5.4 Parking Costs

*This chapter estimates the costs of various types of parking facilities, the number of spaces per vehicle, and the distribution of these costs. For more detailed analysis see "*Comprehensive P*arking* Supply, Cost and Pricing Analysis*" (www.vtpi.org/pscp.pdf).*

5.4.1 Chapter Index

5.4.2 Definitions

There are various types of parking facilities:

- *On-street parking* consists of parking lanes within public road rights-of-way.
- *Off-street parking* is parking facilities on their own land, not on road rights-of-way.
- *Surface parking* refers to parking lots directly on land.
- *Structured parking* (also called *parkades*, *garages* or *ramps*) are multi-story parking buildings.
- *Commercial parking* refers to parking spaces rented to the general public for a profit.

These facilities can have various costs:

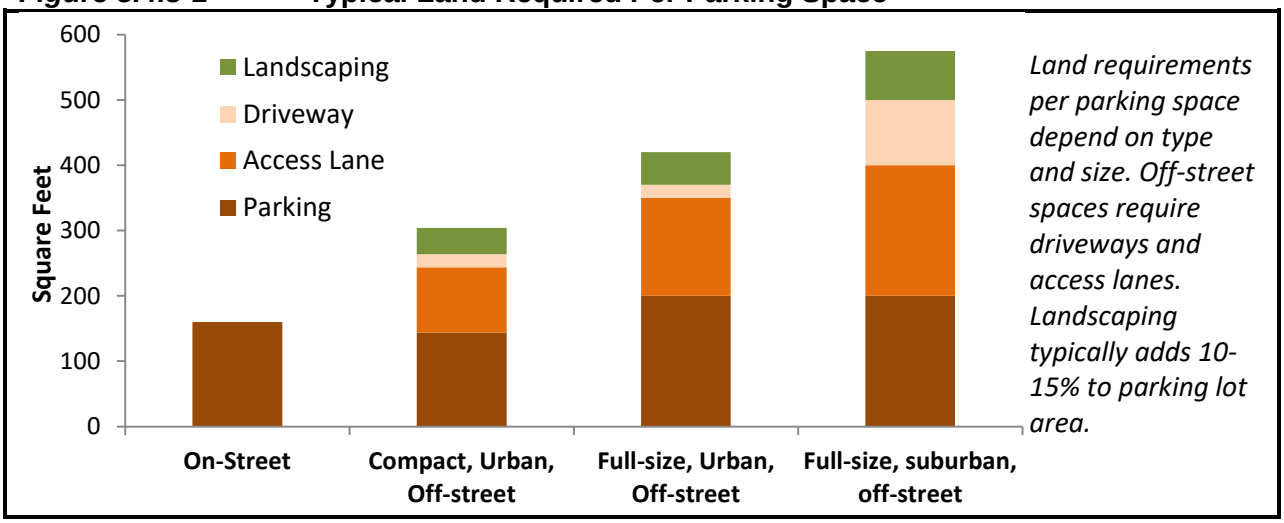
- *Land value*, the opportunity costs of land devoted to parking facilities.
- *Construction costs* for building parking facilities.
- *Operating costs* include maintenance, repairs, cleaning, fee collection, and enforcement.
- *Environmental costs* include stormwater management, heat island effects, habitat displacement, and aesthetic degradation of parking lots.
- *Traffic impacts.* Effects on automobile ownership and use, and resulting traffic impacts.

5.4.3 Discussion

Land Area and Value

A typical parking space is 8-10 feet (2.4-3.0 meters) wide and 18-20 feet (5.5-6.0 meter) long, totaling 144-200 square feet (13-19 sq. meters).[1] Off-street parking typically requires 250-350 square feet (25-35 square meters) per space, including access lanes and landscaping, allowing 125-175 spaces per acre (250-450 per hectare), depending on design. In practice, spaces per acre are often lower. A survey of six typical parking lots found that they average of 85 spaces per acre.[2]

Figure 5.4.3-1 **Typical Land Required Per Parking Space**



Land costs can vary from thousands of dollars per acre in rural areas to millions of dollars per acre in cities. One study estimated that 2010 U.S. urban land averaged about $500,000 per acre (about $680,000 in 2022 dollars), with higher values in central areas and larger cities.[3] Because parking must be located near destinations it requires relatively high-value land. For example, a building located on $5 million per acre land generally requires equally expensive land for parking, rather than cheaper land located a mile away. Land devoted to parking is sometimes considered a sunk cost, but there are usually opportunity costs since that land could be used for buildings, landscaping, sold or leased. Similarly, roadspace used for on-street parking could be used for traffic lanes, busways, bike lanes, wider sidewalks (for café seating or other commercial activities), landscaping, or parklets (small play areas).[4]

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[1] James Hunnicutt (1982), "Parking, Loading, and Terminal Facilities," in *Transportation and Traffic Engineering Handbook*, Institute of Transportation Engineering/Prentice Hall, 1982, p. 651.

[2] Wesley Marshall (2014), "On-Street Parking," *Parking Issues and Policies*, Transport and Sustainability, p. 367; at http://bit.ly/2EhgsFM.

[3] David Albouy, Gabriel Ehrlich, Minchul Shin (2018), "Metropolitan Land Values," *Review of Economics and Statistics*, Vo. 100/3 (https://doi.org/10.1162/rest_a_00710); at https://bit.ly/3K6mVFG.

[4] *Pavement to Parks* (http://sfpavementtoparks.sfplanning.org) San Francisco Parks Department.

Woudsma, Litman, and Weisbrod developed practical methods for valuing land used for transport facilities, including roads, railroads and airports, based on detailed data for specific geographic areas.[5] They find typical values of $100 to $200 per square meter in urban areas $0.40 to $0.60 per square meter in rural areas (2000 Canadian dollars).

Parking Supply and Land Consumption[6]

Various studies have estimated parking supply and land consumption in various areas. Davis, et al. used detailed aerial photographs to estimate the number of parking spaces in surface lots in Illinois, Indiana, Michigan, and Wisconsin.[7] Their analysis excluded on-street parking and residential garages, and only counted the top floors of structured parking. They counted more than 43 million spaces in these four states, averaging 2.5 to 3.0 spaces per vehicle. They found that parking uses approximately 5% of urban land.

Chester, Horvath and Madanat estimate that in 2010 there were between 105 million and 2.0 billion total parking spaces in the U.S., averaging 0.5 to 8 parking spaces per vehicle, as indicated in Table 5.4.3-1.

Table 5.4.3-1 **Estimated U.S. Parking Spaces (millions of spaces)**[8]

Type	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
On-street	35	92	180	150	1,100
Surface	36	520	520	610	790
Structure	34	110	110	84	120
Total	*105*	*730*	*820*	*840*	*2,000*

This table summarizes various estimates of U.S. parking spaces.

Chester, et al. (2015) investigate how Los Angeles County parking supply grew from 1900 to 2010 and how this relates to changes in automobile travel and urban form.[9] They estimate that in 2010 there were 18.6 million parking spaces, including 5.5 million residential off-street, 9.6 million nonresidential off-street, and 3.6 million on-street spaces, as indicated in Figure 5.4.3-2. This averages 3.3 spaces per vehicle: 1.0 residential off-street, 1.7 nonresidential off-street, and 0.6 on-street spaces, with the

[5] Clarence Woudsma, Todd Litman, and Glen Weisbrod (2006), *Report on the Estimation of Unit Values of Land Occupied by Transportation Infrastructures*, Transport Canada; at www.vtpi.org/TC_landvalue.pdf.

[6] Todd Litman (2020), *Transportation Land Valuation*, VTPI (www.vtpi.org).

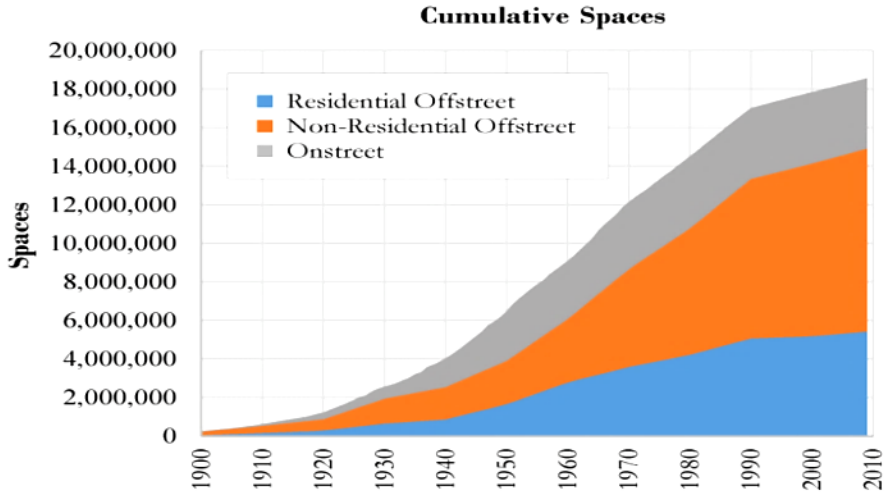
[7] Amélie Y. Davis, et al. (2010), "Estimating Parking Lot Footprints in the Upper Great Lakes Region of the USA" *Landscape and Urban Planning*, Vol. 96/2, pp. 68-77 (doi.org/10.1016/j.landurbplan.2010.02.004).

[8] Mikhail Chester, Arpad Horvath and Samer Madanat (2010), "Parking Infrastructure: Energy, Emissions, and Automobile Life-Cycle Environmental Accounting," *Environmental Research Letters*, Vo. 5, No. 3 (http://dx.doi.org/10.1088/1748-9326/5/3/034001).

[9] Mikhail Chester, et al. (2015), "Parking Infrastructure: A Constraint on or Opportunity for Urban Redevelopment?," *Journal of the American Planning Association*, Vo. 81, No. 4, pp. 268-286 (doi: 10.1080/01944363.2015.1092879); also see www.transportationlca.org/losangelesparking.

greatest density in the urban core and most new growth outside of the core. In total, 14% of the County's incorporated land is used for parking.

Figure 5.4.3-2 **Estimated Los Angeles County Parking Spaces**[10]



The number of parking spaces in Los Angeles grew significantly during the last century. For each motor vehicle there are estimate to be 3.3 spaces: 1.0 residential off-street, 1.7 nonresidential off-street, and 0.6 on-street spaces

Hoehne, et al. estimate that in 2017 the Phoenix, Arizona metropolitan region had 12.2 million parking spaces, with 4.3 spaces per non-commercial vehicle of which 1.3 are off-street residential, 1.3 are off-street non-residential, and 1.7 are on-street, and roads and parking facilities cover approximately 36% of the metro's total land area (10% parking and 26% roadway).[11] Pijanowski found approximately three non-residential off-street parking spaces per vehicle in Tippecanoe County, a typical rural community.[12]

Akbari, Rose and Taha used high-resolution aerial photos to estimate the area of various land-use types in Sacramento, California, summarized below and in table 5.4.3-2.[13]

1. *Downtown and city center.* Vegetation 30%, roofs 23%, and paved surfaces 41%
2. *Industrial.* Vegetation 8–14%, roofs 19–23%, and paved surfaces 29–44%.
3. *Offices.* Vegetation 21%, 16% roofs, and 49% paved areas.
4. *Commercial.* Vegetation 5–20%, roofs 19–20%, and paved surfaces 44–68%.
5. *Residential.* Vegetation 36%, roofs 20%, and paved surfaces 28%.

[10] Chester, et al. (2015).

[11] Christopher G. Hoehne, et al. (2019), "Valley of the Sun-Drenched Parking Space: Growth, Extent, and Implications of Parking Infrastructure in Phoenix," *Cities*, Vo. 89, pp. 186-198 (doi.org/10.1016/j.cities.2019.02.007).

[12] Bryan Pijanowski (2007), *Parking Spaces Outnumber Drivers 3-to-1, Drive Pollution and Warming*, Purdue University (www.purdue.edu); at www.purdue.edu/uns/x/2007b/070911PijanowskiParking.html.

[13] Hashem Akbari, L. Shea Rose and Haider Taha (2003), "Analyzing the Land Cover of an Urban Environment Using High-Resolution Orthophotos," *Landscape and Urban Planning* (www.sciencedirect.com/science/journal/01692046), Vol. 63/1, pp. 1–14.

Table 5.4.3-2 **Calculated Surface-Area Percentages**

Land Use Type	Tree Cover	Barren Land	Grass	Roof	Road	Sidewalk	Parking	Miscellaneous
Residential	14.7	10.2	24.5	19.4	12.7	8.0	4.9	5.6
Commercial/service	9.6	7.3	9.3	19.8	15.5	3.7	31.1	3.8
Industrial	8.1	19.7	6.0	23.4	7.3	1.3	20.0	14.3
Transport/communications	0.0	4.0	0.0	5.0	80.0	1.0	10.0	0.0
Industrial and commercial	2.8	15.6	5.6	19.2	10.3	1.3	32.1	13.1
Mixed urban	26.8	2.1	7.1	23.7	17.6	4.5	9.5	8.7

This table summarizes the surface area of various types of land uses in Sacramento, California.

McCahill and Garrick measured the relationship between vehicle travel and parking land consumption in 12 U.S. cities.[14] They found that a 10 point increase in auto commute mode share is associated with an additional 2.5 square meters of parking land area per capita. The found that pavement covers about 35% of most residential areas and 50–70% in most non-residential areas, as summarized in Table 5.4.3-3. Shoup calculates that US cities average about eight on- and off-street parking spaces for per vehicle.[15]

Scharnhorst used various sources to develop comprehensive parking inventory and cost estimates for five U.S. cities, as summarized in the table below.[16] Per household parking supply and costs are low in denser, multimodal cities like New York and Philadelphia, and high in Jackson, Wyoming, an automobile-oriented resort and commercial center that attracts many tourists and regional shoppers. Parking facilities were categorized into on-street, off-street surface and off-street structured.

Table 5.4.3-3 **Parking Spaces and Costs in Five U.S. Cities** (Scharnhorst 2018)

	New York	Philadelphia	Seattle	De Moines	Jackson
Population	8,537,673	1,567,872	704,352	215,472	10,529
Parking spaces	1,965,377	2,172,896	1,596,289	1,613,659	100,119
Spaces per household	0.6	3.7	5.2	19	27
Vehicles per household*	0.6	1.0	1.9	3.0	3.7
Spaces per vehicle	1.0	3.7	2.7	10	14
Total value	$21 billion	$17 billion	$36 billion	$6.4 billion	$711 million
Value per household	$6,570	$29,974	$117,677	$77,165	$192,138
Value per vehicle	$6,570	$8,101	$61,935	$25,721	$51,929

Scharnhorst used various data sources to measure parking supply and costs in five cities. (Vehicles per household from census data for that community, if available, or its state.)*

[14] Christopher McCahill and Norman Garrick (2012), "Automobile Use and Land Consumption: Empirical Evidence from 12 Cities," *Urban Design International*, Vol. 17, No. 3, DOI: 10.1057/udi.2012.12.

[15] Donald Shoup (2005), *The High Cost of Free Parking.* Planners Press (www.planning.org).

[16] Eric Scharnhorst (2018), "Quantified Parking: Comprehensive Parking Inventories for Five U.S. Cities," Research In. for Housing America, Mortgage Bankers Association (www.mba.org); at https://bit.ly/2LfNk4o.

The study, *Inventorying San Francisco Bay Area Parking Spaces*[17] used a combination of satellite imagery and analysis of parking minimums applied to land parcels to estimate the number and location of parking spaces in the nine-county Bay Area. It estimated that the region has 15 million spaces of which 6.4 million are off-street and 8.6 million are on-street, resulting in approximately 2.4 spaces per automobile and 1.9 spaces per capita. More than two-thirds are in residential areas. It found that parking and roadways make up 20% of incorporated (urbanized) land area.

These studies indicate that in typical North American urban communities there are between three and eight off-street parking spaces per vehicle, plus numerous on-street spaces, the number of which is somewhat arbitrary since many roads have shoulders suitable for parking but not located near popular destinations. The number of parking spaces per vehicle tends to be lower in denser areas where parking is shared, and higher in suburban and rural areas where each destination provides abundant parking on site.

Construction Costs

Parking facility construction costs are affected by the size per space, site conditions (small, irregular, sloped sites with poor soil conditions are more costly), number of levels (more levels increase unit costs), design (exterior aesthetic treatments can increase costs), geographic location and market conditions.[18]

Table 5.4.3-4 **Parking Structure Construction Costs, 2011**[19]

	Construction Cost Per Square Foot		Construction Cost Per Space	
	Underground	**Above Ground**	**Underground**	**Above Ground**
Boston	$95	$75	$31,000	$25,000
Chicago	$110	$88	$36,000	$29,000
Denver	$78	$55	$26,000	$18,000
Honolulu	$145	$75	$48,000	$25,000
Las Vegas	$105	$68	$35,000	$22,000
Los Angeles	$108	$83	$35,000	$27,000
New York	$105	$85	$35,000	$28,000
Phoenix	$80	$53	$26,000	$17,000
Portland	$105	$78	$35,000	$26,000
San Francisco	$115	$88	$38,000	$29,000
Seattle	$105	$75	$35,000	$25,000
Washington DC	$88	$68	$29,000	$22,000
Average	*$103*	*$74*	*$34,000*	*$24,000*

This table summarizes average parking structure construction cost in twelve U.S. cities.

[17] Mikhail Chester, Alysha Helmrich and Rui Li (2022), *Inventorying San Francisco Bay Area Parking Spaces*, Mineta Transportation Institute (https://transweb.sjsu.edu); at https://bit.ly/3QgGgFo.

[18] Laura Madrigal (2022), *How Much Does It Cost to Build a Parking Garage?*, FIXR (www.fixr.com); at www.fixr.com/costs/build-parking-garage.

[19] Donald Shoup (2016), "Cutting the Cost of Parking Requirements," *ACCESS*, pp. 26-33; at www.accessmagazine.org/articles/spring-2016/cutting-the-cost-of-parking-requirements.

Table 5.4.3-4 summarizes results of a parking facility construction costs survey. It indicates that in 2011 costs averaged $24,000 per aboveground and $34,000 per underground space. In addition to these hard costs facility development usually involves soft costs for project planning, design, permits and financing, which typically add 30-40% to a project, plus any incremental land costs.

Table 5.4.3-5 summarizes average parking structure construction costs in various U.S. cities. It indicates that a basic parking structure typically cost $20,000 to $30,000 per space to build, and more for special site or design requirements. Construction costs have increased faster than general inflation in recent years: non-residential construction costs more than doubled between 2002 and 2022.[20]

Table 5.4.3-5 **Parking Structure Construction Costs** (2022)[21]

City	Cost per Sq. Ft.	Cost per Space
Atlanta	$65.65	$21,926
Baltimore	$69.06	$23,065
Boston	$87.06	$29,078
Charlotte	$61.95	$20,690
Chicago	$87.28	$29,153
Cleveland	$73.57	$24,574
Denver	$68.38	$22,842
Dallas	$63.27	$21,134
Detroit	$76.01	$25,392
Houston	$64.53	$21,555
Indianapolis	$68.90	$23,015
Los Angeles	$79.79	$26,653
Miami	$64.61	$21,580
Minneapolis	$80.83	$27,000
Nashville	$64.91	$21,679
New York	$97.14	$32,444
Philadelphia	$85.20	$28,460
Phoenix	$65.49	$21,876
Pittsburgh	$75.65	$25,267
Portland, OR	$74.31	$24,822
Richmond	$63.79	$21,308
St. Louis	$75.57	$25,242
San Diego	$77.87	$26,009
San Francisco	$90.77	$30,316
Seattle	$76.31	$25,490
Washington D.C.	$72.98	$24,376
National Average	*$74.09*	*$24,748*

This table indicates average construction costs for basic parking structures in various U.S. cities. Costs are higher for:

- *Below grade construction.*
- *Site conditions that require deep foundations or grading.*
- *Extra wide spaces for increased convenience.*
- *Higher quality construction, design and materials.*
- *Enclosed or underground structures that require mechanical ventilation and fire sprinklers*
- *Energy efficient Green Garage Certification.*
- *On-site storm water retention.*
- *Enclosed stair towers.*
- *Mixed use development where the parking is integrated with office, retail, residential, or other uses.*
- *State-of-the-art parking access and revenue control system.*
- *User amenities such as pedestrian facilities, wifi and wayfinding.*

[20] Ed Zarenski (2022), *Construction Inflation 2022*, Construction Analytics (https://edzarenski.com); at https://edzarenski.com/category/inflation-indexing.

[21] Carl Walker (2016), *Mean Construction Costs*, Carl Walker Consulting (www.carlwalker.com); at www.carlwalker.com/wp-content/uploads/2016/05/2016-Carl-Walker-Cost-Article.pdf. Original values increased 30% to reflect 2015 to 2022 construction inflation (https://bit.ly/3Py407Q).

Operation and Maintenance

Operation and maintenance costs can include resurfacing, repairs, cleaning, lighting, security, landscaping, snow removal, access control, fee collection, enforcement, insurance, labor and administration. Parking structures may require elevators, fire control and mechanical ventilation. Private facilities must pay taxes and provide profits. Parking facilities typically require resurfacing every 5-15 years, and structures require major reconstruction or replacement after 20-40 years. These costs are higher in areas with harsh climates. Fee collection costs range from less than $50 annually per vehicle for a simple pass system with minimal enforcement, to more than $500 per space for facilities with attendants or automated control systems. This suggests that operating costs typically range from about $500 per space for basic surface parking up to $2,000 for commercial parking facilities with attendants.[22]

Driveway and Curbcut Costs

Off-street parking facilities require driveways with curbcuts. A short driveway typically costs $1,500 to $15,000 to construct, depending on materials and conditions.[23] A curbcut often displaces one on-street parking space and causes risks to sidewalk users.

Geographic Factors

Parking supply, costs and subsidies tend to vary in the following ways:

- Parking spaces per acre, and the portion of land paved for parking, increase with density.
- Parking spaces per vehicle, household and person tend to decline with density.
- The portion of parking that is structured and therefore expensive increases with land values.
- The portion of parking that is priced tends to increase with land values and density.

Parking Costs by Mode

Compact cars sometimes use smaller spaces. Full size vans and trucks require larger spaces which encourages designers to expand standard spaces. Motorcycles sometimes use smaller spaces or share a standard space. About ten bicycles can park in one standard space; bicycles can often park in otherwise unused areas; and bike parking requires no driveways. Rideshare and public transit passengers, walking and telework incur no incremental parking cost, although bus stops can displace on-street parking.

Electric vehicles require recharging stations at some parking spaces. Residential stations typically cost $500 to $1,500 for equipment plus hundreds of dollars for 220-volt wiring installation, and public stations cost many times more.[24] Many jurisdictions mandate their installation in new construction and subsidize public recharging stations.

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[22] PT (2005), "What's it Cost You to Run Your Garage?," *Parking Today* (www.parkingtoday.com).
[23] Nick Gerhardt and Samantha Allen (2022), "How Much does a Driveway Cost?," *Forbes* (www.forbes.com); at https://bit.ly/3wXEz9k.
[24] Home Advisor (2022), *How Much Does an Electric Car Charging Station Cost?*, (www.homeadvisor.com); at https://bit.ly/3RBrWZ7.

Environmental Costs

Paving land for parking imposes environmental costs including stormwater management, heat island effects, aesthetic degradation and greenspace loss (reduced farmland, wildlife habitat, etc.).[25] There are various ways to measure and monetize these costs.[26] Some jurisdictions charge impervious surface fees based on their stormwater management costs, which average about $35 per 1,000 square feet or $12.00 per parking space (see table below). If motor vehicles require an average of three off-street parking spaces these costs average approximately $100 per vehicle-year or 0.1¢ per vehicle-mile, considering just parking facility impacts, not roadways.

Table 5.4.3-7 **Impervious Surface Stormwater Fees, 2022 Dollars**[27]

Jurisdiction	Fee (original values)	Per 1000 Sq. ft. (Annual)	Per Space (Annual)
Chapel Hill, NC	$39 annual 2,000 sq. ft.	$32.18	$10.73
City of Oviedo Stormwater Utility, FL	$4.00 per month per ERU	$24.75	$8.25
Columbia Country Stormwater Utility, GA	$1.75 monthly per 2,000 sq. ft.	$17.33	$5.78
Kitsap County, WA	$47.50 per 4,200 sq. ft.	$18.65	$6.60
Minneapolis, MN	$9.77 monthly per 1,530 sq. ft.	$126.69	$42.17
Raleigh, NC	$4 monthly per 2,260 sq. ft.	$30.46	$9.90
Spokane Country Stormwater Utility, WA	$10 annual fee per ERU.	$5.16	$1.65
Wilmington, NC	$4.75 monthly per 2,500 sq. ft.	$37.62	$12.38
Yakima, WA	$50 annual per 3,600 sq. ft.	$22.90	$10.73
Averages		*$35.08*	*$12.02*

"Equivalent Run-off Unit" or ERU = 3,200 square feet of impervious surface. Original fees updated to 2022 values.

Parking lots are a major contributor to heat island effects, which significantly increase urban area ambient temperatures,[28] and associated costs, including human discomfort and health damages, building cooling expenses and local environmental damages.[29] Parking facilities contain high levels of embodied energy and emissions,[30] particularly structured parking which consumes large amounts of concrete and steel.[31] These costs can be reduced through facility design changes and from reducing total parking supply.

[25] Todd Litman (2022), *Evaluating Transportation Land Use Impacts*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/landuse.pdf.

[26] EFC (2019), *Estimating Benefits and Costs of Stormwater Management*, Environmental Finance Center (www.efc.csus.edu); at www.efc.csus.edu/reports/efc-cost-project-part-1.pdf.

[27] PCW (2002), *Some Existing Water District Funding Sources*, Project Clean Water (www.projectcleanwater.org); values updated based on 1.65 2002 to 2022 inflation.

[28] USEPA (2021), *Heat Island Impacts*, USEPA (www.epa.gov); at https://bit.ly/3wYDxcZ.

[29] Mike Gaworecki (2017), "Urban Heat Island Effect Could More Than Double Climate Costs for Cities," *Mongabay* (https://news.mongabay.com); at https://bit.ly/3wccieE.

[30] Lloyd Alter (2021), *How Homes for Cars Can Emit as Much Carbon as Homes for People*, The Treehugger (www.treehugger.com); at https://bit.ly/3q33pR7.

[31] Doran, Kelly Alvarez (2021), "Why We Need Embodied Carbon Benchmarks and Targets in Building Standards and Policies," *Canadian Architect* (www.canadianarchitect.com); at https://bit.ly/3K93Gva.

Vehicle Travel Impacts

Parking minimums discourage compact development and encourage sprawl, which reduces the viability of walking, cycling and public transit, and increased per capita vehicle travel.[32] Increased parking supply and the low prices that result increase vehicle ownership and use; compared with cost-recovery pricing, unpriced parking typically increases affected vehicle ownership and use by 10-30%.[33]

Marginal Cost Analysis

Existing parking facility costs are often considered sunk, assuming there are minimal savings if demand is reduced, for example, if vehicle ownership or trips decline, parking spaces will simply sit unoccupied. However, over time most parking facilities have opportunity costs since reducing demand allows them to be leased or rented to others, or their land to be converted to other uses or sold. Marginal costs are particularly large in areas with high land prices, where populations are growing, and in areas with high environmental values. Because it typically costs $10,000-30,000 per space more than surface parking, structured parking typically becomes cost effective when land prices exceed about $3 million per acre, assuming 150 spaces per acre.

Parking Cost Distribution

Most parking is unpriced: of only about 5% of U.S. auto commuters pay full parking costs, and parking is unpriced for more than 99% of non-commute trips.[34] Overall, probably less than 5% of non-residential parking costs are paid directly by users. Most employee parking is income tax exempt, a benefit to automobile commuters worth up to $1,800 per year compared employees receiving cash. Unpriced parking costs are borne by governments and businesses, and ultimately by taxpayers and customers.

Many parking spaces are seldom or never used but exist due to motorists' demands for convenience, so their costs should be assigned to motorists as a group, just as lifeboat costs should be assigned to ship passengers who want them available for emergencies. Analyses that only consider the costs of currently used parking facilities overlook the large number of seldom-used spaces, and therefore total parking costs. Previously-described studies indicate that typical North American communities have three to ten parking spaces per vehicle, due to zoning code mandates. As long as motorists support these laws they bear a share of total costs, including those they do not currently use. For example, if an apartment building has parking that costs $3,000 annually per space, and a 60% occupancy rate, parking costs average $5,000 per motorist ($3,000/60%) because the unoccupied spaces exist to serve motorists as a group.

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[32] Donald Shoup (2016), "Cutting the Costs of Parking Requirements," *Access Magazine* (www.accessmagazine.org); at https://bit.ly/3B7Hv5m.

[33] Steven Spears, Marlon G. Boarnet and Susan Handy (2014), *Impacts of Parking Pricing Based on a Review of the Empirical Literature*, Calif. Air Resources Board (ww2.arb.ca.gov); at https://bit.ly/3czkMGg.

[34] Donald Shoup and Mary Jane Breinholt (1997), *Employer-Paid Parking: A Nationwide Survey of Employers' Parking Subsidy Policies* (DOI: 10.1007/978-3-642-59064-1_13); at https://bit.ly/3AGxVFo.

Total Parking Costs

The *Parking Cost, Pricing and Revenue Calculator* (www.vtpi.org/parking.xls) calculates total of various types of parking facilities taking into account land, construction and operating costs. The table and figure illustrate typical results.

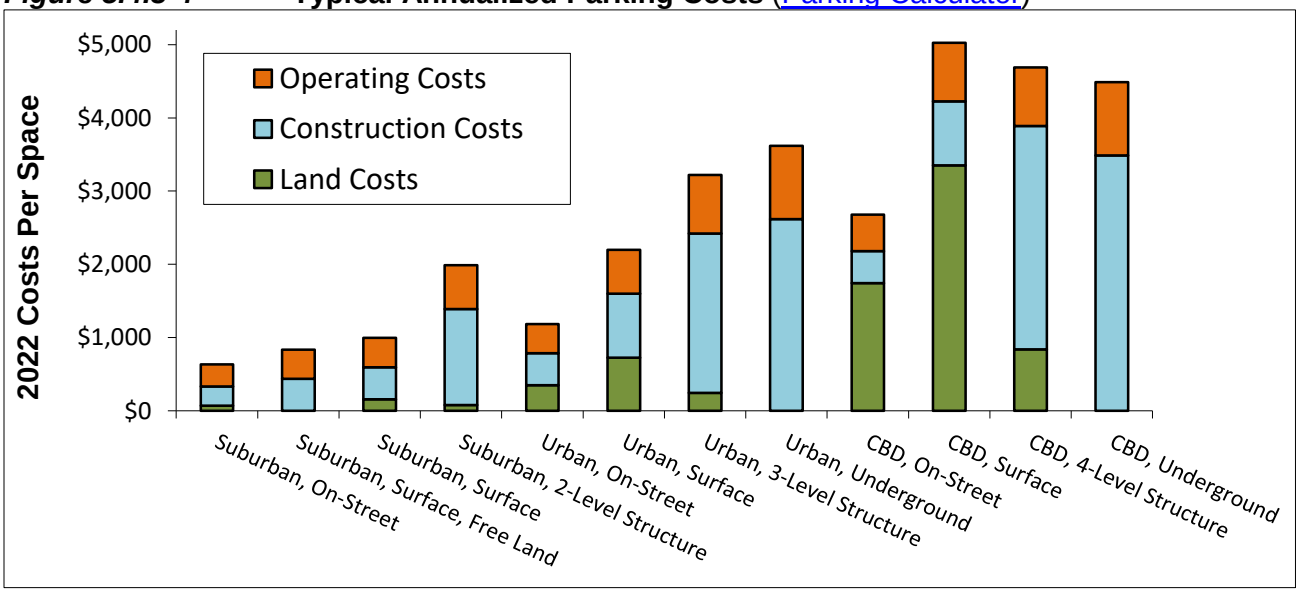
Table 5.4.3-8 **Typical Annualized Parking Costs, 2022** (Parking Calculator)

Facility Type	Land Per Acre	Land Per Space	Annual Construction	Annual O&M	Total Annual
Suburban, On-Street	$200,000	$800	$262	$300	$631
Suburban, Surface, Free Land	$0	$0	$436	$400	$836
Suburban, Surface	$200,000	$1,818	$436	$400	$994
Suburban, 2-Level Structure	$200,000	$909	$1,308	$600	$1,987
Urban, On-Street	$1,000,000	$4,000	$436	$400	$1,185
Urban, Surface	$1,000,000	$8,333	$872	$600	$2,198
Urban, 3-Level Structure	$1,000,000	$2,778	$2,180	$800	$3,222
Urban, Underground	$1,000,000	$0	$2,616	$1,000	$3,616
CBD, On-Street	$5,000,000	$20,000	$436	$500	$2,680
CBD, Surface	$5,000,000	$38,462	$872	$800	$5,025
CBD, 4-Level Structure	$5,000,000	$9,615	$3,051	$800	$4,690
CBD, Underground	$5,000,000	$0	$3,487	$1,000	$4,487

This table shows typical values from the "Parking Cost, Pricing and Revenue Calculator."

This analysis indicates that parking facility costs range from about $800 annually for surface parking on low-priced land, to more than $4,000 for high-amenity parking in central business districts (CBDs). These do not include indirect and environmental costs.

Figure 5.4.3-4 **Typical Annualized Parking Costs** (Parking Calculator)



This figure illustrates annualized costs per parking space. CBD = Central Business District

Most North American homes have costly off-street parking, including driveways and garages for single-family, and underground parking for multifamily housing. This significantly increases housing costs, particularly for lower-priced homes on high cost land.[35] For example, a $50,000 parking space only adds 5% to the total costs of a million dollar home but 20% to the cost of a $250,000 condominium. This is particularly burdensome to low-income, car free households who are forced to pay for costly parking facilities they do not need.[36] Residential garages are used for general storage and workshops in addition to vehicle parking, but even accounting for this, residential driveways and garages used for vehicle parking incurs significant costs.

Analysis of 23 recent Seattle-area multifamily developments found that parking costs increase rents approximately 15% or $246 per month, although 20% of occupants own no motor vehicles and 37% of parking spaces were unoccupied during peak periods.[37] Gabbe and Pierce estimate that parking mandates increase U.S. rents by 17%, $1,700 annually per unit.[38] Manville (2010) found that when parking requirements were removed in downtown Los Angeles, developers provided less parking and more housing, including lower-priced housing with unbundled parking marketed to non-drivers.[39]

Assuming two on-street and three off-street parking spaces (one residential and two non-residential) per vehicle in a typical urban area, with annualized costs averaging $800 per on-street, $1,000 per residential off-street, and $1,200 per non-residential off-street space, this totals $5,000 per vehicle, as indicated in the table below. Costs per space are lower in suburban and rural areas due to lower land costs, but such areas tend to have more spaces per vehicle so total parking costs per vehicle are probably similar.

Table 5.4.3-9 **Estimated Annualized Parking Costs Per Vehicle**

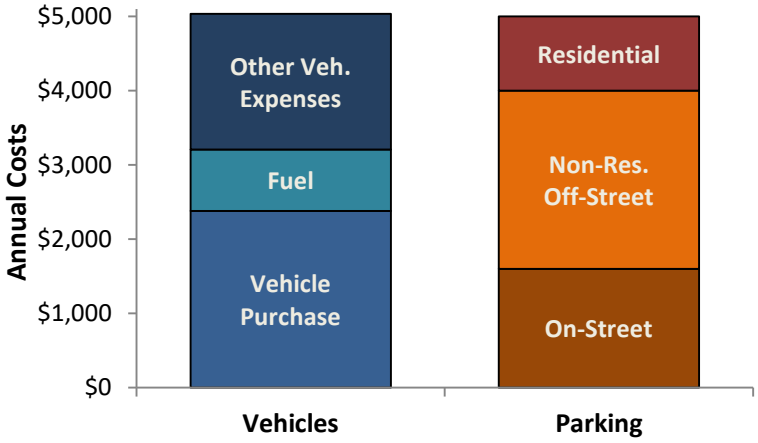
Facility Type	Spaces Per Vehicle	Annual Cost *Per Space*	Paid Directly By Users	Directly-Paid Costs	External Costs	Total Costs
On-street	2	$800	5%	$80	$1,520	$1,600
Non-res. Off-street	2	$1,200	5%	$160	$2,280	$2,400
Residential	1	$1,000	100%	$1,000	0	$1,000
Totals	*5*			*$1,240 (24%)*	*$3,800 (76%)*	*$5,000 (100%)*

This table estimates parking costs per vehicle. Users pay directly for only about a quarter of total parking costs. The rest are borne indirectly through taxes, additional retail prices and lower wages.

[35] Todd Litman (2019), *Parking Requirement Impacts on Housing Affordability*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/park-hou.pdf.
[36] Fox Tuttle (2021), *Parking & Affordable Housing*, Shopworks Architecture (https://shopworksarc.com); at https://shopworksarc.com/wp-content/uploads/2021/02/2021_Parking_Study.pdf.
[37] Jesse London and Clark Williams-Derry (2013), *Who Pays for Parking? How the Oversupply of Parking Undermines Housing Affordability*, Sightline Institute (www.sightline.org); at https://bit.ly/3cFTgXu.
[38] C.J. Gabbe and Gregory Pierce (2016), "Hidden Costs and Deadweight Losses: Bundled Parking and Residential Rents in the Metropolitan U.S.," *Housing Policy Debate*, Vo. 27, No. 2 (https://bit.ly/2ApVELG).
[39] Michael Manville (2010), *Parking Requirements as a Barrier to Housing Development: Regulation and Reform in Los Angeles*, Institute of Transportation Studies (www.its.ucla.edu)' at https://bit.ly/3Rt5bXw.

The figure below compares annual vehicle and parking costs. This indicates that for every dollar that motorists spend on their vehicle, somebody spends about a dollar to park it. Most of these costs are borne indirectly, through higher taxes, higher rents, higher costs of retail goods, and lower wages. Since private automobiles average of about 11,000 annual miles,[40] parking costs average about 45¢ per vehicle-mile. This is a lower-bound estimate that excludes indirect and non-market costs such as increased stormwater management costs, heat island effects, and other environmental damages.

Figure 5.4.3-5 **Comparing Vehicle and Parking Costs**[41]



U.S. motorist spend about $5,000 annually per vehicle. There are an estimated five parking spaces per vehicle, including residential, non-residential off-street, and on-street parking, with costs totaling about $5,000 annually. For every dollar motorists spend on their vehicle, somebody spends about a dollar on parking. This averages about 45¢ per vehicle-mile, of which about 11¢ paid directly by users and 34¢ is subsidy.

Parking Space Valuation

It is sometimes useful to calculate parking space marginal values to calculate incremental benefits and revenues of adding supply, or the savings and losses from supply reductions. Costs and revenue analysis should take into account *load factors*, that is, the portion of parking spaces used at a particular time, or the portion of annual hours a space is used. For example, if parking spaces rent for $75 per month with a 60% average load factor, revenues average $45 per space.

Commercial-area parking facilities are sometimes valued by dividing total retail revenues by their number of spaces to determine revenue per space. If a store with 100 parking spaces generates $100,000 daily sales, each space is estimated to add $1,000 per day value. However, it is more appropriate to use *marginal* analysis. The most convenient parking spaces, typically the 20-40% located closest to building entrances, often have high load factors, but the remaining 60-80%, are only occupied during peak periods. Infrequently-used spaces only contribute to sales the few days that they occupied by customers who would not shop if that space were unavailable.

[40] ORNL (2020), "Figure 9.8," *Transportation Energy Data Book*, Oak Ridge National Lab (https://info.ornl.gov); at https://info.ornl.gov/sites/publications/Files/Pub132663.pdf.

[41] BLS (2022), *Consumer Expenditure Survey*, Bureau of Labor Statistics (www.bls.gov); Table 5.4.3-9.

5.4.4 Estimates

Note: Although many of these estimates are presented in per mile units, the cost is better measured per trip, since parking costs are unaffected by trip length. All monetary units are in U.S. dollars unless indicated otherwise.

Summary Table of Parking Cost Estimates

The table below compares per space (ps), per trip (pt), per vehicle-mile (pvm) and per household (phh) cost estimates of selected studies.

Table 5.4.4-1 **Parking Cost Estimate Summary Table – Selected Studies**

Publication	Costs	Cost Values	2022 USD
Delucchi (1998)	External and bundled parking	$64 to $203 billion	8.7¢ to 26¢ pvm
	Total parking costs	$155 to $296 billion	22¢ to 42¢ pvm
Franco (2016)	Surface parking land & const.	$4,282 per space	$8,000 ps
	Structured parking land & const.	$13,924 to $14,522	$26,000 ps
Greenberg (2005)	Total cost per residential space	$52,000 to $117,000	$54,000 to $120,000 ps
Litman, above (2022)	Total parking costs	45¢ per mile (2022)	45¢ pvm/$5 pt
	Parking subsidies	35¢ per mile	35¢ pvm/$3.50 pt
Nelson/Nygaard (2015)	Urban parking annualized costs	$854 to $4,363 per space	$1,070 to $5,450 ps
Rosenfield (2018)	Commuter parking	$1,000 per commuter	$1,000 per commuter
Scharnhorst (2018)	Cost per household	$6,570 to $192,138	$7,753 to $226,723 phh
Shoup (2005)	Parking subsidies	5¢ to 14¢ per vehicle-mile	8¢ to 21¢ pvm

This summarizes cost estimates of various studies described below. Values updated by the Consumer Inflation Calculator (www.usinflationcalculator.com).

- Shoup estimates that in 2005, unpriced off-street parking costs $127 billion to $374 billion in the U.S., representing a subsidy averaging 5¢ to 14¢ (8¢ to 21¢ in 2022) per vehicle-mile, assuming 2.7 trillion light-duty vehicle-miles.[42]

- By measuring differences in prices between homes with and without off-street parking, and analyzing their impact on development costs, Greenberg estimated that each additional residential parking space increases typical U.S. urban housing costs by $52,000 to $117,000 per home.[43]

- Detailed analysis of MIT employee parking estimated that parking facilities cost $2,500-3,500 annual per space to provide, far less than the $500-1,500 annual user fees, so automobile commuters receive about $1,000 annual subsidy, far more than the subsidy provided transit commuters.[44]

[42] Donald Shoup (2005), *The High Cost of Free Parking*, Planners Press (www.planning.org). p. 218
[43] Allen Greenberg (2005), *How New Parking Spaces May Effectively Increase Typical U.S. Urban Housing Total Unit Costs by $52,000 to $117,000*, TRB Annual Meeting (www.trb.org); at https://bit.ly/3REnFEp.
[44] Adam Rosenfield (2018), *Driving Change: How Workplace Benefits Can Nudge Solo Car Commuters Toward Sustainable Modes*, Mass. Institute of Technology (http://web.mit.edu); at https://bit.ly/39KhRV6.

- Delucchi estimated that in 1991, non-residential, unpriced, off-street parking has a total value of $49 to $162 billion ($106 to $353 billion in 2022 dollars), and bundled residential parking has a total value of $15 to $41 billion ($33 to $89 billion in 2022 dollars), which together totaled $64 to $203 billion ($139 to $442 billion in 2022 dollars).[45] This averaged $457 to $1,157 per motor vehicle year ($1,000 to $2,500 in 2022 dollars), or 4¢ to 12¢ per motor vehicle mile (8.7¢ to 26¢ in 2022 dollars). Table 5.4.4.2 summarizes Delucchi's calculations for the costs of all types of parking, which totaled $155 to $296 billion ($338 to $645 billion in 2022 dollars), $1,100 to $2,100 per vehicle-year ($2,400 to $4,578 in 2022 dollars), or 10¢ to 19¢ per vehicle-mile (22¢ to 42¢ in 2022 dollars).

Table 5.4.4-2 **Calculated Value of Unpaid Parking**[46]

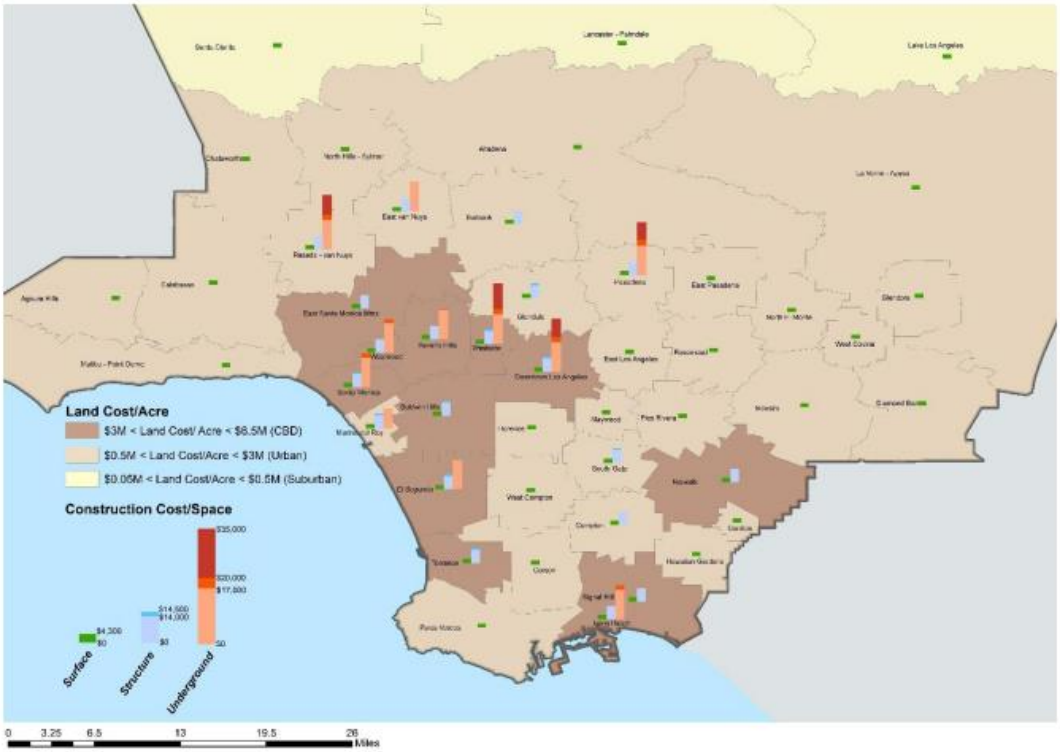
Cost Item	High	Low
Workers 16 years old or older (millions)	115.1	115.1
Of total workers, the fraction that uses motor vehicles	0.866	0.866
Persons per vehicle, for commute trips	1.14	1.14
Of those who drive to work, the fraction that parks free on the street	0.10	0.05
Of those who drive to work, the fraction that pays for parking	0.048	0.048
Calculated average monthly parking rate, excluding taxes ($/month)	42.4	62.7
Total potential revenues from unpriced commuter parking, net taxes (Billions $/year)	37.9	59.3
Non-commute trips that require offstreet, non-residential parking (10^6)	73,796	93,457
Fraction of total vehicle trips that pays full cost for parking	0.04	0.02
Calculated average hourly parking rate, excluding taxes	0.78	1.00
Average time spent in parking space per trip (hours)	2.00	2.50
Potential revenues from unpriced parking for other purposes (billions $/year)	110.3	228.6
Total potential revenues from unpriced parking, excluding taxes (billions $/year)	148.2	287.9
Total calculated payments for presently priced parking, excluding taxes	6.73	7.82
Total potential revenues from parking for all trips, excluding taxes (billions $/year)	155.0	295.8

This table summarizes the estimated value of non-residential, unpriced, off-street parking.

- Researcher Sofia Franco calculated land and construction costs for parking in various locations in Los Angeles, as illustrated below.[47] She estimated that in 2000 in the Los Angeles region surface parking typically costs approximately $4,282 per space, above-ground structured $13,924 to $14,522 per space, and underground from $11,637 to $34,956 per space. The following figure illustrates her results.

[45] Mark Delucchi (1998), "Table 1-6," *Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991*, Institute of Transportation Studies, UCD-ITS-RR-96-3; at www.fhwa.dot.gov/scalds/delucchi.pdf.
[46] Delucchi (1996), *Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991*, Vol. 6, Institute of Transportation Studies (http://engineering.ucdavis.edu/), UCD-ITS-RR-96-3 (6), Table 6-B.1.
[47] Sofia Franco (2016), "Parking Costs in Los Angeles County", Technical Report 2016-2-June, University of California (https://vcpa.ucr.edu); at https://escholarship.org/content/qt07z507xf/qt07z507xf.pdf.

Figure 5.4.4-1 **Los Angeles County: Land and Parking Construction Costs**[48]



Note: Costs are in 2000 USD; CBD = central business district.

- A San Francisco Metropolitan Planning Association study estimated that total annualized costs per parking space range from $854 in suburban areas with low land prices up to $2,522 in a three-story urban parking structure, and $4,363 for Central Business District (CBD) underground parking.[49]

- Chester, Horvath and Madanat calculate parking facility lifecycle energy consumption, greenhouse gas and air pollution emissions based on five parking supply scenarios.[50] Parking energy consumption is estimated to average from 14–18 kJ/Passenger-Km (Scenario 1) to 240–310 kJ/Passenger-Km (Scenario 5), and GHG emissions range from 1.3–1.7 gCO_2e/PKT (Scenario 1) to 19–25 g CO_2e/PKT (Scenario 5), which represents 0.5% to 12% of total estimated transport system lifecycle energy consumption and greenhouse emissions, and 24% to 81% other air pollutants, depending on vehicle type and scenario.

[48] Sofia Franco (2020), *Parking Prices and Availability, Mode Choice and Urban Form*, International Transport Forum Paper 2020/03, OECD (www.itf-oecd.org); at https://bit.ly/3R9fyQz.

[49] Nelson/Nygaard (2015), *Parking Structure Technical Report: Challenges, Opportunities, and Best Practices*, MTC (www.mtc.ca.gov); at https://bit.ly/3ek0tgx.

[50] Mikhail Chester, Arpad Horvath and Samer Madanat (2010), "Parking Infrastructure: Energy, Emissions, and Automobile Life-Cycle Environmental Accounting," *Environmental Research Letters*, Vo. 5, No. 3; at (doi.org/10.1088/1748-9326/5/3/034001).

- A parking supply and demand study in Porirua City, New Zealand found that about a quarter of central city area land is devoted to parking facilities, and cost recovery parking fees would increase the financial cost of driving 30-90% for an average shopping trip and about 100% for an average commuting trip.[51]

- Manville and Shoup estimate parking spaces per hectare and job in various central business districts in the world, and calculate a *parking coverage rate*, the portion of downtown that would be devoted to parking if all parking were provided in surface lots.[52] This varies from under 10% to more than 80%. They argue that a high parking coverage rates tend to spoil many desirable urban environment attributes, including walkability and cost efficiency.

- The National Parking Association's *Parking In America* reports,[53] and Colliers International *Parking Rate Surveys*[54] provide information on parking facility costs, and rates, and employee wages in various North American cities.

- Several sources provide commercial parking prices.[55] These typically indicate that urban parking spaces rent for $50 to $250 per month or $600 to $3,000 per year. These prices do not necessarily reflect full cost recovery for the following reasons. Commercial operators generally charge the highest price they can, based on demand, and their operations are often a temporary use of land being held for future development, and so are not expected to pay land rents or earn a profit. Institutional operators (e.g., hospital and campuses) are generally required to recover facility construction and operating costs but not land costs.

- Klipp found the financial return to Bay Area developers on parking facilities is much less (about half) the return of housing, because parking minimums and other market distortions require far more parking than consumers demand (that is, what they would choose to purchase if optional).[56] He estimates that developers must charge at least 28% more to get the same per-square foot rate of return on housing with parking than without. These lower financial returns constrain developers' lending options and reduce construction of new housing, particularly lower-priced housing in areas with high land costs.

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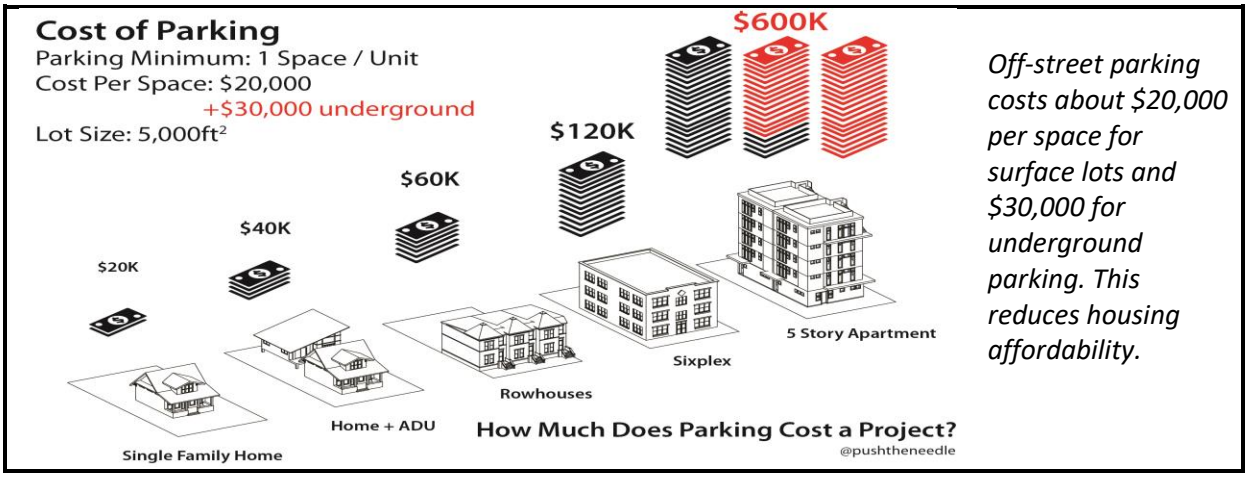
[51] Angus Hulme-Moir (2010), *Making Way for the Car: Minimum Parking Requirements and Porirua City Centre*, Thesis, Victoria University of Wellington (http://researcharchive.vuw.ac.nz/handle/10063/1458).
[52] Michael Manville and Donald Shoup (2005), "People, Parking, and Cities," *Journal of Urban Planning and Development* (www.asce.org), December, pp. 233-245; at https://bit.ly/2NHojQc.
[53] NPA (2009), *Parking in America, The National Parking Association's First Annual Review of Parking Rates*, National Parking Association (www.npapark.org); at http://weareparking.org/?page=ratestudy.
[54] Example, *2021 Atlanta Parking Rate Survey* at https://bit.ly/3RhQXZJ.
[55] See www.bestparking.com and https://spothero.com/cities.
[56] Luke Klipp (2004), *The Real Costs Of San Francisco's Off-Street Residential Parking Requirements*, Transportation for a Livable City (www.livablecity.org); at https://bit.ly/3RlR1b0.

- DiRaimo estimated that for typical residential projects, surface parking costs $20,000 and underground costs $30,000.[57] The following illustration shows how this affects total development costs.



Off-street parking costs about $20,000 per space for surface lots and $30,000 for underground parking. This reduces housing affordability.

The table below compares the scope of parking facility types and costs considered in various studies. Many only consider a subset of total parking facility types and costs, and so underestimate total costs.

Table 5.4.4-3 **Scope of Parking Cost Considered by Selected Studies**

Publication	Chester, et al. (2015)	Delucchi (1998)	Franco (2016)	Greenberg (2004)	Litman (2022)	Rosenfield (2018)
Facility Types Considered						
On-Street	✓	✓	✓		✓	
Off-street residential	✓	✓	✓	✓	✓	
Commute	✓	✓	✓		✓	✓
Off-street non-residential	✓	✓	✓		✓	
Costs Considered						
Land	✓	✓	✓	✓	✓	
Construction	✓	✓	✓	✓	✓	
Operation		✓			✓	
Environmental		✓	✓	✓	✓	
Traffic impacts			✓	✓	✓	

This table summarizes the scope of parking studies. Many studies only consider a subset of total parking types and costs and so underestimate total parking costs and the benefits of parking supply reductions.

[57] Ryan DiRaimo (2021), *Seattle Has the Space*, The Urbanist (www.theurbanist.org); at www.theurbanist.org/2021/03/25/seattle-has-the-space.

5.4.5 Variability

Parking costs vary widely depending on location, supply and use. Parking facility costs tend to increase with land prices and are much higher for structured parking. However, high land price areas, such as central business districts, tend to have fewer parking spaces per capita and a greater share of user paid parking, so parking subsidies per tend to be higher in suburban and rural areas.

The number of parking spaces per acre tends to increase but the number of parking spaces per capita tends to decline with development density. Urban residents have fewer but more expensive parking spaces, suburban residents have more but cheaper spaces. Structured and underground parking have high construction costs, but low land costs. Since land and construction costs tend to increase with density, per capita parking costs are probably similar in urban and suburban areas. Per capita parking costs tend to be highest in automobile-dependent areas with high land values.

5.4.6 Equity and Efficiency Issues

Parking facilities are costly, and most of those costs are born indirectly, through higher taxes, increased building costs, higher prices for other goods, and lower wages. For example, housing costs are typically 10-20% higher, weekly grocery bills and restaurant meals cost a few extra dollars, and most employees are paid hundreds of dollars less per year to finance "free" parking. In addition to these financial costs, parking facilities impose environmental costs, and underpriced parking increases total vehicle travel and associated costs including congestion, crash risk, pollution and sprawl.

There are sometimes debates as to whether unpriced parking should be considered a *subsidy*, or a *bundled good*, that is, something automatically included with a purchase (Delucchi 1998). Regardless of what it is called, unpriced parking is a market distortion that violates the basic economic principles that prices should reflect marginal costs, and that public policies should not arbitrarily favor one type of consumption (such as driving) over others (such as non-auto travel).

These distortions are economically inefficient and unfair. They increase costs to consumers, governments, businesses and the environment. They force non-drivers to pay for costly parking facilities they don't need, and results in households that own fewer than average vehicles and drive less than average cross-subsidizing the parking costs of those that own more than average vehicles and drive more than average. Since vehicle and trips tend to increase with income, this tends to be regressive – it results in lower-income people subsidizing higher-income motorists.

5.4.7 Conclusions

Parking is a large cost of vehicle travel, much of which is external. To avoid double counting costs in chapters 5.1 and 5.6, out-of-pocket parking charges and on-street parking costs are excluded from this chapter's estimates. Only market costs are considered here because non-market costs are included in chapters 5.14 (Land Use Impacts), and 5.15 (Water Pollution and Hydrologic Impacts).

Although residential parking is considered an internal cost, since most households own vehicles, it is actually partly external due to parking facility mandates that force car-free households to pay for costly facilities they do not need, and cause household that own fewer than average vehicles to subsidize the parking costs of those that own more than average vehicles. Although residential garages often have other uses, including general storage and workshops, their costs are significantly increased by special features, such as driveways and curbcuts, required to accommodate motor vehicles.

Field surveys indicate that typical North American communities have at least five parking spaces per vehicle including one residential, two off-street non-residential and two on-street spaces. These are lower-bound estimates because many field studies overlook some types of parking. For example, aerial photos cannot count most structured parking, and estimates based parking minimums tend to overlook some land use types that have numerous parking spaces, such as car dealers and amusement parks. Some large cities, such as New York and San Francisco, may have fewer spaces per vehicle than estimates used here, but most suburban areas seem to have more, including many seldom-or-never-used spaces required by zoning codes.

Estimates of on-street parking supply are somewhat arbitrary; most streets have parking lanes and many rural roads have shoulders that can be used for parking, so the total number of on-street spaces is very large, but many are located far from popular destinations and so are not very useful. Parking lanes and road shoulders use valuable road space that could otherwise be used for bus- and bike-lanes, wider sidewalks or landscaping, and increase pavement area which increases roadway construction and maintenance costs, impervious surface area and heat island effects.

Total estimated annualized parking facility costs, including land, construction and operating expenses for garages, parking lots and driveways, range from about $600 per year for surface parking on inexpensive land to more than $5,000 annually for high-amenity structured parking. Urban areas tend to have fewer but more costly spaces than suburban and rural areas, so their parking costs per vehicle are probably similar. Parking costs are estimated to average about $1,000 annually per space or about $5,000 per vehicle-year, totaling more than a trillion dollars annually in the U.S. This includes many seldom-or-never-used spaces that governments mandate in response motorists' demands for convenience, so all motorists (or at least all who support the mandates) bear a share of the costs even if they do not actively use those facilities.

These costs are higher than most previous estimates. There are several reasons for this:

- Most previous studies only counted a portion of all parking facilities; many only considered non-residential off-street. This study includes residential and on-street spaces.
- Newer field surveys using various methods to count parking spaces, including aerial photos and comprehensive building databases, find far more parking supply than older studies estimated. Suburban and rural areas, where more than half of all North Americans live, appear to have more than three off-street parking spaces per vehicle.
- Many older studies only considered the parking spaces that a typical motorist uses – they typically counted one residential, one worksite and one non-worksite off-street space – ignoring the large number of seldom-or-never used government-mandated spaces that exist in most communities, particularly newer suburbs.
- Most previous studies underestimated total per space costs by only considering direct construction costs, ignoring the value of land and roadspace devoted to parking, and on-going operating costs. Many studies driveway costs, including the loss of on-street spaces caused by curbcuts.
- Urban land values and construction costs have increased significantly – they approximately doubled – during the last two decades, so older estimates must be increased significantly to reflect current costs.

Internal Parking Costs: To avoid double counting user parking fees included in Chapter 5.1, only residential parking costs are considered here. An Average Car residential parking space is estimated to cost $1,000 per year, or 9¢ per mile for a vehicle driven 11,000 miles annually. Some residents park their cars on the street, but this is balanced by residences that have more off-street parking spaces than vehicles, so one off-street space is assumed to exist for each registered automobile. Rural parking space costs are estimated at half of urban due to lower land values.

Compact cars sometimes use “small car” spaces, reducing costs 20% at 25% of destinations for 5% total saving. In addition to their basic parking costs, Electric Cars are assumed to each require one residential recharging station with a $200 annualized costs (assuming $2,000 total installation costs depreciated over ten years), which averages about 1.8¢ per vehicle mile.

Van/Light Trucks have 10% higher costs due to their larger size. Rideshare passengers, buses and trolleys incur no incremental parking cost.[58] Motorcycles are estimated to use half-size parking spaces 50% of the time, for a 25% saving over a car, while bicycle parking costs are estimated at 5% of average car costs due to their small size and ability to use otherwise unused space. Walking and telework incur no parking cost.

[58] Bus stops use curb space, but this is considered a road rather than a parking cost.

Estimate **Internal Parking Costs (2022 U.S. Dollars per Vehicle-Mile)**

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.090	0.090	0.045	0.072
Compact Car	0.086	0.086	0.043	0.068
Electric Car	0.108	0.108	0.063	0.090
Van/Light Truck	0.100	0.100	0.050	0.080
Rideshare Passenger	0.000	0.000	0.000	0.000
Diesel Bus	0.000	0.000	0.000	0.000
Electric Bus/Trolley	0.000	0.000	0.000	0.000
Motorcycle	0.068	0.068	0.034	0.054
Bicycle	0.005	0.005	0.002	0.004
Walk	0.000	0.000	0.000	0.000
Telework	0.000	0.000	0.000	0.000

External Parking Costs: Table 5.4.3-9 estimates that external off-street parking costs total $2,400 per vehicle (on-street parking costs are included in Chapter 5.6). For an Average Car this averages 22¢ per mile for an average car, with higher values for Urban-Peak (40¢ per veh-mile), and lower values for Urban Off-Peak (20¢ per veh-mile) and Rural (15¢ per veh-mile) travel. As described above compact cars, motorcycles, and bicycles are estimated to have 5%, 25%, and 95% lower parking costs, and Vans/Light Truck 10% higher parking costs, and Electric Cars are assumed to require about half of one subsidized non-residential recharging station, which averages 1¢ per vehicle-mile. Rideshare passengers, buses, trolleys, walking and telework incur no user parking costs.

Estimate **External Parking Costs (2022 U.S. Dollars per Vehicle-Mile)**

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.400	0.200	0.150	0.220
Compact Car	0.380	0.190	0.143	0.209
Electric Car	0.410	0.210	0.160	0.230
Van/Light Truck	0.440	0.220	0.165	0.242
Rideshare Passenger	0.000	0.000	0.000	0.000
Diesel Bus	0.000	0.000	0.000	0.000
Electric Bus/Trolley	0.000	0.000	0.000	0.000
Motorcycle	0.300	0.150	0.113	0.165
Bicycle	0.020	0.010	0.008	0.011
Walk	0.000	0.000	0.000	0.000
Telework	0.000	0.000	0.000	0.000

Automobile Cost Range: Minimum and maximum estimates are based on cited estimates.

	Minimum	Maximum (Per Vehicle-Mile)
Internal	$0.05	$0.15
External	$0.10	$0.35

5.4.8 Information Resources

Information sources on parking costs and parking management strategies are described below.

Amy H. Auchincloss, et al. (2014), "Public Parking Fees and Fines: A Survey of US Cities," *Public Works Management & Policy*, Vol. 20, pp. 49-59 (doi.org/10.1177/1087724x13514380).

Mikhail Chester, et al. (2015), "Parking Infrastructure: A Constraint on or Opportunity for Urban Redevelopment? , *Journal of the American Planning Association*, Vol. 81, No. 4, pp. 268-286 (doi.org/10.1080/01944363.2015.1092879); at www.transportationlca.org/losangelesparking.

Mikhail Chester, Alysha Helmrich and Rui Li (2022), *Inventorying San Francisco Bay Area Parking Spaces: Technical Report Describing Objectives, Methods, and Results*, Mineta Transportation Institute (https://transweb.sjsu.edu); at https://bit.ly/3CdEvFO.

Amélie Y. Davis, et al. (2010), "Estimating Parking Lot Footprints in the Upper Great Lakes Region" *Landscape and Urban Planning*, Vo. 96/2, pp 68-77 (doi.org/10.1016/j.landurbplan.2010.02.004).

Sofia Franco (2020), *Parking Prices and Availability, Mode Choice and Urban Form*, International Transport Forum Paper 2020/03, OECD (www.itf-oecd.org); at https://bit.ly/3R9fyQz.

C.J. Gabbe and Gregory Pierce (2016), "Hidden Costs and Deadweight Losses: Bundled Parking and Residential Rents in the Metropolitan United States," *Housing Policy Debate*, Vo. 27, No. 2 (www.tandfonline.com/doi/full/10.1080/10511482.2016.1205647).

Stefan Gössling, et al. (2016), "Urban Space Distribution and Sustainable Transport," *Transport Reviews* (http://dx.doi.org/10.1080/01441647.2016.1147101).

Christopher G. Hoehne, et al. (2019), "Valley of the Sun-Drenched Parking Space: The Growth, Extent, and Implications of Parking Infrastructure in Phoenix," *Cities*, Vol. 89, pp. 186-198 (doi.org/10.1016/j.cities.2019.02.007); at https://bit.ly/2FlRUfN.

Stephen Ison and Corinne Mulley (2014), *Parking Issues and Policies, Transport and Sustainability Volume 5*, Emerald Group (www.emeraldinsight.com); at http://bit.ly/2EhgsFM.

Owen Jung (2009), *Who Is Really Paying for Your Parking Space?*, Department Of Economics, University Of Alberta; at www.vtpi.org/jung_parking.pdf.

Lewis Lehe (2018), "How Minimum Parking Requirements Make Housing More Expensive," *Journal of Transportation and Land Use*, Vol. 11/1 (https://doi.org/10.5198/jtlu.2018.1340).

Todd Litman (2008), *Parking Management: Strategies, Evaluation and Planning*, VTPI (www.vtpi.org); at www.vtpi.org/park_man.pdf.

Todd Litman (2007), *Pavement Buster's Guide: Why and How to Reduce the Amount of Land Paved for Roads and Parking Facilities*, VTPI (www.vtpi.org); at www.vtpi.org/pavbust.pdf.

Todd Litman (2019), *Parking Requirement Impacts on Housing Affordability*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/park-hou.pdf.

Todd Litman (2022), *Comprehensive Parking Supply, Cost and Pricing Analysis*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/pscp.pdf.

Christopher McCahill and Norman Garrick (2014), "Parking Supply and Urban Impacts," *Parking Issues and Policies* (Stephen Ison and Jon Shaw editors), Emerald Press (www.emeraldinsight.com), pp. 33-55; at http://bit.ly/2EhgsFM.

Christopher McCahill and Norman Garrick (2012), "Automobile Use and Land Consumption: Empirical Evidence from 12 Cities," *Urban Design International*, Vo. 17, pp. 221-227 (doi:10.1057/udi.2012.12).

Nelson/Nygaard and Dyett & Bhatia (2015), *Parking Structure Technical Report: Challenges, Opportunities, and Best Practices*, Parking Reform Campaign, MTC (www.mtc.ca.gov); at www.mtc.ca.gov/planning/smart_growth/parking/6-12/MTC_Parking_Structure.pdf.

NPA (various years), *Parking Rate Survey*, National Parking Association (www.npapark.org); at http://weareparking.org/?page=ratestudy.

OMI (2022), *The Parking Paradox of Urban India: Creating a Demand-supply Equilibrium*, Ola Mobility Institute (https://olawebcdn.com); at https://bit.ly/3K3Dq5b.

Parkopedia (www.parkopedia.com) provides parking location and price for many cities.

Adam Rosenfield (2018), *Driving Change: How Workplace Benefits Can Nudge Solo Car Commuters Toward Sustainable Modes*, MIT (http://web.mit.edu); at https://bit.ly/39KhRV6.

PRN (2022), *Progress on Parking Mandates Map*, Parking Reform Network (www.parkingreform.org); at https://parkingreform.org/resources/mandates-map.

Eric Scharnhorst (2018), *Quantified Parking: Comprehensive Parking Inventories for Five U.S. Cities*, Mortgage Bankers Association (www.mba.org); at https://bit.ly/2LfNk4o.

Donald Shoup (2005), *The High Cost of Free Parking*, Planners Press (www.planning.org).

SFPark (2012), *Parking Rates & Policies Survey*, City of San Francisco (www.sfpark.org); at http://bit.ly/1N48lsC.

VTPI (2006), *Parking Cost, Pricing and Revenue Calculator* (www.vtpi.org/parking.xls), by Todd Litman, and the *Parking Costs, Pricing and Revenue Calculator - Developing Country Edition* (www.vtpi.org/Parking_DC.xls), by Yash Saxena. These spreadsheets calculate parking facility costs, cost recovery pricing, and revenue generation.

Richard Willson (2015), *Parking Management for Smart Growth*, Island Press (http://islandpress.org); at http://islandpress.org/book/parking-management-for-smart-growth.