Economics for Wholesale Electricity Markets

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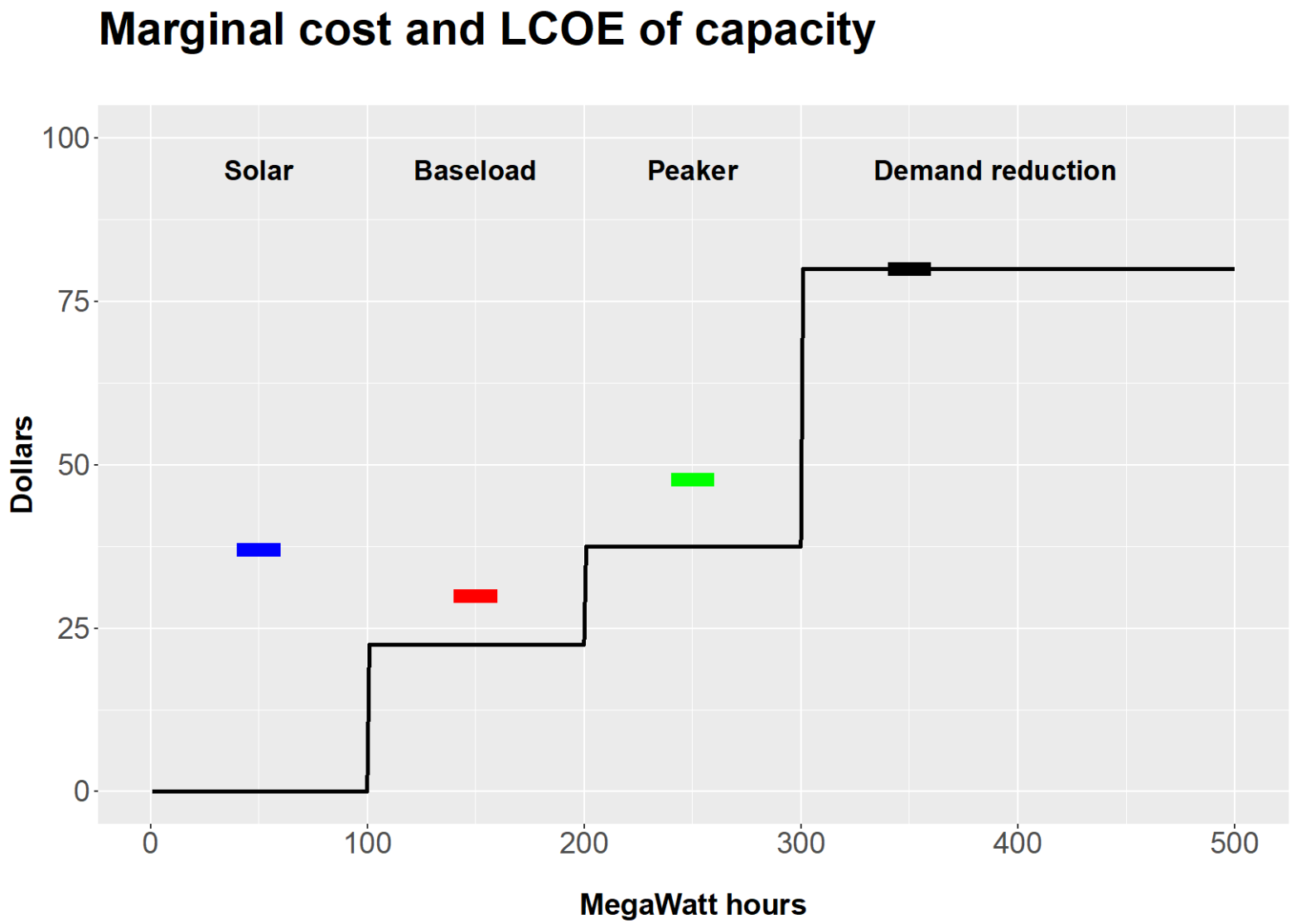
Contracts, Auctions, and Exchanges

Module 6

Objectives

- Explore different ways electricity can be traded
  - Long-term contracts, PPAs
    - Payments for capacity, energy and deviation
  - Banking
    - Informal bilateral barter
  - Auctions for power (and for capacity)
    - Uniform-price, procurement auctions
  - Exchanges

The supply stack



Long-term contracts

- Any large, long-lived capital investment involves a long-term financing contract
- Our focus is on contracts between the generator and the potential buyer of the generator's output, usually a discom
- These contracts are a feature of electricity markets everywhere

Important general characteristics

- Power contracts are large, relatively infrequent transactions between generators and buyers
  - Large sums, long commitments and so, considerable risk
  - There is risk over the prices of both inputs and output(s)
  - With a limited number of potential traders and low liquidity, the market may not be competitive
  - PPAs are not suited to rapidly responding to new information about costs, demand and prices
  - But they provide some certainty to investors

Value of PPAs

- In spite of being cumbersome, PPAs are widely used
- They are an important adjunct to generator financing
  - It may be very costly for an entrepreneur to get financing without a PPA in place
- They reallocate risk between generator and buyer
- They facilitate long-range capacity planning
- Having a significant share of power under PPAs may reduce incentives for market manipulation

A fixed instrument for the predictable

- Incremental demand 20 years hence is very speculative
- Long-term fixed-price PPAs are best applied to the most predictable portion of the electricity market
  - Current baseload demand is an almost sure bet
  - Solar PV, with its zero fuel cost and run-when-available character is at low risk of not running
  - Peaking gas turbines are less well-suited to long-term PPAs
    - What about batteries?

Price formation: the scarcity signal

- The RFP – contracting process does not provide clear price signals
  - Non-uniform: contracts are bundles of different attributes
  - The scope of RFPs may be limited
  - The transaction may not be arms-length
  - The terms reflect party assessments of long-term risks
  - Existing tariffs determine the terms of the contract
- In some cases, discoms are the only buyers
- Contract terms do not give reliable information about the costs of generation

PPA terms

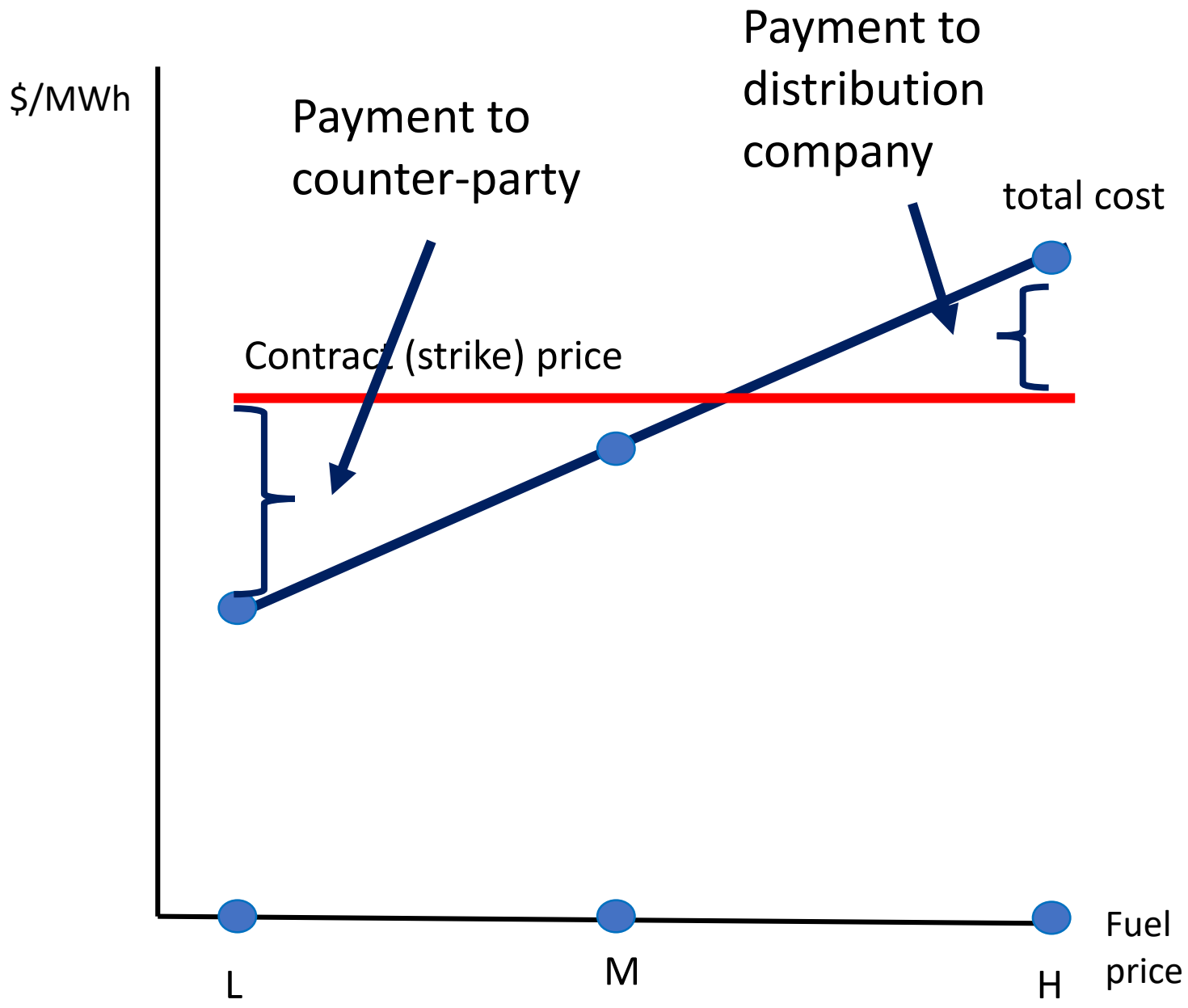
- Capacity payment – a payment sufficient to ensure that the capacity is made available
  - This may be less than actual financing cost
  - Can the generator earn scarcity rents?
- Energy payment – a payment for energy delivered
  - Price may be fixed or may change in specified ways
  - Contingent pricing makes the contracts more complicated
- Deviation terms – what happens if the energy provided deviates from the agreed amount?

The optimal fraction of PPAs

- There isn’t one.
- The right level of PPAs depends on the mix of generators and on the availability of financing
- PPAs should come in different lengths (# of years) for the same reason
- The more active the exchange market, the less likely it is that long PPAs will be anything like 95% of exchange

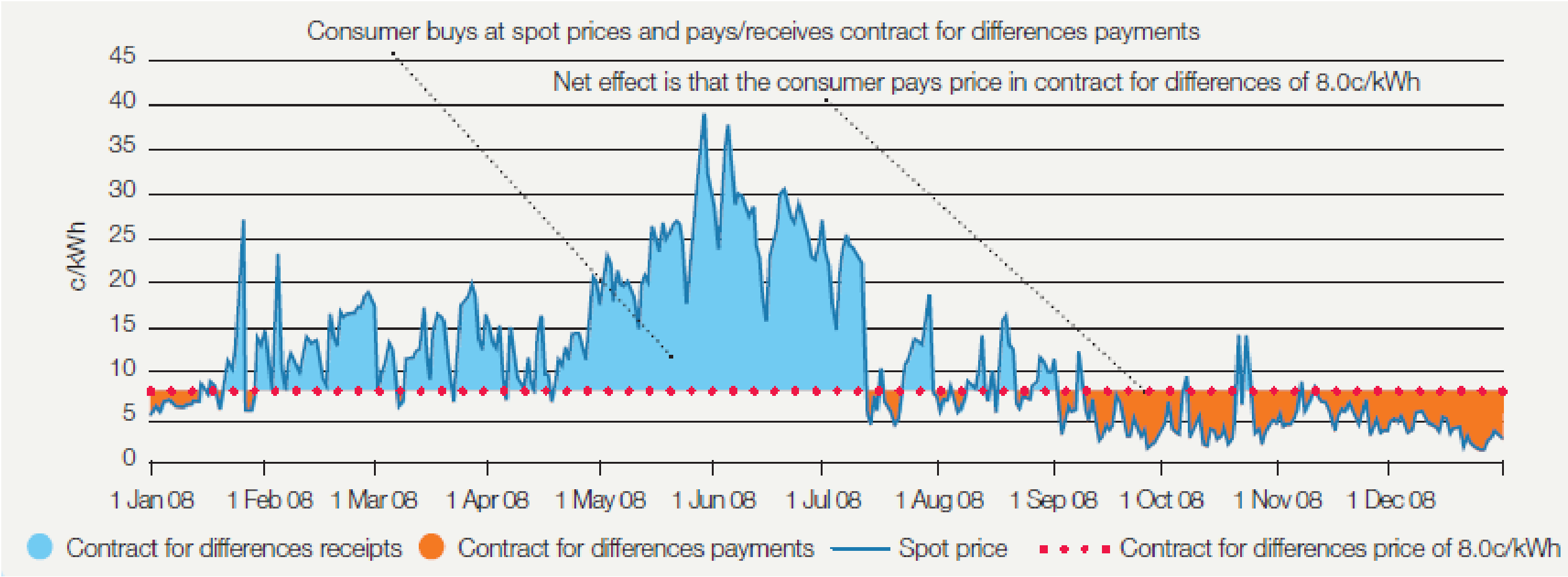
PPAs and risk

- As mentioned before, PPAs do not eliminate risk, they shift it
- Risk can be *reduced* by providing opportunities for hedging it and spreading it
  - Exchange trading can provide these opportunities
- Parties to a PPA could use a contract for differences
  - A two-sided CFD is much like a PPA
  - But you can explicitly shift risk as much as you like with a one-sided CFD, like insurance
  - And you can hedge fuel price risk (and other risks) with CFDs



<u>Contract for differences:</u>
Offers electricity supply at a guaranteed price.
The contract pays the difference between total cost and the strike price

A contract for differences has continuous payments



Source: New Zealand Electric Authority (Te Mana Hiko),
https://www.ea.govt.nz/dmsdocument/13830-managing-electricity-spot-price-risk-guide

Conclusions

- PPAs are best for the most predictable part of demand
  - Less predictable demand may best stay outside of PPAs
  - PPAs may include capacity *and* energy payments
  - PPAs shift risk but do not eliminate it
- They help generators arrange financing
- Some fixed price contracts can reduce manipulation
- Contracting for PPAs is time-consuming and does not provide good information about market prices

Banking: An informal market for power

- "Banking" is a form of seasonal bartering for power
  - Discoms with an excess of power in one season will offer it to discoms with excess demand
  - In return for a return flow of power in another season when the pattern of excess supply and demand is reversed.
  - Discounting for time is in terms of power flows
  - No cash changes hands
  - Not a large factor in Indian electricity markets

Auctions

- An auction is an organized market
- An electricity auction is for procurement
  - Sellers are gencos
  - Buyers are discoms (or other direct buyers)
  - The auctioneer may be an exchange or a system operator
- Buyer announces the quantity needed
- Seller posts quantity-price bids
- Auctioneer matches buyers and sellers according to the auction rules

Why auction?

- Auctions are an extremely inexpensive way of bringing many buyers and sellers together to trade a commodity
  - High liquidity means competitive markets
  - Very low cost exchange
  - Highly transparent, rule-based exchange
  - All traders treated equally
  - Anonymous trading
  - Easily monitored by the auctioneer

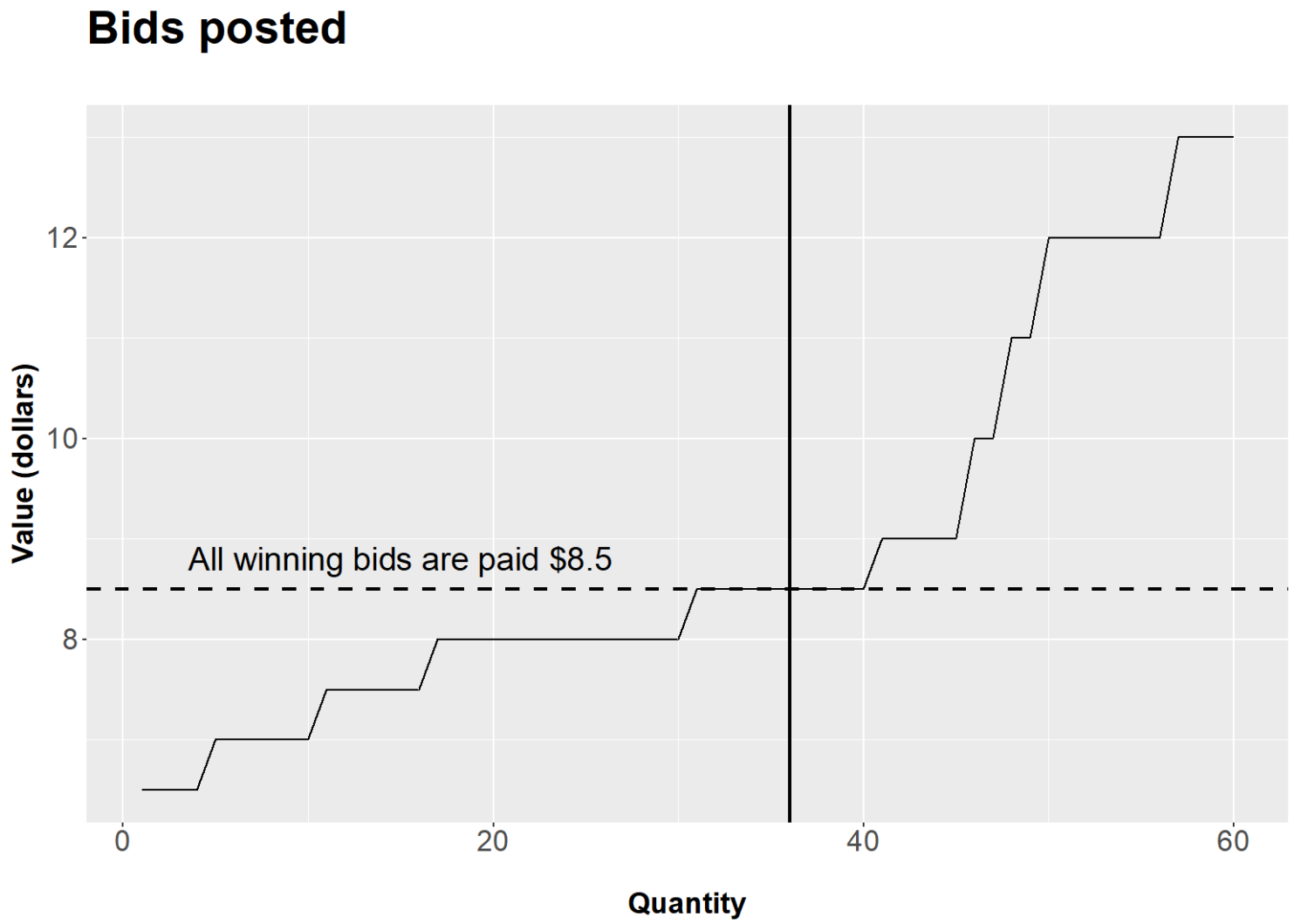
Types of auctions

- A discrete event or a continuous market where the trading occurs as bids and asks arrive
- Discrete auctions may be:
  - Sealed-bid versus sequential
  - Pay-as-bid versus uniform price
- Electricity procurement auctions are usually:
  - Sealed-bid, uniform-price

How day-ahead auctions work

- Buyer sets quantity needed for the next day
  - 5-minute intervals
  - By region (to account for transmission constraints)
- Sellers bid a quantity and a price for each period
- Auctioneer sorts the bids in increasing order and accepts bids up to the quantity required
- **All sellers receive the same price, p***
  - The value of the first rejected bid

Sealed-bid, uniform-price auction



Auctions and the balancing stage

- Auctions can also be used for “real-time” grid balancing
- Winning bidders receive $(Q_{RT} - Q_{DA})*LMP_{RT}$
- The presence of DA and RT markets provides opportunities for risk reduction through hedging
- Opportunities for arbitrage give strong incentives to make better forecasts
  - If you know the demand will be lower in RT than is forecast then sell (short) in DA and buy in RT. Your good forecast pays off!

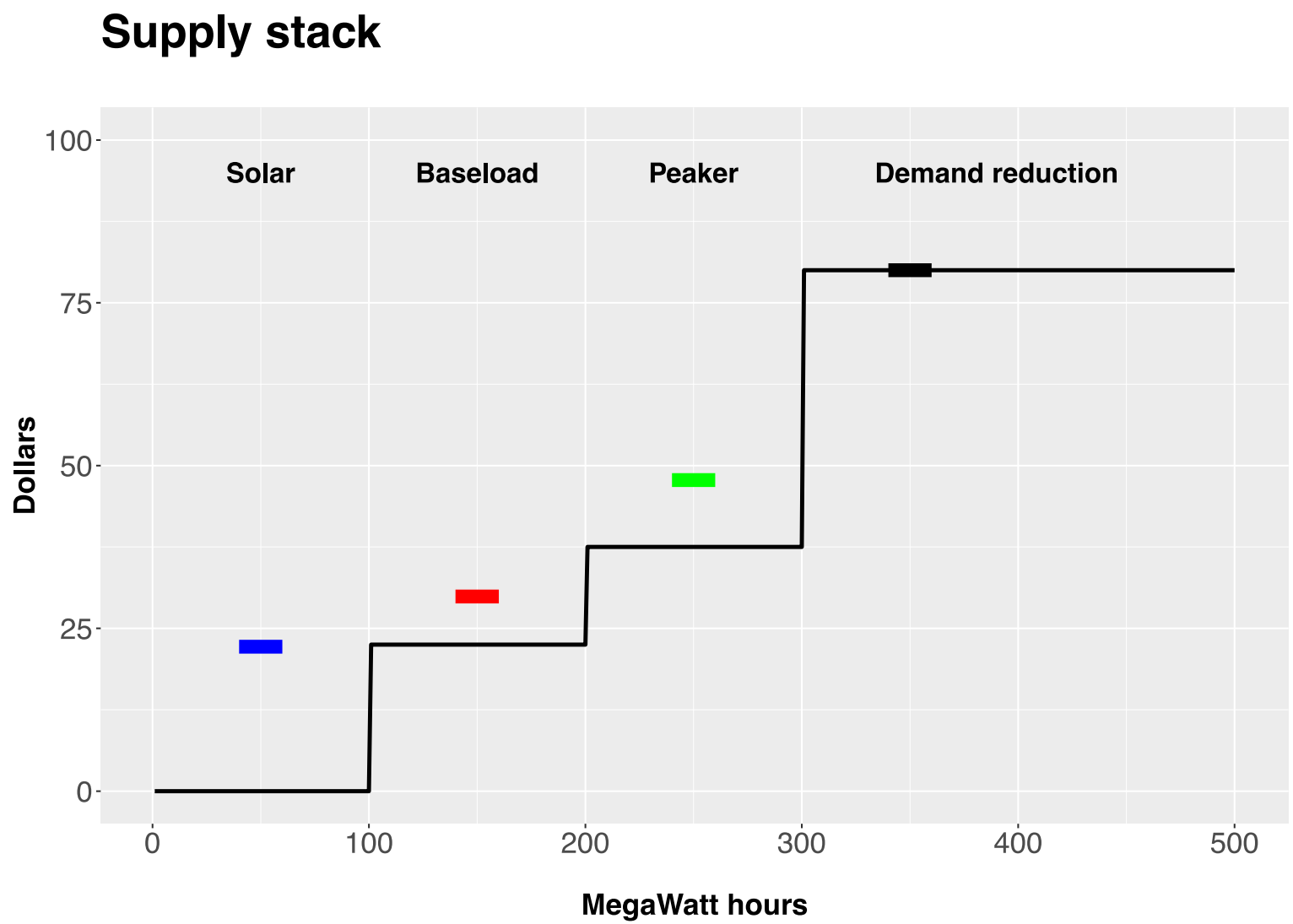
Why *uniform price* auctions?

- Equivalent to pay-as-bid in theory
  - Seller revenues expected to be the same
- But, in practice, uniform price auctions are thought to work better for electricity markets
  - They provide effective price discovery
  - Sellers have incentive to bid their actual values
  - Honest bidding leads to prices matching scarcity
  - So, intermittent sellers make needed scarcity rents

What will sellers bid?

- We discussed earlier that generators have incentive to operate their plants whenever price is greater than MC
  - So what would a genco bid in a uniform-price auction?
- It turns out that, **in a competitive auction**, bidders will want to bid their actual MC
  - Bids above p* will not change the closing auction price
  - But will result in losing some valuable sales at > MC
  - Bids below p* won't change the closing price
  - But will result in some production with price < MC

A day-ahead auction



Double-sided auction: OTC trading

- Suppose you just allow buyers and sellers to continuously post bids (to buy) and offers (to sell)
  - One reason you might do this is to allow very short-run matching of supply and demand during the day
- Genco has unused capacity
- Buyer needs additional power
- Bids and offers are posted, if bid >= offer, it’s a deal
  - Otherwise revise bid/offer or wait for more bids/offers

Double auction trading

Conclusions

- Auctions match buyers and sellers at low cost
  - Result in effective price discovery
  - Limit market manipulation
  - Maximize the value from exchange
  - Widely used in electricity markets
  - Provide liquidity and transparency
- Double-sided auctions can operate continuously

Exchanges

- An exchange is just a place to go to trade something.
- Electricity exchanges provide opportunities to trade electricity *contracts*
  - There are considerable advantages to having some of the electricity demand and supply arranged through an exchange.
- Exchanges may hold both discrete, day-ahead auctions and continuous, double-sided markets (OTC)

Key functions of exchanges

- The primary role of an exchange is to match willing buyers to willing sellers
  - Low cost trading
  - Uniform commodity contract
  - Ease of identifying trading partners
  - Anonymity
  - Reduced credit and delivery risk
  - Competitive pricing
- Exchanges actually *reduce risk* by allowing ex post adjustment of positions

Conclusions

- Exchanges facilitate electricity contract trading through both sealed-bid and continuous auctions
- Exchanges increase flexibility and value by facilitating trading
- Exchanges help discover the market price of energy
- They are widely used in many countries for managing electricity delivery