

UC Berkeley

ACCESS Magazine

Title

ACCESS Magazine Issue 48 Spring 2016

Permalink

<https://escholarship.org/uc/item/6xf1m7hh>

Journal

ACCESS Magazine, 1(48)

Authors

Boriboonsomsin, Kanok
Wu, Guoyuan
Barth, Matthew
et al.

Publication Date

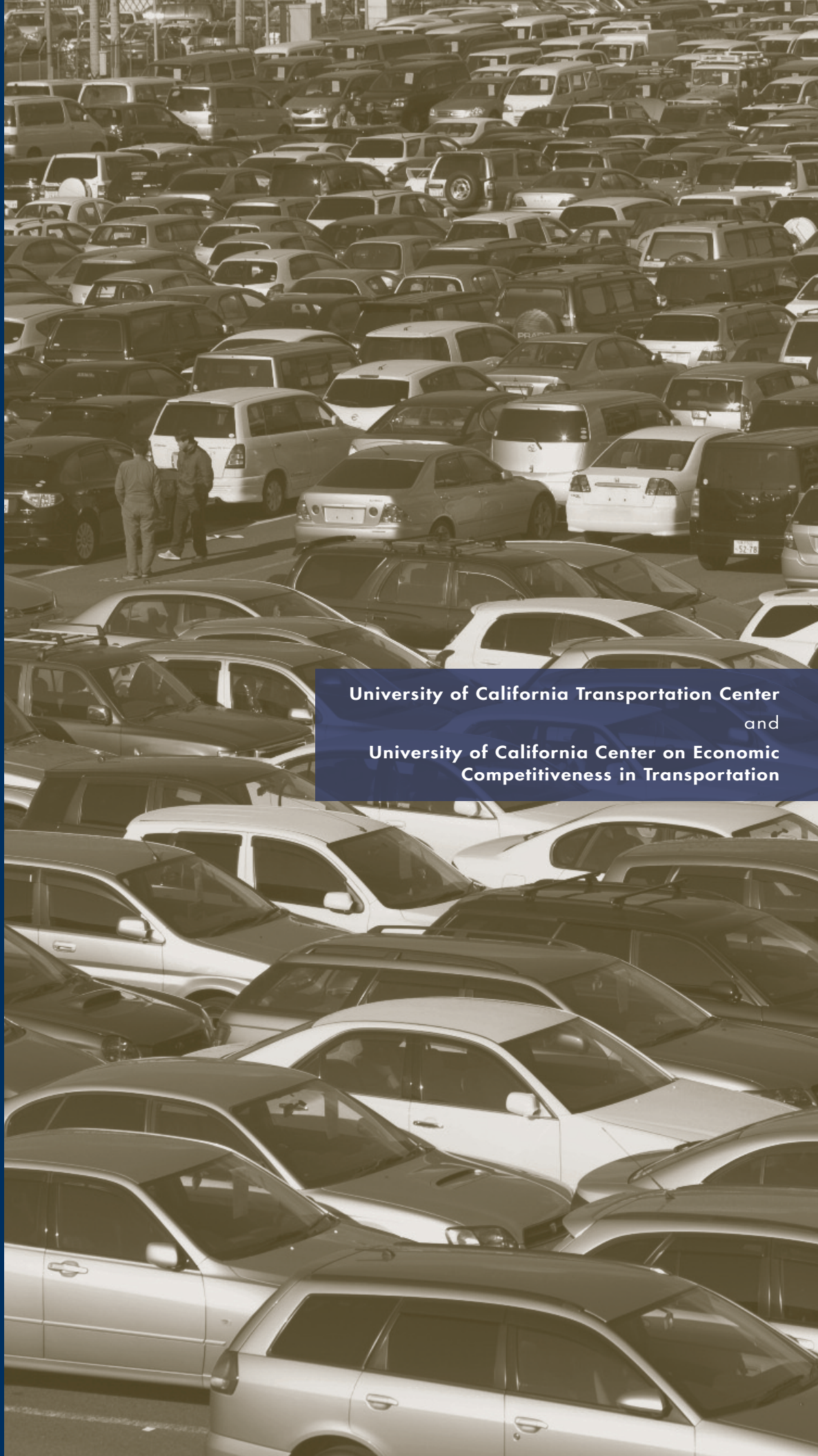
2016-04-01

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-ShareAlike License, available at <https://creativecommons.org/licenses/by-sa/4.0/>

Peer reviewed

SCIENCE EFFECTS OF TRANSPORTATION



University of California Transportation Center
and
University of California Center on Economic
Competitiveness in Transportation

SPRING 2016
NUMBER 48

C O N T E N T S

- 2 *Going the Extra Mile: Intelligent Energy Management of Plug-In Hybrid Electric Vehicles*
KANOK BORIBOONSOMSIN, GUOYUAN WU, AND MATTHEW BARTH
- 8 *Manage Flight Demand or Build Airport Capacity?*
MEGAN S. RYERSON AND AMBER WOODBURN
- 13 *A Driving Factor in Moving to Opportunity*
EVELYN BLUMENBERG AND GREGORY PIERCE
- 20 *Investing in Transportation and Preserving Fragile Environments*
MARTIN WACHS AND JAIMEE LEDERMAN
- 26 *Cutting the Cost of Parking Requirements*
DONALD SHOUP
- 34 *THE ACCESS ALMANAC: Running to Work*
ROBERT CERVERO
- 38 *Recent Publications*
- 40 *Back Issues*
- 41 *Subscription Information*

ACCESS Magazine reports on research at the University of California Transportation Center and the University of California Center on Economic Competitiveness in Transportation. The goal is to translate academic research into readable prose that is useful for policymakers and practitioners. Articles in ACCESS are intended to catapult academic research into debates about public policy and convert knowledge into action.

Authors of papers reporting on research here are solely responsible for their content. Most of their research was sponsored by the US Department of Transportation and the California Department of Transportation, which are not liable for their content or use.

Copyright © 2016 The Regents of the University of California

Phone: 310-903-3448
Fax: 310-825-1575
www.accessmagazine.org



In this issue of *ACCESS*, we cover all kinds of transportation: airplanes, cars, public transit, and running. There's even a nod to ice-skating.

How can we make the already fuel-efficient plug-in hybrid electric vehicles even more fuel-efficient? Kanok Boriboonsomsin, Guoyuan Wu, and Matthew Barth analyze how an intelligent energy management strategy can incorporate trip information to improve engine efficiency and reduce gasoline use and emissions.

Taking to the sky, Megan Ryerson and Amber Woodburn question two ways to manage air traffic congestion: expand airport capacity or manage flight demand. They identify driving forces that routinely favor airport expansion and they highlight how regional planners in Boston encouraged consideration of the economic and environmental benefits of demand management.

Evelyn Blumenberg and Gregory Pierce investigate the role of transportation access in the Moving to Opportunity Program, a federal housing mobility experiment that enabled lower-income families to move to higher-income neighborhoods. They find that access to a car helped program participants to gain and maintain employment.

Martin Wachs and Jaimee Lederman discuss how regional Habitat Conservation Plans can save time and money, and preserve endangered species' habitats when governments build transportation infrastructure. They also suggest regional coordination strategies to streamline financing for environmental mitigation.

Donald Shoup shows that it costs more than the net worth of many American households to construct a single parking space, yet cities require several off-street parking spaces for every household. He argues that removing minimum parking requirements is the cheapest and simplest way to achieve a more just society.

Finally, in the *ACCESS* Almanac, Robert Cervero discusses the latest—and sweatiest—trend in commuting: the run commute. Cervero surveys runners to determine the pros and cons of this demanding commute, and even runs to work himself.

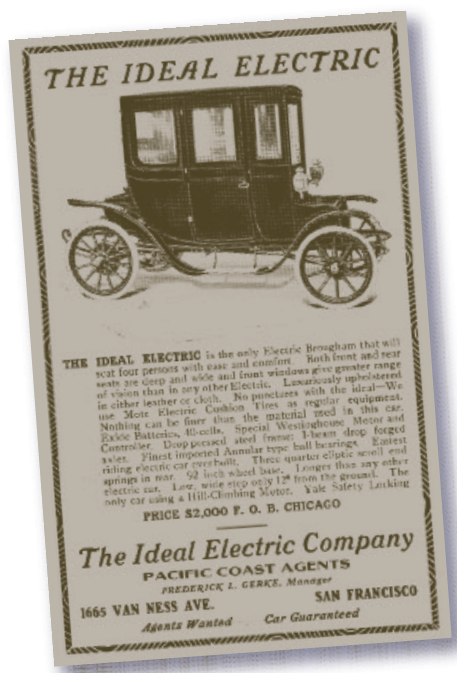
We hope you enjoy going multimodal in this latest issue of *ACCESS*.

Anne Brown
Associate Editor

GOING THE EXTRA MILE

INTELLIGENT ENERGY MANAGEMENT OF PLUG-IN HYBRID ELECTRIC VEHICLES

KANOK BORIBOONSOMSIN, GUOYUAN WU, AND MATTHEW BARTH



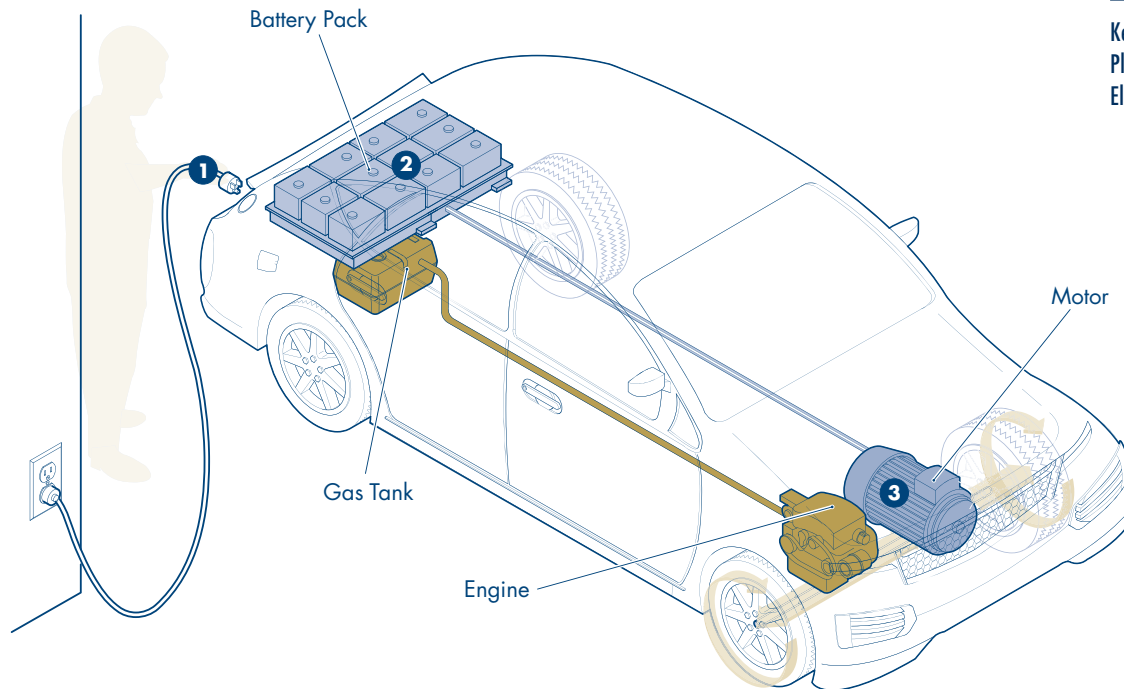
Plug-in hybrid electric vehicles (PHEVs) have generated significant interest for their potential to decrease dependence on imported oil and to cut pollution and greenhouse gas emissions. While hybrid electric vehicles (HEVs) rely on their internal combustion engines to recharge their batteries, PHEVs generally have larger batteries and can be recharged by plugging into an outside electricity source, such as a standard home outlet (Figure 1). As a result, PHEVs are potentially more efficient and cleaner than HEVs, in part because more of their energy can come from clean, renewable sources.

A critical consideration in PHEV development is how energy is produced and used. More flexible and intelligent PHEV energy management strategies can save energy and produce lower emissions. This can translate to an increase in fuel economy of 5 to 10 more miles per gallon of gas for a typical PHEV that already gets 60 miles per gallon. We discuss one strategy to optimize energy management by accounting for vehicle position, speed and acceleration, trip progress, roadway characteristics, traffic conditions, and battery recharging opportunities at intermediate stops. We then evaluate this energy management strategy using an example trip, and find that it can result in substantial efficiency gains.

Kanok Boriboonsomsin is Associate Research Engineer at the College of Engineering - Center for Environmental Research and Technology, the University of California at Riverside (kanok@cert.ucr.edu). Guoyuan Wu is Assistant Research Engineer at the College of Engineering - Center for Environmental Research and Technology, the University of California at Riverside (gywu@cert.ucr.edu). Matthew Barth is Professor of Electrical and Computer Engineering and Director of the College of Engineering - Center for Environmental Research and Technology, the University of California at Riverside (barth@ee.ucr.edu).

FIGURE 1

**Key Elements of
Plug-In Hybrid
Electric Vehicles**



1 Refueling

Minimal trips to the gas station. Batteries charged at home or work.

2 Energy storage

Fuel is stored as electricity in batteries with back-up gas tank.

3 Propulsion

Drives mostly on electric power until batteries are depleted.

ENERGY MANAGEMENT

Energy management in PHEVs depends on factors such as the power required to move the vehicle forward and the battery's state of charge (SOC). SOC is the equivalent of a fuel gauge for the battery pack, ranging from 0 percent (empty) to 100 percent (full). The battery in a PHEV operates best at moderate levels of SOC and is less efficient at very low or very high levels of SOC. Therefore, PHEV energy management strategies tend not to leave the battery pack empty or charge it fully in order to help preserve the battery life.

An important aspect of PHEV energy management is controlling how the battery charge is used and depleted. The charge is expected to drop to a low level when the vehicle reaches a destination where it can be plugged in and recharged. A battery reaching its lowest allowable level means that the vehicle has maximized its use of electricity drawn from the grid, which is usually a cheaper and cleaner energy source than fossil fuels.

Batteries should be used in a way that optimizes energy efficiency for a particular trip. One commonly used strategy is to run the PHEV solely on electric energy until its battery reaches a certain charge level, and then switch to gasoline for the rest of the trip. This strategy—referred to as the binary mode—may result in gasoline consumption where battery use is desirable (such as in stop-and-go traffic or while going down a steep hill). Therefore, the binary mode may not minimize fuel consumption and emissions for a trip. ➤



The intelligent energy management strategy yields fuel savings between 10 and 12 percent.

To develop an intelligent energy management strategy for PHEVs, we first estimated the amount of power the vehicle needs on a continuous basis for the duration of an example trip. Vehicle power is generally a function of vehicle speed, acceleration, mass, and road grade. Therefore, second-by-second vehicle speed profiles must be synthesized based on roadway and traffic information. Fortunately, such real-time traffic information has become increasingly available in the past several years. California's Freeway Performance Measurement System (PeMS), for instance, provides traffic measurement data every five minutes from thousands of loop detectors on the state's freeway system.

Using PeMS data, we calculated a detailed profile of the example trip before it began. Average traffic speed measurements and a large database of real-world vehicle speed profiles allowed us to estimate second-by-second vehicle speeds and corresponding accelerations. We then calculated the vehicle's location at each second along the trip and obtained road grade values for these locations. Using this speed, acceleration, and road grade information, we estimated second-by-second vehicle power requirements for the trip.

We used the estimated vehicle power requirements along with PHEV powertrain models to determine an optimal strategy for depleting the battery charge for the trip. This was done by estimating the engine's power supply and the associated drop or gain in the battery SOC at each second based on the commute variables (elevation, distance, etc.). This allows us to determine a trip's optimal charge-depleting profile that uses minimal power from the internal combustion engine while ensuring that 1) vehicle power requirements are met for the entire trip, and 2) the battery SOC never drops below a pre-set threshold. Solutions may also incorporate battery-recharging opportunities at intermediate stops along a trip chain.

EVALUATION AND RESULTS

To evaluate the effectiveness of our intelligent energy management strategy, we modeled a commute trip of about 25 miles each way along Interstate 210 in Los Angeles and San Bernardino Counties based on real-world traffic patterns. We assumed a westbound morning commute beginning at 8 am, and an eastbound afternoon commute beginning at 4 pm on the same day. During the morning commute, the PHEV would experience heavy congestion in the first half of the trip, and then no congestion thereafter. During the afternoon commute, the PHEV would experience moderate congestion throughout the trip.

We set the range of allowable states of charge between 20 and 80 percent of capacity in order to preserve the battery life. To evaluate the intelligent energy management strategy at the individual trip level, we assumed that the starting SOC is at the maximum allowable charge, 80 percent. Figures 2 and 3 compare SOC profiles of our intelligent energy management strategy and the binary mode strategy, which is commonly used in current PHEVs. Unlike the binary mode, the intelligent energy management strategy SOC reaches the minimum charge level at *the end of each trip* because the strategy uses roadway and traffic information to manage the hybrid powertrain. In some instances, especially during the westbound trip, our intelligent energy management strategy increases the SOC significantly as it takes full advantage of regenerative braking opportunities during traffic congestion and while traveling downhill.

The previous example assumes a full charge at the workplace, but what if we can only partially charge at the workplace? If the two trips are considered as one trip chain, and we know ahead of time that we can only partially recharge the battery at the workplace, our intelligent energy management strategy can still optimize energy consumption for the entire trip chain. Figure 4 compares SOC profiles of the commute trip chain that includes 30 percent SOC gain from a limited battery recharging opportunity at the workplace. In the binary mode strategy, the PHEV consumes the electricity very quickly, and the SOC reaches the minimum limit >

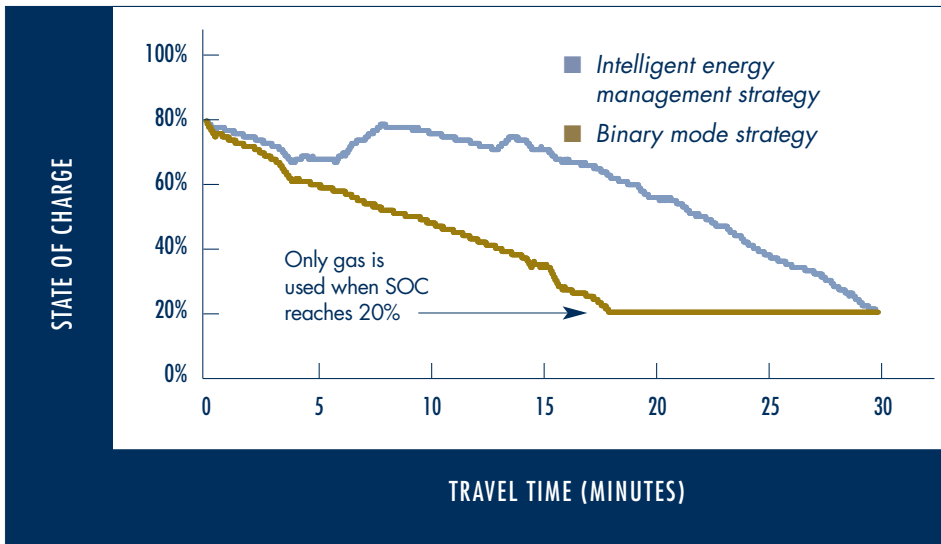


FIGURE 2
State of Charge Profiles
for Westbound Trip from
Home to Work

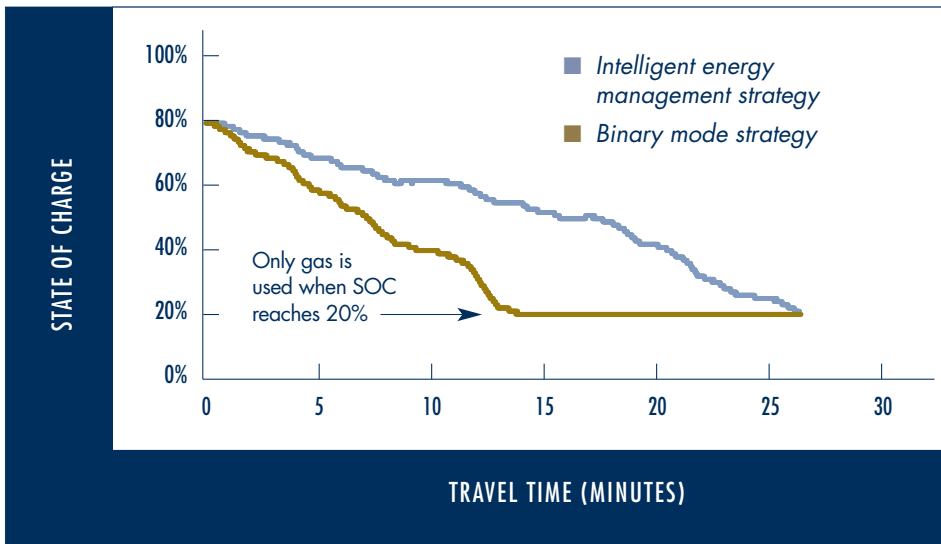


FIGURE 3
State of Charge Profiles
for Eastbound Trip from
Work to Home

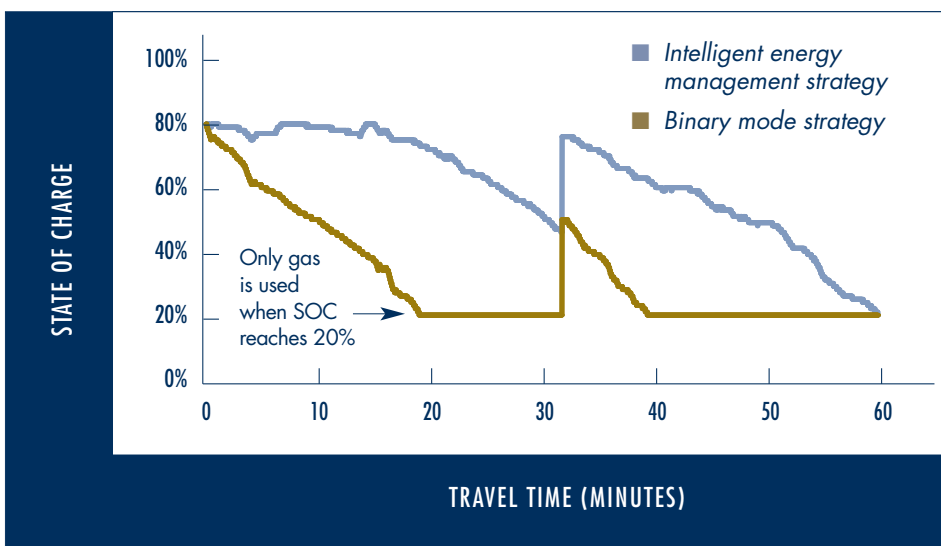


FIGURE 4
State of Charge Profiles
of the Commute Trip Chain
with 30 Percent Battery
Charging at the Workplace

FIGURE 5

Fuel Consumption (Gallons of Gas Equivalent) for Two Individual Trips

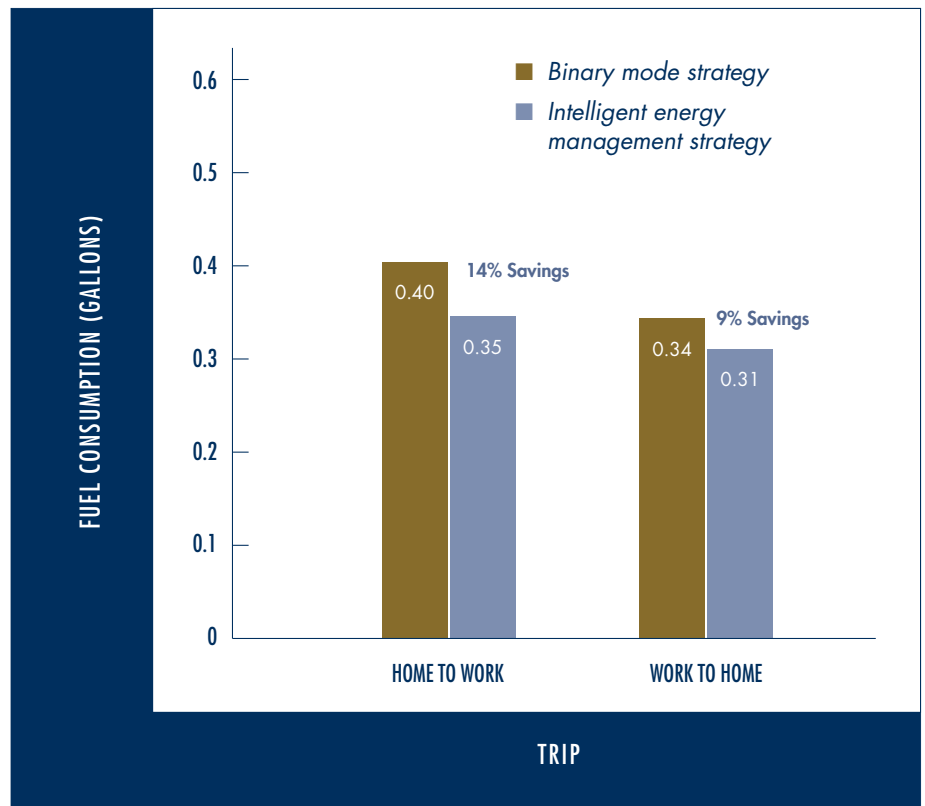
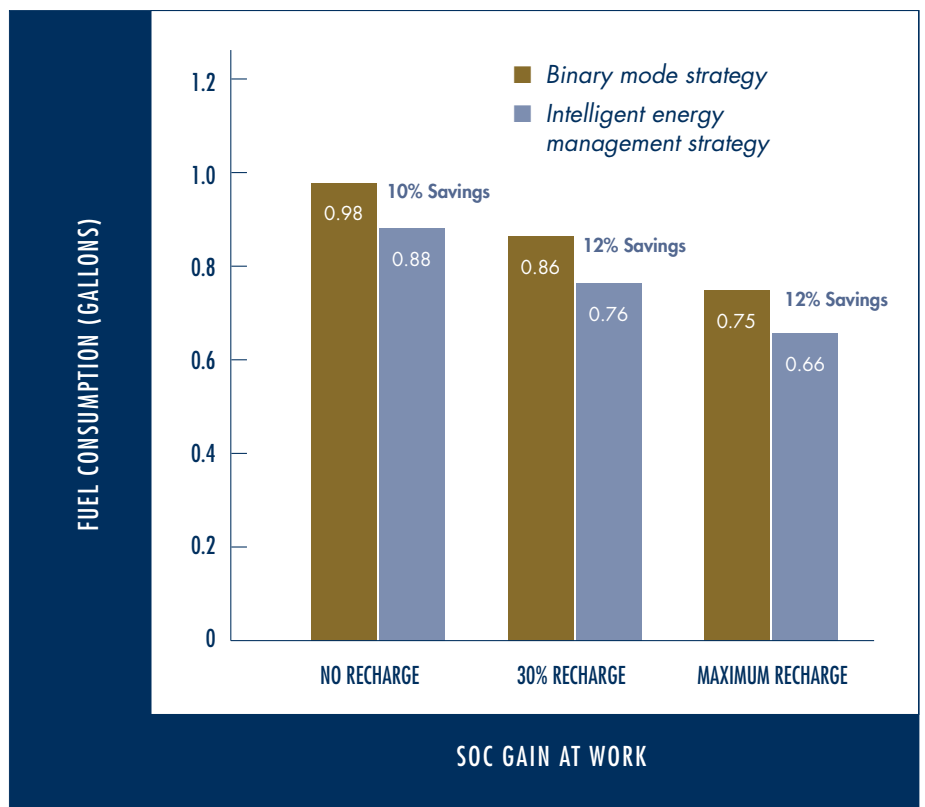


FIGURE 6

Fuel Consumption (Gallons of Gas Equivalent) for Trip Chain with One Stop at Work



far before the individual trips end. After the SOC reaches its minimum limit, the PHEV uses only fuel. In contrast, the intelligent energy management strategy uses the electricity as appropriate, such as to supplement the internal combustion engine when going up hills, which allows the SOC to reach the minimum limit at *the end of the trip chain*.

The example trips show that our intelligent energy management strategy can save 14 percent of fuel consumed on the westbound trip and 9 percent on the eastbound trip compared to the binary mode strategy (Figure 5). Figure 6 estimates fuel consumption if the two commute trips are combined into a single trip chain with one intermediate stop at the workplace. Compared to the binary mode strategy, the intelligent energy management strategy yields fuel savings between 10 percent (no battery recharging at work) and 12 percent (fully recharging at work).

CONCLUSION

Recent advances in PHEV technologies can greatly improve fuel efficiency and reduce harmful vehicle emissions. But most PHEVs use a binary-mode energy management strategy, which does not adapt to real-time driving situations or use each energy source as efficiently as possible.

In this research, we propose an intelligent energy management strategy for PHEVs that takes into account real-time information of vehicle position, roadway characteristics, traffic conditions, and if applicable, battery-recharging opportunities at intermediate stops in a trip chain to optimize fuel efficiency. Our calculation for an example commute trip shows that the intelligent energy management strategy can reduce fuel consumption by between 9 and 14 percent. This corresponds to a fuel efficiency increase from 60 to between 65 and 70 miles per gallon of gasoline equivalent.

Plug-in hybrid electric vehicles in the current market are already more fuel-efficient than conventional gasoline or diesel vehicles. By utilizing real-time information, PHEVs can save even more fuel for drivers and further reduce emissions. ♦

This article is adapted from “Development and Evaluation of an Intelligent Energy-Management Strategy for Plug-in Hybrid Electric Vehicles,” originally published in the *IEEE Transactions on Intelligent Transportation Systems*.

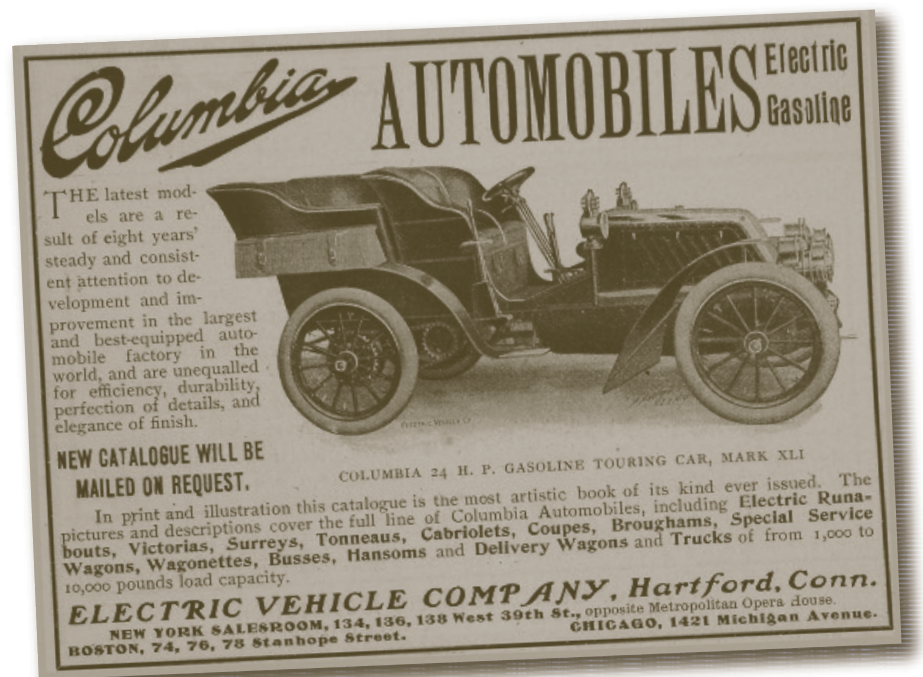
FURTHER READING

Don Anair and Amine Mahmassani. 2012. *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings across the United States*, Cambridge: Union of Concerned Scientists.

Electrification Coalition. 2013. *State of the Plug-in Electric Vehicle Market*, Washington DC.

Qiuming Gong, Yaoyu Li, and Zhong-Ren Peng. 2008. “Trip-Based Optimal Power Management of Plug-In Hybrid Electric Vehicles,” *IEEE Transactions on Vehicular Technology*, 57(6): 3393–3401.

Guoyuan Wu, Kanok Boriboonsomsin, and Matthew Barth. 2014. “Development and Evaluation of Intelligent Energy Management Strategy for Plug-In Hybrid Electric Vehicles,” *IEEE Transactions on Intelligent Transportation Systems*, 15(3): 1091–1100.



Manage Flight Demand or Build Airport Capacity?

MEGAN S. RYERSON AND AMBER WOODBURN

Airports can manage air traffic congestion in two ways: 1) add infrastructure or 2) manage flight demand. The environmental and economic implications of these options, however, often conflict. New runways have significant financial and environmental costs, but they can also stimulate economic development and increase a city's appeal to businesses. Managing demand saves construction costs and encourages fuel efficiency but may limit opportunities for regional growth. Our research finds that airports in the US underestimate or ignore these tradeoffs and, as a result, frequently fail to consider managing demand as an alternative to building new runways.

Megan S. Ryerson is Assistant Professor in the Departments of City and Regional Planning and Electrical and Systems Engineering at University of Pennsylvania (mryerson@design.upenn.edu).

Amber Woodburn is a Doctoral Candidate in the Department of City and Regional Planning at University of Pennsylvania (amwo@design.upenn.edu).

THE AIRPORT CONGESTION PROBLEM

Following federal deregulation in the 1970s, airlines increased their use of hub-and-spoke operations. Rather than offering a nonstop route, flights connect through hub airports. Deregulation allowed airlines to set their own routes, service frequency, and type of aircraft. As a result, fares fell, services increased, and the demand for air travel surged. Increased flight frequency at hubs, however, created congestion and exacerbated environmental impacts such as noise, air pollution, and greenhouse gas emissions. While airlines can benefit from expanding hub airport capacity, it is unclear whether it is the best long-term solution to airport congestion. One alternative is for airports to manage demand.

Airports and the Federal Aviation Administration (FAA) currently have two strategies to manage demand: 1) caps on flights and 2) congestion pricing. The FAA has sole authority to cap the number of flights at an airport. FAA policy, however, does not support caps as a long-term solution, stating that caps are not in the public interest and should be imposed to alleviate air traffic delays only after other alternatives have been tried.

As an alternative to caps, the FAA allows airports to charge congestion fees for landings during peak hours. Congestion charges encourage airlines to 1) shift their flights from peak to off-peak hours, 2) use larger aircraft to consolidate flights, 3) shift traffic to other airports in the region, or 4) eliminate flights altogether. While the FAA allows congestion pricing, the agency does not promote it, stating that such pricing should be employed only when “airport development projects cannot be built in time to prevent congestion.” Furthermore, the FAA limits the total revenue that airports can collect from congestion charges. No US airports currently charge congestion fees.

FAA policy is clear: building capacity is preferred to either congestion pricing or flight caps. As stated in the FAA Authorization Act of 1994, “It is FAA policy that projects that increase [airport] capacity be undertaken to the maximum feasible extent so that safety and efficiency increase and delays decrease.”

DEMAND MANAGEMENT IN AIRPORT PLANNING

Airports have two opportunities during the planning process to evaluate the tradeoffs between adding capacity and managing demand. The first is with an Environmental Impact Statement (EIS). When an airport sponsor—usually a city government or an airport authority—proposes to construct a new runway, it must prepare an EIS in cooperation with the FAA. An EIS includes a detailed description of the proposed project’s environmental and socio-economic impacts, as well as the impacts of all *feasible* project alternatives and the no-build scenario. An EIS is required for airports to comply with the National Environmental Policy Act (NEPA) and to maintain eligibility for federal funds.

To complete an EIS, the FAA and airport sponsor must craft a Purpose and Need Statement to define project objectives and the overarching problems that motivate the project. The EIS must also include alternatives to the preferred project design. Alternatives may include different runway configurations, demand management strategies such as congestion pricing, or other actions that satisfy the project objectives. Airports begin the analysis by evaluating whether the alternatives are technically and economically possible and whether they satisfy the EIS’s Purpose and Need Statement. The alternatives that are deemed feasible advance to the next stage for a full environmental review.

Another opportunity to evaluate tradeoffs occurs during regional planning efforts. The FAA helps regional planning organizations prepare a Regional Airport Systems Plan (RASP). RASPs generally study the regional outcome of demand management (e.g., How will regional flight demand change after demand management policies are in place at a major airport?). >

FAA policy is clear: building capacity is preferred to either congestion pricing or flight caps.

They rarely study alternative strategies to achieve the desired outcome (e.g., Should a major airport use peak pricing or operations policies to limit capacity?). RASPs focus on the regional impacts of different airport demand scenarios rather than directly comparing airport-specific policies. But regional planning agencies can examine and demonstrate demand management tradeoffs using RASPs, and provide this knowledge to airports and the FAA to promote demand management.

It should be noted, however, that while all airports must prepare an EIS to receive FAA funding for expansion, not all regions require a RASP. Even among those that do, there is no guaranteed coordination between regional planning and airport expansion efforts. Federal funding for regional airport capacity studies and runway construction projects are both funded through the same federal program. The division between the two, however, is anything but equal. From 1992 to 2009, 32 percent of total FAA airport improvement funding went to runway construction, while less than 2 percent supported planning activities.

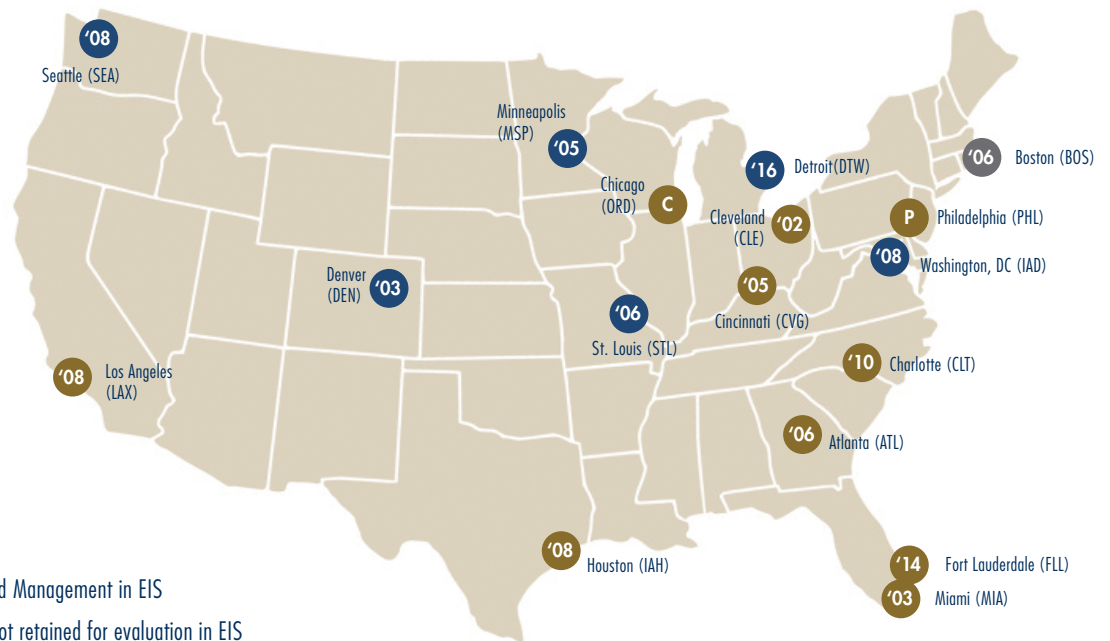
A POOR RECORD OF EVALUATING TRADEOFFS

We collected EISs from the 35 US airports the FAA classified as “nationally significant,” meaning their congestion and delay can spread and cause delays at airports around the world. These airports can reasonably be expected to assess demand management as an alternative to adding capacity. Of the 17 airports that increased or planned to increase runway capacity after 2000 and completed an EIS (Figure 1), only one—Boston Logan International Airport—conducted a comprehensive analysis of demand management as an alternative to a new runway.

FIGURE 1

Demand Management in Airport Environmental Impact Statements

- # Year deployed
- C In construction
- P Planned
- No discussion of Demand Management in EIS
- Demand Management not retained for evaluation in EIS
- Demand Management retained for evaluation in EIS



WHAT MAKES BOSTON UNIQUE?

The New England Airport Coalition, formed in 1994, includes the six New England state aviation agencies, all airport sponsors with scheduled jet passenger service, and a regional economic development council. One of the airport sponsors is Massport, the port authority responsible for Boston Logan Airport. From 2002 to 2006, the regional coalition published two phases of their New England Regional Air Service Study, part of a RASP that ran parallel to Massport's EIS preparation. The study analyzed underutilized regional airports in New England, documented their available capacity, and assessed the economic impact of shifting service from Logan to those airports. Massport stated that this regional planning effort allowed them to understand the impact of demand management at Logan and thus incorporate peak pricing into their EIS.

After documenting the tradeoffs between a new runway and demand management strategies, Massport ultimately chose to build the runway and keep congestion pricing as a potential mitigation measure. As of 2015, they had not used congestion pricing.

WHY DO AIRPORTS REJECT DEMAND MANAGEMENT?

Some airports mention demand management in their EIS but state it is not a feasible alternative to building a runway. Others avoid the subject altogether. Three overarching barriers cause airport sponsors to reject demand management as an alternative to runway growth: 1) narrow Purpose and Need Statements; 2) policy conflicts and uncertainty; and 3) emphasis on airports as a tool for regional economic development.

Narrow Purpose and Need Statements

Seventeen airports in our sample prepared an EIS for runway expansion. Of these, 16 did not include demand management as a feasible alternative, citing the need to accommodate growing demand while keeping delay at an acceptable level (generally 15 minutes per flight, as suggested by the FAA). An EIS that defines a project's purpose and need strictly in terms of physical capacity will reject demand management—and any other no-build policies—as a feasible alternative. For example, Cleveland Hopkins International Airport set a specific goal of building a longer runway, and thus did not evaluate demand management as a feasible alternative.

Narrow Purpose and Need Statements indicate a deeper conflict between the National Environmental Policy Act's procedural requirements and its core objectives. If airport sponsors define project goals in ways that preclude feasible project alternatives, they may be following the letter of NEPA law but not its spirit of environmental stewardship. Additionally, there are legal incentives to produce narrow Purpose and Need Statements. Judges generally defer to the FAA in approving these statements and in interpreting the feasibility of alternatives.

The alternatives analysis in the EIS can generate useful, policy-changing information only if the Purpose and Need are broad enough to entertain nontraditional solutions. As an example from another agency, in 1986, a US Forest Service EIS documented the hazards of herbicides and suggested alternatives that were both reasonable and environmentally superior. The findings prompted the agency to support nonchemical approaches to vegetation management whenever possible rather than accepting herbicides as the only solution. Planners and stakeholders can do something similar by considering a shift in traffic from major airports to regional ones in the EIS alternatives analysis. This analysis can help show the value of demand management. ➤



Demand management holds great potential for airline and airport cost savings and reduced environmental impacts.

FURTHER READING

Jan Brueckner. 2009. "Airport Congestion Management: Prices or Quantities?" *ACCESS*, 35: 10–15.

Megan S. Ryerson and Amber Woodburn. 2014. "Build Airport Capacity or Manage Flight Demand: How Regional Planners Can Lead American Aviation into a New Frontier of Demand Management," *Journal of the American Planning Association*, 80(2): 138–152.

Amber Woodburn, Megan S. Ryerson, and Mikhail Chester. 2013. "Challenges to Analysis of Air and Rail Alternatives in Government Environmental Impact Review Processes," *Transportation Research Record*, 2336: 9–17.

Policy Conflicts and Uncertainty

Four of the eleven EIS documents that initially considered demand management cited legal uncertainties as a reason not to advance it as a feasible alternative. Of these, three airports—Fort Lauderdale-Hollywood, Chicago (O'Hare), and Philadelphia—discussed how federal law explicitly promotes increasing capacity. Additionally, the FAA restricts airports from generating revenue in excess of their costs. Thus some airports—Cleveland, Charlotte, and Fort Lauderdale-Hollywood—asserted they could not charge a congestion fee high enough to encourage airlines to shift flights from the peak hours without violating this revenue cap.

In short, demand management is legal and possible to implement, yet airport sponsors can refuse to advance it as a feasible alternative by citing FAA policy and pro-build language. In contrast, RASP efforts can help circumvent policy conflicts since these are exploratory planning studies that occur outside the NEPA process. Unlike in an EIS, where the underlying mission is to build infrastructure, FAA pro-build policy does not immediately deter RASP planners from exploring alternatives to new runways.

Economic Development and Airline Hubs

The link between airports and economic development in the US has roots from the 1920s. In her look at the history of US airports, Professor Janet Bednarek at the University of Dayton writes that "a city had to have [an airport] in order to achieve its 'destined' growth and development to match or, better, overwhelm its urban rivals." Such urban competition remains today, as seen by airport EIS documents that argue in favor of airport expansion to preserve the city's hub status.

Across all reviewed airport EIS documents, the most frequently cited reason for increasing capacity was to enhance the airport's ability to accommodate flights and, in some cases, remain a hub airport. The sponsors of eleven hub airports (three of which are no longer hubs as of 2015) explicitly cited a desire to protect the hub operation of their primary airline. Eight airports considered demand management but cited their hub status as a reason not to advance it as a feasible alternative. There is limited research on whether expanding capacity helps airports maintain their hub status, or on whether the environmental impacts of constructing a larger airport are offset by the promise of business growth. Therefore, the tradeoffs between increasing capacity and managing demand remain unknown.

CONCLUSION

Demand management holds great potential for airline and airport cost savings and reduced environmental impacts. Strengthening the role of regional planners in the airport planning process would lead to greater consideration of demand management and may bring innovative solutions to airport congestion. We recommend that 1) the FAA play a more direct role in funding regional airport planning and creating regional airport planning coalitions; 2) regional planners collaborate early in the airport EIS process; and 3) planners encourage the FAA to make demand management a mandatory alternative in an EIS for increased airport capacity.

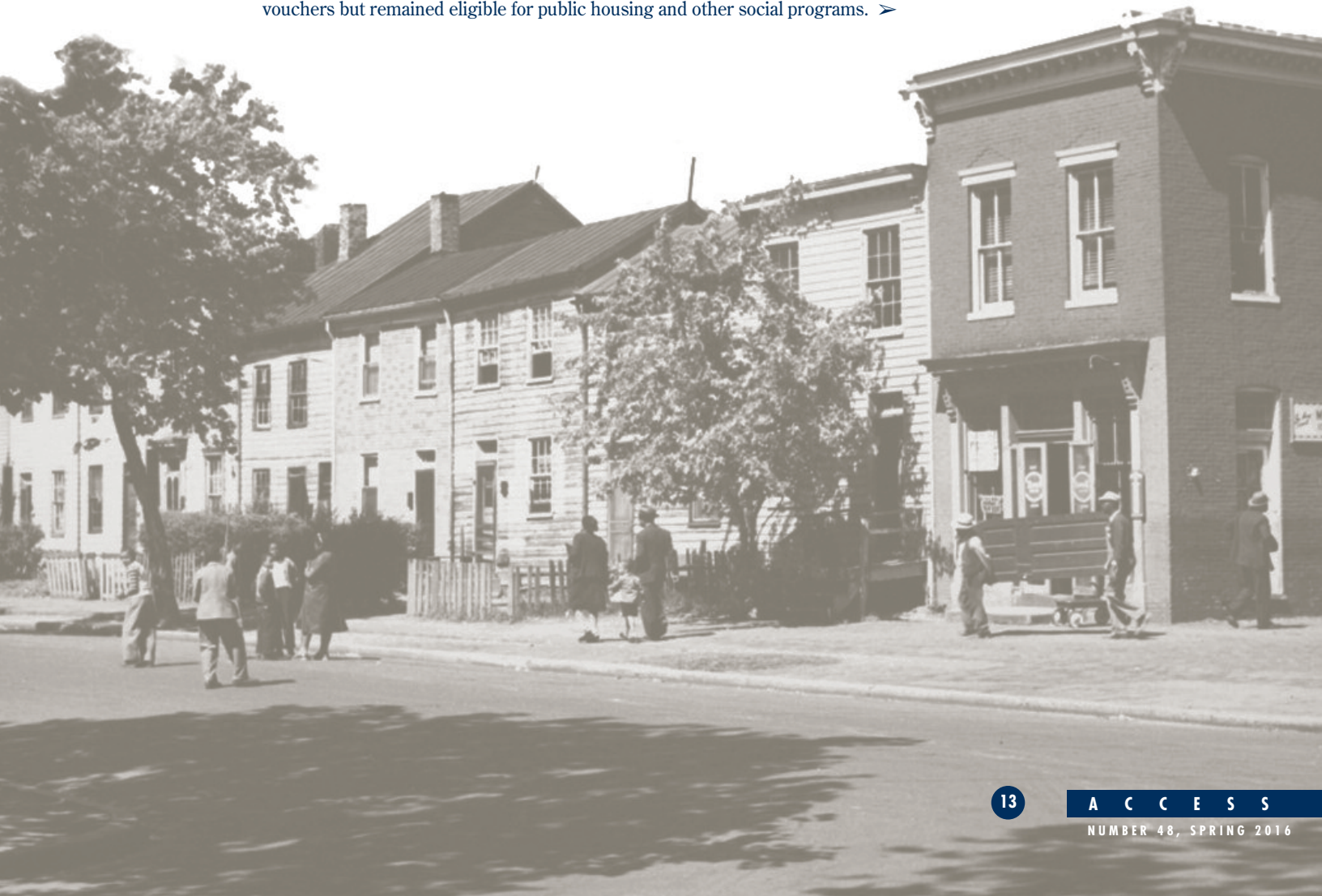
With some creative thinking, airport planners could create a regional planning process that improves the value of EISs, inspires changes to FAA policy, and explores critical alternatives to increased capacity. EIS methods in aviation planning are not set in stone; if new ideas and new people come to the table, more environmentally innovative solutions to airport congestion may arise. ♦

This article is adapted from "Build Airport Capacity or Manage Flight Demand? How Regional Planners Can Lead American Aviation into a New Frontier of Demand Management," originally published in the *Journal of the American Planning Association*.

A Driving Factor in Moving to Opportunity

EVELYN BLUMENBERG AND GREGORY PIERCE

In 1992, the US Congress authorized the Moving to Opportunity (MTO) housing voucher program to operate in five large metropolitan areas: Baltimore, Boston, Chicago, Los Angeles, and New York. The MTO program represented a radical departure from standard housing assistance programs, which clustered participants in very poor neighborhoods that offered few opportunities. Running counter to previous policy, MTO used an experimental framework to assess how moving households on assistance to low-poverty neighborhoods can affect their employment, education, and household income. Under the program, residents were randomly assigned into three groups. The first group received housing vouchers that could be used only in neighborhoods with poverty rates under 10 percent. The second group received similar housing vouchers but with no neighborhood restrictions. The third group did not receive vouchers but remained eligible for public housing and other social programs. ➤





Cars are often the only practical mode of transportation to dispersed job sites.

Despite great fanfare surrounding the MTO program, numerous studies have found that the difference between these housing voucher options had no effect on households' economic outcomes. There are several explanations for the program's disappointing results. The rate at which recipients successfully used vouchers to lease an apartment was only 38 percent among traditional voucher recipients and only 32 percent among voucher recipients who were required to move to low-poverty neighborhoods. Moreover, most people who did move quickly moved out of low-poverty neighborhoods due to a lack of reliable transportation and weak social ties in these new areas. They thus spent little time in neighborhoods with high levels of access to education, racial diversity, or jobs.

Previous assessments of MTO programs, however, have not explicitly examined the influence of transportation access on households' economic outcomes. Using data from the MTO program, we examine whether automobile availability and public transit access affect employment status between the baseline (1994) and interim (2000/2001) surveys. Additionally, we test whether the voucher group in low-poverty neighborhoods was more likely to benefit from automobile access compared to other households, since low-poverty neighborhoods frequently have limited access to transit.

TRANSPORTATION AND EMPLOYMENT

Efforts to improve the employment conditions of low-income families often center on bolstering the labor market, increasing wages, improving educational attainment, and stabilizing family structure. Past research suggests, however, that cars can also play an important role in facilitating employment.

The population within US metropolitan areas has spread out geographically since the 1960s, elevating the importance of cars in accessing regional opportunities. Low-income families have also suburbanized. As Figure 1 shows, however, a slight majority of the poor within metropolitan areas remain in central-city neighborhoods. Living in core urban areas allows households to take advantage of available affordable housing and—for those lacking a car—access to relatively high levels of public transit service.

As cities have spread, however, jobs have dispersed. The low-income residents who stay behind in urban areas can end up being disconnected from suburban employment opportunities. Cars are often the only practical mode of transportation to these dispersed job sites. Even in cities with ample transit service such as Boston and San Francisco, transit is generally slower and less reliable than driving.

Cars make it easier for low-income households to search for and regularly commute to jobs, which increases employment rates. Conversely, employment can provide households with the necessary resources to purchase cars; income is one of the strongest correlates of car ownership. Yet the importance of cars for employment persists even in studies that control for the two-way relationship between car ownership and employment decisions.

Automobile ownership in the United States has become nearly ubiquitous. Even among adults living below the poverty line, 80 percent lived in a household with a vehicle in 2010, compared to 50 percent in 1960. While over six million poor adults live in households without a car, 30 percent of these adults still commute by car, either via carpooling or by borrowing vehicles. A slightly higher percentage commute by public transit, suggesting that proximity to transit is essential to their mobility

Evelyn Blumenberg is Professor and Chair of Urban Planning in the Luskin School of Public Affairs at the University of California, Los Angeles (eblumenb@ucla.edu). Gregory Pierce is a Senior Researcher in the Luskin Center for Innovation at the University of California, Los Angeles (gpspierce@ucla.edu).

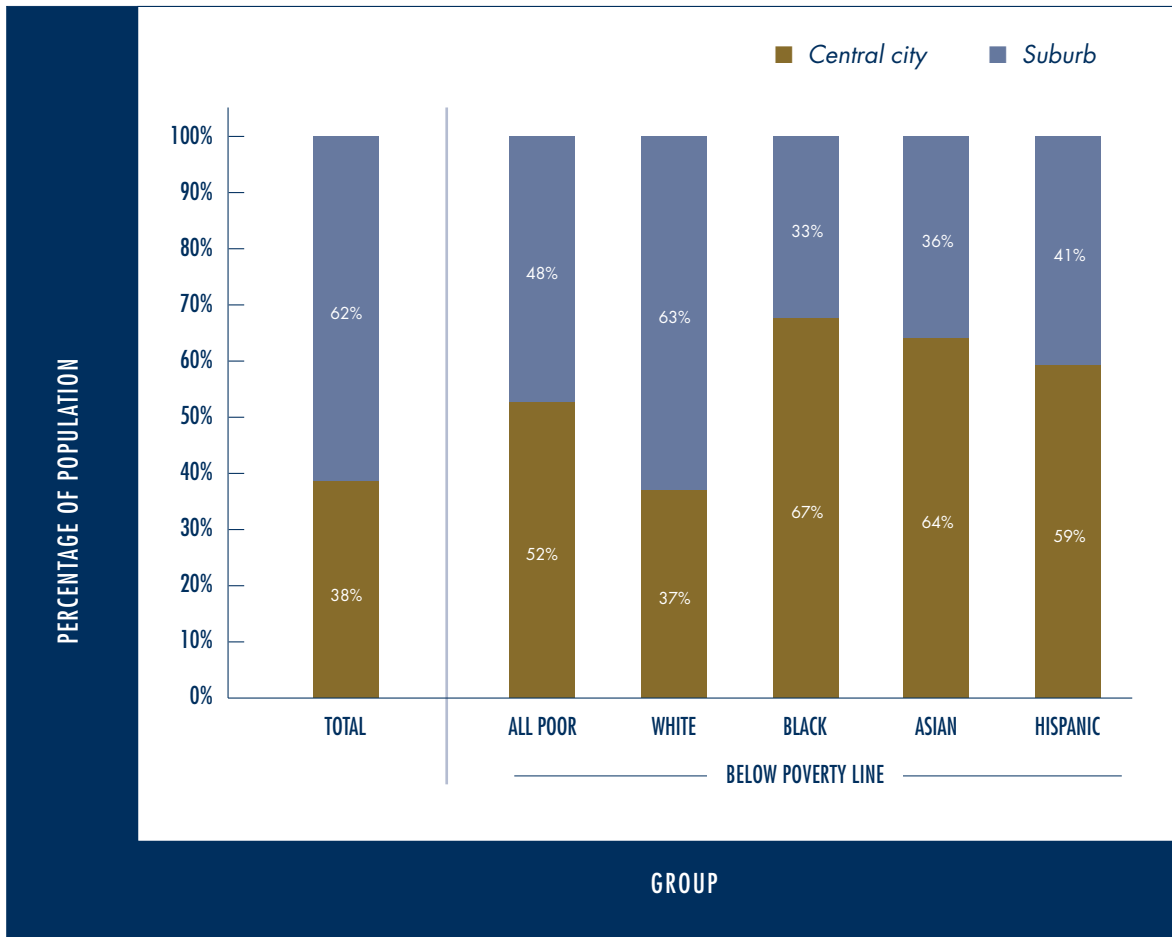


FIGURE 1
Location of US Population within Metropolitan Areas

The few studies that directly compare the relative benefits of cars and public transit, however, find that car access better facilitates job acquisition and job retention compared to transit. Cars may be particularly important for voucher recipients who, compared to public housing residents, tend to live in more spatially dispersed neighborhoods. MTO participants who moved to low-poverty neighborhoods often found themselves far from bus stops and in neighborhoods where buses ran infrequently. Consequently, many MTO families experienced the stress of more difficult transit trips to work.

DATA AND RESEARCH DESIGN

In our analysis, we use data from the 1994 and 2000/2001 MTO surveys to examine the relationship between changes in car ownership, transit access, and full-time employment for 3,199 households. We supplement this information with data on neighborhoods where program participants live.

We focus on two variables: changes in car ownership, and residential relocation to neighborhoods with improved public transit. Both MTO surveys asked households whether they had a car. The baseline survey also asked participants whether they lived within 15 minutes walking time of a bus stop. In addition to self-reported transit proximity, we include a transit supply measure from the Brookings Metropolitan Policy Program. Using these data, we test whether there is a positive relationship between employment rates and moving to neighborhoods with improved transit access. >

EMPLOYMENT, CARS, AND IMPROVED PUBLIC TRANSIT

We first outline trends in full time employment and our transportation variables: car and public transit access. Figure 2 shows that nearly one-third of the sample gained a job by 2000/2001, while over half remained unemployed.

Figure 3 shows the change in car ownership between 1994 and 2000/2001 for the entire sample. While over a quarter of the group gained a car between the two time periods, more than half the sample remained without a car at both time periods. Rates of car ownership are substantially lower among the MTO sample than among the general population of low-income individuals. This finding mirrors data from the 2000 Public Use Microdata Sample of the US Census, which show that approximately 75 percent of adults living below the poverty line had access to a household vehicle, while only 57 percent of low-income adults who receive public assistance lived in households with a car. Additionally, the MTO sample had a lower average income than both the general voucher population as well as people living below the poverty line, which may in part explain the very low car ownership rates observed.

Finally, just over 20 percent of the sample moved to neighborhoods with better access to public transit. Unexpectedly, participants with and without cars were equally likely to move to transit-rich neighborhoods.

DOES ACCESS TO TRANSPORTATION IMPROVE EMPLOYMENT OUTCOMES?

We next tested the relationship between transportation access and employment outcomes among MTO households, after controlling for other determinants of employment. Consistent with previous evaluations of the MTO program, receiving a geographically-restricted voucher was not significantly correlated with job gains or job retention. Table 1 summarizes the transportation results of our regression model. Gaining a car between 1994 and 2000/2001 and maintaining access to a car at both time periods are positively and strongly correlated with finding employment and being employed. The presence of a car raises the probability of finding a job by a factor of two, and of being employed at both time periods by a factor of four.

While improved transit access is not a significant factor in *finding* employment, it appears to be the most important factor associated with *being* employed at both time periods. Moving to a neighborhood with better transit between baseline and interim and living within 15 minutes of a bus stop both greatly raise the probability of having consistent employment. ➤

TABLE 1
Transportation Access
and Employment

TRANSPORTATION PREDICTOR VARIABLES	GAINED EMPLOYMENT	LOST EMPLOYMENT	MAINTAINED EMPLOYMENT
Improved transit	NS	NS	+
Live < 15 minute walk to transit	NS	NS	+
Auto access			
Gained a car	+	NS	+
Lost a car	NS	NS	+
Had a car at both time periods	+	NS	+

“NS” indicates no statistically significant effect. “+” indicates a positive, statistically significant effect. The employment effect of each auto access scenario shown in this table is compared to a reference category of “Did not have a car at both time periods.”

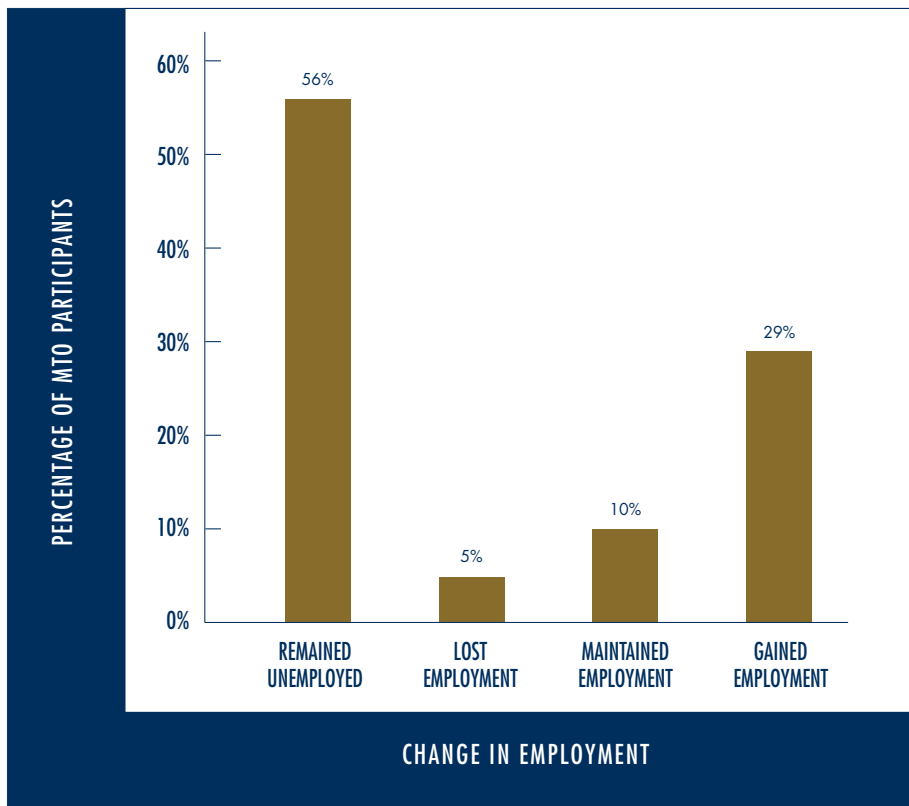


FIGURE 2
MTO Change in Full-Time Employment,
1994–2000/2001

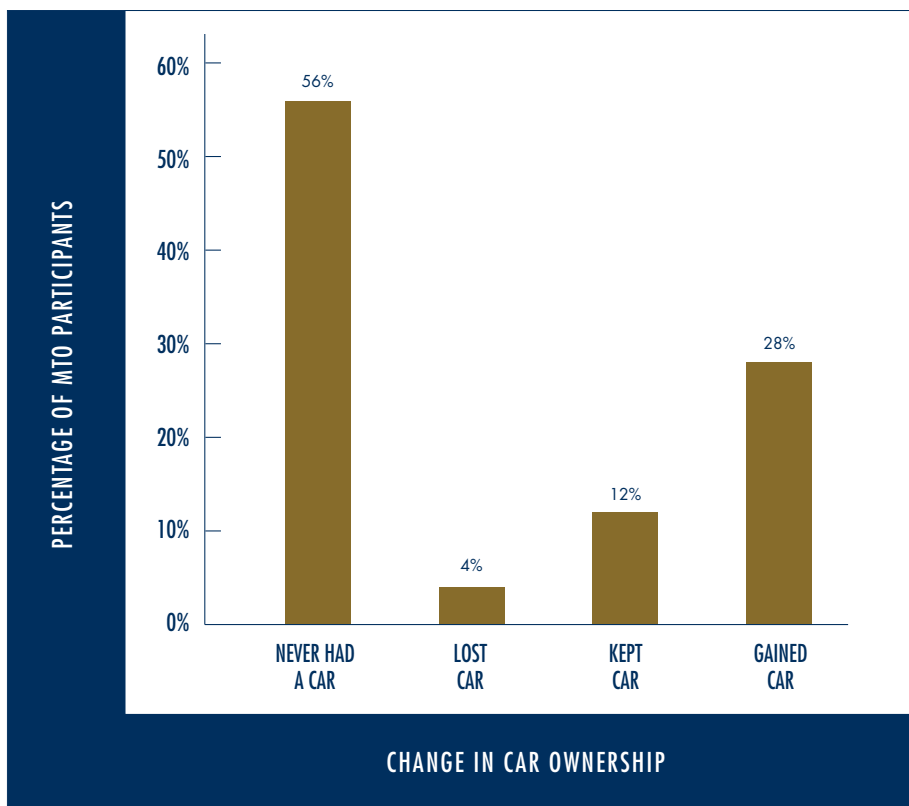


FIGURE 3
MTO Change in Car Ownership,
1994–2000/2001



CONCLUSION

Evidence from the MTO experiment shows that transportation assets play a major role in gaining and maintaining employment for subsidized housing recipients, whereas both previous research and our study find that housing assistance itself had little effect. The model results also show a strong relationship between relocating to transit-rich neighborhoods and remaining employed. People with jobs may strategically relocate to neighborhoods where they can more easily use public transit for their commute. Policies to enable household moves to transit-rich neighborhoods will help participants retain employment.

On the other hand, among unemployed participants, moves to transit-rich neighborhoods do not appear to increase the likelihood of employment. This finding may reflect transit's failure to connect families to opportunities in an increasingly dispersed labor market. Or transit may only facilitate employment in neighborhoods where service levels cross a particular supply threshold. Although MTO metropolitan areas are large and have relatively high levels of transit service, not all neighborhoods are equally well served.

Thus far, policy efforts to coordinate housing and transportation have largely centered on public transit. But policies to increase car access among low-income households will most clearly enhance job gain and retention even in large metropolitan areas, such as MTO study areas, and in dense urban neighborhoods where public housing is located. Additional evidence shows that enabling car ownership by reducing the asset restrictions for families receiving public assistance and by providing low-income auto loans and subsidies can increase employment among the poor. Financing assistance policies may also help families buy cars. Moreover, policies to increase car access—rather than ownership—can provide many of the benefits of cars without the high costs of ownership. These policies might include efforts to promote car sharing, ride sharing, and car leasing.

Many, if not most, policymakers and planners loathe the policies and programs that promote car use, which contribute to traffic congestion, air pollution, sprawl, and high transportation costs. There are many good reasons for these concerns. Yet the responsibility for mitigating the negative externalities of cars should not be shifted to low-income families—the people who currently use cars the least and, as the evidence shows, need them the most. ♦

This article is adapted from “A Driving Factor in Mobility? Transportation’s Role in Connecting Subsidized Housing and Employment Outcomes in the Moving to Opportunity (MTO) Program,” originally published in the *Journal of the American Planning Association*.

FURTHER READING

Evelyn Blumenberg and Gregory Pierce. 2014. “A Driving Factor in Mobility? Transportation’s Role in Connecting Subsidized Housing and Employment Outcomes in the Moving to Opportunity (MTO) Program,” *Journal of the American Planning Association*, 80(1): 52–66.

Judith Feins and Mark Shroder. 2005. “Moving to Opportunity: The Demonstration’s Design and its Effects on Mobility,” *Urban Studies*, 42(8): 1275–1299.

Rolf Pendall, Chris Hayes, Arthur George, Zach McDade, Casey Dawkins, Jae Jeon, Eli Knaap, Evelyn Blumenberg, Gregory Pierce, and Michael Smart. 2014. *Driving to Opportunity: Understanding the Links among Transportation Access, Residential Outcomes, and Economic Opportunity for Housing Voucher Recipients*, Washington DC: Urban Institute.

Policies to increase car access among low-income households will most clearly enhance job gain and retention even in large metropolitan areas.

INVESTING IN TRANSPORTATION AND PRESERVING FRAGILE ENVIRONMENTS

MARTIN WACHS AND JAIMEE LEDERMAN

In the early 1970s, the California Department of Transportation (Caltrans) owned large tracts of environmentally sensitive land near Beach Lake in the Sacramento River Valley. The land, acquired in anticipation of future projects but deemed no longer necessary, was to be declared surplus property and sold according to department protocol. One enterprising staff member, however, was thinking differently. He urged Caltrans to hold on to the land and use it for environmental mitigation credit to offset damage from future transportation projects in other areas. In an unusual move, the agency adopted his creative proposal, and the experiment paid off handsomely. In the following decades, the land fulfilled mitigation requirements for 49 separate projects in 14 counties with documented cost savings to Caltrans of over \$25 million.

This striking example of advanced mitigation—preserving land in anticipation of future environmental mitigation—demonstrates the value of planning at the regional level. In addition to cost savings, the natural environment is also better preserved when thousands of acres of sensitive habitat are conserved together rather than in small parcels. Species can then migrate and complex ecologies can function at a regional scale. Habitat Conservation Plans (HCPs), which are required to comply with the US Endangered Species Act (ESA), are among the most promising paths for achieving regional advanced mitigation in cases where development threatens endangered species habitats. HCPs encourage responsible agencies to balance development against potential harm to endangered species by detailing avoidance, minimization, and mitigation actions. We examine HCPs and show their utility as environmental planning mechanisms that enable the efficient delivery of transportation projects while preserving fragile natural environments.

Martin Wachs is Professor Emeritus of Civil and Environmental Engineering and City and Regional Planning at the University of California, Berkeley, and former Director of the Institute of Transportation Studies and of the University of California Transportation Center. He is also former Chair of the Department of Urban Planning at the University of California, Los Angeles. He is currently a Senior Research Associate at the RAND Corporation and Visiting Professor at UCLA (mwachs@ucla.edu).

Jaimee Lederman is an attorney and a Doctoral Candidate of Urban Planning in the Luskin School of Public Affairs at the University of California, Los Angeles (jaimee.lederman@ucla.edu).

The National Environmental Policy Act, California Environmental Quality Act, and dozens of other federal and state laws address endangered species, clean water, air pollution, and noise. These laws impose stringent review requirements on all new transportation projects to guard against environmental damages. While not intended to completely prohibit projects that harm the environment, these laws and regulations require that public agencies 1) analyze and document the environmental damage done by their facilities, 2) take every available action to avoid, minimize, and mitigate that damage, and 3) provide the public with opportunities to review and comment on the plans before permits are issued. Laws and regulations also empower interest groups and individuals to sue government agencies when they believe protective measures have been overlooked or violated.

Most transportation policymakers understand that past construction practices have damaged air, water, and land, and now recognize the importance of environmental protection. Still, incorporating environmental protection into transportation planning has become increasingly expensive. Highway and rail projects often take several decades to complete because their environmental reviews, mitigation measures, and resulting lawsuits extend project timelines and incur high costs.

These planning challenges led to a focus on streamlining the environmental approval process, with advanced mitigation at the regional or landscape level to protect large tracts of land rather than isolated parcels. Mitigation at an individual project scale is both biologically and administratively inefficient. Highway projects that impinge on a few acres of wetland, rail lines that disturb endangered species habitats, and bridges that upset fish spawning grounds now include environmental mitigation by replacing habitat, creating new breeding grounds, or restoring wetland. Increasingly, transportation agencies are urged to work alongside land management and resources agencies and private land owners to preserve thousand- or even million-acre tracts of land or water in advance of construction. Such preservation proactively offsets damage from multiple future projects.

Agencies are recognizing the value of advanced regional mitigation, but high initial costs, limited funding, complex environmental laws, and legal restrictions placed on transportation agencies all conspire to make this good idea very difficult to implement. ➤

Highway and rail projects often take several decades to complete because their environmental reviews, mitigation measures, and resulting lawsuits extend project timelines and incur high costs.



Habitat Conservation Plans are products of partnerships that, in most instances, are forged between groups that previously opposed one another, sometimes in highly acrimonious disputes.

HABITAT CONSERVATION PLANS

To understand the complexities of advanced mitigation at a regional scale, we studied Habitat Conservation Plans (HCPs) prepared to comply with the requirements of the 1973 Federal Endangered Species Act (ESA). Under the ESA, Congress declared endangered species to have intrinsic value. The Act protects them from harm caused by “economic growth and development untempered by adequate concern and conservation,” and safeguards the “ecosystems upon which they depend.” The Act prohibits “taking” any endangered species, meaning no harm should be caused to any individual endangered species or its habitat. While this protection would effectively prohibit any otherwise lawful development in endangered species habitats, Congress relaxed the regulation in a 1982 provision. The new provision, listed under Section 10 of the Act, allows the “taking” of a listed species if it is incidental to an otherwise lawful activity, such as the construction of a transportation facility. Those building in endangered species habitats must apply for an Incidental Take Permit (ITP) from the US Fish and Wildlife Service (FWS). To receive an ITP, applicants must create a multi-decade HCP that binds them to planned conservation and mitigation strategies.

Thousands of HCPs have resulted in “take permits” that allow planned projects to proceed in compliance with the law. We concentrated on the largest advanced regional or landscape-level HCPs that included mitigation of the impacts of planned transportation projects. We believe many of the lessons learned from HCPs can be applied to other forms of regional advanced mitigation. We studied more than thirty HCPs, each covering more than ten thousand acres. Most of our cases are located in California but also include others in Nevada, Texas, and Wisconsin. We attended conferences and courses, read FWS training manuals and planning documents prepared by dozens of applicant agencies—not all of them successful—and conducted over sixty interviews of federal, state, and local officials.

Each HCP includes a list of projects that require mitigation, the biological impacts of these activities, and a plan to mitigate harm. The HCPs address development and its mitigation over periods of 30 years or more. They usually describe consultations among landowners, public agencies, interest groups, and FWS staff. All include narratives that describe the HCPs as products of partnerships that, in most instances, were forged between groups that had previously opposed one another, sometimes in highly acrimonious disputes. Plan development and approval took years of negotiation and required the involvement of specialized consultants. Many HCP successes were attributed to heroic efforts by a few dedicated public officials who persevered through complicated and unpleasant negotiations.

CHALLENGES OF FUNDING AND FINANCE

Long range conservation plans can yield significant financial and time savings for transportation agencies because they enable infrastructure to be built earlier, at lower cost, and with fewer legal challenges than when each road, bridge, or rail line faces its mitigation obligations in piecemeal fashion. Unsurprisingly, however, we found that raising the considerable sums needed to develop and implement HCPs is difficult.

For example, Butte County, California, estimates a \$1.1 million annual planning cost for its still-in-development HCP. Similarly, Yolo County, California, estimates that the total cost of its HCP plan development will be \$2.4 million over a three-year planning period. These are significant expenditures for local agencies, funds that could otherwise be used to repair roads or purchase buses. Once planning is complete and the HCP is approved, even greater costs of land acquisition, operations, and maintenance must be borne for decades as the plans are implemented. The estimated budgets for land acquisition of three of the largest area-wide HCPs

include \$526 million for Coachella Valley, \$297 million for East Contra Costa, and \$160 million for San Joaquin. These costs are borne over the life of their respective permits, typically 30 years or longer. Santa Clara estimates that land acquisition will represent 72 percent of all capital costs associated with its HCP, or approximately \$238 million. The Western Riverside HCP authority expects land acquisition costs to total \$812 million over 75 years. In all these cases, the environmental impact mitigation costs are comparable to the costs to build a road, an overpass, or a transit station.

HCP agencies receive planning assistance through grants from the Fish and Wildlife Service, but Congress has steadily reduced funding for these grants despite the increasing number of applicants. Several other federal and state programs fund the acquisition of environmentally sensitive land, but well-intentioned restrictions limit their availability to transportation agencies. Because resource agencies believe that transportation agencies should bear the full cost of mitigating damage done by transportation projects, funding from federal and state resource agencies can be used to acquire sensitive land *only* when it is *not* used to mitigate the impacts of transportation projects.

Some local jurisdictions devote general revenues to the financing of HCPs. Another important source of local funding is impact fees levied on residential, commercial, and industrial projects. The fees are collected when building permits are issued for new development. The Riverside County HCP authority, for example, obtains about two-thirds of its revenue from fees on new development. Many areas, like Clark County, Nevada, charge impact fees on all new development even if it does not impinge upon sensitive habitats. But impact fees suffer from a systematic shortcoming. When the economy is expanding and new development is booming, revenues from impact fees rise, but so do prices that must be paid to acquire land needed to implement the HCPs. During recessions, when development slows, land prices drop and HCP agencies can buy land at lower costs, but the impact fee revenue also drops. Few sources provide bridge funding that would allow HCPs to borrow money for land purchases during economic downturns when prices are low, and repay with interest when the economy improves and revenues from development fees rise. ➤



Advanced regional mitigation can effectively reduce the time and cost of complex transportation investment projects while protecting the environment more than traditional project-level or piecemeal mitigations.

INNOVATIONS IN HCP FUNDING

Because of steadily decreasing federal and state funding, transportation projects are increasingly financed by Local Option Sales Taxes (LOSTs), typically created by referenda at the county level. About half of the counties in California, home to over 80 percent of the state's population, have enacted LOSTs to finance voter-approved projects, an impressive feat considering approval of such measures requires a super-majority of two-thirds of those voting. Recognizing the long-term cost savings HCPs produce, a few counties have recently passed sales tax measures that include funding for land acquisition by HCPs. And, while environmental interest groups had traditionally opposed ballot measures to finance transportation infrastructure, their support has been instrumental in achieving voter approval for HCP funding. Orange County's Measure M2 allowed the county to acquire rapidly developing land to mitigate future construction of roads named in the measure. San Diego County's TRANSNET sales tax, which will provide over \$14 billion for transportation improvement projects, incorporates \$650 million in mitigation measures, including HCP land acquisition. Environmental advocacy groups also supported including HCP land acquisition within the TRANSNET sales tax. This support represents a notable reversal since environmentalists had traditionally opposed tax measures to fund transportation projects they believed harmed the natural environment.

LOOKING TOWARD THE FUTURE

The benefits of advanced mitigation are gradually being recognized. Funding, for HCPs, however, must be pieced together from disparate sources. Local governments are the primary funders of HCPs, with state and federal agencies contributing when expenditures are consistent with program rules. Consolidating funding from state and federal programs to enable advanced mitigation planning would benefit HCPs and transportation agencies. The creation of state- and federal-level conservation clearinghouses might provide one avenue to available grant money, facilitating larger-scale conservation projects while reducing administrative costs to the local applicants. One example of this method is the Conserve Florida Water Clearinghouse, a collaboration of the Florida Department of Environmental Protection and Regional Water Management Districts, supported by state legislation to unify water conservation efforts. These programs streamline access to multiple grant programs into a single application.

Establishing low-interest, revolving-loan funds dedicated to species conservation would also increase transportation agencies' access to streamlined funding for HCPs. This could be done under the auspices of State Infrastructure Banks or through financing by the federal Transportation Infrastructure Finance and Innovation Act (TIFIA). HCPs can also access wetlands conservation loans from a fund established under the Clean Water Act, and have pursued similar loans through federal infrastructure loan programs. But establishing a revolving-loan fund dedicated to species protection, perhaps under the ESA, would provide greater access to low-interest loans for HCPs pursuing efficient, lower-cost land acquisition strategies. This bridge funding would be especially valuable when development slows, impact fee revenues decline, and land prices drop.

Our case studies of HCPs show that advanced regional mitigation can effectively reduce the time and cost of complex transportation investment projects while protecting the environment more than traditional project-level or piecemeal mitigations. Advanced regional mitigation is a strategy that could also be employed for mitigation required by federal and state environmental programs besides the ESA. Money spent early in the planning process has proven to be well spent because it produces long-term benefits. Today, there is both a need for and an opportunity to facilitate regional approaches to advanced mitigation by describing them more explicitly in the federal, state, and local instruments by which transportation and environmental conservation programs are funded. ♦

FURTHER READING

Jaimee Lederman and Martin Wachs. 2014. "Habitat Conservation Plans: Preserving Endangered Species and Delivering Transportation Projects," *Transportation Research Record*, 2403: 9–16.

Jaimee Lederman and Martin Wachs. 2014. *Improving Planning and Project Delivery while Preserving Endangered Species*. UCTC-FR-2014-04.

Jaimee Lederman, Martin Wachs, Melanie Schlotterbeck, and Gian-Claudia Sciara. 2014. *Task 4 Report: Funding and Financial Mechanisms to Support Advance Mitigation*. California Department of Transportation, Institute of Transportation Studies, UC Davis, UCD-ITS-RP-15-04.

Gian-Claudia Sciara, Jacquelyn Bjorkman, Jaimee Lederman, Martin Wachs, Jim Thorne, and Stuart Kirkham. 2015. "Experimentation and Innovation in Advance Mitigation: Lessons from California," *Transportation Research Record*, 2502: 144–153.

Marie Venner. 2005. *Early Mitigation for Net Environmental Benefit: Meaningful Off-Setting Measures for Unavoidable Impacts*. National Cooperative Highway Research Program, Transportation Research Board, NCHRP Project 25-25 Task 10.



Cutting the Cost of Parking Requirements

DONALD SHOUP

A city can be friendly to people or it can be friendly to cars, but it can't be both.

Enrique Peñalosa

At the dawn of the automobile age, suppose Henry Ford and John D. Rockefeller had hired you to devise policies to increase the demand for cars and gasoline. What planning regulations would make a car the obvious choice for most travel? First, segregate land uses (housing here, jobs there, shopping somewhere else) to increase travel demand. Second, limit density at every site to spread the city, further increasing travel demand. Third, require ample off-street parking everywhere, making cars the default way to travel.

American cities have unwisely embraced each of these car-friendly policies, luring people into cars for 87 percent of their daily trips. Zoning ordinances that segregate land uses, limit density, and require lots of parking create drivable cities but prevent walkable neighborhoods. Urban historians often say that cars have changed cities, but planning policies have also changed cities to favor cars over other forms of transportation.

Minimum parking requirements create especially severe problems. In *The High Cost of Free Parking*, I argued that parking requirements subsidize cars, increase traffic congestion and carbon emissions, pollute the air and water, encourage sprawl, raise housing costs, degrade urban design, reduce walkability, damage the economy, and exclude poor people. To my knowledge, no city planner has argued that parking requirements do *not* have these harmful effects. Instead, a flood of recent research has shown they *do* have these effects. We are poisoning our cities with too much parking.

Minimum parking requirements are almost an established religion in the planning profession. One shouldn't criticize anyone else's religion but, when it comes to parking requirements, I'm a protestant and I think the profession needs a reformation.

Donald Shoup is Editor of ACCESS and Distinguished Research Professor of Urban Planning in UCLA's Luskin School of Public Affairs (shoup@ucla.edu).

THE HIGH COST OF MINIMUM PARKING REQUIREMENTS

Planners are placed in a difficult position when asked to set parking requirements in zoning ordinances because they don't know the demand for parking at every art gallery, bowling alley, dance hall, fitness club, hardware store, movie theater, night club, pet store, tavern, zoo, and hundreds of other land uses. Planners also do not know how much parking spaces cost or how the parking requirements affect everything else in the city. Nevertheless, planners must set the parking requirements for every land use and have adopted a veneer of professional language to justify the practice. Planning for parking is an ad-hoc talent learned on the job and is more a political activity than a professional skill. Despite a lack of both theory and data, planners have managed to set parking requirements for hundreds of land uses in thousands of cities—the ten thousand commandments for off-street parking.

Without knowing how much the required parking spaces cost to build, planners cannot know how much parking requirements increase the cost of housing. Small, spartan apartments cost much less to build than large, luxury apartments, but their parking spaces cost the same. Many cities require the same number of spaces for all apartments regardless of their size; the cost of the required parking thus greatly increases the price of low-income housing.

Parking requirements reduce the cost of owning a car but raise the cost of everything else. Recently, I estimated that the parking spaces required for shopping centers in Los Angeles increase the cost of building a shopping center by 67 percent if the parking is in an aboveground structure and by 93 percent if the parking is underground.

Developers would provide some parking even if cities did not require it, but parking requirements would be superfluous if they did not increase the parking supply. This increased cost is then passed on to all shoppers. For example, parking requirements raise the price of food at a grocery store for everyone, regardless of how they travel. People who are too poor to own a car pay more for their groceries to ensure that richer people can park free when they drive to the store.

Minimum parking requirements resemble what engineers call a *kludge*: an awkward but temporarily effective solution to a problem, with lots of moving parts that are clumsy, inefficient, redundant, hard to understand, and expensive to maintain. Instead of reasoning about parking requirements, planners must rationalize them. Parking requirements result from complex political and economic forces, but city planners enable these requirements and sometimes even oppose efforts to reform them. Ultimately, the public bears the high cost of this pseudoscience. ➤



A single parking space can cost far more to build than the net worth of many American households.

THE MEDIAN IS THE MESSAGE

Cities require parking for every building without considering how the required spaces place a heavy burden on poor people. A single parking space, however, can cost far more to build than the net worth of many American households.

In recent research, I estimated that the average construction cost (excluding land cost) for parking structures in 12 American cities in 2012 was \$24,000 per space for aboveground parking, and \$34,000 per space for underground parking (Table 1).

By comparison, in 2011 the median net worth (the value of assets minus debts) was only \$7,700 for Hispanic households and \$6,300 for Black households in the United States (Figure 1). One space in a parking structure therefore costs at least three times the net worth of more than half of all Hispanic and Black households in the country. Nevertheless, cities require several parking spaces per household by requiring them at home, work, stores, restaurants, churches, schools, and everywhere else.

Many families have a negative net worth because their debts exceed their assets: 18 percent of all households, 29 percent of Hispanic households, and 34 percent of Black households had zero or negative net worth in 2011 (Figure 2). The only way these indebted people can use the required parking spaces is to buy a car, which they often must finance at a high, subprime interest rate. In a misguided attempt to provide free parking for everyone, cities have created a serious economic injustice by forcing developers to build parking spaces that many people can ill afford.

Urban planners cannot do much to counter the inequality of wealth in the US, but they can help to reform parking requirements that place heavy burdens on minorities and the poor. Simple parking reforms may be city planners' cheapest, fastest, and easiest way to achieve a more just society. >

TABLE 1
The Construction Cost
of a Parking Space

CITY	CONSTRUCTION COST PER SQUARE FOOT		CONSTRUCTION COST PER PARKING SPACE	
	UNDERGROUND \$/SQ FT (1)	ABOVEGROUND \$/SQ FT (2)	UNDERGROUND \$/SPACE (3) = (1) x 330	ABOVEGROUND \$/SPACE (4) = (2) x 330
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

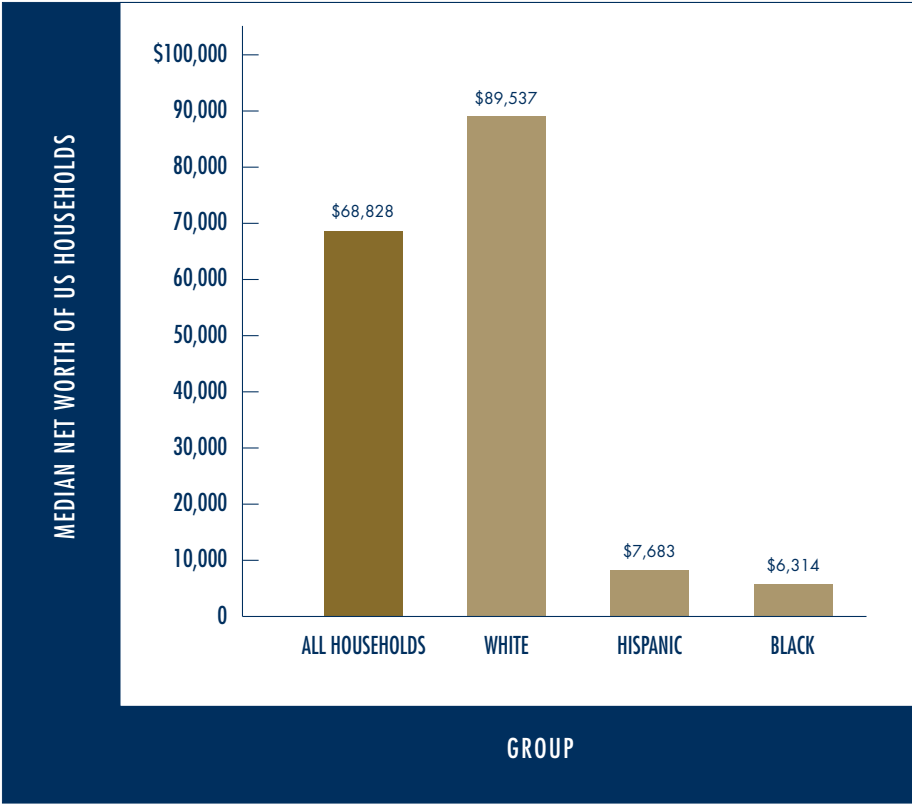


FIGURE 1
Median Net Worth of US Households, 2011

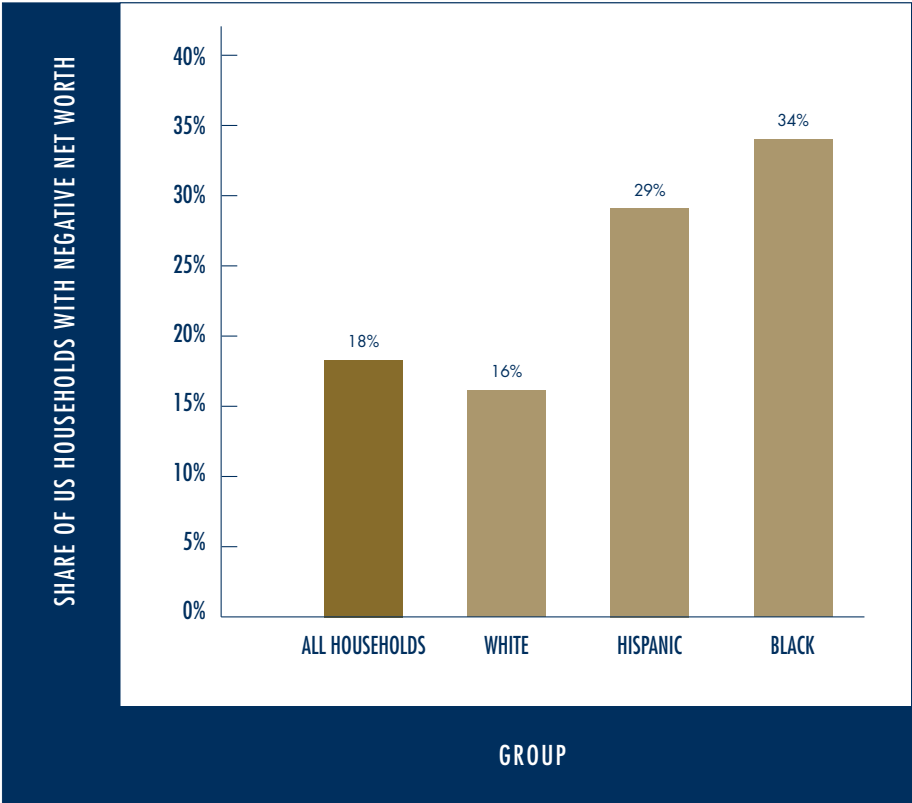


FIGURE 2
Share of US Households with Zero or Negative Net Worth, 2011



PUTTING A CAP ON PARKING REQUIREMENTS

Off-street parking requirements increase the cost and reduce the supply of affordable housing. Most cities do not intend to exclude low-income residents when they require off-street parking, but even good intentions can produce bad results. Thoughtless planning for parking can be as harmful as a perverse and deliberate scheme.

Perhaps because of growing doubts about parking requirements, a few cities have begun to reduce or remove them, at least in their downtowns. Planners and elected officials are beginning to recognize that parking requirements increase the cost of housing, prevent infill development on small lots where it is difficult to build all the required parking, and prohibit new uses for older buildings that lack the required parking spaces.

According to recent newspaper articles, some of the reasons cities have reduced or removed their parking requirements include “to promote the creation of downtown apartments” (Greenfield, Massachusetts), “to see more affordable housing” (Miami), “to meet the needs of smaller businesses” (Muskegon, Michigan), “to give business owners more flexibility while creating a vibrant downtown” (Sandpoint, Idaho), and “to prevent ugly, auto-oriented townhouses” (Seattle).

Given this policy momentum, I thought the time to reform parking requirements in California had arrived when the legislature considered Assembly Bill 904 (the Sustainable Minimum Parking Requirements Act of 2012). AB 904 would have set an upper limit on how much parking cities can require in transit-rich districts: no more than one space per dwelling unit or two spaces per 1,000 square feet of commercial space. The bill defined these districts as areas within a quarter mile of transit lines that run every 15 minutes or better. If passed it would have been a huge boon for both housing and transit.

There are good reasons to adopt this policy. Federal and state governments give cities billions of dollars every year to build and operate mass transit systems, yet most cities require ample parking everywhere on the assumption that nearly everyone will drive for almost every trip. Minimum parking requirements counteract all these transit investments.

For example, Los Angeles is building its Subway to the Sea under Wilshire Boulevard, which already boasts the city's most frequent bus service. Nevertheless, along parts of Wilshire the city requires at least 2.5 parking spaces for each dwelling unit, regardless of the number of rooms. Similarly, 20 public transit lines serve the UCLA campus near Wilshire Boulevard in Westwood, with 119 buses per hour arriving during the morning peak. Nevertheless, across the street from campus, Los Angeles requires 3.5 parking spaces for every apartment that contains more than four rooms. We have expensive housing for people but we want free parking for cars.

Also on Wilshire Boulevard, Beverly Hills requires 22 parking spaces per 1,000 square feet for restaurants, which means the parking lot is seven times larger than the restaurant it serves. Public transit in this over-parked environment resembles a rowboat in the desert.

Cities seem willing to pay any price and bear any burden to assure the survival of free parking. But do people really want free parking more than affordable housing, clean air, walkable neighborhoods, good urban design, and many other public goals? A city where everyone happily pays for everyone else's free parking is a fool's paradise.

WHY CAP PARKING REQUIREMENTS?

Minimum parking requirements create an asphalt wasteland that blights the environment. A powerful force field of free parking encourages everyone to drive everywhere. A cap on parking requirements in transit-rich neighborhoods can reduce this parking blight by making parking-light development feasible.

How will reducing off-street parking requirements affect development? Zhan Guo and Shuai Ren at New York University studied the results when London shifted from minimum parking requirements with no maximum, to maximum parking limits with no minimum. Comparing developments completed before and after the reform in 2004, they found that the parking supplied after the reform was only 52 percent of the previous minimum required and only 68 percent of the new maximum allowed. This result implies that the previous minimum was almost *double* the number of parking spaces that developers would have voluntarily provided. Guo and Ren concluded that removing the parking minimum caused 98 percent of the reduction in parking spaces, while imposing the maximum caused only 2 percent of the resulting reduction. Removing the minimum had a far greater effect than imposing a maximum.

Cities usually require or restrict parking without considering the middle ground of neither a minimum nor a maximum. This behavior recalls a Soviet maxim: "What is not required must be prohibited." AB 904, however, was something new. It would not have restricted parking but instead would have imposed a cap on minimum parking requirements, a far milder reform. A cap on how much parking cities can require will not limit the parking supply because developers can always provide more parking than the zoning requires if they think market demand justifies the cost.

There are precedents for placing limits on parking requirements. Oregon's Transportation Systems Plan requires local governments to amend their land-use and subdivision regulations to achieve a 10 percent reduction in the number of parking spaces per capita. The United Kingdom's transport policy guidelines for local planning specify that "plans should state maximum levels of parking for broad classes of development ... There should be no minimum standards for development, other than parking for disabled people." >

A city where
everyone
happily pays for
everyone else's
free parking is a
fool's paradise.

FAILURE AND THEN SUCCESS IN THE LEGISLATURE

To my dismay, the California Chapter of the American Planning Association (APA) lobbied against AB 904, arguing that it “would restrict local agencies’ ability to require parking in excess of statewide ratios for transit intensive areas unless the local agency makes certain findings and adopts an ordinance to opt out of the requirement.”

City planners must, of course, take direction from elected officials, but the APA represents the planning profession, not cities. AB 904 gave the planning profession an opportunity to support a reform that would coordinate parking requirements with public transportation, but instead the California APA insisted that cities should retain full control over parking requirements, despite their poor stewardship.

AB 904 failed to pass in 2012 but was resurrected in a weaker form as AB 744 and was successful in 2015. AB 744 addresses the parking requirements for low-income housing within half a mile of a major transit stop. If a development is entirely composed of low-income rental housing units, California now caps the parking requirement at 0.5 spaces *per dwelling unit*. It also caps the parking requirement for a development that includes at least 20 percent low-income or 10 percent very low-income housing at 0.5 spaces *per bedroom*. Developers can of course provide more parking if they want to, but cities cannot require more parking unless they conduct a study that demonstrates a need.

Affordable housing advocates initially opposed AB 744 because it would have capped the parking requirements for *all* housing in transit-rich areas. Another California law (SB 1818) already reduces the parking requirements for developments that include some affordable units.

Like the
automobile
itself, parking
is a good
servant but a
bad master.



Reducing the parking requirements for all housing would therefore dilute the existing incentive to include affordable units in market-rate developments. Confining AB 744's parking reduction to affordable housing was therefore necessary to gain political support from the affordable housing advocates, even though a cap on parking requirements for *all* housing would increase the supply and reduce the price of housing without any subsidy.

Statewide caps on parking requirements may be difficult to impose in the face of the demand for local control in all land use decisions. Nevertheless, the California experience shows that a statewide cap can be feasible if it is linked to affordable housing. This link attracted political support from affordable housing advocates who know that parking requirements are a severe burden on housing development, and that reducing the parking requirements for affordable housing will increase its supply.

Without the support from affordable housing advocates, California's cap on parking requirements near transit would probably not have been enacted. Until more people recognize that parking requirements cause widespread damage, one way to increase political support for a cap on parking requirements is to use it as an incentive for building affordable housing. This approach, however, may then lead affordable housing advocates to oppose any general reduction in parking requirements even if it will make all housing more affordable.

AN ARRANGED MARRIAGE

Many believe that Americans freely chose their love affair with the car, but it was an arranged marriage. By recommending parking requirements in zoning ordinances, the planning profession was both a matchmaker and a leading member of the wedding party. But no one provided a good prenuptial agreement. Planners should now become marriage counselors or divorce lawyers where the relationship between people and cars no longer works well.

Like the automobile itself, parking is a good servant but a bad master. Parking should be friendly—easy to find, easy to use, and easy to pay for—but cities should not require or subsidize parking. Cities will look and work much better when markets rather than planners and politicians govern decisions about the number of parking spaces. Putting a cap on parking requirements is a good place to start. ♦

FURTHER READING

California Assembly Bill 744. 2015. "AB-744 Planning and Zoning: Density Bonuses."

Zhan Guo and Shuai Ren. 2013. "From Minimum to Maximum: Impact of the London Parking Reform on Residential Parking Supply from 2004 to 2010," *Urban Studies* 50(6): 1183–1200.

Letters about AB 904 from mayors, planning academics, planning practitioners, and the California Chapter of APA are available here: <http://shoup.bol.ucla.edu/LettersAboutAssemblyBill904.pdf>

Donald Shoup. 2015. "Putting a Cap on Parking Requirements," *Planning*, May: 28–30.

Donald Shoup. 2014. "The High Cost of Minimum Parking Requirements," in Stephen Ison and Corinne Mulley (Eds.), *Parking: Issues and Policies*, Emerald Group Publishing: 87–113.

Donald Shoup. 2013. "On-Street Parking Management v. Off-Street Parking Requirements," *ACCESS*, 42: 38–40.

Donald Shoup. 2011. *The High Cost of Free Parking*. Chicago: Planners Press.



Running to Work

 ROBERT CERVERO

Lacing up
running
shoes and
hoofing it
to work is
arguably the
most active
form of
active
transport.

As a transportation researcher, I sometimes get asked what falls into the Census’s “other” category of how people get to work—hoverboarding, rollerblading, kayaking? In Ottawa, three percent of commuters ice-skate to work in winter months. In other cities, notably big, dense ones with awful traffic and jam-packed subways, an increasingly popular way to commute is running. Lacing up running shoes and hoofing it to work is arguably the most active form of active transport and helps meet the Surgeon General’s recommended 30 or more minutes of physical activity per day. Combining two things we need to do—exercising and getting to work—can pay off. Research shows active commuters cut their odds of obesity by 50 percent.

Running as part of one’s daily livelihood is not new. Our Neolithic ancestors survived by chasing and eventually wearing down their prey. Many of Kenya’s great endurance athletes spent their youth running long distances to and from school in the highlands of the Rift Valley. Running to stay fit, however, is a fairly recent phenomenon, and running to work even more so.

Being a runner, I wanted to learn what we know about this subject. It turns out there is little research on run commuting. In the past few years, however, dozens of websites and blogs have appeared, offering tips and chronicling the growing popularity of this travel mode. For example, The Run Commuter (theruncommuter.com) aims to “educate and encourage people to replace, modify, or supplement their automobile, public transit, or bike commutes with running.” A non-profit organization in Brazil, Corridamiga, pairs “running buddies” to “inspire people to run for urban mobility.”

WHERE IT IS TRENDING AND TRENDY

In 2014, The Run Commuter surveyed 145 runners from 22 countries to learn who run commutes. The majority are college-educated, married, white males. In the US, run commuting is particularly popular in Washington, DC. Worldwide, London is the epicenter of the run-commuting movement. Both cities are natural habitats for run commuting with their traffic congestion, crowded subways, legions of fitness-minded professionals (many training for marathons and triathlons), workplaces that offer showers, downtown gyms, and linear networks of parks, bike paths, and trails that feed into the business districts. Both cities also have well-landscaped, run-inspiring riverfronts. Simon Cook at Royal Holloway University wrote a thesis

Robert Cervero is Professor and Chair of City and Regional Planning at the University of California Berkeley, the Carmel P. Friesen Chair in Urban Studies, and Director of the University of California Transportation Center (robertc@berkeley.edu).



on run commuting, characterizing evenings along the Thames Path as a steady stream of “trainer-clad, backpack-laden, GPS-tracked, fluorescent, sweaty, speedy people making their way from a day at the office.”

Run commuting in London picked up steam during the 2012 Olympics, when transport networks were saturated. Two years later, run commuting had increased threefold. London’s geography also played a role. Every weekday, hordes of workers arrive at one of London’s eight mainline train stations to complete the last leg of their journeys. For many, finishing the last three to five miles on their own is preferable to overcrowded Tube trains. With 14 cyclists killed on London’s roads in 2013, some view running as a safer option.

London’s active run-commuting scene has spawned a variety of running services. Home Run London, the first service of its kind, carries runners’ backpacks or even the runners themselves if they become too tired. The Run2Work campaign, an “awareness-raising, tip-sharing, and encouragement-giving” program, sponsors a run-to-work day the first Thursday of every month and lobbies for the same favorable tax breaks accorded to UK cyclists.

Surveys by The Run Commuter and others in the UK found that most run commuters run to work two to three times per week, averaging around five miles each way. Although the majority run to and from work the same day, many take transit or bike part of the way. There are of course those who run more than others. For the past decade, a small group of Bay Area runners have gathered at 5 am twice a week, every week, for a 15-plus-mile run between Marin County and their jobs in downtown San Francisco. Also twice a week, a medical researcher runs 16 miles each way over hilly dirt roads to her job at the University of Michigan (equivalent to two 50Ks, every week). ➤

Longer term, run commuting has the opposite effect of car commuting, reducing rather than increasing anxiety and stress.

THE LIKES AND DISLIKES OF RUN COMMUTING

What motivates people to run commute? For many, it kills two birds with one stone: combining exercise with commuting. Some are drawn to it as the cleanest, healthiest, lowest-cost commute available. Others prefer it over the stress of fighting traffic, cramped trains, overcrowded platforms, and rude passengers. Still others like the mental benefits—it provides an endorphin rush, elevates moods, enables escapism, and increases productivity at work. Longer term, run commuting has the opposite effect of car commuting, reducing rather than increasing anxiety and stress. Some appreciate the improved work-life balance afforded by run commuting—achieving fitness and training goals while freeing time for friends and family.

To further probe their likes and dislikes, I surveyed 77 run commuters in the US and UK. Respondents were a hearty bunch, averaging three runs per week at a distance of 5.5 miles and a speed of 9 minutes per mile. The most common reason they gave for run commuting was to get in a workout (68 percent of respondents). Next were the mental benefits of mood improvement and escapism (38 percent of respondents). The other top reasons in order were efficiency (it saves time by combining exercise and commuting), being outdoors, saving money, and reducing stress.

What respondents most disliked about run commuting was carrying items in backpacks (33 percent), followed by logistics (e.g., planning for access to clothing and toiletries at work), weather, the absence of showers at workplaces, running in the dark, and arriving at work sweaty.



POLICIES FOR RUN COMMUTING

My survey also included a few policy-related questions. For the days the respondents did not run commute, many were still active commuters—44 percent biked and 22 percent walked. More common, however, was taking transit. Around a third drove some of their non-running days.

Showers and lockers were often a prerequisite to run commuting—they were available to 82 percent of respondents. Providing a shower is far less costly to employers than subsidizing parking spaces and can also attract fitness-minded employees. In London, firms like Barclays and GE showcase their on-site shower facilities as a recruiting tool. London's new Zig-Zag office building markets its basement shower and locker facilities to prospective tenants.

Many measures currently used to encourage cycling can also promote run commuting (e.g., protected pathways, tax breaks, mandatory showers at workplaces). The casual attitude found at many start-ups and high-tech firms also encourage run commuting—informal dress, a free breakfast, and including time spent showering as paid hours.

MY EXPERIENCE

I decided to immerse myself in the subject matter and give active commuting a try. In my case, it meant running from my home in Lafayette, California, to the UC Berkeley campus. It's exactly 10 miles each way, with lots of ups and downs along curvy residential streets, as well as stretches of two-lane arteries without sidewalks or bike paths. I've done plenty of long runs, making the distance seem manageable, and I could shower and change clothes at the gym near my office. Nevertheless, this would be the most physical effort I put into getting to and from work in a single day. And since I did this in January, it meant heading off to work in the dark, guided by a headlamp, and returning home in the dark as well.

My main question was how the experience would affect my productivity and mood. With 1,800 feet of elevation gain, the morning run commute took over two hours, considerably more than my typical 20-minute drive to work. Since I also got in my morning workout, however, the change was a wash time-wise, with roughly the same total time devoted to commuting and exercising. The big difference, however, was that I had at least another two hours to run in the evening. While I felt as alert and keyed into my work as when I drive (one colleague even said I seemed unusually perky that day), I was exhausted by the time I got home.

My own situation, with a mountain separating my home and workplace, makes door-to-door, bi-directional run commuting impractical. For this reason, I did a "linked run commute" the following week, taking BART part of the way. This cut my round-trip commute time by 60 percent and elevation gain by 83 percent, reducing my after-work exhaustion.

Will I do it again? Probably, though only the easier rail-linked version. What I liked was the efficiency of run commuting—combining both utilitarian travel and exercise. What I disliked was the logistical hassle of organizing and dropping off my clothes, laptop, etc. at my office the day before the runs.

If you enjoy running, give it a try, in whatever form works best for you. You'll shrink your carbon footprint, perhaps shed a few pounds, and maybe even arrive at work feeling on top of the world. ♦

FURTHER READING

Simon Cook. 2014. "Jography: Exploring the Mobilities of Road Running," PhD dissertation, Royal Holloway, University of London.

Penny Gordon-Larsen, Janne E. Boone-Heinonen, Steve Sidney, Barbara Sternfeld, David R. Jacobs, and Cora E. Lewis. 2009. "Active Commuting and Cardiovascular Disease Risk: The CARDIA Study," *Archives of Internal Medicine*, 169(13): 1216–23.

The Run Commuter.
<http://theruncommuter.com/>

**Taptich, Michael and
Arpad Horvath**

Air Emission Reduction
Opportunities for
California's Trucking
Sector by 2020 and 2050
AUGUST 2015

**Rayle, Lisa, Susan Shaheen,
Nelson Chan, Danielle Dai,
and Robert Cervero**

App-Based, On-Demand
Ride Services: Comparing
Taxi and Ridesourcing Trips
and User Characteristics in
San Francisco
AUGUST 2014

**Smart, Michael J.,
Kelcie M. Ralph,
Brian D. Taylor,
Carole Turley, and
Anne E. Brown**

Honey, Can You Pick-Up
Groceries on Your Way
Home? Analyzing Activities
and Travel Among Students in
Non-Traditional Households
JULY 2014

**Circella, Giovanni,
Andrew McFadden,
and Farzad Alemi**

California Beyond SB 375:
Evaluating the Impact of
Proposed Land Use and
Transportation Plans on
Future Travel Patterns and
Interregional Travel Behavior
JUNE 2014

**Jariyasunant, Jerald,
Raja Sengupta, and
Joan Walker**

Overcoming Battery Life
Problems of Smartphones
When Creating Automated
Travel Diaries
MAY 2014

**Lederman, Jaimee
and Martin Wachs**

Transportation and Habitat
Conservation Plans: Improving
Planning and Project Delivery
While Preserving Endangered
Species
APRIL 2014

**Grembek, Offer,
Katherine Leung,
Aditya Medury,
Phyllis Orrick, and
David R. Ragland,**

**UC Berkeley;
Anastasia Loukaitou-Sideris,
Camille N.Y. Fink,
Justin Resnick, and
Norman Wong, UCLA;
Kevan Shafizadeh and
Ghazan Khan, California
State University, Sacramento**
A Comparative Analysis of
Pedestrian and Bicyclist Safety
Around University Campuses
MARCH 2014

**Lovejoy, Kristin and
Susan Handy**

The Impacts of Big Box Retail
on Downtown: A Case Study
of Target in Davis, California
JANUARY 2014

**Deakin, Elizabeth,
Karen Trapenberg Frick,
and Kathleen Phu**

Risk Assessment and
Risk Management for
Transportation Research
JANUARY 2014

**Blumenberg, Evelyn and
Gregory Pierce**

Multimodal Travel and the
Poor: Evidence from the
2009 National Household
Travel Survey
AUGUST 2013

**Chatman, Daniel G.,
Andrea Broaddus,
Cheryl Young, and
Matthew Brill**

The Role of Behavioral
Economics in Residential
Choice: A Pilot Study of
Travel Patterns, Housing
Characteristics, Social
Connections, and Subjective
Well-Being
JULY 2013

**Manville, Michael,
Alex Beata, and
Donald Shoup**

Turning Housing into Driving:
Parking Requirements and
Density in Los Angeles and
New York
JUNE 2013

**Pierce, Gregory and
Donald Shoup**

Getting the Prices Right: An
Evaluation of Pricing Parking
by Demand in San Francisco
MAY 2013

Cervero, Robert

Traffic Impacts of Variable
Pricing on the San Francisco-
Oakland Bay Bridge,
California
FEBRUARY 2013

**Barnes, Ian C.,
Karen Trapenberg Frick,
Elizabeth Deakin, and
Alexander Skabardonis**

Impact of Peak and Off-Peak
Tolls on Traffic in San
Francisco-Oakland Bay Bridge
Corridor in California
FEBRUARY 2013

**Cervero, Robert,
Benjamin Caldwell,
and Jesus Cuellar**

Bike-and-Ride: Build It and
They Will Come
DECEMBER 2012

**Hanning, Cooper,
Michael Jerrett,
Jason G. Su, and
Jennifer Wolch**

Safe Routes to Play?
Pedestrian and Bicyclist
Crashes Near Parks in the Los
Angeles Region
SEPTEMBER 2012

**Blumenberg, Evelyn,
Brian D. Taylor,
Michael Smart, Kelcie
Ralph, Madeline Wander,
and Stephen Brumbaugh**

What's Youth Got to Do with
It? Exploring the Travel
Behavior of Teens and
Young Adults
SEPTEMBER 2012

**Yoh, Allison,
Brian D. Taylor,
and John Gahbauer**

Does Transit Mean Business?
Reconciling Academic,
Organizational, and Political
Perspectives on Reforming
Transit Fare Policies
JUNE 2012

**Jariyasunant, Jerald,
Andre Carrel,
Venkatesan Ekambaram,
David Gaker, Raja Sengupta,
and Joan L. Walker**

The Quantified Traveler:
Changing Transport Behavior
with Personalized Travel
Data Feedback
MAY 2012

All papers are available at
www.uctc.net/research/facultypapers.shtml and
www.ucconnect.berkeley.edu/research

DISSERTATIONS

Ralph, Kelcie

Stalled on the Road to Adulthood? Assessing the Nature of Recent Travel Changes for Young Adults in America, 1995-2009
UC LOS ANGELES, 2015

Regue, Robert

Proactive Vehicle Routing to Solve the Dynamic Bike Sharing Rebalancing Problem with Potential Extension to Shared Station Vehicle Systems
UC IRVINE, 2015

Schulte, Nico

The Effect of the Urban Environment on Concentrations of Vehicle Emitted Pollutants
UC RIVERSIDE, 2015

Wang, Ke

A Framework for Analyzing Public-Private Partnerships for Road Transportation under Demand Uncertainty
UC IRVINE, 2015

Wong, Tim

Econometric Models in Transportation
UC IRVINE, 2015

Thomas, Alainna

Collaboration and Learning: The Means to Sustainable Transportation in China
UC BERKELEY 2014

Griswold, Julia Baird

Tradeoffs between Costs and Greenhouse Gas Emissions in the Design of Urban Transit Systems
UC BERKELEY 2013

Kang, Jee Eun

Integration of Locational Decisions with the Household Activity Pattern Problem and Its Applications in Transportation Sustainability
UC IRVINE 2013

POLICY BRIEFS

Sivakumaran, Karthik, Yuwei Li, Michael Cassidy, and Samer Madanat
Bus to Rail: a Crucial Link

Cervero, Robert, Benjamin Caldwell, and Jesus Cuellar
and Jesus Cuellar
Bike-and-Ride: Build It and They Will Come (Based on the UCTC Faculty Research Paper)

Griswold, Julia, Samer Madanat, and Arpad Horvath
Designing Low-Carbon Transit Systems

Loukaitou-Sideris, Anastasia, Harrison Higgins, Dana Cuff, David Dixon, and Dan Oprea
Up in the Air: Urban Design for Light Rail Stations in Highway Medians

Macdonald, Elizabeth, Rebecca Sanders, Paul Supawanich, and Alia Anderson
Performance Measures for Complete Streets

Fink, Camille N. Y. and Brian D. Taylor
Zen in the Art of Travel Behavior: Riders Use Their Cameras to Talk about Their Transit Experience

Orrick, Phyllis, Karen Trapenberg Frick, and David Ragland
Why Do Building Owners Invest in Bicycle-Oriented Design?

Gan, Qijian, Jieli Sun, Wenlong Jin, and Jean-Daniel Saphores
Estimating Emissions Using an Integrated Traffic Model

Dissertations available at
www.uctc.net/research/diss.shtml and
www.ucconnect.berkeley.edu/education/

Policy Briefs available at
www.uctc.net/research/briefs.shtml

BOOKS

Trapenberg Frick, Karen
Remaking the San Francisco–Oakland Bay Bridge: A Case of Shadowboxing with Nature
Routledge, 2016

DiMento, Joseph F.C. and Cliff Ellis
Changing Lanes: Visions and Histories of Urban Freeways
MIT Press, 2012

Rubin, Elihu
Insuring the City: The Prudential Center and the Postwar Urban Landscape
Yale University Press, 2012

Lucas, Karen, Evelyn Blumenberg, and Rachel Weinberger, eds.
Auto Motives: Understanding Car Use Behaviours
Emerald Group Publishing, 2011

Ogden, Joan and Lorraine Anderson
Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers
University of California, Davis, 2011

Shoup, Donald
The High Cost of Free Parking
Planner's Press, 2005 and 2011

Boarnet, Marlon G., ed.
Transportation Infrastructure: The Challenge of Rebuilding America
The American Planning Association, 2009

Dyble, Louise Nelson
Paying the Toll: Local Power, Regional Politics, and the Golden Gate Bridge
University of Pennsylvania Press, 2009

Loukaitou-Sideris, Anastasia and Renia Ehrenfeucht
Sidewalks: Conflict and Negotiation over Public Space
MIT Press, 2009

Sperling, Daniel and Deborah Gordon
Two Billion Cars: Driving Toward Sustainability
Oxford University Press, 2009

Sperling, Daniel and James S. Cannon
Reducing Climate Impacts in the Transportation Sector
Springer, 2008

Cervero, Robert
The Transit Metropolis
Island Press, 1998; China Architecture and Building Press, 2007

ACCESS 47, FALL 2015

We Want to Hear from You!
Dan Spurling

Quantified Traveler: Travel Feedback Meets the Cloud to Change Behavior
Raja Sengupta and Joan L. Walker

Unraveling the Modal Impacts of Bikesharing
Susan Shaheen and Elliot Martin

Does Transit-Oriented Development Need the Transit?
Daniel G. Chatman

Life-Cycle Impacts of Transit-Oriented Development
Matthew J. Nahlik and Mikhail V. Chester

Changing Lanes
Joseph F. C. DiMento and Cliff Ellis

THE ACCESS ALMANAC: Common Ground
Karen Trautenberg Frick

ACCESS 46, SPRING 2015

The Road Less Traveled
John A. Mathews

The Social Context of Travel
Michael J. Smart and Nicholas J. Klein

The First Big-Box Store in Davis
Susan L. Handy, Kristin Lovejoy, Gian-Claudia Sciarra, Deborah Salom, and Patricia L. Mokhtarian

Informal Parking: Turning Problems into Solutions
Donald Shoup

Suburban Transit in Mexico City
Erick Guerra

A Bathtub Model of Downtown Traffic Congestion
Richard Arnott

THE ACCESS ALMANAC: Painting the Present, Imagining the Future
Richard Willson

ACCESS 45, FALL 2014

Passing the Baton
Michael Cassidy, Robert Cervero, and Donald Shoup

Phantom Trips
Adam Millard-Ball

Trip Generation for Smart Growth Projects
Robert J. Schneider, Susan L. Handy, and Kevan Shafiqzadeh

Pounds that Kill
Michael L. Anderson and Maximilian Auffhammer

Fuel-Efficiency Standards: Are Greener Cars Safer?
Mark Jacobsen

An Innovative Path to Sustainable Transportation
Dan Spurling

THE ACCESS ALMANAC: Making Parking Meters Popular
Donald Shoup

ACCESS 44, SPRING 2014

Shedding Weight
John A. Mathews

Parking Requirements and Housing Development: Regulation and Reform in Los Angeles
Michael Manville

Carmageddon in Los Angeles: The Sizzle and the Fizzle
Brian D. Taylor and Martin Wachs

Carmageddon or Carmaheaven? Air Quality Results of a Freeway Closure
Arthur Winer, Yifang Zhu, and Suzanne Paulson

Pursuing the Technological Sublime: How the Bay Bridge Became a Megaproject
Karen Trautenberg Frick

We Can Learn Something from That! Promoting an Experimental Culture in Transportation
Joseph Schofer and Raymond Chan

THE ACCESS ALMANAC: Parking Charity
Donald Shoup

ACCESS 43, FALL 2013

The Goals of ACCESS
Donald Shoup

Going Mental: Everyday Travel and the Cognitive Map
Andrew Mondschein, Evelyn Blumenberg, and Brian D. Taylor

Driving Down Diesel Emissions
Robert Harley

From Fuel Taxes to Mileage Fees
Paul Sorensen

Sfpark: Pricing Parking by Demand
Gregory Pierce and Donald Shoup

Parking Reform Made Easy
Richard Willson

THE ACCESS ALMANAC: Vehicular ad hoc Networks: Storms on the Horizon
Amelia Regan

ACCESS 42, SPRING 2013

Getting on Board with Public Transit
John A. Mathews

Equity as a Factor in Surface Transportation Politics
Alan Altshuler

Parking without Paying
Michael Manville and Jonathan Williams

Is a Half-Mile Circle the Right Standard for TODs?
Erick Guerra and Robert Cervero

Opportunities and Challenges for TODs in Southern California
Anastasia Loukaitou-Sideris

Greenhouse Gas Management: Local Efforts to Curb a Global Phenomenon
Juan Matute

THE ACCESS ALMANAC: On-Street Parking Management v. Off-Street Parking Requirements
Donald Shoup

ACCESS 41, FALL 2012

Twenty Years of ACCESS
Robert Cervero

New Automobile Regulations: Double the Fuel Economy, Half the CO₂ Emissions, and Even Automakers Like It
Nic Lutsey

Two-Way Street Networks: More Efficient than Previously Thought?
Vikash V. Gayah

Peering Inside the Pork Barrel
Gian-Claudia Sciarra

When Do Slower Roads Provide Faster Travel?
Kenneth A. Small and Chen Feng Ng

Will China's Vehicle Population Grow Even Faster than Forecasted?
Yunshi Wang, Jacob Teter, and Daniel Sperling

THE ACCESS ALMANAC: Planning for High Speed Rail
Martin Wachs

ACCESS 40, SPRING 2012

Transit and the "D" Word
Erick Guerra and Robert Cervero

Thinking Outside the Bus
Hiroyuki Iseki, Michael Smart, Brian D. Taylor, and Allison Yoh

The Defeat of the Golden Gate Authority: Regional Planning and Local Power
Louise Nelson Dyble

Dynamic Ridesharing
Elizabeth Deakin, Karen Trautenberg Frick, and Kevin Shively

Can Public Transportation Increase Economic Efficiency?
Matthew Drennan and Charles Brecher

THE ACCESS ALMANAC: Solar Parking Requirements
Donald Shoup

ACCESS 39, FALL 2011

Retrofitting the Suburbs to Increase Walking
Marlon G. Boarnet, Kenneth Joh, Walter Siembab, William Fulton, and Mai Thi Nguyen

Beyond Rationality in Travel Demand Models
Joan L. Walker

The Davis Bicycle Studies: Why Do I Bicycle but My Neighbor Doesn't?
Susan L. Handy

Worldwide Bikesharing
Susan Shaheen and Stacey Guzman

Parking Infrastructure and the Environment
Mikhail Chester, Arpad Horvath, and Samer Madanat

THE ACCESS ALMANAC: Ending the Abuse of Disabled Parking Placards
Donald Shoup

ACCESS 38, SPRING 2011

Small Steps
Michael Manville

Political and Public Acceptability of Congestion Pricing: Ideology and Self-Interest in Sweden
Björn Härsman and John M. Quigley

Transportation, Jobs, and Economic Growth
Martin Wachs

Cash for Clunkers? The Environmental Impact of Mexico's Demand for Used Vehicles
Lucas W. Davis and Matthew E. Kahn

The Impact of Carsharing on Household Vehicle Ownership
Elliot Martin and Susan Shaheen

Free Parking or Free Markets
Donald Shoup

THE ACCESS ALMANAC: Life in the Fast Lane
Eric A. Morris

ACCESS 37, FALL 2010

The Vital Last Step in Research
Donald Shoup

What Density Doesn't Tell Us About Sprawl
Eric Eidlind

Falling Immigration Rates Mean Falling Transit Ridership
Evelyn Blumenberg and Alexandra Norton

Electric Two-Wheelers in China: Promise, Progress and Potential
Christopher Cherry

Life-Cycle Environmental Assessment of California High Speed Rail
Mikhail Chester and Arpad Horvath

Megacities and Megatraffic
Mark Kutzbach

THE ACCESS ALMANAC: Graduated Parking Fines
Donald Shoup

ACCESS 36, SPRING 2010

What are the Key Policy Issues?
Robert Cervero and Karen Trautenberg Frick

Just Road Pricing
Lisa Schweitzer and Brian D. Taylor

Public Parking Spaces for Shared Cars
Andrea Osgood

Restricting Transportation Infrastructure: Bad for Business in California?
Karen Chapple and Carrie Makarewicz

Vibrant Sidewalks in the United States: Re-integrating Walking and a Quintessential Social Realm
Anastasia Loukaitou-Sideris and Renia Ehrenfeucht

Fixing Broken Sidewalks
Donald Shoup

ACCESS 35, FALL 2009

ACCESS Moves to LA
Michael Manville

Traffic Congestion and Greenhouse Gases
Matthew Barth and Kanok Boriboonsomsin

Airport Congestion Management: Prices or Quantities?
Jan Brueckner

Moving Los Angeles
Paul Sorensen

TOD and Carsharing: A Natural Marriage
Robert Cervero

Paved With Good Intentions: Fiscal Politics, Freeways, and the 20th Century American City
Jeffrey Brown, Eric A. Morris, and Brian D. Taylor

ACCESS 34, SPRING 2009

Transportation Technologies for the 21st Century
Elizabeth Deakin

Saving Fuel, Reducing Emissions: Making Plug-In Hybrid Electric Vehicles Cost-Effective
Daniel M. Kammen, Samuel M. Arons, Derek M. Lemoine, and Holmes Hummel

Moving Forward with Fuel Economy Standards
Lee Schipper

Transforming the Oil Industry into the Energy Industry
Daniel Sperling and Sonia Yeh

Intelligent Transport Systems: Linking Technology and Transport Policy to Help Steer the Future
Elizabeth Deakin, Karen Trautenberg Frick, and Alexander Skabardonis

ACCESS 33, FALL 2008

Transportation Planning as an Integral Part of Urban Development: The Emerging Paradigm
Elizabeth A. Deakin

Multimodal Transportation in California: Connecting Planes, Trains, and Automobiles
Adib Kanafani

Planning Water Use in California
William Eisenstein and G. Mathias Kondolf

Integrating Infrastructure Planning: The Role of Schools
Deborah McKay, Jeff Vincent, and Carrie Makarewicz

Transportation Infrastructure and Sustainable Development: New Planning Approaches for Urban Growth
Marlon G. Boarnet

ACCESS 32, SPRING 2008

California's Growth: An Uncertain Future
Michael B. Teitz

California Futures: Accommodating Growth in an Era of Climate Change and Rising Fuel Prices
Elizabeth Deakin

The Challenge of Urban Transportation in California
Elizabeth Deakin and Robert Cervero

A Strategy for Infrastructure: The California Infrastructure Initiative
David E. Dowall and Robin Reid

California's Housing Problem
Cynthia Kroll and Krute Singa

SUBSCRIPTIONS TO ACCESS

To receive a free subscription to *ACCESS*, please go to:

www.accessmagazine.org/subscribe

Enter your email address and click "join." You will then be asked to confirm your subscription.

You can also find us here:

<https://www.facebook.com/read.access>

https://twitter.com/Access_Magazine

ACCESS is published twice a year.



VISIT OUR WEBSITE AT
www.accessmagazine.org



ACCESS NUMBER 48, SPRING 2016

UCCONNECT Director
Michael Cassidy

UCTC Director
Robert Cervero

Editor
Donald Shoup

Managing Editor
John A. Mathews

Associate Editors
Anne Brown
Trevor Thomas

Design
Mitche Manitou

Editorial Board
Matthew Barth
Michael Cassidy
Robert Cervero
Mikhail Chester
Elizabeth A. Deakin
Susan Handy
Amelia Regan
Donald Shoup
Brian Taylor
Karen Trapenberg Frick
Richard Willson

Assistant Editors
Sam Blake
Katherine Bridges
Jordan Fraade
Emory Johnson
Rosemary McCarron
Evan Scott Moorman
Taner Osman
Heidi Schultheis
Ryan Sclar
Andrew Stricklin
Ryan Taylor-Gratzer
Zoe Unruh
Julie Wedig

PHOTO CREDITS

p. 3: PluginCars.com and Leanne Kroll,
www.leannekroll.com

p. 8: Anders Ryerson

**INSTITUTE OF TRANSPORTATION STUDIES
UCLA
405 HILGARD AVE
BOX 951656
LOS ANGELES, CA 90095-1656**

ADDRESS SERVICE REQUESTED

**NON-PROFIT ORGANIZATION
U.S. POSTAGE PAID
UNIVERSITY OF CALIFORNIA
LOS ANGELES**

