Market-Based Capacity Payments

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What is Reliability

- NERC (National Electric Reliability Council) defines reliability as: “the degree to which the performance of the elements of the electrical system results in power being delivered to consumers within accepted standards and in the amount desired”
- Reliability encompasses two concepts:
  - **Security**: “the ability of the system to withstand sudden disturbances.” This aspect concerns short-term operations and is addressed by *ancillary services* which include: Voltage support, Congestion relief, Regulation (AGC) capacity, Spinning reserves, Nonspinning reserves, Replacement reserves.
  - **Adequacy**: “the ability of the system to supply the aggregate electric power and energy requirements of the consumers at all times”. This aspect concerns planning and investment and is addressed by Planning reserves, Installed capacity, Operable capacity or Available capacity.
Markets and Reliability

- Security is a *public good* while Adequacy is mostly a *private good*.
- Security can be provided through competitive procurement of ancillary services. However, decisions concerning required amounts, dispatch and cost allocation need be centralized due to externalities and free rider effects.
- Generation adequacy decisions can be decentralized and left to the market. Inadequate supply will result in high prices which in turn encourage new capacity. Customers can decide how much they want to pay for and suppliers will decide how much to invest. These are individual economic and risk management decisions.
Alternative Approaches to Ensuring Generation Adequacy

- Rely on energy markets. Consumers and suppliers interact through unrestricted energy spot markets. Energy spot and future energy prices provide price signals and compensation for capacity investment. Technology mix and generation capacity are determined by entry and exit of suppliers and by customer choice of desired price risk. (California, Nordpool)

- Central agency (ISO or Regulator) specifies requirements for planning reserves based on traditional planning tools. Capacity market allow supplier to trade reserves and efficiently reallocate the reserves requirements but the capacity market and energy market may not be in equilibrium (PJM, New York, New England)

- Generators receive capacity payments based on availability, technology, VOLL, LOLP to incent investment and availability. (old UK system, Argentina, Spain, Brazil)
"The capacity fee is a means of ensuring that there is sufficient available generation in the system. This reduces the risk that there will be an interruption in supply that will cause the market price of electricity to rise to the value of loss of load (VLL)".
Theoretical Justifications and Interpretations of Capacity Payments

- **Peak load pricing (Boiteux)**
  Energy and capacity are separate commodities. Peak load users are responsible for capacity requirements and consume energy while off peak user only consume energy. Hence, efficient pricing must charge MC off-peak and MC+Capacity charge on-peak.

- **Reliability pricing**
  The two commodities are energy and reliability of supply. Additional capacity increases reliability (reduces LOLP) on and off peak hence capacity cost should be allocated over all time periods so as to reflect the value of improved reliability.

- **Cost recovery**
  Marginal cost-based pricing does not produce enough revenue to recover cost. A capacity fee must be added to make up the difference.
Cost Recovery Through a Combination of Marginal Costs and Capacity Payment

\[ F_3 + C_3(T_1 + T_2 + T_3) = F_1 + C_1T_1 + C_2T_2 + C_3T_3 \]

\[ F_1 \]

\[ F_2 \]

\[ F_3 \]

\[ C_1 \]

\[ C_2 \]

\[ C_3 \]
Capacity Payments Covered by Raising Energy Prices to VOLL During Shortage Periods

\[ F_3 + C_3^\ast(T_0 + T_1 + T_2 + T_3) = VOLL^\ast T_0 + C_1^\ast T_1 + C_2^\ast T_2 + C_3^\ast T_3 \]
Supply and Demand Uncertainty Cause High Price Volatility in Energy Only Price Systems

- Price volatility is an inherent aspect of electricity due to its nonstorability and the steep supply curve.

Typical Generation Resource Stack

Electricity On-peak Spot Prices

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If all agents had perfect knowledge then there would be no need for a capacity fee. This is because agents would build generators that would be utilised only in the price spike periods. However, agents find it difficult to plan for uncertain and infrequent events and so a market level optimism tends to occur. In this case, each generator believes that there will never be a large reduction in generation capacity due to break-down and so does not build capacity for that demand.

The capacity fee tries to smooth out the price spikes by paying for available capacity even when it is not dispatched. The capacity fee is not a subsidy, the expected payments to generators is exactly the same with or without the capacity fee, it merely changes the profile of payments over time.
Capacity Payments in ASMAE Rules Provide Uniform Mandatory Price Spike Insurance to Uncontracted Load

- Capacity Fee (Month, Submarket, Patamar)
  - = Actuarial value of mitigated scarcity rent.
  - = Average over hydrological scenarios \{\text{LOLP}*(VLL-MAE price forecast)}\}

Key Features:

- Paid to generators based on uncontracted availability.
- LOLP calculation not affected by daily availability declaration.
- Allocated to load on a prorata basis.
- Revenue reconciliation with inter-submarket adjustments.
- Inter-month smoothing (Highest/Lowest < 2).
- Not paid to demand side bids.

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Recommendation 1:

- Demand side bids should be treated as an energy call option that is exercised if the MAE purchase price reaches the bid.
- Include Demand side bids in Capacity Fee Calculation
- Exempt Uncontracted demand side bids from the Capacity Fee component of MAE price whether they are dispatched or not since they forgo the protection that the capacity fee provides
- Contracted demand side bids should get capacity payment like generators as premium for the call option they provide (in addition to the energy payment if dispatched)
- Not paying demand side bids capacity fee results in inefficient dispatch and leads to over capacity.
Inefficient Dispatch and Over-capacity When Demand Side Bids Do Not Get Capacity Fee
Recommendation 2:

- Replace mandatory uniform centralized price insurance with market based risk management alternatives
- Buyers should decide how much they want to pay for capacity according to the price risk they are willing to assume or price level at which they are willing to be curtailed (buyer is responsible for providing curtailment technology or demonstrating ability to incur financial risk).
- Generators diversify investment risk through forward supply contracts and energy call options that systematically link capacity payments to an obligation to supply energy at a pre-specified “strike price”
- An *Energy Call Option* is an option but not an obligation to buy energy at a specified “strike price”. Generators selling a call option receive a premium (capacity payment) from the buyer and are liable to supply the called energy at the strike price or settle the call financially.
Recommendation 2 (cont’d)

- Generators that do not receive capacity payments (uncontracted) are entitled to sell their energy at free market prices which can go as high as VOLL.
- New generation will be built only if justified by the market value of the energy call options.
- Demand can participate in mitigation of price risk by subjecting their load to curtailment (or self-curtailing) during high price periods and avoiding capacity payments.
- VOLL can be set administratively or replaced by demand side response to price signals. VOLL serves both as a price cap for uncontracted energy and as a penalty for contracted but not delivered energy.
- The role of regulatory agencies is reduced to ensuring that load serving entities and generators have the resources (financial or physical) to meet their obligations.

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Recommendation 2 (cont’d)

- Public risk exposure can be regulated by imposing hedging requirements on load serving entities requiring that they hold forward contracts and buy additional energy call options up to \((1+X)\) of peak load (\(X=\) planning reserves).

- Regulating reserves obligation is more reliable than inducing capacity expansion through capacity payments (demand for capacity is steep while supply function is flat so small error in price results in large error in quantity).

- Setting reserve obligations in terms of energy call options requirements links the capacity obligations to energy prices and provides flexibility in meeting the obligation financially (operable and installed capacity markets in the US that are based on physical capacity obligations have been problematic).
Setting Prices vs. Quantities for Capacity

[This figure is due to Larry Ruff]

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Pricing Capacity as Energy Call Options

Theoretical probabilistic models for calculating LLOP are replaced by stochastic price models underlying the pricing of forward contracts and options but prices are negotiated directly between generators and load. Capacity value depends on modeling assumptions.

Alternative Price Behavior Models

Value of Spark-Spread Call Options Under Alternative Models

The role of models is to forecast prices but not to set them. The market figures the right price.

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Conclusions

- Capacity Payments represent a form of price insurance which is inherently a private good and can be provided through decentralized markets.
- Regulation should focus on facilitating decentralization, trading, customer choice and demand side responses (foster metering communication and EC technologies)
- The role of capacity payments in ensuring adequacy of supply can be fulfilled by risk management approaches and hedging instruments that permit diverse choices and promote demand side participation. The value of capacity as a hedge for price risk should be determined by the market.
- If capacity payment are intended to correct failures of capital markets then regulatory intervention should address directly the availability and cost of long-term financing for capacity expansion secured by short-term contracts (e.g., through loan guarantees) and focus on promoting market confidence and rules that facilitate liquid markets for energy futures and other risk management instruments.