General Course Information:

ELEN E6906, Topics Course, FUTURE ENERGY: ECONOMICS, SYSTEMS, POLICIES

Instructor Information

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Course Description  Climate change is bringing, and will continue to bring for the foreseeable future, profound changes to our approach to energy, including production, consumption, public policies and engineering systems to enable the changes. The goal of this course is to provide a holistic view of these changes from the combined perspectives of economics, science and engineering, and public policy.

We will begin by reviewing the first four chapters of D.S. Kirsch and G. Strabac’s “Fundamentals of Power System Economics”, 2nd edition (“Introduction”, “Basic Concepts from Economics”, “Markets for Electrical Energy”, “Participation in Markets for Electrical Energy”). We will largely bypass electricity markets and related optimizations, which are covered well in texts and other courses.

We will study the science, economics and policy implications of climate change, including related models. Since much is work in progress, we will attempt to present both sides of arguments, e.g., the “Dismal Theorem” and the counterargument. We will proceed to understand the basics of all the major renewable energy sources, and understand the consequences of their variabilities on applications and prices. We will get an understanding of the challenges faced by regulators from the coexistence of grid and renewables’ power, and their various approaches from around the globe. We will examine the challenges to systems from significant wind and solar penetrations, the necessary role for storage systems, various approaches for sharing stored energy, the role of transmission networks, energy system expansion design.

Reading, discussing and researching the contents of the papers listed below will be central to the course. Students will take turns at presenting the papers, and leading class discussions.

Course Prerequisite  Students must have either taken ELEN 6767, “Internet Economics, Engineering and the Implications for Society”, or have good understanding of the following economic concepts: social welfare maximization; elasticity; competitive, oligopoly, monopoly markets; subadditivity in cost functions with large fixed cost; first and second best pricing; average cost pricing; Cournot & Bertrand pricing; Ramsey pricing; Price of Anarchy; Pigovian taxes; Coasian bargaining; externalities.
Course requirements: Active participation; homework; two papers; project with oral presentation.

Grading policy:
35% active participation
15% homework
15% mid-term paper
15% project and oral presentation
20% final exam paper

Themes & Reading:

   (i) Fundamentals of Renewable Energy
   Basic characteristics of biomass, hydropower, wind, solar, geothermal energy sources; intermittency and environmental externalities; policies for renewable energy transition.


   M. Roser, “Why did renewables become so cheap so fast?”
   https://ourworldindata.org/cheap-renewables-growth

   (ii) Social Costs of Various Energy Sources


   (iii) Status, Prospects of Renewable Energy


2. Climate Change: Science, Economics, Policies

   (i) Models for Estimating the Social Cost of Carbon


(ii) “Dismal Theorem” and Counterargument


http://www.nber.org/papers/w16353

(iii) Policy Implications

https://doi.org/10.1016/j.econlet.2021.109955


4. Regulators’ Dilemma
Regulators, notably in California, have the problem of setting prices and subsidies for centralized, stable grid power, which is subject to high sunk and fixed costs, and decentralized, variable power from PV/solar panels, with contrasting societal impacts.


5. Future Energy Systems & Networks

(i) Implications of Significant Wind Generation Penetration


(ii) Role of Storage and Transmission for Renewable Energy Sources


(iii) Tackling Storage Needs for Renewable Energy Sources


(iv) Transmission Systems

Strategies & Brattle Group


(v) Carbon Aware Datacenters


(vi) Energy System Expansion Design Optimization

C. Skar, R. Egging, A. Tomasgard, “The Role of Transmission and Energy Storage for Integrating Large Shares of Renewables in Europe”, International Association for Energy Economics, Q1, 2016


6. Case Studies

University of Texas, Energy Institute, “The Timeline and Events of the February 2021 Texas Electric Grid Blackouts”, 2021