

Recommendations on the “Proposal for Determining and Assigning the Reliability Charge for the Wholesale Energy Market”

Frank A. Wolak
Department of Economics
Stanford University
Stanford, CA 94305-6072
wolak@zia.stanford.edu
<http://www.stanford.edu/~wolak>
Chairman, Market Surveillance Committee of the
California Independent System Operator

Outline of Presentation

- Recommendations based on extent to which CREG’s capacity charge proposal (CCxC) achieves proposed goals for market design process
 - Review proposed market design goals
- Costs and benefits of existing reliability charge (ECxC) that are shared by CCxC proposal
- Costs and benefits unique to CCxC proposal
 - Long-term reliability
 - Short-term reliability
- Modification of ECxC to ensure greater reliability
- Transition process from current capacity payment mechanism to forward contracts for energy approach
 - Transform capacity payment into forward contract based on price of energy
 - CREG mandates hedging levels and horizons by load-serving entities (LSEs)

Market Design Goals

- Proposed objectives for market designer
 - Lowest possible average annual delivered price of electricity consistent with
 - Long-term financial viability of industry
 - Pre-specified level of reliability of supply of electricity
 - For Colombia this is the ability to survive a severe El Nino event without rationing or disruption in the wholesale electricity market
- CCxC and SEC proposals will be evaluated in terms of their ability to achieve these goals
- If costs of market design change exceed benefits, so that the net result is increased delivered prices to consumers, proposed change should not be implemented

CREG

Capacity Payment

3

Benefits versus Costs of ECxC

- Major question raised in previous meeting and discussions with individual market participants
 - What benefits do Colombia consumers receive from capacity payment mechanism?
 - Ability of generation units to provide energy is tested
 - Once per week during dry period of year
 - Once per month during wet period
 - Units unable to operate are penalized
- Both ECxC and CCxC provide no contractual guarantee of that
 - Necessary capacity will be constructed to meet future demand
 - There will be sufficient energy in system to meet demand under severe El Nino conditions
- Average energy actually produced by unit in a month can differ substantially from unit's firm energy computed in CRT allocation mechanism under ECxC
- Capacity made available from a unit during a given hour can be substantially less than value of CRT for unit under ECxC mechanism

CREG

Capacity Payment

4

Benefits versus Costs of ECxC

- ECxC provides stable revenue stream to suppliers
 - US \$5.25/kW per month capacity charge for “Theoretical Remunerable Capacity” (CRT) of generation unit for the month
- ECxC and CCxC can encourage over-investment in generation capacity and inefficient mix of capacity
 - Favors construction of generation units that will receive
 - High values of CRT in the case of ECxC
 - High values of firm “energy capacity” in the case of CCxC
 - These inefficiencies are likely to be smaller for CCxC proposal because firm energy payments are lower than capacity payments under ECxC
 - Under CCxC, all suppliers that have not sold firm energy can bid to provide firm power capacity from unused capacity
 - Capacity sold as firm power capacity need not have been dispatched to provide energy in firm energy capacity allocation process
 - Supplier must only bid lower than market-clearing price in firm power capacity auction

CREG

Capacity Payment

5

Benefits versus Costs of ECxC

- Over-investment in generation capacity and inefficient mix of capacity can distort spot electricity prices
 - During off-peak hours too many base load units (high CRT units) can depress spot prices
 - During peak-hour too few peaking units can increase spot prices
- ECxC and CCxC do nothing to limit ability of suppliers to exercise unilateral market power in the spot market for energy
 - Capacity payment is fixed revenue stream that is unchanged by bidding behavior and operating behavior of the supplier in the spot market
 - Generation unit owner receiving capacity payment is able to bid to raise *spot* market price of energy (exercise unilateral market power in *spot* market) to same extent as it would be able to do an identical wholesale electricity market without a capacity payment
 - This is not the case for a wholesale energy market where suppliers have fixed-price forward contract obligations versus the same market where suppliers do not have fixed-price forward contract obligations
 - Fixed price forward contract obligations limit ability of suppliers to exercise unilateral market power in spot market
 - Wolak (2000) “An Empirical Analysis of the Impact Forward Contracts on Bidding Behavior in Wholesale Electricity Market,” (available from web-site)
 - California in Summer 2000 versus California in Summer 2001 and 2002
 - Wolak (2003) “Diagnosing the California Electricity Crisis,” (available from web-site)

CREG

Capacity Payment

6

Benefits versus Costs of ECxC

- Both ECxC and CCxC pay suppliers for generation capacity that is already installed
 - They do not pay suppliers to install generation capacity
 - Under ECxC, suppliers construct generation facilities in hopes of receiving a significant CRT allocation
 - Under CCxC, suppliers construct generation facilities in hopes of receiving a significant firm energy allocation or winning capacity in firm power auction at a high price
- In virtually all markets around the world, retailers or large loads sign fixed price forward contracts for energy to guarantee that supplier will construct new generation capacity
 - Majority of forward contracts signed by State of California *guaranteed construction* of generating facility in California
 - Over 10,000 MW of new generation capacity brought on-line since summer 2000

CREG

Capacity Payment

7

Benefits versus Costs of ECxC

- Benefits to generation owners from current scheme is approximately \$US 500,000 payment per year by consumers
- In return, consumers receive the ability to test and penalize generation owners with positive value of CRT for being unable to operate when called
 - No contractual guarantee to supply firm energy from ECxC process
 - No contractual guarantee to supply capacity that is greater than or equal to the unit's value of CRT to the spot market each hour of the day
 - No contractual guarantee that system can manage severe El Nino event without rationing or disruption of spot market operation
 - Fixed-price forward contracts for energy to meet 100% of system demand under prospective dispatch with severe El Nino conditions would provide such a contractual guarantee

CREG

Capacity Payment

8

Conclusion on ECxC

- Capacity payment or capacity requirement schemes are much better suited for fossil fuel-based systems where major concern is inadequate generation capacity necessary to meet energy demand
 - Primary concern in hydro-based system, and Colombian system in particular, is adequate energy available to meet demand during very low water conditions
 - Buy energy in advance rather than pay for capacity or buy capacity in advance to obtain contractual guarantee of adequate energy during low-demand conditions
 - Nordpool solution to reliable supply in hydro-dominated system
 - My strategy to obtain ticket to Colombia for meeting
- Despite shortcomings of capacity payment mechanisms in general, does CCxC satisfy benefits versus costs test relative to ECxC?
 - Lower delivered price of electricity at same or higher level of reliability

Benefits versus Costs of CCxC

- CCxC attempts to improve reliability and reduce amount of capacity payments by consumers
 - Both are consistent with stated goals of market design process
- CCxC pays administrative capacity charge to “average hourly assigned energy” or “firm energy capacity” for the month
- CCxC allows suppliers that own capacity that was not taken as “firm energy capacity” to bid to provide “firm power capacity”
 - Price paid for firm power capacity determined through auction
 - Auction mechanism has potential to yield higher price than \$5.25/kW per month
 - Potential for greater revenues to sellers of peak power capacity

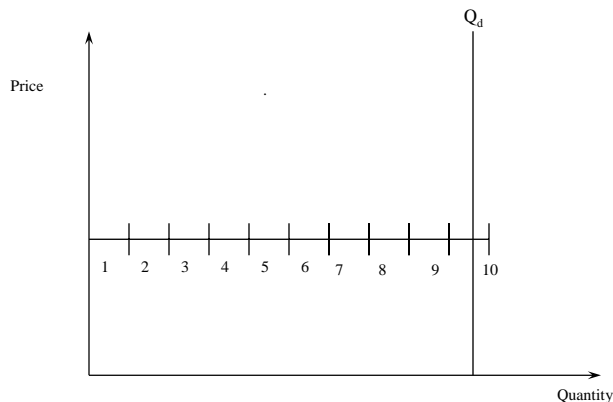
Benefits versus Costs of CCxC

- Long-term potential reliability problem with CCxC due to significant increase in capacity payment uncertainty
 - Recall that under CCxC suppliers invest in hopes of receiving a high value of firm energy capacity and selling firm power capacity at high price
 - Firm power price is only set for, at most, one year and could change dramatically across months and years
 - Increased uncertainty in price of firm power capacity dulls incentive for suppliers to construct new generation capacity
- As discussed above, both CCxC and ECxC provide same level guarantees of reliability once capacity payment have been made
 - Ability to call on units to operate and penalize them if they are not available
- Because of firm power capacity payment uncertainty and inability to lock-in firm power price and quantity over long period of time, there are reduced incentives for new investment

Benefits versus Costs of CCxC

- Consumers are likely to pay less for capacity in the short-term because of current supply and demand balance in Colombia
 - Total capacity payments will be more volatile in short and long term
- Over long term it is very likely that consumers will pay more in capacity payments and there will less new capacity built
 - Consumers are likely to pay more because capacity markets, such as proposed peak power capacity auction, are extremely susceptible to the exercise of unilateral market power
 - Inelastic demand for capacity and inelastic supply of capacity
 - Recall that firm power 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)

Firm Power 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

CREG

Capacity Payment

13

Firm Power Auction Equilibrium

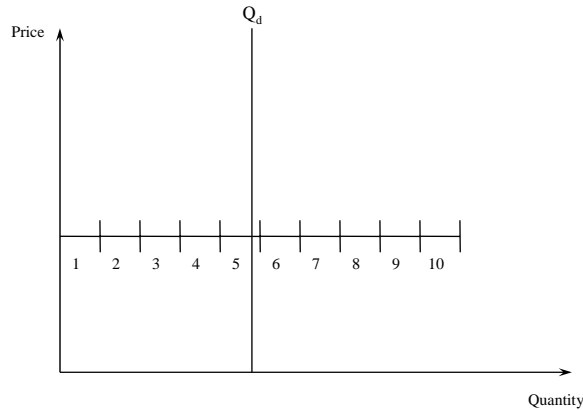
- 9 firms all bid \$0/MW for one 1 MW
- 1 firm bids \$10,000/MW for 1 MW
- Equilibrium price is \$10,000/MW
- Each of 9 firms bidding \$0/MW has no incentive to unilaterally change its bid
 - Earns highest possible profit given capacity
- 1 firm bidding \$10,000/MW has no incentive to unilaterally change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

CREG

Capacity Payment

14

Firm Power Auction—No Pivotal Supplier



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

CREG

Capacity Payment

15

Benefits versus Costs of CCxC

- Long-term reliability conclusion—Consumers likely to pay more over long-term on average
 - For reduced level of new investment in generation capacity
- What about impact of CCxC mechanism on operation of energy market?

CREG

Capacity Payment

16

Benefits versus Costs of CCxC

- Dispatch to determine firm energy based on monthly “price functions” submitted by hydroelectric suppliers and variable costs submitted by fossil fuel suppliers
 - These price functions and variable costs become upper bounds on generation unit-level bid prices for that month in spot market
 - This upper bound on bid prices is designed to limit ability of supplier to exercise unilateral market power in spot market for energy by raising bid price
 - This is consistent with market design goal of lower delivered prices of electricity to final consumers
- Suppliers are aware of this constraint at the time they submit price functions and variable costs,
 - Therefore, they have an incentive to distort these price functions and variable costs to allow themselves flexibility to exercise unilateral market power in spot market

CREG

Capacity Payment

17

Benefits versus Costs of CCxC

- This can lead to an actual dispatch from spot market differing dramatically from dispatch used to determine firm energy capacity allocations based on monthly “price functions” submitted by hydroelectric suppliers and variable costs submitted by fossil fuel suppliers
 - Units that were awarded firm energy capacity from administrative process sell less energy in spot market
 - Units that sold firm power capacity or were not awarded firm energy capacity or did not sell firm power capacity sell more energy
 - Greater disconnect between payments received by suppliers and reliability service supplied
 - Creates potential for reduced reliability in short-run because generation units used in inefficient manner
 - System operator gains very little information from firm energy allocation process about the reliability and energy services units will actually provide

CREG

Capacity Payment

18

Benefits versus Costs of CCxC

- Bid caps reduce ability of supplier to manage risk through bidding behavior in spot market
 - If supplier's estimate of the opportunity cost of water is higher than the upper bound on its bid price, the supplier's only choice is to withhold capacity to achieve a market price equal to its estimate of the opportunity cost of water
 - Capacity withholding by suppliers can reduce short-term system reliability because less capacity is available to the system operator to manage system contingencies
- Short-term reliability conclusions from CCxC
 - Reduced short-term reliability
 - Little reason to believe spot energy prices will fail at result because suppliers will anticipate impact of bid price bounds
 - Bounds on price bids into spot increase spot price volatility, because less capacity is bid into market

Overall Conclusion on CCxC

- CCxC is inconsistent with goals of market design process
 - Does not satisfy benefits versus costs test terms of reducing delivered price of consumers
 - Does not improve system reliability beyond ECxC and is likely to degrade it in the future
- Possible fixes to improve ECxC or CCxC.
 - Two potential solutions
 - Modify ECxC
 - Transition to forward contracts for energy market by converting ECxC payments to forward contracts that are phased out over time

Suggested Modification of ECxC

- Continue with current prospective dispatch to process to determine value of CRT for each generation unit in system
 - For each supplier compute PCRT = Portfolio CRT = Total MWs of CRT allocated to that supplier
 - Supplier continues to receive CRT times administrative capacity payment (currently \$US 5.25/kW-month) for each generation unit owned
 - In exchange supplier must provide PCRT of availability to system 24 hours per day, 7 days per week, and 365 days per year
 - Availability is the total amount of generation capacity supplied to market at a bid price less than or equal to bid cap on spot market
 - Value of supply curve level at the bid cap on the spot market

Suggested Modification of ECxC

- Supplier with given value of PCRT must ensure that this amount of MWs of generation capacity is bid into the market either from units its owns or from other capacity in the system that is not satisfying this PCRT requirement during all hours of month
- Suppliers to that fail to provide this amount availability will be charged the cost of shortage per MW (roughly \$US 1/kWh) that they fail to provide
- Example—Supplier with 500 MW PCRT and 800 MW of capacity
 - Every hour of month supplier must bid into spot market at least 500 MW from these generation units or other generation capacity that is not being used to satisfy the PCRT requirements of other suppliers
 - For units it does not own suppliers must notify CND what capacity is meeting this requirement each hour or be subject cost of shortage penalty
 - Suppose that only 400 MW of this supplier's unit have bid into the market (because remaining capacity is forced out) supplier must find 100 MW of other capacity in system that does not satisfy PCRT requirement to bid in
 - May need to compensate the supplier doing this on their behalf
 - Failure to do implies a \$1000/MW*100 MW penalty

Suggested Modification of ECxC

- Scheme guarantees that system operator will have generation capacity available to sell energy at or below the bid cap on the spot market that is at least equal to the sum of the values of CRT across all generation units every hour of the month
 - Satisfaction of this scheme implies that if the demand in the month never exceeds total of CRT across all generation units in the system the market will always have sufficient generation capacity available to meet energy demand
- It implies a different perspective on capacity payment
 - Payment for guaranteeing a given MWs of availability, not paying for MWs of installed capacity

CREG

Capacity Payment

23

Suggested Modification of ECxC

- Suppliers in the aggregate receive the same amount of capacity payments as they currently do
 - Costs of any purchases of availability in bilateral market by suppliers must be paid by them, because capacity payment is for providing PCRT value in MWs of availability all hours of the month
 - Market power by one supplier exercised in this bilateral market must be borne by suppliers purchasing availability, not final consumers
 - Should not to be a serious problem, because one supplier is unlikely to be consistently on buying or selling side
 - Different from CCxC scheme where higher price in firm power capacity market due to market power of supplier is passed on to final consumers in their total capacity payments

CREG

Capacity Payment

24

Transition to Forward Contracts for Energy

- Convert existing capacity payment mechanism into fixed price “cap” contract of following form
 - Run prospective dispatch process to determine value of firm energy, FE, for each generation unit and the value of CRT for that generation unit
 - In exchange for receiving fixed payment each month for each generation unit equal to the value of CRT times the capacity charge, the supplier must make payment for month equal to
 - $\text{Max}(0, P(\text{avg}) - P(\text{hist_avg})) * \text{FE} * (\text{number of hours on the month})$
 - $P(\text{avg})$ = average Bolsa price of during that month
 - $P(\text{avg_hist})$ = average Bolsa price in that month over past 5 years
- This payment scheme implies that if the average Bolsa price for that month is less than the historical average Bolsa price over the past five years
 - The supplier receive the full capacity payment for this month
 - This provides strong incentives for all suppliers to bid and operate their generation units to keep the average Bolsa price for the month below this historical level despite the fact that the supplier would like to sell its energy in the highest priced hours of the month

CREG

Capacity Payment

25

Transition to Forward Contracts for Energy

- To transition from the administrative capacity charge to a forward contracts for energy market, each year the values of CRT and FE would be multiplied by a factor, f , ($0 < f < 1$), that becomes smaller each year and eventually equals zero
- The supplier would receive $f * \text{CRT}$ times the capacity charge each month in exchange for the payment obligation
 - $\text{Max}(0, P(\text{avg}) - P(\text{hist_avg})) * \text{FE} * f * (\text{number of hours on the month})$
 - $P(\text{avg})$ = average Bolsa price of during that month
 - $P(\text{avg_hist})$ = average Bolsa price in that month over past 5 years
 - FE = firm energy for that generation unit
- As this payment scheme phases out suppliers are free to sell their energy in the spot market or through bilateral contracts for energy

CREG

Capacity Payment

26

Transition to Forward Contracts for Energy

- CREG must set would set portfolio standards and contracting levels for various delivery horizons for LSEs
 - LSEs would be required to meet these standards or face financial penalties
- A sample portfolio standard and delivery horizon
 - 1 year from delivery 100% of forecast demand in forward contracts
 - Portfolio must be composed of at least 85% swaps, with the remainder in caps at average strike price less than 3 times average spot price from previous year

Designing a Hedging Strategy

- Extent of demand-side involvement is a major determinant of load-serving entity's hedging strategy
 - Little demand-side involvement implies greater need for forward contracting
 - Price risks loads are willing to bear determines remaining price risks LSE must manage through its hedging strategy
- Because Colombia is dominated by hydro capacity there is an even greater need for active demand-side involvement
 - Less need for internal meters than in fossil-based system
 - Significant and persistent differences in wholesale prices due to hydro conditions

Designing a Hedging Strategy

- As extent of load covered by swap contracts increases, contract price it must pay should increase
 - Purchasing last 10% of load as a swap contract can be very expensive
- Cap contracts at a relatively high strike price can limit spot price exposure
 - In Australian market with spot price cap of \$AU 10,000/MWh, a \$300/MWh cap contract strike price is widely traded
 - These cap contracts are used to provide price spike insurance during times when the LSEs expect suppliers to face very inelastic residual demand curves
 - Caps and other option contracts can be a much cheaper way to obtain price spike insurance for the last 10 percent of retail demand
- Procurement process should provide incentives for LSEs to use these hedging instruments

Concluding Comments

- Capacity payments are a very expensive mechanism for attempting to achieve capacity adequacy—lower cost approaches are available
 - No guarantee that adequate capacity will be built
 - Depends on level of capacity payment
 - Little success with capacity payments in international markets
 - Particularly in US markets
 - CCxC mechanism unlikely to achieve market design goals in long-term and amplifies problems with ECxC scheme
- Modifications of ECxC proposal are possible to increase reliability (reduce probability of rationing under severe El Nino event) substantially

Concluding Comments

- Forward contracts approach has come closest to achieving market design goals in a number of international markets
 - 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
- Colombia can implement forward contracts approach
 - Transition process possible
 - CREG must set portfolio standards for adequate hedging during transition period
- Contract adequacy approach can allow significant demand-side involvement as part of load-serving entity's hedging strategy
 - With symmetric treatment of load and generation, individual loads can choose level of exposure to spot price risk
 - LSEs can offer spot price risk and mean price profiles and consumers choose which combination they prefer
 - Forward contracting is then tailored to hedge remaining fixed price retail obligations of LSEs