Economics for Wholesale Electricity Markets

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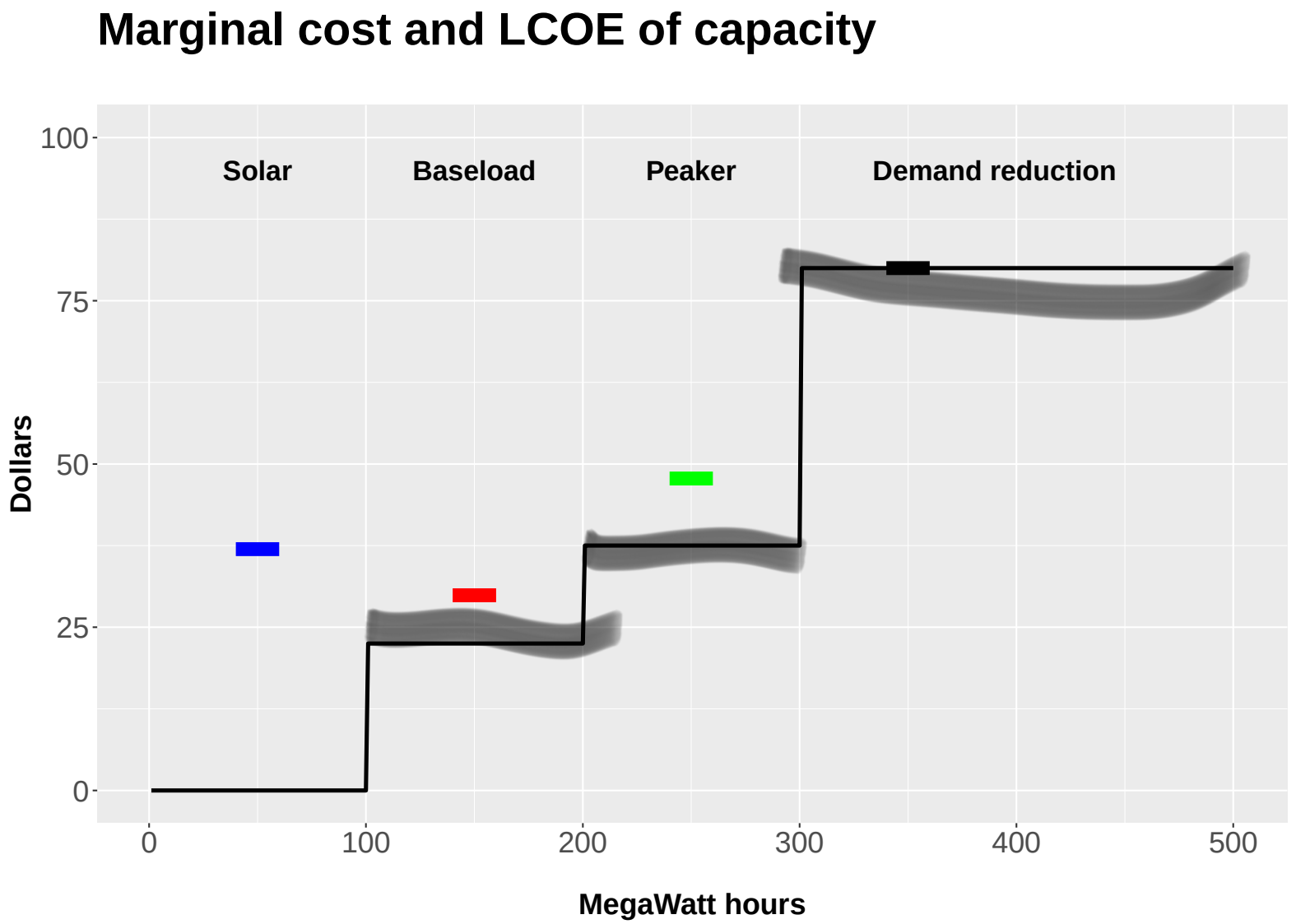
System Management

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



Who decides on dispatch?

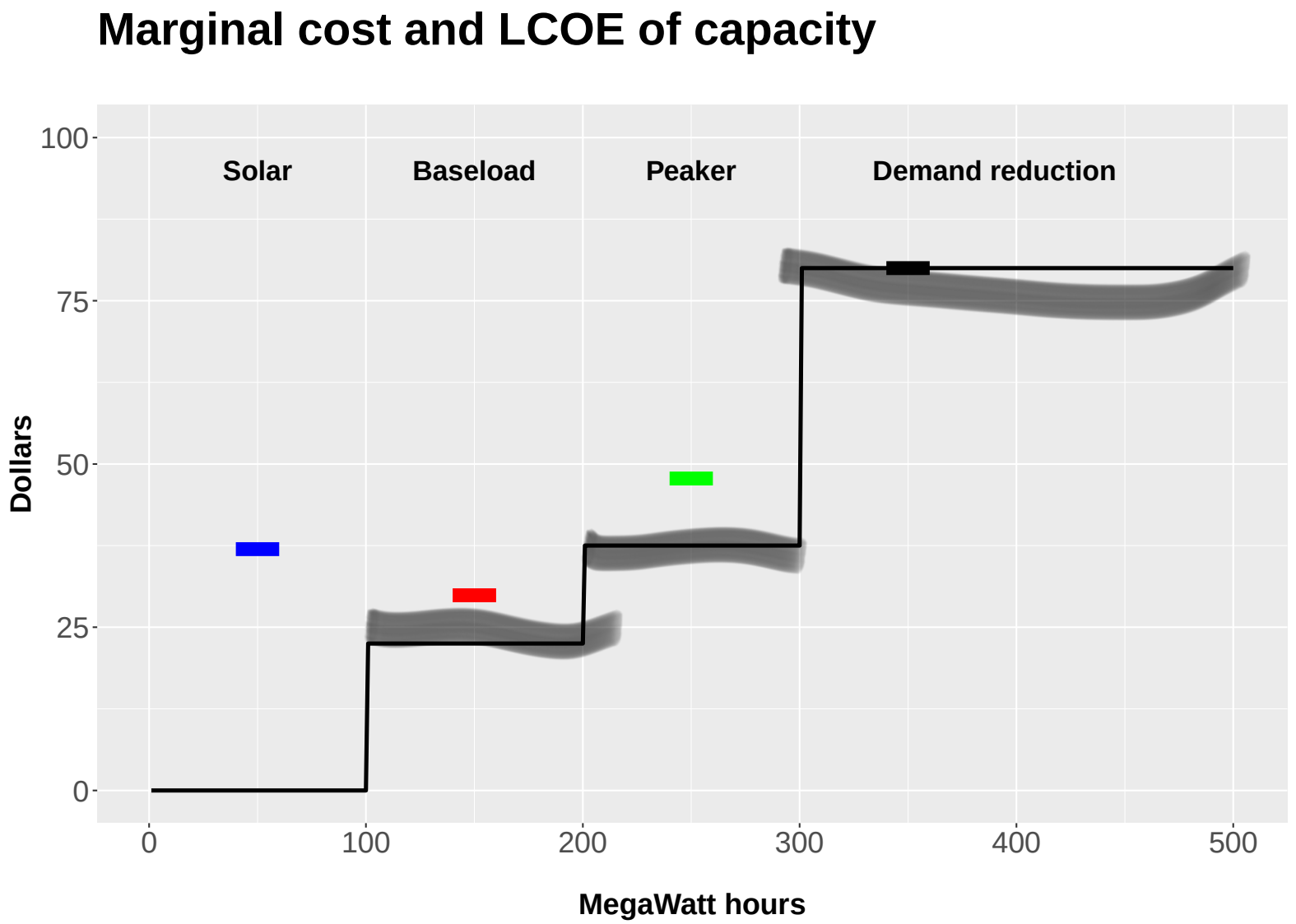
- Two different approaches:

- 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



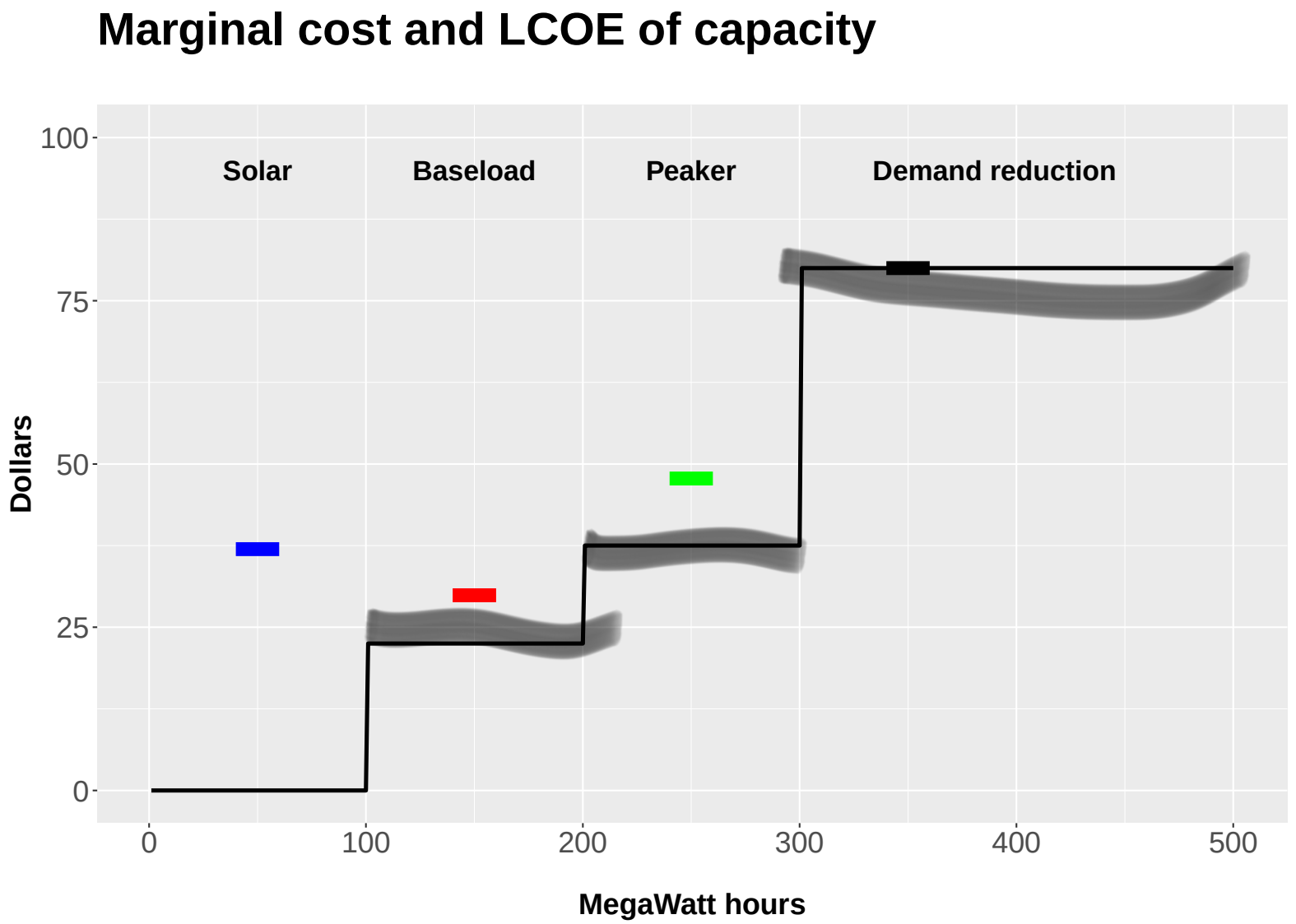
Merit order incentives

- 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



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