Transportation and Energy

ENVIRON/ENERGY 630

Duke University—Nicholas School of the Environment
Fall 2017

Tuesday and Thursday, 1:25 to 2:40
LSRC A247

Instructor
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Course Description and Objectives

While our standard of living relies on affordable and independent mobility, our current transportation system produces environmental, economic, and social stresses that in turn pose challenges to its long-term viability. The movement of people and goods in the US, for instance, relies on petroleum for more than 90% of its energy needs and is responsible for nearly one-third of the country's greenhouse gas (GHG) emissions. In addition, transportation continues to have significant impacts on urban air quality and, through its interaction with land use, negatively affects water resources and ecosystem services. Beyond these concerns, the policy, planning, and environmental communities often link our current transportation system to a variety of negative social, health, and economic outcomes—most of which are due to our dependence on the automobile. And yet transportation as we have come to know it in the US supports a lifestyle with numerous benefits, and one to which people around the world aspire. As demand for mobility continues to increase worldwide, the challenge going forward will therefore be to develop transportation options that preserve the best of what works today while reducing negative impacts to sustainable levels.

This class focuses on an important piece of this problem by examining transportation-related energy use and its impact on the environment. Understanding the transportation-energy linkage requires an awareness of how technology, infrastructure, and policy, as well as personal and cultural preferences, affect demand for personal mobility and freight movement. You will gain familiarity with each of these dimensions and their interactions through the study of: historical and current transportation trends, existing and emerging vehicle designs and fuel pathways, public transit and community design, infrastructure planning and operation, and national to local policy and regulatory frameworks. Cutting across these themes will be consideration of strategies to reduce transportation energy use and its environmental impacts, and the course will introduce information resources and tools for evaluating

both. Finally, the class will provide you with opportunities to hone your problem solving and analytical skills, and will challenge you to think critically and creatively about the complex trade-offs among transportation options.

By the end of the course, you will be able to:

- Describe historical and contemporary trends in global transportation demand and energy use, as well as related environmental impacts
- Understand the economic, social, and cultural factors that shape demand for personal mobility and freight movement
- Evaluate claims regarding the extent to which vehicle design changes, alternative fuel use, and urban planning strategies might reduce transportation energy use and GHG emissions
- Critique *and design* comprehensive strategies to reduce long-term transportation energy use and GHG emissions
- Locate transportation information and data resources, apply publicly available assessment tools, and perform basic scoping calculations related to transportation energy use and its environmental impacts

Course Format

We will use class time for discussion of the readings and material introduced in class, small group problem solving and other participatory exercises, plus student-led presentations of chosen transportation-related topics. The course will wrap up with presentations of your project work.

Prerequisites

This course does not have formal prerequisites. All students who are interested in the connection between transportation, energy use, and the environment are welcome.

Coursework and Grading

Your grade will be based on the following:

Assignments	35% (6 assignments)
Group Presentations	10% (all group members receive the same grade)
Team Project	40% (all group members receive the same grade)
Class Participation	10%
Reading Summaries	5%

I will use the following rubric to translate cumulative scores into final grades:

[99 to 100]	A+	[80 to 83)	B-
[93 to 99)	A	[77 to 80)	C+
[90 to 93)	A-	[73 to 77)	C
[87 to 90)	B+	[70 to 73)	C-
[83 to 87)	B	Below 70	F

Assignments will consist of a mix of quantitative problem solving and reflective writing, and must be uploaded to Sakai by 1:00pm on the posted due date (see below for policy on late assignments). **The**

assignments are to be completed individually. You may discuss assignment questions with your colleagues, but the work you submit must be your own (per the Duke Honor Code).

Group presentations will involve 15 minute overviews of key topics and short student-led class discussions. Groups of three students will be free to pick a topic related to items from the schedule below (first come, first served). Potential topics range from use of natural gas as a vehicle fuel to bus rapid transit, telework, high speed rail, the use of social media in transportation, and other subjects that we will discuss in class. I am also willing to entertain additional suggestions if you have an interest in a subject not listed. Your presentation should provide an overview of your topic, with a discussion of its history, status, and potential to reduce transportation energy use and associated environmental impacts (be sure to define your timeframe). You should consider all relevant technical, economic, policy, and social dimensions—and their interactions.

The ***team project*** will give you a chance to synthesize and apply what we have learned in class. Working in groups of three, you will construct a scenario of how a country or region (e.g., state, province, or metropolitan area) of your choosing can achieve a 50% reduction in its annual transportation-related greenhouse gas emissions by 2035, relative to a business as usual projection. I will provide specific details about the project and my expectations at the start of the semester. In short, you will need to consider all relevant factors (technology, economics, policy, and regulation, as well as social, cultural, and behavioral issues) and their interactions, though you are free to emphasize those strategies and approaches that you feel are most promising. You will need to back up your vision with solid analysis; and while this is meant to be a creative exercise, you will need to be realistic (i.e., you cannot rely on radical assumptions about technological breakthroughs or changes in human nature). Products include a preliminary baseline analysis due at mid-term, and a final in-class presentation and write-up.

Class participation will be based on attendance, contribution to class discussions, and evidence of having prepared for class. The more interactive the class is, the more we will all get out of it.

To encourage your preparation, I will occasionally ask you to submit a ***reading summary***—either a paragraph reaction to the day's readings or a short list of questions for further discussion—via Sakai prior to the start of class (this does not apply to the "optional" readings). These submissions will not be graded or returned, though we will use your thoughts to structure our discussions.

Policy on late assignments and absences

All assignments and reading summaries/discussion questions must be uploaded to Sakai by 1:00pm on the posted due date. Assignments handed in after 1:00pm on the posted due date will incur a 25 point penalty for each 24 hour period they are late (i.e. from 1:00pm to 1:00pm the next day). **Assignments submitted more than 3 days (72 hours) after the posted due date will not receive credit**. **You will not receive credit for reading summaries/discussion questions submitted after 1:00pm on the day of class.**

Group presentations (in class) may shift with the schedule, but must be ready on the agreed day. The project presentations will take place during the last two class sessions of the semester, and the project write-ups will be due by 5:00pm on December 4.

If you know of conflicts with the course schedule that will affect a majority of the students, please let me know as soon as possible. I will make due date exceptions only for serious illnesses and personal emergencies.

If you are sick and cannot complete assigned work, you must complete a Short-Term Illness Notification Form (STINF) at: http://trinity.duke.edu/undergraduate/academic-policies/illness. The website provides instructions, but note the following text: **"**Definition of Incapacitation: An incapacitating illness or injury is one in which you are hospitalized, under medical care for a short-term condition, or otherwise sufficiently debilitated as to be unable to perform basic academic tasks. Colds, headaches, or other such mild complaints that result in your feeling less than 100% are not considered incapacitating, and you should not use the STINF in such instances. Appropriate uses of the STINF might include such conditions as influenza, migraine, sinus infection, and strep throat." In the event of something even more serious, of course, I will make every effort to accommodate your situation.

Readings

Readings are available on Sakai or via web links to public documents and information resources (we will not use a separate textbook). The schedule below lists reading assignments, which you must complete prior to each day's class. I may also assign additional readings based on your interest in related topics.

Note that the readings are intended to introduce a variety of viewpoints, some contradictory, and not all of which I share. Your job is to read critically and use the factual basis we develop in class to reach your own conclusions about the issues we discuss.

Sakai

If you are registered for the class, you will have complete access to our Sakai website. All course materials, including this syllabus, assignments, and readings, are available on Sakai.

Classroom Etiquette

Please arrive on time and refrain from checking email and social media, texting, and websurfing while we are together. These activities are more obvious that you might think, and I will not hesitate to cold call anyone who appears to be using their device for anything other than notetaking or researching the occasional discussion question. If I feel that electronic media are becoming too much of a distraction, I will ask you to turn off and store all phones, tablets, and laptops during class.

My Expectations of You

This is your course. At minimum, I expect you to attend class and be an active participant, which, in turn, requires that you prepare for each class in advance, having completed the readings and other assignments. I also expect you to have an open mind, but to think critically and use what we learn in making your own judgments.

In addition, if you have suggestions on how to improve the course, please let me know. Feedback received midstream can be more useful (to you and me) than end-of-term evaluations, and I am happy to make reasonable changes if a majority concurs.

What You Can Expect from Me

I'm here to help you learn. I understand and appreciate the diversity in your backgrounds, interests, and analytical strengths, and have tried to design the course to accommodate these differences while providing opportunities to help you develop in new areas. Again, I appreciate feedback. I'm available during my office hours if you have questions about the class (or anything related), and am happy to find mutually agreeable times outside of these windows to meet. Just let me know what works best for you.

Nicholas School Honor Code and the Duke Community Standard

All activities of Nicholas School students, including those of you in this course, are governed by the Duke Community Standard (http://integrity.duke.edu/standard.html), which states:

"Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity. To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised."

Please add the following affirmation to the end of all assignments and your projects, and sign your name beside it: "I have adhered to the Duke Community Standard in completing this assignment."

Topic and Reading Schedule

This schedule below is subject to change, and I may modify it as we go along if extra time is needed (or desired!) for particular topics. I'll provide updates to the schedule in class and via email. See the assignment and project handouts for specific due dates.

August 29 Tuesday ***Class 1***	Introduction and course overview; Transportation sustainability
August 31 Thursday ***Class 2***	Transportation trends: Historical perspectives and current issues Introduce group presentations *Reading* • Maria Figueroa, Oliver Lah, Lewis M. Fulton, Alan McKinnon, and Geetam Tiwari (2014). Energy for Transport. Annual Review of Environment and Resources Vol. 39:295-325, DOI: 10.1146/annurev-environ-031913-100450 http://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-031913-100450 • *Optional*: Todd Litman (2016). The Future Isn't What It Used to Be: Changing Trends and Their Implications for Transport Planning. Victoria Transport Policy Institute. http://www.vtpi.org/future.pdf

September 5 Tuesday ***Class 3***	Transportation demand: Factors affecting activity and preferences Introduce projects *Reading* • Chapter 1 (Transport, Mobility, Emissions, and Development, pp. 21-38) from: Kopp, Andreas, Rachel I. Block, and Atsushi Iimi (2013). Turning the Right Corner: Ensuring Development through a Low-Carbon Transport Sector. Directions in Development. Washington, DC: World Bank. doi:10.1596/978-0-8213-9835-7. License: Creative Commons Attribution CC BY 3.0. http://documents.worldbank.org/curated/en/239191468331236091/Turning-the-right-corner-ensuring-development-through-a-low-carbon-transport-sector
September 7 Thursday ***Class 4***	Technology change; Petroleum overview *Reading* • Chapter 2 (Gasoline and Oil) from: Martin, Jeremy (2016). Fueling a Clean Transportation Future: Smart Fuel Choices for a Warming World. Cambridge, MA: Union of Concerned Scientists. http://www.ucsusa.org/sites/default/files/attach/2016/02/Fueling-Clean-Transportation-Future-full-report.pdf • Robin Cowan and Staffan Hultén (1996). Escaping Lock-in: The Case of the Electric Vehicle. Technological Forecasting and Social Change 53(1):61–79. (Read to page 68 only.) http://www.sciencedirect.com/science/article/pii/0040162596000595 • *Optional*: US Department of Energy, Energy Information Administration (n.d.). Energy Explained: Your Guide to Understanding Energy. Oil and Petroleum Products sections. http://www.eia.gov/energyexplained/index.cfm
September 12 Tuesday ***Class 5***	Petroleum overview; CAFE standards; Light duty vehicles: Design and other factors affecting efficiency, power, and energy requirements *Reading* • Richard P. Larrick and Jack B. Soll (2008). The MPG Illusion. Science 320(5883):1593-1594. http://science.sciencemag.org/content/320/5883/1593.full • Chapter 4 (Road Vehicle Technology) from: Andreas Schäfer, John B. Heywood, Henry D. Jacoby, Ian A. Waitz (2009). Transportation in a Climate-Constrained World. Cambridge, MA: MIT Press.

September 14 Thursday ***Class 6***	Light duty vehicles: Design and other factors affecting efficiency, power, and energy requirements *Reading* • Chapter 4 (Road Vehicle Technology) from: Andreas Schäfer, John B. Heywood, Henry D. Jacoby, Ian A. Waitz (2009). Transportation in a Climate-Constrained World. Cambridge, MA: MIT Press. • John Heywood and Don MacKenzie (Editors) (2015). On the Road toward 2050: Potential for Substantial Reductions in Light-Duty Vehicle Energy Use and Greenhouse Gas Emissions. MIT Energy Initiative Report. Cambridge, MA: Massachusetts Institute of Technology. http://energy.mit.edu/publication/on-the-road-toward-2050/
September 19 Tuesday ***Class 7***	Light duty vehicles: Otto and Diesel Cycles, improving ICEs, limits to conventional vehicle design *Reading* • John Heywood and Don MacKenzie (Editors) (2015). On the Road toward 2050: Potential for Substantial Reductions in Light-Duty Vehicle Energy Use and Greenhouse Gas Emissions. MIT Energy Initiative Report. Cambridge, MA: Massachusetts Institute of Technology. http://energy.mit.edu/publication/on-the-road-toward-2050/
September 21 Thursday ***Class 8***	Light duty vehicles: Otto and Diesel Cycles, improving ICEs, limits to conventional vehicle design (continued) **Suggested Group Presentation Topic: Diesel for LDV passenger transportation** *Reading* • John Heywood and Don MacKenzie (Editors) (2015). On the Road toward 2050: Potential for Substantial Reductions in Light-Duty Vehicle Energy Use and Greenhouse Gas Emissions. MIT Energy Initiative Report. Cambridge, MA: Massachusetts Institute of Technology. http://energy.mit.edu/publication/on-the-road-toward-2050/
September 26 Tuesday ***Class 9***	Light duty vehicles: Otto and Diesel Cycles, improving ICEs, limits to conventional vehicle design (finish); Light duty vehicle electric powertrains: Hybrid and plug-in electric vehicles *Reading* • International Energy Agency (2017). Global EV outlook 2017: Two million and counting. Paris: IEA Publications. https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

September 28 Thursday	Light duty vehicle electric powertrains: Hybrid and plug-in electric vehicles (continued)
Class 10	**Suggested Group Presentation Topic: Solid-state EV batteries** *Reading* • Chapters 2 (Plug-In Electric Vehicles and Charging Technologies), 5 (Charging Infrastructure for Plug-In Electric Vehicles), and 6 (Implications of Plug-In Electric Vehicles for the Electricity Sector) from: National Research Council (2015). Overcoming Barriers to Deployment of Plug-in Electric Vehicles. Committee on Overcoming Barriers to Electric-Vehicle Deployment; Board on Energy and Environmental Systems; Division on Engineering and Physical Sciences; Transportation Research Board; National Research Council. Washington, DC: The National Academies Press. http://www.nap.edu/catalog/21725/overcoming-barriers-to-deployment-of-plug-in-electric-vehicles
October 03 Tuesday	Light duty vehicle electric powertrains: Hybrid and plug-in electric vehicles (continued)
Class 11	**Suggested Group Presentation Topic: EV Charging Infrastructure** *Reading* • Chapters 2 (Plug-In Electric Vehicles and Charging Technologies), 5 (Charging Infrastructure for Plug-In Electric Vehicles), and 6 (Implications of Plug-In Electric Vehicles for the Electricity Sector) from: National Research Council (2015). Overcoming Barriers to Deployment of Plug-in Electric Vehicles. Committee on Overcoming Barriers to Electric-Vehicle Deployment; Board on Energy and Environmental Systems; Division on Engineering and Physical Sciences; Transportation Research Board; National Research Council. Washington, DC: The National Academies Press. http://www.nap.edu/catalog/21725/overcoming-barriers-to-deployment-of-plug-in-electric-vehicles
October 05 Thursday ***Class 12***	Emerging transportation energy pathways: First-generation biofuels *Reading* • Dennis Keeney (2008). Ethanol USA. Environmental Science & Technology 43(1):8-11. http://pubs.acs.org/doi/abs/10.1021/es8016182 • International Energy Agency (2011). Technology roadmap: Biofuels for transport. (Focus on pages 5 to 20 and 25 to 34.) http://www.iea.org/publications/freepublications/publication/biofuels_roadmap_web.pdf
October 10 Tuesday	Fall Break (no class)

October 12 Thursday ***Class 13***	Emerging transportation energy pathways: Second-generation biofuels **Suggested Group Presentation Topic: Algal biofuels** *Reading* • John R. Regalbuto (2009). Cellulosic Biofuels—Got Gasoline? Science 325 (5942): 822-824. http://science.sciencemag.org/content/325/5942/822.full • John Ohlrogge, Doug Allen, Bill Berguson, Dean DellaPenna, Yair Shachar-Hill, and Sten Stymne (2009). Driving on Biomass. Science 324 (5930):1019-1020. http://science.sciencemag.org/content/324/5930/1019.full
October 17 Tuesday ***Class 14***	Emerging transportation energy pathways: Hydrogen, fuel cell vehicles, and other alternative fuels **Suggested Group Presentation Topic: Fuel cells** **Suggested Group Presentation Topic: Coal to liquid fuels** **Suggested Group Presentation Topic: Natural gas as a transportation fuel** *Reading* • International Energy Agency (2015). Technology roadmap: Hydrogen and fuel cells. http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapHydrogenandFuelCells.pdf • Robert F. Service (2014). Stepping on the Gas. Science 346(6209): 538-541. DOI: 10.1126/science.346.6209.538. http://science.sciencemag.org/content/346/6209/538.full
October 19 Thursday ***Class 15***	Urban design: Mobility, behavior, zoning, and sprawl *Reading* • Todd Litman (2017). Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior. Victoria Transport Policy Institute. http://www.vtpi.org/landtravel.pdf

October 24 Tuesday

Class 16

Urban design: Urban form, alternatives to sprawl

Suggested Group Presentation Topic: Transit Oriented Design

Reading

- Erick Guerra and Robert Cervero (2012). Transit and the "D" word. Access 40 (Spring 2012). http://www.accessmagazine.org/wp-content/uploads/sites/7/2016/01/access40_transitanddensity-1.pdf
- APTA. TOD 101: Creating Livable Communities with Transit. American Public Transportation Association. http://www.apta.com/resources/hottopics/sustainability/Documents/TOD-101-Creating-Livable-Communities-With-Transit.pdf
- Mark R. Stevens (2017). Does Compact Development Make People Drive Less? Journal of the American Planning Association, 83(1):7-18, DOI:10.1080/01944363.2016.1240044? http://www.tandfonline.com/doi/full/10.1080/01944363.2016.1240044
- The Economist (2017). How not to create traffic jams pollution and urban sprawl. The Economist, 8 April 2017. https://www.economist.com/news/briefing/21720269-dont-let-people-park-free-how-not-create-traffic-jams-pollution-and-urban-sprawl

October 26 Thursday

Class 17

Urban design: Sustainable planning paradigm, Durham biking case study

Suggested Group Presentation Topic: Curitiba, Brazil

Suggested Group Presentation Topic: Two- and Three-Wheeled Vehicles

Suggested Group Presentation Topic: Biking

Reading

- Selections from Chapter 5 (The Urban Transportation Planning Process by Robert A. Johnson, pp. 115-134 only) from: Susan Hanson and Genevieve Giuliano (eds.) (2004). The Geography of Urban Transportation (Third Edition). NY: The Guilford Press.
- Wendy Graber (2016). Bicycling as an Alternative Mode of Transportation: Durham, NC. Duke University, Nicholas School of the Environment.

October 31 Tuesday ***Class 18***	Urban design: Alternative modes, public transit **Suggested Group Presentation Topic: Bus Rapid Transit** **Suggested Group Presentation Topic: High-speed Rail (including Maglev)** **Suggested Group Presentation Topic: Hyperloop** *Reading* • David A. King (2014). 3 Big Challenges for Planning Multi-Modal Cities: It's just not as simple as "stop prioritizing cars." CITYLAB, 9 October 2014. https://www.citylab.com/design/2014/10/3-big-challenges-for-planning-multi-modal-cities/381254/ • Steven Polzin (2016). Public Transportation Ridership: Three Steps Forward, Two Steps Back? Recent data showing declining transit ridership is only the latest news to cast doubt on expectations of a public transit renaissance. Planetizen, 12 April 2016. https://www.planetizen.com/node/85595/public-transportation-ridership-three-steps-forward-two-steps-back
November 02 Thursday ***Class 19***	Urban design: Critique of design strategies; The future of personal mobility: Intelligent transportation systems, Autonomous vehicles **Suggested Group Presentation Topic: Autonomous Vehicles** *Reading* • Randal O'Toole (2009). The Myth of the Compact City: Why Compact Development Is Not the Way to Reduce Carbon Dioxide Emissions. CATO Institute. Policy Analysis No. 653. https://www.cato.org/publications/policy-analysis/myth-compact-city-why-compact-development-is-not-way-reduce-carbon-dioxide-emissions

November 07 Tuesday ***Class 20***	The future of personal mobility: Intelligent transportation systems, Autonomous vehicles **Suggested Group Presentation Topic: Use of social media in transportation** **Suggested Group Presentation Topic: Congestion pricing** **Suggested Group Presentation Topic: Ridesourcing (e.g., Uber, Lyft)** **Suggested Group Presentation Topic: Telework** *Reading* • Lew Fulton, Jacob Mason, and Dominique Meroux (2017). Three Revolutions in Urban Transportation. New York: Institute for Transportation and Development Policy and The University of California Davis Institute of Transportation Studies. https://www.itdp.org/3rs-in-urban-transport/ • Scott Corwin, et al. (2015). The future of mobility: How transportation technology and social trends are creating a new business ecosystem. Deloitte University Press. http://www2.deloitte.com/content/dam/Deloitte/ru/Documents/manufacturing/dup-future-of-mobility.pdf • Zia Wadud and Jillian Anable (2016). Automated Vehicles: Automatically Low Carbon? London: Institution of Mechanical Engineers. https://www.imeche.org/policy-and-press/reports/detail/automated-vehicles-automatically-low-carbon • Jeffery B. Greenblatt and Samveg Saxena (2015). Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. Nature Climate Change 5: 860-863, doi:10.1038/nclimate2685 http://www.nature.com/nclimate/journal/v5/n9/full/nclimate2685.html
November 09 Thursday ***Class 21***	Air travel **Suggested Group Presentation Topic: Aviation biofuels** *Reading* • Andreas W. Schäfer, Antony D. Evans, Tom G. Reynolds, and Lynnette Dray (2015). Costs of Mitigating CO2 Emissions from Passenger Aircraft. Nature Climate Change 6:412-417, doi:10.1038/nclimate2865 http://www.nature.com/nclimate/journal/v6/n4/full/nclimate2865.html

November 14 Tuesday ***Class 22***	Transportation Life Cycle Assessment and the GREET model; Moving things: Freight vehicle and logistics design **Suggested Group Presentation Topic: Transportation Energy Use Along Global Supply Chains** **Suggested Group Presentation Topic: Walmart's Supply Chain Energy and GHG Reduction Efforts** *Reading* • Mikhail V. Chester and Arpad Horvath (2009). Environmental assessment of passenger transportation should include infrastructure and supply chains. Environ. Res. Lett. 4 (2009) 024008 (8pp), doi:10.1088/1748-9326/4/2/024008 http://iopscience.iop.org/1748-9326/4/2/024008/ • "How We Move Things" (pp. 46-82) from: US Department of Transportation (2015). Beyond traffic 2045: Trends and choices. https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf • Carrie Denning and Camille Kustin (2015). The Good Haul: Innovations That Improve Freight Transportation and Protect the Environment. New York: Environmental Defense Fund. http://www.edf.org/sites/default/files/10881_EDF_report_TheGoodHaul.pdf
November 16 Thursday ***Class 23***	Moving things: Freight vehicle and logistics design (continued) **Suggested Group Presentation Topic: Next Generation HDVs** **Suggested Group Presentation Topic: Next Generation Locomotives** **Suggested Group Presentation Topic: Drones for Package Delivery** Related environmental and health issues; Climate impacts on transportation; Lifecycle assessment of transportation options *Reading* • P. van Loon, A.C. McKinnon, L. Deketele, and J. Dewaele (2014). The Growth of Online Retailing: A Review of its Carbon Impacts. Journal of Carbon Management 5(3):285-292, DOI:10.1080/17583004.2014.982395 http://www.tandfonline.com/doi/full/10.1080/17583004.2014.982395 • Julia B. Edwards and Alan C McKinnon (2009). Shopping trip or home delivery: Which has the smaller carbon footprint? http://www.greenlogistics.org/SiteResources/343c5312-af8f-4cc0-a271-4191cb2ccdff_Edwards-McKinnon-ShoppingTripOrHomeDelivery-FocusLogisticsJuly2009.pdf

November 21 Tuesday ***Class 24***	Wrap up: Other environmental impacts of transportation; Climate impact on transportation; Transportation policy revisited **Suggested Group Presentation Topic: CA Low Carbon Fuel Standard** *Reading* • Chapter 6 (Policies for Reducing GHG Emissions from and Petroleum Use by Light-Duty Vehicles, pp. 131-151) from: National Research Council (2013). Transitions to Alternative Vehicles and Fuels. Committee on Transitions to Alternative Vehicles and Fuels; Board on Energy and Environmental Systems; Division on Engineering and Physical Sciences; National Research Council. Washington, DC: National Academies Press. https://www.nap.edu/catalog/18264/transitions-to-alternative-vehicles-and-fuels • David Levinson (2015). Rethinking American Transportation: U.S. transportation policy needs to be brought into the 21st century. National Review, 19 November 2015. http://www.nationalreview.com/article/427228/rethinking-american-transportation-david-levinson • Chapters 3 (Impacts of Climate Change on Transportation) and 5 (Meeting the Challenges) from: National Research Council (2008). Potential impacts of climate change on U.S. transportation. Washington DC: Committee on Climate Change and U.S. Transportation, Transportation Research Board and Division on Earth and Life Studies, National Research Council of the National Academies. http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf
November 23 Thursday	Thanksgiving (no class)
November 28 Tuesday ***Class 25***	Project Presentations
November 30 Thursday ***Class 26***	*Last class session* Project Presentations
December 04 Monday	Project write-ups due by 5:00pm