Problem Set 6: Market Clearing and Settlement

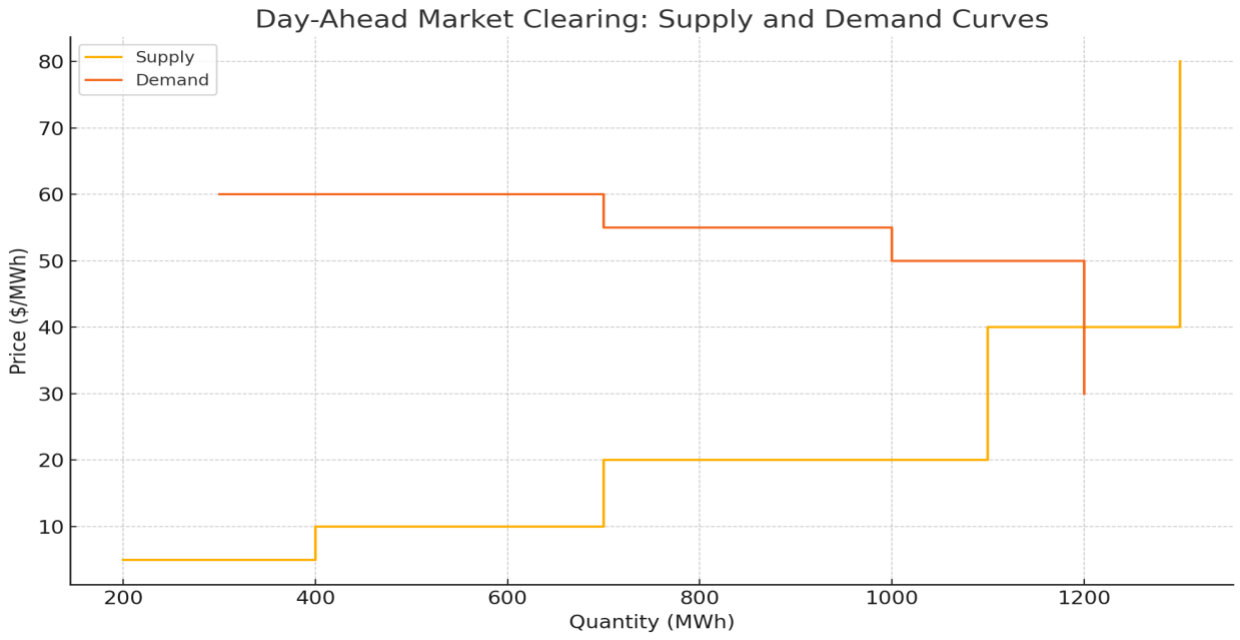
In this problem set, we'll work through some market clearing and settlement calculations. Please put your answers in the spaces provided rather than Excel.

Part 1. Day-ahead Market Clearing and Settlement

An ISO receives the following bid/offer quantities and prices for hour ending (HE) 14:00 in the day-ahead market.

	Bid/offer quantity	Bid/offer price
Supply		
G1	300	$20/MWh
G2	200	$5/MWh
G3	400	$40/MWh
G4	200	$80/MWh
G5	200	$10/MWh
Demand		
L1	300	$50/MWh
L2	200	$30/MWh
L3	400	$55/MWh
L4	300	$60/MWh

1. Draw supply and demand curves for these bids/offers and find the day-ahead market clearing amount and market clearing price. You can either draw by hand or (better) use PowerPoint and paste in your figure.



MCP = $40/MWh

2. Calculate revenues (cleared bid * MCP) and net revenues (cleared bid * MCP – cleared bid * bid price) for each generator

	Cleared Quantity	**Revenues**	**Net Revenues**
G1	300	300 × $40= $12,000	($40- $20) × 300 *=6000*
G2	200	200 × $40 = $8000	$(40-5) × $200= $7000
G3	0	0	0
G4	0	0	0
G5	200	200 × $40 = $8000	(40-10) × $20 = $6000

3. Calculate costs for loads.

	Cleared Quantity(MWh)	**Cost (S)**
L1	300	12,000
L2	200	8,000
L3	400	400 × 40 = $16,000
L4	300	300 × 40 = $12,000

Part 2. Market Clearing and Settlement

4. We're going to look at real-time settlement for three generators and two loads (note: this problem is totally unrelated to Part 1). Let's say the day-ahead market clearing price from HE 14:00 to 15:00 was $30/MWh. In real-time, however, a transmission line goes down and prices spike to an average of $500/MWh from HE 14:00 to 15:00.

Day-ahead settlement will just be DA × DA price MWh. Remember that in a two-settlement system, real-time (RT) settlement will be incremental to day-ahead (DA) settlement, which means that real-time settlement will be (RT MWh – DA MWh) × RT price. Net settlement will be day-ahead settlement + real-time settlement. Calculate day-ahead and real-time settlements in the table below.

	Day-ahead cleared quantity (MWh)	**Real-time cleared quantity (MWh)**	**Day-ahead settlement ($/h)**	**Real-time settlement ($/h)**	**Net settlement ($/h)**
G1	300	200	9000	-50,000	-41,000
G2	300	300	9000	0	9,000
G3	200	300	6000	50,000	56,000
L1	100	110	3000	5000	8,000
L2	200	190	6000	-5000	1,000

Thought question: What does this tell you about real-time market risks?

Real-time markets are volatile and unpredictable. A generator like G1 lost $41,000 simply by under-delivering when prices spiked. Meanwhile, G3 gained $50,000 by over-delivering. Loads like L1 paid more, and L2 saved money just by adjusting 10 MWh. This shows how small deviations can result in large financial impacts when real-time prices deviate dramatically from day-ahead forecasts.

Part 3. Contracts and Markets

5. A buyer (load) and seller (generator) have a 100 MW contract for differences (CfD) in an ISO market. The CfD price ("strike price") is $30/MWh. The ISO market clearing price in a given hour is $50/MWh. In a CfD, if the market price is higher than the strike price the seller pays the buyer the difference. If the market price is lower than the strike price, the buyer pays the seller the difference.

Calculate the payments to and from different parties:

How much ($/h) will the ISO pay the seller (generator)?	$5,000/h
How much ($/h) will the buyer (load) pay the ISO?	$2,000/h
How much ($/h) will the seller (generator) pay the buyer (load)?	$2,000/h
What is the net revenue ($/h) a to the seller (payment from ISO minus payment to buyer)?	$3,000/h
What is the unit revenue ($/MWh) to the seller ($/h net revenue / 100 MW)	$30/MWh
What is the net cost ($/h) to the buyer (payment to ISO plus payment from buyer)?	$3,000/h
What is the unit cost ($/MWh) to the buyer ($/h net revenue / 100 MW)	$30/MWh

(Hint: all of the $/h payments are just MW × $/MWh. Your unit revenue and unit cost should equal the CfD strike price.)

- Even though the market cleared at $50**,** the contract ensures both buyer and seller settle at $30/MWh. That's the beauty of a CfD , it provides price certainty, even in volatile markets**.**