California ISO
Your Link to Power

California Independent
System Operator Corporation

Capacity Market Design Issues

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Outline

- **Rationale for capacity payment mechanisms and markets**
- **Reasons for poor performance of capacity payments mechanisms**
  - Lack of incentive for performance of capacity resources
  - Market power in energy market
  - Market power in short-term capacity market
  - Inadequate revenues to fund new investment
- **Are capacity payment mechanisms necessary for resource adequacy?**
  - International experience
  - Unique features of California market
- **What is necessary for resource adequacy in California?**
  - Fixed-price forward contracting for virtually all energy far in advance of delivery that clear against prices at locations where load is consumed
    - Existing California resource adequacy mechanism consistent with this
  - Capacity payments are redundant if this is the case
- **Why are capacity payments so popular given experience with them?**
- **Creating a "capacity payment mechanism" that addresses shortcomings of previous capacity payment mechanisms**

Rationale for Capacity Payments

- **State regulators prohibit consumers from realizing benefits of paying the real-time price of electricity**
  - Require customers to pay a fixed retail price that does not vary with hourly wholesale price of electricity
    - Retail price must still cover hourly wholesale prices during all hours of the year
    - Consumer just has no ability to benefit from reducing demand in high-priced periods and transferring demand to low-priced periods
  - Real-time demand is completely price inelastic
- **Price or bid caps set below willingness of many consumers to curtail their demand are imposed on short-term markets**
  - **Potential for supply at bid cap to be less than demand at bid cap**
  - Loads have less of an incentive to hedge spot price risk through forward contracts
    - Over-reliance on short-term markets increases outage risk
  - Generation unit owners may earn insufficient energy market revenues to remain financially viable because of bid caps
    - Likely for high marginal cost units

Rationale for Capacity Payments

- **Reduces spot price volatility**
  - But there are cheaper ways to accomplish this
  - Should reducing spot price volatility be a goal of market design?
- **Provides "bankable" revenue source for generation unit owners to encourage new investment**
  - Is this revenue source plus expected spot market revenues (no forward energy sales) sufficient to obtain funding for new investment?
- **Asymmetric costs of having enough generation capacity to meet demand**
  - Costs of capacity shortfall greater than costs of over-capacity

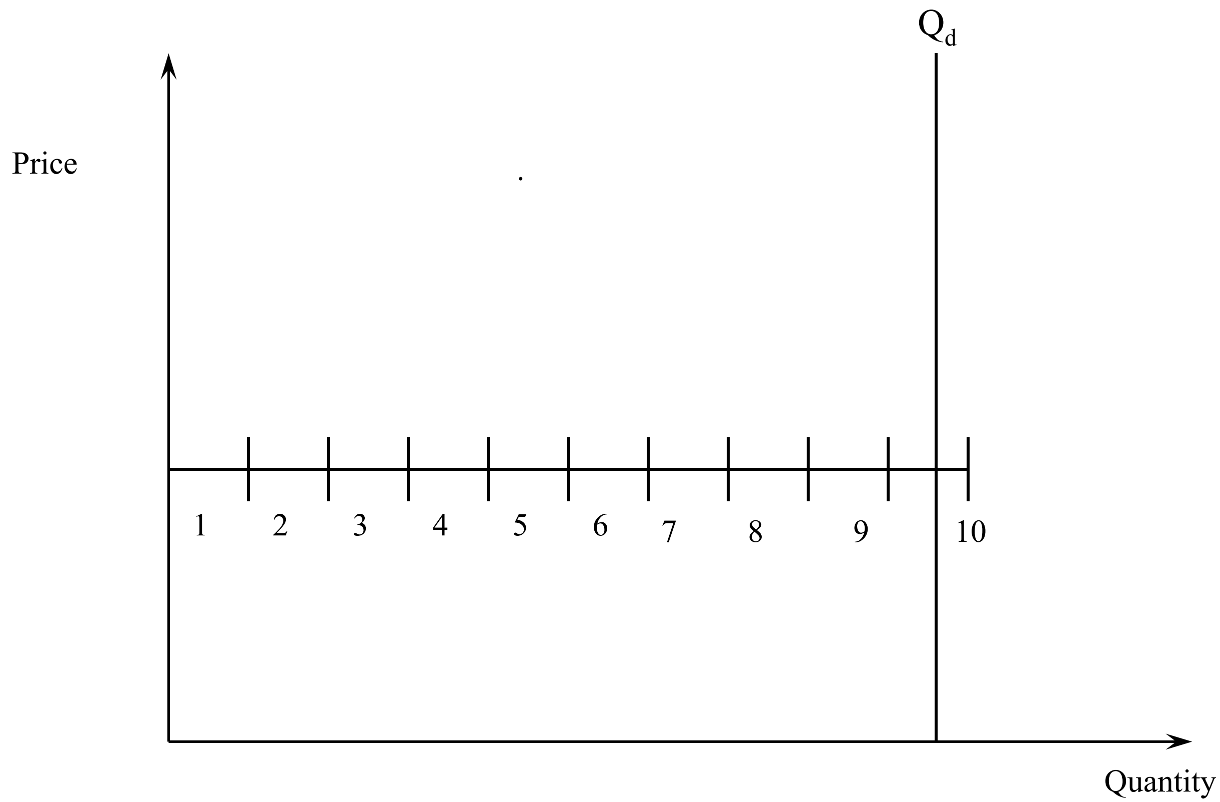
Analysis of Capacity Payments

- **Performance problems with capacity markets/payments**
  - What is customer buying besides existence of plant?
  - Does not limit incentives of suppliers to exercise unilateral market power in the spot market for energy
    - Owner receiving capacity payment is able to bid to raise spot market price of energy, or more generally withhold energy from the spot market similar to supplier without capacity payment
    - Only required to bid in at or below bid cap in energy market if plant is available
  - Requires consumers to pay for something they don't want—new generation capacity
    - Consumers want a reliable supply of electricity
  - Capacity payment mechanism provides no contractual guarantee that generation capacity necessary to meet demand will be built or available to supply electricity when it is needed
- **Recent capacity payment mechanisms have attempted to address this problem**
  - Peak energy rent refunds relative to "price of peaker plant"
  - Addressing this issue has been a very controversial process
    - Fixed-price energy contracts addresses performance issue

Analysis of Capacity Markets

- **Medium- and short-term capacity markets are extremely susceptible to the exercise of unilateral market power**
  - Inelastic demand for capacity and inelastic supply of capacity
    - Recall that capacity market buys existing generation capacity
  - When no supplier is pivotal
    - Price = marginal cost of supplying existing capacity = 0
  - When one supplier is pivotal
    - Price = min(infinity, price cap)

Capacity Auction--Pivotal Supplier



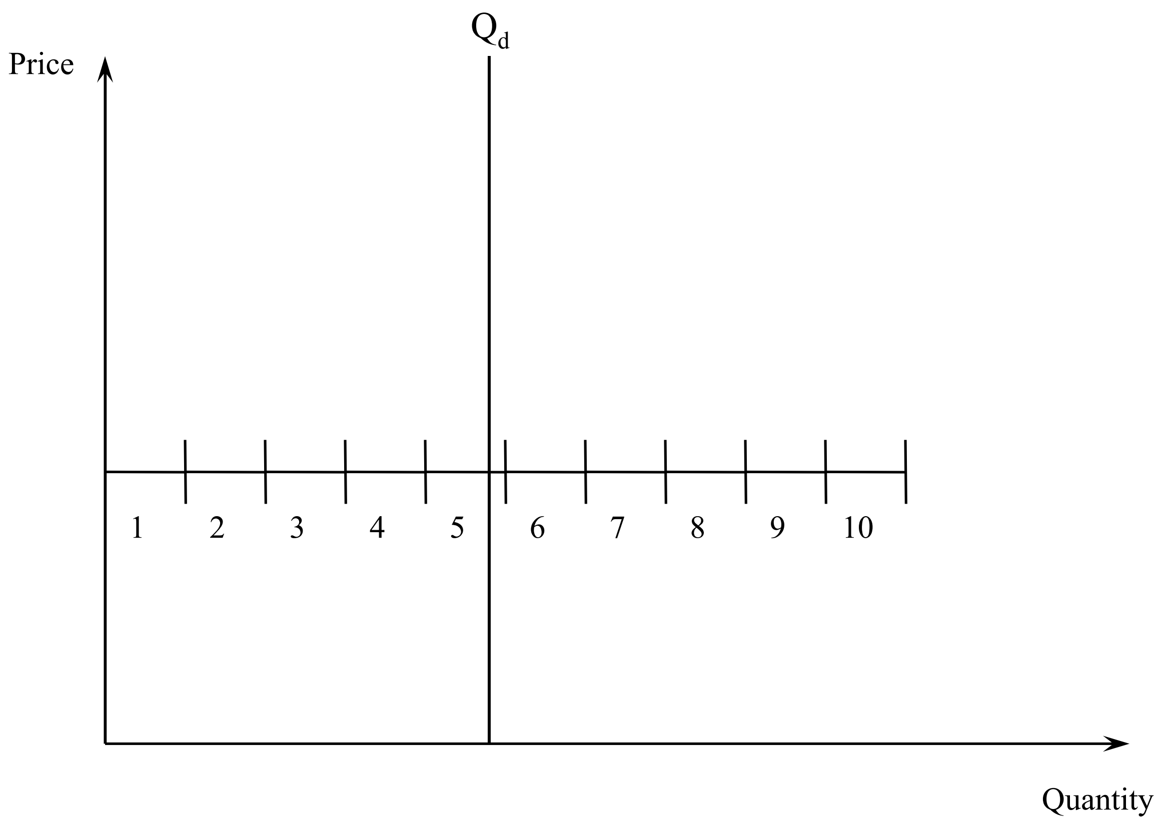
10 Firms--Each has 1 MW to sell, Market Demand is 9.5 MW

Marginal Cost = $0/MW, Price Cap of $10,000/MW

Auction Equilibrium

- **9 firms all bid $0/MW for one 1 MW**
- **1 firm bids $10,000/MW for 1 MW**
- **Equilibrium price is $10,000/MW**
- **Each of 9 firms bidding $0/MW has no incentive to unilaterally change its bid**
  - Earns highest possible profit given capacity
- **1 firm bidding $10,000/MW has no incentive to unilaterally change its bid**
  - Cannot increase price
  - Decreasing price only reduces profit
  - Reductions in quantity can only reduce profit

Capacity Auction—No Pivotal Supplier



A Nash equilibrium to this auction is that all firms bid zero and each sell $Q_d/10$.

Analysis of Capacity Markets

- **Medium- and short-term capacity markets send extremely noisy price signal to existing and new generation owners**
  - One month to one-year price signal
  - Supplier faces risk of capacity payment allocation mechanism or capacity market outcome in subsequent periods
- **Frequent market power in capacity market requires administrative pricing**
  - "Deemand curve" approach sets administrative price for capacity
  - Intersect actual supply of capacity with "administratively set curve" that pays lower price for more capacity
    - Pay positive price for excess capacity
- **Capacity payments are made only for generation capacity that is already installed**
  - They do not pay suppliers to install generation capacity
  - Suppliers construct generation facilities and to hope to sell in the capacity market
  - Constructing more capacity lower's average price paid in world with "deemand curve"

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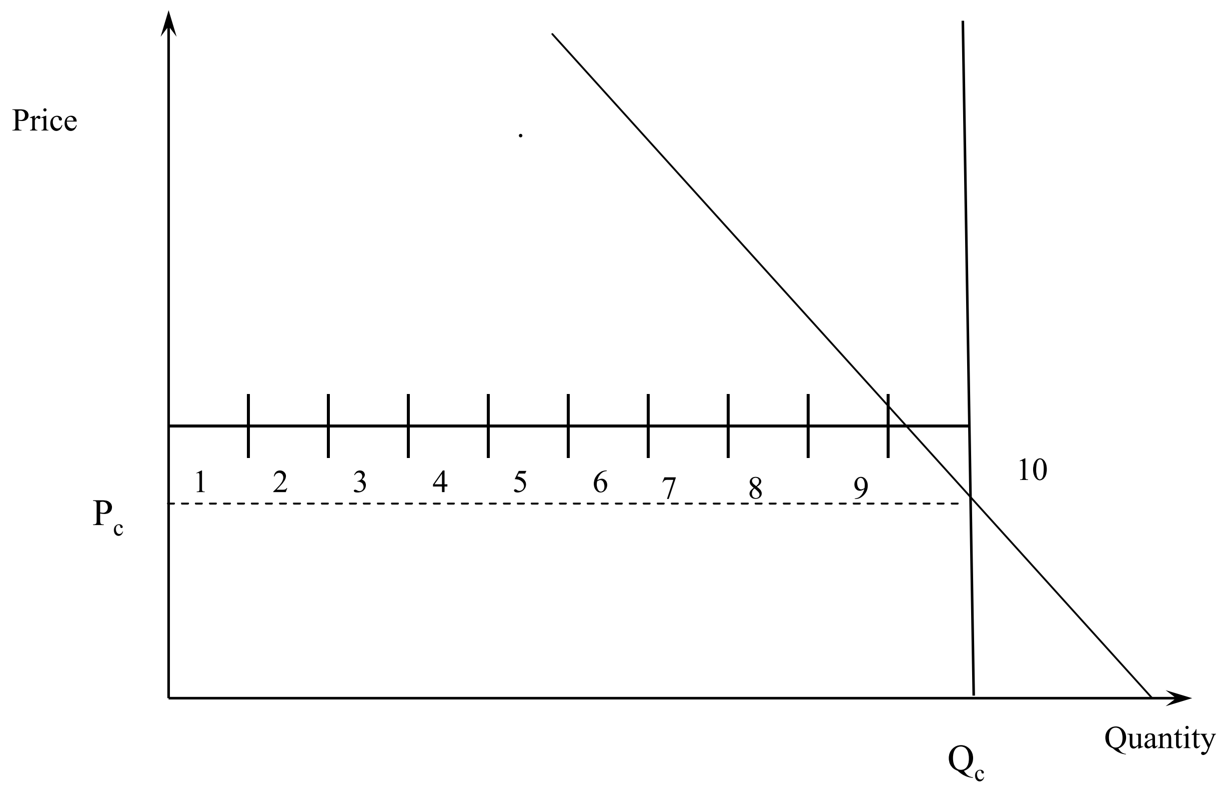
Capacity "Deemand Curve"



10 Firms--Each has 1 MW to sell, Market Demand is 9.5 MW

Marginal Cost = $0/MW, Price Cap of $10,000/MW

Analysis of Capacity Payments

- **Should reducing short-term energy price volatility be a goal?**
- **Spot price provides very powerful signal to generation unit owners to**
  - Operate during high-priced hours
  - Shutdown or reduce production in low-priced hours
- **If retail customers face real-time prices, spot prices serve a similar function for when and when not to consume**
- **By limiting price volatility these incentives are dulled**
- **Consumers care most about annual or monthly electricity bill**
  - Are not going to disconnect from system because of high prices during some hours of month or day
- **Conclusion—Market design goal of limiting meaningful short-term electricity price volatility reduces overall market efficiency**
  - Particularly if vast majority of final demand covered by fixed-price long-term contracts for energy

Analysis of Capacity Payments

- **Is the prospect of capacity payments alone sufficient to attract new investment?**
  - Capacity payments typically recover less than half of a unit's total cost and in most case significantly less than half of this total cost
- **Can an investor take the prospect of a short-term capacity payment and obtain funding to construct a new generation facility?**
  - Capacity payments are made to existing units, not to new entrants
  - Supplier faces risk of failing to sell in capacity market or to receive capacity payment allocation in *future years or even future months*
- **For these reasons, it is difficult to see how power plants can be financed with prospect of capacity payment only**
- **Conclusion--Long-term energy or reserve contracts are needed to finance new investment**
  - Capacity payments are redundant if long-term energy or reserve contracts are needed to finance new investment

Analysis of Capacity Payments

- **Are capacity shortfalls a fundamental concern in any operating wholesale electricity market and in California in particular?**
- **There are significant losses associated with excess generation capacity**
  - Power plant built but not used
  - Alternative use of site of generation facility is lost
  - Environmental costs associated with plant operation
- **All known market meltdowns around the worlds are due to inadequate energy not inadequate capacity**
  - Problems in California, Chile, Brazil, New Zealand due to energy shortfalls in hydro-dominated systems, not generation capacity shortfalls
- **Conclusion—Capacity shortfalls do not appear to be problem in wholesale electricity markets**
  - Mix of generation capacity and availability of energy are main problems
  - Why attempt to solve problem that doesn't exist?

International Experience with Resource Adequacy

- **Australia, England and Wales, Nordic Country markets have been existence for more than ten years**
  - None of these electricity markets have capacity markets or payments
  - These three wholesale markets are generally acknowledged to have come the closest to achieving market design goals stated above
  - In all of these markets, LSEs rely on a portfolio of forward contracts for meeting future demand needs
  - Particularly in England and Wales there has been substantial investment in new generation capacity since re-structuring process begin in 1990
  - Particularly in Queensland, Australia has seen substantial investment in new generation capacity since re-structuring began in the early 1990's

California's Resource Adequacy Challenge

- **California is increasing import dependent—more than 20% of energy consumption on annual basis**
  - Difficult to determine which resources outside of California are providing capacity to California
- **California is hydroelectric dependent**
  - Energy shortfall primary problem, not capacity shortfall
- **Eastern US markets are much less, if at all, import dependent and hydro-electric dependent**
- **Post-June 2001 resource adequacy process in California has worked surprising well**
  - Based on fixed-price forward contract coverage for virtually all of final demand
  - Events of July 2006 heat storm bear out ability of existing mechanism to provide adequate resources to meet demand
    - Peak demand of 52,000 MW met with few 5-minute prices at bid cap and no hourly prices at bid cap

California's Resource Adequacy Challenges

- **Major problem with existing resource adequacy mechanism is forward contracts signed may clear against locations where little load is located**
  - Implementing locational marginal pricing (LMP) market under MRTU will allow contracts to be cleared against all injection and withdrawal points
  - Must-offer obligation is unnecessary if there is adequate fixed-price forward contracting against prices at locations where load is served
- **If LSE has portfolio of forward financial contracts limiting its exposure to spot prices, suppliers that sold contracts have strong incentive to find the lowest cost way to fulfill these obligations at the "delivery date"**

California's Resource Adequacy Challenges

- **Other major problem with existing resource adequacy process is little demand for long-term contracts beyond 1-2 year delivery horizon**
  - Revenue streams of longer duration are needed to finance new generation investment
- **Minimum forward contracting levels must be mandated by California Public Utilities Commission**
  - Each retailer must hold 100% of current demand N years into future
  - Regulatory recovery of these contracts should be guaranteed
    - Sharing rule on profits from futures sales and purchases if retailer's load changes
- **Spot price volatility limited if regulator mandates minimum contracting levels in advance of delivery**
  - Preferable regulatory intervention to capacity market intervention because it solves problem of revenue adequacy for existing and new investment
  - No difference from renewable portfolio standard of 20% of load met from renewable sources
    - 100% of load met from forward contract sources, 20% of which is from renewable sources
- **No stranded contract problem in aggregate because of demand growth**
  - Retailer with too many contracts sells to retailer with too little
  - Seller equally likely to make profit or loss if forward market is competitive

California's Resource Adequacy Challenges

- **Fixed-price forward contract holdings by California LSEs at current levels would have largely prevented California electricity crisis**
  - Despite reduced import availability in summer 2000, sellers of forward contracts would still have had significant supply obligations to California market
  - No benefits to raising spot prices in California until these forward contract obligations were covered
  - Spot prices may have risen, but this would have caused limited consumer harm
  - Summer 2001 had lower hydro availability than summer 2000, but significantly higher forward contract coverage by LSEs
  - In a hydro-based system, LSEs should have an even larger forward contract coverage, because spot price risk is greater
    - Higher electricity prices do not cause more water to appear behind the turbines
- **Eastern capacity payment/market would have done little prevent California electricity crisis**

Explaining Popularity of Capacity Payments

- **Generation unit owners obtain additional revenue stream**
  - Small but increasing performance penalty risk in existing mechanisms
- **Large LSEs can prevent small LSEs from purchasing to much energy from capped short-term energy market**
  - If all LSEs have capacity obligation that is fixed fraction of their peak demand
  - All LSEs pay for demand-weighted share of capacity and have potential to benefit from less volatile wholesale prices
- **If there is a capacity shortfall curtailment is still random**
  - All retailers pay for capacity in an attempt to prevent this
- **Mandated forward contracting requirements serves same role with higher-powered incentive to prevent shortfall**
  - Supplier must purchase energy from short-term market and sell at fixed-price in forward contract

Designing a Capacity Market if You Must

- **Performance incentives in capacity product**
  - Make capacity product similar to option contract
  - Seller has obligation to pay max(0,P(spot,k) –P(strike,k) times number of MWs of capacity sold 24 hours per day and 365 days per year
    - P(strike, k) = strike price at location k, P(spot,k) = spot price at location k
  - Maximum value of P(strike,k) can be set by regulator
    - Need sufficient to protect consumers--$200/MWh to $400/MWH
- **Market power in short-term capacity market**
  - Make distinction between local and system-wide requirements
  - Local requirement--Area where timely entry is deemed to be sufficiently unlikely that competition in long-term procurement process can not discipline prices paid for capacity
    - Set tight maximum price for local capacity in short-term market
  - System-wide requirements—Area where entry can occur to discipline long-term procurement process
    - Set damage control bid cap in short-term market
    - Procurement must take place far in advance of delivery to achieve competitive price
  - Generation unit needed for local requirement should have option of making cost of service filing to recover costs
    - Setting generous local capacity price can be extremely expensive for consumers
    - Over-paying all suppliers to insure that highest cost supplier achieves cost-recovery is an ineffective regulatory mechanism

Designing a Capacity Market if You Must

- **Market power in short-term energy market**
  - Strong incentive or ideally regulatory mandates for fixed-price forward contract coverage of final demand for 1 to 3 years into future still needed
  - Capacity market should be designed to provide revenue adequacy in beyond 3 years into future
    - For example, 120% of current demand must be purchased in option contract that clears against short-term energy prices 3 to 5 years into future or even further into future
- **Regulator must ensure that LSEs hedge spot price risk in sufficiently far in advance of exercise date to give suppliers best opportunity to provide least-cost physical hedge for this future spot price risk**
  - Signing forward contract too close to “delivery date” limits set of options for seller to use as physical hedge
    - Only technologies and suppliers actually able to deliver energy demanded can compete
    - Increases likelihood suppliers can transfer market power in short-term market to long-term contract market

Designing a Capacity Market if You Must

- **Centralized market versus bilateral market**
  - Little difference between two regimes without "dee-mand curve"
    - All LSEs must purchase load-weighted share of aggregate requirement
  - Centralized "dee-mand curve" approach requires LSEs to purchase load-weighted share of total capacity at price set by "dee-mand curve"
  - Very difficult for load to pay different prices for capacity product to different generation unit owners in a bilateral market
    - No inherent cost advantage to load from bilateral market
  - Bilateral market may make it easier for certain entities to carve out special deals to meet capacity obligation
- **Centralized market can more easily impose standardized market power mitigation mechanism on suppliers**
  - This logic argues for a centralized "dee-mand curve" approach for local requirements
  - Bilateral market for system-wide requirements
  - Allow all generation units to compete in system-wide market
  - Maximize participation in local markets

Designing a Capacity Market if You Must

- **Make capacity product purely financial for as long as possible to delivery date subject to reliability concerns of system operator**
  - Requiring a capacity showings is expensive process with limited value
  - Financial incentive is reason suppliers provide both capacity and energy
  - During crisis period in California there was sufficient capacity to meet demand
    - Suppliers had little financial incentive to provide it to the market and strong financial incentive to withhold it from the market
- **ISO can impose physical showing requirements on capacity suppliers a various horizons to delivery date, but these are unnecessary if implicit performance penalty in strike price is high enough**
  - 2-4 years out paper capacity
  - 1-2 portfolio of units must be greater than capacity sold
  - 1 day ahead identify specific units

Concluding Comments

- **Capacity payments can be a very expensive mechanism for attempting to achieve capacity adequacy—lower cost approaches are available**
  - No guarantee that adequate capacity will be built
    - Need other revenue sources
  - Little success with capacity payments in international markets
    - Particularly in US markets
- **Capacity payments does not eliminate need to hedge short-term energy price risk**
  - Energy contract revenues needed to fund new investment
  - Buy necessary energy far enough in advance of delivery to allow maximum flexibility of suppliers to meet these obligations at least cost and limit market power in spot market
  - Allow significant demand-side involvement in wholesale market
- **Capacity payment mechanism should focus**
  - Keeping generation units in operation that are needed for local reliability constraints
  - Building new generation capacity
  - Provide strongest possible incentives for generation units to meet performance standards
    - Generation units available
- **Generation units that are financially viable based on forward energy sales and short-term energy and ancillary services sales should not receive capacity payments**
- **Capacity payment should not be so generous that no units are required to make cost-of-service filings to receive cost recovery**
  - Generous capacity payments must be paid for by consumers, which limits potential benefits of wholesale electricity market

Questions/Comments?

Frequency of Prices in Victoria, Australia

	Year 2001	Year 2002
p > $4000/MWh	0.00017	0.00011
$4000 > p > $2000	0.0012	0.00091
$2000 > p > $1000	0.0010	0.00057
$1000 > p > $500	0.0014	0.00086
$500 > p > $100	0.0070	0.0072
$100 > p > $50	0.0426	0.0431
$50 > p	0.9466	0.9472
Annual Mean	$36.01	$33.15
Current bid cap = $10,000/MWh		