NATIONAL HOUSEHOLD TRAVEL SURVEY

Compendium of Uses

January 2015 - June 2015
Introduction

This compendium contains various uses and applications of the National Household Travel Survey (NHTS) data used in transportation planning and research from January 2015 to June 2015. Published journal articles and reports that cite the use of NHTS data were selected using the Transportation Research Board (TRB) Annual Meeting Online Portal http://amonline.trb.org/ and Google Alerts, notification emails sent by Google when new search results matched predetermined search terms pertaining to NHTS data. The key word and search engine terms used in both online sources were the National Household Travel Survey and NHTS.

The research papers were grouped into 11 categories that were created based on the Subject Areas and index terms identified in each abstract as well as category titles used in previous NHTS compendium databases. The categories are as follows:

1. Bicycle and Pedestrian Studies
2. Demographic Trends
3. Energy Consumption
4. Environment
5. Policy and Mobility
6. Special Population Groups
7. Survey, Data Synthesis, and Other Applications
8. Traffic Safety
9. Transit Planning
10. Travel Behavior
11. Trend Analysis and Market Segmentation

A one-page description of each paper is provided which includes the Title, Authors, Abstract, Subject Areas, and Availability.

Research articles and reports in this document cover a diverse range of topics in the areas of transportation, health, safety, environment, and engineering and were published in various journals including, but not limited to, the American Journal of Public Health, the International Journal of Behavioral Nutrition and Physical Activity, and the National Center for Transit Research. Several papers were also submitted by researchers and graduate students for presentation and publication to the Transportation Research Board 94th Annual Meeting and can be found in the 2015 TRB Annual Meeting Compendium of Papers.

Please note that this 2015 compendium consists of approximately 192 research papers and articles. This document was updated on an on-going basis with newly published papers that cite NHTS data. For information about adding a research paper to the NHTS compendium, please contact Adella Santos at adella.santos@dot.gov.

Search and documentation support was provided Jasmy Methipara (MacroSys) who also categorized and formatted the paper abstracts.
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1. **Bike and Pedestrian Studies**


**Abstract:** Objectives: To describe and estimate the prevalence of dog walking using a nationwide sample. Methods: 2009 National Household Travel Survey data (N = 5100) were analyzed for: duration of dog walks, number of dog walks/day, total dog walking minutes/day. Results: In a one-day period, 67% of dog walkers took at least one walk ≥10 minutes, 20% walked a dog for at least 30 minutes, and 28% took more than one dog walk. Older participants and participants with children were more likely to accumulate ≥ 30 minutes of dog walking in a one-day period. Conclusions: A majority of dog walks occurred in bouts ≥ 10 minutes, suggesting dog walking is a legitimate form of health-enhancing physical activity which contributes to meeting physical activity guidelines.

**Subject Area:** Pets; Physical Activity; Walking

http://www.ingentaconnect.com/content/png/ajhb/2015/00000039/00000004/art00006
PeopleForBikes: Much of what we thought we knew about women and bikes was wrong  
Brian -staff

Abstract: PeopleForBikes says new analysis of its research into American bicycling shows that many assumptions about women and bikes are wrong. The study of women and bicycling used data from PFP’s participation study, released earlier this year. Regarding women and cycling, the study showed that 45 million American women rode a bike outside at least once last year, compared to 59 million men. The gender gap was considerably smaller than that shown by other studies; for example, the 2009 National Household Travel Survey found that just 24 percent of bicycle trips were made by women.

Subject Area: bicycle, women

Availability: www.bicycleretailer.com  PeopleForBikes: Much of what we thought we knew about women and bikes was wrong  Brian -staff; May 28, 2015
http://www.bicycleretailer.com/studies-reports/2015/05/28/peopleforbikes-much-what-we-thought-we-knew-about-women-and-bikes-was
**Energy Flux and its Role in Obesity and Metabolic Disease** *Gregory Hand and Steven N. Blair*

**Abstract:** In order to reverse the global obesity pandemic, there is a need for an enhanced understanding of the energy dynamics that underlie the problem. To maintain a stable body weight, energy intake must, over time, match or equal energy expenditure, a concept known as energy balance. Obesity results from a positive state of energy balance (i.e. when energy intake exceeds energy expenditure). However, recent research suggests that strategies to combat obesity should focus on energy flux (the amount of calories going through a system), rather than energy balance alone. In other words, it is easier to maintain weight loss at higher levels of physical activity. Recent findings suggest that a high energy flux, maintained by increasing energy expenditure, can improve an individual’s metabolic profile without changing weight. Further understanding of this concept may help in the design of interventions to achieve and maintain a healthy weight.

**Subject Area:** Energy balance, energy flux, obesity, metabolic disease

Analysing bicycle-sharing system user destination choice preferences: Chicago’s Divvy system Ahmadreza Faghih-Imania & Naveen Eluru

Abstract: In recent years, there has been increasing attention on bicycle-sharing systems (BSS) as a viable and sustainable mode of transportation for short trips. However, due to the relatively recent adoption of BSS, there is very little research exploring how people consider these systems within existing transportation options. Given recent BSS growth around the world, there is substantial interest in identifying contributing factors that encourage individuals to use these systems. The current study contributes to this growing literature by examining BSS behavior at the trip level to analyze bicyclists’ destination preferences. Specifically, we study the decision process involved in identifying destination locations after picking up a bicycle at a BSS station, using a random utility maximization approach in the form of a multinomial logit model (MNL). The quantitative frameworks developed have been estimated using 2013 data from the Chicago’s Divvy system. In our modeling effort, we distinguish between BSS users with annual membership and short-term customers with daily passes. The developed model should allow bicycle-sharing system operators to plan services more effectively by examining the impact of travel distance, land use, built environment, and access to public transportation infrastructure on users’ destination preferences. Using the estimated model, we generated utility profiles as a function of distance and various other attributes, allowing us to represent visually the trade-offs that individuals make in the decision process. To illustrate further the applicability of the proposed framework for planning purposes, destination station-choice probability prediction is undertaken.

Subject Area: Bicycle sharing systems; Divvy Chicago; Destination choice; Location choice; Multinomial logit model; Bicycle infrastructure

Albert Lea shows how walking and other healthy habits can rejuvenate a rural community Jay Walljasper

Abstract: Albert Lea, MN is working to prove that healthy lifestyles like walking and good nutrition are not just big city things.

Subject Area: walking, small town

Availability: www.Minnpost.com Albert Lea shows how walking and other healthy habits can rejuvenate a rural community May 22, 2015 Jay Walljasper
https://www.minnpost.com/health/2015/05/albert-lea-shows-how-walking-and-other-healthy-habits-can-rejuvenate-rural-community
What is Causing the Worldwide Rise in Body Weight? Robin P Shook, Steven N Blair, John Duperly, Gregory A Hand, Sandra M Matsudo, & Joanne L Slavin

Abstract: The worldwide rise in body weight has reached epidemic proportions and this has serious public health consequences. Despite the universal recognition of this problem, its causes are still debated: some attribute it to excess caloric intake; others blame a lack of physical activity (PA); some implicate specific changes to micro- and macro-nutrients. During the past century, government health agencies have developed guidance on healthy eating. These, along with advances in agriculture and food manufacturing, have largely eliminated nutrient deficiencies and helped reduce the consumption of fat. Over the past 60 years, however, technological advances and shifts in the types of occupations prominent in industrialized as well as developing countries have resulted in well-documented decreases in energy expenditure. Energy intake must be balanced with energy expenditure in order to prevent weight gain, and there is increasing evidence that this balance must be at a relatively high level of energy flux. A program that was started in São Paulo in 1996 known as ‘Agita’ has sought to motivate populations to engage in small amounts of physical exercise daily to tackle growing obesity levels. This multi-agency initiative is one example of how to successfully increase exercise within a community and scale both within (e.g. all states in Brazil) and across many nations. Reducing caloric intake in whole populations is challenging especially at relatively low levels of energy expenditure, and evidence suggests that there is a critical energy flux threshold for regulating intake to achieve energy balance. Increasing PA, however, may be more achievable than reducing intake. Activity raises caloric expenditure and can offset excess intake. The implementation of programs to achieve greater PA is therefore vital if the worldwide rise in body weight is to be halted, while we also need to implement programs to help people eat smarter.

Subject Area: Physical activity, energy intake, energy expenditure, overweight, obesity epidemic, diet, energy balance, energy flux, guidelines

Utilitarian and Recreational Walking Differ in Their Associations with theBuilt Environment Bumjoon Kang, Anne V. Moudon, Philip M. Hurvitz, & Brian E. Saelens

Abstract: n/a

Subject Area: walking classification, built environment

Availability: Conference: Moving Active Transportation to Higher Ground: Opportunities for Accelerating the Assessment of Health Impacts, Washington DC; Session: Determinants of Active Travel; April 14, 2015 Bumjoon Kang, Anne V. Moudon, Philip M. Hurvitz, & Brian E. Saelens; University of Buffalo
http://onlinepubs.trb.org/onlinepubs/conferences/2015/ActiveTransportation/Presentations/Bumjoon%20Kang.pdf
From Minneapolis, Evidence That the Census Undercounts Walking and Biking
Angie Schmitt

Abstract: The U.S. Census is the most widely cited source of data about how Americans get around. It’s updated regularly and it covers the whole country, but it comes up short in a number of ways. The Census only asks about commute trips, and commuting only accounts for about 16 percent of total household travel [PDF]. What happens when you measure the other 84 percent? Researchers at the University of Minnesota set out to design a better way to track how people move around the Twin Cities region, and one key finding is that walking and biking appear to be growing a lot faster than the Census indicates.

Subject Area: Census, Biking, UMN Survey

Our View: Consider your bike as a transportation option Editorial Board Rockford Register Star

Abstract: May is national Bike Month

Subject Area: Bicycle to work

City of Turlock promotes bike to work week *Elizabeth Arakelian*

**Abstract:** It is Bike to Work Week and that means there is no better time to enjoy the spring weather than getting on your bike and peddling to work. Cycling has been on the rise in recent years as the number of trips made by bicycles in the United States has more than doubled from 1.7 billion in 2001 to 4 billion in 2009 according to the National Household Travel Survey. The League of American Bicyclists ranked California as the eighth most bicycle friendly state in the country in their 2015 listing.

**Subject Area:** Bicycle to work

The National Physical Activity Plan: A Call to Action From the American Heart Association A Science Advisory From the American Heart Association William E. Kraus, MD, FAHA, Chair; Vera Bittner, MD, MSPH; Lawrence Appel, MD, MPH, FAHA; Steven N. Blair, PED, FAHA; Timothy Church, MD, MPH, PhD; Jean-Pierre Després, PhD, FAHA; Barry A. Franklin, PhD, FAHA; Todd D. Miller, MD, FAHA; Russell R. Pate, PhD; Ruth E. Taylor-Piliae, PhD, RN, FAHA; Dorothea K. Vafiadis, MS, FAHA; Laurie Whitsel, PhD

Abstract: The health benefits of regular physical activity and the relation between physical inactivity and chronic disease morbidity and mortality are well established. Also clear is the fact that efforts to increase physical activity at the population level will require collective action by government, nongovernment, for-profit, and nonprofit entities working together at the local, state, and national levels. The US National Physical Activity Plan (NPAP), developed by the National Physical Activity Plan Alliance, of which the American Heart Association (AHA) is a member, is designed to facilitate this collective action, to help organizations from all sectors of society work together to increase physical activity in all segments of the American population. The purposes of this advisory are to summarize the data that describe the health benefits of regular physical activity and the public health burden of low levels of physical activity, to describe the NPAP and the role it will play in increasing population levels of physical activity, and to encourage readers of Circulation to join the AHA’s efforts to promote its implementation.

Subject Area: physical activity

Walking distance, route choice, and activities while walking: A record of following pedestrians from transit stations in the San Francisco Bay area
Hyungkyoo Kim

Abstract: With the goal of making more walkable urban environments, studies on pedestrian behavior heavily rely on surveys or are increasingly using global positioning system tracking as the main vehicle of collecting data. Alternatively, this study adopts following pedestrians, a direct observation method, to examine pedestrians’ walking distance, route choice, and activities while walking from transit stations. Following 139 pedestrians from Glen Park and Rockridge BART stations in the San Francisco Bay Area to their final destinations on weekday afternoons suggests three major findings. Pedestrians walked 548 m on average and up to 1100 m, exceeding 1/4 mile (400 m), a rule-of-thumb distance frequently implemented in practice. Seventy-five per cent of the pedestrians walked along the main streets and twenty-nine per cent chose to walk longer routes. Seventy-four per cent of them engaged in various activities while walking, including shopping, window shopping, conversing with others and using street furniture. This study provides not only quantitative findings that are consistent with those from similar studies, but also descriptive information about pedestrian behavior, which they rarely do.

Subject Area: walking distance; route choice; pedestrian activities; transit station area; following pedestrians

Transportation for the Twenty-First Century Designing Healthy Communities and Active Lifestyles with Safe Routes to School Deb Hubsmith and Margaux Mennesson

Abstract: A study released in spring 2013 by the US PIRG Education Fund shows that after decades of steady growth, US driving rates have slowed and even stalled and that, in the long term, Americans are unlikely to return to driving as much as they did before. The groundbreaking report finds that millennials (the generation of people born between 1983 and 2000) drove 23 percent fewer miles on average in 2009 than they did in 2001—a greater decline in driving than any other age group. Millennials are also more likely than previous generations to want to live in urban and walkable neighborhoods and are more open to nondriving forms of transportation than older Americans. As millennials grow older and start having families, how will communities evolve to serve the needs of those who value dense, urban neighborhoods and walkable/bikeable centers with less reliance on driving? When safety is paramount to parents, how will cities and towns ensure that children can safely walk and bicycle to and from school and around the community? Safe Routes to School programs will play an integral role in the way cities and towns serve these families now and in the coming decades.

Subject Area: Safe Routes to School; millennials

Walking beyond the Socioeconomic Status in an Objectively and Perceptually Walkable Pedestrian Environment Zeynep Toker

Abstract: An extensive body of literature suggests that physical environment, physical activity, and socioeconomic status (SES) are intrinsically linked to each other and to weight related health problems. In this study, the role of objective and perceived pedestrian environment characteristics (microscale measures) was explored in relation to people’s recreational walking patterns in two neighborhoods with opposite SES. A total of 441 street segments were assessed and a total of 133 questionnaires were conducted. The findings suggest that recreational walking can take place beyond a neighborhood’s suggested SES when objective and especially perceived microscale characteristics (pedestrian environment) are favorable.

Subject Area: physical environment, physical activity, socioeconomic status, public health

Modeling spatial segregation and travel cost influences on utilitarian walking: Towards policy intervention Yong Yang, Amy H. Auchincloss Daniel A. Rodriguez, Daniel G. Brown, Rick Riolo, & Ana V. Diez-Roux

Abstract: We develop an agent-based model of utilitarian walking and use the model to explore spatial and socio-economic factors affecting adult utilitarian walking and how travel costs as well as various educational interventions aimed at changing attitudes can alter the prevalence of walking and income differentials in walking. The model is validated against US national data. We contrast realistic and extreme parameter values in our model and test effects of changing these parameters across various segregation and pricing scenarios while allowing for interactions between travel choice and place and for behavioral feedbacks. Results suggest that in addition to income differences in the perceived cost of time, the concentration of mixed land use (differential density of residences and businesses) are important determinants of income differences in walking (high income walk less), whereas safety from crime and income segregation on their own do not have large influences on income differences in walking. We also show the difficulty in altering walking behaviors for higher income groups who are insensitive to price and how adding to the cost of driving could increase the income differential in walking particularly in the context of segregation by income and land use. We show that strategies to decrease positive attitudes towards driving can interact synergistically with shifting cost structures to favor walking in increasing the percent of walking trips. Agent-based models, with their ability to capture dynamic processes and incorporate empirical data, are powerful tools to explore the influence on health behavior from multiple factors and test policy interventions.

Subject Area: Agent-based model; Utilitarian walking; Travel costs; Spatial segregation; Socioeconomic disparities; Behavior feedback

Charge your smartphone while you ride on this eco-friendly bamboo bicycle!

Heather Suhr

Abstract: n/a

Subject Area: bamboo bicycle; electricity generation

Where does Bicycling for Health Happen? Analysing Volunteered Geographic Information through Place and Plexus

**Greg P. Griffin & Junfeng Jiao**

**Abstract:** Research on the role of bicycling for health through physical activity has been limited by the lack of information on where bicyclists ride. New big data sources available through smartphone-based applications provide a rich source to provide bicycle volume data more comparable to the scale of information available for automotive and public transit modes. In the case of smartphone apps for fitness tracking, results of this data can be used similar to the growing application of global positioning systems for automotive travel surveying. The authors evaluate data from Travis County, Texas for the purpose of determining where bicyclists ride, primarily for fitness purposes. Ride trip volumes are evaluated with residential and employment density, land use diversity, bicycle facilities and terrain to characterize places chosen for bicycling for health. Though limited to bicycle rides and routes voluntarily logged using the smartphone app, this method provides promise for applications in multi-modal transportation planning and health impact assessment studies.

**Subject Area:** bicycling, health, crowdsourcing, VGI, GIS, built environment

**Availability:** Griffin, Greg P., and Junfeng Jiao. "Where does Bicycling for Health Happen? Analysing Volunteered Geographic Information through Place and Plexus."
https://soa.utexas.edu/sites/default/disk/Where%20does%20Bicycling%20for%20Health%20Happen,%20Journal%20of%20Transport%20and%20Health%20accepted%20manuscript.pdf
Public awareness of and support for infrastructure changes designed to increase walking and biking in Los Angeles County Lauren N. Gase, Noel C. Barragan, Paul A. Simon, Richard J. Jackson, & Tony Kuo

Abstract: Objective: Policies to promote active transportation are emerging as a best practice to increase physical activity, yet relatively little is known about public opinion on utilizing transportation funds for such investments. This study sought to assess public awareness of and support for investments in walking and biking infrastructure in Los Angeles County.
Method: In the fall of 2013, the Los Angeles County Department of Public Health conducted a telephone survey with a random sample of registered voters in the region. The survey asked respondents to report on the presence and importance of walking and biking infrastructure in their community, travel behaviors and preferences, and demographics.
Results: One thousand and five interviews were completed (response rate 20%, cooperation rate 54%). The majority of participants reported walking, biking, and bus/rail transportation investments as being important. In addition, participants reported a high level of support for redirecting transportation funds to active transportation investment — the population average was 3.28 (between ‘strongly’ and ‘somewhat’ support) on a 4 point Likert scale.
Conclusion: Voters see active transportation infrastructure as being very important and support redirecting funding to improve the infrastructure. These findings can inform policy-decisions and planning efforts in the jurisdiction.

Subject Area: Walking; Bicycling; Active transportation

Association between neighborhood walkability and GPS-measured walking, bicycling and vehicle time in adolescents Jordan A. Carlson, Brian E. Saelens, Jacqueline Kerr, Jasper Schipperijn, Terry L. Conway, Lawrence D. Frank, Jim E. Chapman, Karen Glanz, Kelli L. Cain, & James F. Sallis

Abstract: Objectives: To investigate relations of walking, bicycling and vehicle time to neighborhood walkability and total physical activity in youth. Methods: Participants (N=690) were from 380 census block groups of high/low walkability and income in two US regions. Home neighborhood residential density, intersection density, retail density, entertainment density and walkability were derived using GIS. Minutes/day of walking, bicycling and vehicle time were derived from processing algorithms applied to GPS. Accelerometers estimated total daily moderate-to-vigorous physical activity (MVPA). Models were adjusted for nesting of days (N=2987) within participants within block groups. Results: Walking occurred on 33%, active travel on 43%, and vehicle time on 91% of the days observed. Intersection density and neighborhood walkability were positively related to walking and bicycling and negatively related to vehicle time. Residential density was positively related to walking. Conclusions: Increasing walking in youth could be effective in increasing total physical activity. Built environment findings suggest potential for increasing walking in youth through improving neighborhood walkability.

Subject Area: Density; Land use; Mode share; Physical activity; Transportation

2. Demographic Trends

The same mode again? An exploration of mode choice variability in Great Britain using the National Travel Survey Eva Heinen, & Kiron Chatterjee

Abstract: The main focus of travel behaviour research has been explaining differences in behaviour between individuals (interpersonal variability) with less emphasis given to the variability of behaviour within individuals (intrapersonal variability). The subject of this paper is the variability of transport modes used by individuals in their weekly travel. Our review shows that previous studies have not allowed the full use of different modes in weekly travel to be taken into account, have used categorical variables as simple indicators of modal variability and have only considered a limited set of explanatory indicators in seeking to explain modal variability. In our analysis we use National Travel Survey data for Great Britain. We analyse modal variability with continuous measures of modal variability (Herfindahl–Hirschman Index, the difference in mode share between the primary and secondary mode, the total number of modes used). Taking inspiration from Hägerstrand (1970), we conceive that modal variability is determined by different types of spatial mobility constraints and find that reduced modal variability is predicted for having mobility difficulties, being aged over 60, being non-white, working full-time, living in smaller settlement, lower household income, having regular access to a car, having no public transport pass/season ticket and not owning a bicycle. The findings can support a change in perspective in transport policy from encouraging people to replace the use of one mode with another to encouraging people to make a change to their relative use of different transport modes.

Subject Area: Intrapersonal variability; Mode choice; Multimodality; Modal variability; Mobility constraints

Beyond Traffic *USDOT*

**Abstract:** Beyond Traffic is an invitation to the American public—including the users, developers, owners, and operators of the transportation network and the policy officials who shape it—to have a frank conversation about the shape, size, and condition of that system and how it will meet the needs and goals of our nation for decades to come. The Blue Paper includes a discussion about the transportation needs of those in poverty and references the NHTS News Brief on Transportation Mobility and Poverty.

**Subject Area:** poverty and transportation

**Availability:** USDOT Blue Paper; Beyond Traffic 2045 Trends and Choices Feb. 2. 2015
Commuting Time and Household Responsibilities: Evidence Using Propensity Score Matching

J. Ignacio Gimenez-Nadal & Jose Alberto Molina

Abstract: The growth in women’s participation in the labor force has attracted attention to the gender differences in commuting behavior, and to their implications. This study analyses the relationship between individual commuting behavior and household responsibilities, with a focus on gender differences in that relationship. Using the Dutch Time Use Surveys for the years 2000 and 2005, we analyze the relationship between commuting time, and the time devoted to home production and childcare. To deal with reverse causality, we use Propensity Score Matching techniques to obtain imputed data for individuals. After reverse causality is taken into account, we find that the effect of home production on commuting time for women is more than double the effect for men, while childcare time has an effect on women’s commuting time behavior only. Our results explain why prior studies have found that women have shorter commutes than men, shedding light on the Household Responsibility Hypothesis (HRH).

Subject Area: commuting, home production, childcare, propensity score matching, Multinational Time Use Study

Joint Shaping and Altering the Demand Profile by Residential Plug-in Electric Vehicles for Forward and Spot Markets in Smart Grids Farshad Rassaei, Wee-Seng Soh and Kee-Chaing Chua

Abstract: Plug-in electric vehicles (PEVs) can significantly increase the elasticity of residential electricity demand. This elasticity can be employed to shape the daily aggregated electricity demand profile of a system comprised of a large number of residential PEVs’ users sharing one electricity retailer or an aggregator. In this paper, we propose a joint demand shaping and altering algorithm for managing vehicle-to-grid (V2G) enabled PEVs’ electricity assignments (charging and discharging) in order to diminish the overall electricity procurement costs for a retailer bidding to two-settlement electricity markets, i.e., a day-ahead (DA) and a real-time (RT) market. This approach is decentralized, scalable, fast converging and does not violate users’ privacy. Our simulations’ results demonstrate significant overall cost savings (up to 28%) for a retailer bidding to an operational electricity market by using our proposed algorithm. This becomes even more salient when the power system is integrating a large number of intermittent energy resources wherein RT demand altering is crucial due to more likely contingencies and hence more RT price fluctuations and even more so-called black swan events. Lower electricity procurement cost for a retailer finally makes it able to offer better deals to customers and expand its market capacity. This implies that customers can enjoy lower electricity bills as well.

Subject Area: Black swan event, demand altering, demand shaping, electricity markets, flexible load, Plug-in electric vehicles, residential load, retailer, smart grids, vehicle-to-grid.

Energy consumption of electric vehicles based on real-world driving patterns: A case study of Beijing Hewu Wang, Xiaobin Zhang, & Minggao Ouyang

Abstract: This study assesses the energy reduction associated with Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs) compared to conventional vehicles (CVs) for real-world driving conditions in a specific geographic region (Beijing, China). To understand the driving patterns in Beijing, a passenger car travel survey has been conducted since 2012, including over 1000 vehicles. The initial results from driving range distribution have been calculated. In this study, first, a Utility Factor and the typical driving cycles based on 2000 days’ worth of Global Position System (GPS) data are analyzed. Next, the real-world energy consumption of CVs, HEVs, PHEVs and BEVs are simulated. Finally, the fuel consumption of vehicles under different driving patterns is compared to provide data on the optimal electric vehicles and reliable test cycles for Beijing. We find that electric vehicles in Beijing, including HEVs, PHEVs and BEVs, yield more fuel reduction benefits than in the U.S. because of the severe driving conditions and short driving ranges. For PHEVs in Beijing, smaller batteries, corresponding to a 30–50 km Charging Depleting (CD) range, are preferred to meet the demands of most drivers and add less extra cost to the vehicle. We also confirm that the Chinese current suggested label values based on NEDC cycle underestimate the fuel consumption of vehicles and fuel reduction benefits of electric vehicles in Beijing. This study addresses the importance of developing and using the real-world driving cycles in designing and evaluating electric vehicles.

Subject Area: Electric vehicle; Plug-in hybrid electric vehicle; Driving patterns; Driving cycle; Driving range; Fuel consumption

Charging ahead on the transition to electric vehicles with standard 120 V wall outlets Samveg Saxena, Jason MacDonald & Scott Moura

Abstract: Electrification of transportation is needed soon and at significant scale to meet climate goals, but electric vehicle adoption has been slow and there has been little systematic analysis to show that today’s electric vehicles meet the needs of drivers. We apply detailed physics-based models of electric vehicles with data on how drivers use their cars on a daily basis. We show that the energy storage limits of today’s electric vehicles are outweighed by their high efficiency and the fact that driving in the United States seldom exceeds 100 km of daily travel. When accounting for these factors, we show that the normal daily travel of 85–89% of drivers in the United States can be satisfied with electric vehicles charging with standard 120 V wall outlets at home only. Further, we show that 77–79% of drivers on their normal daily driving will have over 60 km of buffer range for unexpected trips. We quantify the sensitivities to terrain, high ancillary power draw, and battery degradation and show that an extreme case with all trips on a 3% uphill grade still shows the daily travel of 70% of drivers being satisfied with electric vehicles. These findings show that today’s electric vehicles can satisfy the daily driving needs of a significant majority of drivers using only 120 V wall outlets that are already the standard across the United States.

Subject Area: Electric vehicles; Range anxiety; EV charging; EV range; Clean transportation

Probabilistic Modeling of Nodal Charging Demand Based on Spatial-Temporal Dynamics of Moving Electric Vehicles Tang, D. & Wang P.

Abstract: High penetration of electric vehicles (EVs) as moving loads in power system have drawn increasing concerns about their negative impacts. Due to the spatial-temporal random dynamics of EVs, it is a challenge for identification and positioning of the space and time varying impacts. Most previous studies investigated system-wide EV charging demand based on data analysis with deterministic charging location and time. In this circumstance, this paper proposes a probabilistic model for nodal charging demand based on the spatial-temporal dynamics of moving EVs. Following the introduction to the integrated system with graph theory, a spatial-temporal model of moving EV loads is established based on random trip chain and Markov decision process (MDP). The nodal EV charging demands are derived from the charging probabilities of single and multiple EVs. The system studies show that this model is capable to assess the nodal charging demand due to the spatial-temporal distribution of moving EVs.

Subject Area: Electric vehicle (EV); load modeling; nodal charging demand; power system; smart grid

A Profile of Charging/Discharging Loads on the Grid Due to Electric Vehicles Under Different Price Mechanisms Mingyang Li & Bin Zou

Abstract: In this paper, a profit maximization model of electric vehicle charging/discharging is constructed and is aimed at the maximum operating profits, while being constrained by power batteries charging/discharging capacities and the travel needs of electric vehicles, which can express the charging/discharging decision of electric vehicles well. A calculation and analysis of the economic benefit and charge distribution of electric vehicle charging/discharging have been made by simulating user travel needs with Monte Carlo method, on the basis of the user travel rule derived from National Household Travel Survey (NHTS) in 2009. The results indicate that the economic benefits of the rational charging/discharging model can be significantly improved by responding to the time of use and real-time electricity price. Meanwhile, due to the relatively cheaper off-peak electricity price at night in contrast to the expensive on-peak electricity price during the day, electric vehicles tend to charge at low load time and discharge inversely at peak load time in the distribution system so as to achieve peak load shifting. The battery storage function of electric vehicles is worth further developing.

Subject Area: electric vehicle charging; Monte Carlo

Optimizing the performance of vehicle-to-grid (V2G) enabled battery electric vehicles through a smart charge scheduling model Z. Li, M. Chowdhury, P. Bhavsar, & Y. He

Abstract: A smart charge scheduling model is presented for potential (1) vehicle-to-grid (V2G) enabled battery electric vehicle (BEV) owners who are willing to participate in the grid ancillary services, and (2) grid operators. Unlike most V2G implementations, which are considered from the perspective of power grid systems, this model includes a communication network architecture for connecting system components that supports both BEV owners and grid operators to efficiently monitor and manage the charging and ancillary service activities. This model maximizes the net profit to each BEV participant while simultaneously satisfying energy demands for his/her trips. The performance of BEVs using the scheduling model is validated by estimating optimal annual financial benefits under different scenarios. An analysis of popular BEV models revealed that one of the existing BEVs considered in the study can generate an annual regulation profit of $454, $394 and $318 when the average daily driving distance is 20 miles, 40 miles and 60 miles, respectively. All popular BEV models can completely compensate the energy cost and generate a positive net profit, through the application of the scheduling model presented in this paper, with an annual driving distance of approximately 15,000 miles. Simulation analysis indicated that the extra load distribution from the optimized BEV charging operations were well balanced compared to the unmanaged BEV operations.

Subject Area: Battery electric vehicle, Vehicle to grid, Smart grid, Charge scheduling

Abstract: The U.S. Department of Energy’s (DOE’s) role to propel the development and deployment of science and technology to address the nation’s future energy challenges should include the integration of renewables and interactions between the smart electricity grid of the future and the evolution of electrified transportation. DOE’s EV Everywhere initiative intends to accelerate the adoption of electrified transportation. DOE’s Office of Energy Efficiency and Renewable Energy’s Grid Integration Initiative, working in support of DOE’s Grid Tech Team, brings together five program offices to collaborate on ways to enhance the value proposition and the overall efficiency of a long-term system scenario built around energy efficiency and renewable energy technologies. These offices include Vehicle Technologies, Building Technologies, Fuel Cells Technologies, Wind & Water Power Technologies, and Solar Energy Technologies. The report begins with a discussion of the current state of the energy and transportation systems, followed by a summary of some Vehicle Grid Integration (VGI) scenarios and opportunities. The current efforts to create foundational interface standards are detailed, and the requirements for enabling PEVs as a grid resource are presented. Existing technology demonstrations that include vehicle to grid functions are summarized. The report also includes a data-based discussion on the magnitude and variability of PEVs as a grid resource, followed by an overview of existing simulation tools that can be used to explore the expansion of VGI to larger grid functions that might offer system and customer value. The document concludes with a summary of the requirements and potential action items that would support greater adoption of VGI.

Subject Area: PEV, electricity Grid, VGI

The Advancement Of Electric Vehicles – Case: Tesla Motors Disruptive Technology Requiring Systemic Innovating  

Lehtinen, Petri

Abstract: Electric vehicles have existed for over 100 years as a disruptive innovation. Even though they have always been easier to use, quieter and cleaner, gasoline cars have beaten it in price, range and faster fueling. As gasoline cars have been the technological standard for the past 150 years there has been no motivation by car manufacturers to advance electric vehicles. By producing electric vehicles Tesla Motors has appropriately become the first successful startup car manufacturer in over 100 years. This research studies the systemic innovating of electric vehicles by Tesla Motors.

Disruptive innovation is widely researched and often connected to electric vehicles. However systemic innovation has been rarely researched and none has shown that electric vehicles can be seen as one since they require significant adjustments to the business system they are embedded in to succeed as a disruptive innovation. Therefore I suggest that in certain instances a disruptive innovation requires systemic innovating. In the context of electric vehicles systemic innovating can be done on the disruptive technology level of batteries, on the finished product level of the car and on the external level of services such as charging stations.

Tesla Motors is doubling the world’s lithium-ion battery production to enable inexpensive electric vehicles. It has produced an electric vehicle platform architecture that has advantages not seen in gasoline cars. It is also creating the standard for charging stations and its battery swapping technology is providing almost instant charging. As Tesla Motors is solving the challenges of high price, low range and slow charging, at the same time it is capitalizing and building on the unique advantages electric vehicles have always had and ultimately proving electric vehicles superiority. This is largely the result of the visionary of Tesla Motor’s CEO Elon Musk who is aiming to transform the world into sustainable energy and transportation through solar panels and batteries.

Subject Area: electric vehicle, EV, tesla motors, disruptive innovation, open innovation, systemic innovation, Elon Musk

Life Cycle Air Emissions Impacts and Ownership Costs of Light-Duty Vehicles Using Natural Gas As a Primary Energy Source Jason M. Luk, Bradley A. Saville, & Heather L. MacLean

Abstract: This paper aims to comprehensively distinguish among the merits of different vehicles using a common primary energy source. In this study, we consider compressed natural gas (CNG) use directly in conventional vehicles (CV) and hybrid electric vehicles (HEV), and natural gas-derived electricity (NG-e) use in plug-in battery electric vehicles (BEV). This study evaluates the incremental life cycle air emissions (climate change and human health) impacts and life cycle ownership costs of non-plug-in (CV and HEV) and plug-in light-duty vehicles. Replacing a gasoline CV with a CNG CV, or a CNG CV with a CNG HEV, can provide life cycle air emissions impact benefits without increasing ownership costs; however, the NG-e BEV will likely increase costs (90% confidence interval: $1000 to $31,000 incremental cost per vehicle lifetime). Furthermore, eliminating HEV tailpipe emissions via plug-in vehicles has an insignificant incremental benefit, due to high uncertainties, with emissions cost benefits between −$1000 and $2000. Vehicle criteria air contaminants are a relatively minor contributor to life cycle air emissions impacts because of strict vehicle emissions standards. Therefore, policies should focus on adoption of plug-in vehicles in nonattainment regions, because CNG vehicles are likely more cost-effective at providing overall life cycle air emissions impact benefits.

Subject Area: Natural Gas; Air emissions; CNG; BEV; HEV

Demand Response for Residential Electric Vehicles With Random Usage Patterns in Smart Grids Rassaei, F., Soh, W., & Chua, K.

Abstract: Electric vehicles (EVs) are expected to become widespread in future years. Thus, it is foreseen that EVs will become the new high-electricity-consuming appliances in the households. The characteristics of the extra power load that they impose on the distribution grid follow the patterns of people’s random usage behaviors. In this paper, we seek to provide answers to the following question: assigning real-world randomness to the EVs’ availability in the households and their charging requirements, how can EVs’ demand response (DR) help to minimize the peak power demand and, in general, shape the aggregated demand profile of the system? We present a general demand-shaping problem applicable for limit order bids to a day-ahead (DA) energy market. We propose an algorithm for distributed DR of the EVs to shape the daily demand profile or to minimize the peak demand. Additionally, we put these problems in a game framework. Extensive simulations show that, for certain practical distributions of EVs’ usage, it is possible to accommodate EVs for all the users in the system and yet achieve the same peak demand as when there is no EV in the system without any changes in the users’ commuting behaviors.

Subject Area: Day-ahead (DA) market; demand response (DR); electric vehicle (EV); flexible load limit order bids; random usage patterns; residential load; smart grids; vehicle-to-grid (V2G)

Charging And Observance Of Electric Vehicle Supported By Real Time Power Grid D Varghese

Abstract: n/a

Subject Area: electric vehicles charging;

Availability: Charging And Observance Of Electric Vehicle Supported By Real Time Power Grid D Varghese.
Probabilistic Agent-Based Model of Electric Vehicle Charging Demand to Analyse the Impact on Distribution Networks Pol Olivella-Rosell, Roberto Villafafila-Robles, Andreas Sumber and Joan Bergas-Jané

Abstract: Electric Vehicles (EVs) have seen significant growth in sales recently and it is not clear how power systems will support the charging of a great number of vehicles. This paper proposes a methodology which allows the aggregated EV charging demand to be determined. The methodology applied to obtain the model is based on an agent-based approach to calculate the EV charging demand in a certain area. This model simulates each EV driver to consider its EV model characteristics, mobility needs, and charging processes required to reach its destination. This methodology also permits to consider social and economic variables. Furthermore, the model is stochastic, in order to consider the random pattern of some variables. The model is applied to Barcelona’s (Spain) mobility pattern and uses the 37-node IEEE test feeder adapted to common distribution grid characteristics from Barcelona. The corresponding grid impact is analyzed in terms of voltage drop and four charging strategies are compared. The case study indicates that the variability in scenarios without control is relevant, but not in scenarios with control. Moreover, the voltages do not reach the minimum voltage allowed, but the MV/LV substations could exceed their capacities. Finally, it is determined that all EVs can charge during the valley without any negative effect on the distribution grid. In conclusion, it is determined that the methodology presented allows the EV charging demand to be calculated, considering different variables, to obtain better accuracy in the results.

Subject Area: electric vehicles charging; agent-based modelling and simulation; distribution network; coordinated charging; load flow analysis; stochastic modelling

Early Hydrogen Station Economics Analysis Changzheng Liu & Zhenhong Lin

Abstract: Deployment of the hydrogen supply infrastructure is one of most critical issues that must be addressed for a successful market transition to fuel cell electric vehicles (FCEV). Not only must hydrogen refuelling infrastructure be constructed, it must also be commercially viable and sell hydrogen to customers at retail prices that will encourage the continued expansion of the vehicle market. The objective of this study is to develop a station deployment optimization model and analyze station network economics and risk of investment. The model optimizes key deployment decisions to meet fuel demand by trading off infrastructure cost and fuel accessibility cost. Decision variables are when, where to build and the size of stations. Fuel accessibility cost is relative to gasoline, measured by additional detour time in order to access hydrogen refuelling stations. A case study is conducted for the City of Santa Monica in California. Deployment schemes generated from the optimization model are relatively robust to assumed level of fuel inconvenience cost, suggesting that the importance of station scale economy outweighs fuel convenience, subject to the caveats of model limitations. The model does not capture the dynamic interaction between vehicle demand and refuelling convenience. If vehicle demand was modelled endogenously, the importance of refuelling convenience would be valued higher by the model. Another factor might be that the area of study is small, which limits potential detour time savings that could be achieved from adding more stations. Cash flow analysis results suggest that the station network at the study area (the city of Santa Monica) may endure negative cash flows for about a decade. Driving patterns of early FCEV adopters matter to the economics of city station network. If FCEV users on average have long annual driving distance and trips are concentrated within the region, the profitability of local station networks would be improved.

Subject Area: hydrogen station, optimization, cash flow analysis

Probabilistic estimation of plug-in electric vehicles charging load profile Nima H. Tehrani, & Peng Wang

Abstract: Plug-in electric vehicles (PEVs) are widely considered as a sustainable mode of transport by countries worldwide due to high efficiency and low or zero carbon emissions. However, PEVs will add significant additional load to the existing power distribution system and it will be a challenge to meet the new demand. In this study, probabilistic modelling has been presented to estimate the system-wide PEV charging load within domestic grids. U.S. national household travel survey data set has been utilized to quantitatively determine the mobility behaviour of PEVs.

Uncertain nature of the problem in modelling and data preparation should be taken into account. Due to the existence of complex interdependencies between the system inputs, the problem definition leads to a multivariate uncertainty analysis problem. The modelling procedure is decomposed into two basic components: the modelling of the marginal distributions; and that of the stochastic dependence structure. In addition, Copula theory is presented for the multivariate modelling of dependent random variable. The results indicate that the PEVs can contribute to increase the load demand at certain hours, although the charging demand is very limited most of the time. Moreover, the probabilistic distribution of aggregated PEV charging demand is compared with that obtained by the Monte Carlo simulation. The numerical results have shown the effectiveness of the proposed methodology.

Subject Area: Load profile; Charging demand; PEV; Electric vehicle; Probabilistic modelling; Monte Carlo simulation

Uncertainty-Based Design of a Bilayer Distribution System for Improved Integration of PHEVs and PV Arrays ElNozahy, M. & Salama, M.

Abstract: Recent years have seen increased interest in green technologies such as photovoltaic (PV) electricity and plug-in hybrid electric vehicles (PHEVs). Such technologies, however, have been found to be detrimental to distribution networks. This paper introduces a novel distribution system architecture that can better accommodate the expected growth in PV electricity and PHEVs. In the proposed architecture, the distribution system becomes a bilayer system composed of the traditional ac layer that serves existing system loads, plus an embedded dc layer that interfaces with PV arrays and PHEVs. A bidirectional converter interconnects the two layers and controls the power flows between them. This paper presents the key design and operational aspects of the proposed architecture, with consideration of different uncertainties inherent in the system. To this end, a probabilistic benchmark has been developed for modeling these uncertainties and for use with the sizing and scheduling of different system components. Monte Carlo (MC) simulations confirmed the technical and economic merit of the proposed design methodology.

Subject Area: Bilayer system; Monte Carlo (MC) simulation; direct current; photovoltaic (PV) arrays; plug-in hybrid electric vehicles (PHEVs)

An optimization model of energy and transportation systems: Assessing the high-speed rail impacts in the United States Venkat Krishnan, Eirini Kastrouni, V. Dimitra Pyrialakou, Konstantina Gkritza, & James D. McCalley

Abstract: This paper presents a long-term investment planning model that co-optimizes infrastructure investments and operations across transportation and electric infrastructure systems for meeting the energy and transportation needs in the United States. The developed passenger transportation model is integrated within the modeling framework of a National Long-term Energy and Transportation Planning (NETPLAN) software, and the model is applied to investigate the impact of high-speed rail (HSR) investments on interstate passenger transportation portfolio, fuel and electricity consumption, and 40-year cost and carbon dioxide (CO2) emissions. The results show that there are feasible scenarios under which significant HSR penetration can be achieved, leading to reasonable decrease in national long-term CO2 emissions and costs. At higher HSR penetration of approximately 30% relative to no HSR in the portfolio promises a 40-year cost savings of up to $0.63 T, gasoline and jet fuel consumption reduction of up to 34% for interstate passenger trips, CO2 emissions reduction by about 0.8 billion short tons, and increased resilience against petroleum price shocks. Additionally, sensitivity studies with respect to light-duty vehicle mode share reveal that in order to realize such long-term cost and emission benefits, a change in the passenger mode choice is essential to ensure higher ridership for HSR.

Subject Area: National infrastructure planning; Energy and transportation infrastructure optimization; Multimodal passenger transportation; High-speed rail; Sustainability; Resilience

Charging Behavior Impacts on Electric Vehicle Miles Travel: Who is Not Plugging in? Gil Tal; Michael A. Nicholas; Jamie Davies; & Justin Woodjack

Abstract: The growing plug-in electric vehicle (PEVs) market features new models of battery electric vehicles (BEVs) and Plug-in hybrid vehicles (PHEVs) with varying battery sizes and electric driving range. How are these different models being used in the real world? A common assumption in PEV impact analysis is that PEV owners will maximize their vehicle utility by appropriately sizing their battery to their driving needs and by charging their vehicles as much as possible to recover the cost of the vehicle purchase. Based on these assumptions we expect a high correlation between PHEV owners usage of the vehicle and the number of plug-in events, and we expect drivers of PHEVs with small battery to plug in more than owners of vehicles with a larger battery and similar driving patterns. This paper examines the assumptions presented using a survey of more than 3,500 PEV owners conducted in California from May and June 2013. The online survey includes extensive data on driving and charging behavior using web-map questions and includes owners of all PEV models in the market including more than 600 Volts and 800 Plug-in Priuses. The results show that small battery PHEV electric vehicle miles traveled (eVMT) are lower than larger range PHEV or BEVs not only because of the battery size but also as a result of the public charging availability and charging behavior. Higher electric range PHEV and BEV drivers charge more often and report more charging opportunities in the same areas that smaller battery PHEVs could not find chargers.

Subject Area: PEVs; BEVs; PHEVs; battery size; electric driving range

Power quality of actual grids with plug-in electric vehicles in presence of renewables and micro-grids  

**R. Romo, & O. Micheloud**

**Abstract:** The penetration of plug-in electric and hybrid-electric vehicles (PEVs and PHEVs) will increase significantly in the next 20 years. The insertion of PEVs in households will facilitate the use of renewable sources and possibly create economic benefits to users, as shown in a Mexican example here presented, but also will introduce some challenges such as how the penetration of PEVs affect the quality of existing power grids. The contribution of this work is to review the literature in reference to the power quality problems and to test them in a real distribution system based on the Mueller community in Austin, Texas that has PEVs and photovoltaic panels (PVs). The results show that a coordinated delay charge mode reduces the loading on transformers at peak hours and improves voltage regulation. Additionally, it is shown that photovoltaic panels introduce a power factor reduction during daytime in the main feeder. Corrective measures should be considered for high levels of PV penetration, such as reactive power support, VAr compensators or community energy storage, which can be presented as one potential solution to most of the problems listed in current literature. However, more research needs to be done in a much broader scale because power systems differ from each other and between countries, but there is a consensus that high power demand by PEVs leads to voltage statutory violations at some points in the grid and smart charging is required to operate the system efficiently.

**Subject Area:** Plug-in electric vehicle; Vehicle to grid (V2G); Pay as bid pricing; Renewable intermittency balance; Micro-generation; Domestic photovoltaic generation

Scalable Real-Time Electric Vehicles Charging With Discrete Charging Rates

Abstract: Large penetration of electric vehicles (EVs) can have a negative impact on the power grid, e.g., increased peak load and losses, that can be largely mitigated using coordinated charging strategies. In addition to shifting the charging process to the night valley when the electricity price is lower, this paper explicitly considers the EV owner convenience that can be mainly characterized by a desired state of charge at the departure time. To this end, the EV charging procedure is defined as an uninterruptible process that happens at a given discrete charging rate and the coordinated charging is formulated as a scheduling problem. The scalable real-time greedy (S-RTG) algorithm is proposed to schedule a large population of EVs in a decentralized fashion, explicitly considering the EV owner criteria. Unlike the majority of existing approaches, the S-RTG algorithm does not rely on iterative procedures and does not require heavy computations, broadcast messages, or extensive bi-directional communications. Instead, the proposed algorithm schedules one EV at a time with simple computations, only once (i.e., at the time the EV connects to the grid), and only requires low-speed communication capability making it suitable for real-time implementation. Numerical simulations with significant EVs penetration and comparative analysis with scheduling policies demonstrate the effectiveness of the proposed algorithm.

Subject Area: Charging; electric vehicle (EV); scheduling algorithm; smart grid.


Abstract: Nowadays, it is a common concern for modern electrical networks and energy management systems to derive an optimal operation management considering energy costs, pollutant emissions, and security, of the system in the presence of plug-in electric vehicles (PEVs). In this paper, a multiobjective optimization problem is solved to schedule power sources in a typical microgrid, while PEVs are viewed as a stochastic factor. PEVs residing in a city are considered as probable loads and/or generations depending on how they interact with the utility grid. A novel stochastic methodology is used to calculate the 24 h expected power demand and generation of vehicles aggregated in municipal parking lots. The objective functions of the problem are voltage security margin to be maximized and the total power losses, the total electrical energy costs, and the total emissions of power sources, which should be minimized. Based on different scenarios, the impact of PEVs penetration on base load, voltage profile, and also the value of objective functions, are assessed. Numerical results show the effect of different fleets of PEVs, as well as on the operation of future microgrids.

Subject Area: Batteries, Cities and towns, Fuel cells, Microgrids, Probabilistic logic, Security, System-on-chip

Potential to Electrify Miles with Different Plug-in Vehicle Innovation Paths D. J. Santini, and Y. Zhou

Abstract: With their high energy and power capabilities, lithium ion batteries allow many powertrain combinations and permutations. California regulators credit two plug-in technology innovation paths: (1) PHEVs spun-off from HEVs; (2) battery electric vehicles (BEV) and REX/BEVx spun off from BEVs, where x signifies limited gasoline engine range extension. A third path is the “Super EV” with 200+ mile range and >302 hp, far more than otherwise available BEVs. Data on 2014 commercial plug-in vehicles is presented. Past cost of ownership studies focusing on path 1 PHEVs and path 2 BEVs are discussed. Price and marketability implications are examined. A thought experiment is derived, informed by marketability and financial payback considerations, assuming regular use of 50-100% of a BEV battery pack and 100+% of a PHEV or REX/BEVx pack. The BEV is chosen by customers driving less miles than the hypothetical maximum electric range; PHEVs and REX/BEVx vehicles by those driving further. Promising potential to electrify miles nationwide is estimated with modified option 2 BEVx designs. Financially, the best path 2 market segment is new, low density single family construction where the vehicle makes long commutes at relatively high average speed. The REX/BEVx range extension feature can be effective because a significant proportion of total national miles (42%) is caused by a relatively few vehicles (12%) driving beyond the range of most currently available BEVs (~ 70 miles). Some 45% of those miles could be electrified by a BEVx with 70 miles of electric range with one charge per day. Adaptation of BEVx range extension would enhance REX/BEVx marketability, increasing national fleet-wide GHG and oil use reduction.

Subject Area: lithium ion batteries; PHEV; BEV; electric range

Hierarchical Charge Control of Large Populations of EVs Shao, C.; Wang, X.; Wang, X; Du, C.; & Wang, B.

Abstract: Cooperation between the controllable load, such as electrical vehicles (EVs) and the generation, provides the power system new operating strategies. A novel hierarchical charge control framework is proposed based on the Benders decomposition for large populations of EVs. The grid, unit, and accurate EV constraints can be considered. On the upper level, the cooperative dispatch scheme between the generation and the EV aggregators is obtained. On the lower level, the feasibility of the scheme is checked with EV constraints considered. The levels are coordinated by the Benders cuts. In addition, the distributed approximate Benders cuts is also proposed, which helps to protect user privacy and a three-level framework is developed based on the decentralized control. The case studies on IEEE Reliability Test System have verified the proposed framework and method is valid and feasible. The charge control based on it can minimize the grid operation cost and improve the unit operating efficiency.

Subject Area: Batteries; Discharges (electric); Indexes; Linear programming; Privacy Sociology; Statistics

Exploring the Drivers’ side of the “Blend Wall”: U.S. Consumer Preferences for Ethanol Blend Fuels Francisco X. Aguilar, Zhen Cai, Phillip Mohebian, & Wyatt Thompson

Abstract: Analysis of stated preferences from over 2,300 U.S. respondents show that general attitudes nationwide favor the use of ethanol as a motor fuel but a sizeable segment (~ 20%) indicated strong unwillingness to buy ethanol blend fuels. Results from a discrete choice experiment analyzed using mixed logit regressions show that, all else constant, price-per-gallon and miles-per-gallon dominated preferences for fuel attributes but ethanol content made the average consumer more likely to choose a blend fuel. Findings provide strong evidence of heterogeneity in preferences driven by attitudes but also affected by age and income. At a point of price per mile equivalence for ethanol and gasoline, in a market where gasoline, E20 and E85 were available with no regulatory, supply or technological constraints, E85 would dominate market share. In this case ethanol would account for 56% of volume of motor fuels consumed. Our results show a high level of consumer substitutability of gasoline with ethanol and willingness to choose high ethanol blend fuels - which could help expand ethanol use beyond the current regulatory and technological limits of the blend wall.

Subject Area: Ethanol fuel blends; Choice-based model; Mixed effects logistic regression; Market share analysis; US

Robust Optimization for Bidirectional Dispatch Coordination of Large-Scale V2G  
Bai, X. and Qiao, W.

Abstract: This paper proposes a robust optimization (RO) model for bidirectional dispatch coordination of large-scale plug-in electric vehicles (PEVs) in a power grid in which the PEVs are aggregated to manage. The PEV aggregators are considered as a type of dispatchable demand response and energy storage resource with stochastic behaviors, and can supply load or provide ancillary services such as regulation reserve to the grid. The proposed RO model is then reformulated as a mixed-integer quadratic programming model, which can be solved efficiently. Computer simulations are performed for a power grid with ten generators and three PEV aggregators to validate the economic benefit of the RO model for bidirectional dispatch coordination of the PEVs and the robustness of the RO model to the uncertainty of the PEVs' stochastic mobility behaviors.

Subject Area: Bidirectional dispatch; coordination; plug-in electric vehicle (PEV); robust optimization (RO); smart grid; vehicle to grid (V2G)

Availability: Bai, Xiaoqing, and Wei Qiao. "Robust Optimization for Bidirectional Dispatch Coordination of Large-Scale V2G."  
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=7039286
Effects of Regional Temperature on Electric Vehicle Efficiency, Range, and Emissions in the United States Tugce Yuksel and Jeremy J Michalek

Abstract: We characterize the effect of regional temperature differences on battery electric vehicle (BEV) efficiency, range, and use-phase CO2 emissions in the U.S. The efficiency of a BEV varies with ambient temperature due to battery efficiency and cabin climate control. We find that annual energy consumption of BEVs can increase by an average of 15% in the Upper Midwest or in the Southwest compared to the Pacific Coast due to temperature differences. Greenhouse gas (GHG) emissions from EVs vary primarily with marginal regional grid mix – which has twice the GHG-intensity in the Upper Midwest as on the Pacific Coast. However, even within a grid region, BEV emissions vary by up to 22% due to spatial and temporal ambient temperature variation and its implications for vehicle efficiency and charging duration and timing. Cold climate regions also encounter days with substantial reduction in EV range: the average range of a Nissan Leaf on the coldest day of the year drops from 70 miles on the Pacific Coast to less than 45 miles in the Upper Midwest. These regional differences are large enough to affect adoption patterns and energy and environmental implications of BEVs relative to alternatives.

Subject Area: Battery efficiency; regional temperature; EV range

Stochastic Modeling of Battery Electric Vehicle Driver Behavior Impact of Charging Infrastructure Deployment on the Feasibility of Battery Electric Vehicles  Jing Dong, Zhenhong Lin

Abstract: A stochastic modeling approach is proposed to characterize battery electric vehicle (BEV) drivers' behavior. The approach uses longitudinal travel data and thus allows more realistic analysis of the impact of the charging infrastructure on BEV feasibility. BEV feasibility is defined as the probability that the ratio of the distance traveled between charges to the BEV range is kept within a comfort level (i.e., drivers are comfortable with driving the BEV when the battery's state of charge is above a certain level). When the ratio exceeds the comfort level, travel adaptation is needed—use of a substitute vehicle, choice of an alternative transportation mode, or cancellation of a trip. The proposed stochastic models are applied to quantify BEV feasibility at different charging infrastructure deployment levels with the use of GPS-based longitudinal travel data collected in the Seattle, Washington, metropolitan area. In the Seattle case study, the range of comfort level was found to be critical. If BEV drivers were comfortable with using all the nominal range, about 10% of the drivers needed no or little travel adaptation (i.e., they made changes on less than 0.5% of travel days), and almost 50% of the drivers needed travel adaptation on up to 5% of the sampled days. These percentages dropped by half when the drivers were only comfortable with using up to 80% of the range. In addition, offering opportunities for one within-day recharge can significantly increase BEV feasibility, provided that the drivers were willing to make some travel adaptation (e.g., up to 5% of drivers in the analysis).

Subject Area: stochastic model; BEV; charging infrastructure

Charging Behavior Impacts on Electric Vehicle Miles Traveled: Who Is Not Plugging In? Gil Tal, Michael A. Nicholas, Jamie Davies, & Justin Woodjack

Abstract: The growing market for plug-in electric vehicles (PEVs) features new models of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) with varying battery sizes and electric driving ranges. How are the various models being used in the real world? A common assumption in PEV impact analysis is that PEV owners will maximize their vehicle's utility by appropriately sizing the battery to their driving needs and by charging their vehicle as much as possible to recover the cost of the vehicle purchase. On the basis of these assumptions, a high correlation between PHEV owner use of the vehicle and the number of plug-in events is expected, and drivers of PHEVs with a small battery are expected to plug in more than do owners of vehicles with a larger battery and similar driving patterns. The assumptions presented are examined through a survey of more than 3,500 PEV owners conducted in California in May and June 2013. The online survey included extensive data on driving and charging behavior using web map questions. Owners of all PEV models on the market, including more than 600 Volts and 800 Prius Plug-Ins, were surveyed. The results show that small-battery PHEV electric vehicle miles traveled are lower than longer-range PHEV or BEV electric vehicle miles traveled not only because of battery size but also because of public charging availability and charging behavior. Higher electric-range PHEV and BEV drivers charge more often and report more charging opportunities in areas where smaller-battery PHEVs could not find chargers.

Subject Area: PEVs; BEV’s; PHEVs’ charging behavior

Abstract: With the increasing attention and support behind plug in hybrid electric vehicles, research must be conducted to examine the impacts of vehicles on electric distribution and transmission systems. This research aims first to model the behavior of vehicle battery chargers during system disturbances and mitigate any impacts. A distribution test system example is modeled and several different vehicle charger topologies are added. Faults are applied to the distribution system with vehicle chargers connected and the results are examined. Based on these results, a control strategy to mitigate their negative impacts is suggested. Photovoltaic panels are then added to the system and the study is repeated. Several services that plug in hybrid electric vehicles are capable of providing to the electric system are presented in order to allow electric vehicles to be seen as an asset to electric systems rather than a burden. These services are particularly focused on an electric system such as might be found on a college campus, which in this case is represented by the Clemson University electric distribution system. The first service presented is dynamic phase balancing of a distribution system using vehicle charging. Distribution systems typically face problems with unbalance. At most large car parks, a three phase electric supply is expected even though current standardized chargers are single phase. By monitoring system unbalance and choosing which phase a vehicle is allowed to charge from, unbalance between phases is reduced in a distribution system. The second service presented is a decentralized vehicle to campus control algorithm based on time of use rates. Using time of use electricity prices, discharging vehicle batteries during high prices and recharging at low prices is explored. Battery degradation as well as limits placed by required vehicle range availability are included in the decision on whether to charge or discharge. Electric utilities will also benefit from a reduction of load at peak times if vehicles discharge back to the campus. A comparison with stationary battery energy storage is included.
Quantifying EV Battery End-of-Life through Analysis of Travel Needs with Vehicle Powertrain Models

Samveg Saxena, Caroline Le Floch, Jason MacDonald, & Scott Moura

Abstract: Electric vehicles enable clean and efficient transportation, however concerns about range anxiety and battery degradation hinder EV adoption. The common definition for battery end-of-life is when 70-80% of original energy capacity remains, however little analysis is available to support this retirement threshold. By applying detailed physics-based models of EVs with data on how drivers use their cars, we show that EV batteries continue to meet daily travel needs of drivers well beyond capacity fade of 80% remaining energy storage capacity. Further, we show that EV batteries with substantial energy capacity fade continue to provide sufficient buffer charge for unexpected trips with long distances. We show that enabling charging in more locations, even if only with 120V wall outlets, prolongs useful life of EV batteries. Battery power fade is also examined and we show EVs meet performance requirements even down to 30% remaining power capacity. Our findings show that defining battery retirement at 70-80% remaining capacity is inaccurate. Battery retirement should instead be governed by when batteries no longer satisfy daily travel needs of a driver. Using this alternative retirement metric, we present results on the fraction of EV batteries that will be retired with different levels of energy capacity fade.

Subject Area: electric vehicles; battery degradation; capacity fade; power fade; battery second life; battery retirement


**Peak-Minimizing Online EV Charging: Price-of-Uncertainty and Algorithm Robustification**

*Shizhen Zhao, Xiaojun Lin & Minghua Chen*

**Abstract:** We study competitive online algorithms for EV (electrical vehicle) charging under the scenario of an aggregator serving a large number of EVs together with its background load, using both its own renewable energy (for free) and the energy procured from the external grid. The goal of the aggregator is to minimize its peak procurement from the grid, subject to the constraint that each EV has to be fully charged before its deadline. Further, the aggregator can predict the future demand and the renewable energy supply with some levels of uncertainty. The key challenge here is how to develop a model that captures the prior knowledge from such prediction, and how to best utilize this prior knowledge to reduce the peak under future uncertainty. In this paper, we first propose a 2-level increasing precision model (2-IPM), to capture the system uncertainty. We develop a powerful computation approach that can compute the optimal competitive ratio under 2-IPM over any online algorithm, and also online algorithms that can achieve the optimal competitive ratio. A dilemma for online algorithm design is that an online algorithm with good competitive ratio may exhibit poor average-case performance. We then propose a new Algorithm- Robustification procedure that can convert an online algorithm with reasonable average-case performance to one with both the optimal competitive ratio and good average-case performance. The robustified version of a well-known heuristic algorithm, Receding Horizon Control (RHC), is found to demonstrate superior performance via trace-based simulations.

**Subject Area:** Electric Vehicles charging; aggregator; RHC

A Comprehensive Analysis of Plug in Hybrid Electric Vehicles to Commercial Campus (V2C) Andrew D. Clarke, Elham B. Makram

Abstract: Vehicle to grid is an emerging technology that utilizes plug in hybrid electric vehicle batteries to benefit electric utilities during times when the vehicle is parked and connected to the electric grid. In its current form however, vehicle to grid implementation poses many challenges that may not be easily overcome and many existing studies neglect critical aspects such as battery cost or driving profiles. The goal of this research is to ease some of these challenges by examining a vehicle to grid scenario on a university campus, as an example of a commercial campus, based on time of use electricity rates. An analysis of this scenario is conducted on a vehicle battery as well as a stationary battery for comparison. It is found that vehicle to campus and a stationary battery both have the potential to prove economical based on battery cost and electricity rates.

Subject Area: Electric Vehicles, Power Distribution, Economic Analysis, Vehicle to Building (V2B), Battery Storage

Understanding Fuel Cell Plug-In Hybrid Electric Vehicle Use, Design, And Functionality Shawn Salisbury

Abstract: The fuel cell plug-in hybrid electric vehicle (FCPHEV) has been shown to be a promising vehicle architecture in terms of cost, emissions reduction, and reducing petroleum use. It combines a high power battery pack and a small fuel cell to make a zero emissions vehicle with all of the capabilities of current consumer vehicles. Previous FCPHEV studies have projected vehicle cost, emissions, and efficiency, but little work has been performed towards understanding the use, design, and functionality of the architecture. This study presents several topics which will help to advance the state of the FCPHEV.

Plug-in hybrid vehicles, including FCPHEVs, can use two different sources of fuel depending upon how the vehicle is driven and charged. To quantify this fuel use, SAE J2841 establishes a utility factor method based upon transportation survey data that includes assumptions about vehicle use and battery charging habits. The utility factor model is an important tool for automakers, consumers, and researchers, and it is used by the EPA to determine the fuel economy of plug-in hybrid vehicles. In the Section A of this study, the utility factor model is examined and compared to data collected from over 1,400 Chevrolet Volts in order to assess its accuracy. Until now, there has been no large-scale set of vehicle data to which the model could be compared. Results show that the assumptions of the J2841 utility factor model are not representative of the driving behavior of this set of plug-in vehicles.

A hydrogen fueled vehicle requires a high pressure gaseous fuel storage and delivery system that is very different than the fueling systems of current conventional vehicles. The design and execution of the system is critical to the safety and functionality of an FCPHEV, but previous literature on hydrogen fueled vehicles covers fuel systems in little detail. Section B of this study details the considerations that one must make when designing a high pressure hydrogen fuel system and provides an example of how those considerations were met for the FCPHEV built by Colorado State University in the EcoCAR 2 competition.

The FCPHEV built for the EcoCAR 2 competition is the first of its kind to publish real-world driving data. Data taken from the vehicle during on-road testing is analyzed in Section C of this study to prove the FCPHEV concept and increase the understanding of overall system operation. The results of the driving tests demonstrate the viability of the FCPHEV and highlight its advantages over current zero emissions vehicle architectures.

Subject Area: fuel cell plug-in hybrid electric vehicle;

On the Complexity of Optimal Electric Vehicles Recharge Scheduling Cristina Rottondi, Giacomo Verticale, & Giovanni Neglia

Abstract: The massive introduction of Electric Vehicles (EVs) is expected to significantly increase the power load experienced by the electrical grid, but also to foster the exploitation of renewable energy sources: if the charge process of a fleet of EVs is scheduled by an intelligent entity such as a load aggregator, the EVs’ batteries can contribute in flattening energy production peaks due to the intermittent production patterns of renewables by being recharged when energy production surpluses occur. To this aim, time varying energy prices are used, which can be diminished in case of excessive energy production to incentivize energy consumption (or increased in case of shortage to discourage energy utilization). In this paper we evaluate the complexity of the optimal scheduling problem for a fleet of EVs aimed at minimizing the overall cost of the battery recharge in presence of time variable energy tariffs. The scenario under consideration is a fleet owner having full knowledge of the customers’ traveling needs at the beginning of the scheduling horizon. We prove that the problem has polynomial complexity, provide complexity lower and upper bounds, and compare its performance to a benchmark approach which does not rely on prior knowledge of the customers’ requests, in order to evaluate whether the additional complexity required by the optimal scheduling strategy w.r.t. the benchmark is worthy the achieved economic advantages. Numerical results show considerable cost savings obtained by the optimal scheduling strategy.

Subject Area: Optimization; Modeling; Electric Vehicles, Vehicle-to-Grid Interactions; Optimal Recharge Scheduling

Quantifying EV Battery End-of-Life through Analysis of Travel Needs with Vehicle Powertrain Models  

Samveg Saxena, Caroline Le Floch, Jason MacDonald, & Scott Moura

Abstract: Electric vehicles enable clean and efficient transportation, however concerns about range anxiety and battery degradation hinder EV adoption. The common definition for battery end-of-life is when 70-80% of original energy capacity remains, however little analysis is available to support this retirement threshold. By applying detailed physics-based models of EVs with data on how drivers use their cars, we show that EV batteries continue to meet daily travel needs of drivers well beyond capacity fade of 80% remaining energy storage capacity. Further, we show that EV batteries with substantial energy capacity fade continue to provide sufficient buffer charge for unexpected trips with long distances. We show that enabling charging in more locations, even if only with 120V wall outlets, prolongs useful life of EV batteries. Battery power fade is also examined and we show EVs meet performance requirements even down to 30% remaining power capacity. Our findings show that defining battery retirement at 70-80% remaining capacity is inaccurate. Battery retirement should instead be governed by when batteries no longer satisfy daily travel needs of a driver. Using this alternative retirement metric, we present results on the fraction of EV batteries that will be retired with different levels of energy capacity fade.

Subject Area: electric vehicles; battery degradation; capacity fade; power fade; battery second life; battery retirement


A Comprehensive Analysis of Plug in Hybrid Electric Vehicles to Commercial Campus (V2C)  

Andrew D. Clarke, & Elham B. Makram

**Abstract:** Vehicle to grid is an emerging technology that utilizes plug in hybrid electric vehicle batteries to benefit electric utilities during times when the vehicle is parked and connected to the electric grid. In its current form however, vehicle to grid implementation poses many challenges that may not be easily overcome and many existing studies neglect critical aspects such as battery cost or driving profiles. The goal of this research is to ease some of these challenges by examining a vehicle to grid scenario on a university campus, as an example of a commercial campus, based on time of use electricity rates. An analysis of this scenario is conducted on a vehicle battery as well as a stationary battery for comparison. It is found that vehicle to campus and a stationary battery both have the potential to prove economical based on battery cost and electricity rates.

**Subject Area:** Electric Vehicles, Power Distribution, Economic Analysis, Vehicle to Building (V2B), Battery Storage

http://www.scirp.org/journal/PaperInformation.aspx?paperID=53111
Understanding fuel cell plug-in hybrid electric vehicle use, design, and functionality

Salisbury, Shawn

Abstract: The fuel cell plug-in hybrid electric vehicle (FCPHEV) has been shown to be a promising vehicle architecture in terms of cost, emissions reduction, and reducing petroleum use. It combines a high power battery pack and a small fuel cell to make a zero emissions vehicle with all of the capabilities of current consumer vehicles. Previous FCPHEV studies have projected vehicle cost, emissions, and efficiency, but little work has been performed towards understanding the use, design, and functionality of the architecture. This study presents several topics which will help to advance the state of the FCPHEV. Plug-in hybrid vehicles, including FCPHEVs, can use two different sources of fuel depending upon how the vehicle is driven and charged. To quantify this fuel use, SAE J2841 establishes a utility factor method based upon transportation survey data that includes assumptions about vehicle use and battery charging habits. The utility factor model is an important tool for automakers, consumers, and researchers, and it is used by the EPA to determine the fuel economy of plug-in hybrid vehicles. In the Section A of this study, the utility factor model is examined and compared to data collected from over 1,400 Chevrolet Volts in order to assess its accuracy. Until now, there has been no large-scale set of vehicle data to which the model could be compared. Results show that the assumptions of the J2841 utility factor model are not representative of the driving behavior of this set of plug-in vehicles. A hydrogen fueled vehicle requires a high pressure gaseous fuel storage and delivery system that is very different than the fueling systems of current conventional vehicles. The design and execution of the system is critical to the safety and functionality of an FCPHEV, but previous literature on hydrogen fueled vehicles covers fuel systems in little detail. Section B of this study details the considerations that one must make when designing a high pressure hydrogen fuel system and provides an example of how those considerations were met for the FCPHEV built by Colorado State University in the EcoCAR 2 competition. The FCPHEV built for the EcoCAR 2 competition is the first of its kind to publish real-world driving data. Data taken from the vehicle during on-road testing is analyzed in Section C of this study to prove the FCPHEV concept and increase the understanding of overall system operation. The results of the driving tests demonstrate the viability of the FCPHEV and highlight its advantages over current zero emissions vehicle architectures.

Subject Area: Fuel Cell ; Plug-In Hybrid Vehicle

4. **Environment**

Emissions and Cost Implications of Controlled Electric Vehicle Charging in the U.S. PJM Interconnection *Allison Weis, Jeremy J. Michalek, Paulina Jaramillo, and Roger Lueken*

**Abstract:** We develop a unit commitment and economic dispatch model to estimate the operation costs and the air emissions externality costs attributable to new electric vehicle electricity demand under controlled vs uncontrolled charging schemes. We focus our analysis on the PJM Interconnection and use scenarios that characterize (1) the most recent power plant fleet for which sufficient data are available, (2) a hypothetical 2018 power plant fleet that reflects upcoming plant retirements, and (3) the 2018 fleet with increased wind capacity. We find that controlled electric vehicle charging can reduce associated generation costs by 23%–34% in part by shifting loads to lower-cost, higher-emitting coal plants. This shift results in increased externality costs of health and environmental damages from increased air pollution. On balance, we find that controlled charging of electric vehicles produces negative net social benefits in the recent PJM grid but could have positive net social benefits in a future grid with sufficient coal retirements and wind penetration.

**Subject Area:** EV electricity demand; emissions; charging schemes

**Availability:** Ackelsberg, Marth

Measurement of black carbon emissions from in-use diesel-electric passenger locomotives in California Nicholas W. Tang, Joshua S. Apte, Philip T. Martien, & Thomas W. Kirchstetter

Abstract: Black carbon (BC) emission factors were measured for a California commuter rail line fleet of diesel-electric passenger locomotives (Caltrain). The emission factors are based on BC and carbon dioxide (CO2) concentrations in the exhaust plumes of passing locomotives, which were measured from pedestrian overpasses using portable analyzers. Each of the 29 locomotives in the fleet was sampled on 4–20 separate occasions at different locations to characterize different driving modes. The average emission factor expressed as g BC emitted per kg diesel consumed was 0.87 ± 0.66 g kg⁻¹ (±1 standard deviation, n = 362 samples). BC emission factors tended to be higher for accelerating locomotives traveling at higher speeds with engines in higher notch settings. Higher fuel-based BC emission factors (g kg⁻¹) were measured for locomotives equipped with separate “head-end” power generators (SEP-HEPs), which power the passenger cars, while higher time-based emission factors (g h⁻¹) were measured for locomotives without SEP-HEPs, whose engines are continuously operated at high speeds to provide both head-end and propulsion power. PM10 emission factors, estimated assuming a BC/PM10 emission ratio of 0.6 and a typical power output-to-fuel consumption ratio, were generally in line with the Environmental Protection Agency's locomotive exhaust emission standards. Per passenger mile, diesel-electric locomotives in this study emit only 20% of the CO2 emitted by typical gasoline-powered light-duty vehicles (i.e., cars). However, the reduction in carbon footprint (expressed in terms of CO2 equivalents) due to CO2 emissions avoidance from a passenger commuting by train rather than car is appreciably offset by the locomotive's higher BC emissions.

Subject Area: Locomotive emissions; Black carbon; Particulate matter; Emission standards; Carbon footprint

The importance of grid integration for achievable greenhouse gas emissions reductions from alternative vehicle technologies

Brian Tarroja, Brendan Shaffer & Scott Samuelsen

Abstract: Alternative vehicles must appropriately interface with the electric grid and renewable generation to contribute to decarbonization. This study investigates the impact of infrastructure configurations and management strategies on the vehicle–grid interface and vehicle greenhouse gas reduction potential with regard to California's Executive Order S-21-09 goal. Considered are battery electric vehicles, gasoline-fueled plug-in hybrid electric vehicles, hydrogen-fueled fuel cell vehicles, and plug-in hybrid fuel cell vehicles. Temporally resolved models of the electric grid, electric vehicle charging, hydrogen infrastructure, and vehicle powertrain simulations are integrated. For plug-in vehicles, consumer travel patterns can limit the greenhouse gas reductions without smart charging or energy storage. For fuel cell vehicles, the fuel production mix must be optimized for minimal greenhouse gas emissions. The plug-in hybrid fuel cell vehicle has the largest potential for emissions reduction due to smaller battery and fuel cells keeping efficiencies higher and meeting 86% of miles on electric travel keeping the hydrogen demand low. Energy storage is required to meet Executive Order S-21-09 goals in all cases. Meeting the goal requires renewable capacities of 205 GW for plug-in hybrid fuel cell vehicles and battery electric vehicle 100s, 255 GW for battery electric vehicle 200s, and 325 GW for fuel cell vehicles.

Subject Area: Greenhouse gas emissions; Electric grid; Electric vehicles; Fuel cell vehicles; Smart charging; Energy storage

Is Liberalism Now an Essentially Contested Concept? Ruth Abbey

Abstract: n/a

Subject Area: environment, liberalism


http://books.google.com/books?hl=en&lr=&id=9ApgBwAAQBAJ&oi=fnd&pg=PA211&ots=VAWz_XBCxi&sig=liLm7YQSNaqD_Rs0By8pof7IqcU
Sustainability, Resiliency, and Grid Stability of the Coupled Electricity and Transportation Infrastructures: Case for an Integrated Analysis Jarod C. Kelly; Tulga Ersal; Chiao-Ting Li; Brandon M. Marshall; Soumya Kundu; Gregory A. Keoleian; Huei Peng; Ian A. Hiskens; and Jeffrey L. Stein

Abstract: Electrified vehicles (EVs) couple transportation and electrical infrastructures, impacting vehicle sustainability, transportation resiliency, and electrical grid stability. These impacts occur across timescales; grid stability at the millisecond scale, resiliency at the daily scale, and sustainability over years and decades. Integrated models of these systems must share data to explore timescale dependencies, and reveal unanticipated outcomes. This paper examines EV adoption for sustainability, resiliency, and stability effects. Sustainability findings, consistent with previous studies, indicate that electrification generally reduces lifecycle greenhouse gas (GHG) emissions, and increases and . Electrified vehicles enhance vehicle resiliency (ability of vehicle to complete typical trips during fuel outage). Coupled results enhance EV resilience research, finding that a 16-km (10-mi) all-electric range plug-in hybrid EV improves resiliency versus a gasoline-only vehicle. Increasing EV market share reduces grid stability. Stability depends upon charging profiles and background electrical demand. Stability-related grid outages increase with EV market penetration. This paper modeled these systems in their coupled form across timescales yielding results not obvious if the systems were modeled in isolation.

Subject Area: Sustainability, Resiliency, Electrical grid, Electrical grid stability, Transportation, Electric vehicles, Lifecycle assessment

Stochastic comparative assessment of life-cycle greenhouse gas emissions from conventional and electric vehicles Arash Noshadravan, Lynette Cheah, Richard Roth, Fausto Freire, Luis Dias, & Jeremy Gregory

Abstract: Purpose: Electric vehicles (EVs) are promoted due to their potential for reducing fuel consumption and greenhouse gas (GHG) emissions. A comparative life-cycle assessment (LCA) between different technologies should account for variation in the scenarios under which vehicles are operated in order to facilitate decision-making regarding the adoption and promotion of EVs. In this study, we compare life-cycle GHG emissions, in terms of CO2eq, of EVs and conventional internal combustion engine vehicles (ICEV) over a wide range of use-phase scenarios in the USA, aiming to identify the vehicles with lower GHG emissions and the key uncertainties regarding this impact. Methods: An LCA model is used to propagate the uncertainty in the use phase into the greenhouse gas emissions of different powertrains available today for compact and midsize vehicles in the US market. Monte Carlo simulation is used to explore the parameter space and gather statistics about GHG emissions of those powertrains. Spearman’s partial rank correlation coefficient is used to assess the level of contribution of each input parameter to the variance of GHG intensity. Results and discussion: Within the scenario space under study, battery electric vehicles are more likely to have the lowest GHG emissions when compared with other powertrains. The main drivers of variation in the GHG impact are driver aggressiveness (for all vehicles), charging location (for EVs), and fuel economy (for ICEVs). Conclusions: The probabilistic approach developed and applied in this study enables an understanding of the overall variation in GHG footprint for different technologies currently available in the US market and can be used for a comparative assessment. Results identify the main drivers of variation and shed light on scenarios under which the adoption of current EVs can be environmentally beneficial from a GHG emissions standpoint.

Subject Area: Electric vehicles; Greenhouse gas emissions; Life-cycle assessment; Uncertainty analysis

A Model System to Evaluate the Impacts of Vehicle Purchase Tax and Fuel Tax on Household Greenhouse Gas Emissions Liu, Yan & Cirillo, Cinzia

Abstract: This paper proposes a model system to forecast household-level greenhouse gas emissions (GHGEs) from private transportation and to evaluate the effects of car-related taxation schemes on vehicle emissions. The system contains four sub-models which specifically capture households’ vehicle type and vintage, quantity, usage, and greenhouse gas emission rates (GHGERs) for different vehicle types. The vehicle GHGERs are calculated using MOVES 2014 (Motor Vehicle Emission Simulator 2014), which is authorized by the Environmental Protection Agency (EPA). The whole model system has been applied to the Washington D.C. Metropolitan Area. The authors employ the 2009 National Household Travel Survey (NHTS) with supplementary data from Consumer Reports, American Fact Finder and the 2009 State Motor-Vehicle Registrations (SMVR). Two tax schemes, vehicle purchase tax and fuel tax, have been proposed and their effects on vehicle GHGEs reduction are predicted. The average annual GHGEs per vehicle is 5.86 tons carbon dioxide-equivalent (CO₂E) gas without the proposed taxes. After implementing two taxation policies, the results show that: (1) The impacts on reducing GHGEs from fuel taxes are higher than those from purchase taxes; (2) Purchase taxes mainly reduce GHGEs by decreasing the car quantity for households with more vehicles; (3) Fuel taxes successfully reduce GHGEs by decreasing car usage of households with fewer vehicles. The model system can be extended to other zones, counties, states and nations.

Subject Area: Automobile ownership; Computer models; Environmental impacts; Fuel taxes; Greenhouse gases; Households; Sales tax; Travel surveys

http://docs.trb.org/prp/15-1894.pdf
A benefit-cost assessment of new vehicle technologies and fuel economy in the U.S. market Richard A. Simmons, Gregory M. Shaver, Wallace E. Tyner, & Suresh V. Garimella

Abstract: Increasingly stringent fuel economy and emissions regulations alongside efforts to reduce oil dependence have accelerated the global deployment of advanced vehicle technologies. In recent years, original equipment manufacturers (OEMS) and consumers have generally been successful in mutually deploying cleaner vehicle options with little sacrifice in cost, performance or overall utility. Projections regarding the challenges and impacts associated with compliance with mid- and long-term targets in the U.S., however, incur much greater uncertainty. The share of existing new vehicles that is expected to comply with future regulations, for example, falls below 10% by 2020. This article explores advanced technologies that result in reduced fuel consumption and emissions that are commercially available in 2014 Model Year compact and midsize passenger cars. A review of the recent research literature and publicly available cost and technical specification data addressing correlations between incremental cost and fuel economy is presented. This analysis reveals that a 10% improvement in the sales-weighted average fuel economy of passenger cars has been achieved between 2011 and 2014 at costs that are at or below levels anticipated by the regulations by means of reductions in weight, friction, and drag; advancements in internal combustion efficiency; turbocharging combined with engine downsizing; transmission upgrades; and the growth of hybrids. Benefit-cost analyses performed on best-selling models in the selected classifications reveal that consumers thus far are not substantially incentivized to purchase fuel economy. Under baseline conditions, benefit-cost ratios are above a breakeven value of unity for only 6 of 28 models employing improved fuel-economy technologies. Sales-weighted data indicate that the “average” consumer that elected to invest in greater fuel economy spent $1490 to realize a 17.3% improvement in fuel economy, equating to estimated savings of $1070. Thus savings were, on average, insufficient to cover technology costs in the baseline scenario. However, a sensitivity analysis reveals that a majority of new technologies become financially attractive to consumers when average fuel prices exceed $5.60/gallon, or when annual miles traveled exceed 16,400. The article concludes with techno-economic implications of the research on future fuel economy regulations for stakeholders. In general, the additional cost consumers incur in exchange for a given level of fuel economy improvement in the coming years will need to be steadily reduced compared to current levels to ensure that the expected benefits of fuel savings are financially warranted.

Subject Area: Fuel economy; Clean vehicle technologies; Alternative vehicles; Hybrid vehicles; CAFE; Benefit-cost

Improvement of Default Local MOVES Input Data for the 2011 National Emissions Inventory

John Koupal, Timothy DeFries, Cindy Palacios, Allison DenBleyker & Heather Perez

**Abstract:** The Coordinating Research Council (CRC) sponsored a project to develop improved inputs for EPA’s Motor Vehicle Emissions Simulator (MOVES), for use in the 2011 U.S. National Emissions Inventory (NEI). Under contract with CRC, ERG identified the most promising MOVES inputs for improvement, and performed a detailed review of candidate data sources for each. ERG then developed improved defaults for passenger car and light truck age distributions and populations and long-haul truck VMT allocations. Age distributions and vehicle populations were developed for every county in the U.S. based on vehicle registration data purchased from IHS, Inc. The age distributions showed an average age range of 4 to 16 years for cars and trucks vs. MOVES national default of 9 years. Long-haul truck VMT allocations were derived from the 2007 Freight Analysis Framework (FAF), producing unique allocations by region of the country, urban/rural and interstate/non-interstate, and are intended to replace the uniform long haul allocations currently used in MOVES. The updated long-haul fractions for combination trucks varied by region of the country, road type and urban/rural area, ranging from around 30 percent on urban unrestricted roads, to up to 90 percent for some rural restricted roads, in comparison to a static MOVES default of 59 percent. These updates will be used in the 2011 NEI, and provide a resource for emissions modelers at the federal, regional, state and municipal levels to improve local inventory and air quality modeling.

**Subject Area:** MOVES; National Emissions Inventory;

Characterization of nanoparticle emissions and exposure at traffic intersections through fast–response mobile and sequential measurements

Anju Goela, & Prashant Kumar

Abstract: Quantification of disproportionate contribution made by signalised traffic intersections (TIs) to overall daily commuting exposure is important but barely known. We carried out mobile measurements in a car for size–resolved particle number concentrations (PNCs) in the 5–560 nm range under five different ventilation settings on a 6 km long busy round route with 10 TIs. These ventilation settings were windows fully open and both outdoor air intake from fan and heating off (Set1), windows closed, fan 25% on and heating 50% on (Set2), windows closed, fan 100% on and heating off (Set3), windows closed, fan off and heating 100% on (Set4), and windows closed, fan and heating off (Set5). Measurements were taken sequentially inside and outside the car cabin at 10 Hz sampling rate using a solenoid switching system in conjunction with a fast response differential mobility spectrometer (DMS50). The objectives were to: (i) identify traffic conditions under which TIs becomes hot–spots of PNCs, (ii) assess the effect of ventilation settings in free–flow and delay conditions (waiting time at a TI when traffic signal is red) on in–cabin PNCs with respect to on–road PNCs at TIs, (iii) deriving the relationship between the PNCs and change in driving speed during delay time at the TIs, and (iv) quantify the contribution of exposure at TIs with respect to overall commuting exposure. Congested TIs were found to become hot–spots when vehicle accelerate from idling conditions. In–cabin peak PNCs followed similar temporal trend as for on–road peak PNCs. Reduction in in–cabin PNC with respect to outside PNC was highest (70%) during free–flow traffic conditions when both fan drawing outdoor air into the cabin and heating was switched off. Such a reduction in in–cabin PNCs at TIs was highest (88%) with respect to outside PNC during delay conditions when fan was drawing outside air at 25% on and heating was 50% on settings. PNCs and change in driving speed showed an exponential–fit relationship during the delay events at TIs. Short–term exposure for ~2% of total commuting time in car corresponded to ~25% of total respiratory doses. This study highlights a need for more studies covering diverse traffic and geographical conditions in urban environments so that the disparate contribution of exposure at TIs can be quantified.

Subject Area: Particle number concentration; Number size distribution; In–vehicle exposure; Respiratory deposition doses; Traffic intersections


Policymaking Should Consider the Time-dependent Greenhouse Gas Benefits of Transit-oriented Smart Growth

Nahlik, Matthew J., and Mikhail V. Chester

Abstract: Cities are increasingly developing greenhouse gas (GHG) mitigation plans and reduction targets based on a growing body of knowledge about climate change risks, and changes to passenger transportation are often at the center of these efforts. Yet little information exists for characterizing how quickly or slowly GHG emissions reductions will accrue given changes in urban form around transit, and whether benefits will accrue quickly enough to meet policy year targets (such as reaching 20% of 1990 GHG emissions levels by 2050). Even more complicated is when cities focus on achieving GHG reductions through integrated transportation and land use planning, as changes in emissions can occur across many sectors (such as transportation, building energy use, and electricity generation). Using the Los Angeles Expo line, a framework is developed to assess how financing schemes can affect the rate of redevelopment and resulting life-cycle GHG emissions from travel and building energy use. The framework leverages an integrated transportation and land use life-cycle assessment model that captures upfront construction of new development near transit and the long-term changes in household energy use for travel and buildings. The results show that for the same amount of development around the Expo line, it is possible to either meet (if aggressive redevelopment happens early) or not meet (if significant redevelopment does not start until decades out) state GHG goals by 2050. The time-based approach reveals how redevelopment schedules should be considered when setting strategies for meeting future GHG emission targets.

Subject Area: GHG; climate change; emissions targets

Real-world fuel economy and CO2 emissions of plug-in hybrid electric vehicles

Patrick Plötz, Simon Funke, & Patrick Jochem

Abstract: Plug-in hybrid electric vehicles (PHEV) combine electric propulsion with an internal combustion engine. Their potential to reduce transport related greenhouse gas emissions highly depends on their actual usage and electricity provision. Various studies underline their environmental and economic advantages, but are based on standardised driving cycles, simulations or small PHEV fleets. Here, we analyse real-world fuel economy of PHEV and the factors influencing it based on about 2,000 actual PHEV that have been observed over more than a year in the U.S. and Germany. We find that real-world fuel economy of PHEV differ widely among users. The main factors explaining this variation are the annual mileage, the regularity of daily driving, and the likelihood of long-distance trips. Current test cycle fuel economy ratings neglect these factors. Despite the broad range of PHEV fuel economies, the test cycle fuel economy ratings can be close to empiric PHEV fleet averages if the average annual mile-age is about 17,000 km. For the largest group of PHEV in our data, the Chevrolet Volt, we find the average fuel economy to be 1.45 litres/100 km at an average electric driving share of 78%. The resulting real-world tank-to-wheel CO2 emissions of these PHEV are 42 gCO2/km and the annual CO2 savings in the U.S. amount to about 50 Mt. In conclusion, the variance of empirical PHEV fuel economy is considerably higher than of conventional vehicles. This should be taken into account by future test cycles and high electric driving shares should be incentivised.

Subject Area: electric vehicles, plug-in hybrid electric vehicles, real-world fuel economy, utility factor

5. **Policy and Mobility**

**Assessment of motor vehicle use characteristics in three Indian cities** Rahul Goel, Dinesh Mohan, Sarath K. Guttikunda, & Geetam Tiwari

**Abstract:** Estimates of emissions and energy consumption by vehicular fleet in India are not backed by reliable values of parameters, leading to large uncertainties. We report new methods, including primary surveys and secondary data sources, to estimate in-use fleet size, annual mileage (kilometers per year), and fuel efficiency of cars and motorised two-wheelers (MTW) for Delhi, and except fleet size and annual mileage of cars, for Visakhapatnam and Rajkot. We estimated that the official number of registered cars and MTW in Indian cities is more than two times the actual number of in-use vehicles. The private vehicular fleet in India is the youngest, its fuel efficiency one of the highest, and annual kilometers travelled is the lowest, compared to many high-income countries, such as the USA and those in European Union. Along with high renewal rate of fleet, the data suggest that it is possible for India to have one of the most fuel-efficient vehicle fleets in the world in the future, if fuel-efficiency standards and fiscal policies to contain growing dieselization are implemented in the country at the earliest.

**Subject Area:** India; Cars; Motorised two-wheelers; Fuel efficiency; In-use fleet size; Annual mileage

Abstract: I was retained to analyze the travel burdens associated with the State of Texas provision that individuals generally must present one of several approved forms of photo identification in order to cast an in-person ballot that will be counted. More specifically, I was retained to investigate the travel burdens associated with citizens of voting age who do not already hold an accepted photo ID to travel to an officially designated location to apply for and obtain a photo identification card called an Election Identification Certificate (EIC). In this report I focus on the time required to access an EIC location by car, via public transportation, or on foot, because time is the most salient and readily quantifiable of the various costs involved in travel. The main output of the analysis and of this report is an estimate of travel time burdens across the population of all citizens of voting age, by race/ethnicity, as well as a description of different rates of poverty among the racial/ethnic groups generally and an estimate of travel time burdens among those burdened by poverty.

Subject Area: driver’s license; transit burden, voting

Availability: VOTERS, TEXAS LEAGUE OF YOUNG. "IN THE UNITED STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF TEXAS CORPUS CHRISTI DIVISION."
Empirical distributions of vehicle use and fuel efficiency across space: Implications of asymmetry for measuring policy incidence  
Jonathan A. Cook, James N. Sanchirico, Deborah Salon, & Jeffrey Williams

Abstract: Concerns about local air pollution and climate change have prompted all levels of government to consider a variety of policies to reduce vehicle dependence and fuel consumption, as the transportation sector is one of the largest sources of local and global emissions. Because many of the policy options under consideration are market-based (e.g., gasoline tax, carbon tax), it is important to consider how the impacts would vary across space and affect different subpopulations. Evaluating incidence is relevant for both the expected costs and benefits of a particular policy, however detailed data on vehicle-miles traveled (VMT) and fuel consumption allowing for the distributions of these variables to be estimated at a fine geographic scale is rarely available. This paper uses a unique dataset with more than 20 million vehicles in California to derive estimates of VMT and fuel consumption in order to examine the spatial distribution of impacts for an increase in the price of gasoline as well as the consequences of using different statistics for policy evaluation. Results show that VMT and fuel consumption distributions are not symmetrically distributed and vary significantly within transportation planning regions. To understand the potential implications of this asymmetry, we do a back of the envelope comparison using the mean and mode of the VMT or fuel consumption distribution for policy analysis. We find that assuming a symmetric distribution can lead to a divergence of 20–40% from the estimates based on the empirical distribution. Our results, therefore, introduce caution in interpreting the incidence of policies targeting the transportation sector based on averages.

Subject Area: VMT; Fuel consumption; Transportation policy; Climate policy; Spatial analysis; Policy incidence

Optimal policy instruments for externality-producing durable goods under present bias Garth Heutel

Abstract: When consumers exhibit present bias, the standard solution to market failures caused by externalities—Pigouvian pricing—is suboptimal. I investigate policies aimed at externalities for present-biased consumers. Optimal policy includes an instrument to correct the externality and an instrument to correct the present bias. Either instrument can be an incentive-based policy (e.g. a tax on fuel economy) or a command-and-control policy (e.g. a fuel economy mandate). Under consumer heterogeneity, a command-and-control policy may dominate an incentive-based policy. Calibrated to the US automobile market, simulation results suggest that the second-best gasoline tax is 3–30% higher than marginal external damages. The optimal price policy includes a gasoline tax set about equal to marginal external damages and a fuel economy tax that increases the price of an average non-hybrid car by about $550–$2200 relative to the price of an average hybrid car.

Subject Area: Present bias; Energy policy; Gasoline tax; Quasi-hyperbolic discounting

Racialized Mobility Transitions in Philadelphia: Connecting Urban Sustainability and Transport Justice Mimi Sheller

Abstract: National level statistics show a decade-long decline in the use of cars in the United States as well as other developed countries. This transition has been connected to growth in more sustainable forms of urban transport such as walking, bicycling, and increased use of transit, as well as changes in urban spatial planning. This article examines the recent trends toward more sustainable mobility in Philadelphia, in order to locate these cultural changes in a specific spatial, cultural, and racial context. The article raises the crucial yet often ignored issue of how urban spatial form and mobility regimes in post-industrial cities like Philadelphia are highly inflected by racial space and racialized mobilities. It suggests that wider trends toward decreasing young white automobility in cities across the U.S. must be situated in relation to changing patterns of suburbanization of poverty, gentrification of city centers, and struggles over public transit access and investment. The specific case is analyzed in relation to multi-level transition theories, cultural analysis of mobility frames and discourses, and the addition of local observation of everyday transport drawing on perspectives from mobilities research. A focus on racial space and transport inequality adds new insights to understanding the limits of any transition that may be taking place in the American automobility regime, and it expands how such transitions are being culturally framed and promoted.

Subject Area: millennials, race, VMT, poverty

Conceptualising and Measuring Spatial Indicators of Employment Through a Liveability Lens

Hannah Badland, Melanie Davern, Karen Villanueva, Suzanne Mavoa, Allison Milner, Rebecca Roberts, & Billie Giles-Corti

Abstract: Employment is a well-known social determinant of health and wellbeing and important for the liveability of a region. Yet, spatial data are rarely used to understand barriers and facilitators of accessing employment within a city. Therefore it remains challenging to plan cities that provide equitable opportunities for urban job seekers. This paper sought to: (1) identify urban planning and neighbourhood spatial attributes that facilitate access to employment; (2) conceptualise how neighbourhood attributes that facilitate accessible urban employment may be related to health and wellbeing behaviours and outcomes; and (3) isolate potentially important neighbourhood-level spatial measures that policy-makers and planners could use to assess urban employment accessibility. A conceptual framework was developed through a social determinants of health lens, where more upstream (e.g., neighbourhood attributes) and more downstream (e.g., behaviours, intermediate outcomes) determinants of urban employment were identified in relation to long-term health and social outcomes of interest. Six potential neighbourhood spatial measures of employment were identified. These were classified into measures of: access to employment (n = 4), local employment (n = 1), and neighbourhood employment level (n = 1). The spatial measures proposed rely on routinely collected administrative datasets existing within Australia (i.e., census data); therefore can be replicated over time and data are available nationally. Together, this research identified a suite of potential (and readily available) spatial measures that can be used to assess selected neighbourhood attributes as they relate to urban employment access. Such spatial measures can be used to inform future planning decisions that integrate policies across multiple sectors, thereby improving employment accessibility in an urban context.

Subject Area: Geographical information systems; Liveability; Policy; Social determinants of health; Urban planning

**Transport Challenges in Rural Indiana**

*V. Dimitra Pyrialakou, Brigitte Waldorf, & Konstantina Gkritza*

**Abstract:** In this publication we look at the transport situation in Indiana’s rural counties. We first explore the transport need in Indiana’s rural counties. Next we look at the public transportation availability in rural counties and proximity to hospitals, schools, and recreational opportunities. In combination, public transportation availability and proximity to services determine a county’s accessibility levels. Comparing needs and accessibility, we then identify the counties with the greatest transport challenges, that is, those counties with the largest gaps between needs and accessibility. Finally, we discuss the planning and policy implications for addressing the mismatch between transport needs and available opportunities and resources in rural Indiana.

**Subject Area:** rural Indiana transport

**Availability:** Pyrialakou, V. Dimitra. "Transport Challenges in Rural Indiana."  
https://extension.purdue.edu/extmedia/EC/EC-796-W.pdf
Reforming the Taxation of Vehicle Use and Ownership  

Stef Proost, Kurt van Dender and Jonas Eliasson

Abstract: In many economies, motor fuel taxes have long been the main instruments for generating tax revenues from the transport sector. Nowadays they are also rationalized on the grounds of reducing congestion, carbon emissions, local air pollution, energy dependency, and sometimes accident costs. However, for several reasons, there is now much debate about reforming or partially replacing these taxes. This debate raises several kinds of research questions, including efficient design of such tax instruments and what factors affect their design in reality, CTS organised an international symposium where recent research regarding these issues was presented. This report summarises some findings from the symposium.

Subject Area: Fuel tax, vehicle tax, transport pricing

Optimal Fuel Taxes and Heterogeneity of Cities Prof. Dr. Georg Hirte, & Stefan Tscharaktschiew Ph.D.

Abstract: In the United States all levels of jurisdictions are allowed to levy supplements to the federal fuel tax level. While fuel tax differentials at the state level are substantial, there is a relatively small differentiation across cities. This seems surprising given the heterogeneity of U.S. metropolitan areas. Against this background, the objective of the present paper is to analyze whether the current small level of tax differentiation across heterogeneous metropolitan areas is justified on efficiency grounds. We employ a spatial urban computable general equilibrium approach and calculate optimal gasoline taxes for an average U.S. prototype urban area characterized by a medium degree with respect to the spatial distribution of jobs (implying a medium spatial expansion of the urban area, medium degree of externalities, medium public transit share etc.) and for cities that differ with respect to these and further characteristics. We find that in our prototype urban economy the optimal gasoline tax is higher than current rates as suggested by previous studies calculating nationwide optimal gasoline taxes. Furthermore, it is shown that optimal tax levels may vary considerably across heterogeneous cities, much more than actual tax rates. This implies that stronger spatial fuel tax differentiation across cities could raise social welfare. However, we also show that setting an optimal spatially uniform tax, i.e. a uniform tax that maximizes the sum of the benefits generated in all cities, is capable to generate a significant fraction of the maximum achievable welfare gain under optimal city specific locally differentiated gasoline taxes. Interestingly, such an optimal uniform tax could deviate from all city specific optimal fuel tax levels. This suggests that the additional benefit from spatial fuel tax differentiation might actually be relatively small, in our case the efficiency premium is less than one-thirds.

Subject Area: Fuel tax; Gasoline tax; Urban economics; Tax differentiation; Job sprawl

**Streets to Live In: Justice, Space, and Sharing the Road** Laura M. Hartman, & David Prytherch

**Abstract:** Public streets are central to the built environment, where individuals seek a fair share of the roadway’s benefits and harms. But the American street, an asphalt landscape typically defined and designed for cars, can be inaccessible, unhealthy, and dangerous for the non-motorized, whose transportation choices have the smallest ecological footprint. Concern for social equity and sustainability requires rethinking the street geographically and ethically, and asking: “In what sense is the street a space of justice (or injustice)? How do traditional street regulation and design manifest ethical priorities? And what might a more just street look like, in theory and practice?” Such questions prompt one to engage both the spatial and moral, thus drawing from critical geography and ethics (including religion) to analyze roadways in terms of fairness and relational wholeness, and argue for what might be called a shalom street. Engaging such ethical concepts with the technical vocabularies of street regulation and design requires analyzing how national model standards and their interpretation (in the case study state of Ohio) enforce and materialize justice (or injustice) on the street. The promise of more just alternatives such as more sustainable and fair “Complete Streets” to live in needs to be explored.

**Subject Area:** social justice; public policy

http://www.pdcnet.org/enviroethics/content/enviroethics_2015_0037_0001_0021_0044

Abstract: Throughout the United States' troubled history of race and gender relations, the simple ability to travel from one location to another has been a crucial element of social justice. Keeping African-Americans, women, and other minority groups "in their place" frequently became a preoccupation of dominant groups to limit other groups' physical and social mobility (Domosh & Seager, 2001, p. 115). Homer Plessy's 1892 arrest for riding in a railcar reserved for Caucasians became the basis of the United States Supreme Court's "separate but equal" doctrine which remained in place for sixty years. Rosa Parks' legendary refusal to move to the back of an illegally segregated city bus in Montgomery, Alabama not only led to a boycott of Montgomery's transit system, but also affirmed the use and place of civil disobedience to protest violations of civil and social justice (Banks, 1994; Parks & Haskins, 1992). The 1961 Freedom Riders' protests of segregated public buses through the very use of public buses, and the Southern violence that greeted them, exposed how the simple act of using publicly-provided transportation facilities can, itself, be a political act. Thus, among many notable others, Homer Plessy, Rosa Parks, and the Freedom Riders revealed the inextricably close relationship between physical mobility and social justice.

Subject Area: social justice; public policy


Abstract: Activity-based models (ABMs) adopt the notion of tours to model activity-travel patterns, as the concept of a tour closely mimics the way in which individuals chain their activities in the real world. Each tour may be defined by a primary destination (corresponding to a primary purpose) and may also include a multitude of secondary stops on the way to the primary destination (outbound half tour) or on the way back (inbound half tour). This paper presents a tour characterization framework capable of simulating all of the secondary stops on a tour, the time allocated to each of the activities, and the sequence of stops on a tour. The first component that simulates the mix of activities and their corresponding durations was presented in an earlier paper (Garikapati et al, 2014). This paper presents the stop sequencing component capable of determining the order in which activities will be pursued on outbound and inbound half tours. Model estimation results and comparisons between observed and predicted stop-sequencing patterns are presented. The models are found to perform quite well in replicating the observed stop making patterns. The overall tour characterization framework is designed to accommodate the continuous treatment of time in ABMs in practice.

Subject Area: activity participation, time allocation, tour-based model, stop sequencing, sequential activity type choice, tour-based modeling framework

Road Traffic Congestion: A Concise Guide *John C. Falcocchio, & Herbert S. Levinson*

**Abstract:** This book on road traffic congestion in cities and suburbs describes congestion problems and shows how they can be relieved.

**Subject Area:** traffic congestion; mobility; speed

The Impact of Traffic Congestion on Mobility John C. Falcocchio, & Herbert S. Levinson

Abstract: Mobility is the ability of people and goods to travel easily, safely, quickly and reliably. Trip mobility varies with the speed of travel, and it may be defined as the number of trips taken and their distance (trip-miles) within the traveler’s daily travel time and cost budgets. Therefore, lower speeds resulting from traffic congestion reduce mobility.

Subject Area: traffic congestion; mobility; speed

A Model System To Evaluate The Impacts Of Vehicle-Related Taxation Policies On Household Greenhouse Gas Emissions  Liu, Yan

Abstract: This thesis proposes a model system to forecast household-level greenhouse gas emissions (GHGEs) from private transportation and to evaluate effects of car-related taxation schemes on vehicle emissions. The system contains four sub-models which specifically capture households' vehicle type and vintage, quantity, usage, and greenhouse gas emissions rates for different vehicle types. An integrated discrete-continuous vehicle ownership model is successfully implemented, while MOVES2014 (Motor Vehicle Emission Simulator 2014) is utilized. The model system has been applied to the Washington D.C. Metropolitan Area. The 2009 National Household Travel Survey (NHTS) with supplementary data from the Consumer Reports, the American Fact Finder and the 2009 State Motor Vehicle Registrations (SMVR) are used for estimations and predictions. Three tax schemes, vehicle ownership tax, purchase tax and fuel tax, have been proposed and their impacts on vehicle GHGEs reduction are predicted. The proposed model system can be extended to other regions, counties, states and nations.

Subject Area: Discrete Choice Model; Emission Reduction; Greenhouse Gas; Integrated Vehicle Ownership Model; MOVES; Taxation Policy

Transport policy and the car divide in the UK, the US and France: beyond the environmental debate

Porter, Christopher, David Kall, Daniel Beagan, Richard Margiotta

Abstract: This document is the Final Report for NCHRP Project 25-38, Input Guidelines for Motor Vehicle Emissions Simulator Model (MOVES). The other major product of this research is a resource document, titled Developing Inputs for the Motor Vehicle Emissions Simulator Model: Practitioners’ Handbook, that provides information for practitioners on how to develop local inputs for the U.S. Environmental Protection Agency’s MOVES model. Four tools, along with supporting documentation (MOVES Tool Documentation), were also developed to assist MOVES users in developing specific inputs.

Subject Area: Vehicle inventory; MOVES source types

Transport policy and the car divide in the UK, the US and France: beyond the environmental debate Olivier Coutard, Gabriel Dupuy, & Sylvie Fol

Abstract: Public aid programs to subsidize the auto-mobility of low-income households are at the heart of a trade-off between economic, environmental and social concerns. This article will analyze comparative research into the origins and development of such programs in three countries characterized by different levels of car dependence (France, the UK and the US). It will show that these programs, which are of obvious benefit for the households in question and have largely escaped criticism, despite undermining policies that restrict the use of cars, remain of marginal importance in all three countries. This reasons for this are twofold: firstly, auto programs are not an appropriate solution to the difficulties encountered by a significant portion of poor households and, secondly, wider development of such policies would constitute a considerable political gamble, especially as they risk destabilizing the mechanisms for funding public transit and weakening their social legitimacy.

Subject Area: public aid; auto programs; public transit

Pay-As-You-Drive Insurance Its Impacts on Household Driving and Welfare

Brice G. Nichols, & Kara M. Kockelman

Abstract: Vehicle-miles traveled (VMT) can greatly affect crash risk and, therefore, insurance costs, but accurately assessing VMT has been challenging for insurance agencies. Affordable technology now allows insurance companies to track VMT better and has prompted pilot programs and further research of mileage-based, or pay-as-you-drive (PAYD), insurance. Research shows that PAYD programs can discourage extraneous driving and thereby save drivers money (but reduce consumer welfare by less than consumer cost savings) and reduce crash risks, insurers' costs, and externalities. Studies consider aggregate, national, and statewide effects of PAYD policies, with some focus on equity effects, but much heterogeneity is ignored. This study bolsters existing work by predicting PAYD effects with the use of National Household Travel Survey (NHTS) data. These data are used to model driver response to driving cost changes and an insurance pricing model (per vehicle) according to actual loss data and risk factors by vehicle type. This study anticipates PAYD impact variations across a sample of NHTS households and vehicle types and finds that on average households save enough on reduced insurance and travel costs to cover lost welfare from VMT reductions. Results suggest that the average (light-duty) vehicle will be driven 2.7% less (237 fewer annual miles per year), with average consumer benefits of only $2.00 per vehicle with a premium that is partially fixed and partially mileage based. Drivers with the lowest annual VMT needs are expected to receive the largest welfare benefits, thanks to a convex relationship between VMT and crash losses. This analysis provides support to existing literature that PAYD policies can reduce VMT and insurance pricing equity without harming driver welfare.

Subject Area: pay as you drive insurance; VMT

http://www.ce.utexas.edu/prof/kockelman/public_html/TRB14PAYD.pdf
A simple empirical analysis on the link between socioeconomic status and spatial mobility Keita, Moussa

Abstract: Considering spatial mobility as an important dimension of human capability with direct implications for well-being, this study examines the link between individuals’ socioeconomic status and their degree of mobility. We use data from the National Household Travel Survey (NHTS) conducted in United States in 2009 by the US Department of Transportation. We construct two complementary mobility variables: one translating the average distance individuals travel by day and the other capturing the average number of trips made by individuals in a day. Using both exploratory and multivariate linear regressions analyzes, our results show that socioeconomic status determines significantly individuals’ degree of mobility. We found that mobility is significantly higher among the most educated individuals and those with high income levels. It also appears strong heterogeneity in the mobility according to gender or individuals’ age. We found, in particular, that men are more mobile than women in terms of distance traveled. But conversely, women are much more mobile than men in terms of frequency of trips.

Subject Area: spatial mobility, socio-economics status

Sustainability Of Multimodal Intercity Transportation Using A Hybrid System Dynamics And Agent-Based Modeling Approach Ludovic F. Hivin

Abstract: Demand for intercity transportation has increased significantly in the past decades and is expected to continue to follow this trend in the future. In the meantime, concern about the environmental impact and potential climate change associated with this demand has grown, resulting in an increasing importance of climate impact considerations in the overarching issue of sustainability. This results in discussions on new regulations, policies and technologies to reduce transportation's climate impact. Policies may affect the demand for the different transportation modes through increased travel costs, increased market share of more fuel efficient vehicles, or even the introduction of new modes of transportation. However, the effect of policies and technologies on mobility, demand, fleet composition and the resulting climate impact remains highly uncertain due to the many interdependencies. This motivates the creation of a parametric modeling and simulation environment to explore a wide variety of policy and technology scenarios and assess the sustainability of transportation. In order to capture total transportation demand and the potential mode shifts, a multimodal approach is necessary. The complexity of the intercity transportation System-of-Systems calls for a hybrid Agent-Based Modeling and System Dynamics paradigm to better represent both micro-level and macro-level behaviors. Various techniques for combining these paradigms are explored and classified to serve as a hybrid modeling guide. A System Dynamics approach is developed, that integrates socio-economic factors, mode performance, aggregated demand and climate impact. It is used to explore different policy and technology scenarios, and better understand the dynamic behavior of the intercity transportation System-of-Systems. In order to generate the necessary data to create and validate the System Dynamics model, an Agent-Based model is used due to its capability to better capture the behavior of a collection of sentient entities. Equivalency of both models is ensured through a rigorous cross-calibration process. Through the use of fleet models, the fuel burn and life cycle emissions from different modes of transportation are quantified. The radiative forcing from the main gaseous and aerosol species is then obtained through radiative transfer calculations and regional variations are discussed. This new simulation environment called the environmental Ground and Air Mode Explorer (eGAME) is then used to explore different policy and technology scenarios and assess their effect on transportation demand, fleet efficiencies and the resulting climate impact. The results obtained with this integrated assessment tool aim to support a scenario-based decision making approach and provide insight into the future of the U.S. transportation system in a climate constrained environment.

Subject Area: Agent-based model; fleet models; intercity transportation; environmental impact

Promoting Sustainable Travel Modes for Commute Tours: A Comparison of the Effects of Home and Work Locations and Employer-Provided Incentives  
Dr. Hongwei Dong, Dr. Liang Ma & Dr. Joseph Broach

Abstract: By using data from the 2011 Oregon Household Activity Survey, conducted in the Portland, Oregon, metropolitan area, this study conducts tour-based analyses of commute mode choice and applies them to evaluate and compare the effects of three sets of variables: the built environment at home, the built environment at workplace, and employer-provided financial incentives. The analysis results suggested that compared to the built environment at home, the built environment at workplace showed more additional explanatory power, illustrating the importance of including work location related variables in the models that simulate commute mode choice and trip chaining. Furthermore, we found that employer-provided financial incentives, in particular, parking fees at workplaces and the provision of subsidized transit passes, could also be very efficient policy levers to encourage commuters to use more sustainable commute modes, especially public transit. While the model results clearly show that the effects of many variables vary by tour complexity, we did not find strong evidence to the hypothesis that trip-chaining creates a barrier to shifting commuters’ travel mode from auto to non-auto modes.

Subject Area: employer-provided incentives, home location, Oregon, Portland, sustainable commute mode, trip chaining, work location

Environmental Policy And Vehicle Safety: The Impact Of Gasoline Taxes
Damien Sheehan-Connor

Abstract: Policies to reduce carbon emissions by vehicles, such as fuel economy standards and gasoline taxes, have impacts on vehicle weight and thus on safety. This paper develops a model that separately identifies the impact of vehicle weight on mortality and selection effects that impact accident propensity. The main results are that (1) the safety externalities associated with heavy vehicles are greater than the environmental ones; (2) under fuel economy standards, vehicle weights have recently decreased with little likely effect on accident deaths; and (3) similar environmental benefits could be combined with substantial reductions in deaths by implementing higher gasoline taxes. (JEL H23, D62)

Subject Area: fuel economy standards, gasoline taxes, safety externalities

6. Special Population Groups

The relationship between age and driving attitudes and behaviors among older Americans Alexander J Mizenko, Brian C Tefft, Lindsay S Arnold, & Jurek G Grabowski

Abstract: Background: Due to a decreasing birth rate and longer life expectancy, the proportion of Americans over the age of 65 is expected to rise in coming years. Drivers over 65 drive two billion miles yearly, a number that will increase. For that reason, it is imperative to understand their attitudes and perceptions. It is also important to understand whether drivers over 65 can be treated as one cohesive group, or if there are differences among them.

Methods: A web-enabled survey was conducted among Americans in the years 2011–2013. Responses from 1793 persons over 65 regarding attitudes towards driving behaviors, support for safety interventions, and engagement in unsafe behaviors were analyzed. Respondents were stratified by age: 65–69, 70–74, and 75 and older. Age groups were compared using logistic regression. Other potential explanatory factors were analyzed and controlled for.

Results: The three groups were similar on many outcomes. However, statistically significant differences were found between them with regard to perceptions on speeding and the support for speed cameras, among other outcomes. In nearly all cases, those 75 and older were the most “pro-safety.” However, when adjusted for demographic characteristics other than age, a larger proportion of respondents 75 and older reported engaging in red light running and drowsy driving in the last 30 days, and the difference was statistically significant. Conclusion: Older drivers are strongly “pro-traffic safety.” However, the finding that those 65–69 are less so is concerning. This is especially true if it is the result of a cohort effect instead of an age effect. The increase in certain behaviors among those 75 and older is also concerning; drivers over this age are more prone to fatal injury when involved in a motor vehicle crashes. This poses a public health issue as the 75 and older population expands.

Subject Area: Traffic, Safety, Seniors, Driving, Aging

Chapter 4 The Influence of Parent’s Perceptions and Residential Self-Selection to the Children’s Travel Modes at Single Parent Households Yusak O. Susilo

Abstract: Purpose: This chapter investigates the impacts of households’ residential self-selection, parents’ perceptions and travel patterns on their children’s daily travel mode shares, among single parent households. Methodology/approach: To capture the complexity of the relationships between parent and children daily travel mode choices, an integrated model structure is introduced and the model estimated with simultaneous equation modelling. Findings: The results show that, beside the daily activity-travel engagements of the parent, both parents’ perceptions and his/her residential self-selection reasons play significant roles in influencing their children daily travel mode shares. The parent’s perceptions play more significant roles in influencing children’s travel modes shares, whilst the residential self-selection reasons have more significant influence on the parent’s travel mode choice. Research limitations/implications: The finding of this study reveals a fact that wherever the children live, their travel behaviour tend to be ‘neutral’ and open to influence by their parents throughout their childhood. Originality/value: This study adds to our understanding of the interactions between parents’ attitudes and behaviours with their children’s travel patterns. This study focuses on single parent households, on which there is very little literature.

Subject Area: Children travel behaviours, single parent households, parents’ perceptions and residential self-selection, United Kingdom

Health Care Provider Mobility Counseling Provision to Older Adults: A Rural/Urban Comparison Andrea L. Huseth-Zosel, Gregory Sanders, Melissa O'Connor, Heather Fuller-Iglesias, & Linda Langley

Abstract: The current study examined rural–urban differences in health care provider (HCP) perceptions, attitudes, and practices related to driving safety/cessation-related anticipatory guidance provision to older adults. A cross-sectional survey was conducted with HCPs in several north central states. Exploratory factor analysis was used to examine dimensions of HCP perceptions and attitudes related to mobility counseling. Binary logistic regression analyses were conducted to determine if HCP rurality was significantly predictive of HPC provision of mobility counseling by age. Rural HCPs were less likely than urban HCPs to provide mobility counseling to their patients aged 75 or older. Rural HCPs were less likely to refer patients to a driving fitness evaluation resource if they had questions related to driving issues, and were less likely to perceive there were adequate resources to help with driving issues. Rural–urban differences in HCP mobility counseling provision may contribute to potential health disparities between urban and rural patients. Both rural and urban HCPs need training about older driver issues, so they may educate their patients about driving safety/cessation. Future research should examine the association between rural–urban differences in HCP mobility counseling provision and rural older adult overrepresentation in motor vehicle injuries and fatalities statistics.

Subject Area: Older drivers; Driving cessation; Mobility counseling; Rural

Older Adult Active Transportation in Massachusetts Marguerite Hutcheson

Abstract: Active transportation can facilitate healthy aging through improved mobility and physical health. Living in a walkable environment is linked to increased active transportation among older adults. Yet there is a gap in research on active transportation and its relationship to walkability among older adults living in Massachusetts. My research addresses this gap through descriptive GIS mapping and quantitative analysis of age-based trends in transportation using data from the 2010-2011 Massachusetts Travel Survey (MTS) and Walk Score®. The main findings were that overall travel and rates of active transportation tended to decrease with age (p<0.01). ZIP codes with higher Walk Scores® also had higher rates of walking for both younger and older adults. Though these results cannot establish causation, they can be useful in efforts to make neighborhoods friendlier to older adult pedestrians.

Subject Area: active transportation; elderly; walkability

Who escort children: mum or dad? Exploring gender differences in escorting mobility among parisian dual-earner couples Benjamin Motte-Baumvol, Olivier Bonin, & Leslie Belton-Chevallier

Abstract: The present article looks to pinpoint explanatory factors for the sharing of escorting of children in dual-earner families. It proposes a detailed analysis of inequalities and interactions in dual-earner families when it comes to escorting children by taking into account the characteristics of trips to and from school for children, the characteristics of the parents’ occupations, and the characteristics of the household. Compared with earlier research, the model considers more detailed data about the escorts’ jobs, such as specific working hours, which provide a better understanding of the constraints on parents and insight into the choices made when both parents are in a position to escort their children. The findings depart somewhat from those of earlier work on the question because more specific data are considered. They show a marked gender inequality in escorting because mothers in dual-earner families do more than two-thirds of the escorting. But the factors explaining the sharing of escorting act almost symmetrically for both parents, with the effect of work starting and finishing times being preponderant. These models confirm that the inequality kicks in ahead of this: mothers in dual-earner households are more often than fathers in jobs with short working hours and which are more compatible with escorting.

Subject Area: Escorting; Chauffeuring trips; Dual-earner families; Parenting; Household interactions; Household travel survey

Travel patterns & socio-demographic correlates of global positioning system (GPS) derived walking & vehicle trips among churchgoing Latinas Natalicio Serrano

Abstract: Presentation: Travel behaviors play an important role in public health. Vehicle Time: linked to increased obesity. Walking: Increased walking reduces the risk of CVD2. Latinos: Spend about 59 min/day in a vehicle. More likely to walk for leisure related travel than their white counterparts.

Subject Area: Latinas; church; walking; physical activity and location measurement system

National older driver crash trends *Jessica B. Cicchino*

**Abstract:** *Presentation:* Trends in crash rates and driving in older populations

**Subject Area:** senior, crashes, fatalities, survivability

Vulnerability modeling of casinos in the United States: A case study of Philadelphia  
Moira Conway

Abstract: As the number of states that have legalized casino gaming has continued to increase in the United States, it is important to consider one of the most important costs identified in international gambling research, that of problem gambling. This project seeks to examine the potential impacts of problem gaming in the major metropolitan area of Philadelphia, which is currently the largest city in the United States with an open commercial casino. To understand the vulnerability to problem gaming of the neighborhoods where casinos are located in the metropolitan area of Philadelphia, a GIS vulnerability model was created in order to examine the accessibility to the casinos of those most vulnerable to problem gaming. The results show that three out of the four casinos in metropolitan Philadelphia are located in areas where people are vulnerable to problem gaming. These findings demonstrate a need for public policy to mitigate the potential impacts of problem gaming on the community. The GIS model created for this project is the first vulnerability study of a major urban area in the United States and has the potential to be expanded to contribute to gambling research within the United States and abroad.

Subject Area: GIS; Casinos; Philadelphia

Lakritz: Fear factor harms children Naomi Lakritz

Abstract: Discussion on the low rates of biking and walking to school

Subject Area: bike, walk, school

Availability: calgaryherald.com; Lakritz: Fear factor harms children March 26, 2015
**Analysis of the Transportation Disadvantaged in an Aging Society** Sungyop Kim, and Gudmundur F. Ulfarsson

**Abstract**: Older adults have been reported as one of the most transportation disadvantaged groups. In particular, mobility challenges for older minority females are notable. This study investigates personal, household, and residential environment factors associated with transportation mobility of older minority females age 65+ using the 2009 National Household Travel Survey conducted in the U.S. Principal Component Analysis and a linear regression model are employed to develop a mobility measure and to examine various factors on the measure. This study found that U.S. born older minority females have distinctly different characteristics from foreign born older minority females with regards to mobility. Public transit use is positively associated with older minority populations’ mobility and not driving reduces the mobility level. Older minority women in low income households have lower mobility levels, but those with a college degree have higher mobility levels. This study concludes that older minority populations are not homogenous, thus, more in-depth research on various sub-groups of older minority populations is warranted in an increasingly diverse aging society.

**Subject Area**: aging; transportation disadvantaged; minority; mobility

Multi-Modal School Transportation Planning - Part I Todd Litman

Abstract: This lesson describes why and how to improve school transportation options, particularly active modes such as walking and bicycling. School leaders play important roles in collaborating with communities when planning transportation options to encourage the use of alternative transportation modes. Improving travel options is an important and timely issue because walking and bicycling provide direct benefits to students and parents, and indirect benefits to the community at large from reduced vehicular traffic. Many people would prefer to drive less and rely more on alternative modes, provided they are safe and convenient (LaPlante, 2010). Thus, communities may desire to plan for walking and bicycling improvement in collaboration with school leaders.

Subject Area: school transportation; bike and walk

Availability: missing a citation
http://online.tarleton.edu/ACEF/MultiModalSchoolTransportationPlanningPartI/PartIFinalMultiModalSchoolTransportationPlanning_print.html
Bounding the Potential Increases in Vehicles Miles Traveled for the Non-Driving and Elderly Populations and People with Travel-Restrictive Medical Conditions in an Automated Vehicle Environment

Harper, Corey, Mangones, Sonia, Hendrickson, Chris T, & Samaras, Constantine

Abstract: Automated vehicles represent a technology that promises to increase mobility and accessibility not only to the senior population but also to non-drivers and people with medical conditions. This paper estimates the impact of a fully automated vehicle environment on the total vehicle miles traveled (VMT) by the current U.S. population 19 and older due to an increase in mobility from the non-driving and elderly populations and people with travel-restrictive medical conditions. The primary source of data for this project is the 2009 National Household Transportation Survey (NHTS), which provides information on current travel characteristics of the U.S. population. The changes to the total VMT are estimated by examining three possible demand wedges. In demand wedge one, the assumption made is that non-drivers would travel as much as the drivers within each age group and gender. Demand wedge two assumes that the driving elderly without medical conditions will travel as much as young adults (ages 19-64) within each gender. Demand wedge three makes the assumption that drivers with medical conditions will travel as much as the drivers without medical conditions within each age group and gender in a fully autonomous and connected vehicle environment. The combination of the results from all three demand wedges represents an upper bound of 297 billion miles or a 12% increase in overall VMT. Since traveling has other costs than driving effort, this estimate serves to bound the potential increase from these populations to inform the scope of the challenges, rather than forecast specific VMT scenarios.

Subject Area: Aged drivers; Intelligent vehicles; Persons with disabilities; Traffic forecasting; Travel demand; Vehicle miles of travel

The influence of parents’ travel patterns, perceptions and residential self-selectivity to their children travel mode shares Yusak O. Susilo, & Chengxi Liu

Abstract: Using the UK National Travel Survey from 2002 to 2006, this paper investigates the influence of households’ residential self-selectivity, parents’ perceptions on accessibilities and their travel patterns on their children daily travel mode share. In doing this, this study introduces a model structure that represents the complex interactions between the parents’ travel patterns, their perceptions on public transport services and their reported residential self-selectivity reasons and the children travel mode shares. This structure is analysed with structural equation modelling. The model estimation results show that parents’ residential self-selectivity, parents’ perceptions and satisfactions on accessibilities and their daily travel patterns significantly influence the children’s daily travel mode shares. However, the effects are not uniform across household members. This study has revealed that households’ residential self-selectivity behaviours have more correlations with the children’s non-motorised mode shares, whilst the parents’ perceptions and satisfactions on transport infrastructure and public transport service qualities have more correlations with parents’ mode shares. The results also confirm that parents’ non-motorised modes use in travelling is highly correlated with the children’s physically active travel mode shares. However, at the same time, the results also show that the effects of mothers’ car use to the children travel mode shares is more apparent than fathers’.

Subject Area: Children travel behaviours; Physically active travel mode participations; Parents’ perceptions; Household’s residential self-selectivity; Household interactions; United Kingdom National Travel Survey

Accident patterns and prospects for maintaining the safety of older drivers
Gert Weller, Nora Strauzenberg, Margit Herle, Bernhard Schlag and Susann Richter

Abstract: In most OECD countries, seniors are currently the fastest growing demographic group and this trend is likely to continue for the next two or three decades. Forecasts suggest that by 2030, every fourth person will be older than 65 years (Schlag, 2008b). In OECD countries, it is expected that in 2050 more than a quarter of the population will be older than 65 years (OECD, 2012). In OECD countries the proportion of people over 80 years will rise from 4 % in 2010 to more than 10 % in 2050 (Colombo, Llena-Nozal, Mercier, & Tjadens, 2011). In addition to the economic and financial effects from this demographic shift, there will also be a greater focus on transport safety for older people. The reason for this is the interaction between this demographic shift and increased mobility, especially in the demographic group of elderly drivers (Schlag, 2008b). Thus, there is a strong need for political and social debate that is solution oriented. The project “Safer Mobility for Elderly Road Users” (SaMERU) is intended to significantly contribute to this debate at the European level. Part of this project is to assess the risks to older transport users, based on scientific work and detailed analysis on accident figures. It is also highly recommended that communication be improved between doctors and patients in terms of mobility advice because doctors have an important role to play in assessing driving capability (Eby & Molnar, 2009). Another key factor of fostering the mobility of elderly people is sustainable town planning and transport planning that adequately takes into consideration the requirements and age limitations of this target group (see Chapter 3). This should include a number of various aspects. Accessibility, transport options and civil infrastructure should all be incorporated into planning. This report mainly discusses the structural measures which contribute to this goal.

Subject Area: elderly safety; accidents;

7. Survey, Data Synthesis, and Other Applications

Time use in travel surveys and time use surveys – Two sides of the same coin?
Regine Gerike, Tina Gehlert, & Friedrich Leisch

Abstract: An in-depth understanding of travel behaviour determinants, including the relationship to non-travel activities, is the foundation for modelling and policy making. National Travel Surveys (NTS) and time use surveys (TUS) are two major data sources for travel behaviour and activity participation. The aim of this paper is to systematically compare both survey types regarding travel activities and non-travel activities. The analyses are based on the German National Travel Survey and the German National Time Use Survey from 2002.

The number of trips and daily travel time for mobile respondents were computed as the main travel estimates. The number of trips per person is higher in the German TUS when changes in location without a trip are included. Location changes without a trip are consecutive non-trip activities with different locations but without a trip in-between. The daily travel time is consistently higher in the German TUS. The main reason for this difference is the 10-min interval used. Differences in travel estimates between the German TUS and NTS result from several interaction effects. Activity time in NTS is comparable with TUS for subsistence activities.

Our analyses confirm that both survey types have advantages and disadvantages. TUS provide reliable travel estimates. The number of trips even seems preferable to NTS if missed trips are properly identified and considered. Daily travel times are somewhat exaggerated due to the 10-min interval. The fixed time interval is the most important limitation of TUS data. The result is that trip times in TUS do not represent actual trip times very well and should be treated with caution.

We can use NTS activity data for subsistence activities between the first trip and the last trip. This can potentially benefit activity-based approaches since most activities before the first trip and after the last trip are typical home-based activities which are rarely substituted by out-of-home activities.

Subject Area: Time use; Travel survey; Time use survey; Travel time; Mobility; Number of trips

Aggregation Bias in Discrete Choice Models with an Application to Household Vehicle Choice Timothy Wong, David Brownstone and David Bunch

Abstract: This paper studies the practice of aggregating choices within discrete choice models. Researchers often do not observe choices at the exact level they are made, and hence aggregate choices to the level that is observed. Modeling choices at a fine level of detail can also lead to large choice sets that exceed the practical capabilities for model estimation. However, the practice of aggregation misspecifies the true choice set of interest. We investigate this concern within the context of the Berry, Levinsohn, and Pakes (BLP) choice model for micro- and macro-level data. We compare the practice of aggregating choices to specifications from two papers that address these concerns (McFadden, 1974; Brownstone and Li, 2014), with application to vehicle choice data. We find that aggregation affects both the point estimates and standard errors obtained from the model. In particular, standard errors are smaller with aggregation. This result has significant empirical implications. Discrete choice models are widely used to estimate consumer valuation of fuel efficiency, a quantity that is relevant to energy analysts concerned that consumers undervalue fuel efficiency technologies (the “energy paradox”). If so, then there is space for policies that increase adoption of such technologies. However, estimates of consumer valuation across vehicle choice studies are inconclusive. The findings of this paper suggest that this disparity may be partly explained by the practice of aggregating choices. In addition, the BLP model applied here is usually estimated sequentially, and the standard errors derived from this process are inconsistent. Thus, this paper also derives consistent standard errors for the model and examines their performance compared to the sequential standard errors that are commonly used.

Subject Area: Choice-set aggregation; Discrete choice; Energy paradox; Fuel efficiency; Vehicle choice.

Stochastic Modeling of Plug-in Electric Vehicles Load Demand in Residential Grids Considering Nonlinear Battery Charge Characteristic  

Ali Ahmadian, Mahdi Sedghi & Masoud Aliakbar-Golkar

Abstract: In order to investigate the impact of Plug-in Electric Vehicles (PEVs) in distribution network studies, realistic modeling of PEVs load demand is important. One of the most important characteristics of the PEVs is the nonlinear behavior of their batteries in charging periods that should be considered in PEVs demand modeling. An accurate stochastic modeling of PEVs load demand proposed in this paper. The charging characteristic of batteries has been considered in linear and nonlinear charge profiles, separately, and the results of them are compared with each other as well. The results show that the nonlinear modeling of batteries has a significant effect on the load of the fleet, and it should be considered in relevant studies.

Subject Area: PEVs, Stochastic modeling, nonlinear charge profile, load demand modeling

Using household travel surveys to adjust ITE trip generation rates
Kristina M. Currans & Kelly Clifton

Abstract: The Institute of Transportation Engineers (ITE) Trip Generation Handbook has become the predominant method for estimating vehicle trips generated by development. The handbook is often criticized for its inability to account for multimodal behavior in urban contexts, often overestimating vehicle traffic. The purpose of this research is to develop and test a ready-to-use method for adjusting the ITE handbook vehicle trip generation estimates for urban context. This method was created using household travel surveys from Oregon, Washington, and Maryland, as well as nationally available built environment data. Three adjustments were estimated for eight general land-use categories, including a “pooled” category considering all travel survey data. The performance of three adjustments were tested using 195 establishment-level vehicle trip generation datasets compiled from three independent sources. Using this data, the performances of four land-use categories were tested. The overall findings suggest that the simplest of the three adjustments developed provided similar results to the more complex adjustment methods. Moreover, adjustments applied using the “pooled” land-uses category also provided similar results to the more detailed segmentation of travel survey data. Both of these findings punctuate the need for a simple, urban adjustment for trip generation estimates.

Subject Area: Trip generation handbook; urban adjustment for trip generation

Interview with Alan Pisarski, January 2015 Conducted by Nicholas Tulach, Edited by Robert B. Noland

Abstract: n/a

Subject Area: Alan Pisarski

Trip generation: Introduction to the special section  
Susan L Handy

Abstract: This paper introduces a set of articles about how transportation planners need better tools for estimating trip generation, and to develop better tools we need more data collection, especially methods that capture passenger trips by personal vehicles, transit, walking, and bicycling, as well as freight trips. With such data in hand, researchers would be able to develop models that both produce more accurate estimates of vehicle trips and generate trip estimates for other passenger modes and for freight. Such estimates would help to ensure adequate provision for these modes and not just for cars.

Subject Area: Travel data collection

**Generation of Mandatory Activities and Formation of Mandatory Tours: Application to the Activity-Based Model for Phoenix, AZ**

*Binny M. Paul, Peter Vovsha, James E. Hicks, Gaurav Vyas, Vladimir Livshits, & Kyunghwi Jeon*

**Abstract:** Most activity based models (ABMs) in practice generate tours first and then predict details of intermediate stops. However, the basic unit of travel analysis in ABM system is an activity. This central idea is somewhat lost in many ABM designs in both research and practice. This paper outlines an approach to model daily travel in ABMs by generating activities first and then forming tours. This approach is based on the idea that higher priority activities are scheduled first and other activities are built around these prioritized activities. There are four steps to this approach – formation of mandatory tour skeletons, participation in shared non-mandatory activities, allocation of individual non-mandatory activities to day segments, and lastly activity sequencing and tour formation. This paper focuses on the first step.

Traditionally, a person with a mandatory daily activity pattern was assumed to have a single commuting tour to the usual workplace. However, in reality a significant number of workers pursue multiple work-related activities, including non-workplace (business) activities. Some previously developed ABMs tackled this issue by incorporating a mandatory tour frequency model. This approach distinguishes business activities from the regular workplace activities. First the frequency and chronological ordering of workplace/business activities is modeled, and then the location of business activities, and finally the tour breakdown decision. These models make the ABM system behaviorally more realistic and more useful in practice since they address certain travel markets like “midday business circulation” in urban business districts that are largely missing in most travel models.

**Subject Area:** Activity based models, tour formation, mandatory activity, mandatory tour skeleton

Imputing trip purposes for long-distance travel Yijing Lu, & Lei Zhang

Abstract: Planning and policy analysis at the national, state and inter-regional corridor levels depends on reliable information and forecasts about long-distance travel. Emerging passive data collection technologies such as GPS, smartphones, and social media provide the opportunity for researchers and practitioners to potentially supplement or replace traditional long-distance travel surveys. However, certain important trip information, such as trip purpose, travel mode, and travelers’ socio-demographic characteristics, is missing from passively collected travel data. One promising solution to this data issue is to impute the missing information based on supplementary data (e.g., land use) and advanced statistical or data mining algorithms. This paper develops machine learning methods, including decision tree and meta-learning, to estimate trip purposes for long-distance passenger travel. A passively collected long-distance trip dataset is simulated from the 1995 American Travel Survey for the development and validation of the machine learning methods. The predictive accuracy of the proposed methods is evaluated for several scenarios varying with trip purposes and the extent of data availability as inputs. This research design will provide not only a practically useful approach for long-distance trip purpose imputation, but also generate valuable insights for future long-distance travel surveys. Results show that the accuracy of the trip purpose imputation methods based on all available data decreases from 95 % with two purposes (business and non-business) to 77 % with four purposes (business, personal business, social visit, and leisure). Based on a two-purpose scheme, the predictive accuracy of the imputation algorithms decreases from 95 % when all input data is used (a full-information model), to 72 % with a minimum information model that only utilizes the passively collected data. If traveler’s socio-demographic characteristics are available (possibly through other imputation models), the predictive accuracy only decreases from 95 to 91 %.

Subject Area: Trip purpose imputation model; Long distance travel; Passively-collected spatial–temporal data; Travel survey methods; Machine learning

Data Verification and Misbehavior Detection in Vehicular Ad-hoc Networks
Ghaleb, Fuad A., Anazida Zainal, and Murad A. Rassam

Abstract: n/a

Subject Area: Engineering design, Modeling, Network analysis, Vehicles

A Data-Driven Network Analysis Approach to Predicting Customer Choice Sets for Choice Modeling in Engineering Design Mingxian Wang and Wei Chen

Abstract: In this paper, we propose a data-driven network analysis based approach to predict individual choice set for customer choice modeling. Taking into account product associations and customer heterogeneity, we apply data analytics to mine existing data of customer choice set, which is then used to predict choice set for individual customers in a new choice modeling scenario. Product association network is constructed first to identify product communities based on existing data of customer choice sets, where links between products reflect the proximity or similarity of two products in customers' perceptual space. To account for customer heterogeneity, customers are classified into clusters (segments) based on their profile attributes and for each cluster the product consideration frequency is computed. For predicting choice sets, a probabilistic sampling approach is proposed integrating product associations, customer segments, and the link strengths in the product association network. In case studies, we first implement the approach using an example with simulated choice set data. The quality of predicted choice sets is examined by assessing the estimation bias of the developed choice model. We then demonstrate the proposed approach using actual survey data of vehicle choice, illustrating the impact of choice sets on the customer utility representation and the agreement between choice model and reality. From both examples, improved choice modeling results are consistently observed using the predicted choice sets, demonstrating the benefits of the proposed method for choice modeling.

Subject Area: Engineering design, Modeling, Network analysis, Vehicles

Analyzing Cell Phone Location Data For Urban Travel: Current Methods, Limitations And Opportunities Serder Çolak, Lauren Alexander, Bernardo Alvim, Shomik Mehndiretta, & Marta González

Abstract: Travelers today utilize technology, which generates vast amounts of data at low costs. In essence, these data have the potential to supplement most of the outputs from regional travel demand models. Creating new analysis tools may shift the paradigm of how we approach data and modeling when assessing travel demand. Recent work has shown how processed origin-destination trips, as developed by trip data providers, supports travel analysis. Much less is reported on how raw data from telecommunication providers can be processed to support such analysis or to what extent the raw data can be treated to extract travel behavior. This work discusses how cell phone data can be processed to inform a four-step transportation model, focusing specifically on the limitations and opportunities of such data. We show a data treatment pipeline that uses only phone data and population density to generate trip matrices in two Metropolitan areas: Boston and Rio de Janeiro. We detail how to label zones as home and work based on frequency and the time of day. Based on the labels (home, work, or other) of consecutive stays we can assign purposes to trips such as home-based-work. The resulting number of trips pairs are expanded using the total population from census data. We show comparable results with existing information reported in local surveys in Boston and existing origin-destination matrices in Rio de Janeiro. Our results detail a method to use passively generated cellular data as a low cost option for transportation planning.

Subject Area: Mobile phone data, data mining, human mobility, trip production and attraction, trip distribution, travel surveys.

Panel, Continuous, and Cross-Sectional Travel Surveys – Germany's Experience  Martin Kagerbauer & Stacey Bricka, Ph.D.

Abstract: There is recurring interest in the U.S. in moving to a stronger travel survey design that would enable the identification of changes in travel patterns over time. There are multiple reasons supporting this desire, but the two main reasons have to do with cost and data. With respect to cost, household travel surveys conducted on an infrequent basis tend to be large budget items, while smaller surveys conducted continuously or on a more regular basis have the potential to be shown as regular budget items with a lower dollar amount per year. On the data side, significant advancements in travel demand modeling techniques and tools have paved the way to the desire to understand travel more from a behavioral perspective. To understand variations in travel patterns, panel surveys and multi-day cross-sectional surveys are discussed more frequently as possible solutions. The purpose of this paper is to further the discussion of alternative survey types through documenting the design and administrative elements of continuous and panel surveys conducted in Germany. The goal is both document the German approach to answering behavioral questions and to identify where and how the German surveys might inform an advanced survey type in the United States.

Subject Area: travel surveys, panel, multi-day cross-sectional

Exploring Origin-Destination Passenger Travel Flow Patterns in Traffic Analysis District Clusters of Small/Medium Size Regions

Ho-Ling Hwang, Shih-Miao Chin, Daniel Wilson, Tim Reuscher and Angel Canales

Abstract: Information on Origin-Destination (OD) based daily travel flows is a vital, but rather challenging to obtain, part of the regional transportation planning process. OD data specifies traffic flow volumes between specified geographic zones or specific points of locations. Traditionally, this data has been difficult to gather due to the expense of manual data collection and entry through license plate surveys and/or traveler interviews. This data is crucial for the calibration of travel demand models, which without OD data, are mainly based on known land use patterns and existing road networks, providing only generalized travel information. The major goal of this case study is to investigate how data as gathered under the 2009 National Household Travel Survey (NHTS) can be used to produce Traffic Analysis District (TAD)-based regional travel flow information critical to support transportation planners in two small/medium size Metropolitan Planning Organizations (MPO) in New York State. The research team works closely with transportation analysts from Syracuse Metropolitan Planning Council (SMPC) and Binghamton Metropolitan Transportation Study (BMTS) to identify TAD clusters in their respected MPOs that are most feasible for performing travel flow analysis at a disaggregated sub-county level. The process involves the use of Geographic Information System (GIS) and examinations of detail geospatial data on business establishment locations, population size in the region, and considers the degree of travel activities (e.g., sufficient household trips originated from the given area) using data from the 2009 NHTS. Specifically, this process defines eight TAD-based zones for the SMPC region and five TAD-based zones for the smaller BMTS. The decision of dividing each MPO into specific TAD-based zones is made based on the considerations of not only having sufficient household travel data to support necessary analyses, but also ensuring that meaningful and useful results can be generated to support each MPO’s planning needs through this study effort. Analyses of travel flow patterns among TAD-based zones within each MPO, as well as between these zones and outside MPO regions, are conducted separately. This allows region-specific analyses to be performed so that any uniqueness in regional characteristics and their travel patterns can be revealed.

Subject Area: TAD-based travel flows; OD data

Efficient Storage of Big-Data for Real-Time GPS Applications Akulakrishna, Pavan Kumar; J, Lakshmi; & K, Nandy S

Abstract: GPS applications need real-timeresponsiveness and are location-sensitive. GPS data is time-variant, dynamic and large. Current methods of centralized or distributed storage with static data impose constraints on addressing the real-time requirement of such applications. In this project we explore the need for real-timeliness of location based applications and evolve a methodology of storage mechanism for the GPS application’s data. So far, the data is distributed based on zones and it also has limited redundancy leading to non-availability in case of failures. In our approach, data is partitioned into cells giving priority to Geo-spatial location. The geography of an area like a district, state, country or for that matter the whole world is divided into data cells. The size of the data cells is decided based on the previously observed location specific queries on the area. The cell size is so selected that a majority of the queries are addressed within the cell itself. This enables computation to happen closer to data location. As a result, data communication overheads are eliminated. We also build some data redundancy, which is used not only to enable failover mechanisms but also to target performance. This is done by nine-cell approach wherein each cell stores data of eight of its neighbours along with its own data. Cells that have an overload of queries, can easily pass-off some of their workload to their near neighbours and ensure timeliness in response. Further, effective load balancing of data ensures better utilization of resources. Experimental results show that our approach improves query response times, yields better throughput and reduces average query waiting time apart from enabling real-time updates on data.

Subject Area: Big data storage of GPS applications; Data layout of GPS applications; Data storage of GPS applications


Abstract: This paper presents an empirical comparison of the following approaches to estimate annual mileage budgets for multiple discrete-continuous extreme value (MDCEV) models of household vehicle ownership and utilization: (1) The log-linear regression approach to model observed total annual household vehicle miles traveled (AH-VMT), (2) The stochastic frontier regression approach to model latent annual vehicle mileage frontier (AH-VMF), and (3) Other approaches used in the literature to assume annual household vehicle mileage budgets. For the stochastic regression approach, both MDCEV and multiple discrete-continuous heteroscedastic extreme value (MDCHEV) models were estimated and examined. When model predictions were compared with observed distributions of vehicle ownership and utilization in a validation data sample, the log-linear regression approach performed better than other approaches. However, policy simulations demonstrate that the log-linear regression approach does not allow for AH VMT to increase or decrease due to changes in vehicle-specific attributes such as changes in fuel economy. The stochastic frontier approach overcomes this limitation. Policy simulation results with the stochastic frontier approach suggest that increasing fuel economy of a category of vehicles increases the ownership and usage of those vehicles. But this doesn’t necessarily translate into an equal decrease in usage of other household vehicles confirming previous findings in literature that improvements in fuel economy tend to induce additional travel. In view of policy responsiveness and prediction accuracy, we recommend using the stochastic frontier regression (for estimating mileage budgets) in conjunction with the MDCHEV model for discrete-continuous choice analysis of household vehicle ownership and utilization.

Subject Area: MDCEV; annual miles; household vehicle ownership and utilization; stochastic frontier regression; discrete-continuous choice

Associations Between Television Watching and Car Riding Behaviors and Development of Depressive Symptoms: A Prospective Study Xuemei Sui, MD, MPH, PhD; Wendy J. Brown, PhD, Carl J. Lavie, MD, Delia S. West, PhD, Russel R. Pate, PhD, Jonathan P.W. Payne, MS, Steven N. Blair, PED

Abstract: Objective: To examine the longitudinal association between sedentary behaviors and risk of development of depressive symptoms. Patients and Methods: The study population consisted of 4802 participants in the Aerobics Center Longitudinal Study (1012 women and 3790 men) aged 18 to 80 years who did not report depressive moods when they completed a health survey during 1982 in which they reported their time spent watching television (TV) and riding in a car each week. All participants completed a follow-up health survey when they responded to the 10-item Center for Epidemiologic Studies Depression Scale. Those who scored 8 or more on the Center for Epidemiologic Studies Depression Scale were considered to have depressive symptoms. Results: Among the 4802 participants, 568 reported depressive symptoms during a mean follow-up of 9.3 years. After multivariate adjustment including moderate- and vigorous-intensity physical activity, time riding in a car, time watching TV, and combined time spent in the 2 sedentary behaviors were positively associated with depressive symptoms (each P<.05 for trend). Individuals who reported 9 h/wk or more riding in a car, more than 10 h/wk watching TV, or 19 h/wk or more of combined sedentary behavior had 28%, 52%, and 74% greater risk of development of depressive symptoms than those who reported less than 5 h/wk, less than 5 h/wk, or less than 12 h/wk, respectively, after adjusting for baseline covariates and moderate- and vigorous-intensity physical activity. The positive association between time riding in a car or time watching TV and depressive symptoms was only observed among individuals who did not meet the current physical activity guidelines. Conclusion: More time reported in these 2 sedentary behaviors was positively associated with depressive symptoms. However, the direct associations between time spent in car riding and TV viewing and depressive symptoms were only significant among those who did not meet the current physical activity recommendations.

Subject Area: Sedentary behavior; depression;

U.S. National And Inter-Regional Travel Demand Analysis: Person-Level Microsimulation Model And Application To High-Speed Rail Demand Forecasting Lei Zhang & Yijing Lu

Abstract: The objective of this proposed research project is to develop a prototype microsimulation-based national and inter-regional passenger travel demand model for High Speed Rail demand forecasting and other national-level travel analysis. The proposed research represents the first attempt to develop a microsimulation-based national long-distance travel demand model for high speed rail and national travel analysis. All major behavioral dimensions of long-distance travel will be considered, except for route choice and network loading that require significant new network data collection/coding efforts and cannot be achieved with the limited budgeted of this project. Compare to the traditional four-step approach, microsimulation-based techniques offer several advantages: (1) It is easier to consider tours, multi-day and multi-stop trips, and intermodal access/egress transfers that are important for long-distance travel modeling; (2) Households and persons are the basic units of analysis, which enables detailed behavioral representations and interactions; and (3) It provides a rich framework in which travel is analyzed as a multi-day, monthly, quarterly, or yearly pattern of behavior, derived from activity participation. There are also significant differences between long-distance trips considered in the proposed microsimulation-based model and trips on a daily/weekly basis represented in metropolitan/state-level tour/activity-based models developed in previous research. For instance, it is often the case that households first choose travel modes for long-distance vacation trips based on travel budget before selecting destinations. Categorization of trip purposes is also different for long-distance trips. Cost of travel for long-distance trips is not just travel disutility, but also includes lodging, food, etc., and the same with the total travel time for long-distance which usually covers not only in-vehicle travel time but also the ingress/egress time, transfer time, and lodge time. The much lower frequency of long-distance travel may also imply a different decision-making process. This research is exploratory in nature, and it is hoped that the final product, the prototype microsimulation-based model, will be able to predict high speed rail travel demand among various OD pairs at the national level.

Subject Area: microsimulation; travel demand model; High speed rail

Demand and Capacity Problems in the Next Generation Air Transportation System Davide Pu

Abstract: This thesis investigates two main aspects of air transportation system, demand and capacity. The first study aims to estimate the potential market for Zip Vehicles, an advanced commuter type of aircraft equipped with automation and electric propulsion technologies. A Multinomial Logit Model was developed to estimate the mode choice behavior of commuters between Zip vehicle, auto and transit in seven metropolitan areas in the United States. The results showed that the Out-of-Vehicle travel time plays an important role in the decision process of commuters. Zip Vehicle is predicted to achieve residual demand with the current technologies and could become more competitive if it was equipped with Vertical Take-Off Technology. The second study developed a hybrid airport runway capacity model that blends both deterministic and simulation techniques. The model includes a graphic user interface that allows high degree of freedom to modify input parameters, such as airport information, weather conditions, minimum separation distances and aircraft grouping system. The model is widely validated and it appears to be a consistent solution for estimating airport capacity at different levels and with various degree of extensibility

Subject Area: airport capacity model aviation aircraft runway mode choice model zip vehicle simulation

Optimizing Distribution of Pandemic Influenza Antiviral Drugs Bismark Singh, Hsin-Chan Huang, David P. Morton, Gregory P. Johnson, Alexander Gutfraind, Alison P. Galvani, Bruce Clements, Lauren A. Meyers

Abstract: We provide a data-driven method for optimizing pharmacy based distribution of antiviral drugs during an influenza pandemic in terms of overall access for a target population and apply it to the state of Texas, USA. We found that during the 2009 influenza pandemic, the Texas Department of State Health Services achieved an estimated statewide access of 88% (proportion of population willing to travel to the nearest dispensing point). However, access reached only 34.5% of US postal code (ZIP code) areas containing <1,000 underinsured persons. Optimized distribution networks increased expected access to 91% overall and 60% in hard-to-reach regions, and 2 or 3 major pharmacy chains achieved near maximal coverage in well-populated areas. Independent pharmacies were essential for reaching ZIP code areas containing <1,000 underinsured persons. This model was developed during a collaboration between academic researchers and public health officials and is available as a decision support tool for Texas Department of State Health Services at a Web-based interface.

Subject Area: influenza pandemic drug distribution;

Phantom Trips Overestimating the Traffic Impacts of New Development  
Adam Millard-Ball

Abstract: Trip Generation is the standard reference for assessing the impacts of new development on traffic congestion and the environment in the U.S. However, a comparison to household surveys suggests that Trip Generation overestimates trips by 55% – likely because its data represent a biased sample of development in the U.S. Moreover, the data in Trip Generation are ill-suited to many analyses of traffic impacts, development impact fees, and greenhouse gas emissions, because they do not account for substitution effects. Most trips “generated” by new developments are not new, but involve households reshuffling trips from other destinations. These twin problems – theoretical and practical – are likely to lead to the construction of excessive roadway infrastructure, and the overestimation of the congestion, fiscal and environmental impacts of new development.

Subject Area: Trip Generation; phantom trips; development impact fees; GHG

http://www.opr.ca.gov/docs/Millard-Ball_-_Comments_on_Preliminary_evaluation_on_alternatives_to_LOS.pdf  
8. Traffic Safety

Motor Vehicle Occupant Fatality Risk Based on Person-Time Exposed: Age, Sex, and Period of Week C. Craig Morris, Ph.D.

Abstract: During the 5 years from 2008 through 2012, motor vehicle crashes killed 34,091 people each year in the United States, on average, 23,783 (69.8) percent of whom were motor vehicle occupants. This study analyzes motor vehicle occupant fatality risk in terms of person-time exposed as a function of age, sex, period of week, and interactions of these factors. Results reveal strong circadian periodicities of occupant fatalities and fatality risk, with greater risk during late evening-early morning hours every day of the week and the greatest risk during Friday–Saturday and Saturday–Sunday evening-to-morning hours. But these circadian trends interact with age and sex whereby young male occupants exhibit the most fatalities and risk. The circadian variation in occupant fatality risk—across demographic age-sex populations, days of the week, and drunk- and nondrunk-driver-related fatal crashes—suggests a drowsiness component acting alone, and sometimes synergistically with alcohol, to impair the judgment and performance of motor vehicle occupants.

Subject Area: Motor vehicle crash; fatalities; fatality risk;

Weather, Traffic Accidents, and Climate Change Benjamin Leard and Kevin Roth

Abstract: We exploit random daily variation in weather to document the relationship of temperature, rainfall, and snowfall with traffic accidents and travel demand. Using information on 46.5 million accidents from the State Data System of police reported accidents for 20 states and travel demand for 207,455 households included in the National Household Transportation Survey, we find unanticipated effects of weather on accidents and their severity. Our estimates suggest that while warmer temperatures and reduced snowfall are associated with a moderate decline in non-fatal accidents, they are also associated with a significant increase in fatal accidents. This increase in fatalities is due to a robust positive relationship between fatalities and temperature. Half of the estimated effect of temperature on fatalities is due to changes in the exposure to pedestrians, bicyclists, and motorcyclists as temperatures increase. The application of these results to middle-of-the-road climate predictions suggests that weather patterns for the end of the century would lead to 603 additional fatalities per year. Between 2010-2099, the present value social cost of all types of accidents caused by climate change is $58 billion.

Subject Area: Traffic Accidents, Traffic Fatalities, Climate Change

Young Drivers and Their Passengers: A Systematic Review of Epidemiological Studies on Crash Risk  

Abstract: Purpose: A systematic review of the literature was conducted to appraise the evidence from epidemiological studies of crash risk in young drivers accompanied by passengers, compared with solo driving. Methods: Databases searched were the Cochrane Library, Embase, Scopus, Transportation Research Information Services, and Web of Science for studies published between January 1, 1989 and August 1, 2013. Epidemiological studies were selected for review if they focused on crashes of young drivers (≤24 years old) and included both a no-passenger comparison group and some measure of exposure to enable calculation of estimates. Results: Fifteen articles (17 studies) were selected; seven studies reported on fatal crashes and 10 on nonfatal or combined fatal/nonfatal crashes. Studies on fatal crashes showed increased risk, compared with solo driving, for young drivers with at least one passenger (significant estimates ranging from 1.24 to 1.89) and two or more passengers versus solo driving (1.70–2.92). Increased risk was also found for fatal crashes and for combined or nonfatal crashes with male versus female passengers (1.53–2.66) and for younger versus older drivers (1.42–3.14). Conclusions: Results more clearly indicated an increased risk for passenger presence in fatal crashes than that in nonfatal or combined fatal/nonfatal crashes. Findings of this review, based on correlational studies, support licensing policies that limit the presence and number of young passengers for young drivers.

Subject Area: Systematic review; Traffic accident; Driver; Passenger; Adolescent; Young adult

Did the Great Recession Keep Bad Drivers Off the Road? Vikram Maheshri & Clifford Winston

Abstract: Motorists’ fatalities and the fatality rate (roadway deaths per vehicle-mile traveled (VMT)) tend to decrease during recessions. Using a novel dataset of individual drivers, we establish that recessions have differential impacts on driving behavior by decreasing the VMT of observably risky drivers, such as those over age 60, and by increasing the VMT of observably safer drivers.

Subject Area: fatality rate; recession, vmt, risky drivers

Temporal trends in motor vehicle fatalities in the United States, 1968 to 2010 - a joinpoint regression analysis Priti Bandi, Diana Silver, Tod Mijanovich, & James Macinko

Abstract: Background: In the past 40 years, a variety of factors might have impacted motor vehicle (MV) fatality trends in the US, including public health policies, engineering innovations, trauma care improvements, etc. These factors varied in their timing across states/localities, and many were targeted at particular population subgroups. In order to identify and quantify differential rates of change over time and differences in trend patterns between population subgroups, this study employed a novel analytic method to assess temporal trends in MV fatalities between 1968 and 2010, by age group and sex. Methods: Cause-specific MV fatality data from traffic injuries between 1968 and 2010, based on death certificates filed in the 50 states, and DC were obtained from Centers for Disease Control and Prevention Wide-ranging Online Data for Epidemiologic Research (CDC WONDER). Long-term (1968 to 2010) and short-term (log-linear piecewise segments) trends in fatality rates were compared for males and females overall and in four separate age groups using joinpoint regression. Results: MV fatalities declined on average by 2.4% per year in males and 2.2% per year in females between 1968 and 2010, with significant declines observed in all age groups and in both sexes. In males overall and those 25 to 64 years, sharp declines between 1968 and mid-to-late 1990s were followed by a stalling until the mid-2000s, but rates in females experienced a long-term steady decline of a lesser magnitude than males during this time. Trends in those aged <1 to 14 years and 15 to 24 years were mostly steady over time, but males had a larger decline than females in the latter age group between 1968 and the mid-2000s. In ages 65+, short-term trends were similar between sexes. Conclusions: Despite significant long-term declines in MV fatalities, the application of Joinpoint Regression found that progress in young adult and middle-aged adult males stalled in recent decades and rates in males declined relatively more than in females in certain age groups. Future research is needed to establish the causes of these observed trends, including the potential role of contemporaneous MV-related policies and their repeal. Such research is needed in order to better inform the design and evaluation of future population interventions addressing MV fatalities nationally.

Subject Area: motor vehicle fatality trends;

Automobile Safety During Adulthood  

Douglas M. Wiegand, Jeffrey S. Hickman, & E. Scott Geller

Abstract: Injuries and fatalities from motor vehicle crashes constitute one of the most significant public health threats in the USA and abroad. This entry provides a summary of current traffic surveillance statistics in the USA, defines key terms and methodologies in traffic safety research, and discusses the application of behavior-based safety (BBS) in preventing motor vehicle injuries and fatalities. A critical analysis of interventions designed to prevent injuries and deaths from motor vehicle crashes is offered in terms of their relative effectiveness, and future directions in traffic safety research are discussed in terms of embracing positive psychology.

Subject Area: traffic surveillance; behavior-based safety

An assessment of driving fitness in patients with visual impairment to understand the elevated risk of motor vehicle accidents Shiho Kunimatsu-Ianuki, Aiko Iwase, Makoto Araie, Yuki Aoki, Takeshi Hara, Toru Nakazawa, Takuhiro Yamaguchi, Hiroshi Ono, Tomoyuki Sanuki, & Makoto Itoh

Abstract: Objective To assess the driving fitness of patients with glaucoma by identifying specific areas and degrees of visual field impairment that threaten safe driving. Design Case-control study. Setting, and participants This prospective study included 36 patients with advanced glaucoma, defined as Humphrey field analyzer (HFA; 24-2 SITA standard program) measurements of mean deviation in both eyes of worse than −12 dB, and 36 age-matched and driving exposure time-matched normal subjects. All participants underwent testing in a novel driving simulator (DS) system. Participants were recruited between September 2010 and January 2012. Main outcome measures The number of collisions with simulated hazards and braking response time in 14 DS scenarios was recorded. Monocular HFA 24-2 test results from both eyes were merged to calculate the binocular integrated visual field (IVF). The position of the IVF subfields in which the collision-involved patients had lower sensitivity than the collision-uninvolved patients was compared with the track of the hazard. The cut-off value to predict an elevated risk of collisions was determined, as were its sensitivity and specificity, with the area under the receiver operating characteristic (AUROC) curve. Results Patients with advanced glaucoma were involved in a significantly higher number of collisions in the DS than the age-matched and driving exposure time-matched normal subjects (119 vs 40, respectively, p<0.0001), especially in four specific DS scenarios. In these four scenarios, IVF sensitivity was significantly lower in the collision-involved patients than in the collision-uninvolved patients in subfields on or near the track of the simulated hazard (p<0.05). The subfields with the largest AUROC curve had values ranging from 0.72 to 0.91 and were located in the paracentral visual field just below the horizontal. Conclusions Our novel DS system effectively assessed visual impairment, showing that simulators may have future potential in educating patients.

Subject Area: visual impairment; glaucoma; safe driving;

Driver Demographics, Built Environment, and Car Crashes: Implications for Urban Planning Dongkwan Lee

Abstract: This study investigates the effects of the surrounding environment on crashes, with a focus on crash severity and at-fault drivers characterized by gender and age. Crashes where a vehicle is the guilty party are investigated. The study adopts two approaches: aggregate and disaggregate. In the aggregate approach, the numbers of crashes, classified in terms of severity (fatalities, injuries, property damages only), and gender and age of the driver (with several age groups covering the 15-100 age span), represent the variables to be investigated, and have been derived for the Central Ohio Region from the multiple files of the crash database of the Ohio Department of Public Safety, over the period 2006-2011. These data are aggregated at the level of Traffic Analysis Zones (TAZ). OLS models are first estimated, but spatial autocorrelation tests point the existence of spatial autocorrelation (SA). Spatial econometrics models are then used to eliminate the SA bias: the Spatial Autoregressive Model (SAR) and the Spatial Error Model (SEM). Subsequent analyses are conducted using the SEM estimates, as the SEM model is successful in completely eliminating spatial autocorrelation. The aggregate approach uses a large set of explanatory variables classified into six groups: Regional and Locational, Socio-Economic, Land-Use, Public Transit and Traffic Flow, Circulation and Network, and Physical Characteristics. The results show that variables in all these groups have significant impacts on crash severity and frequencies. The disaggregate approach accounts for more variables that influence crash severity, but cannot be captured in the aggregate approach, such as weather conditions, light conditions, road conditions, type of intersection, and type of vehicle. All these variables are directly related to an individual crash. The logit model is used to explain the probability of a Bodily Injury (BI) crash at the crash scene, where the alternative is Property Damage Only (PDO) crash. Because the age of the at-fault driver is a continuous independent variable, it is possible to precisely assess the impact of age, for both male and female drivers. The results of the logit model estimation show that there is a significant relationship between the probability of a BI crash and drivers’ behavior, built environment, driving conditions, and driving situation.

Subject Area: bodily injury crash, built environment, property damage only

Tracking progress in teenage driver crash risk in the United States since the advent of graduated driver licensing programs Anne T. McCartt, & Eric R. Teoh

Abstract: Introduction: This study examined U.S. teenagers' crash rates since 1996, when the first graduated driver licensing (GDL) program in the United State was implemented. Methods: Passenger vehicle driver crash involvement rates for 16–19 and 30–59 (middle-aged) year-olds were examined, using data from the Fatality Analysis Reporting System, National Automotive Sampling System General Estimates System, Census Bureau, and National Household Travel Surveys. Results: Per capita fatal and police-reported crash rates in 2012 were lower for 16 year-olds than for middle-aged drivers but older teenagers' rates were higher. Mileage-based fatal and police-reported crash rates in 2008 were higher for teenagers than for middle-aged drivers and higher for 16–17 year-olds than for older teenagers. In 1996–2012, teenagers' per capita fatal and police-reported crash rates declined sharply, especially for 16–17 year-olds, and more so than for middle-aged drivers. Substantial declines also occurred in teenagers' mileage-based fatal and police-reported crash rates from 1995–96 to 2008, generally more so than for middle-aged drivers. Regarding factors in fatal crashes in 1996 and 2012, proportions of young teenagers' crashes occurring at night and with multiple teenage passengers declined, more so than among older teenagers and middle-aged drivers. The proportion of fatally injured drivers who had been drinking declined for teenagers but changed little for middle-aged drivers. Improvements were not apparent in rates of driver errors or speeding among teenage drivers in fatal crashes. Conclusions: Teenage drivers' crash risk dropped during the period of implementation of GDL laws, especially fatal crash types targeted by GDL. However, teenagers' crash risk remains high, and important crash factors remain unaddressed by GDL. Practical applications: Although this study was not designed to examine the role of GDL, the results are consistent with the increased presence of such laws. More gains are achievable if states strengthen their laws.

Subject Area: Teenage drivers; Teenage driver crash risk; Graduated driver licensing

Driver distraction detection and recognition using RGB-D sensor  Céline Craye and Fakhri Karray

Abstract: Driver inattention assessment has become a very active field in intelligent transportation systems. Based on active sensor Kinect and computer vision tools, we have built an efficient module for detecting driver distraction and recognizing the type of distraction. Based on color and depth map data from the Kinect, our system is composed of four sub-modules. We call them eye behavior (detecting gaze and blinking), arm position (is the right arm up, down, right of forward), head orientation, and facial expressions. Each module produces relevant information for assessing driver inattention. They are merged together later on using two different classification strategies: AdaBoost classifier and Hidden Markov Model. Evaluation is done using a driving simulator and 8 drivers of different gender, age and nationality for a total of more than 8 hours of recording. Qualitative and quantitative results show strong and accurate detection and recognition capacity (85% accuracy for the type of distraction and 90% for distraction detection). Moreover, each module is obtained independently and could be used for other types of inference, such as fatigue detection, and could be implemented for real cars systems.

Subject Area: distracted driving; ITS;

9. **Transit Planning**

Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado  
*W. Marshall, A Henao, and R. Bronson*

**Abstract:** This report presents a three-part research program examining transportation resiliency and the ability for a transportation system to maintain or return to a previous level of service after a disruptive, black swan type event. With transportation as the second highest household expenditure, it is vital to understand the disproportionate impact that a drastic increase in gas price might have on a major city and region. We seek to increase our understanding of resiliency, vulnerability, and transportation affordability issues by asking what would happen if the cost of driving suddenly doubled or tripled. Who is better off and why? How much difference does being near downtown or jobs make? What matters in terms of transit infrastructure? How much of a role do current travel behaviors play? The results of this report illustrate that transportation choice helps create network redundancy and facilitates adaptability under extreme conditions. While alternative fuels and improvements to the fuel economy of vehicles would help reduce the long-term impacts, the most vulnerable households are already spending more than 30% of their income solely on transportation costs and would be the least likely to benefit from such technological improvements. The most resilient households will live in cities and regions that plan for and invest in diversifying and expanding transportation choice. Those living in cities and regions that continue to promote the automobile as the only viable mode of transportation might be not currently view themselves as at risk, but they will be the most vulnerable should a “black swan” event occur.

**Subject Area:** black swan event; transportation resiliency;  

Regulation of public bus services: The Israeli experience Yoram Ida & Gal Talit

Abstract: The present research discusses structural reforms in the regulation of public bus services in Israel. In 2000, the market underwent a significant change; as a result, some of the bus services on fixed routes that were previously provided by two monopolistic operators are currently provided by means of competitive tendering. The research examined the reasons for this change, the measures taken in order to implement it, and the outcomes from the perspective of time. The findings indicated that, as in other countries, competitive tenders in Israel have succeeded in reducing costs, compared with the past, and this has led to a reduction in the related subsidies required of the government. At the same time, there was a general rise in the level of service provided to the public and a decline in fares. It seems that the government succeeded in improving its degree of control over the provision of bus services, but frequent changes in the structure of the tenders and their characteristics might reflect difficulties in the implementation of competition in the bus services in Israel.

Subject Area: Competitive tendering; Bus services; Regulation; Contract type; Contract period; Bus operators; Supervision and control

Understanding the effects of complex seasonality on suburban daily transit ridership  
Kashfi, Syeed Anta, Jonathan M. Bunker, and Tan Yigitcanlar

Abstract: Fluctuations in transit ridership pattern over the year have always concerned transport planners, operators and researchers. Predominantly, metrological elements have been specified to explain variability in ridership volume. However, the outcome of this research points to new direction to explain ridership fluctuation in Brisbane. It explored the relationship between daily bus ridership, seasonality and weather variables for a one-year period, 2012. Rather than segregating the entire year’s ridership into the four calendar seasons (summer, autumn, spring, and winter), this analysis distributed the yearly ridership into nine complex seasonality blocks. These represent calendar season, school/university (academic) period and their corresponding holidays, as well as other observant holidays such as Christmas. The dominance of complex seasonality over typical calendar season was established through analysis and using Multiple Linear Regression (MLR). This research identified a very strong association between complex seasonality and bus ridership. Furthermore, an expectation that Brisbane’s subtropical summer is unfavourable to transit usage was not supported by the findings of this study. A nil association of precipitation and temperature was observed in this region. Finally, this research developed a ridership estimation model, capable of predicting daily ridership within very limited error range. Following the application of this developed model, the estimated annual time series data of each suburb was analysed using Fourier Transformation to appreciate whether any cyclical effects remained, compared with the original data.

Subject Area: Seasonality; Time series; Bus; Ridership; Fourier transformation; Regression

An Industrial Design Proposal Responding to Unmet Transportation Needs in the United States

Y. Wang

Abstract: n/a

Subject Area: transportation needs

Regional Sky Transit Brian A. Seeley MD

Abstract: Future, on-demand, electrically-powered “Sky Taxi” aircraft must be able to deliver both people and packages at high proximity “pocket airparks” that minimize the length of ‘last mile’ surface travel for the short-range trips that people most often make. These are sub-100 mile trips that stay within metropolitan ‘mega-regions’. Such a regional “Sky Transit” system would serve a vastly larger user base than that for trips that exceed 160 km (100 miles) in length. Sky Transit would necessarily operate with a very different type of aircraft than the conventional take-off and landing (CTOL) type used on longer range, higher speed general aviation (GA) flights. Ultra-quiet, V/ESTOL Sky Taxis, by having a much higher duty cycle than GA, would also be much more affordable. Fortunately, electrically-powered aircraft whose range is somewhat limited by present day battery technology could still fulfill the Sky Transit mission requirements if designed for robotic battery swap. A prospective business model for such regional Sky Transit using various cost scenarios and market penetrations shows its potential for strong profitability as well as numerous societal benefits. The San Francisco metropolitan region is analyzed with respect to its inter-county and major corridor surface traffic volumes in order to project realistic ridership for a fully implemented regional Sky Transit system. The analysis includes actual trip distances that account for direct flight path versus tortuous surface road path lengths. The subjective aspect of ‘crowding of the skies’ is examined by projections of a sky image simulated during peak operations. Partitioning of the region’s airspace by assignment of altitudes is used as a means to estimate such projections and the attendant separation distances. Fast tempo take-off and landing operations are examined for their effect upon profitability and system capacity. Peak capacity at locations with the greatest number of daily travelers is examined in terms of operational intervals and safe aircraft separations. The relationship between land parcel size and availability with high proximity for the most popular traveler destinations is examined as a means to define the limiting case of short runway operations. Trip fares and their effect upon ridership and profitability are explored relative to alternative modes of surface travel and on a cost per km basis. The total regional electrical energy demand that would attend a full-fledged, electrically-powered Sky Transit System is estimated. The effect of Sky Transit in easing surface gridlock is estimated, along with its effect in reducing GHG emissions.

Subject Area: sky transit

Designing Shuttle Connections To Commuter Rail Using Census Origin And Destination Data Gretchen Johnson, Hazel Scher & Thomas Wittmann

Abstract: Designing shuttles that help transit riders complete the “last mile” of their trip (from a transit station/stop to their destination) plays an important role in leveraging rail capacity and growing a regional transit market. Unavailable or imprecise data have made effective shuttle route design based on a defined potential market difficult. This paper presents a methodology to determine the size and location of the untapped market of commuters who drive long distances for work but could make the same trip using commuter rail and last mile shuttle service. The authors conducted the analysis using U.S. Census Longitudinal Employer-Household Dynamics (LEHD) data, a relatively new public dataset of statewide workplace and residence pairs at the Census block level. As a case study, the authors determined the potential for last mile shuttle connections between employment and 14 FrontRunner commuter rail stations outside of downtown Salt Lake City. To capture the shuttle market, the workplace and residence pairs in this methodology were selected based on three criteria: 1) a residence within the FrontRunner park-and-ride shed, 2) a workplace within two miles of a FrontRunner station, and 3) an overall trip distance of 15 miles or greater. The authors identified stations with the highest number of trips that met all three criteria and designed shuttle routes based on the associated employment locations. While this analysis focused on non-traditional commuting patterns, the same methodology is useful for many different analyses of commuter markets.

Subject Area: shuttles; last mile

The Impacts Of Socio-Economic And Demographic Shifts In Transit Served Neighborhoods On Mode Choice And Equity *Steven Apell*

Abstract: Today the use of transit-oriented development (TOD) is a common strategy for metropolitan areas endeavoring to advance the sustainable communities strategy. At the same time, urban areas in America are experiencing rising energy prices and new geographies of employment, poverty, and wealth. Furthermore, the Millennial generation, and some Baby boomers are changing their residential preference from the suburbs to the central city. These modifications in the urban economy and residential preferences are likely to intensify competition for housing in the central city. Increased demand for housing generates high rents, which often results in the displacement of low-income, transit-dependent population. Consequently, the effectiveness of transit-oriented development is compromised as new affluent households increase vehicle use for home-based trips. Using 1990 and 2010 census data, this research investigated the unintended consequences of TOD policy on mode choice and equitable accessibility in block groups within one mile radius of rail stations in six metropolitan statistical areas. The research employed geographic information systems (GIS) and multivariate regression to analyze the relationship between socio-economic and demographic change in transit-oriented development and associated effects on mode choice for work commute. The findings reveal that while driving declined between 1990 - 2010, transit use for work commute increased in most metropolitan areas in the study. In addition, transit-oriented developments are associated with a high number of affluent households, college graduates, and White-collar employees, when compared with block groups with no transit-oriented development. However, the percentage of foreign-born residents have increased in transit-oriented development, while the percentage of Black and White population have declined. In addition, block groups within one mile of transit stations show nearly similar levels of transit use and driving when compared block groups within the half mile radius. These findings have significant implications on the long term effectiveness of TOD policy.

Subject Area: TOD; sustainable communities;

10. Travel Behavior

Commuting Patterns of Workers in a Village of Barddhaman District, West Bengal
Bhaswati Mondal

Abstract: Commuting helps to keep balance between residence and workplace of workers. With growing accessibility and connectivity, the importance of commuting is increasing all over the world. It is becoming a major substitute to migration. In commute-studies, commute-pattern is an important chapter. It highlights commuters’ directions of movement, distance they cover, modes of transport they use, the time they take to commute, etc. Unlike the urban-based commute pattern, commute pattern in rural areas are relatively an under-researched issue. In fact, traditionally rural people are thought to carry a sedentary lifestyle. Using primary data, this study aims to explore the commute patterns of rural workers located in the village of Gandharbapur of Barddhaman district of West Bengal, India. All the commuters were found to be engaged in non-farm work. Commuters stem from two major groups. One group of commuters is accumulated farm-income induced. They possess sufficient agricultural land. Investing their surplus farm-income, they have established non-farm works. The second group of commuters is poverty-driven. They are landless poor or are marginal farmers and to escape poverty, they have slipped into these works. Located beyond the suburban area (Memari being the nearest town), most commuters commute to nearby rural areas. Due to non-availability of public transport, women commute less than men do. Regular-paid government employees commute longer than other workers commute. The article concludes with a summary of findings and recommendations for further research.

Subject Area: Commuting, Working Commuters, Commuting Patterns, Rural area, Barddhaman District, West Bengal, India

http://spaceandculture.in/index.php/spaceandculture/article/view/140
Transport mode choice in South East Asia: Investigating the relationship between transport users’ perception and travel behaviour in Johor Bahru, Malaysia Leanne Yong Le Loo, Jonathan Corcoran, Derlie Mateo-Babiano, Renee Zahnow

Abstract: The worldwide increase in private car dependency poses a set of significant environmental, economic and social sustainability challenges that continue to undermine the urban quality of life. Rapid motorisation, particularly in South East Asia (SEA), has emerged as a global concern given the region’s cumulative population, rate of industrialisation, and large-scale urbanisation. Thus, there is a compelling need to enhance our understanding of the underlying dynamics of how people perceive and use transportation such that transport planning is better placed to address the current, unsustainable travel patterns in SEA. Despite this need, there has been relatively limited SEA-based research that has endeavoured to examine travel perceptions and transport mode choice from a non-instrumental perspective. This research redresses this deficit by investigating the relationship between transport users’ perceptions and travel behaviours within SEA, with a particular focus on psychosocial drivers of transport mode choice interfaced with more traditional instrumental measures. Spatially stratified survey data have been collected in a case study area, Johor Bahru, Malaysia, comprising users from different transport user groups. Employing regression modelling, drivers of individual’s travel behaviour are examined. Results highlight the merit in recognising the role of non-instrumental motives alongside instrumental motives to explain transport mode choice. We conclude by highlighting that transport mode choices are motivated by a range of locational, socio-demographic, psychological and cultural determinants. The current research has contributed to a better understanding of transport mode choice in Johor Bahru and provides a foundation for future SEA-based travel behaviour research. Studies in this area can inform more sustainable travel behaviour in the SEA region.

Subject Area: Car use; Public transport use; Transport mode choice; Psychological motives; South East Asia

Characterizing the spatial and temporal patterns of farmers' market visits
James Mack, & Daoqin Tong

Abstract: This research presents a study of visits to farmers' markets, a rapidly growing urban phenomenon in the U.S., from a geographic perspective. Although the social and economic impacts of farmers' markets have received considerable attention recently, examining farmers' market access in space-time is still lacking in the existing analytical frameworks. This study challenges conventional food access measures that have been primarily focused on the spatial separation between markets and consumers' homes and proposes a more realistic space-time based strategy. A survey was conducted on twelve markets in Tucson, Arizona. Analysis results show that majority of market patrons went to a market that was different from the one nearest to their homes, and the market choice, including the geographic location and the associated market operating time, was highly affected by patrons' other daily activities. The particular types of activities combined with farmers' market trips were found to vary temporally and fluctuate based on patron's employment characteristics. Our study suggests that conventional food access measures should be used in caution to assess farmers' market access as these measures can lead to an overestimate of the travel consumers are willing or even able to incur.

Subject Area: Farmers' markets; Food access; Space-time; Trip-chaining

Neo-Traditional Town Centers and Residential Travel Behavior: Effect of Retail Composition Sung Won Han

Abstract: Neo-traditional developments are often comprised of mix-use neighborhoods with a town center that acts as the central commercial district that is easily accessible to the surrounding residents without a car. This paper investigates the reality of walking and biking in two such neo-traditional developments in Colorado. I compared frequency and purpose of non-car trips in two neighborhoods whose local town centers differ in retail composition. The first town center, Belmar, has a higher composition of comparison goods and services such as clothing, apparel, and other comparison goods. The second, East 29th Avenue Town Center, has a higher composition of convenient goods and services such as the library, dry cleaners, and dog wash store. An analysis of travel behavior surveys from fifty residents of each site reveals no significant difference in the travel behavior between residents of the two neighborhoods. While having a higher percentage of convenience goods was not shown to increase the residents’ perception of driving less, my evidence suggests that only specific convenience goods, such as grocery stores and dry cleaners, increases the residents’ perception of making less car trips. While the absence of significant findings may have resulted from a small sample size, and the absence of travel diaries, this research can serve as an exploratory study for further research on the relationship between retail composition and travel behavior.

Subject Area: mixed development; retail composition; non-motorized vehicles

Analysis of plug-in hybrid electric vehicles’ utility factors using GPS-based longitudinal travel data

Wu, Xing, Md Aviquzzaman, and Zhenhong Lin

Abstract: The benefit of using a PHEV comes from its ability to substitute gasoline with electricity in operation. Defined as the proportion of distance traveled in the electric mode, the utility factor (UF) depends mostly on the battery capacity, but also on many other factors, such as travel pattern and recharging pattern. Conventionally, the UFs are calculated based on the daily vehicle miles traveled (DVMT) by assuming motorists leave home in the morning with a full battery, and no charge occurs before returning home in the evening. Such an assumption, however, ignores the impact of the heterogeneity in both travel and charging behavior, such as going back home more than once in a day, the impact of available charging time, and the price of gasoline and electricity. Moreover, the conventional UFs are based on the National Household Travel Survey (NHTS) data, which are one-day travel data of each sample vehicle. A motorist’s daily travel distance variation is ignored. This paper employs the GPS-based longitudinal travel data (covering 3–18 months) collected from 403 vehicles in the Seattle metropolitan area to investigate how such travel and charging behavior affects UFs. To do this, for each vehicle, we organized trips to a series of home and work related tours. The UFs based on the DVMT are found close to those based on home-to-home tours. On the other hand, it is seen that the workplace charge opportunities significantly increase UFs if the CD range is no more than 40 miles.

Subject Area: Utility factor, PHEV, Longitudinal travel data

Households with more vehicles Travel More  *EIA Trisha Hutchins*

**Abstract:** Based on data from the National Household Travel Survey, households with more vehicles not only travel more, but often put more miles on their most-used vehicle compared to households with fewer vehicles. Households with just one vehicle drove an average of 10,600 miles per year, while households with six or more vehicles traveled a total of 57,700 miles. Sixty-eight percent of households have either one or two cars

**Subject Area:** household vehicles, VMT

**Availability:** Today in Energy: EIA April 16, 2015
http://www.eia.gov/todayinenergy/detail.cfm?id=20832
American Driving Survey: Methodology and Year One Results, May 2013 – May 2014  Triplett, Tim; Santos, Robert; Rosenbloom, Sandra

Abstract: This report documents the methodology of the American Driving Survey (ADS) as well as the results of the first full year of data collection, which occurred between May 21, 2013 and May 31, 2014. Interviews were conducted with 3,319 drivers sampled from among 4,287 households that were initially contacted and screened. The first year data show that all drivers 16 and older drive, on average, 29.2 miles per day or 10,658 miles a year. Men reported driving more miles than women; Caucasians reported driving more miles than respondents of other races; Hispanic respondents reported driving the least. Teenagers and drivers ages 75+ also drive significantly fewer miles on average. About one-third of all drivers did not drive at all on the day about which they were interviewed. About 50% of all miles driven are in a car, and another 40% in a sports utility vehicle (SUV) or pickup truck. People drive, on average, more on weekdays and less on weekends. There is a significant mileage gap between rural and urban drivers, but the gap is smaller on the weekends than on weekdays. People drive, on average, less during the winter months and more during the summer months. To investigate the extent to which data from the ADS was similar to or different from other data from other well-accepted sources, data from the ADS was compared to data from the Federal Highway Administration’s 2009 National Household Travel Survey (NHTS).

Subject Area: Age groups; Drivers; Gender; Methodology; Persons by race and ethnicity; Statistics; Time duration; Travel by vehicle type; Travel surveys; Trip length

Vehicle Miles (Not) Traveled: Why Fuel Economy Requirements Don’t Increase Household Driving Jeremy West, Mark Hoekstra, Jonathan Meer & Steven L. Puller

Abstract: A major concern with addressing the negative externalities of gasoline consumption by regulating fuel economy, rather than increasing fuel taxes, is that households respond by driving more. This paper exploits a discrete threshold in the eligibility for Cash for Clunkers to show that fuel economy restrictions lead households to purchase vehicles that have lower cost-per-mile, but are also smaller and lower-performance. Whereas the former effect can increase driving, the latter effect can reduce it. Results indicate these households do not drive more, suggesting that behavioral responses do not necessarily undermine the effectiveness of fuel economy restrictions at reducing gasoline consumption.

Subject Area: CAFÉ; fuel economy, fuel taxes, VMT

Measuring the impacts of weather variability on home-based trip chaining behaviour: a focus on spatial heterogeneity Chengxi Liu, Yusak O. Susilo, & Anders Karlström

Abstract: Using the 2011 Swedish national travel survey data, this paper explores the influence of weather characteristics on individuals’ home-based trip chaining complexity. A series of panel mixed ordered Probit models are estimated to examine the influence of individual/household social demographics, land use characteristics, and weather characteristics on individuals’ home-based trip chaining complexity. A thermal index, the universal thermal climate index (UTCI), is used in this study instead of using directly measured weather variables in order to better approximate the effects of the thermal environment. The effects of UTCI are segmented into different seasons to account for the seasonal difference of UTCI effects. Moreover, a spatial expansion method is applied to allow the impacts of UTCI to vary across geographical locations, as individuals in different regions have different weather/climate adaptations. The effects of weather are examined in subsistence, routine, and discretionary trip chains. The results reveal that the ‘ground covered with snow’ condition is the most influential factor on the number of trips chained per trip chain among all other weather factors. The variation of UTCI significantly influences trip chaining complexity in autumn but not in spring and winter. The routine trip chains are found to be most elastic towards the variation of UTCI. The marginal effects of UTCI on the expected number of trips per routine trip chain have considerable spatial variations, while these spatial trends of UTCI effects are found to be not consistent over seasons

Subject Area: Trip chaining complexity, Weather impact, Thermal index, Spatial heterogeneity

Sensitivity of location-sharing services data: evidence from American travel pattern  Zhenhua Chen & Laurie A. Schintler

Abstract: This paper investigates sensitivity of location-sharing services (LSS) data with a focus on understanding American daily travel pattern using three LSS datasets: Brightkite, Gowalla and Foursquare. Through a systematic data refining process, person miles of travel and daily person trip are created and compared both among themselves and with the US National Household Travel Survey (NHTS) of 2009. The results suggest that LSS data provides a better estimation of person miles of travel than daily person trip on average. In addition, the comparison with the NHTS reveals that LSS data tends to have a better reflection of daily travel behavior among metro areas with high population density.

Subject Area: Location-sharing services data, American travel behavior, Personal miles of Travel, Daily person trips, National Household Travel Survey

Concentration of Travel Demand in Space and Time John C. Falcocchio, & Herbert S. Levinson

Abstract: The concentrations of people and their activities (density) in space and in time are a natural consequence of human behavior in urban areas. If all travel demand were evenly distributed throughout the day, and among the various parts of the urban area, the urban traffic congestion problem would be greatly reduced. But travel demand patterns reflect where and when people live, work, and play. Therefore they are concentrated in space and time. It is these spatial and temporal concentrations that contribute to the urban traffic congestion problem.

Subject Area: Engineering Economics, Organization, Logistics, Marketing, Civil Engineering, Complexity & Transportation

No Rest for the Weary: Commuting, Hours Worked, and Sleep James M. Bishop

Abstract: This paper is the first to combine data from large nationwide surveys to investigate how commuting and work hours affect sleep. I estimate that 11-21% of the marginal unit of time spent working and 22-30% of the marginal unit of time spent commuting replaces sleep. Controlling for these effects, commuting before 5 a.m. and after 9 a.m. each increase the likelihood of short sleep. I also find that time spent commuting and working and the prevalence of these strange commute times each contribute to unintentionally falling asleep at some time during the day, while early commuting in particular increases the likelihood of falling asleep while driving. Little of these effects are explained by reduced time spent sleeping, indicating that there are multiple biological channels through which commuting duration and timing impact road safety. None of these effects appear for non-workers as opposed to the employed, supporting the validity of the results. Overall, most of the effects are stronger for women than for men, though the prevalence of early commutes is particularly associated with less sleep among men.

Subject Area: Commuting; Sleep; Time Allocation; Gender


Abstract: This study analyses the determinants of residential location patterns of dual-worker households in the Seoul Metropolitan area (SMA) using the 2006 Household Travel Survey (HTS) data. To achieve this we employ two statistical methods: (1) a multinomial logit (MNL) model for analysing the residential location patterns of dual-worker households given the couples' predetermined joint workplaces; and (2) standard regression models to identify the determinants of couples' spatial separation (or proximity) between their homes and workplaces. Our major findings can be summarised as follows: (1) dual-worker households in the SMA are likely to choose a residence closer to the wife's workplace than the husband's; (2) the wife's commute length and duration are significantly shorter than the husband's; (3) the wife's family serving role is the most important factor in determining a location with greater proximity between the home and the wife's workplace; and (4) commute times better depict gender differences than commute distance.

Subject Area: Dual-worker household, residential choice, workplace location

Measuring Commuting in the American Time Use Survey  

Gray Kimbrough

Abstract: The journey between work and home plays an important role in daily time use, acting as both a fixed time cost of labor force participation and as a constraint on time for other activities. Data from the American Time Use Survey (ATUS) offer the opportunity to examine commuting behavior and its relationship to demographics, labor market characteristics, and the amount of time spent on other activities. Previous analyses have been complicated by the difficulties of obtaining commuting time measures from the ATUS. Travel information can be difficult to interpret in the ATUS, and many commuting trips are likely misclassified using stock measures of work-related travel. To address this shortcoming, I review the strategies of previous researchers to reclassify travel. After surveying possible methodologies, I focus on applying to the ATUS a methodology applied to the National Household Transportation Survey (NHTS). Detailed time information in the NHTS allows me to compare both aggregate commuting measures and the timing of commuting in the two surveys. I further extend the analysis to compare to journey-to-work information in another commonly used dataset, the American Community Survey. These comparisons and the methodology provided serve to enable and validate further analysis of commuting behavior using the ATUS, leveraging the advantages of this dataset.

Subject Area: commute; time value; ATUS

**Variations in Americans’ Day-to-Day Travel Patterns**  
*Prateek Bansal, Daniel J. Fagnant, & Kara Kockelman*

**Abstract:** Travel patterns vary over space (from city to city, region to region, & state to state) & over time (day to day & month to month) due to region-specific events (e.g., local rainstorms), holidays, & various other factors. In order to optimally serve demand over time & space (e.g., transit, shared autonomous vehicle fleets, roadway supply), it is very valuable to understand these variations. NHTS 2009 data allow us to quantify these variations.

**Subject Area:** VMT, Trip lengths, Occupancy

**Availability:** TRB 2015 Poster Presentation; *Variations in Americans’ Day-to-Day Travel Patterns*  
Bansal, P.; Fagnant, D. & Kockelman, K.
Origin-destination trips by purpose and time of day inferred from mobile phone data
Lauren Alexander, Shan Jiang, Mikel Murga, and Marta C. Gonzalez

Abstract: In this work, we present methods to estimate average daily origin-destination trips from triangulated mobile phone records of millions of anonymized users. These records are first converted into clustered locations at which users engage in activities for an observed duration. These locations are inferred to be home, work, or other depending on observation frequency, day of week, and time of day, and represent a user's origins and destinations. Since the arrival time and duration at these locations reflect the observed (based on phone usage) rather than true arrival time and duration of a user, we probabilistically infer departure time using survey data on trips in major US cities. Trips are then constructed for each user between two consecutive observations in a day. These trips are multiplied by expansion factors based on the population of a user's home Census Tract and divided by the number of days on which we observed the user, distilling average daily trips. Aggregating individuals' daily trips by Census Tract pair, hour of the day, and trip purpose results in trip matrices that form the basis for much of the analysis and modeling that inform transportation planning and investments. The applicability of the proposed methodology is supported by validation against the temporal and spatial distributions of trips reported in local and national surveys.

Subject Area: Mobile phone data, data mining, human mobility, trip production and attraction, trip distribution, travel surveys.

Determinants of Per Capita Vehicle Miles Traveled (VMT): The Case of California Mintesnot Woldeamanuel and Andrew Kent

Abstract: This study uses multivariate regression to isolate determinants of per capita VMT in California from the National Household Travel Survey (NHTS), as well as a Chow Test to identify structural change between the 2001 and 2009 NHTS. Results across the 2001 and 2009 NHTS data sets indicate certain determinant variables have emerged over time and others have changed in strength of impact. Our findings support mixed methods VMT reduction strategies to achieve near- and long term GHG targets. This research intends to derive a comprehensive understanding of California specific per capita VMT determinants by isolating significant VMT variables from the National Household Travel Survey for the years 2001 and 2009. Comparing significant variables between both years will grant an understanding of how determinants have changed or remained constant. Through the analysis we will also determine what kinds of variables have the greatest relative impacts on annual per capita VMT in California. Our primary research questions include: (1) what are per capita VMT determinants in California? (2) how do per capita VMT determinants rank relatively? (3) how have per capita VMT determinants changed over the past decade? Through answering these questions, we hope to recommend which per capita VMT determinants the State of California and local MPOs should concentrate on to best reduce per capita VMT and achieve California’s ambitious greenhouse gas reduction targets.

Subject Area: VMT determinants; GHG targets

The Gender Gap in Non-Work Travel: The Relative Roles of Income Earning Potential and Land Use Marlon G. Boarnet, & Hsin-Ping Hsu

Abstract: We empirically test two hypotheses: (1) that gender differences in income earning potential play a role in the within-household division of non-work travel and (2) that compact land use development can reduce the within-household gender gap in non-work travel. Using the 2001 Southern California Household Travel Survey, we find that non-work travel patterns for men and women do not vary much by gender unless children are in the household. Households with children display a striking difference in chauffeuring trips and women bear most of the chauffeuring burden. Adjusting for sociodemographics, women in households with children take over 300% more chauffeuring trips than do men living alone. The difference in chauffeuring trips among females and males within the household, the “within-household, female-male chauffeuring gap”, is larger for households with employed males and smaller in households with employed females. The chauffeuring gap is smaller when the woman’s earning power is larger compared to the man in the same household. The chauffeuring gap is larger for households that have higher amounts of single family residential land use in the quarter-mile area around their residence, and the chauffeuring gap is larger for households that live farther than a half mile from the nearest bus stop. The magnitude of the effect of those two land use variables on the chauffeuring gap is similar to the magnitude of variables that measure within-household differences in income-earning potential or female and male employment status, suggesting that more dense land use and better transit service can help reduce disproportionate chauffeuring burdens of women.

Subject Area: Gender; Non-Work Travel; Chauffeuring; Income Earning Potential; Land Use


**Abstract:** Whereas one line of recent neighborhood research has placed an emphasis on zooming into smaller units of analysis such as street blocks, another line of research has suggested that even the meso-area of neighborhoods is too narrow and that the area surrounding the neighborhood is also important. Thus, there is a need to examine the scale at which the social ecology impacts crime. We use data from seven cities from around the year 2000 to test our research questions using multilevel negative binomial regression models (N = 73,010 blocks and 8,231 block groups). Our results suggest that although many neighborhood factors seem to operate on the microscale of blocks, others seem to have a much broader impact. In addition, we find that racially and ethnically homogenous blocks within heterogeneous block groups have the most crime. Our findings also show the strongest results for a multitude of land-use measures and that these measures sharpen some of the associations from social characteristics. Thus, we find that accounting for multiple scales simultaneously is important in ecological studies of crime.

**Subject Area:** neighborhoods; crime; aggregation; spatial effects

Electric vehicles in multi-vehicle households  

**Abstract:** The suitability of an electric vehicle of a given range to serve in place of a given conventional vehicle is not limited by the daily travel over distances within that range, but rather by the occasional inconvenience of finding alternative transport for longer trips. While the frequency of this inconvenience can be computed from usage data, the willingness of individual users to accept that replacement depends on details of available transportation alternatives and their willingness to use them. The latter can be difficult to assess. Fortunately, 65% of US households have access to the most convenient alternative possible: a second car. In this paper we describe an analysis of prospective EV acceptance and travel electrification in two-car households in the Puget Sound region. We find that EVs with 60 miles of useful range could be acceptable (i.e. incur inconvenience no more than three days each year) to nearly 90% of two-car households and electrify nearly 55% of travel in those households (32% of all travel). This compares to 120 miles range required to achieve the same fraction of electrified travel via one-for-one replacement of individual vehicles. Even though only one third of personal vehicles in the US may be replaced in this paradigm, the ‘EV as a second-car’ concept is attractive in that a significant fraction of travel can be electrified by vehicles with modest electric range and virtually no dependence on public charging infrastructure.

**Subject Area:** Electric vehicle; Hybrid electric vehicles; Plug-in hybrid; Electric range; Acceptance

Young people are driving less than their parents. But why? Joseph Stromberg

Abstract: Recently, there has been a big change in US transportation: young people are driving fewer miles than their parents. For most of modern US history, Americans steadily drove more and more miles every year, particularly as suburbs expanded. But then, around 2007, driving went into decline, with young people driving significantly less.

Subject Area: millennials, VMT

Even As Batteries Age, Electric Cars Meet Commuter Needs: Study **Bengt Halvorson**

**Abstract:** In the first study of its kind, scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) quantitatively show that electric vehicles (EVs) will meet the daily travel needs of drivers longer than commonly assumed. Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation. Samveg Saxena, who leads a vehicle powertrain research program at Berkeley Lab, analysed real-world driving patterns and found that batteries that have lost 20 per cent of their originally rated energy storage capacity can still meet the daily travel needs of more than 85 per cent of US drivers.

**Subject Area:** daily travel; electric vehicle; energy storage

**Availability:** www.thecarconnection.com **Even As Batteries Age, Electric Cars Meet Commuter Needs: Study** April 14, 2015 DOE/Lawrence Berkeley National Laboratory.
Abstract: In the first study of its kind, scientists at the Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab) quantitatively show that electric vehicles (EVs) will meet the daily travel needs of drivers longer than commonly assumed. Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation. Samveg Saxena, who leads a vehicle powertrain research program at Berkeley Lab, analysed real-world driving patterns and found that batteries that have lost 20 percent of their originally rated energy storage capacity can still meet the daily travel needs of more than 85 percent of US drivers.

Subject Area: daily travel; electric vehicle; energy storage

Electric Vehicles Can Last Longer, Says LBNL Scientist indiawest.com

Abstract: Putting speculation to rest, scientists at Lawrence Berkeley National Lab led by Indian American Samveg Saxena have quantitatively showed that electric vehicles can meet the daily travel needs of drivers longer than commonly assumed. The new study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation.

Subject Area: daily travel; electric vehicle; energy storage

Is Range Anxiety Really That Big A Problem For EV Owners? George Zack

Abstract: Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. However, research recently published in the journal of Power Sources - co-authored by researchers from the University of California at Berkeley and from the Lawrence Berkeley National Laboratory - suggests that range anxiety is overstated. Electric vehicles can still meet the daily needs of their owners, even after losing significant charge through degradation, say researchers at the US Department of Energy’s Lawrence Berkeley National Laboratory. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation. Samveg Saxena, who leads a vehicle powertrain research program at Berkeley Lab, analysed real-world driving patterns and found that batteries that have lost 20 per cent of their originally rated energy storage capacity can still meet the daily travel needs of more than 85 per cent of US drivers.

Subject Area: daily travel; electric vehicle; energy storage

Electric car battery degradation not as serious as feared Ecomento.com

Abstract: In the first study of its kind, scientists at the Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab) quantitatively show that electric vehicles (EVs) will meet the daily travel needs of drivers longer than commonly assumed. Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation. Samveg Saxena, who leads a vehicle powertrain research program at Berkeley Lab, analysed real-world driving patterns and found that batteries that have lost 20 per cent of their originally rated energy storage capacity can still meet the daily travel needs of more than 85 per cent of US drivers.

Subject Area: daily travel; electric vehicle; energy storage

Availability: ecomento.com Electric car battery degradation not as serious as feared April 2, 2015 DOE/Lawrence Berkeley National Laboratory."
http://ecomento.com/2015/04/02/electric-car-battery-degradation-not-as-serious/
Electric cars more useful than thought: Study The Economic Times (India times)

Abstract: In the first study of its kind, scientists at the Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab) quantitatively show that electric vehicles (EVs) will meet the daily travel needs of drivers longer than commonly assumed. Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation. Samveg Saxena, who leads a vehicle powertrain research program at Berkeley Lab, analysed real-world driving patterns and found that batteries that have lost 20 per cent of their originally rated energy storage capacity can still meet the daily travel needs of more than 85 per cent of US drivers.

Subject Area: daily travel; electric vehicle; energy storage

Goodbye, range anxiety? Electric vehicles may be more useful than previously thought DOE/Lawrence Berkeley National Laboratory

Abstract: In the first study of its kind, scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) quantitatively show that electric vehicles (EVs) will meet the daily travel needs of drivers longer than commonly assumed. Many drivers and much prior literature on the retirement of EV batteries have assumed that EV batteries will be retired after the battery has lost 20 percent of its energy storage or power delivery capability. This study shows that the daily travel needs of drivers continue to be met well beyond these levels of battery degradation.

Subject Area: daily travel; electric vehicle; energy storage

Availability: ECNMAG.com Goodbye, range anxiety? Electric vehicles may be more useful than previously thought March 30, 2015 DOE/Lawrence Berkeley National Laboratory."
Electric vehicles more useful: Indian American scientist zeenews.india.com

Abstract: New York: Putting speculation to rest, scientists at the Berkeley Lab led by an Indian American have quantitatively showed that electric vehicles (EVs) can meet the daily travel needs of drivers longer than commonly assumed.

Subject Area: daily travel; electric vehicle; energy storage

More Miles, Less Cars Andrea Wells

Abstract: Autonomous vehicles may reduce the number of vehicles a family needs, but may lead to an increase in total miles driven, say researchers at the University of Michigan Transportation Research Institute.

Subject Area: Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle

http://www.insurancejournal.com/magazines/editorsnote/2015/04/06/362798.htm
Driverless Cars Impact: Fewer Cars, More Miles *Claims Journal*

**Abstract:** Autonomous vehicles may reduce the number of vehicles a family needs, but may lead to an increase in total miles driven, say researchers at the University of Michigan Transportation Research Institute.

**Subject Area:** Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle

**Driverless cars waste more energy!** *Adel Murad*

**Abstract:** A world moving toward driverless cars is a world consuming more energy, according to several academic studies from the University of Michigan and other institutes. There are positive sides to using autonomous cars but the net result is more millage and that means more energy. This trend could reverse recent momentum of declining fuel consumption.

**Subject Area:** Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle

Robot-driven cars may rack up more miles *Lloyd Alter*

**Abstract:** Whether you love the idea or hate it, the self-driving car is likely coming soon, and it's going to have a huge impact. I wrote about why the Google car could change everything, and noted that since cars were parked 90 percent of the time, it was likely that we might need 90 percent fewer of them and they would always be on the move doing something.

**Subject Area:** Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle

Driver-less cars could severely hit multi-car households: Study domain-b.com

Abstract: Another study warns that self-driving cars will eliminate many multicar households, reduce U.S. auto sales by 40% over the next 25 years and force General Motors and Ford to cut North American production by more than half. By analyzing data from the government's National Household Travel Survey, UMTRI researchers Brandon Schoettle and Michael Sivak found that families with three or more vehicles in their driveway rarely use more than one at a time.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

**Analyst: Driverless cars will cut U.S. sales by 40%**  
*Greg Gardner*

**Abstract:** Another study warns that self-driving cars will eliminate many multicar households, reduce U.S. auto sales by 40% over the next 25 years and force General Motors and Ford to cut North American production by more than half. By analyzing data from the government's National Household Travel Survey, UMTRI researchers Brandon Schoettle and Michael Sivak found that families with three or more vehicles in their driveway rarely use more than one at a time.

**Subject Area:** autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

Research: mpg down for new vehicles and miles up for autonomous cars Bryan Jonston

Abstract: Research Institute show a decline in the average mpg for new vehicles sales and that driverless cars in the future may cause more trips. Average fuel economy (window-sticker values) of cars, light trucks, vans and SUVs purchased in February was 25.2 mpg, down from 25.4 mpg in January and now just 0.1 mpg higher than a year ago. Overall, vehicle fuel economy is up 5.1 mpg from October 2007*, the first full month of monitoring by researchers Michale Sivak and Brandon Schoettle.

Subject Area: Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle

Dirty downside to driverless cars shown in university study Isaac Arnsdorf

Abstract: Driverless cars better be able to refuel themselves. They’ll consume more energy than cars with drivers. That’s the somewhat counterintuitive conclusion in a new study by researchers at the University of Michigan in Ann Arbor. They say that autonomous autos could reverse a years-long trend of declining fuel consumption

Subject Area: Technology Michigan Tesla Vehicle Technology Google Autonomous Vehicle


Future Urban Transportation Technologies for Sustainability with an Emphasis on Growing Mega Cities: A Strategic Proposal on Introducing a New Micro Electric Vehicle Segment Emilio Honey, Hojin Lee, and In-Soo Suh

Abstract: The current transportation regime is largely based on two alternatives: (1) fixed route public transit, and (2) private ownership of internal combustion engine (ICE) powered vehicles per households. This paper analyzes one possible transportation alternative, Micro Electric Vehicles or MEVs, and compares with the ICE vehicles in terms of social, economic and environmental benefits, especially emphasizing its environmental advantage over ICE vehicles for future sustainability. While some representative models of MEVs exist in a limited market capacity, but global technical standards are generally insufficient and non-homogenous across nations, which restricts the development of the proposed transportation sector. The focus of this paper is to analyze the characteristics and potential benefits of MEVs in economical and environmental perspectives, including development status and technical standards, with a particular focus in the E.U., the U.S., Japan, and Korea. Based on the data of analysis, this paper aims to derive and propose a cooperative and adaptive global policy framework designed to speed up adoption and expansion of the global MEV market, including passenger and utility vehicles. We propose MEV to be a new mobility segment in the global transportation market because of their advantage in environmental impact, sustainability, overall cost of ownership, and safety.

Subject Area: Micro Electric Vehicle, MEV, Quadricycle, Sustainability, Safety, Fuel Economy, CO2

The Future Of Fully Automated Vehicles: Opportunities For Vehicle- And Ride-Sharing, With Cost And Emission Savings Daniel James Fagnant

Abstract: Fully automated or autonomous vehicles (AVs) hold great promise for the future of transportation, with Google and other auto manufacturers intending on introducing self-driving cars to the public by 2020. New automation functionalities will produce dramatic transportation system changes, in safety, mobility, travel behavior, and the built environment.

This work’s results indicate that AVs may save the U.S. economy up to $37.7 billion from safety, mobility and parking improvements at the 10% market penetration level (in terms of system-wide vehicle-miles traveled [VMT]), and up to $447.1 billion with 90% market penetration. With only 10% market share, over 1,000 lives could be saved annually. However, realizing these potential benefits while avoiding pitfalls requires overcoming significant barriers including AV costs, liability, security, privacy, and missing research.

Additionally, once fully self-driving vehicles can safely and legally drive unoccupied, a new personal travel transportation mode looks set to arrive. This new mode is the shared automated vehicle (SAV), combining on-demand service features with self-driving capabilities. This work simulates a fleet of SAVs operating within Austin, Texas, first using an idealized grid-based representation, and next using Austin’s actual transportation network and travel demand flows. This second model incorporates dynamic ride-sharing (DRS), allowing two or more travelers with similar origins, destinations and departure times to share a ride.

Model results indicate that each SAV could replace around 10 conventionally-owned household vehicles, with a fleet of 1715 SAVs serving over 56,000 person-trips. SAVs’ ability to relocate unoccupied between serving one traveler and the next may cause an increase of 7-10% more travel; however, DRS can result in reduced overall VMT, given enough SAV-using travelers willing to ride-share. Furthermore, using DRS results in overall lower wait and service times for travelers, particularly from pooling rides during peak demand. SAVs should produce favorable emissions outcomes, with an estimated 16% less energy use and 48% lower volatile organic compound emissions, per person-trip compared to conventional vehicles. Finally, assuming SAVs cost $70,000 each, an SAV fleet in Austin could provide a 19% return on investment, when charging $1 per trip-mile served. In closing, this new paradigm holds much promise in helping to create a more efficient and sustainable transport system.

Subject Area: shared autonomous vehicles; dynamic ride-sharing

http://repositories.lib.utexas.edu/handle/2152/25932
Self-driving cars may cut household's vehicle count Greg Gardner

Abstract: Self-driving cars could reduce the number of vehicles a household needs and open up new commuting options for Americans, according to a report released Monday by the University of Michigan Transportation Research Institute. By analyzing data from the government’s National Household Travel Survey, UMTRI researchers Brandon Schoettle and Michael Sivak found that families with three or more vehicles in their driveway rarely use more than one at a time.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

The Performance and Benefits of a Shared Autonomous Vehicles Based Dynamic Ridesharing System: An Agent-Based Simulation Approach Zhang, Wenwen; Guhathakurta, Subhrajit; Fang, Jinqi; Zhang, Ge

Abstract: The recently introduced concept of Shared Autonomous Vehicle (SAV) system, a taxi system without drivers or a short-term rental car-sharing program with autonomous vehicles, presents great potential to promote ridesharing travel behavior. Given the reliability and flexibility provided by the SAV system, some hurdles in the current ridesharing programs, such as lack of flexibility to handle near term travel schedule changes, can be overcome. However, the existing studies regarding SAV system are limited to non-ridesharing (NR) systems. To fulfill this research gap, this study designed and applied an agent-based model to simulate the performance and estimate the potential benefits of an SAV system with dynamic ridesharing (DR-SAV). The modeled DR-SAV system will assign SAVs to serve vehicle-trips, with similar travel profile as in 2009 National Household Travel Survey (NHTS), in a 10*10 mile grid based city, for each one-minute time step. Two vehicle-trips may voluntarily participate into the ridesharing service, if both of them are willing to share rides with strangers and the additional delay time cost triggered by ridesharing can be offset by travel cost reductions. Preliminary results show that a DR-SAV system can provide more satisfactory level of service compared with an NR-SAV system, in terms of shorter trip delays, more reliable services (especially during peak hours), less Vehicle Miles Travelled (VMT) generation, and less trip costs. Additionally, the results also indicate that a DR-SAV system can be more environment-friendly in the long run.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

http://trid.trb.org/view.aspx?id=1337820
Autonomous Cars: Fewer Vehicles, More Miles evworld.com

Abstract: The University of Michigan's Transportation Research Institute projects that the advent of self-driving vehicles will cut car ownership by as much as 43 percent. UMTRI researchers Brandon Schoettle and Michael Sivak recently analyzed the revised edition of the 2009 U.S. National Household Travel Survey in the light of the advent of self-driving, autonomous vehicles and came to some interesting conclusions, one that is likely to trouble carmakers.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

Driverless cars could cut auto sales in half Richard Read

Abstract: Today's sky-high auto sales could plummet as driverless cars start hitting the streets, research suggests. The reason? Driverless cars would let people share a vehicle for separate trips. America's auto market is booming right now, but a study from the University of Michigan Transportation Research Institute suggests that today's sky-high sales figures could plummet in the next decade, as autonomous cars start hitting the streets.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

Autonomous vehicles may lead to an increase in miles driven  

**Bernie Degroat**

**Abstract:** Autonomous vehicles may reduce the number of vehicles a family needs, but may lead to an increase in total miles driven, say researchers at the University of Michigan Transportation Research Institute. UMTRI researchers Brandon Schoettle and Michael Sivak examined U.S. National Household Travel Survey data that contained comprehensive information about each trip made by a person within a selected household, including the exact start and stop times of each trip.

**Subject Area:** autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

**Availability:** Degroat, Bernie; Phys.org *Autonomous vehicles may lead to an increase in miles driven*  
Feb. 12, 2015.  
Self-Driving Vehicles Could Cut Car Ownership Nearly in Half, Report Finds
Megan Gannon

Abstract: In the not-too-distant future, the typical picture of a big American household in the suburbs might include just one car in the driveway: A new report finds that self-driving cars have the potential to cut U.S. car ownership nearly in half. For the report, Brandon Schoettle and Michael Sivak of the University of Michigan Transportation Research Institute looked at 2009 data from the U.S. National Household Travel Survey, which found that 31.9 percent of households had one car, 41.6 percent had two cars and 26.5 percent had three or more vehicles.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

Self-driving cars may lead to fewer vehicles driven more  

Greg Gardner

**Abstract:** Self-driving cars could cut the number of vehicles a household needs, but open up new commuting options for Americans and even lead to more total miles driven, according to a report released Monday by the University of Michigan Transportation Research Institute. By analyzing data from the government’s National Household Travel Survey, UMTRI researchers Brandon Schoettle and Michael Sivak found that families with three or more vehicles in their driveway rarely use more than one at a time.

**Subject Area:** autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

**Availability:** Gardner, Greg; Detroit Free Press, USA Today  
Self-driving cars may lead to fewer vehicles driven more  
Feb. 9, 2015.  
Potential Impact of Self-Driving Vehicles on Household Vehicle Demand and Usage  
Schoettle, Brandon, Michael Sivak, and Sustainable Worldwide Transportation

Abstract: In this report we present an analysis of the potential for reduced vehicle ownership within households based on sharing of completely self-driving vehicles that employ a “return-to-home” mode, acting as a form of shared family or household vehicle. An examination of the latest U.S. National Household Travel Survey (NHTS) data shows a general lack of trip overlap between drivers within a majority of households, opening up the possibility for a significant reduction in average vehicle ownership per household based on vehicle sharing. This reduction in ownership and an accompanying shift to vehicle sharing within each household, in the most extreme hypothetical scenario, could reduce average ownership rates by 43% (from 2.1 to 1.2 vehicles per household). Conversely, this shift would result in a 75% increase in individual vehicle usage (from 11,661 to 20,406 annual miles per vehicle). However, given the number of current unknowns regarding sufficient gaps between trips, future self-driving-vehicle implementation, self-driving-vehicle acceptance, and possible vehicle-sharing strategies within households, these results serve only as an upper-bound approximation of the potential for household sharing of completely self-driving vehicles.

Subject Area: autonomous vehicles, self-driving vehicles, driverless vehicles, vehicle sharing, vehicle demand, vehicle ownership, vehicle usage, National Household Travel Survey, NHTS

Governor Hogan thinks only 10% of Marylanders use transit. Actually, 25% or more do. Jim Titus

Abstract: Maryland Governor Larry Hogan says that Maryland should shift its focus away from transit toward building more roads because (he says) less than 10% of people use transit. But the real number is far more. Hogan’s mistaken assertion comes from the Census Bureau's American Community Survey (ACS), which estimates that 9.1% of Maryland’s 2.9 million workers over the age of 16 used transit as their primary mode for commuting in 2013. A comment on the article references NHTS: “What about the National household Travel Survey? The latest one was done in 2009, but it should show a statistically significant snapshot of all travel in Maryland.”

Subject Area: Maryland Transit users; ACS; census

Measuring & Mitigating Electric Vehicle Adoption Barriers Tommy Carpenter

Abstract: Transitioning our cars to run on renewable sources of energy is crucial to addressing concerns over energy security and climate change. Electric vehicles (EVs), vehicles that are fully or partially powered by batteries charged from the electrical grid, allow for such a transition. Specifically, if hydro, solar, and wind generation continues to be integrated into the global power system, we can power an EV-based transportation network cleanly and sustainably. To this end, major car manufacturers are now producing and marketing EVs. Unfortunately, at the time of this writing, drivers are slow to adopt EVs due to a number of concerns. The two greatest concerns are range anxiety—the fear of being stranded without power and the fear that necessary charging infrastructure does not exist—and the unknown return on investment of EVs over their lifetime. Towards measuring the barriers to adoption, we build a sentiment analysis system for programmatically mining detailed perceptions towards EVs from ownership forums. In addition, we design the most comprehensive electric bike trial to date, which allows us to study several aspects of electric vehicles, including range anxiety, at a much lower cost. Towards mitigation, we develop algorithms for managing a network of gasoline vehicles to be used by EV owners when a planned trip exceeds the range of their EV. Further, we design a model for taxi companies to compute whether it is profitable to transition a fraction of their fleet to EVs. To summarize our findings, we find that sentiments towards EVs are very positive, especially regarding performance and maintenance, but there are concerns over range anxiety and the higher initial price of EVs. Larger batteries cost more, so alleviating range anxiety with larger batteries leads to pricier vehicles. Conversely, EVs with low range capabilities can also induce costs, because drivers and fleets that own EVs may have to often acquire (or own as an additional vehicle) a gasoline vehicle to fully meet their mobility demands. As a result, EVs are best suited for drivers and fleets that are able to make long-term return on investment calculations, and whose mobility patterns do not include many very long trips. Fleets can greatly reduce their operating costs by adopting EVs because they have the capital to make upfront investments that are profitable long-term. We show that even under conservative assumptions about revenue loss due to battery depletion, EVs are already profitable (the company saves more than enough money to recoup all initial investments) for a large taxi company in San Francisco. Similarly, EVs can be profitable for two-car families (those who already have a gasoline car) and for those who can easily acquire a gasoline vehicle when needed, hence our work on sizing networks of gasoline-vehicle pools for EV owners. Finally, we find that not only are electric bikes and EVs operationally similar, the sentiments towards the two technologies are as well. Advancements made in the battery sector, especially those that reduce costs or weight, are likely to accelerate sales in both markets. The results presented in this thesis, as well as in prior work, suggest that EVs are suitable for many drivers and will hence serve a role in our eventual transition away from fossil fuels.

Subject Area: Electrical Vehicle adoption;