Markets for Resource Adequacy

Peter Cramton
University of Maryland
(joint with Steven Stoft)

17 May 2007

Goals of electricity markets

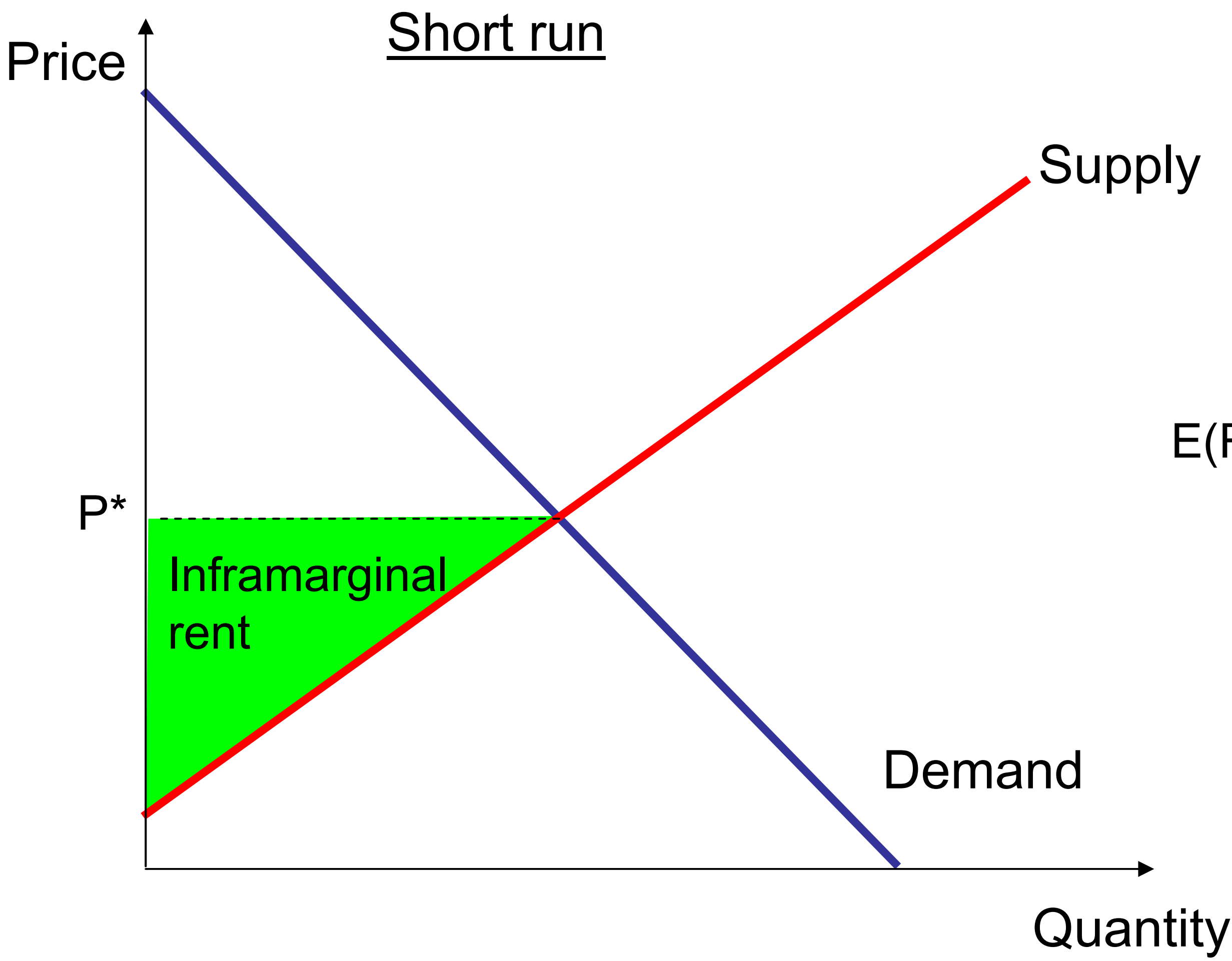
- Short-run efficiency
  - Least-cost operation of existing resources
- Long-run efficiency
  - Right quantity and mix of resources

A tale of two markets

- New England (33 GW)
  - Thermal dominated
  - Reliability
    - Resources to serve annual peak
    - Resources to respond to contingencies
  - Product
    - Capacity: Ability to supply energy during hours short of reserves
- Colombia (13 GW)
  - Hydro dominated
  - Reliability
    - Resources to supply energy in dry period
  - Product
    - Firm energy: Ability to supply energy during dry periods

Why a firm energy market at all?

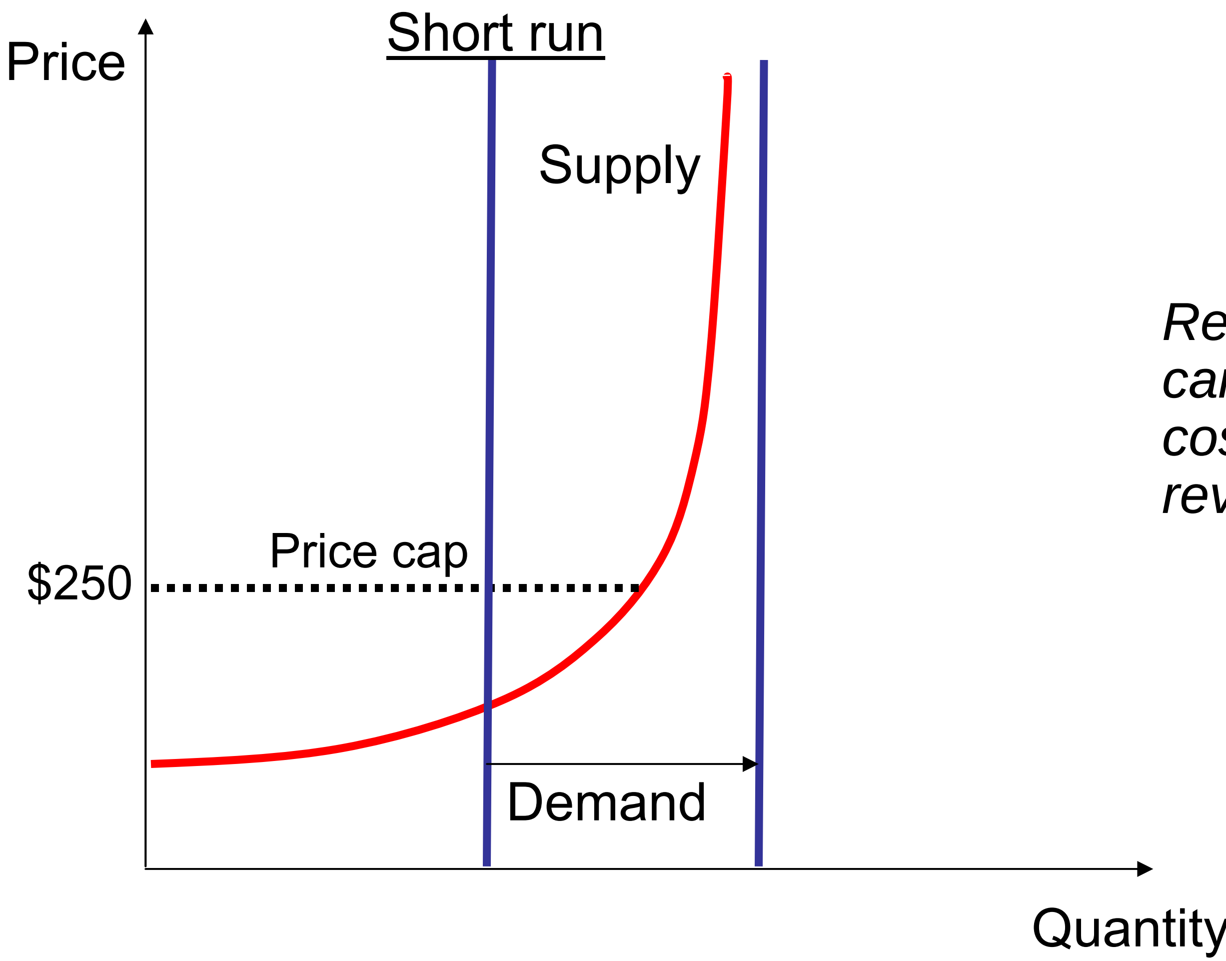
Other industries don't have one



Long run

E(Rent) = Fixed cost

Electricity demand is inelastic



Result: Generators cannot cover fixed costs from energy revenues

Why have a market?

- Absence of demand response
- Market power during scarcity
- Spot prices too low during scarcity
  - Price caps
  - Operator decisions, such as voltage reduction, which impact price

Energy-only is problematic

- High risk (occasional NZ$17,000 price)
- Market power
- Weak investment signal
- Intervention likely
  - Government's Whirinaki 155 MW reserve plant
  - Needed for 1 in 60 dry year

Purpose of market

- Induce just enough investment to maintain adequate resources
- Induce efficient mix of resources
- Reduce market risk
- Avoid market power in firm energy market
- Reduce market power in energy market
- Pay no more than necessary

Key features

Forward procurement

- New projects compete in advance of entry
  - Coordinated entry
    - Less uncertainty in achieving target
    - Avoid boom/bust
  - New entry sets price directly
- Long-term commitment for new resources
  - Reduced investor risk
  - Better price signal for new investment

Product

- Firm energy — availability of energy during scarcity events
  - Dry period (seasonal scarcity)
  - Outages (spot scarcity)
- Scarcity event defined by high energy price
  - Energy price is a *transparent* trigger
  - Energy price is a *reliable* trigger

Product is:

- Firm energy + mandatory hedge
- Firm energy =
  - Expected energy contribution to system in dry period
- Mandatory hedge = (call option)
  - Obligation follows load
    - Unit's daily obligation based on its firm energy sold
    - Obligation over day tied to dispatch
    - Matching obligations with dispatch improves the performance of the spot energy market
  - Rewarded if shift output to higher priced hours

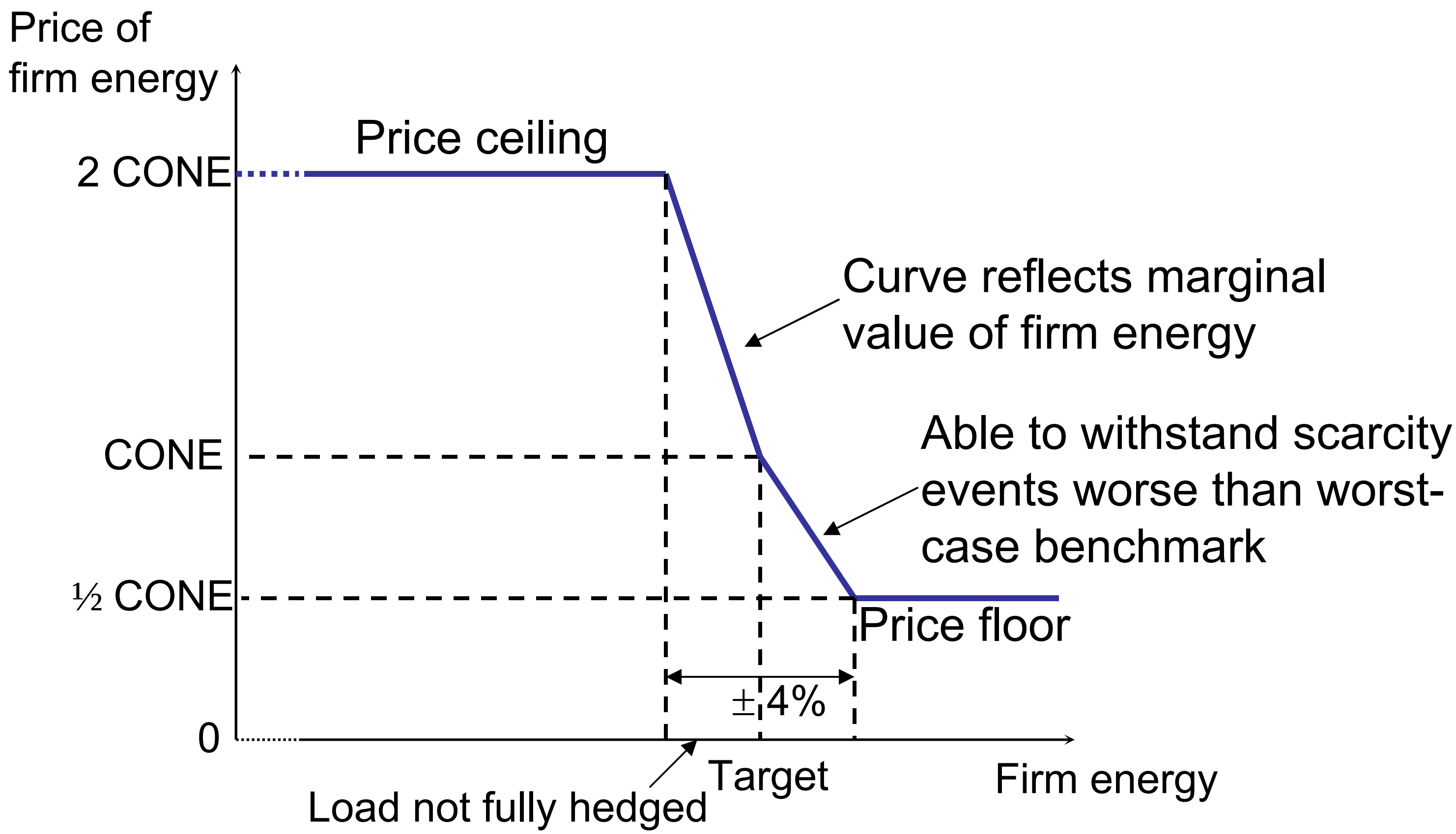
Planning period

- Time between auction date and start of commitment
- 4 years — long enough for new entry to occur (except large hydro projects)
- Makes firm energy market contestable and allows new entry to set the price
  - Existing resources would set the wrong price because of sunk costs and market power

Commitment period

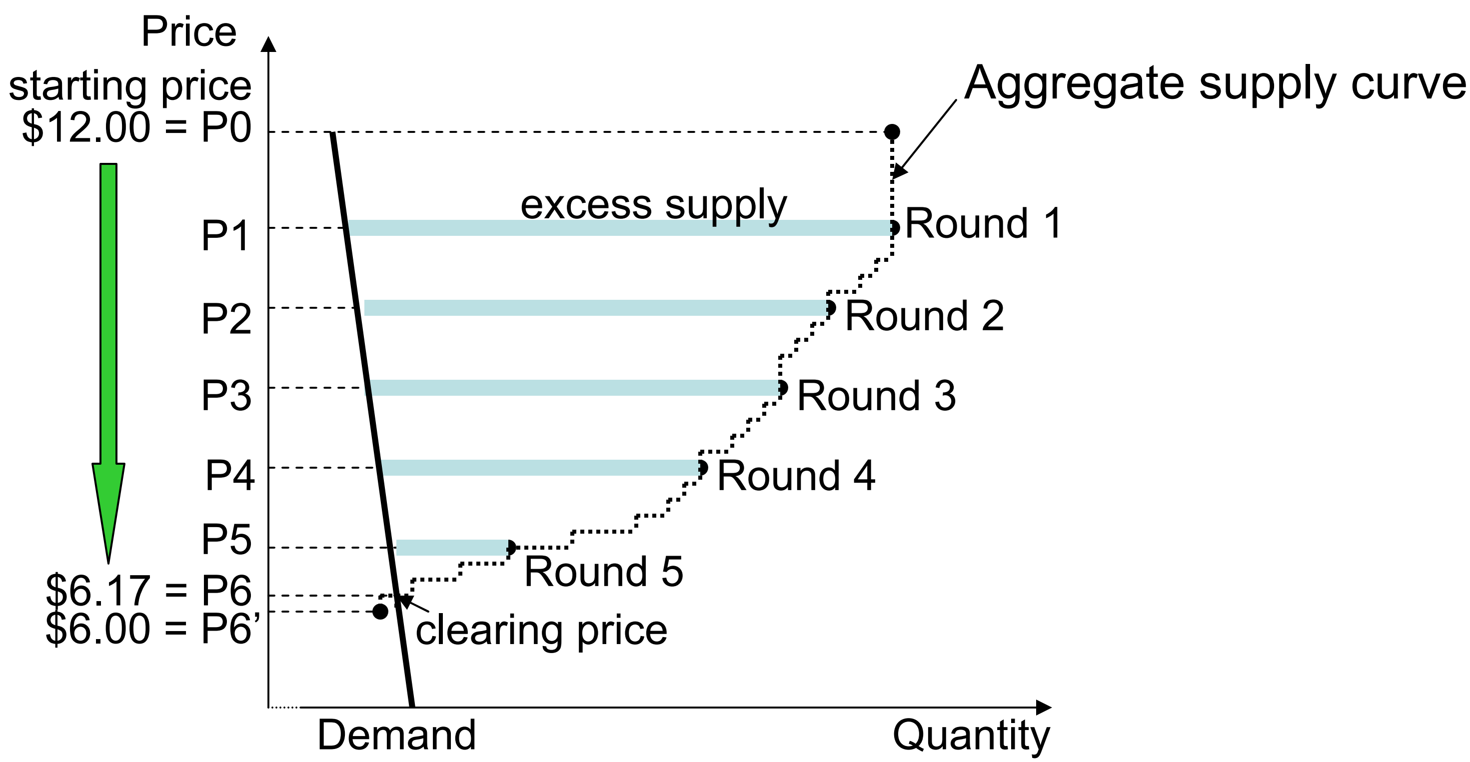
- New resource — up to 20 years
  - Long commitment lets new resource lock-in firm energy price, reducing risk and encouraging investment
- Existing resource — one year
  - Does not need long commitment, since costs are already sunk
  - Short commitment reduces risk (more draws from price distribution)

Demand curve



CONE = Cost of New Entry (marginal unit)

Descending clock auction



Market power

- Addressing market power in firm energy market is essential
- Strong incentive to exercise market power
  - Existing resources have substantial sunk costs
  - New resources are only a tiny fraction of total
  - Market is concentrated
    - Any of top-4 suppliers could unilaterally set price
- Long-term price signals are more stable and efficient if determined from competitive forces, rather than market power

Market power solution

- New resource
  - Bids are not mitigated in any way
  - Assumes competition for new resources
- Existing resource
  - Resource can opt out of market or retire
  - Opt-out bid
    - Not revealed during auction
    - Cannot impact the price for existing supply
  - Retirement
    - Can impact price, but exit is permanent

Performance incentives

- Performance incentives come from energy spot price; this is not changed by hedge
- Hedge assures that normal performance will receive normal reward in wet and dry years alike
- Every extra MWh of energy is rewarded the same with or without hedge
  - Those that perform better receive more
  - Those that perform worse receive less

Why not have a very high strike price? (US$250 or more)

- Benefits of call option are largely lost
  - Load hedge
  - Mitigation of market power in spot energy market
- No reason to set strike price higher than marginal cost of an expensive thermal unit

Simulation

Purpose

- Assess supplier risk
- Consider variations of market design
- Evaluate alternative auction parameters

Distribution of annual profits per MWh of firm energy

Scenario	Stat	With hedge: Firm energy payment	With hedge: Hedge payment	With hedge: Energy rent	No hedge: Energy rent + peak energy rent	With hedge: Profits after FC	No hedge: Profits after FC
Benchmark	Mean	3.26	0.07	35.75	38.41	-0.72	-1.39
	Std. Dev.	0.44	0.39	3.84	20.71	2.91	20.49
Steep FE demand curve	Mean	3.15	0.06	35.75	38.24	-0.92	-1.64
	Std. Dev.	0.54	0.38	3.79	20.12	2.83	19.93
High demand response	Mean	3.26	0.02	35.75	36.42	-0.77	-3.38
	Std. Dev.	0.44	0.10	3.84	6.19	2.80	5.53

- Hedge dramatically reduces risk
- Energy rent primary source of risk
- Impact of higher strike price
  - Profit distribution shifts toward no hedge case
    - Large increase in energy rent risk
    - Small decrease in hedge payment risk
    - Large increase in profit risk overall

Conclusion

Physical resource with hedge

- Coordinated entry reduces boom/bust cycle
- Hedge reduces risk
  - Load is hedged from high spot prices
  - Suppliers get nearly constant payment, rather than highly variable peak energy rents
- Hedge improves spot market
  - Mitigates market power problem during scarcity
    - Can rely on demand response rather than rationing
  - Better spot market improves forward energy market
    - Spot energy prices are more stable and predictable