# Lab 1: Complex capacity expansion modeling

In this lab session we will work with a full complex capacity expansion model to get a feel for how the model works. We will also explore the sensitivity of results to parameters such as the inclusion of unit commitment constraints. By the end of this lab session, students will be comfortable working with a basic capacity expansion model and will be adequately prepared for HW5.

Please work through the steps below in groups of 2, making sure to discuss as a team when possible.

**Both team members should do these first steps individually on their own computers, to be ready for HW5:**

1. Download and install VSCode, and the Julia extension, if you don't have it already.
2. Download and install the Gurobi solver, making sure to obtain an academic license, if you don't have it already.
3. Test that your Gurobi license is working using these instructions.
4. Install the Gurobi package in Julia by going to the package manager and typing "add Gurobi".

**The remainder of the steps should be done as a team. For the questions which require you to propose changes and analyze results, please type up your responses in a separate document and submit your responses to the Canvas assignment (one per team). Please include the names of all team members on this document.**

1. **Refresh your course repository to the latest version.** Then, open the "Lab1.jl" file in the course repo under Notebooks, and use the code in the file to run the basic capacity expansion model with 10 sample days, **using the Gurobi solver**. You will have to modify the paths to be specific to your computer.
2. As a team, **propose a change** in inputs to the capacity expansion model that you expect will result in some sort of interesting result. What is your hypothesis about what will happen? And what outputs will you look at to examine the results? (Write this down in your separate document.)
3. **Run the model** with this change, and look at the outputs you proposed above. What happened? Is it the same as what you hypothesized or different? Why?
4. The model you just ran does not include unit commitment. **What do you think will happen when you add unit commitment?** How does this relate to what you learned from reading the Poncelet paper? What results will you look at to test your hypothesis?
5. **Run the model with unit commitment** by using the "solve_cap_expansion_uc" function instead of the "solve_cap_expansion" function. Note there is one additional argument for the MIP gap, set this to 0.01. Examine the results as you proposed above. Did what happened match what you expected? Why?

6. The function you just ran used integer variables for unit commitment. **What do you think will happen when you use linearized unit commitment?** What outputs will you look at to test this?
7. **Run the model with linearized unit commitment** by using the "solve_cap_expansion_uc" function, but adding "true" as a final argument after the MIP gap argument to turn the linear relaxation on. Examine the outputs as you proposed above. What happened? How does it compare to what you hypothesized?
8. **(Bonus question if time.)** Play around with tightening/loosening the MIP gap for the integer UC model. How does this affect run time and results?