Department of Electrical, Computer, & Energy Engineering
University of Colorado - Boulder
ECEN 5407 – Renewable Energy & the Future Power Grid

Project #2
Designing a 100% Renewable Energy System

Motivation

As we move toward a power grid with increasing levels of variable renewable energy, it is important to consider the design differences between a power system with and without renewable energy. We have spent quite a bit of time this semester understanding the current power system, which was largely designed without wind and solar power in mind. But how would the system look if we were to design it from scratch to supply 100% of demand with renewable energy sources?

Project Teams

This project is to be completed in teams of three or four students. Students will be allowed to choose their team for the project, but a final team list must be submitted by Tuesday October 11th, by email to the instructor and no changes will be allowed after this date. All students in the group will be expected to contribute equally to the project. Team members may specialize in different components of the project, but every team member should be able to speak with confidence about all aspects of the project.

Assignment

You are an engineer in the planning department of a (very) small utility near San Diego, California. Your utility has just announced that it is severing all electrical connections with the rest of the state, and is going to operate its grid with 100% renewable energy by 2025. Your job is to design this system and demonstrate to your company's CEO exactly how the system will operate. From previous interactions, you know that your CEO will ask you for dispatch stacks that demonstrate what generators are providing power at key times during the year. You have been provided with your balancing authority's load from 2012, which has been scaled up to represent expected load growth to 2022 (see file on Canvas). You have access to historical wind and solar data resources in your area (see Suggested Resources), and understand the importance of considering time synchronous wind, solar, and load data. You have free reign to design the system as you would like, and can choose to incorporate other flexibility options, such as demand response, electric vehicles, and storage devices, using your engineering judgement.

Formatting

Your final report should be completed in the IEEE Transactions format, with a maximum page length of 8 (two-columned) pages. You can download a Microsoft Word or LaTeX template at: https://www.ieee.org/publications_standards/publications/authors/author_templates.html .
References should follow the IEEE reference styles indicated in the template. Since you should

be including references in your final report, it is recommended that you utilize a reference management program, such as EndNote, Mendeley, or Zotera.

Important Dates and Submission Procedures

Your project final report will be due at the beginning of class on Thursday, December 8th. Please submit on Canvas before class. In addition, you will be asked to provide a 10-minute presentation on your final design and report in class on either Thursday December 1st or Tuesday December 6th. All group members will be expected to speak for roughly equal periods of time during the presentation, as well as participating in answering follow-up questions. You should create PowerPoint slides for your presentation that show (at a minimum): your generation resource mix by installed capacity, your generation resource mix by annual energy, dispatch stacks from your peak load day and other critical time periods, your plans for providing ancillary services, and the details of any flexibility options which you have included.

Project Grading

Your final project grade will be based on three components: your final report, your project presentation, and your project performance evaluation by the other group members. The final report will account for 60% of the numerical score, the project presentation 30%, and your peer evaluations will account for the final 10%.

Suggested Resources

WIND Toolkit – Wind speed and power timeseries data: http://www.nrel.gov/grid/wind-toolkit.html

NSRDB – Solar irradiance timeseries data: https://nsrdb.nrel.gov/

System Advisor Model (SAM) – useful for converting solar irradiance to solar power through the PVWatts module or CSP modules. Can also convert wind speed to wind power under different turbine technology assumptions. https://sam.nrel.gov/

PVLib: Converts solar irradiance to PV power output: https://pvpmc.sandia.gov/applications/pv_lib-toolbox/

Homer – microgrid modeling software (***warning:*** only a 30 day free trial): http://homerenergy.com/

MATPOWER – MATLAB based powerflow tool: http://www.pserc.cornell.edu/matpower/