous vehicles. *Journal of Planning Education and Research*, 36(2), 210-224.
- Guo, Z. (2013) Residential Street Parking and Car Ownership, *Journal of the American Planning Association*, 79 (1): 32-48.
- Guo, Z., & McDonnell, S. (2013). Curb parking pricing for local residents: An exploration in New York City based on willingness to pay. *Transport Policy*, 30, 186-198.
- Guo, Z. and S. Ren (2013) From Minimum to Maximum: Impact of the London Parking Reform on Residential Parking Supply from 2004 to 2010, *Urban Studies*, 50(6):1183-1200.
- Hamer, P., Currie, G., & Young, W. (2011, September). Parking Price Policies—A review of the Melbourne congestion levy. In 34th Australasian Transport Research Forum, Adelaide, South Australia.
- Hamer, P., Young, W., & Currie, G. (2012). Do long stay parkers pay the Melbourne congestion levy?. *Transport Policy*, 21, 71-84.
- Henderson, J. (2009). The spaces of parking: Mapping the politics of mobility in San Francisco. *Antipode*, 41(1), 70-91.
- Hensher, D. A., & King, J. (2001). Parking demand and responsiveness to supply, pricing and location in the Sydney central business district. *Transportation Research Part A: Policy and Practice*, 35(3), 177-196.
- Ison, S., Mulley, C., Mifsud, A., & Ho, C. (2014). A Parking Space Levy: A Case Study of Sydney, Australia. In *Parking Issues and Policies* (pp. 317-333). Emerald Group Publishing Limited.
- Jakle, J. & Sculle, K. (2004) *Lots of parking – Land use in car culture*, Charlottesville: U. Virginia Press.
- Jia, W., Wachs, M., 1999. Parking requirements and housing affordability: a case study of San Francisco. Paper presented at the 78th Annual Meeting of the Transportation Research Board, Washington DC, January 1999.
- Kent, J. L., & Dowling, R. (2013). Puncturing automobility? Carsharing practices. *Journal of Transport Geography*, 32, 86-92.
- Dowling, R., & Kent, J. (2015). Practice and public-private partnerships in sustainable transport governance: The case of car sharing in Sydney, Australia. *Transport Policy*, 40, 58-64.
- Kent, J. L., & Dowling, R. (2016). "Over 1000 cars and no garage": how urban planning supports car (park) sharing. *Urban Policy and research*, 34(3), 256-268.
- Knoflacher, H. (2006). A new way to organize parking: the key to a successful sustainable transport system for the future. *Environment and urbanization*, 18(2), 387-400

- Kodransky, M., and Hermann, G., (2011) "Europe's parking U-Turn: from accommodation to regulation." (2011), ITDP.
- Lee, A., & March, A. (2010). Recognising the economic role of bikes: sharing parking in Lygon Street, Carlton. *Australian Planner*, 47(2), 85-93.
- Legacy, C., & Taylor, E., (2018 – forthcoming), Resisting regeneration: Community opposition and the politicisation of transport-led regeneration in Australian cities, in Ruming, K., (ed), *Urban Regeneration in Australia*.
- Li, F. and Z. Guo (2014) Do parking standards matter? Evaluating the London parking reform with a matched-pair approach, *Transportation Research Part A: Policy and Practice* 67(0): 352-365.
- Litman, T.A., (2014), Economically Optimal Transport Prices and Markets: What Would Happen If Rational Policies Prevailed? paper 11, presented at the International Transportation Economic Development Conference, (<https://tti.tamu.edu/conferences/ited2014>); at www.vtpi.org/ITED_optimal.pdf.
- Litman (2004) Litman, T., 2004. Parking Requirement Impacts on Housing Affordability. /www.vtpi.org.
- Manville (2017) *Travel and the Built Environment Time for Change*
- Manville, M (2013) Parking Requirements and Housing Development, *Journal of the American Planning Association*, 79(1):49-66.
- Manville, M., & Williams, J. A. (2012). The price doesn't matter if you don't have to pay: legal exemptions and market-priced parking. *Journal of Planning Education and Research*, 32(3), 289-304.
- Manville, M, Beata, A & Shoup, D (2013), Turning Housing Into Driving: Parking Requirements and Density in Los Angeles and New York, *Housing Policy Debate* 23(2): 350-375.
- Marsden, G., (2006), The evidence base for parking policies – a review, *Transport Policy* 13 (2006) 447-457.
- Marusek, S. (2011), *Politics of parking: rights, identity, and property*, Burlington, VT : Ashgate,2011.
- Mclvor, M. (2017), *The social costs of on-street parking – searching, policy and unpriced externalities*, Masters Thesis submitted to University of Amsterdam, (supervisor: J.N. van Ommeren).
- McDonnell, S, Madar, J & Been, V (2010) Minimum parking requirements and housing affordability in New York City, *Housing Policy Debate*, 21(1): 45-68.
- Millard-Ball, A., Weinberger, R. R., & Hampshire, R. C. (2014). Is the curb 80% full or 20% empty? Assessing the impacts of San Francisco's parking pricing experiment. *Transportation Research Part A: Policy and Practice*, 63, 76-92.
- Milosavljević, N., & Simićević, J. (2016). User response to parking policy change: A comparison of stated and revealed preference data. *Transport Policy*, 46, 40-45.
- Mingardo, G., van Wee, B., & Rye, T. (2015). Urban parking policy in Europe: A conceptualization of past and possible future trends. *Transportation Research Part A: Policy and Practice*, 74, 268-281.
- MinnPost, (2017), "Why the future of Minneapolis parking garages may not include parking", November 17th 2017.
- Mingardo, G., Van Meerkerk, J., 2012. Is parking supply related to turnover of shopping areas? The case of the Netherlands. *J. Retail. Consum. Serv.* 19 (2), 195–201.
- Mississauga Parking Master Plan – Best Practices Overview document – 'Parking matters' (2017).

- Mordialloc Chelsea Leader, "Kingston Council moot five-storey parking lot over the railway line in Mentone to offer commuters spaces", Mordialloc Chelsea Leader, November 17th 2017).
- Pandhe, A., & March, A. (2012) Parking availability influences on travel mode: Melbourne CBD, *Australian Planner*, 49, 161–171.
- Phillip Boyle & Associates (2017), *West Melbourne Parking Precinct Plan Discussion of Evidence*, City of Melbourne, October 2017.
- Phillip Boyle & Associates (2017), *Impact of Amendment C133 Final Report*, City of Melbourne, January 2017.
- Shoup (1995) Shoup, D.C., (1995). An opportunity to reduce minimum parking requirements. *Journal of the American Planning Association* 61 (1), 14–28.
- Shoup, D.C., (1997), "Evaluating the effects of cashing out employer-paid parking: Eight case studies", *Transport Policy*, Vol. 4 No. 4, pp. 201-216.
- Pierce, G & Shoup, D (2013) Getting the Prices Right, *Journal of Am. Planning Assn*, 79(1): 67-81.
- Shoup, D. C. (2005) *The high cost of free parking*. Chicago: Planners Press, APA. Stubbs, M. (2002) *Car Parking and Residential Development: Sustainability, Design and Planning Policy, and Public Perceptions of Parking Provision*. *Journal of Urban Design*, 7, 213-237.
- Shoup, D., (2006), "Cruising for Parking", *Transport Policy* 13 (2006) 479-486.
- Shoup, D., (1999), "The trouble with minimum parking requirements", *Transportation Research Part A* 33 (1999) 549-574.
- Shoup, D., Yuan, Q., & Jiang, X., (2017), *Charging for Parking to Finance Public Services*, *Journal of Planning Education and Research*, 2017 vol. 37 (2) 135-149.
- Still, B., & Simmonds, D. (2000). Parking restraint policy and urban vitality. *Transport reviews*, 20(3), 291-316.
- Taylor, E. J. (2016). *Cohabiting with cars, in Housing and Home Unbound: Intersections in Economics, Environment and Politics in Australia*.
- Thigpen, C.G. & Volker, J.M.B., (2017), *Repurposing the paving: The case of surplus residential parking in Davis, CA*, *Cities*, Volume 70, October 2017, Pages 111–121
- Yen, B. T., Burke, M., Tseng, W. C., Ghafoor, M., Mulley, C., & Moutou, C. (2015, September). Do restaurant precincts need more parking? Differences in business perceptions and customer travel behaviour in Brisbane, Queensland, Australia. In *Australasian Transport Research Forum (ATRF), 37th, 2015, Sydney, New South Wales, Australia*.
- Taylor, E., (2017), *Dr Elizabeth Taylor: Parking pricing and the 'Arab Spring': They may price our roads, but they'll never price - our parking?*, <https://vimeo.com/234420487> (based on VISTA data - paper under review)
- Taylor, E., (2014) "Fight the towers! Or kiss your car park goodbye": How often do residents assert car parking rights in Melbourne planning appeals?, *Planning Theory and Practice*, 15(3): 328-348.
- Taylor, E. J., & van Bommel-Misrachi, R. (2017). The elephant in the scheme: Planning for and around car parking in Melbourne, 1929–2016. *Land Use Policy*, 60, 287-297.
- Ter Schure, J., Napolitan, F., & Hutchinson, R. (2012). Cumulative impacts of carsharing and unbundled parking on vehicle ownership and mode choice. *Transportation Research Record: Journal of the Transportation Research Board*, (2319), 96-104.

Thigpen, C.G. & Volker, J.M.B., (2017), Repurposing the paving: The case of surplus residential parking in Davis, CA, *Cities*, Volume 70, October 2017, Pages 111–121.

Topp, H. H. (1991). Parking policies in large cities in Germany. *Transportation*, 18(1), 3-21.

Van Ommeren, J., de Groot, J., & Mingardo, G. (2014). Residential parking permits and parking supply. *Regional Science and Urban Economics*, 45, 33-44.

Weinberger, R. (2012) Death by a thousand curb-cuts: Evidence on the effect of minimum parking requirements on the choice to drive. *Transport Policy*, 20, 93-102.

Wilson, R. W. (2013) *Parking reform made easy*, Washington, DC, Island Press.

Young, W. (2016). A view of parking policy in an Australian city. *The Implementation and Effectiveness of Transport Demand Management Measures: An International Perspective*, 151.