Conventional Approaches to Non-residential Parking Policy

Overall effect on California petroleum use		Affects Petroleum Demand Through Intermediate Indicators:	
Magnitude	High	**Primary**	Distance Traveled
Certainty	Medium	**Secondary**	Mode Choice and System Operations Efficiency
Applicable Level of Government	Local		
Relevant Laws or Cases Affecting Factor	1926 Supreme Court *Euclid v. Ambler* (272 U.S. 364) and various local codes		
Overall Time-Horizon of Reversal	The transition away from conventional parking policy would occur gradually over the long-term, based on future changes to the built environment. Changes in urban form would occur most rapidly in areas where current parking policy most constrains the built environment. Even so, the change would occur gradually at the margins, rather than through sweeping redevelopment of existing neighborhoods.		
Relevant Topics	Parking, zoning, urban form		
Summary	Many cities are unwilling or unable to use market controls to manage a finite resource: on-street parking. Instead, they use minimum parking requirements in an attempt to alleviate scarcity and avoid the tragedy of the commons — spillover parking demand. Conventional parking approaches, which seek to predict and provide for peak parking demand in order to avoid parking spillover, greatly subsidize the true cost of parking and distort urban form. Several alternatives to conventional parking policy exist. They include allowing for adaptive reuse, shared parking, in-lieu fees, wayfinding to increase utilization of existing parking infrastructure, and the market-based allocation of parking spaces.		

Introduction

Under a conventional parking policy approach, a local government mandates a minimum number of spaces that must be included with new developments. The goal of such policy is to satiate parking demand in order to reduce the potential for conflicts that result from on-street parking scarcity. To accomplish this goal, a local government must predict parking

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demand and provide (or require the provision of) a sufficient number of spaces to meet that demand.

The primary challenge local governments face in implementing the conventional "predict and provide" parking approach is forecasting the number of spaces needed to meet demand. Just as demand for roadway space varies by time and location, demand for parking varies by time, location, and a building's purpose. In many cases, local governments require that buildings provide sufficient parking to meet peak annual demand. This means that a restaurant cannot open unless it provides sufficient parking to meet demand for Mother's Day brunch. It also means that a retail store cannot open unless it provides sufficient parking to meet demand for the Friday after Thanksgiving.

While this constraint leads to fewer restaurants and retail stores, those driving to those locations that do exist will not be subject to parking scarcity *if* parking demand manifests as predicted. However, parking demand does not always manifest as predicted in areas where an automobile can park in a lot designated for one building and its occupants can walk to another building, especially if such behavior is more convenient or cheaper for the occupants. Available parking spaces may be out of sight and undiscoverable by the potential user. The complexity of neighborhoods increases with density and diversity of uses. In general, the more complex the area, the less certain parking demand forecasts will be.

Rather than develop neighborhood- and site-specific parking demand forecasts, many local governments use national averages from the Institute of Transportation Engineers *Parking Generation* manual, now in its 4th edition (2010).

Criticisms of conventional parking policy

To the parking user, scarcity is the most salient parking problem. Under the predict-and-provide parking paradigm, the solution to scarcity is more supply. To the non-user, community, and stakeholders seeking reductions in petroleum use, more parking supply creates new challenges. We detail and discuss several assumptions that we believe are implicit in a local government's decision to provide or ensure the provision of "adequate" or "enough" parking in an attempt to alleviate scarcity. These are subjective, relative terms, and their use often:

- assumes that parking should be free, or implicitly ignores the role of economic incentives in making choices;
- treats parking and land as an abundant resource, ignoring the negative feedback imposed by scarcity
- unintentionally discourages walking as a policy goal by requiring parking be provided as near as possible to an intended use;
- assumes that the quality of all parking spaces is uniform: that all are equally-discoverable and accessible;
- and assumes that individuals lack any other means of accessing a property other than traveling in and storing an automobile.

Furthermore, we argue that conventional parking policy only functions as intended where these conditions are met — and that minimum parking requirements become a self-fulfilling prophecy. If an area does not meet the above conditions, it will approach or attempt to approach these conditions after several decades of applying parking standards to all new development and changes in use.

Conventional parking policy attempts to suspend or ignore the role of market economics in managing scarcity. Fundamentally, because cities have underpriced public on-street parking, they require developers and business owners to underprice private off-street parking. This has larger ramifications in areas where parking is relatively more expensive to provide: dense areas and areas with higher land values.

Most implementations of conventional parking policy ignore parking prices, or assume that parking will be free. In the Institute of Transportation Engineers *Parking Generation* manual, national observations of parking demand by land use are based on samples where parking is unpriced. The Institute and others (Wilson, 1995 and Shoup, 2005) warn that parking demand varies by local conditions and implore local governments to seek additional information about how parking demand is sensitive to community and site-specific conditions, including prices. In practice, many local governments disregard these cautions. Doing so ignores an individual's sensitivity to transparent prices – an incentive forming the foundation of microeconomics – in areas where nearby on-street or off-street parking is priced or has time limitations.

Conventional parking policy assumes land is an abundant resource and thus distorts urban form and produces additional traffic congestion. Floor area ratio is a zoning control to limit density by only allowing a specified amount of building square footage on a given lot size. Providing required parking with surface parking can serve as an additional density constraint (Willson, 1995). Surface parking is cheapest to construct, but the land costs are not amortized over other, revenue-producing uses. Thus, structured and subterranean parking are popular in many suburban and urban settings with higher land values. However, because stacking parking has far fewer barriers than stacking roadways, the tendency to construct multi-level parking in denser areas increases parking spaces per acre without any increase in roadway capacity (Manville and Shoup, 2005). The result in a land-constrained area is additional traffic congestion.

While discouraging walking is not an explicit objective of conventional parking policy, this goal is implicit when a local government requires that a building's required parking be nearby. Dedicating parking to individual uses, typically as an attempt to avoid conflicts produced by incentives to park closer or cheaper, discourages (and in some cases, prohibits) walking between several uses or parcels. Regardless of conventional parking policy's effect on petroleum use, present public health concerns necessitate the reconsideration of parcel-specific parking requirements, as obesity is now far more prevalent than when California cities first amended their zoning codes to require parking.

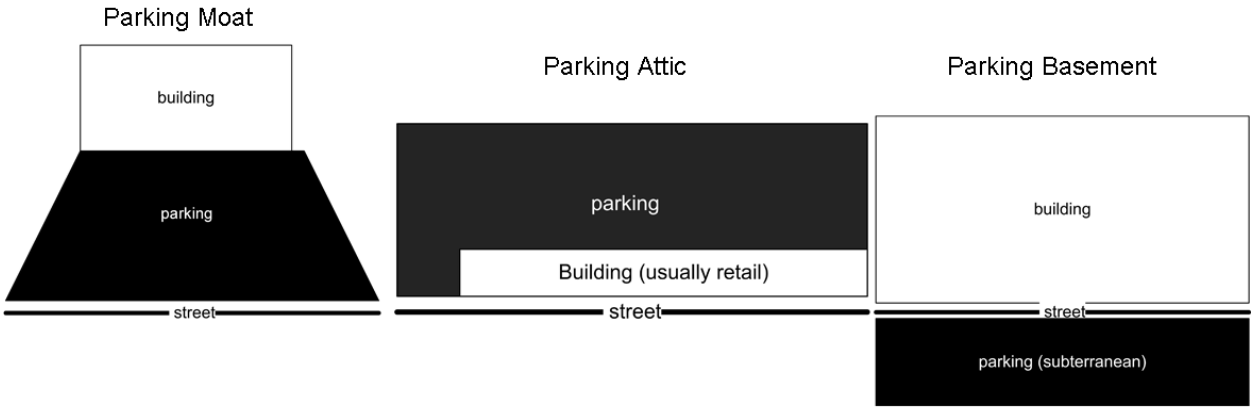
Conventional parking policy treats parking quality as uniform. However parking design, accessibility, and other attributes vary by implementation. Mukhija & Shoup (2006) point out that planners typically regulate parking quantity but not parking quality. They argue that planners should be more concerned with parking's impact on urban design, including the location of parking and its interfaces with pedestrian facilities. Others point out that users perceive parking to be scarce if they cannot discover or access it. While regular users may be able to locate available parking in a distant corner of a lot or structure, unfamiliar users may be unable to do so. Smith (2005) suggests that better parking lot and structure design can improve access and discoverability.

Conventional parking policy approaches often assume that individuals lack any other means of accessing a property other than traveling in and storing an automobile. This assumption is implicit in most parking requirements. Traffic engineers can have difficulty observing parking needs in complex environments where on-street or nearby off-street parking is priced because any excess off-street parking capacity may be used by those responding to

price incentives. As such, many of the Institute of Transportation Engineer's parking observations are for isolated uses disconnected from other demand generators – a rarity in dense, urban environments. The Institute now encourages engineers to submit parking observations from sites with a variety of characteristics, but collecting these observations is more complicated (Institute for Transportation Engineers, 2010). Policy based on these figures implicitly ignore many local conditions, like residences within walking distance, transit service, and cycling amenities. Instead, conventional approaches distill a complex question – the peak number of a building's occupants that will require vehicle storage – into a linear function dependent on national observations for a use: how square footage for each use relates to parking demand. Such an approach requires implicit tradeoffs with the quality and viability of transportation alternatives (Willson 1995, Shoup 2005).

In areas where one or more of the conditions do not apply, conventional parking policy is inappropriate without local or site-specific modifications. Generally, these conditions only apply in exurban environments with large parcels and where all off-street spaces are more accessible than on-street spaces (a parking moat). In more complex, urban and inner-ring suburban environment with smaller lot sizes and occasional structured parking (a parking attic) and subterranean parking (a parking basement), conventional policy can prove a less effective means of avoiding on-street scarcity than in exurban and outer suburban settings.

Figure 1: Parking moat, attic, and basement



Self-fulfilling parking policy prophecy

Figure 2: Self-fulfilling parking policy: a reinforcing cycle

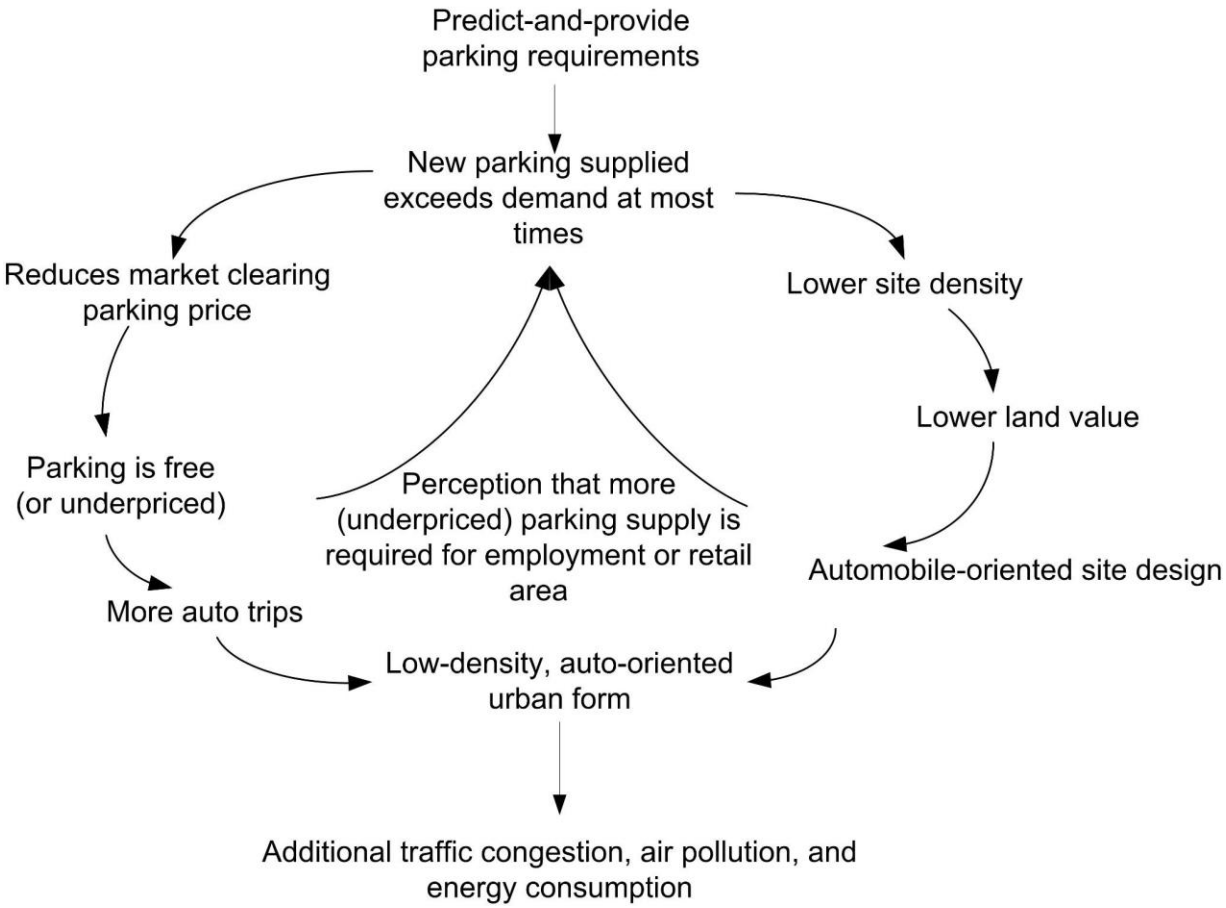


Figure adapted from Willson (1995)

Because parking policy applies to every zoning decision, it's one of the more powerful factors we assess in *Unraveling Petroleum*. The feedback this cycle produces amplifies demand for subsidized parking over time. Every new development reinforces the predict-and-provide paradigm, a path-dependency that makes parking policy changes less and less acceptable to parking users over time.

History of conventional parking policy approach

Local governments derive their ability to mandate parking provision from their authority to regulate land uses through zoning. A 1926 U.S. Supreme Court case, *Euclid v. Ambler* (272 U.S. 364) authorized zoning as a police power implicitly granted to states and people under the Tenth Amendment to the U.S. Constitution. Police power allows states and local governments to issue regulations that protect the health, safety, morals, and general welfare of their residents.

The legal rationale behind requiring a minimum amount of parking with a land use is that:

> (1) mandating off-street parking supply in the zoning code mitigates the traffic that would occur if drivers were forced to search the streets for an available parking space.

(2) existing uses have a greater right to on-street parking than do new uses

The first rationale is short-sighted in a multi-round repeated game where participants adjust their behavior in response to feedback.

Zoning for parking was rare before World War II but proliferated between 1946 and 1969 as an incrementalist approach to resolving conflicts brought about by increasing automobile storage needs (Ferguson, 2004). California cities played a leading role in incorporating minimum parking requirements within their zoning codes: Los Angeles was the first major city to require off-street parking for multifamily housing (1935), Fresno was the first to require off-street parking for non-residential uses (1939), and Pasadena was the first city to require off-street parking for most developments (1945) (Ferguson, 2004). Historically, many parking standards have used supply-side measurements, such as the number of required spaces per housing unit, beds, or bowling alley lane. Ferguson (2004) points out that new policies often use demand-side and spatial measures, such as required spaces per person, employee, or square foot of building use.

Santa Monica case study

We use Santa Monica, California as an example of local parking policy. While each local government with zoning authority has discretion over its own parking policy, many use a conventional approach with few substantive variations.

The bulk of Santa Monica's growth occurred between 1920 to 1970, when the city's population grew from 15,252 to 88,289 – just under the 2011 estimated population (90,377). The city's period of growth spanned the introduction of parking requirements—it's 1950 population was 71,595. As such, the city has nonresidential buildings in traditional neighborhoods which were not subject to parking-related zoning controls, and some nonresidential buildings which were subject to the requirements. Santa Monica has also tried several of the alternatives to conventional parking policy discussed later in this brief, providing real-world examples of their implementation.

The city's current parking policy, Municipal Code 9.04.10.08, applies minimum parking requirements to every change of use and every building erected or substantially remodeled after 1993. The purpose of these requirements is to:

- "provide parking in proportion to the needs generated by varying types of land use"
- "reduce traffic congestion and hazards",
- "protect neighborhoods from the effects of vehicular noise and traffic generated by uses in adjacent non-residential districts,"
- "ensure the maneuverability of emergency vehicles," and
- "provide accessible, attractive, and well-maintained off-street parking facilities"

Santa Monica's parking policy is largely conventional, and its minimum parking requirements are largely based on the national observations presented in *Parking Generation*. Santa Monica has made a few changes to support local policy objectives. For instance, new buildings over 15,000 square feet must provide bicycle parking at 5% the required number of auto spaces. All of the bicycle parking shall be shall not be further than ½ the distance from the furthest off-street auto parking space to the main entrance of the building. New buildings over 50,000 square feet must provide 50% of bicycle parking for long-term commuters, and 10% of required automobile parking spaces must be dedicated to vanpool or carpool vehicles. Like many conventional policies, Santa Monica's parking policy implicitly discourages walking by requiring that all spaces be located on the parcel or

building site or, in commercial and industrial districts, within one thousand feet of the perimeter or the parcel (SMMC 9.04.10.08.190(a)).

Costs of parking

A Whole Foods Market, at 2201 Wilshire Boulevard in Santa Monica provides an example of the true cost of off-street parking. The building provides all of the parking the city requires for a supermarket of its size – 130 subterranean spaces in two levels below the store's basement.

In Table 1, we calculate the hourly per-user parking subsidy at different per-space construction costs and average annual utilization rates. All figures are amortized over 10 years, 15 hours per day (the store is open from 7am to 10pm), and 365 days per year.

Table 1: Hourly per-user parking subsidy

	Average annual utilization during business operating hours			
Per Space Construction Cost	33%	50%	75%	90%
$25,000.00	$1.38	$0.91	$0.61	$0.51
$40,000.00	$2.21	$1.46	$0.97	$0.81
$55,000.00	$3.04	$2.01	$1.34	$1.12

The 130 off-street spaces under the Whole Foods are less-easily-accessible than the surrounding on-street spaces. Thirteen metered on-street parking spaces border the store. Santa Monica charges $1 per hour for parking at these metered spaces between 9am and 6pm. Note that many hourly per-user estimates exceed this cost. Metered parking is free for 6 of store's operating hours, including the busy, congested dinnertime hours. A preferential parking district in the surrounding neighborhood allows 2 hours of free parking for any vehicle without a permit.

Whole Foods Market is a for-profit venture: it passes on the cost of parking, just as it passes on the cost of kale. The Whole Foods Market at 2201 Wilshire Boulevard does not charge users directly for parking, nor does it discriminate between those that arrive via the subterranean parking structure or some other means. Therefore, the store indirectly charges all shoppers for the cost of providing the 130 subterranean parking spaces, regardless of how they arrived at the store.

Alternative parking policy approaches

Allow adaptive reuse of existing buildings

Because Santa Monica has commercial buildings developed both before and after the onset of parking requirements, the city provides an example of how conventional parking policy can limit the adaptive reuse of existing buildings. Conventional parking policy often requires a minimum number of parking spaces for each change in use. Existing uses are grandfathered in – the parking requirements only apply when a new use differs from the previous use.

This is the case in Santa Monica, where the hypothetical conversion of a 5,000 square foot bookstore to a restaurant would require additional parking spaces.

Santa Monica requires that retail uses provide 3 ⅓ parking spaces per 1,000 square feet of gross floor area. The city could seek a more precise parking demand estimate for book superstore, which *Parking Generation* presents at 0.89 spaces per 1,000 square feet of floor area. However, this ratio is based on only one observation in Seattle – hardly a sufficient sample to make valid statistical inferences (Institute of Transportation Engineers, 2010).

Though the existing bookstore may not be required to provide any parking if in a building constructed prior to parking requirements, we'll assume that it provides all the parking required: 17 spaces. Santa Monica Municipal Code requires that the hypothetical restaurants provide 3 ⅓ spaces for 1,000 square feet of support area, 46 ⅔ spaces for 3,500 square feet of service and seating area open to customers, and 10 spaces for 500 square feet of separate bar area: 60 spaces in total.

The restaurant cannot open until it finds an additional 43 parking spaces within 1,000 feet (if located in a commercial district) or obtains a variance or conditional use permit that allows it to operate without code required parking. The variance or conditional use permit is offered on a case-by-case basis and may be contingent on the restaurant obtaining off-site parking and offering valet services.

In addition to creating a business plan and lining up investors, the restaurateur must wait several months for the uncertain outcome of a discretionary decision regarding the variance or conditional use permit. This adds an additional risk that is insurmountable for many projects, likely reducing the scope and scale of uses that require high levels of parking in Santa Monica and other cities, and increasing vacancies among former uses that require fewer parking spaces.

A by-right pathway for changes in building use reduces the risk of opening a new business. Adaptive re-use and in-lieu fees provide such a pathway. Specifically, adaptive reuse policies allow existing buildings to change in use without necessitating additional parking. A local government may combine adaptive reuse with a fee in-lieu of providing parking. In downtown Santa Monica, the restaurateur can pay a fee instead of providing 43 additional parking spaces.

In-lieu fees

When a local government requires a parcel to supply parking, they implicitly require the parcel owner or developer to subsidize the creation of new parking spaces. If the local government offers the parcel owner or developer the opportunity to pay a fee in-lieu of providing parking, it can use these revenues for almost anything. Under California law, there must be a substantial nexus between the fee and its use. However, local governments can use these revenues to manage parking demand: constructing additional spaces, subsidizing transit, providing bicycle share or bicycle parking, or investing in systems that help users locate available parking spaces.

Shoup (2005) claims in-lieu fees allow flexibility. Rather than requiring that each use provide its own parking, in-lieu fees can support shared parking and park-once districts. Rather than pressuring the destruction of historic structures to provide additional parking, in-lieu fees can support historic preservation and adaptive re-use.

In 1986, Santa Monica established an in-lieu fee in the Bayside District, the downtown neighborhood around the city's pedestrian-oriented shopping street, the Third Street Promenade. The city assesses an annual parking developer fee of $1.50 per gross square foot of floor area on uses that do not provide the required amount of parking. The city has

not adjusted the fee since 1986. The roughly $605,000 annual revenues fill a financing and operating deficit not covered by directly-assessed parking fees (Nelson\Nygaard Consulting Associates, 2012).

As of this writing, the city is considering an update to the parking development fee that would impose a one-time charge of $20,000 rather than the annual assessment (Nelson\Nygaard Consulting Associates, 2012). The fee would be used for transportation demand strategies in addition to expanding, operating, and maintaining publicly-owned parking facilities. As such, use of in-lieu fees allows Santa Monica to support other transportation policy goals. The city officially promotes walking, carpooling, vanpooling, biking, use of transit, and other transportation demand management measures through its transportation management ordinance, first adopted in 1991 (SMMC 9.16)

Shared parking

Under conventional parking policy each use must provide sufficient parking to meet peak or near-peak demand. For a mall, minimum parking requirements are based on a December weekend. For a movie theater, the June/July blockbuster season. For a sit-down restaurant and bar, a weekend evening. For an office building, the work-day. However, because each individual use provides its own spaces, a mall with restaurants, a movie theater, and office space may cumulatively provide far more free parking than ever used at any one time.

A shared parking approach considers variation in parking demand across uses and time, accommodating aggregate peak demand rather than the sum of individual peak demand. The idea behind shared parking is to use existing infrastructure more efficiently rather than construct new infrastructure that isn't needed. The Urban Land Institute's *Shared Parking* outlines a shared parking approach (Smith, 2005). While the shared parking approach generally recognizes that land for parking is scarce and that space quality is not uniform, implementations that fail to consider local conditions often assume that parking should be free and implicitly discourage walking and use of alternative modes.

Shared Parking outlines two approaches to creating a shared parking agreement. The first requires contractual agreements between adjacent uses to make one property's spaces available to the other's parkers. If allowed by a local government, this ad-hoc approach can lead to the proliferation of shared parking agreements without formal government intervention. The second approach is a parking management district, which is actively managed by a business improvement association or the local government. This approach can establish park-once districts, where individuals are encouraged to park once and walk to multiple land uses. Park-once is common where buildings and parking have a single owner, such as a mall, but is less common in areas where buildings and parking have multiple owners. Santa Monica's downtown parking district behaves as a park-once district, though it does not use the shared parking time-of-use formulas.

Shared parking policy can be the foundation for a multi-use district. As part of a strategy to revitalize downtown areas to promote a greater span of activity after business hours and on weekends, shared parking can help balance an area's parking demand over time. Existing parking infrastructure in an office district may accommodate restaurants and retail, creating a by-right pathway that encourages developers and entrepreneurs to find the right mix of uses within parking constraints.

Shared Parking emphasizes the need for good parking facility design, as many users perceive a parking facility to be at capacity even when 10% or more spaces remain unoccupied (Smith, 2005). While frequent parkers may be familiar with a parking facility's layout and the probable location of available spaces, infrequent parkers may not be. One

option is to offer monthly parkers discounts to use spaces in the less-accessible portion of a parking facility to enable frequent turnover of easily-accessible spaces. Structure design and management can maximize the effectiveness of shared parking arrangements. Santa Monica requires spaces in a mixed-use development be accessible during operating hours and prohibits building managers from assigning shared parking spaces to individuals (SMMC 9.04.10.08.220).

Wayfinding

Wayfinding, including real-time parking information, is an important tool for infrequent parkers. Static and dynamic signage can aid in parking discovery, alleviating the inability of infrequent parkers to find available spaces.

New online-enabled services help with locating and accessing available parking. Parking Panda is a smartphone application and web-based platform that allows individual parking space owners to rent their spaces by the hour or day. The system allows for advanced reservations — reducing parking discovery and pricing uncertainty (Yglesias, 2012). ParkMe is a Santa Monica-based company that offers a smartphone application and website to display real-time occupancy and pricing for public off-street parking structures and on-street metered parking in Santa Monica and other cities. ParkMe offers static information on parking rates for facilities that do not provide real-time information

Transportation Sustainability Fee

San Francisco's Transportation Sustainability Fee is a proposed element of the city/county's Transportation Sustainability Program (San Francisco Planning Department, 2012). The Program advances on in-lieu fees, which use minimum parking requirements as a basis for assessing fees. San Francisco's proposed program abandons parking as an enforcement mechanism and instead imposes a fee on new developments based on square footage and use. As with fees remitted in-lieu of providing parking, the revenues can be used to fund transportation options other than parking. San Francisco plans to use the majority of revenues for transit capital and operations, with some revenues for bicycle and pedestrian infrastructure and services. The Transportation Sustainability Fee will replace the city's Transit Impact Development Fee, which the city currently uses to mitigate new development's impact on the transit system. Other cities in California could consider such a program as an alternative to in-lieu fees and traffic impact fees. As of this writing, the San Francisco program is under environmental review.

Let prices do the planning

Shoup (2005) believes the best way for cities to manage parking is to let prices do the planning: eliminate minimum off-street parking requirements for non-residential uses and adjust the prices of on-street parking to achieve an 85% occupancy rate. Such an approach would reduce parking subsidies over time and eliminate parking-related congestion. Though the technical requirements for implementation are simple, the market-based approach requires a substantial shift from the conventional parking policy paradigm.

Quantifying the effects of a conventional approach to non-residential parking policy

We limit the scope of our analysis to non-residential parking policy, which we expect to affect mode choice and distance traveled but not vehicle availability. Even so, our estimated effect on statewide motor vehicle fuel use is substantial. Below, we detail assumptions for our assessment of how conventional parking policy affects mode choice, distorts land use and distances traveled, and leads to cruising for parking and congestion.

We then estimate the proportion of statewide motor vehicle fuel use that is attributable to conventional parking policy under low-case, mid-case, and high-case assumptions.

Some energy and environmental effects of conventional parking policy are beyond the scope of our analysis. Life-cycle greenhouse gas emissions associated with the construction of parking spaces do not affect our assessment, but are significant nonetheless. Chester, Horvath, and Madanat (2010) estimate lifecycle greenhouse gas emissions for various types of parking spaces. They estimate on-street parking at about 730 kg of CO_2-equivalent per space, surface parking at about 1,300 kg of CO_2-equivalent per space, and structured parking space at about 5,000 kg CO_2-equivalent per space. As a comparison, the average per-capita emissions in California are 12,200 kg of CO_2-equivalent across all sectors and about 4,672 kg of CO_2-equivalent kg per person for transportation. We're not alone in ignoring construction energy and emissions: community-scale greenhouse gas emissions inventories typically ignore emissions from construction – shifting these emissions out-of-scope in many climate planning activities.

Mode choice

The decision to require parking as a condition of building leads to less walking, biking, public transit use, and ridesharing versus a counterfactual case in which nonresidential uses aren't subject to parking mandates. In California 1.58% of person miles traveled are by walking and biking, and 2.53% are by public transit (U. S. Federal Highway Administration, 2011). In our assessment, we multiply the existing 4.1% of person-miles traveled via these modes by a factor of 1.5 (low case) 2 (mid-case) and 4 (high-case) to estimate mode choice effects. We believe these estimates may be conservative, as we do not consider changes in ridesharing.

Effects of land use distortions on distance traveled

Next, we consider how parking policy distorts land use to make vehicle trips longer than they would otherwise be.

Manville and Shoup (2005) point out how little scholars about the amount of land area devoted to parking. Despite parking's effects on cities, people, and travel, few empirical studies have inventoried parking spaces and area. Estimates of the proportion of land devoted to both parking and the roadway network range from one-third in suburban areas to two-thirds in central business districts. Estimates of parking coverage – defined as the ratio of parking surfaces to land area – in California central business districts range from 18% in Sacramento, to 31% in San Francisco, to 81% in Los Angeles (Manville and Shoup, 2005). Parking coverage is a better measure of parking density – and by extension the effects that concentrated vehicle trip ends can have on roadway network congestion – than a measure of the extent to which surface parking distorts land use and distance traveled. While all parking in central business districts serves as a magnet for vehicle travel, only surface parking and single-purpose parking structures distort land uses.

Using aerial photography, Akbari, Rose, and Taha (2003) calculated that that 11.8% of all urbanized land area in Metropolitan Sacramento is devoted to parking. Within the central business district, about 10.5% of surface area is devoted to parking; 31% to roads; and about 26% to buildings. Region-wide, the authors found the ratio of surface area devoted to be higher in commercial/service (31.1%), industrial (20.0%), and industrial/commercial (31.8%) areas than in residential areas (4.9%), and that non-residential areas comprised just over half (50.7%) of the built-up land area.

We use the urbanized area of Sacramento as a proxy for statewide distortions due to parking areas. Although urbanized areas made up only 4.7% of the total land area in the

Sacramento region, the vast majority of travel activity is based in these areas. Statewide, about 88.5% of all household vehicle travel occurs by households located in urbanized areas (U. S. Federal Highway Administration, 2011). As of Census 2010, about 95% of California residents live in urbanized areas.

We use a low-end estimate of 5% and high-end estimate of 20% for differences in travel distances attributable to conventional policy approaches to non-residential parking. In the low case, a 5 mile trip from home to a grocery store is one-quarter mile longer because of required parking. In the high case, the trip is 1 mile longer.

We apply this distance distortion only to the 72.1% of statewide vehicle travel we estimate to be based in urbanized areas (88.5% of all VMT) and between home and shopping, recreation, and work or not home-based (76% of trips and 81% of vehicle miles traveled) (U. S. Federal Highway Administration, 2011).

Cruising for parking

Cruising for parking accumulates additional travel distances while drivers search for available parking spaces. Though oft-cited as an effect of conventional parking policy, cruising for parking alone has a small effect on statewide petroleum use. Cruising results not from the decision to provide off-street parking, but the incentives created when on-street parking is underpriced relative to off-street parking.

Shoup (1997) estimated that one underpriced metered parking space in Westwood Village generates about 1,825 additional vehicle miles traveled annually. Most of California is dissimilar from Westwood Village and most parking spaces do not generate similar levels of cruising.

We were not able to find data on the number of metered street spaces for all California cities. Additionally, not all metered spaces in cities generate significant cruising. We use a range of estimates for spaces statewide that achieve Westwood-like cruising levels (from 25,000 to 200,000); the high-end assumes cruising also occurs at some non-metered spaces. Our overall estimate is not sensitive to cruising, as we estimate searching for parking to have a very small effect on statewide motor vehicle fuel use (only 0.11% in the high case).

Table 2: Number of metered spaces for selected California cities

City	On-Street Metered Spaces	Source
Los Angeles	37,000	(Los Angeles Department of Transportation, n.d).
San Francisco	23,000	(San Francisco Municipal Transportation Agency, 2013)
Santa Monica	5,967	(Santa Monica, n.d.)
San Diego	5,262	(City of San Diego, n.d.)
San Jose	2,600	(San Jose, n.d)

Berkeley	1,600	(City of Berkeley, n.d.)
Pasadena	1,200	(City of Pasadena, n.d)
Sum of sample	75,029	

Additional congestion due to conventional parking policy

Conventional parking policy has two types of congestion-related effects. The first effect is from additional distance traveled. Vehicles that are cruising for parking generate additional traffic congestion, typically during peak hours and in areas with that are already congestion-prone. However, the additional distance generated from cruising is small in relation to the additional miles traveled because of land use distortion. Secondly, conventional parking policy creates additional parking spaces in a dense area without increasing the capacity of roadway networks – leading to additional congestion independent of distanced traveled.

The Texas A&M Transportation Institute's oft-cited Urban Mobility Report lists 2011 excess fuel consumed in California metropolitan areas due to traffic congestion at 389,943,000 gallons — about 2.2% of statewide motor vehicle fuel use. Considering the second effect, perhaps all or most of the congestion in California could be attributed to nonresidential minimum parking requirements. However, we apportion this loss in system operations efficiency somewhat conservatively — based solely on the first effect. We assume that system operations efficiency losses are uniformly distributed over expected changes in vehicle miles traveled rather than disproportionately caused by the decision to concentrate parking spaces.

Cumulative effect on California motor vehicle fuel use

The low and high cases are presented as possible lower and upper bounds, with the mid-case being our best estimate, shying slightly conservatively due to data limitations.

Table 3: Cumulative effect on California motor vehicle fuel use

Case	Mode choice effect	Land use distortion - additional distance traveled	Spaces affected by cruising behavior	System operation efficiency loss	Cumulative effect on California motor vehicle fuel use
Low	150%	5%	25,000	0.12%	5.7%
Mid	200%	10%	100,000	0.24%	11.2%
High	400%	20%	200,000	0.53%	24.9%

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