Economics for Wholesale Electricity Markets

Dr. William Shobe
System Management

Module 7
Dispatch: Which plants will run?

- Earlier, we showed that **system costs are lowest** if plants are run in order of increasing marginal cost (merit order)
- The level of demand will determine how far we go up the merit order stack
  - Price is determined by the MC of the most costly unit run
  - During low demand periods, low-cost, baseload generators will set the price
  - In high demand periods, higher cost generators set the price, while lower cost facilities earn scarcity rents
The supply stack again

Marginal cost and LCOE of capacity

MegaWatt hours

Dollars

Solar  Baseload  Peaker  Demand reduction
Who decides on dispatch?

• Two different approaches:

• Discoms with plants under contract
  • Limited set of available gencos
  • Dispatch by contract or by merit order

• System operator
  • All gencos sell through one dispatcher
Merit order dispatch

• With merit order dispatch, the marginal costs are determined in the day-ahead market
  • A procurement auction can be held for the forecast need
  • On the day of generation, true-up to actual realized demand can be met with fast response resources at their marginal cost
  • Generators not meeting their obligation are charged for replacing that power at the market price
• On the day of service, true up to actual demand is done via a “real-time” market and market for ancillary services
The supply stack again

Marginal cost and LCOE of capacity

MegaWatt hours

Dollars

Solar Baseload Peaker Demand reduction

Marginal cost and LCOE of capacity
Merit order incentives

• Under dispatch by merit order periods of high prices compensate high fixed-cost generators through scarcity rents
  • Limits on prices may result in the need for separate payments to capacity
Too many long-term contracts

• If all power is under long-term, take-or-pay contracts for a fixed price, then dispatch would be by LCOE
  • Costs of generation are higher or curtailment is more likely
  • There is incentive to build too much baseload and too little peaker
• Solar is more complicated. Even with low LCOE, high solar penetration may lower prices to solar when it is available
  • Resulting in too little scarcity rents
  • What if solar were the marginal (price-setting) generator?
  • Incentives to shift demand to times when solar is available
The supply stack again

Marginal cost and LCOE of capacity

MegaWatt hours

Dollars

Solar
Baseload
Peaker
Demand reduction

0 100 200 300 400 500

Marginal cost and LCOE of capacity
Conclusions

• Dispatch by merit order results in the lowest cost of power generated
  • And provides incentives for a mix of generators
• Using long-term, fixed-price contracts for most dispatch can raise costs
  • May over-emphasize big baseload plants
Dispatch by locality

• Dispatch across more than one locality will generally lower costs
  • Suppose State B has 100 MWh of baseload
  • And State S has 100 MWh each of solar and peaker
  • State S and State B both need 75 MWh today
  • Without trade between the states, 25 MWh of zero cost solar will go to waste and 25 MWh of baseload will run instead, with variable costs of $22.5*25 = $562.5
  • The least-cost dispatch would be 100 MWh of solar and 50 MWh of baseload
Multi-state dispatch

• Taking advantage of cost savings from multi-state, merit order dispatch needs:
  • Bidding mechanism to build the supply stack
  • Transmission capacity (and pricing congestion)
  • Dispatch coordination

• Each one of these has benefits, but together, the benefits are even greater
Transmission

• Grid segments have limited capacity

• When a segment is congested, one plant’s production can interfere with another’s, if they are on the same side of a congested segment

• A “load pocket” is an area where local demand must be met by local generation due to congestion
  • Even if it would otherwise be cheaper to buy from another location
  • In a load pocket, local plants can have significant market power
  • High prices will reflect market power rather than generation costs
Grid investment

• Transmission planning needs to respond to present and future congestion

• It also needs to be at the appropriate scale
  • Planning transmission investments needs to be multi-regional
  • Local incentives are diffuse, grid adequacy is a public good
  • Generators in load pockets can profit from congestion

• The relationship between renewables and transmission investment is complicated
  • Distributed power can increase or decrease need for grid enhancement
Locational prices and FTRs

• If there is congestion, MC will be set by different generators in different regions
• So prices will vary by location
• The value of improving transmission depends on the price difference and how long it lasts
• Solution: sell Financial Transmission Rights (FTRs)
  • The price will depend on the losses from congestion
• Use the revenues to help finance transmission upgrades
Who dispatches?

- Dispatch could be handled by a state discom or by an ISO (independent system operator)
  - An ISO can combine multiple discoms for cost advantage
- Either arrangement *could* use merit order dispatch
- What is the basis for local discom dispatch choices?
- How does this affect choices for multi-regional cost savings?
What is dispatched?

• Day-ahead: forward decision about load and reserves
• Real-time: spot decision about load and reserves
• Other ancillary services:
  • voltage regulation, black start, etc.
• Transmission services
  • Financial transmission “rights” may be traded
  • But actual use is determined by generation dispatch
Voltage/frequency regulation

- Mismatch between demand and supply results in frequency deviations
  - Can be managed by changing generation or by demand reduction
  - Frequency regulation can be handled with dispatchable regulation reserves
  - The deviation settlement mechanism is designed to give generators incentive to adjust generation to adjust the frequency
Deviation settlement mechanism

- Frequency falls outside of acceptable range
- Initial price signal is sent out to gencos
- Gencos independently decide how to respond to the announced deviation price
- Depending on how all gencos respond, the price will adjust
- Generators receive a price that is a mix of the announced and final deviation price
  - Based on the deviation from their contracted generation amount
Dispatch-based frequency regulation

• Various levels of reserves are bid in the day-ahead market
  • Price depends on the level of commitment of the reserves
  • Cost or opportunity cost
• Reserves and regulation services are offered in the balancing ("real-time") market
• Reserves are dispatched in merit order (at marginal cost) as needed
Distributed energy services

• Definition: energy (and ancillary) services that are attached to the grid at the distribution level rather than the transmission level
  • Lower voltage connection to the distribution system
  • Two way flow
  • Aggregated small sources
  • Possibly intermittent (as with renewables or demand management)
  • Geographically diverse
  • Batteries, renewables, demand reduction, others...

• Key new challenge to grid management
Conclusion

• Price-based dispatch can work for ancillary grid management services as well as for energy