Sustainable Energy Systems

PLAN/ENEC/ENVR 584 – Fall 2021

Professor: Dr. Noah Kittner (he/him), [kittner@unc.edu](mailto:kittner@unc.edu)

**Course Description**: Energy is critically important to society because it enables healthy and prosperous communities. This course will provide an introduction to urgent topics related to energy, sustainability, and the environment. The course material will focus on new technologies, policies, and plans in cities and different governing bodies in the energy system with a focus on developing tools to analyze energy for its sustainability, impact on people, the environment, and the economy. Topics range from investigating energy at different scales and considering how national, state-level, and municipal policies affect local energy generation and consumption. Much of the course will cover emerging renewable energy technologies including the smart grid, demand-response programs, energy efficiency options and how they help achieve climate and sustainability goals.

Dr. Kittner’s Office: 157 Rosenau Hall, **virtual office by Zoom during pandemic (**<https://uncsph.zoom.us/j/8475709857>)

Office Hours: Thursdays 9:30-10:30 AM or by appointment

Class time: Mondays & Wednesdays 11:15-12:30 PM

Location: Philips 256 & Zoom

TA: Julia Prieto [juliamp@live.unc.edu](mailto:juliamp@live.unc.edu) , available by appointment

**Community Standards and Mask Use On Campus**: This semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community – your classmates and me – as we learn together. If you choose not to wear a mask, or wear it improperly, , I will ask you to leave immediately, and I will submit a report to the [Office of Student Conduct](https://cm.maxient.com/reportingform.php?UNCChapelHill&layout_id=23). At that point you will be disenrolled from this course for the protection of our educational community. Students who have an authorized accommodation from Accessibility Resources and Services (ARS) have an exception. For additional information, see [Carolina Together](https://carolinatogether.unc.edu/university-guidelines-for-facemasks/).

**Participation and discussion** during the synchronous classroom will be important to succeed in this class. Overall, expect to devote 9-12 hours of work per week for this course including synchronous/asynchronous assignments and components posted on Sakai.

**Communication Protocol**: Please use PLAN/ENEC/ENVR 584 in subject line of email regarding course. For logistical questions on the course, please also CC our TA, Julia Prieto.

**Course Goals**:

After taking this course, you should begin to understand in energy issues with both a quantitative and a qualitative emphasis. You will be able to analyze energy units, develop and defend energy costs, and assess environmental impacts. You will gain a basic understanding of the transition to more sustainable electricity infrastructure in the United States and globally and how policies and plans influence sustainability.

**References and Books**:

There are no required textbooks for the course, however, there are some key references that will come in handy. Required readings will be posted in the Sakai site for reference.

Sustainable Energy Without the Hot Air by David Mackay (particularly Ch. 2, 18, 19, 20-26, 29)

Short Circuiting Policy by Leah Stokes

Power Loss by Richard Hirsh

**UNC Honor Code**

All students are expected to follow the guidelines of the UNC honor code. In particular, students are expected to refrain from “lying, cheating, or stealing” in the academic context. If you are unsure about which actions violate that honor code, please see me or consult [honor.unc.edu](https://studentconduct.unc.edu/).

**Accessibility Resources**

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in difficulties with accessing learning opportunities.

All accommodations are coordinated through the Accessibility Resources and Service Office. See the ARS Website for contact information: <https://ars.unc.edu> or email [ars@unc.edu](mailto:ars@unc.edu).

Relevant policy documents as they relate to registration and accommodations determinations and the student registration form are available on the [ARS website under the About ARS tab](https://ars.unc.edu/about-ars/policies).

**Discrimination**

*Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison –*[*Adrienne.allison@unc.edu*](mailto:Adrienne.allison@unc.edu)*), Report and Response Coordinators in the Equal Opportunity and Compliance Office (*[*reportandresponse@unc.edu*](mailto:reportandresponse@unc.edu)*), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (*[*gvsc@unc.edu*](mailto:gvsc@unc.edu)*; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.*

**The Learning Center:**The UNC Learning Center is a great resource both for students who are struggling in their courses and for those who want to be proactive and develop sound study practices to prevent falling behind. They offer individual consultations, peer tutoring, academic coaching, test prep programming, study skills workshops, and peer study groups. If you think you might benefit from their services, please visit them in SASB North or visit their website to set up an appointment: <http://learningcenter.unc.edu>.

**The Writing Center:**The Writing Center is located in the Student and Academic Services Building and offers personalized writing consultations as well as a variety of other resources. This could be a wonderful resource to help with your writing assignments in this course (and any assignments in your other courses). You do not need a complete draft of your assignment to visit; they can help you at any stage! You can chat with someone in the writing center or set up as appointment on their website: <http://writingcenter.unc.edu>.

**Assignments**

There will be discussion and debates on contemporary energy plans and projects. These assignments will be detailed on Sakai and students will sign up for different debate teams.

**Schedule**

**Week 1** (8/18)

Introduction to course logistics, group discussion on energy

*What are units of energy?*

-Introduction to energy, basic nomenclature, units of energy

-Energy vs. Power

Readings: *The Road Not Taken*, Lovins 1976; *Azevedo* 2020 Decarbonization

On Sakai: HW 1

**Week 2** (8/23, 8/25)

*How did our energy system get to where it is today?*

Soft vs. hard energy paths

Existing and historical energy use: Intro to fossil fuels

Sankey Diagram LLNL Energy/Electricity for US

Readings: Master’s Energy Fundamentals

Combustion

Pacala and Socolow - Stabilization Wedges

**HW 1 Due**

**Week 3** (8/30, 9/1)

*What are the economics of a sustainable energy transition?*

Economics and social perspectives of electricity generation, transmission, distribution

Grid integration challenges

Reading: Master’s Transmission and Distribution (Losses) Economics

**Week 5** (9/6, 9/8)

*Can we live on renewables?*

Emerging Technologies: Solar PV and Wind (Lec 1)

**HW 2 Due**

**Week 6** (9/13, 9/15)

*How can we balance the intermittency of solar and wind?*

Emerging Technologies: Solar PV and Wind (Lec 2)

Intermittency Challenges

Reliability

**Week 7** (9/20, 9/22)

*Is energy storage the answer to balancing renewable energy?*

Emerging Technologies: Energy Storage

Readings:

DOE Grid Storage Report

Bistline 2020

Schmidt et al. 2017 Future cost of electrical energy storage

Kittner et al. 2017 Energy storage

**HW 3 Due**

*What can humans do to enable sustainable energy systems?*

Smart Grid, Energy Efficiency, Demand Response: The Behavior Challenge

Attari et al 2010

Wilson & Dowlatabadi, 2007

Rebound Effect

**Week 8** (9/27, 9/29)

*Does scale matter?*

From the bottom-up: Micro-grids and distributed energy resources

Guest lecture: Deborah Sunter, Expert on urban energy systems

Readings: City-integrated renewable energy

**HW 4 Due**

**Week 9** (10/4, 10/6)

*What can communities and small groups do to enable more sustainable energy?*

Community-based energy systems and planning approaches

Reading: GridShare in Bhutan

**Week 10** (10/11, 10/13)

*What planning and policy tools are available for the energy system?*

Energy Planning and Policy

**HW 5 Due**

**Week 11** (10/18, 10/20)

*Who benefits from the energy system and who bears the costs?*

Energy Poverty and Environmental Justice (Concepts and U.S. context)

Google Project Sunroof Dataset

Sunter, D. A., Castellanos, S., & Kammen, D. M. (2019). Disparities in rooftop photovoltaics deployment in the United States by race and ethnicity. *Nature Sustainability*, *2*(1), 71-76.

Carley and Koniskey

Nussbaumer, P., Bazilian, M., & Modi, V. (2012). Measuring energy poverty: Focusing on what matters. *Renewable and Sustainable Energy Reviews*, *16*(1), 231-243.

**Week 12** (10/25, 10/27)

*What are the justice implications of a clean energy transition?*

Energy Poverty and Environmental Justice (fossil fuel extraction and energy supply chains)

Bednar, D. J., & Reames, T. G. (2020). Recognition of and response to energy poverty in the United States. *Nature Energy*, 1-8.

H. Cooley and C. Donelly (2012) *Hydraulic Fracturing: Separating the Frack from the Fiction* (The Pacific Instiute).

**Week 13** (11/1, 11/3)

*What can we accomplish with markets and technology?*

*What can we accomplish with policy and planning?*

Grid Integration of Renewable Energy

**Week 14** (11/8, 11/10)

*How does energy fit into the broader decarbonization debate?*

Low-carbon society

-Decarbonization debate (Teams to be formed after Week 12)

**Policy Brief**

**Final Exam**

**Grading Policy**

**Sakai participation – Response to Articles and Discussions**

**20%**

**Homework (5 Problem Sets)**

**20%**

**Midterm**

**15%**

**Policy Brief**

**10%**

**Energy Debate**

**15%**

**Final Exam**

**20%**

**Late Assignments**: All late assignments will be subjected to a 20% penalty if turned in one-day late. If assignments are turned more than 24 hours late, they will be subjected to a 50% penalty. No credit for assignments more than two weeks late will be given.

**Extra Credit (up to 5%):**

Students may attend Energy and Climate related Professional Webinars and Write 2-page op-ed pieces with evidence and back-of-the-envelope calculations for extra credit. These are professional webinars that can be posted in Sakai, or if you find one on your own, that could count as well with permission of the TA/Professor. An extra credit response is graded. Each Professional Webinar response can count as 1% of your final grade, depending on the quality of the write-up and following the rubric. The total number of conference reports can add up to 5% of your final grade (so essentially you can do this a maximum of five times during the semester).