ECEN 460 Lab 9
Electricity Market Auctions

Objective:

Gain experience and insights on the use of auctions for dispatching electric generation.

Background

This lab explores how auctions are used to dispatch electricity markets. In the lab you will be one of small number of electric generator owners selling electricity into an auction-based market in which there is a single buyer called the Independent System Operator (ISO). Hence this is similar to the auctions run by entities such as ERCOT or MISO. The other generator owners will be your fellow classmates.

The lab is organized into several scenarios, and each scenario consists of a sequence of trading periods where each period is assumed to be one hour. During each period the ISO needs to buy a certain amount of electricity, and you will be responsible for trying to sell electricity from your generation to help meet the ISO's requirements. Each student has an identical generation portfolio of five generators with varying maximum capacities and marginal costs; the total capacity for each student is 100 MW. Your hourly cost to supply electricity from each generator is just its output (in MW) multiplied by its marginal cost (in $/MWh).

During each period you must decide the offer price for each of your generators, and then you will submit these offers to the ISO. Once all the offers have been submitted, the ISO will perform an auction to determine which generators get selected to run, which do not run, and what is the market clearing price (in $/MWh). In this lab the ISO will sequentially buy generation based on the offers, starting with the lowest offer and continuing until its MW load is met. The assumption here is that there are no transmission system constraints so the location of your generators in the grid does not matter. Your goal in this lab is to maximize your profit.

In this lab we will be considering two scenarios for how you get paid for your generation. The first is last accepted offer (LAO) in which the amount you get paid per MW for each of your generators is the value of the LAO. That is, the highest offer that was accepted. This would correspond to the bus locational marginal price (LMP). The second is the pay as offer (PAO) approach in which the amount you get paid per MW is whatever you offer. Your profit is then your income minus your cost. Hence generators that had high offers that were not accepted have no income and no cost, and therefore zero profit.

The only market information you will receive during this lab is 1) at the beginning of each period you will receive the total MW load the ISO must buy for that period, and 2) at the end of the period you will receive the LAO and information about how much of your generation was accepted and information about your profit.

During this lab it is extremely important that you do not talk with any of your fellow market participants about anything related to the electricity market such as your upcoming offers or profit. In an actual electricity market this could be considered illegal collusion!

Procedure for Submitting Offers

1. Open the client program provided by the TA. The display should look as shown in Figure 1. Then enter the IP address and Port Number provided by the TA, enter your name in the Your Name field, and when instructed by the TA click the **Connect to Server** button. This connects your client to the sever, which will function as the ISO. When connected many of the Market Simulation group fields will be filled in with data provided by the server.

Figure 1: Client Form on Startup

2. Once all the students have connected, the TA will start the scenario, which will consist of a series of trading periods. The first scenario will be a short practice game, with three or four trading periods in which all generators that are selected to generate electricity will be paid the $/MWh associated with the last accepted offer (LAO). Note that the last offer accepted is usually only partially accepted since the total of the accepted offers must exactly meet the system load. In the case of identical offers equal to the LAO price (say multiple students submit $30/MWh) the server selects one randomly. Once the TA has started the scenario in the Current Period group you will see the period number and the total Load MW that the ISO needs to procure. The load will vary from period to period. For all periods except the first you will also see results from the last period. These include the Clearing Price ($/MWh), which is the price of the LAO, and your specific results. **You will not see results for the other students, and you should not attempt to obtain this information.** Keep a log of your results for each period. You should then

enter in your five offers into the bold Offer fields. This is shown in Figure 2. Note, for this lab the offers are limited to being between $ 0/MWh and $ 200/MWh.

Figure 2: Client Form Ready to Submit Offers

3. Once you have selected all five of your offers click on the **Submit Offers for Period** button. Once you submit your offers they cannot be changed. To prevent accidental submittals you'll be asked to confirm your offers. After this the **Submit Offers for Period** button will be disabled, and you'll need to wait until all the offers from the other students are submitted. Once they are submitted the TA will move on to the next period.

4. The above process repeats until the end of the practice scenario. At that point the TA will provide an anonymous list of the total profits for all the players, such as writing them on the whiteboard. This will give you a feel for how well you are doing relative to the others in the lab. At this point the TA will stop the server, and setup the next scenario.

5. The next scenario is also one in which all accepted generators are paid the LAO. Except this one will be 15 periods long. In order to create the correct incentives for you to maximize your profit, ideally you would be paid a portion of your profit. However, we cannot do that. Rather, students with high profits for this scenario will be exempt from having to turn in a report for this lab, receiving full credit just for their market performance. However, this threshold will be determined for the class as a whole, so just doing well in your group may not be sufficient. But we do guarantee at least 50% of the students will be exempt one way or another. So consider your strategy as you go through

the trading period! Also be sure to record your results from each period. This will help you both in determining your strategy for future periods and should be included in your lab writeup (if one is required). At the end of this scenario the TA will again provide anonymous profit values so you can again get a feel for how well you are doing, and will again need to stop the server.

6.	The last regular scenario functions similarly to the previous one, except generators are paid based upon what they offer into the market (pay as offer). So if you offer $ 0/MWh for your 50 MW generator, and the LAO is $ 100/MWh, you will be paid zero! Again this scenario will be 15 periods long, and the students with the high profit values will be exempt from doing a lab report (counting as part of the minimum of 50% exempt).

7.	Optionally, as time allows and provided there are sufficient students the TA may run addition 15 period games with one or both of the above scenarios. This is a second change for lab report exemption, and high scores in this round will only increase the number of students receiving exemptions.

Report:

Provide a through summary of your results from both of the two 15 period scenarios. Describe the strategy you used in submitting your offers, and provide a detailed analysis of why you think your strategy did not result in the highest profits.