ESP/ECI 252: SUSTAINABLE TRANSPORTATION TECHNOLOGY & POLICY
Spring 2017

Instructor:
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Course Description: The course is interdisciplinary, drawing upon economics, environmental sciences, policy science, market research, and engineering. The objective is to understand the many forces and events that have shaped auto-centric transportation systems, and to explore investments and policies that would direct it to a more sustainable future. The focus is the US, but students are free (and encouraged) to apply lessons and insights to regions at different levels of development and different circumstances.

This course addresses the role of technical fixes and behavioral changes in creating a more environmentally, economically, and socially sustainable transportation system. The emphasis is on policy instruments, markets, and organizations as they relate to environmental and technology issues. Which strategies and policies are most efficient and effective? Most equitable? Which policies and strategies should be pursued most aggressively, and how?

The course is motivated by the challenge of significantly reducing greenhouse gas emissions, and is structured around vehicles, fuels, mobility, and land use. The course is targeted at advanced graduate students with considerable transportation coursework. It is intended to be a synthesis course for graduate students who have already taken several courses on travel behavior, economics, environmental analysis, energy policy, and transportation technology. It provides students with an opportunity to synthesize what they have learned elsewhere in methods courses and more narrow empirical courses.

Format and Organization: The course will be built around class discussions of specific transportation policies. We will generally address one policy (or strategy or technology) per 3-hour class. We will generally have a guest speaker, who will do a short presentation on the topic, along with framing by the professor, then questions and arguments by designated students, followed by open discussion.

Each student will be required to respond formally participate in two class discussions. The discussion will address the design and desirability of specific policies and strategies. Each student will be assigned as a respondent to two course topics, and graded for participation (~6 per class),

Below are the proposed topics and draft schedule. The schedule will be finalized at the first class, with the possibility of some changes in topics.

Week 1. Introduction and Organization

Week 2. California's ZEV mandate

Nine other states have adopted California's ZEV mandate, China is likely to adopt a version of it, and Europe is exploring possible adoption. But is this good policy? Is there a better way to accelerate the commercialization of "ZEVs"? Should the policy be continued? Until when? What changes should be considered for 2026+?

- UC Davis, Achieving California's Greenhouse Gas Goals: A Focus on Transportation, Prepared for Next 10 Foundation, 2015, Chapter 3, pp. 27-43 ("UC Davis Policy Institute Next10 report")
- James Bushnell, "Economists are from Mars, Electric Cars are from Venus," https://energyathaas.wordpress.com/2015/12/14/economists-are-from-mars-electric-cars-are-from-venus/

Week 3: CAFE/GHG standards for LDVs

What is the best way to reduce GHGs from light duty vehicles? Are carbon/fuel taxes a better policy approach than performance standards? If performance standards are retained, should they be attribute-based, as they are now, or should they be based on fleet averages or something entirely different (ie, weight-based vs size vs corporate average)? How might or should GHGs and energy use of LDVs be regulated post 2025 (considering changes in energy, materials, and vehicle usage)?

- Chapter 2 of "UC Davis Policy Institute Next10 report" (pp.13-28)
- SKIM the following: Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, Efficiency Technology and Cost Assessment for US 2025–2030 Light-Duty Vehicles, ICCT, March 2017 ("LDV-tech-potential_ICCT_white-paper_22032017.pdf"

Week 4. Trucks

Policies to reduce pollution and energy use of trucks has lagged behind cars for a variety of reasons. Going forward, what are the best strategies to reduce energy use and GHG emissions for heavy duty trucks (and buses)? What about "zero emission trucks"? What is the role of biofuels, electricity, hydrogen, and natural gas?

- Drew Kodjak, Ben Sharpe, Oscar Delgado, "Evolution of heavy-duty vehicle fuel efficiency policies in major markets," **Mitig Adapt Strateg Glob Change** (2015) 20:755–775 (

Week 5. Climate Policy for Transportation

Addressing cap and trade, market instruments.

- A. Denny Ellerman, Paul L. Joskow, "The European Union's Emissions Trading System in perspective" (Bushnell_ Joskow_Ellerman_EU_ETS_Pew2008)
- Ian W.H. Parry, William A. Pizer, "Emissions Trading versus CO2: Taxes versus Standards" (Bushnell_ParryPizerRFF2007)

Week 6. Low Carbon Fuel Standard

Is the LCFS the best policy to reduce GHG emissions from transportation energy? How does it relate to lags in developing advanced biofuels? How should LCFS be changed post-2020?

- Plevin et al, "Fuel carbon intensity standards may not mitigate climate change" ("Plevin, MAD O'Hare LCFS Energy Policy.pdf").
- Bruce Dale, "A New Industry Has Been Launched: The Cellulosic Biofuels Ship (Finally) Sails Biofuels," Bioprod, Bioref. 9:1–3 (2015)
- Chapter 5 of "UC Davis Policy Institute Next10 report"

Week 7. Transportation Finance

How can or should the current policies for financing transport finance be updated and reformed to take into consideration funding shortfalls, more energy efficient vehicles, and increasing use of non-petroleum energy? How might it relate to shrinking of transit use, expansion of bike infrastructure, and opportunities with new mobility services? How should EVs be taxed?

- Alan Jenn, Inês Lima Azevedo, Paul Fischbeck, "How will we fund our roads? A case of decreasing revenue from electric vehicles" TRS, 2015 ("jenn2015_EV revenue")
- Robert S. Kirk, William J. Mallett, Funding and Financing Highways and Public Transportation, Congressional Research Service, 2013 ("Jenn_kirk2013funding")
- Marty Wachs, "A Quiet Crisis in Transportation Finance Options for Texas," Rand Corporation, 2006.("Jenn_wachs2006")

Week 8. Policies for New Mobility Services and Automated Vehicles (and Public Transit)

What policy changes could/should be made with respect to app-based demand-responsive services? How can they be better directed to serve the public interest? How might new mobility and transit services partner?

- D. Sperling, Ellen van der Meer, and Susan Pike, "Vehicle Automation: Our Best Shot at a Transportation Do-Over?" Chapter 3 in D. Sperling et al, *Three Revolutions: Steering Shared, Automated, Electrified Vehicles Toward a More Livable Future* (Island Press, 2018).
- Anne GrosseOphoff, Saskia Hausler, Kersten Heineke, and Timo Möller, "How shared mobility will change the automotive industry," McKinsey and Co., April 2017 ("shared mobility and automotive industry McKinsey 2017.pdf")

Grading and Requirements: Students will write 4 short papers. The 4 papers must be <2 pages (single spaced) and will account for 80% of the course grade. An outline must be submitted (by email) before the class at which the topic is addressed. One tenth of the grade for each paper will be based on outlines that are reasonably competent and turned in on time.

Each paper is based on the weekly course topic. The papers must be submitted by Sunday night following the class when the topic was discussed. There are 9 classes, and there will not be formal topics introduced the first and last week. And thus papers must be submitted for 4 of the 7 weekly discussion topics.

The 4 papers should be carefully researched, and well referenced with scholarly papers and professional reports. Newspaper and internet publications may only be used to document an event that took place, or to highlight an issue or assertion by some individual or organization.

The remaining 20% of the grade is for participation. Each student will be assigned as a respondent to two course topics (~5 per class), with the grade based on communication of that knowledge during that respective class discussion, and active participation throughout the quarter (requiring students to be well prepared to discuss a topic when it is introduced in class).

Readings: Students will be assigned at least two readings for each class discussion, and will be required to read it before the class. Students assigned to a particular class will be expected to be especially knowledgeable about the readings, and to have done other backup readings on the topic as well. All assigned readings will be posted on the class website (Smart Site).

Background Readings

General

Growth in mobility and accessibility in US and elsewhere. Role of transit and motor vehicles. Implications of motorization for economy, environment, and society (energy use, climate change, pollution, traffic congestion; urban livability, land use, aesthetics, equity, safety, ecology, and other goals).

1. Sperling and Gordon, Two Billion Cars (Oxford University Press, 2009)
2. David Greene and Steven Plotkin, *Reducing Greenhouse Gas Emissions from U.S. Transportation*, Pew Center for Global Climate Change, 2011 http://www.pewclimate.org/publications/reducing-ghg-emissions-from-transportation
3. D. Sperling and James Cannon, eds., *Climate and Transportation Solutions: Findings from the 2009 Asilomar Conference on Transportation and Energy Policy* (2010) Download PDF book
4. William Mitchell, Chris Borroni-Bird, and Larry Burns, *Reinventing the Automobile: Personal Urban Mobility for the 21st Century,* MIT Press, 2010.
5. Joan Ogden and Lorraine Anderson, eds (2012), Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers
6. Theodoros I. Zachariadis, ed., Cars and Carbon: Automobiles and European Climate Policy in a Global Context, 2012 http://link.springer.com/book/10.1007/978-94-007-2123-4/page/1
7. "Climate change: In the balance," *The Economist*, April 5, 2014
8. IPCC, "Transport," Chapter 8 in Working Group III mitigation report, 2014
9. IPCC, "Summary for Policymakers," 2014
10. UC Davis, *Achieving California's Greenhouse Gas Goals: A Focus on Transportation*, Prepared for Next 10 Foundation, 2015
11. Stacy Davis, Susan Williams, Robert G. Boundy, Transportation Energy Databook: Edition 35, Oak Ridge National Laboratory, 2016
12. Björn Nykvist and Måns Nilsson, "Rapidly falling costs of battery packs for electric vehicles," Nature Climate Change, Vol 5, April 2015

Vehicle Efficiency and Advanced Vehicle Technology

Automotive technologies are beginning to undergo massive transformations. The continuing emphasis on reducing air pollution and the emerging emphasis on reducing greenhouse gases, along with continuing concern about petroleum supply, is resulting in major changes.

What are the most promising vehicle options: fuel cells, hybrids, diesel engines? Is electric-drive inevitable? Which strategies and technologies are detours, and which will lead to the greatest improvements? Will there be a more diverse set of vehicle sizes and technologies in the future? What types of vehicles are most attractive and in what contexts?

Important policy issues include the ZEV program, CAFE, and European CO_2 standards for automakers.

1. Chapters 2 and 3 of "UC Davis Policy Institute Next10 report"
2. Chapters 2 and 4. Joan Ogden and Lorraine Anderson, eds (2012), Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers ("Ogden_STEPSbook_2012")
3. Chapters 2, 3, and 6. D. Sperling and D. Gordon, *Two Billion Cars.*
4. Anup Bandivadekar et al, *On the Road in 2035*, MIT, July 2008. ("MIT On the Road 2035")
5. Sofronis Clerides and Theodoros Zachariadis, "Are Standards Effective in Improving Automobile Fuel Economy?" Discussion Paper 2006-06 ("fuel economy-EU-Zach")
6. "HD_GHG&FE_ICCT_2011.pdf"
7. "NRC_CAFE_2013"
8. "CAFETrends_2013_EPA"
9. GE Helfand,"Standards," Encyclopedia of Energy, Natural Resource, and Environmental Economics, (2013), vol. 3, pp. 217-221. ("Regulations Standards GloriaHelfand 2013")
10. D. Sperling and Anthony Eggert, "California's climate and energy policy for transportation," *Energy Strategy Reviews* 5 (2014) 88-94. ("CalifPolicy sperling Eggert_12-14")
11. Delucchi, Mark A., et al, "An Assessment of Electric Vehicles: Technology, Infrastructure Requirements, Greenhouse-Gas Emissions, Petroleum Use, Material Use, Lifetime Cost, Consumer Acceptance, and Policy Initiatives." *Philosophical Transactions of the Royal Society A* 372. 20120325. 2014 ("Delucchi_etal_EVassessment_11-13.pdf")
12. CARB, California's Advanced Clean Cars Midterm Review: Summary Report for the Technical Analysis of the Light Duty Vehicle Standards, January 18, 2017 ("Mid-term review 01-17.pdf")
13. Yunshi Wang, D Sperling, Gil Tal, Haifeng Fang, "China's electric car surge," *Energy Policy* 102 (2017) 486–490 ("China EV Surge Yunshi et al 2017")
14. Mike Nicholas and Gil Tal, "Exploring Potential Updates to California's ZEV Rules," UC Davis, May 5, 2016 (unpublished) ("feebate_policybrief_11-21-16 clean.doc")
15. Dan Sperling and Alan Jenn, "California Feebate: How to Increase Sales of Energy Efficient and Electric Vehicles at No Cost to Taxpayers," Institute of Transportation Studies, UC Davis, November 2016 ("feebate_policybrief_11-21-16 clean.doc")
16. Sanya Carley, Denvil Duncan, John D. Graham, Saba Siddiki, and Nikolaos Zirogiannis, *A Macroeconomic Study of Federal and State Automotive Regulations*

with Recommendations for Analysts, Regulators, and Legislators, Indiana University, March 2017 ("CAFE Indiana 03-2017.pdf")
17. Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, Efficiency Technology and Cost Assessment for US 2025–2030 Light-Duty Vehicles, ICCT, March 2017 ("LDV-tech-potential_ICCT_white-paper_22032017.pdf")
18. Paul Wolfram, Nic Lutsey, Electric vehicles: Literature review of technology costs and carbon emissions, ICCT, July 2016 ("EVs ICCT_LitRvw_tech-costs_201607.pdf")
19. Tom Cackette and Rick Rykowski, Technical Assessment of CO2 Emission Reductions for Passenger Vehicles in the Post-2025 Timeframe, February 2017. Prepared for EDF ("Cackette CAFE post 2025 02-17.pdf")
20. ~~Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, Efficiency Technology and Cost Assessments for US 2025-2030 Light Duty Vehicles, ICCT, March 2017 ("LDV-tech-potential_ICCT_white-paper_22032017.pdf")~~
21. Lutsey, N., Slowik, P., & Jin, L. (2016). Sustaining electric vehicle market growth in U.S. cities. http://www.theicct.org/leading-us-city-electric-vehicle-2016

Low-Carbon Fuels

Which new fuels are most compelling? Attractive options include biofuels, electricity, hydrogen, and natural gas, as well fuels made from coal and other non-petroleum fossil sources. Key policies include California's low carbon fuel standard and the US renewable fuel standard.

1. Chapter 5 of "UC Davis Policy Institute Next10 report"
2. Chapters 4 and 5. D. Sperling and D. Gordon, *Two Billion Cars.*
3. Chapters 1 and 3. Joan Ogden and Lorraine Anderson, eds (2012), Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers ("Ogden_STEPSbook_2012")
4. S. Kent Hoekman, "Biofuels in the U.S. – Challenges and Opportunities," *Renewable Energy* 34 (2009) 14–22 ("Biofuels Kent Hoekman 2009")
5. Gert Jan Kramer and Martin Haigh, "No quick switch to low-carbon energy," *Nature* **462**, 568-569 (3 December 2009) http://www.nature.com/nature/journal/v462/n7273/full/462568a.html
6. "Exxon_EnergyForecasts_2013"
7. *BP Energy Outlook* 2035, 2014 ("BP energy stats 2014")
8. Bruce Dale, "A New Industry Has Been Launched: The Cellulosic Biofuels Ship (Finally) Sails," *Biofuels, Bioproducts, and Biorefining*, 2015. ("Biofuels cellulosic Bruce Dale editorial")
9. Sonia Yeh, Julie Witcover, Gabriel E. Lade, Daniel Sperling, "A review of low carbon fuel policies: Principles, program status and future directions," Energy Policy, 97 (2016) 220–234. ("LCFS_EP_07-16.pdf")
10. Justin Fox, "From Peak Oil to Peak Oil Demand in Just Nine Years," Bloomberg, November 2016 ("From Peak Oil to Peak Oil Demand in Just Nine Years - Bloomberg 11-16.pdf")
11. Richard J. Plevin, Mark A. Delucchi, Michael O'Hare, "Fuel carbon intensity standards may not mitigate climate change," *Energy Policy* 105 (2017), pp. 93-97. ("Plevin, MAD O'Hare LCFS Energy Policy.pdf")

Travel Demand, Land Use, and New Mobility Services

We have created a car-centric transportation monoculture in the US, and other nations are imitating the US. How might vehicle usage be reduced in a way that also reduces GHG emissions, while still offering a high level of accessibility? What is the role of pricing, land use management, transit, demand management, and new mobility services? What changes in policies are possible and desirable? How might transit be reformed to gain market share? Are there important synergies between different policies and strategies?

1. Chapter 4 of "UC Davis Policy Institute Next10 report"
2. Chapter 2 of Sperling and Gordon, *Two Billion Cars*.
3. Robert Puentes and Adie Tomer, "The Road…Less Traveled: An Analysis of Vehicle Miles Traveled Trends in the U.S.," Brookings, 2008.
4. Patrick Moriarty, Damon Honnery, "Low-mobility: The future of transport," *Futures* 40 (2008) 865–872 ("Low mobility futures 2008")
5. Caroline Rodier, "A Review of the International Modeling Literature: Transit, Land Use, and Auto Pricing Strategies to Reduce Vehicle Miles Traveled and Greenhouse Gas Emissions," *Transportation Research Record,* 2009 ("LU-VMT Rodier 2008")
6. Reid Ewing and Arthur C. Nelson, "CO2 Reductions Attributable to Smart Growth in California," 2008. ("EwingNelsonAnalysisFinal")
7. Ken Orski, "A Contrarian View of 'Sprawl'," Innovation Briefs, 2006 ("Sprawl contrarian view of sprawl Orski 2006")
8. Ewing, R., Bartholomew, K., Winkleman, S., Walters, J. and Chen, D. (2008). The VMT/CO2/climate connection. In N. Stewart (Ed.), *Growing cooler*: t*he evidence on urban development and climate change*. The Urban Land Institute. pp. 37-54.
9. Gordon, P. and Richardson, H.W. (1997). Are compact cities a desirable planning goal? *Journal of the American Planning Association*, Vol. 63, pp. 95-105.
10. Shaheen, S. and Finson, R. (2004). Intelligent transportation systems. *Energy Encyclopedia* 3, 487-496.
11. "Pucher et al CYCLING REVIEW2010.pdf"
12. Julie Pierce, "The Future of SB 375 Implementation and Regional Planning," *Western City*, March 2015 ("The Future of SB 375 Implementation")
13. Rand, *Autonomous Vehicle Technology: A Guide for Policymakers*, 2014. ("autonomous vehicles Rand 2014")
14. Hall and Krueger, *An Analysis of the Labor Market for Uber's Driver-Partners in the United States,* January 22, 2015 ("Uber Drivers Hal Krueger 01-2015")
15. Uber and MADD, *More Options, Shifting Mindsets, Driving Better Choices*, 2014 ("UberMADD Report")
16. Felix Creutzig, Blanca Fernandez, Helmut Haberl, Radhika Khosla, Yaco Mulugetta, and Karen C. Seto, "Demand-Side Solutions for Climate Change Mitigation," *Annual Review of Environment and Resources* 2016. 41:173–98. "GHG policy for transport Creutzig 2016.pdf")
17. TRB*, Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*, Transportation Research Board, Special Report 319, 2015 "TRB-NAS Mobility prepub 2015.pdf")
18. Bern Grush and John Niles, "Public fleets of automated vehicles and how to manage them," *Thinking Highways* ("Public-fleets-of-automated-vehicles-and-how-to-manage-them 2017.pdf")

19. D. Sperling et al, "Automated Vehicles," Chapter 3 in *The Three Transportation Revolutions* (2017) ("AV chapter 03-16 clean.docx")
20. Kara Kockelman et al, An Assessment of Autonomous Vehicles: Traffic Impacts and Infrastructure Needs—Final Report, UT Austin, 2016 ("UT Austin Automated vehicles.pdf")
21. Zia Wadud, Don MacKenzie, Paul Leiby, "Help or hindrance? The travel, energy and carbon impacts," *Transportation Research* A, 86 (2016), pp. 1-18 ("Automation impacts Wadud Mackenzie Leiby 03-16.pdf")
22. Peter Cohen et al, "Using Big Data to Estimate Consumer Surplus: The Case of Uber," NBER Working Paper Series, 2016 ("Uber pricing paper 2016.pdf")
23. Lindsay, Greg*, Now Arriving: A Connected Mobility Roadmap for Public Transpor*t, New Cities Foundation (2016), ("Transit and new mobility New Cities foundation 10-16.pdf")
24. Sharon Feigon and Colin Murphy, *Shared Mobility and the Transformation of Public Transit*, TRB TCRP, 2016 ("Shared-Mobility APTA-TCRP 2016.pdf")
25. Ryan Snyder*, Planning Implications of Autonomous Vehicle,* February 2016 ("Planning Implications of Autonomous Vehicles 02-16.pdf")
26. Bruce Schaller, *UNSUSTAINABLE? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City*, February 2017 ("Schaller Uber in NYC 2017.pdf")
27. Steve Polzin, "Setting Expectations for Mobility as a Service,"