The Potential of Short-Term Markets to Support Ramping Capacity

B.F. Hobbs
Chair, CAISO MSC
Director, E^2SHI, The Johns Hopkins University
bhobbs@jhu.edu

Folsom, March 11, 2014
(corrected)

Short-Term Energy Prices Can Support Ramping Capacity

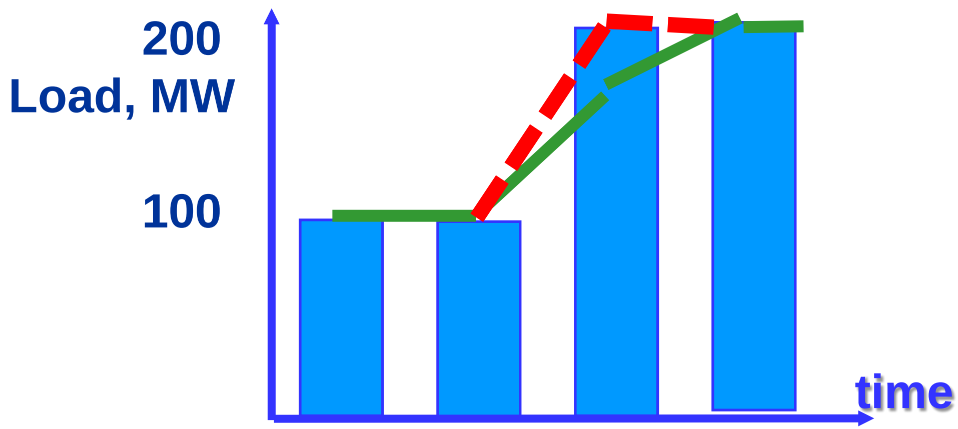
- ***If:***
  - **Intervals are sufficiently short**
  - **no forecast error**
  - **no price caps/floors, no market power**
  - **no "non-convexities" (lumpy costs, prohibited regions)**
- ***Then:*** **energy prices "support" optimal solution. I.e., given the prices:**
  - **System-optimal <u>schedules</u> ↔ profit maximizing**
  - **System-optimal <u>capacity additions</u> ↔ profit maximizing**

Prices in Morning Ramp

A system with two types of generation:

- 100 MW of quick start peakers @ \$80/MWh
- 220 MW of slow thermal @ \$25/MWh, with max ramping = 60 MW/hr

Morning ramp loads, optimal generation, prices:



Fast	0	0	40	0	MW
Slow	100	100	160	200	MW
DA Price:	25	<u>-30</u>	<u>80</u>	25	\$/MWh

(=RT rolling forward prices)

System optimal schedule ↔ Profit maximizing schedule

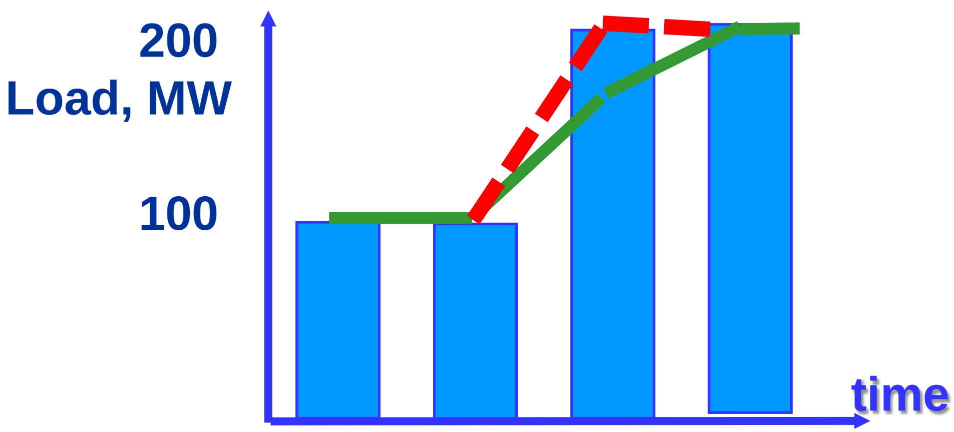
Who Profits in Morning Ramp?

A system with two types of generation:

100 MW of quick start peakers

220 MW of slow thermal

Morning ramp:



Fast	**0**	**0**	**40**	**0**	**MW**
Slow	**100**	**100**	**160**	**200**	**MW**
DA Price:	**25**	**-30**	**80**	**25**	**$/MWh**

(=RT rolling forward price)

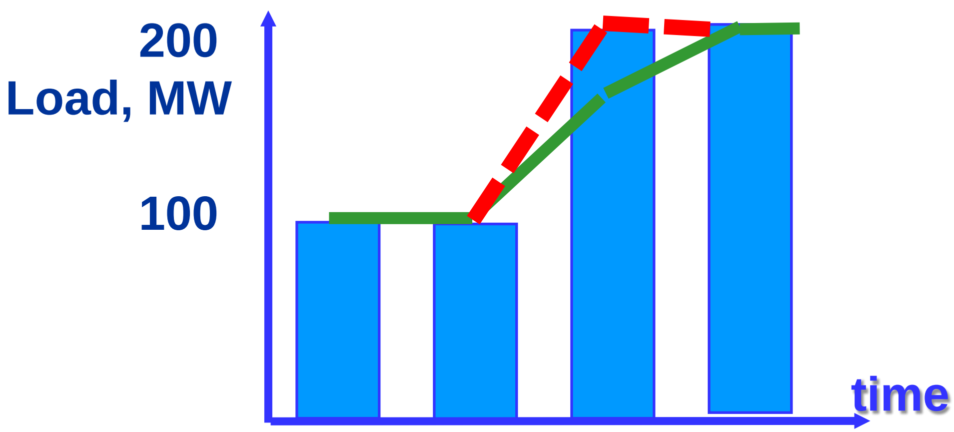
- **Flexible unit** can grab high price, avoid low price
- **If increase RR of slow unit** by 1 MW → earn ($80-$25)/MW
- **Completely Inflexible 1 MW slow unit** earns **$0** = (1MW*((25-25)+(-30-25)+(80-25)+(25-25))
- **Flexible 1 MW slow unit** earns +**$14** = (0.5MW*((25-30)+(-30-25))+0.8(80-25)+1(25-25))
- **Storage, DR** paid for delivering during ramp (and buying power during pre-ramp)

How are Costs Allocated to Load in Morning Ramp?

A system with two types of generation:

- 100 MW of quick start peakers
- 220 MW of slow thermal

Morning ramp:



Fast	0	0	40	0	MW
Slow	100	100	160	200	MW
DA Price:	25	<u>-30</u>	<u>80</u>	25	$/MWh

(=RT rolling forward price)

Load that contributes to ramp *pays more:*

- Constant 1 MW load pays <u>**$25/MWh**</u>

  =[25+(-30)+80+25]/4)

- Ramping load pays <u>**$34/MWh**</u>

  =[0.67*[25+(-30))
  +1.33*(80+25]/4

Imports that contribute to meeting ramp *are paid more:*

- Constant 1 MW import paid **$25/MWh**
- 1 MW load (average) that ramps paid **$34/MWh**

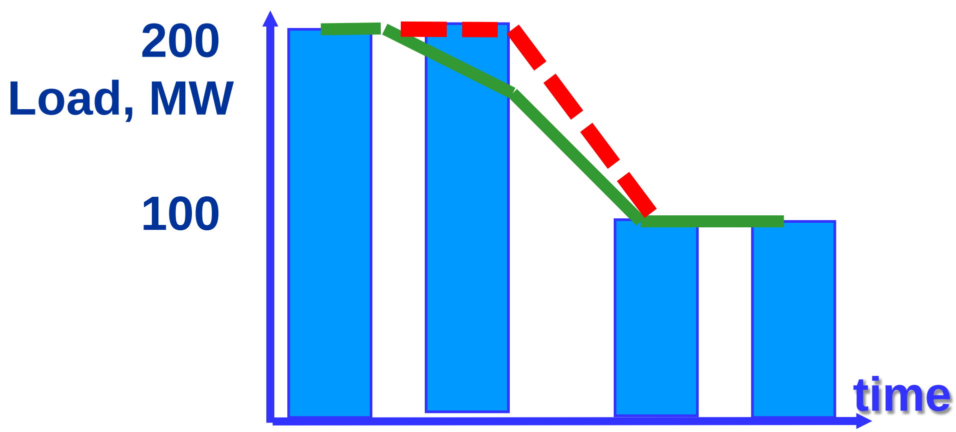
Who Profits in Evening Ramp-Down?

A system with two types of generation:

100 MW of quick start peakers

220 MW of slow thermal

Evening ramp down:

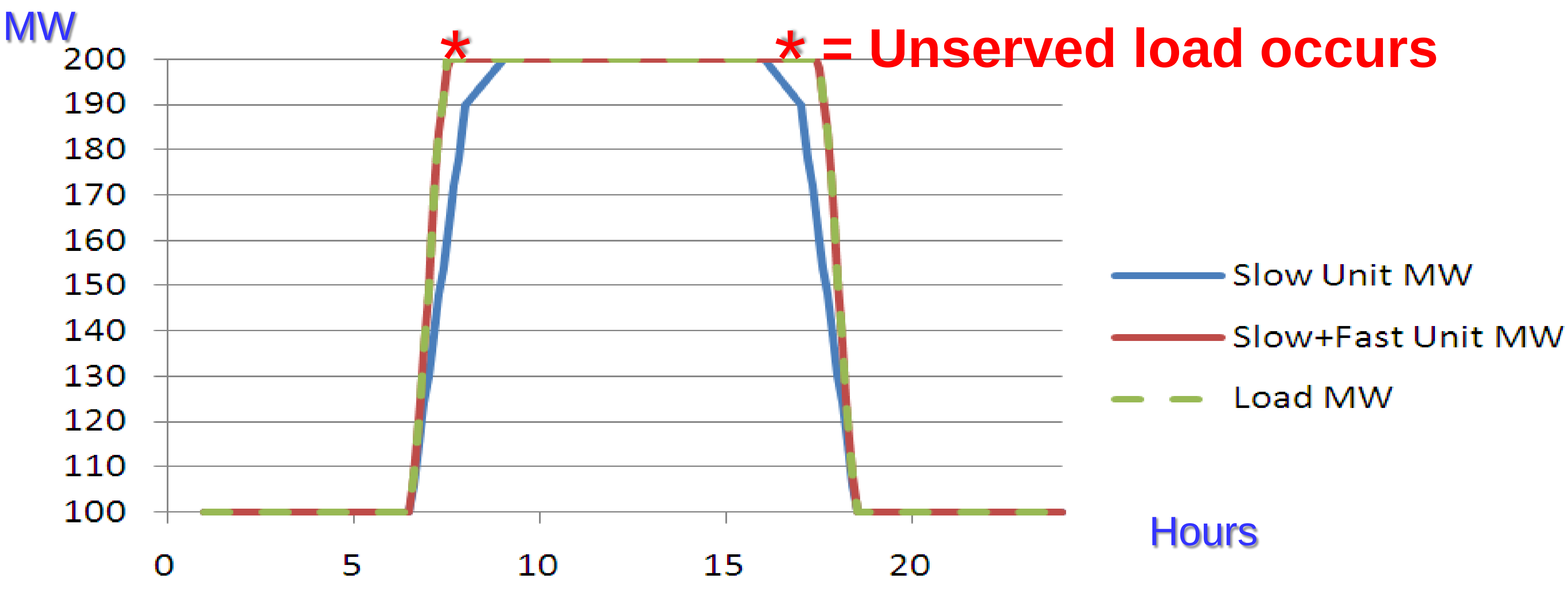


Fast	**0**	**40**	**0**	**0**	**MW**
Slow	**200**	**160**	**100**	**100**	**MW**
DA Price:	**25**	**<u>80</u>**	**-<u>30</u>**	**25**	**$/MWh**
RT Rolling P:	**25**	**80**	***<u>(25 or price floor)</u>***	**25**	**$/MWh**

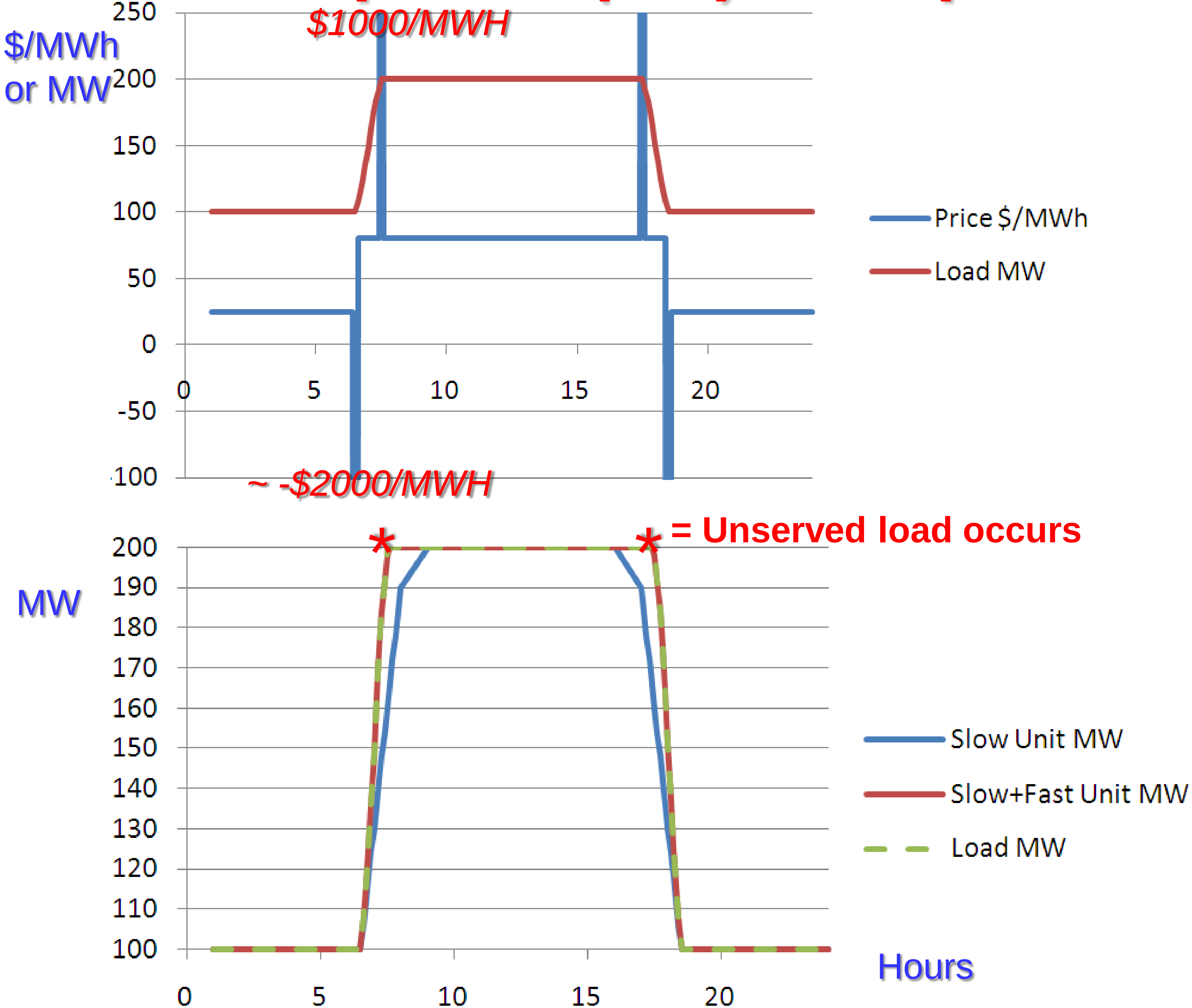
- **Flexible unit** can grab high price, avoid low price
- **If increase RR of slow unit** by 1 MW → earn (*DA*) ($80-$25)/MW
- **Completely Inflexible 1 MW slow unit** earns (*DA*) **<u>$0</u>** = (1MW*((25-25)+(-30-25)+(80-25)+(25-25))
- **Flexible 1 MW slow unit** earns **<u>$14</u>** *(DA)* = (0.5MW*((25-30)+(-30-25)) +0.8(80-25)+1(25-25))
- **Storage, DR** paid for delivering during ramp (and buying power during post-ramp)

Optimal Capacity

- Slow capacity @$200K/MW/yr → ***200 MW***
- Fast capacity @$80K/MW/yr → ***38 MW***
- Unserved load = $1000/MWh →***2 MW*** **max**
- No price floor or ceiling



Short run prices (DA) + Dispatch



Conclusions

- **Under heroic assumptions:**
  - **Energy prices enough to support optimal ramp schedules & capacity**
  - **If assumptions don't hold:**
    - ***Uncertainty → need for flexiramp***
    - ***Missing money → need for capacity payments***
- **Advantages of using short-run markets:**
  - **Resources rewarded for helping at time and place needed**
    - ***Appropriate payments, accounting for scheduling constraints (energy & start limits, storage, DR ….)***
    - ***Imports appropriately rewarded***
  - **Costs allocated to load according to contribution to need for resources**
- **Flexible RA: insurance if spot markets don't work**
  - **If they do, FRA price → 0**