

Qualitative Evaluation of Storage Benefits using the 4600 Benefit Cost Framework

Review of 4600 Worksheet Assignment responses

January 10, 2023

Benefits related to displacing a marginal unit:

- 1. Energy supply and transmission operating value of energy provided or saved
- 5. Energy DRIPE
- 21. Non-energy costs/benefits (oil, gas, water, wastewater)*
- 31. Public health
- 32. National Security and US international influence
- 6. GHG compliance costs
- 25. GHG externality costs
- 7. Criteria air pollutant + other environmental compliance costs
- 26. Criteria air pollutant + other environmental externality costs
- 16. REC cost/value

* we removed "participant" from this category name in order to capture all non-energy benefits

Net benefit = benefit of discharging – cost of charging - losses

Benefits related to system investment/spending:

- 3. Forward Commitment: Capacity Value
- 8. Electric Transmission Capacity Costs/Value
- 9. Electric transmission infrastructure costs for Site Specific Resources
- 10. Distribution Capacity Costs
- 11. Distribution Delivery Costs
- 12. Distribution system safety loss/gain
- 13. Distribution system performance
- 19. Investment under Uncertainty

Avoiding build is premised on eliminating a system constraint.

Benefits related to resilience:

15. Distribution system and customer reliability/resilience impacts

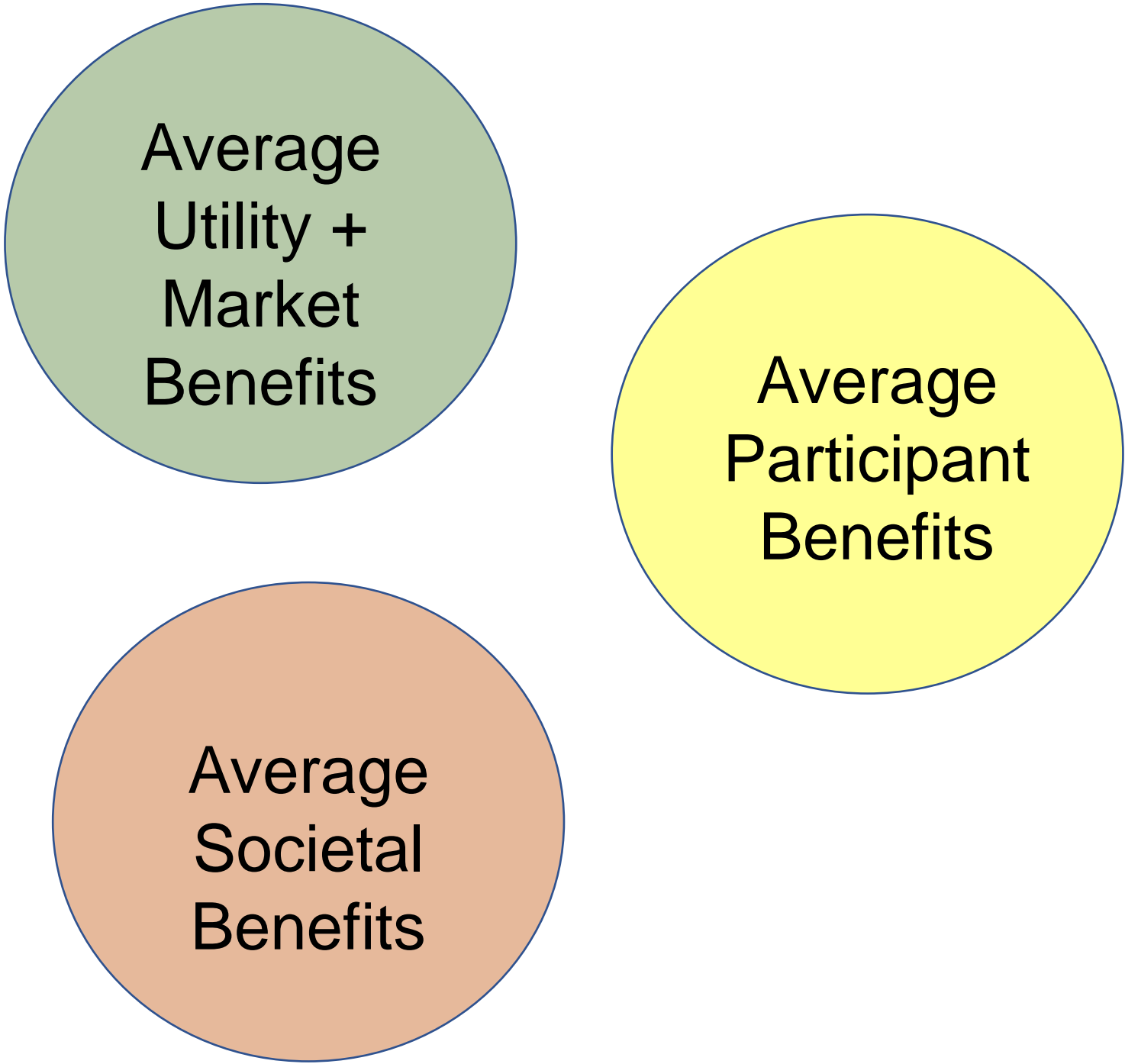
Resilience benefits:

- Only delivered during **system outage**
- Require the storage resource to be **charged going into** the outage

Benefits related to equity and LMI customers:

- 14. Utility low income
- 22. Low-income participant benefits
- 30. Societal low income impacts
- 24. Nonparticipant (equity) rate and bill impacts

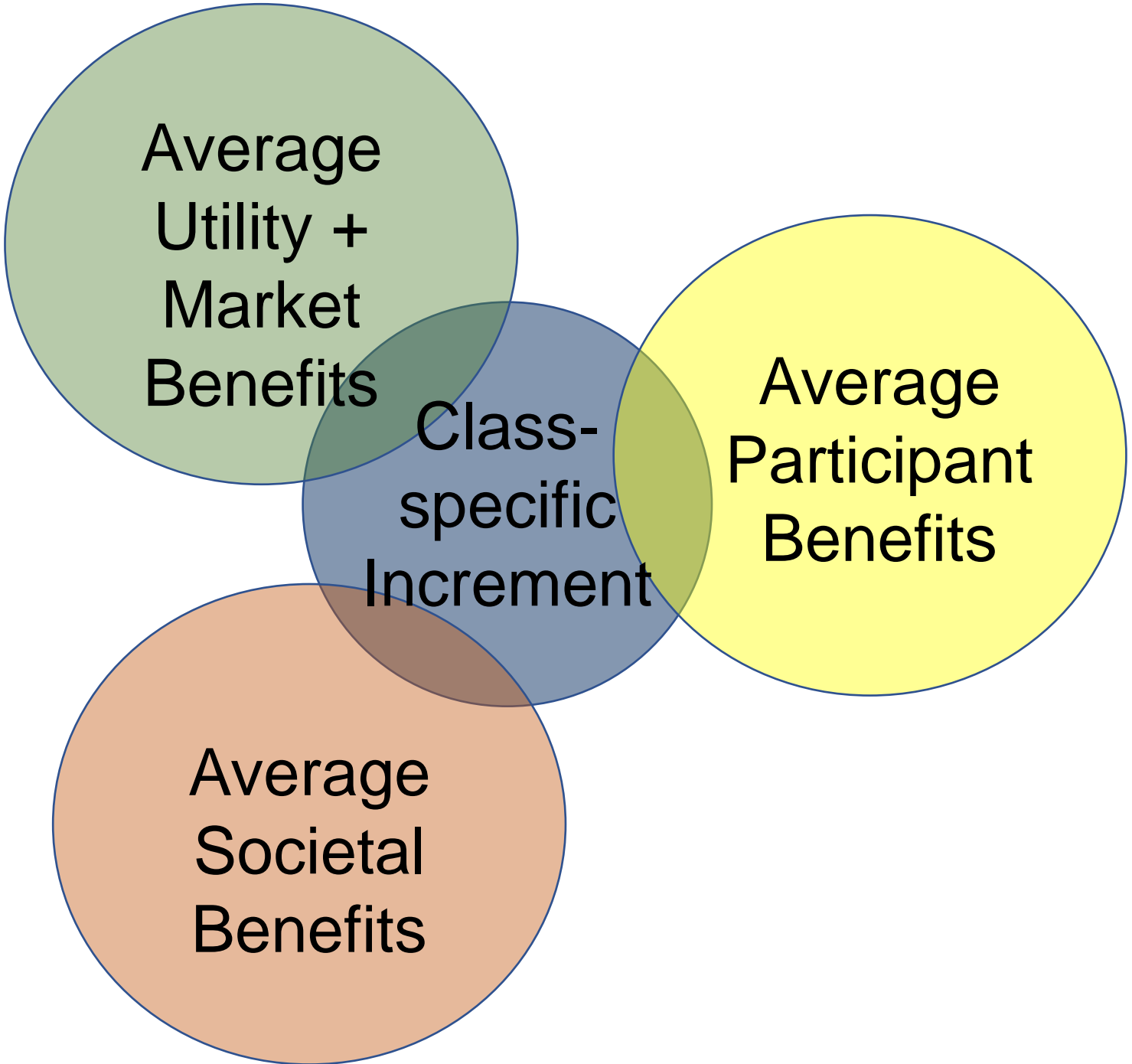
For an average benefit, there might be incremental benefits associated with a specific group of customers.



Average
Utility +
Market
Benefits

Average
Participant
Benefits

Average
Societal
Benefits

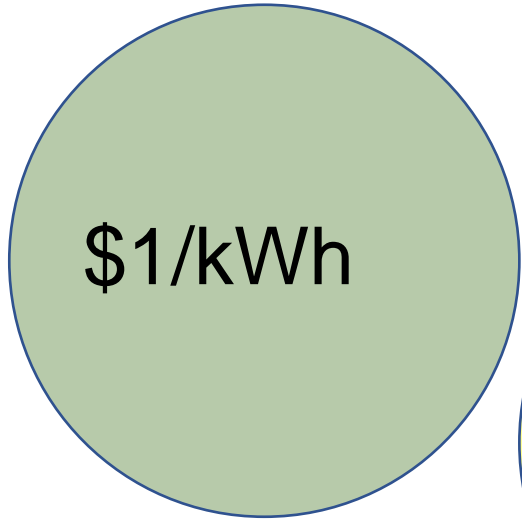


Average
Utility +
Market
Benefits

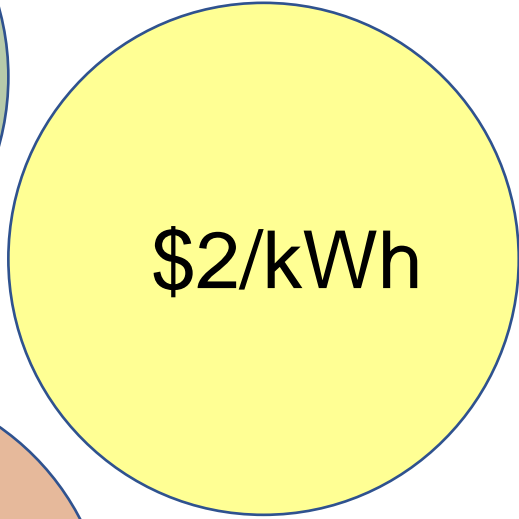
Class-
specific
Increment

Average
Participant
Benefits

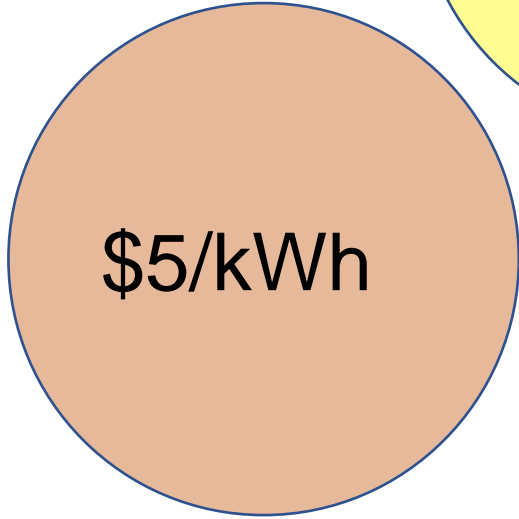
Average
Societal
Benefits



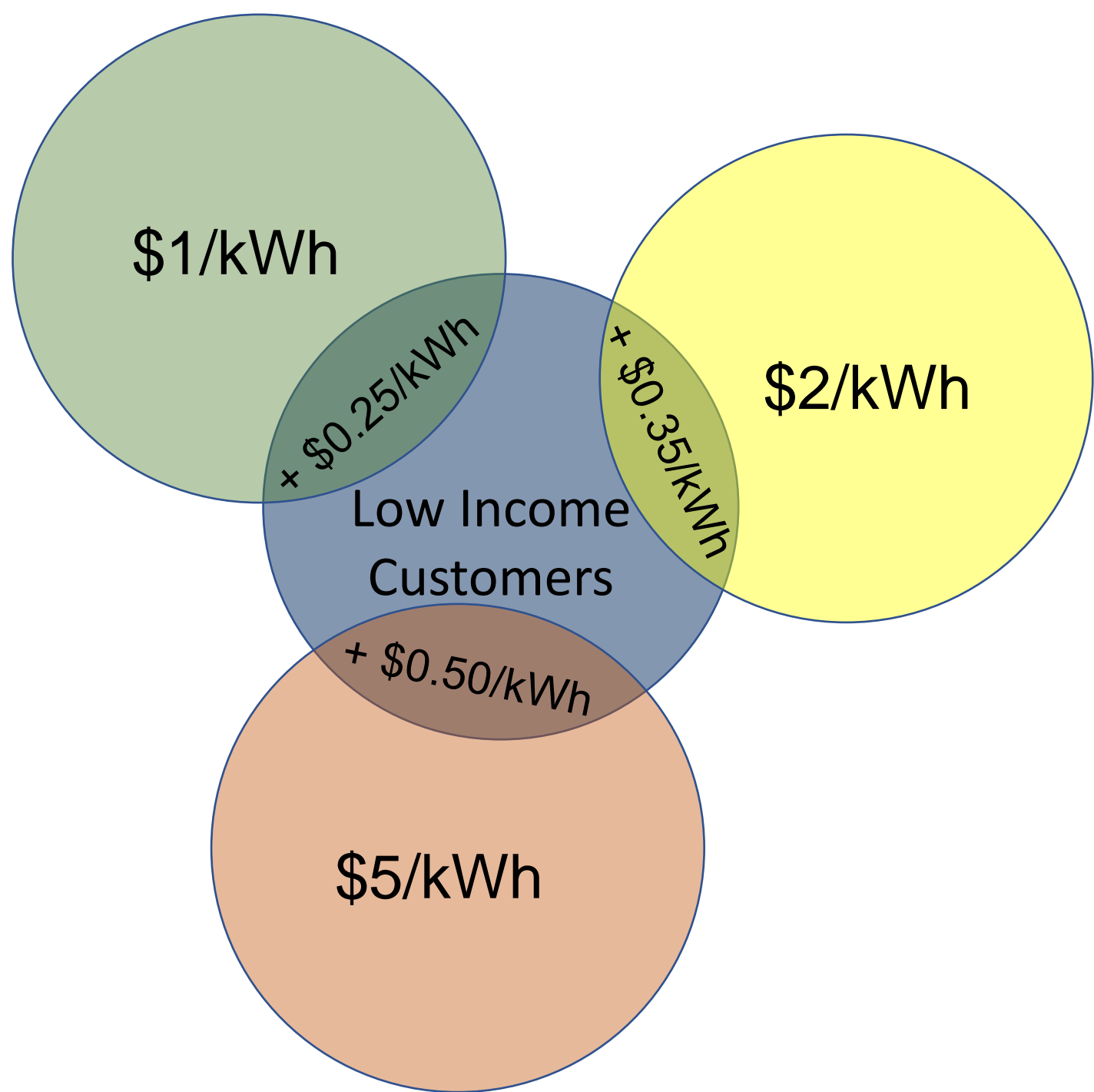
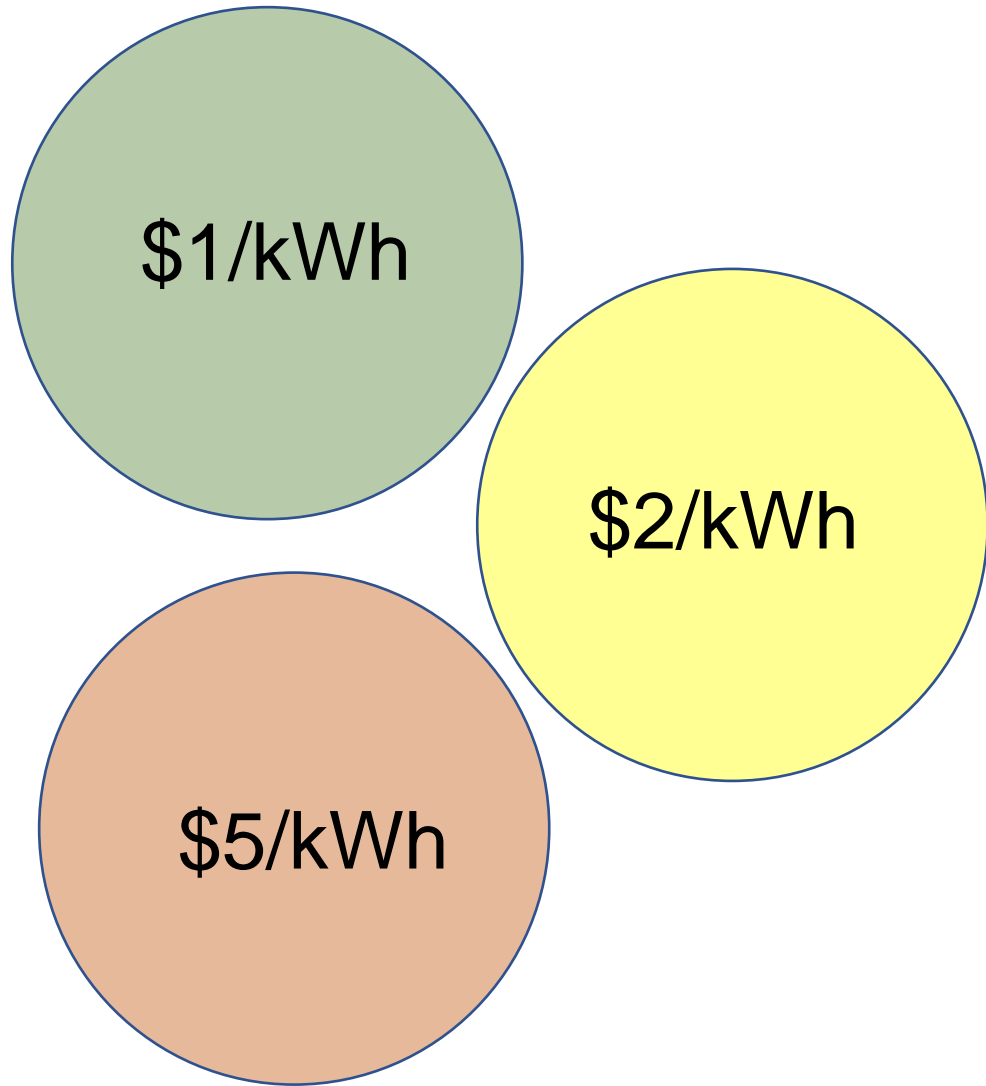
\$1/kWh



\$2/kWh



\$5/kWh



Benefits related to learning and innovation:

20. Innovation and Learning by Doing

29. Innovation and knowledge spillover (related to R&D preceding larger scale development)

Benefits related to the size & volatility of market:

- 2. Retail supplier risk premium
- 4. Forward Commitment: Avoided Ancillary Services Value
- 17. Net risk benefits to utility system operations (generation, transmission, distribution)
- 23. Consumer Empowerment & Choice

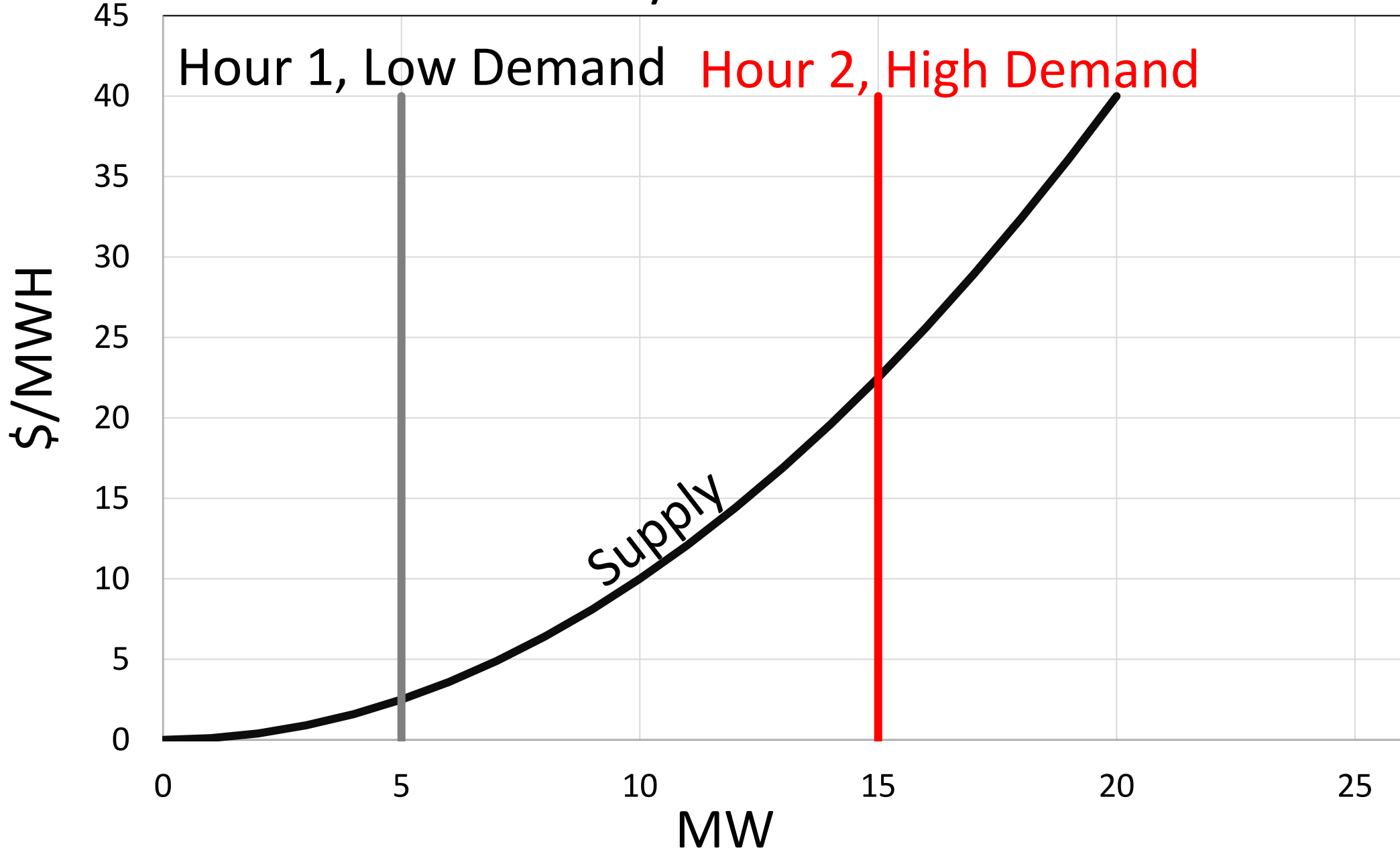
Other benefits:

- 18. Option value of individual resources
- 27. Conservation and community benefits
- 28. Non-energy costs/benefits: Economic Development

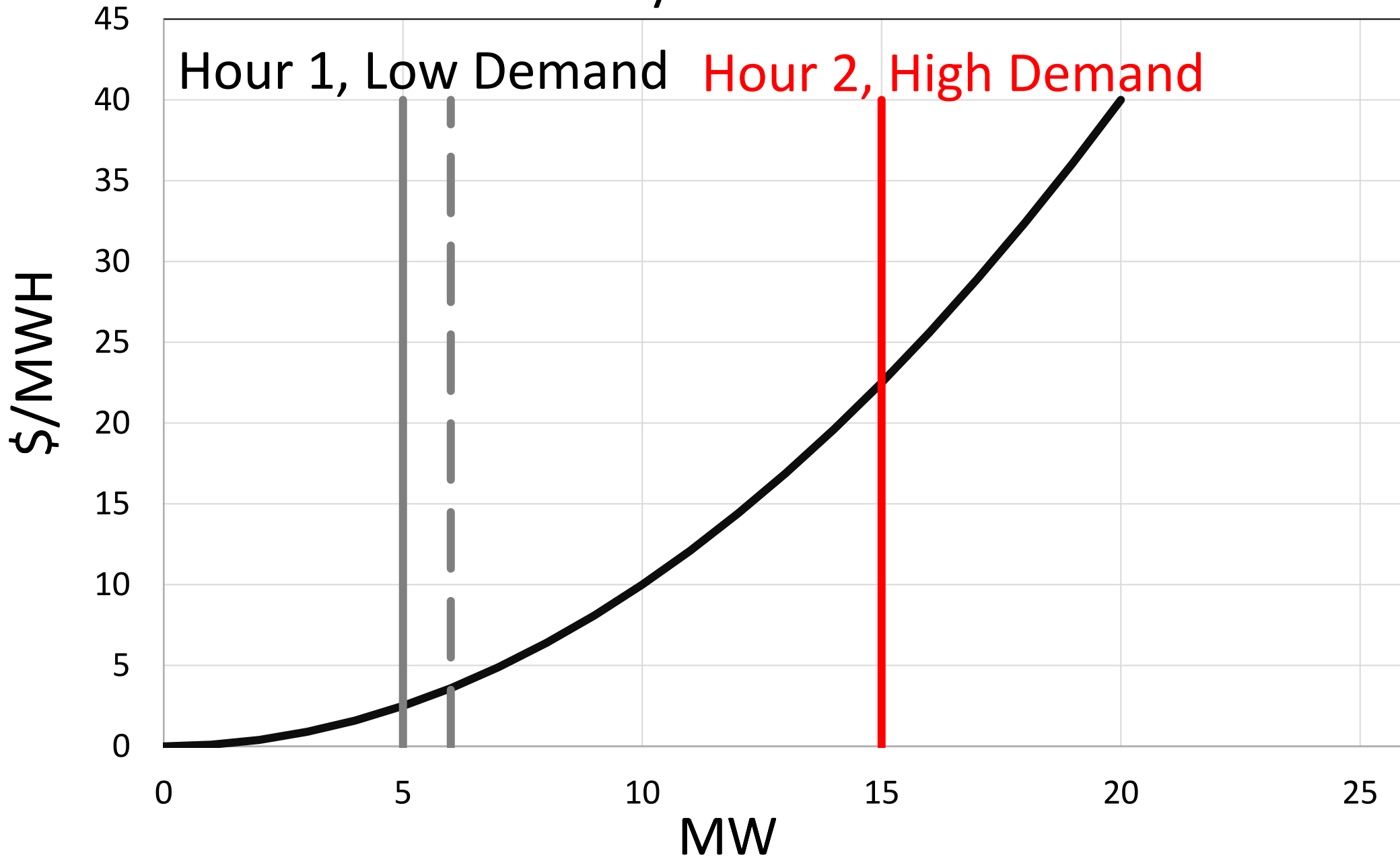
Deep Dive: Drivers of Key Benefits

Energy

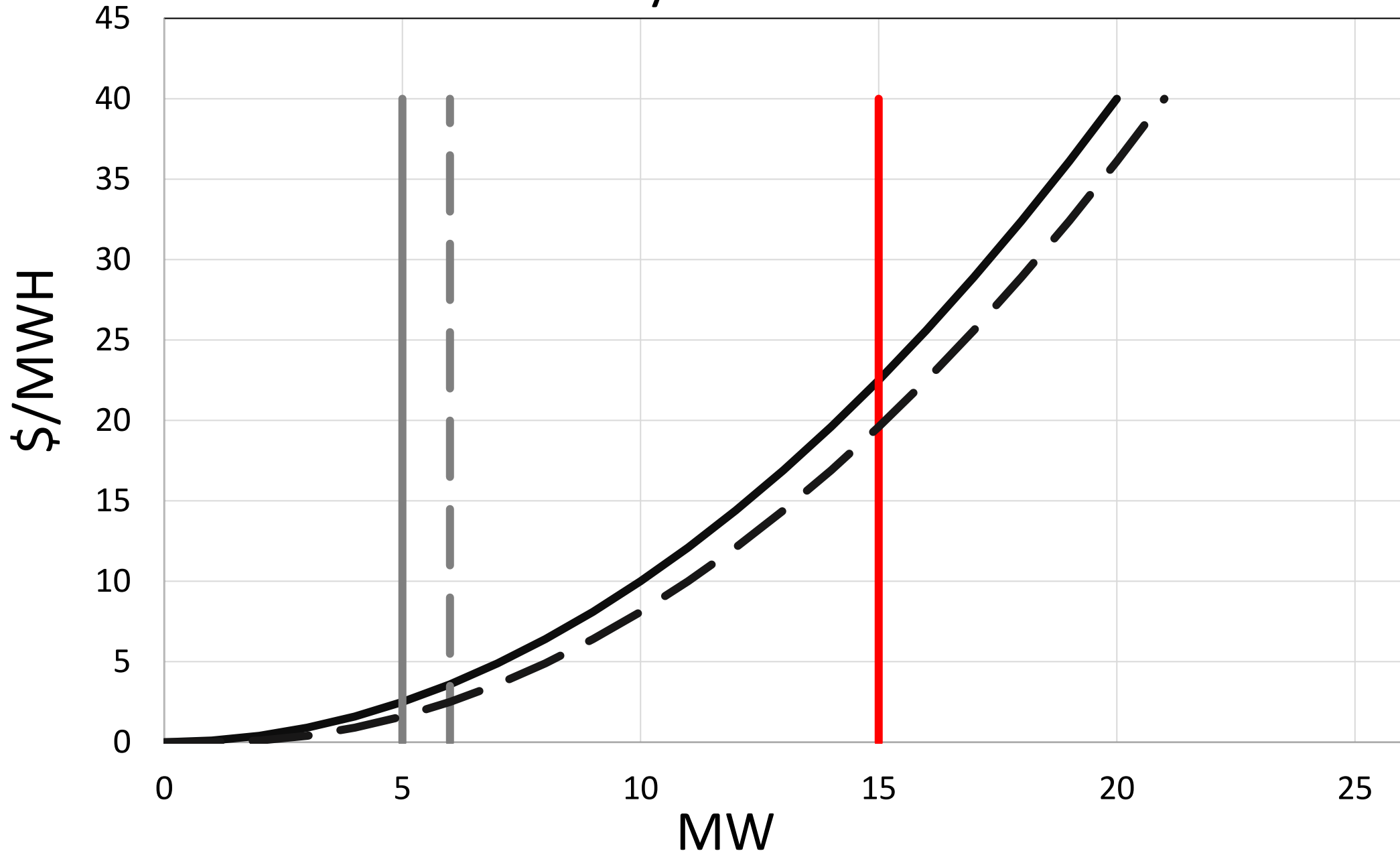
A 2-Hour Day with Inelastic Demand



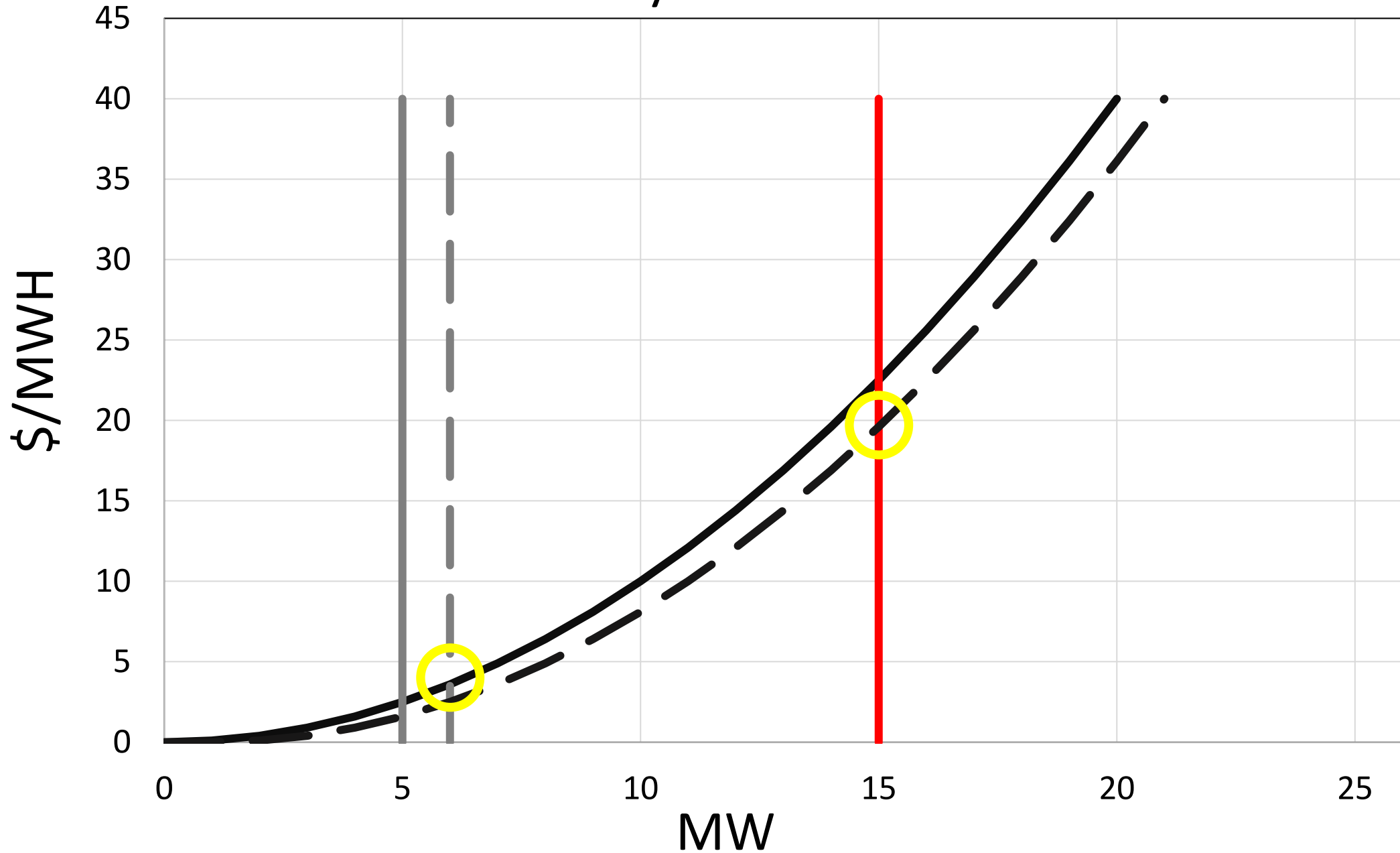
A 2-Hour Day with Inelastic Demand



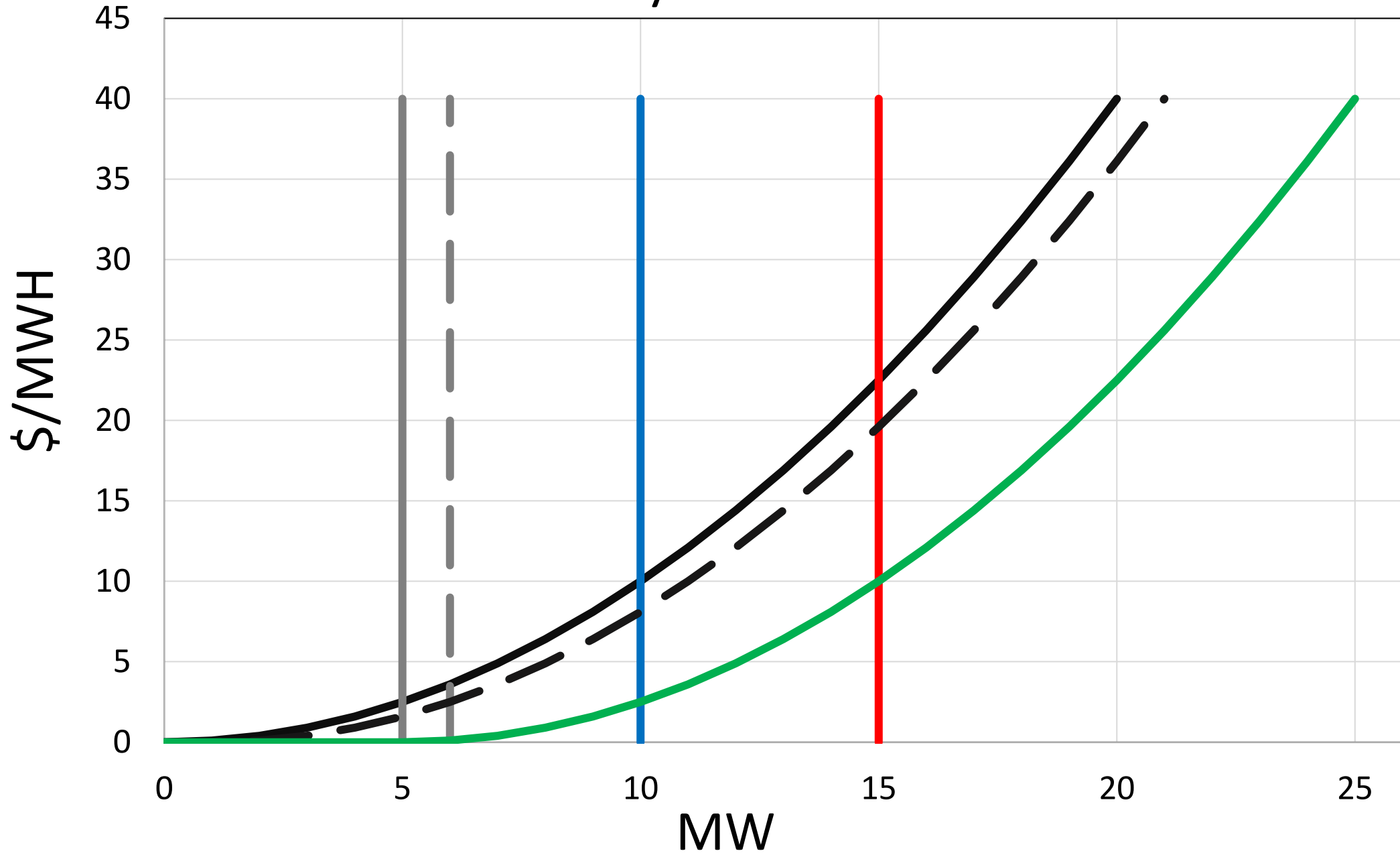
A 2-Hour Day with Inelastic Demand



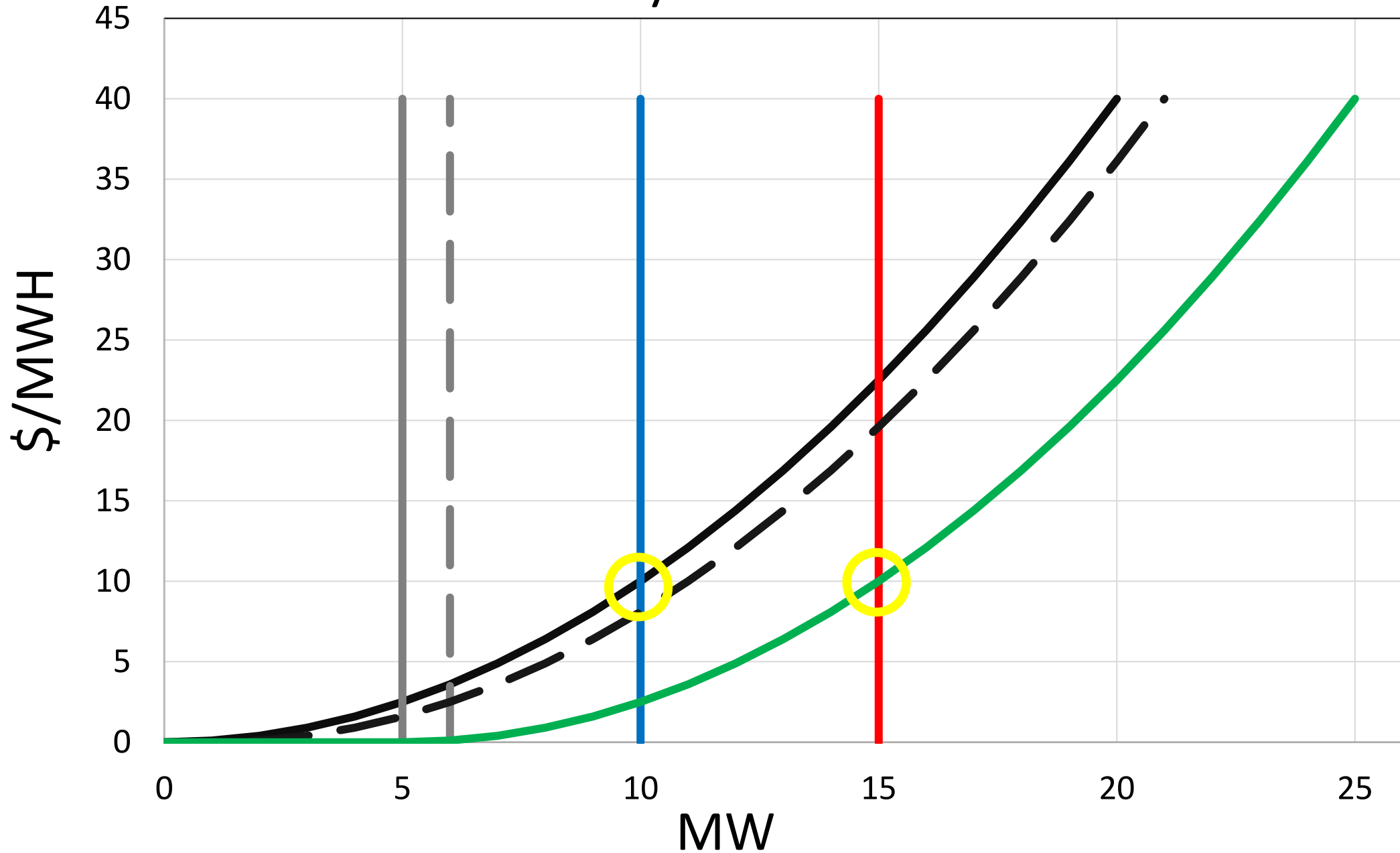
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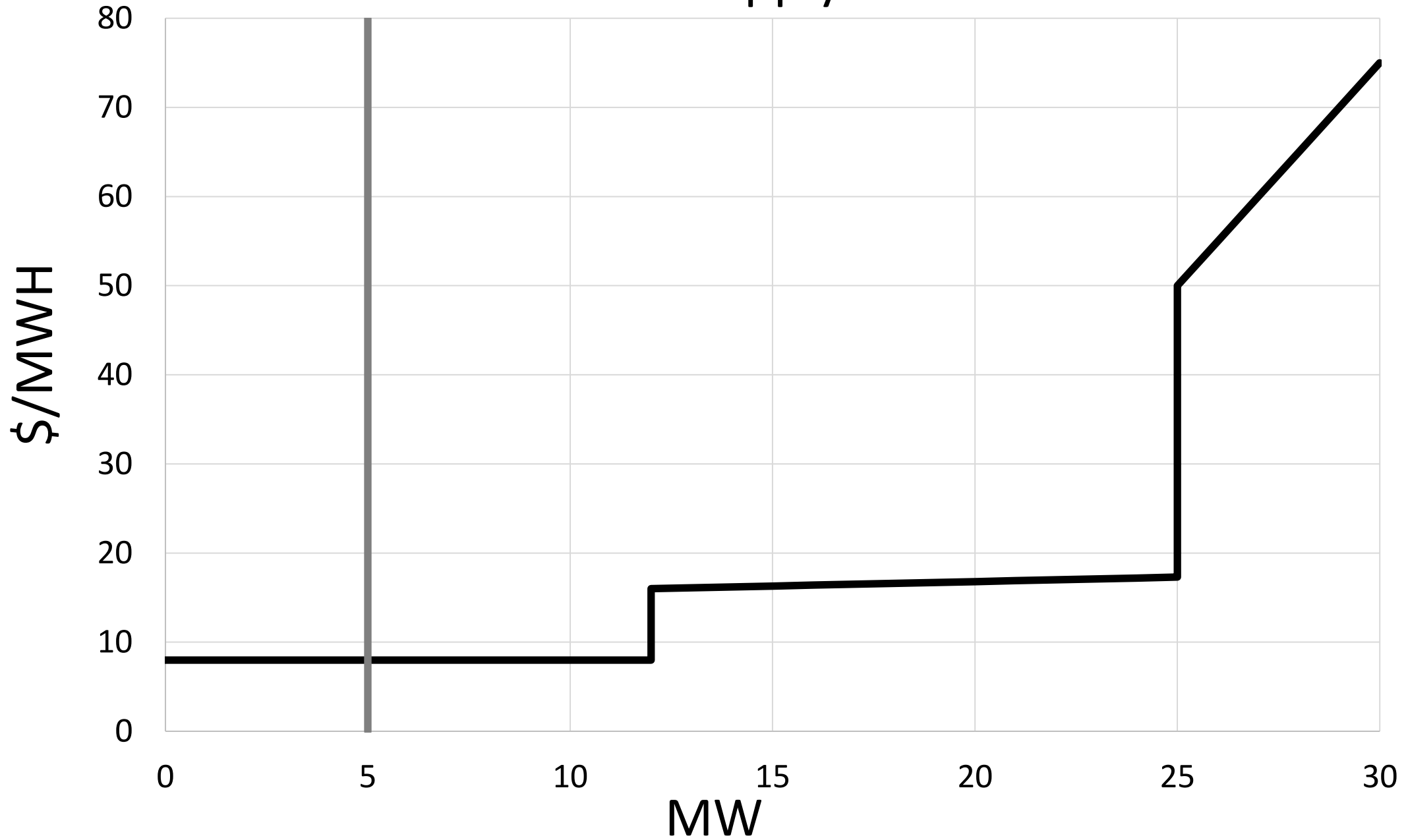
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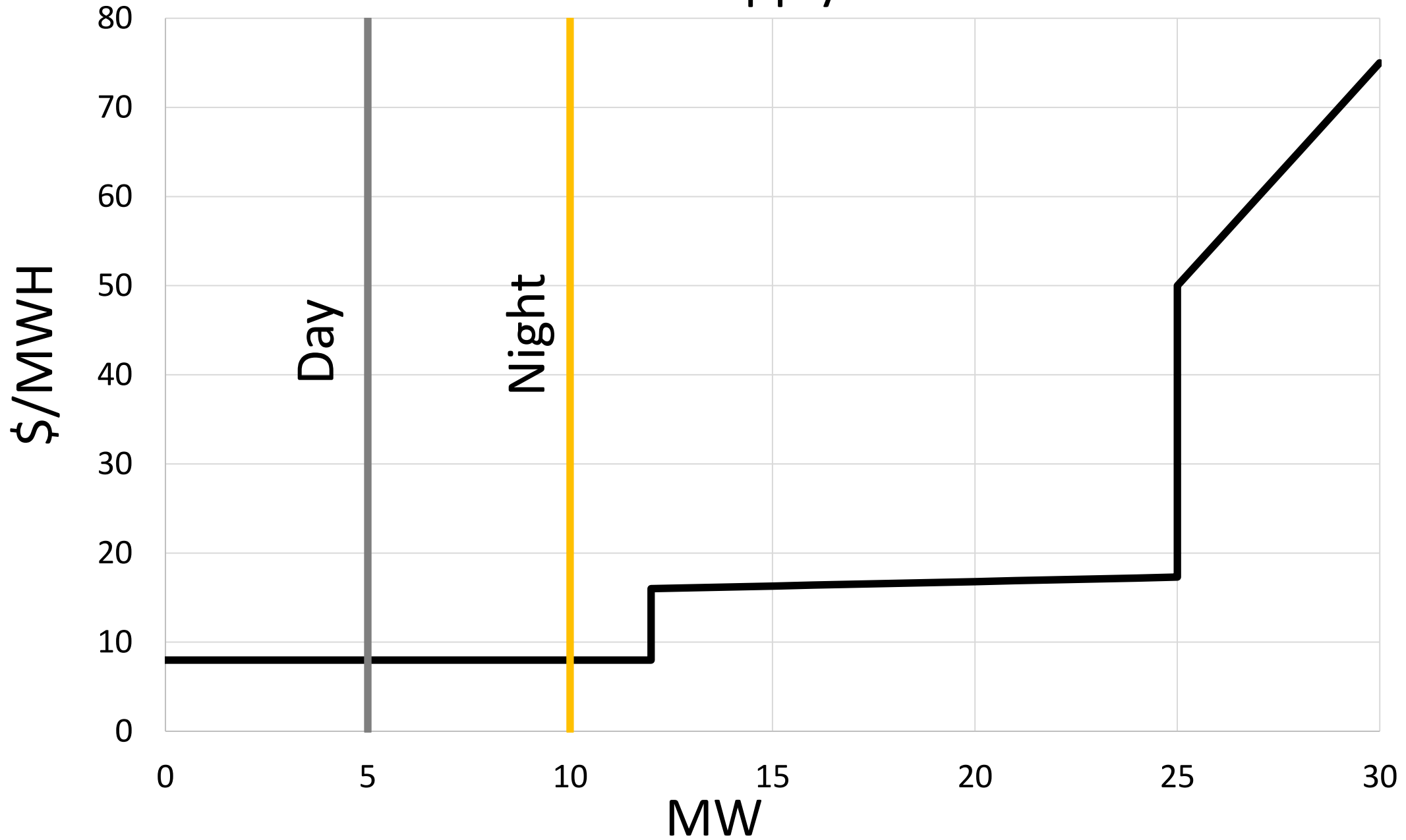
A 2-Hour Day with Inelastic Demand



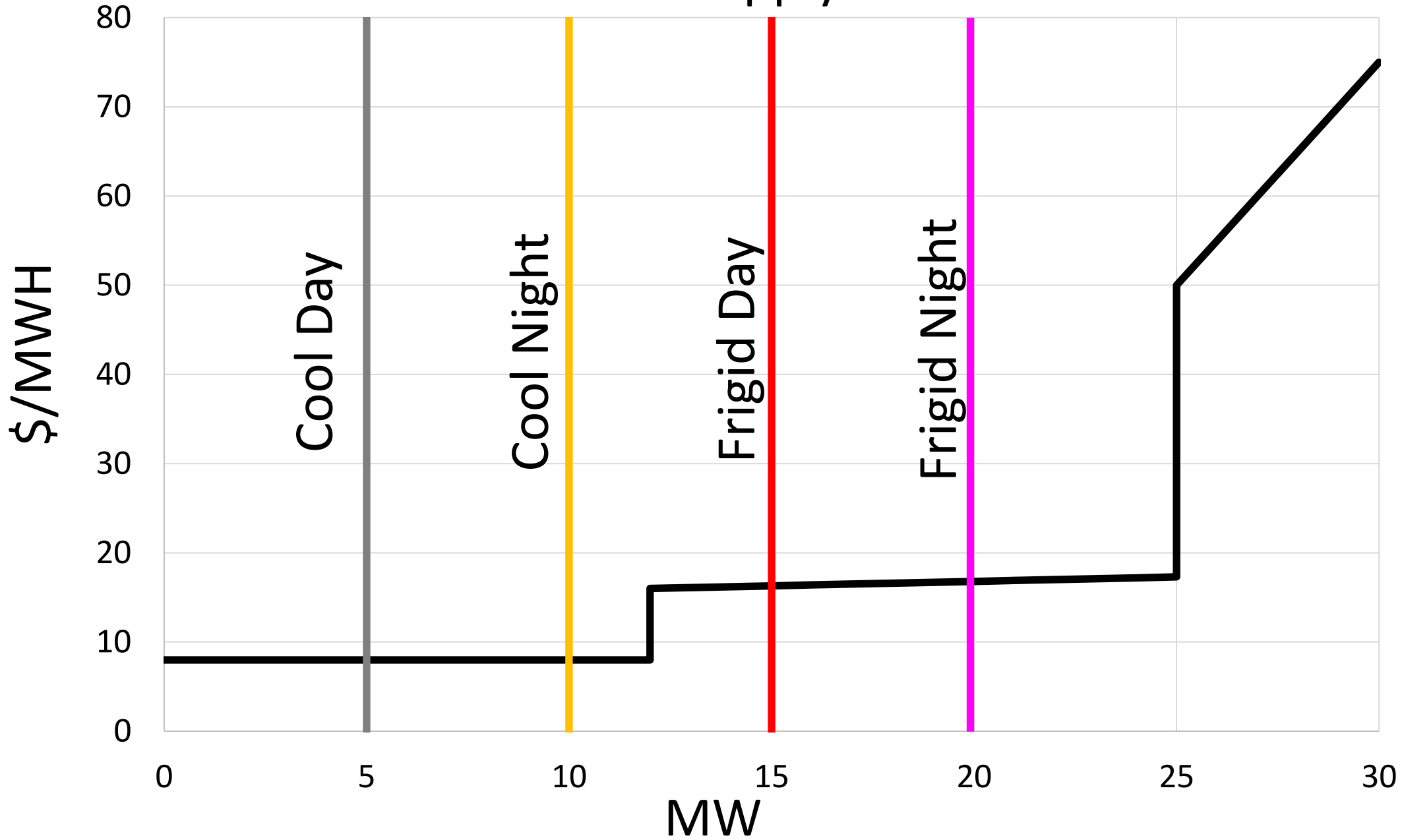
Flat Supply Curves



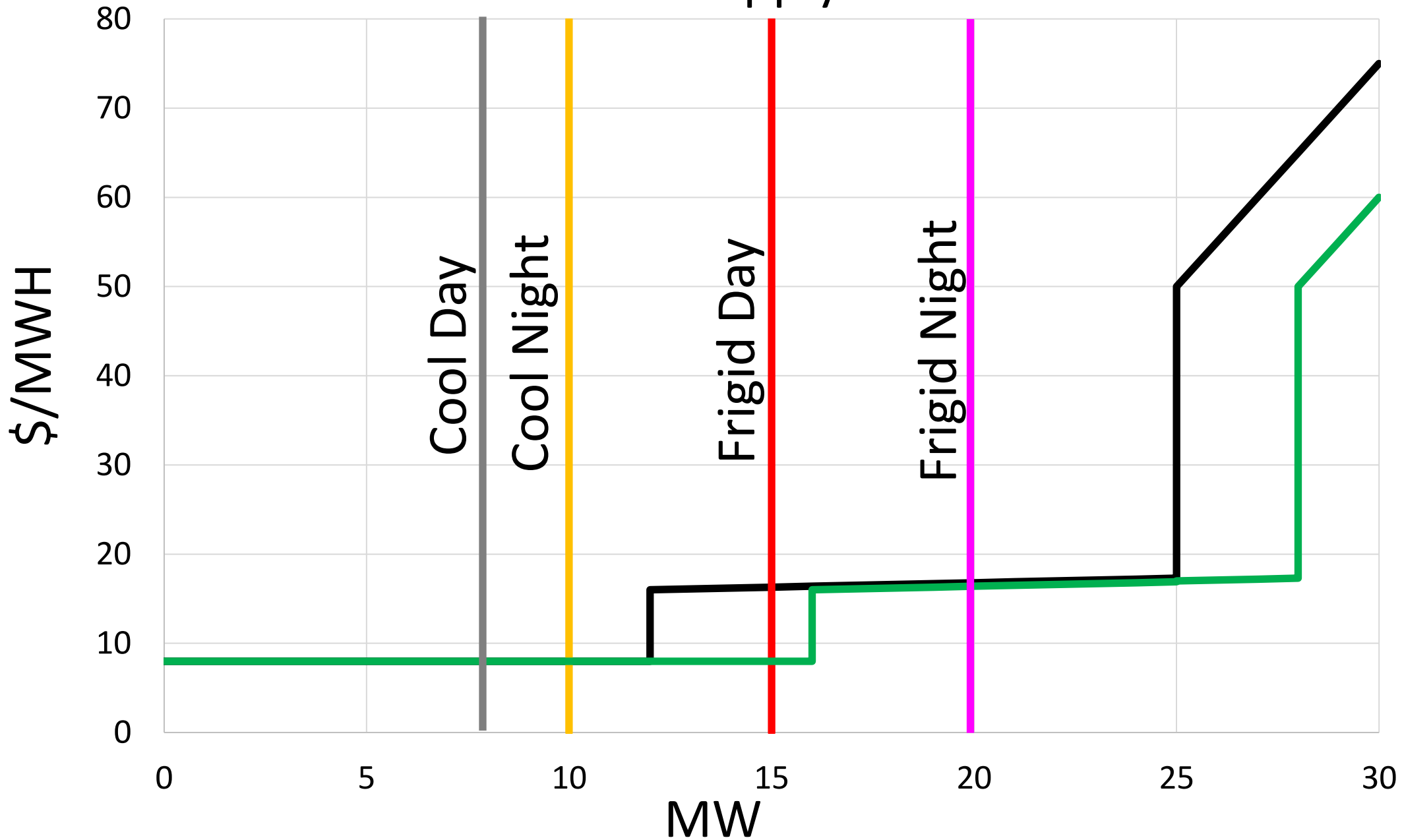
Flat Supply Curves



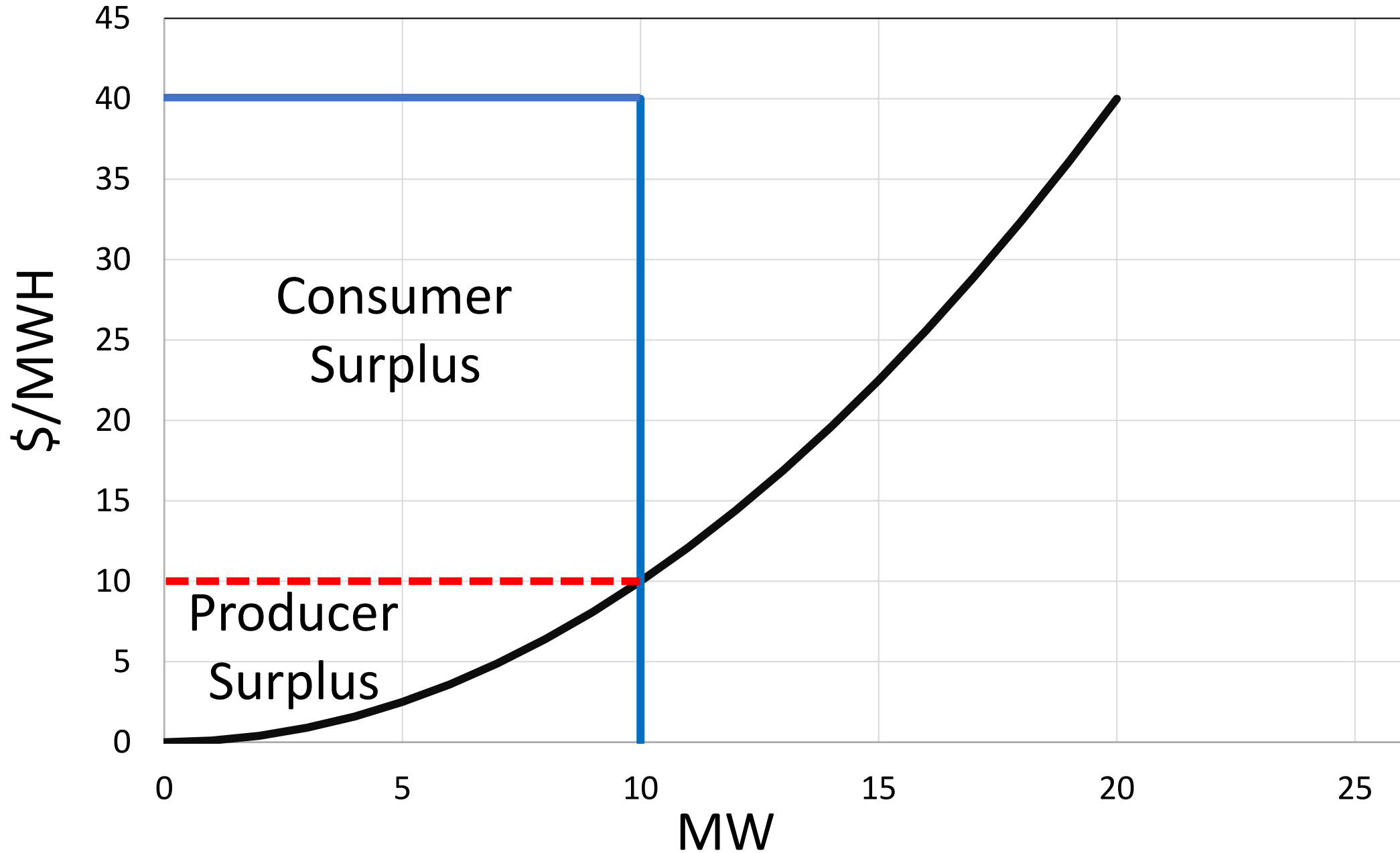
Flat Supply Curves



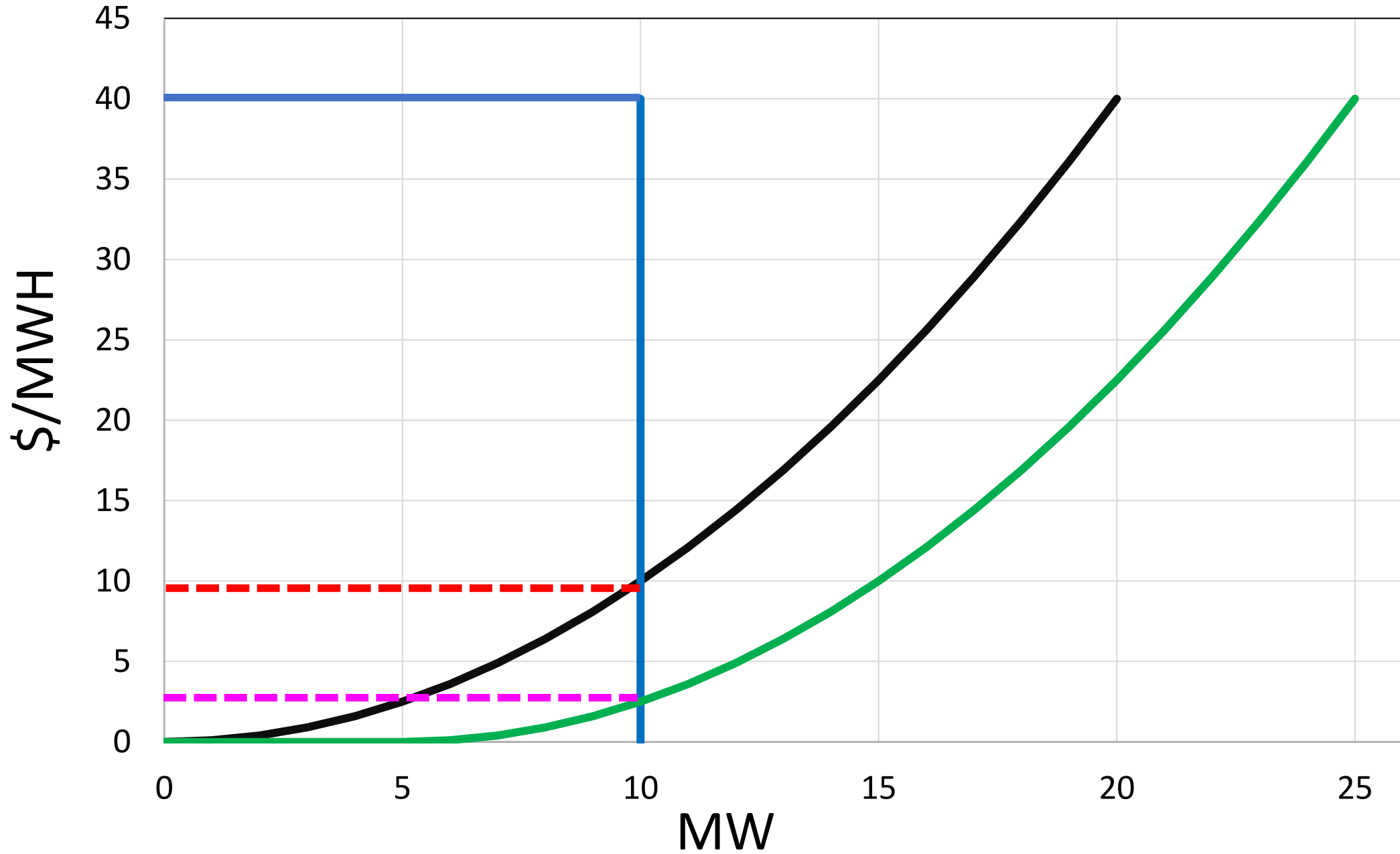
Flat Supply Curves



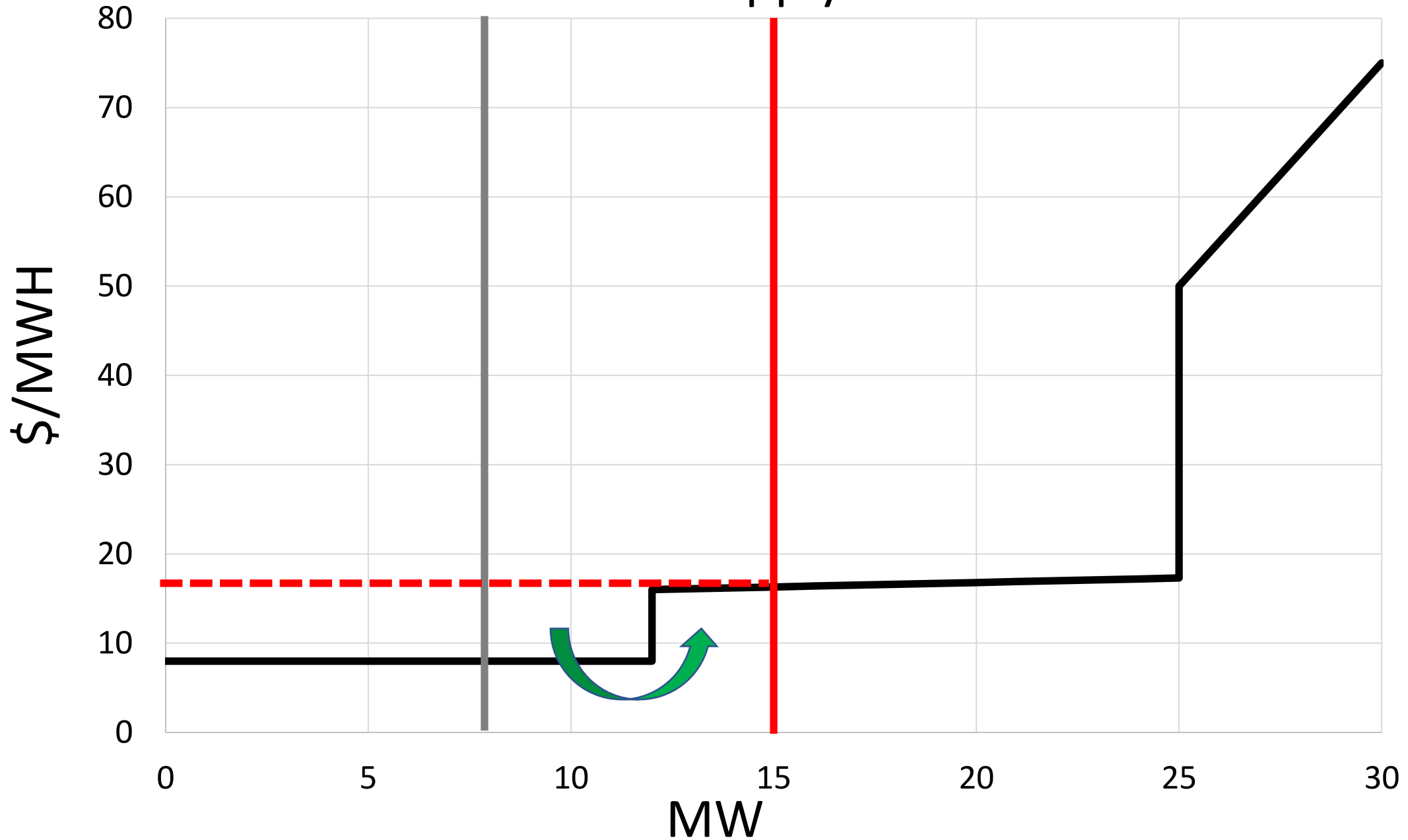
Reminder



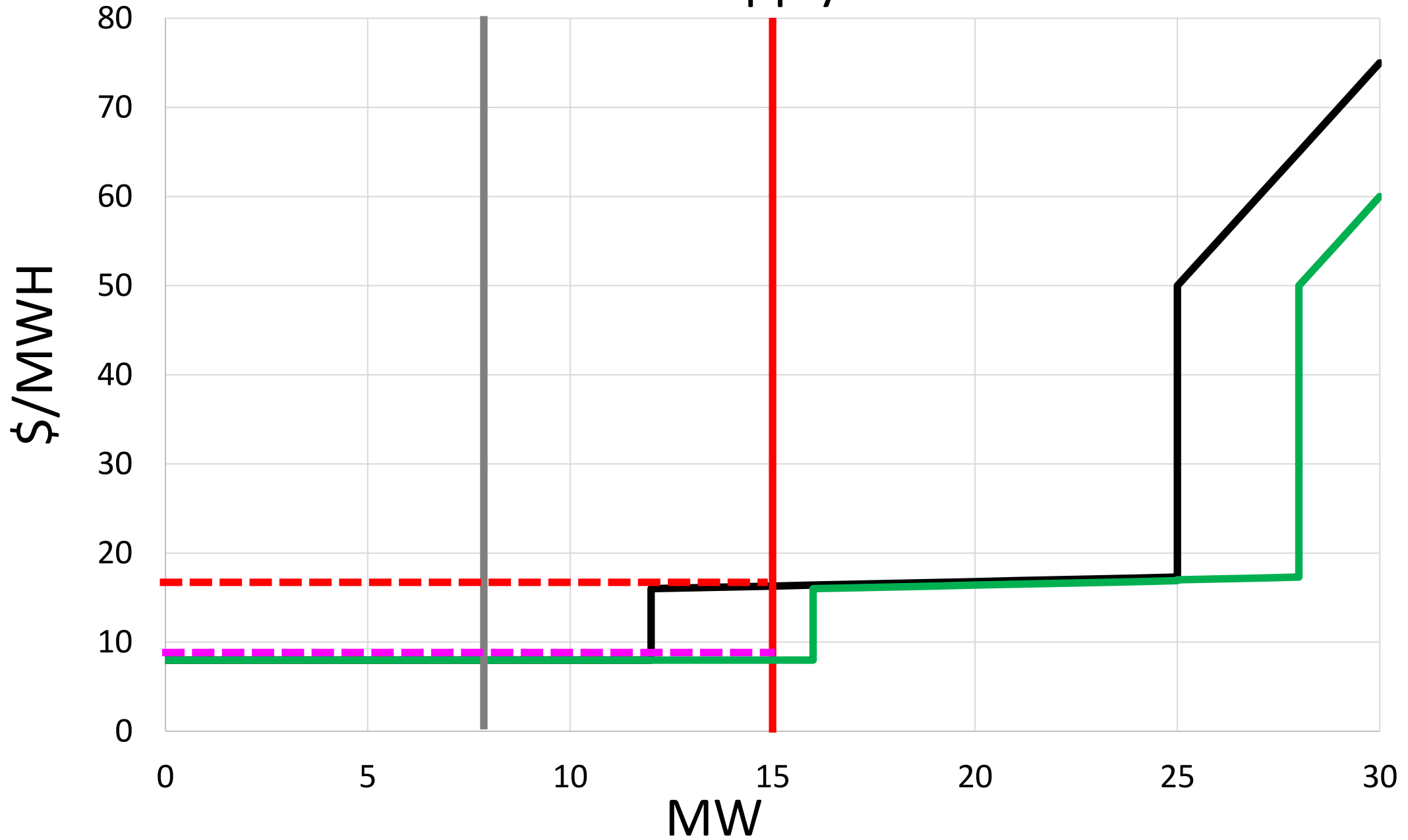
Reminder



Flat Supply Curves



Flat Supply Curves



Capacity and reserve

Transmission + Distribution Capacity

Two potential constraints:

1. The existing wire is insufficient to serve specific load
2. The existing wire is insufficient to serve a specific generator

Drivers may differ depending on the potential constraint, and may include:

- cost to upgrade?
- Is there enough unconstrained capacity on the wire to sufficiently charge the battery before it is needed to discharge later? → *if the wire is constrained most of the time, the battery might not be able to charge from the system*

Distribution-connected 40 MW Solar Facility

DIVE BRIEF

DOE provides \$505M to advance long-duration energy storage fed by renewables

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By Elizabeth McCarthy

in fb tw



Adeline Kon/Utility Dive

