

Capacity Market Fundamentals

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Market design

- Establishes rules of market interaction
- Economic engineering
 - Economics
 - Computer science
 - Engineering, operations research

Market design accomplishments

- Improve allocations
- Improve price information
- Reduce risk
- Enhance competition
- Mitigate market failures

Applications

- *Electricity markets*
- Spectrum auctions
- Natural resource auctions (timber, oil, etc.)
- Emission allowance auctions
- Financial securities
- Procurement

Objectives

- Efficiency
- Transparency
- Fairness
- Simplicity

Principle

“Make things as simple as possible,
but not simpler” -- Albert Einstein

Electricity

Goals of electricity markets

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

Challenges of electricity markets

- Must balance supply and demand
at every instant
at every location
- Physical constraints of network
- Absence of demand response
- Climate policy

Climate policy

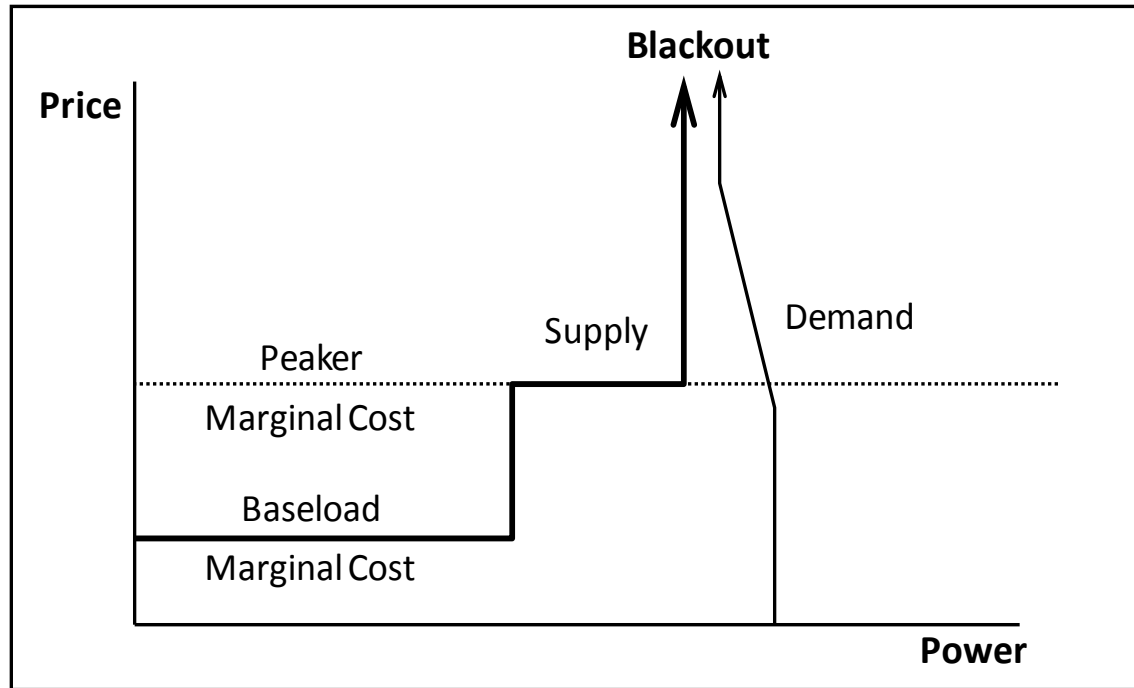
- Transformation to renewable
- Germany
 - Replace nuclear with renewable
 - 80% renewable (mostly wind) by 2050
 - Significant probability of multiple days with wind in-feed less than 5% of capacity
 - Must back-up wind with peaker capacity
 - Require additional 30 GW of peakers by 2030
 - *How to get this built?*

Three Markets

- Short term (5 to 60 minutes)
 - Spot energy market
 - Energy: day ahead, real time with congestion pricing
 - Reserves: 30m non-spin, 10m non-spin, 10m spin, freq. regulation
- Medium term (1 month to 3 years)
 - Forward energy market
 - Bilateral contracts
- Long term (4 to 20 years)
 - Capacity market (thermal system)
 - Firm energy market (hydro system)
 - Bilateral contracts (Texas, Nord Pool)
- Address risk, market power, and investment

Why not energy only?

- Market failure
 - Absence of demand side
- Practical realities
 - Price caps
 - Operator decisions
 - *Missing money*



Long-term market:
Buy enough in advance

Purpose of market

- *Operational reliability*
- Pay no more than necessary
 - Induce just enough investment to maintain adequate resources
 - Induce efficient mix of resources
 - Reduce market risk
 - Reduce market power during scarcity

The four P's to a successful design

- Planning
- Product
- Pricing
- Performance

Planning

- How much do you need?
 - Transmission and generation
- Rating of resources
 - Contribution of resource during scarcity events
- Planning by experts, not politicians
- Planning responsive to new information
- Planning optimizes reliability tradeoff:
more capacity vs. more blackouts

Product

- What is load buying?
 - Energy during scarcity period (capacity)
- Enhance substitution
 - Technology neutral where possible
 - Separate zones only as needed in response to binding constraints
- Long-term commitment for new resources to reduce risk

Pricing

- Good price formation
 - Advance purchase before project costs are sunk
 - Descending clock auction to encourage price discovery
 - Downward sloping demand curve for price stability (buy more when price is low)

Performance

- Strong performance incentives
 - Obligation to supply during scarcity events
 - Deviations settled at price $> \$5000/\text{MWh}$
 - Penalties for underperformance
 - Rewards for overperformance
- Tend to be too weak in practice, leading to
 - Contract defaults
 - Unreliable resources
- Recent adopters: New England, PJM (and Texas within energy-only market)

Example long-term markets

- Great Britain, New England, PJM (thermal dominated)
 - Product
 - Capacity: Ability to supply energy during hours short of reserves
- Colombia and Brazil (hydro dominated)
 - Product
 - Firm energy: Ability to supply energy during dry periods
- Comparison of what load is buying
 - GB, PJM, New England: price coverage only during shortages
 - Colombia: price coverage during extended dry periods
 - Brazil: full price coverage from long-term contract with new entry and medium-term contracts with existing resources
- Generator exposure to the spot energy price
 - Texas > PJM > New England > Colombia > Brazil

New vs. existing

- New investment desires long-term commitment (5 or more years)
- Existing does not need long-term commitment (1 year is best)
- Can we have the same price?
 - Yes, existing gets same price in expectation
- But does existing need to be paid at all
 - Yes, if solution is consistent with long run market

Conclusion

Forward markets address key problems of wholesale markets

- Investment
 - Coordinated entry to have what is needed
- Risk
 - Lock in price for capacity
 - Both suppliers and demanders face less risk
- Market power
 - Suppliers/demanders in more balanced position entering spot

Conclusion

- Never ignore essentials
 - Encourage participation
 - Demand performance
 - Make bids binding (deposits or letters of credit)
 - Avoid collusion and corruption
- Long-run market requires
 - Well-functioning spot market
 - Strong regulatory framework with manageable regulatory risk