ISE 416 / SSIE 516

Fundamentals of Energy System Analytics

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Fall 2024

Term Paper

Logistics

- Prepare a summary of your research question in a 1-page proposal. The Project proposal is **due on Tuesday November 5th.**
- The **term paper is due by Tuesday December 13th** before 11:59 PM.
- Papers will be prepared by each team.
- Length: about 12-15 pages (single space, 12 point) is the recommended length. ***Do not*** go over 15 pages.
- Each team will summarize their term papers during **brief 20-minute presentations** (15 mins presentation, 5 mins Q&A) along with 2 other teams in one of two 85-minute blocks (3 teams per block) to be scheduled **on December 3rd and December 5th**.
- Your term paper will focus on the specific region you chose for the System Research assignment, and will build on the cumulative knowledge about your system developed through subsequent assignments. The task also challenges you to apply the concepts and methods discussed during lectures and in readings and requires you to "think like a central planner" to both *diagnose* shortcomings in the current regulation and market design in your region and *prescribe* policy reforms to improve the system you studied.
- Note that sample project reports will be made available on Brightspace. Feel free to use it as a resource to learn how to structure research questions. If you use one or more of these summaries to generate ideas for your paper, be sure to site both the student's summary (citation format can be: SR number, as in "Neha Patankar, SR#") and, if relevant, any underlying primary sources cited in the summary.
- Base power system related data for each region including existing generators, potential resources, their cost and technical characteristics projection, load profiles, renewable generation profiles, fuel prices, existing regional policies, and transmission network will be made available via Google Drive. A sample dataset can be found here: https://drive.google.com/drive/folders/1x_H5O2tIi1CKaXd-rdwzVTCWqok_p2Ru?usp=sharing

Term paper task

Your paper should have three components.

First, begin with a *brief*, roughly one-two page, summary of the relevant ***background*** regarding the region you have chosen for the System Research assignments. This should provide the description of the energy sector, how it is structured and how it is transitioning. This includes electricity generation mix, transmission network, major industries, electricity/fuel demand from various sectors.

Second, describe the research question for your region and provide motivation for your choice.

Third, describe the data that you will need to answer your research question and determine the source, resolution and reliability of the data.

Fourth, diagnose the performance, upcoming transition, and shortcomings of the energy system in your region under each of the following four key segments/topics:

1. **Electricity Generation** – This should include existing, planned, and retiring capacity by type
2. **End-use energy demand –** This can include just one or more sectors of your choice. For e.g., electric vehicle demand is increasing in the transportation sector, electricity demand for heating and cooling in the residential sector is increasing.
3. **Transmission network** – You must create at least 2-zone model for your research question and provide details about transmission expansion, cost, congestion pricings
4. **Wholesale electricity generation, system operation and security of supply** - provide wholesale energy prices, revenue generated by different generators, operational details of thermal power plants, reserve requirements.

Fifth, in addition to diagnosing the energy system of your region, ***prescribe and justify two regulatory and/or market reforms*** to better prepare the energy system in your region to decarbonize (reduce CO_2 and other greenhouse gas emissions), during the next decade and beyond, while continuing to ensure reliable, safe, affordable, and universal electricity service.

The overall term paper task basically amounts to reviewing current practices in your chosen region and proposing an ensemble of regulatory measures, covering all major segments of the electricity sector and your chosen end use sector, in order to facilitate a transition to a low-carbon energy system in an efficient, affordable, and reliable manner.

Do not focus on legislative changes. If your region already has a broad climate change, decarbonization, or clean energy legislation, executive order, or policy goal for the electricity sector, briefly describe this policy context. If not, assume that the policy goal is for the power sector to reduce CO_2 emissions 70-80% by 2030 and reach a 100% carbon-free (or net zero emissions) electricity system by 2045. Assume that this policy framework is a given or fixed context.

You may think of yourself as a member of a governmental committee that has the task of proposing modifications to the existing regulatory framework of the electric power and energy sector to facilitate decarbonization goals.

You may also propose reforms to enable efficient utilization of distributed energy resources to reduce system costs, improve quality of service/reliability, and/or reduce greenhouse gas emissions.

Grading rubric

In terms of **grading**, it is obviously important that your diagnosis of current practices and prescribed measures make good regulatory sense. Explain the thinking behind your proposals and the application of sound regulatory and economic principles, as well as a good understanding the underlying engineering constraints and considerations.

Provide **references** to support your opinions where relevant, and cite papers, reports, and other material that you have encountered and are drawing on in your proposals. Give credit where credit is due and avoid any concerns of plagiarism by citing prior work that has informed your thinking! Your proposals do not need to be novel inventions (although this is welcome) and can be application of ideas or concepts proposed or implemented elsewhere. The challenge is for you to consider the many practices available across the world (and in numerous papers and proposals and consultant reports), identify the best solutions, describe (in your own words) why the proposed solutions are appropriate in the context of your specific system, and justify their advantages, while being cognizant of their potential drawbacks, and how these may be mitigated.

For **undergraduates**: 60% of your grade will reflect the diagnosis of the current regulatory/market features in your region, while 40% will reflect the prescribed reforms.

For **graduate students:** 40% of your grade will reflect the diagnosis of the current regulatory/market features in your region, while 60% will reflect the prescribed reforms.

In other words, graduate students' grades will depend more heavily on the proposal and justification of creative regulatory improvements, while undergraduates' grades will depend more heavily on application of concepts and best practices to evaluate the current system of regulation and markets. (Consider allocating your limited pages in rough proportion to the grading emphasis above).