COG:
Fixing the Intertemporal Pricing Problem & Other Comments

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Overview

1. The intertemporal problem

- What is the “right” price in different periods?
- Calculating the “right” price
- Misleading “perpetual high price” example

2. Spatial distortions (Appendix C) likely to be rare

Purpose of Treating COGs as Flexible Units in Pricing

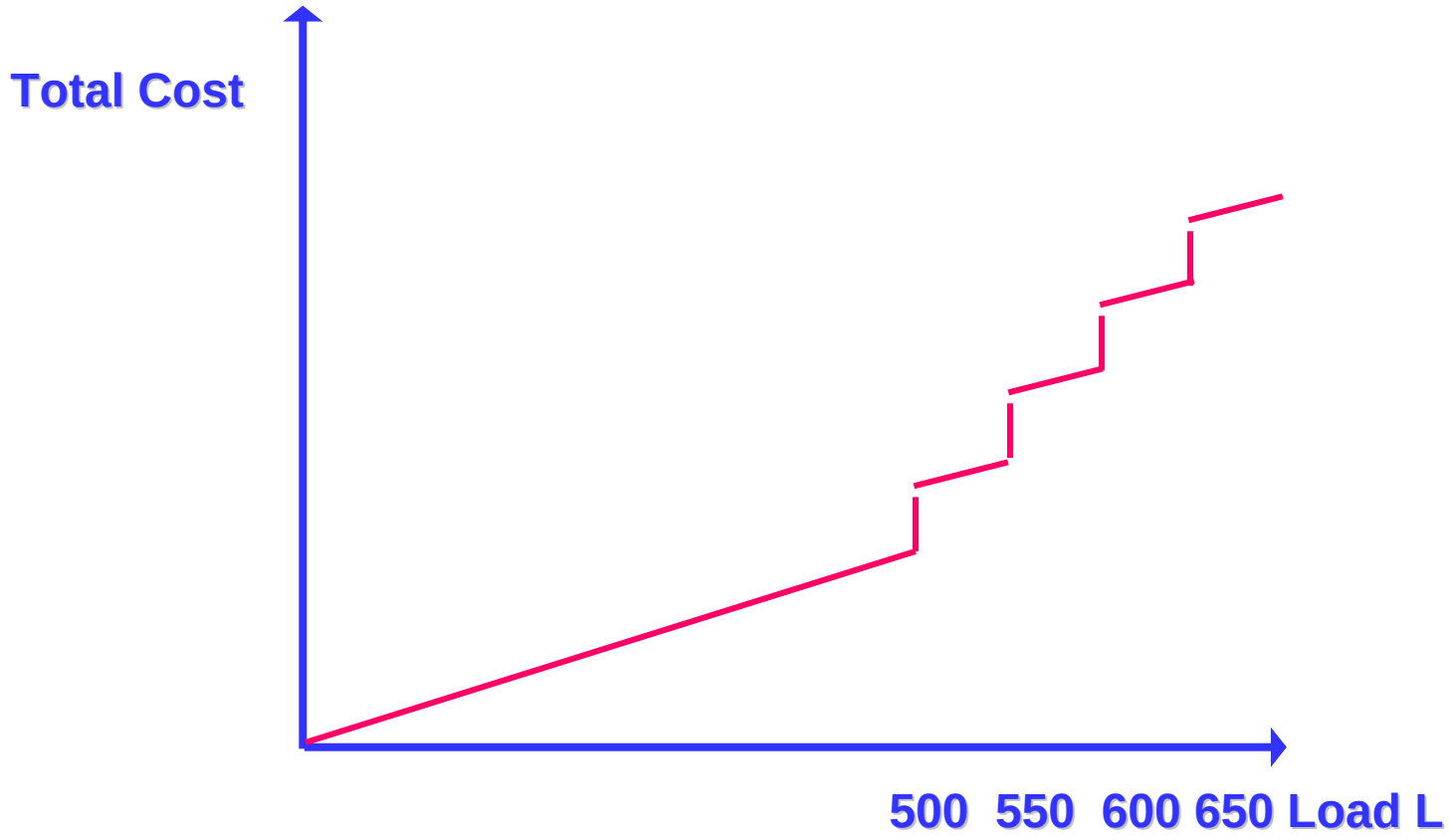
- **Assumptions**
  - COGs are small, high priced units
  - Variation in load >> size of units

- **Thus, *if* more COGs are dispatched in response to demand variations, the relevent "incremental" cost is better represented by *average* cost of COGs**
  - Want to give more appropriate price signal to responsive load and investors in generation

Single Period Example

(Kudos to R. O'Neill of FERC for suggesting this approach)

- **Assumptions**
  - 500 MW Steam unit (ST), marginal cost = 55$/MWh
  - Several 50 MW COGs, average cost = $100/MWh
  - Variation of total cost with load:



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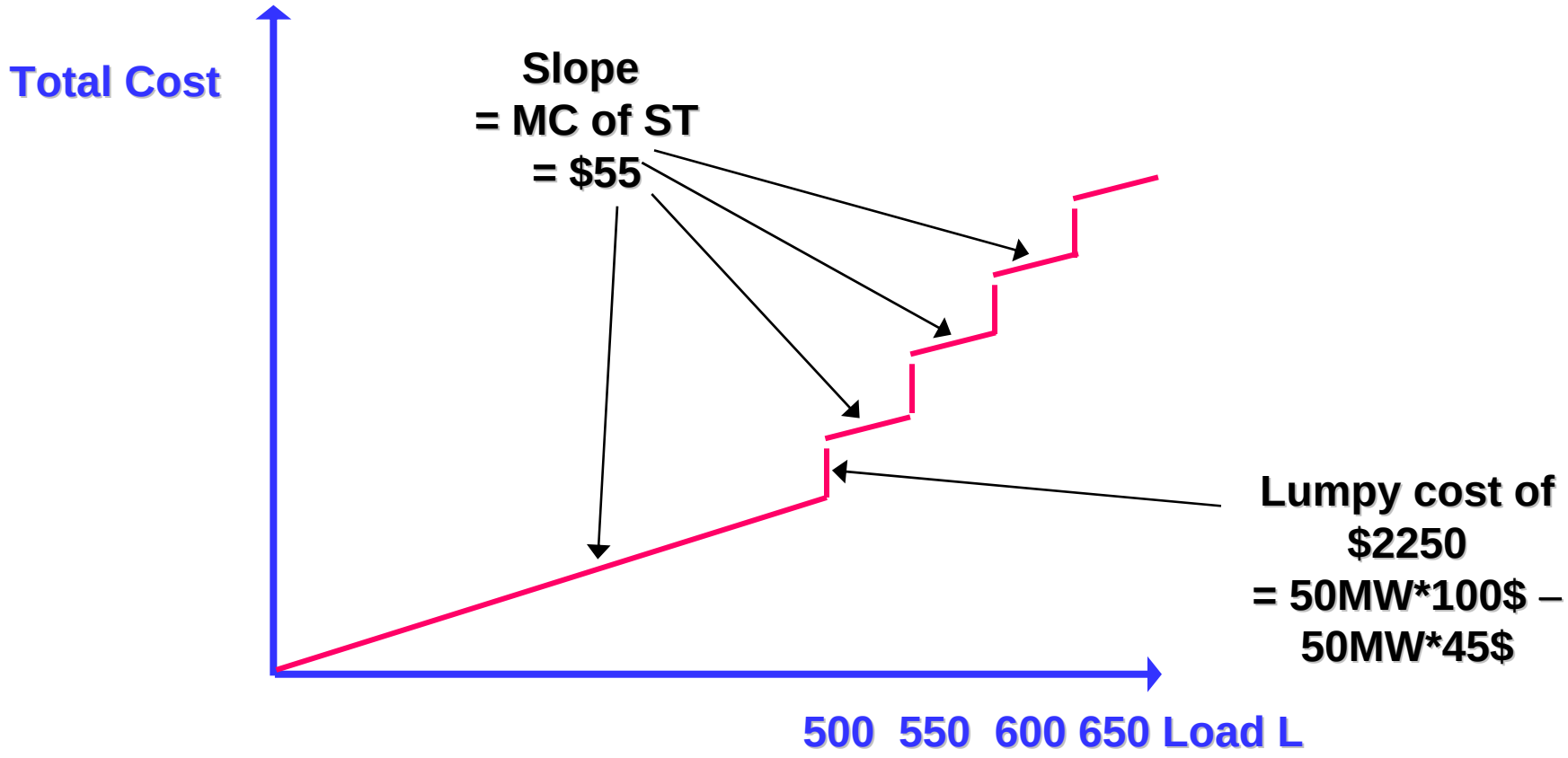

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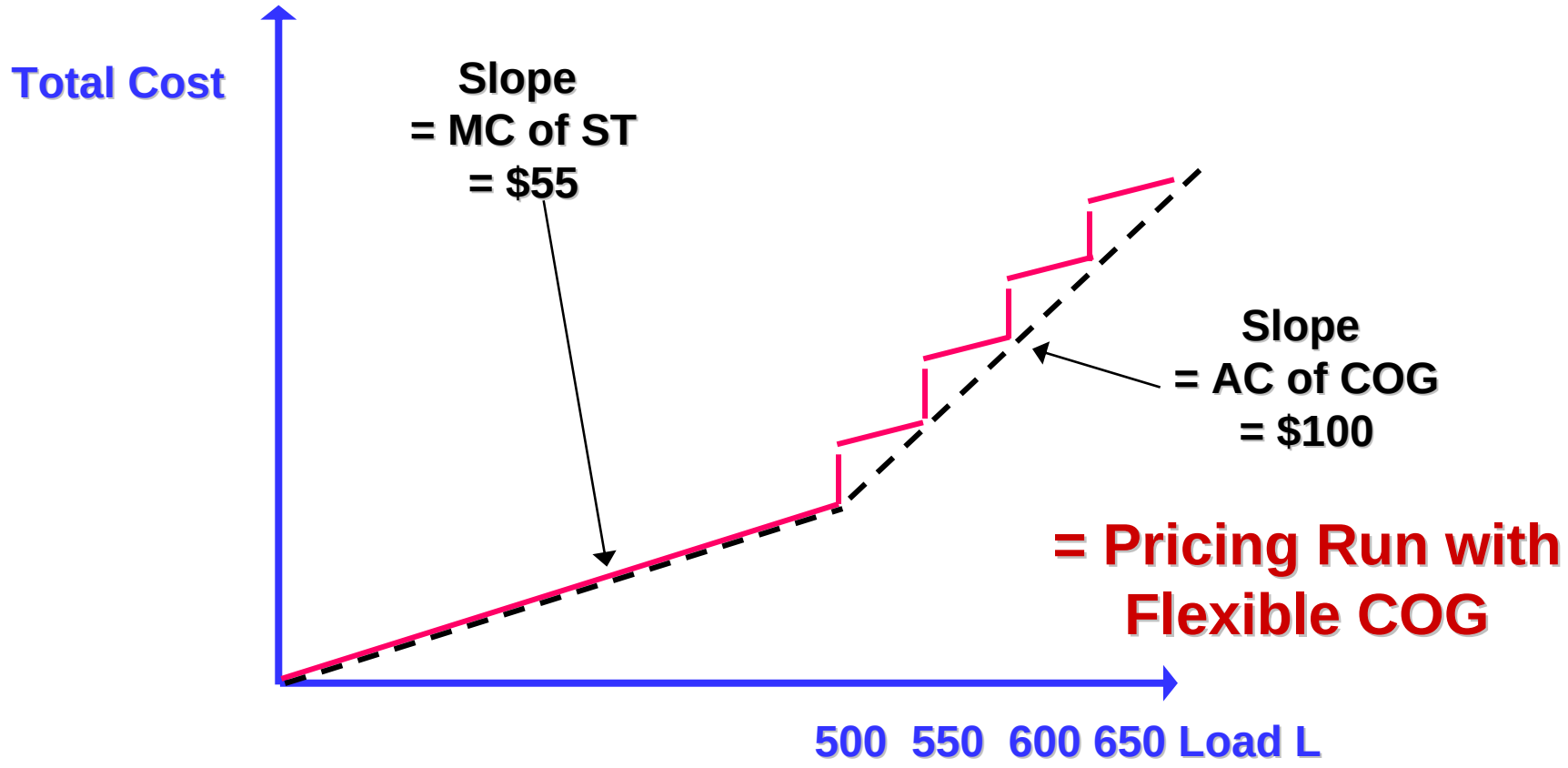
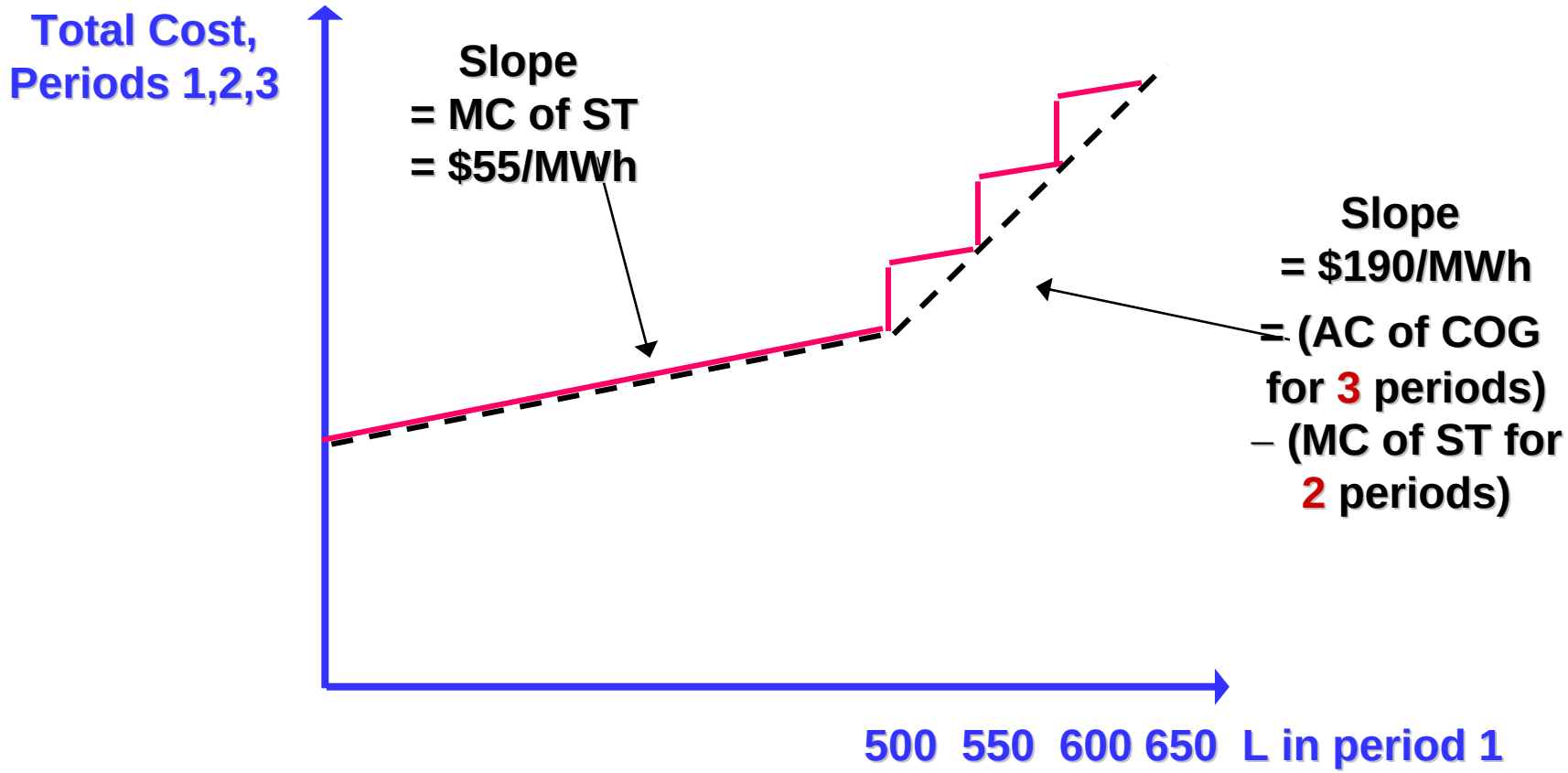


Three Period Example

- Assumptions
  - 500 MW Steam unit (ST), MC = 55$/MWh
  - Several 50 MW COGs, AC = $100/MWh; must operate for 3 periods
  - Load in periods t=2 & 3 = 450 MW; so COGs "not needed" then



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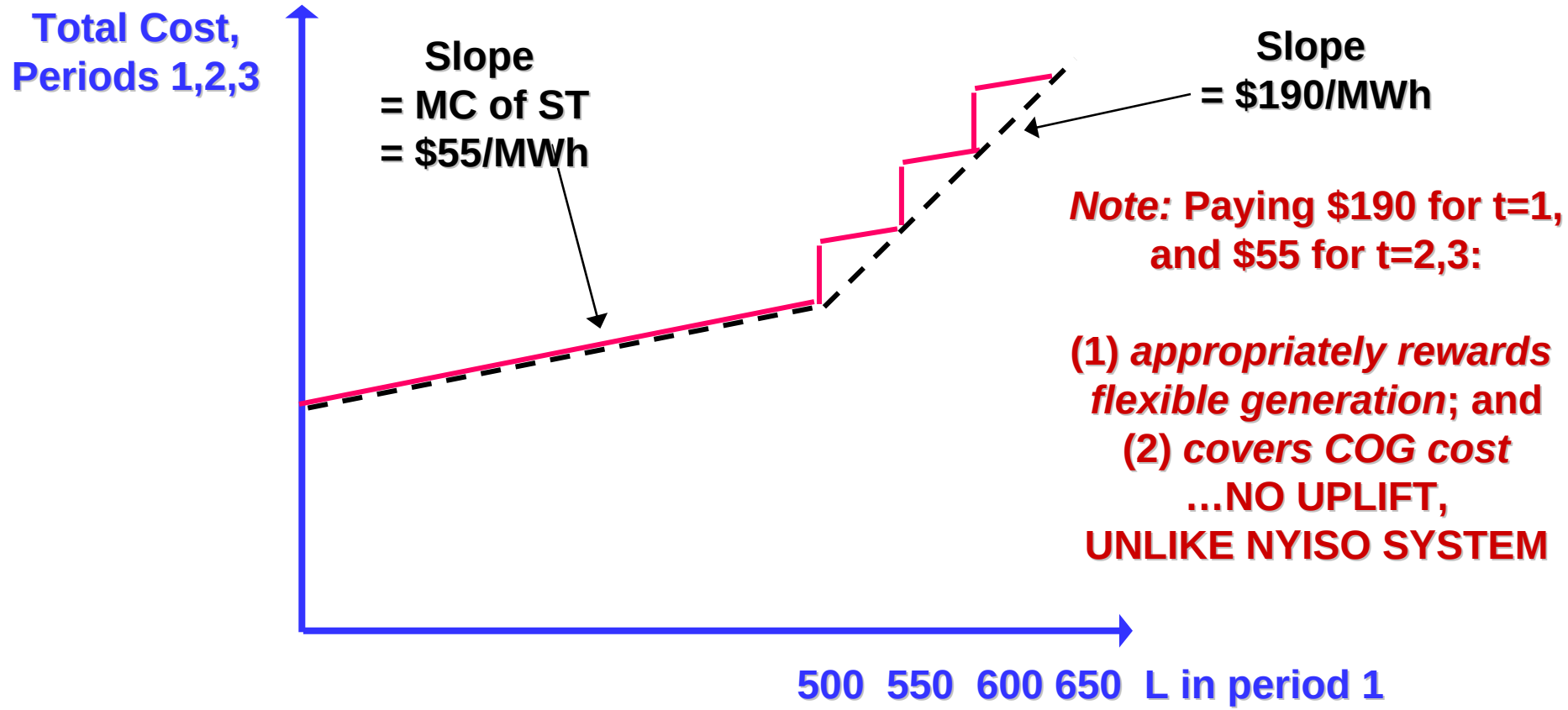
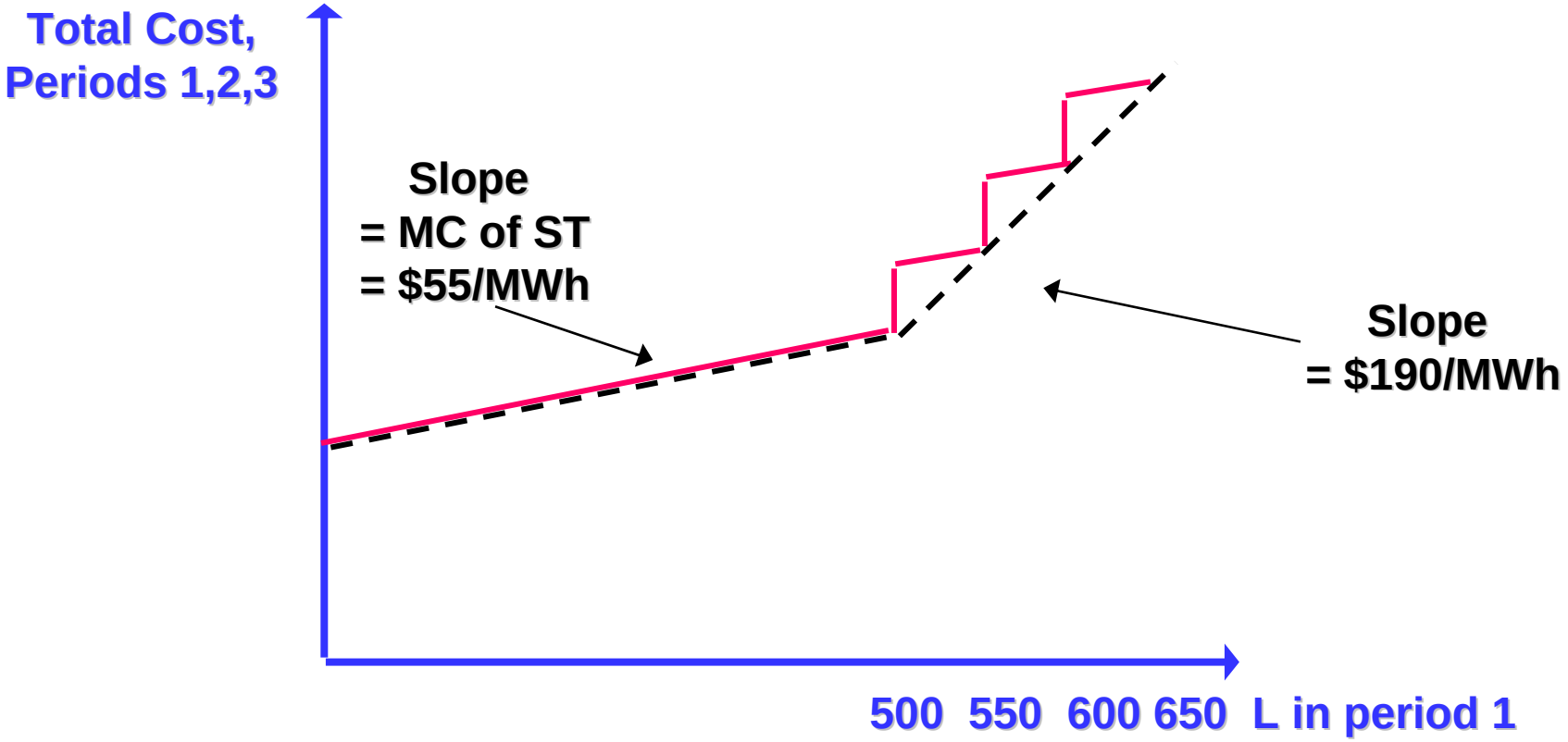


Three Period Example

- How can we get these prices in a pricing run?
  - Impose min run time constraint for amount of COG dispatch in period 1
- E.g., If L in t=1 is 520 MW
  - Then 20 MW of COG is dispatched in t=1 in pricing run; that's the lower bound to COG dispatch in t=2,3
  - Yields λ_1 = \$190, $\lambda_2 = \lambda_3$ = \$55



One Possible Procedure

- **Scheduling run (MILP):**
  - *Impose all COG constraints*
- **Pricing run 1 (MILP):**
  - *For t in which COG output = 0, constrain off*
  - *For t in which COG output = capacity:*
    - *Allow continuous dispatch all periods*
    - *Enforce min run time constraint starting in period in which generator is first turned on: i.e., output must equal first period output for min run period*
    - *Integer variables needed to identify first period to turn on (which might be later)*
- **Pricing run 2 (LP):**
  - *For t in which COG output = 0 in Pricing run 1, constrain off*
  - *For other t:*
    - *Allow continuous dispatch all periods*
    - *Enforce min run time constraint starting in first period in which generator is turned on in Pricing Run 2*

Other Comments (1)

- **Perpetuation of overly high prices (Appendix A)**
  - ***Problem:*** **Inability of flexible generation to move fast enough to shut down COG results in perpetual COG-based prices**

- **Example: ST capacity unlimited, COG capacity = 14 MW**
  - ***t=0*****: ST at 100 MW (max ramp rate = 5 MW)**
  - ***t=1*****: 114 MW load; COG dispatched because ST can't move fast enough. COG sets price**
  - **If 114 MW load occurs, t=2,3,…, COG will be dispatched *ad nauseum*, setting price forever, even if ST's capacity enough to meet all load**

- **Example is misleading:**
  - **No feasible schedule could ever move ST up to meet that load,**
    - **So perpetual COG prices are a result of insufficient ramping capacity, not pricing algorithm**
  - **In real system:**
    - **would ramp up ST and other flexible (perhaps costly) units at same time in order to shut down COG**
    - **Once COG shut down, then ramp down other flexible units to allow ST to take full load**

Other Comments (2)

- **Possible Distortion of Spatial Prices (Appen. C):**
  - ***Problem:*** **Interaction of transmission constraints can result in:**
    - **prices exceeding marginal cost of any marginal unit**
    - **relaxing COG constraint and increasing λ at its bus can decrease λ at other buses below cost of scheduled generator**

- **Occurs if:**
  - **interaction of transmission constraints causes such "amplification" of LMPs (possible but how common?), *and***
  - **a COG is "marginal" (in California, likely to be infrequent)**

Coincidence seems unlikely to occur often; in those cases, can pay uplift to harmed generator