Transportation and Energy

ENVIRON 630 (ENERGY 630)

Duke University—Nicholas School of the Environment
Fall 2015

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

Instructor
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Office hours Wed. 1:00 to 3:00, or by appointment

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Office hours Mon. 2:00 to 3:00 and Wed. 3:00 to 4:00

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.

In this class, we will focus on an important piece of this problem by examining transportation-related energy use and its impact on the environment. We will touch on related human health and social concerns, but largely through their connection to energy and GHG emission reduction strategies. The following questions frame the course:

• How much energy does it take to move ourselves and our stuff around?
• How have these trends changed over time and how do they vary across the globe?
• What cultural, social, and technological factors shape these trends?
• In what ways is our transportation energy use unsustainable?
• What can we do about it?

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.

Course Format
We will use class time for discussion of the readings and material introduced in class, as well as student-led presentations of chosen transportation-related topics. A few practitioners will also make appearances as guest speakers. 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: 40% (6 assignments)
Group Presentations: 10% (all group members receive the same grade)
Team Project: 40% (all group members receive the same grade)
Class Participation: 5%
Reading Summaries: 5%

I will use the following rubric to translate cumulate scores into final grades:
[99 to 100] A+
[93 to 99) A
[90 to 93) A-
[87 to 90) B+
[83 to 87) B
[80 to 83) B-
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 the assignments 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**

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 percent 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 after the posted due date will receive a grade of zero. 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 class sessions of the semester, and the project write-ups will be due as announced.

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 exceptions only for serious illnesses and personal emergencies. If you are sick, you will need to complete the Short-Term Illness Notification Form (STINF) at: [http://trinity.duke.edu/academic-requirements?p=policy-short-term-illness-notification](http://trinity.duke.edu/academic-requirements?p=policy-short-term-illness-notification). The website provides instructions, but note the following text:

“Definition of Incapacitation:
An incapacitating illness or injury is one in which a student is 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**


Additional readings are available on Sakai or via web links to public documents and information resources.

The schedule below lists reading assignments, which must be completed prior to each day’s class (see the note above under Coursework and Grading). “Optional” readings provide further background, but are not required. I may assign additional readings based on your interest in particular 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 should have complete access to our Sakai website. All course materials, including assignments and readings, are available on Sakai.

**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 arrive prepared, having completed the readings and other assignments. Please be on time and refrain from checking email, texting, and websurfing while we are together. 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, feedback is appreciated. 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](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.

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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Readings</th>
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<td><strong>Tuesday</strong></td>
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<tr>
<td><strong>Class 1</strong></td>
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<tr>
<td><strong>Thursday</strong></td>
<td><strong>Transportation demand: Factors affecting activity and preferences</strong></td>
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<td><strong>Class 2</strong></td>
<td><strong>Introduce group presentations</strong></td>
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September 1  
Tuesday

Class 3

Transportation trends: historical perspectives and current issues
Introduce projects

Readings


September 3  
Thursday

Class 4

Technology change; CAFE standards; brief petroleum overview; energy security

Readings

- Selections from Chapter 5 (Aligning Big Oil with the Public Interest, pp.113-140 only), from: Daniel Sperling and Deborah Gordon (2009). Two Billion Cars: Driving Toward Sustainability. NY: Oxford University Press.

September 8  
Tuesday

Class 5

Light duty vehicles: Design and other factors affecting efficiency, power, and energy requirements

Readings

<table>
<thead>
<tr>
<th>Date</th>
<th>Class</th>
<th>Reading Information</th>
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</table>
| **September 10** | 6      | **Suggested Group Presentation Topic:** Diesel for LDV passenger transportation  
**Readings**  
| **September 15** | 7      | Light duty vehicles: Otto and Diesel Cycles, improving ICEs, limits to conventional vehicle design (continued)  
**Readings**  
- See September 10  
| **September 17** | 8      | Guest Speaker: Josiah Knight, Associate Professor of Mechanical Engineering and Materials Science, Pratt School of Engineering  
**Readings**  
- tba |
**September 22 Tuesday**

**Class 9**

Light duty vehicle electric powertrains: Hybrid and plug-in electric vehicles

**Suggested Group Presentation Topic: Batteries**

**Readings**


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**September 24 Thursday**

**Class 10**

Light duty vehicle electric powertrains: Plug-in electric and fuel cell vehicles; Hydrogen

**Suggested Group Presentation Topic: Fuel cells**

**Readings**


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<tr>
<th>September 29</th>
<th>Emerging transportation energy pathways: First-generation biofuels</th>
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<tbody>
<tr>
<td>Tuesday</td>
<td><strong>Class 11</strong></td>
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<td>Readings</td>
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<table>
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<tr>
<th>October 1</th>
<th>Emerging transportation energy pathways: Second-generation biofuels; Other alternative fuels</th>
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<tbody>
<tr>
<td>Thursday</td>
<td><strong>Class 12</strong></td>
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<tr>
<td></td>
<td>Suggested Group Presentation Topic: Algal biofuels</td>
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<td>Readings</td>
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</table>
**October 6 Tuesday**

**Class 13**

Urban design: Compact growth, transit oriented development, and vehicles miles traveled

**Suggested Group Presentation Topic:** Transit Oriented Development

**Readings**


**October 8 Thursday**

**Class 14**

Urban design: Compact growth, transit oriented development, and vehicles miles traveled (continued)

**Suggested Group Presentation Topic:** Bus Rapid Transit

**Readings**


**October 13 Tuesday**

Fall Break (no class)
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<thead>
<tr>
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<th>Thursday</th>
<th>Class</th>
<th>Topic</th>
<th>Suggested Group Presentation Topic</th>
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<tr>
<td>October 15</td>
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<td>Alternative modes of personal transportation: Biking, walking, telework, carpooling</td>
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<td><strong>Suggested Group Presentation Topic:</strong> Biking</td>
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<td><strong>Suggested Group Presentation Topic:</strong> Telework</td>
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<td><strong>Suggested Group Presentation Topic:</strong> Use of social media in transportation</td>
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<td>October 5</td>
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<td><strong>Readings</strong></td>
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<tr>
<td>October 20</td>
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<td>16</td>
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<td>Guest Speaker: John Hodges-Copple, Regional Planning Director, Triangle J Council of Governments</td>
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<td>October 2</td>
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<td>Transportation and land use; The transportation planning process</td>
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<td><strong>Readings</strong></td>
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<tr>
<td>October 22</td>
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<td>17</td>
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<td>Intelligent Transportation Systems; Pricing; Autonomous Vehicles</td>
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<td>October 2</td>
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<td><strong>Suggested Group Presentation Topic:</strong> Congestion pricing</td>
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<td><strong>Suggested Group Presentation Topic:</strong> Personal autonomous vehicles</td>
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<td><strong>Readings</strong></td>
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### October 27  <br>**Tuesday**  
**Class 18**  
**Preliminary project presentations**  
**Air travel**  
**Readings**  

### October 29  <br>**Thursday**  
**Class 19**  
**Air travel**  
**Suggested Group Presentation Topic: Aviation biofuels**  
**Readings**  


### November 3  <br>**Tuesday**  
**Class 20**  
**Moving things: Global and US freight movement; Supply chain design**  
**Suggested Group Presentation Topic: Transportation energy use along global supply chains**  
**Readings**  


November 5
Thursday
Class 21

Moving things: Freight vehicle and logistics design

**Suggested Group Presentation Topic:** Next generation HDVs

**Suggested Group Presentation Topic:** Next generation locomotives

**Readings**


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<th>November 10 Tuesday</th>
<th>Related environmental and health issues; Climate impacts on transportation; Lifecycle assessment of transportation options</th>
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<tr>
<td>Class 22</td>
<td>Readings</td>
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### November 12

**Class 23**

Transportation Policy

**Suggested Group Presentation Topic:** CA Low Carbon Fuel Standard

**Readings**


### November 17

**Class 24**

Transportation Policy and Course Wrap-up

### November 19

**Class 25**

Project Presentations

### November 24

**Class 26**

Project Presentations

### November 26

Thanksgiving (no class)