Overview of Convex Hull Pricing

- Theoretical pricing model aiming to include start, no load, and minimum energy costs in prices.
- Computationally infeasible, never implemented
- Not an established economic concept
- Solves a multiperiod joint unit commitment and dispatch problem
- Solution is physically infeasible, resulting in prices that are inconsistent with dispatch.
What is a convex hull?

Convex set

Nonconvex set
What is a convex hull?

Convex set

Nonconvex set with a convex hull
Mechanics

• Same cost minimizing unit commitment and dispatch from the actual supply curve
• Solves a separate solution for pricing using the convex hull supply curve, infeasible solution
  • Convex hull supply violates physical resource constraints like minimum output and ramp rate.
• Prices consistently include commitment costs.
• Infeasible outcomes determine prices by violating physical constraints that create nonconvexities.
Prices Inconsistent with Dispatch

- Dispatch and prices from two different solutions
- Prices do not equal the marginal cost of generation or the marginal value of load.
  - Lost allocative efficiency
- Required lost opportunity cost payments to correct marginal cost dispatch incentives
  - Uplift payments to both generation and load to reduce incentive to follow prices
  - Lower total uplift should result, but magnitude of change is unclear
Price Signals

• Market participants cannot rely on convex hull prices to signal optimal behavior.
• Congestion patterns would differ from the efficient solution.
  • Creates FTR revenue shortfalls
• Negative prices become positive
  • Signaling less load where more is needed
  • Signaling more generation where less is needed
Correcting Price Signals

• Lost opportunity costs rely on after the fact settlements to correct price incentives.
  • Commitment costs also part of LOC calculation
  • LOC required for offline resources
• Mechanism required to ensure tight dispatch following to get correct results in practice
  • More PJM command and control for many resources and load
  • Strong deviation penalties, no LMP if over dispatch, or uplift disqualification may be necessary
Correcting Price Signals

- Resources and load may follow prices instead of dispatch if uncertainty about after the fact true up payments.
- Prices less transparent
  - More difficult to understand and verify pricing, because inconsistent with dispatch and multiperiod pricing
  - Participant specific LOC payments not public and not known until settlements
Multiperiod Solution

• Uses same time horizon as commitment problem
• Commitment costs in convex hull pricing are allocated unevenly, based on the economics of the solution.
  • For example, prices for a peak period could include total accrued start and no load costs for resources started several hours earlier.
• Computationally difficult to solve
• No concept of rolling period implementation
  • Need to look forward and look back
Practical Considerations

• Theory assumes away practical considerations.
  • Computationally difficult
  • Participants respond differently to prices, dispatch signals, and uplift payments
  • Multiperiod implementation
• Changes to convex hull model to address practical considerations raise costs and move results away from theory.
References


