Economics for Wholesale Electricity Markets

Dr. William Shobe
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

Marginal cost and LCOE of capacity

- Solar
- Baseload
- Peaker
- Demand reduction

Dollars vs. MegaWatt hours
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
Contract for differences:
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),
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

Bids posted

All winning bids are paid $8.5
Auctions and the balancing stage

- Auctions can also be used for “real-time” grid balancing
- Winning bidders receive \((Q_{RT} - Q_{DA}) \times LMP_{RT}\)
- 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

Supply stack

MegaWatt hours

Solar  Baseload  Peaker  Demand reduction

Dollars

0  25  50  75  100
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