Incentives and Rate Designs for Efficiency and Demand Response

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Project Objectives

Develop:

- A ***conceptual framework*** for improving rate design incentives for efficiency and demand response
- ***Prototype rate designs*** that illustrate application of the framework
- ***Phase 2 plan*** to apply framework, develop specific rates, and address regulatory barriers

Our Conceptual Framework

- *Economic efficiency* – retail pricing that maximizes the *net economic benefits* produced by electricity
- Achieved when:
  - **Price** (marginal value) = **Marginal cost**, or
  - *Curtailable service* program credits = market value

Marginal Cost-based Pricing

- Vast literature supports basing utility pricing and programs on marginal costs
  - Walras (1800s)
  - Boiteux (1949), Steiner (1957)
  - Bonbright (1961)
  - Kahn (1970-71)
  - Caramanis, Bohn & Schweppe (1987) [LMP]

Our Conclusion

- Recent efforts to encourage demand-responsive rates such as CPP and RTP in CA are consistent with moving toward economically efficient, *marginal cost-based retail pricing*.

- However, the considerable delays and revised rate proposals suggest that the primary barrier to improving retail rates in California appears to be:
  - ***NOT*** a lack of target rate designs, but
  - ***Constraints*** imposed by traditional rate-making practices of the utilities and regulators

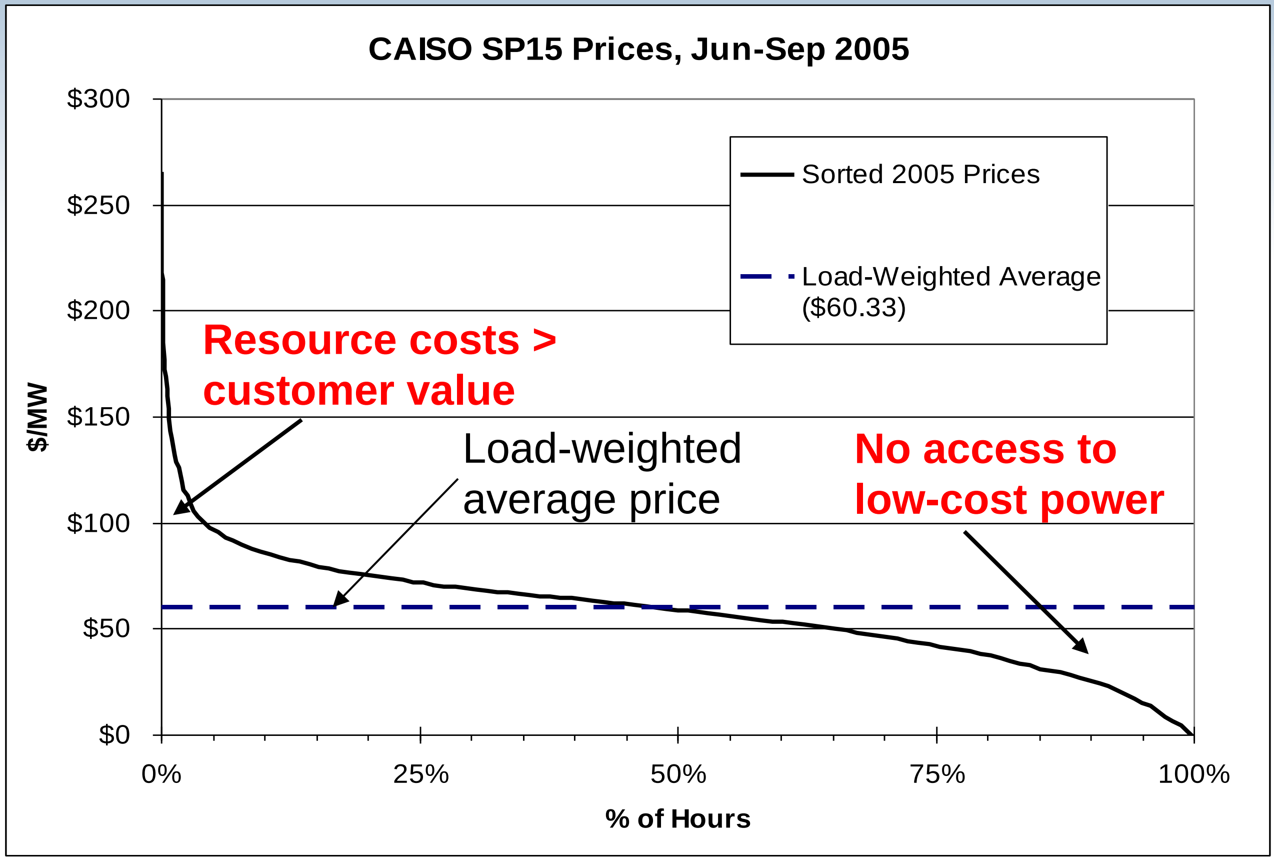
Our Recommendation:
Phase 2 project to…

1. Review current rates relative to our Phase 1 conceptual framework:
   - Principal current IOU tariffs
   - Recent CPP and RTP proposals
2. Develop candidate efficient rate designs (*e.g.*, RTP, CPP, day-type TOU), based on data for:
   - Agreed-upon marginal cost scenarios
   - Customer loads for a case study utility
3. Work with stakeholders to assess barriers / determine transition path to acceptance

Background:
The Need for Responsive Demand

- Energy ***market inefficiencies*** exist due to the combination of:
  - Varying hourly marginal costs
  - Fixed retail prices
- Resulting in:
  - Non-responsive electricity demand
  - Extra generation capacity and higher costs *to meet non-responsive demand*

Opportunities for Increased Economic Efficiency:
Frequent Differences Between MC and Price

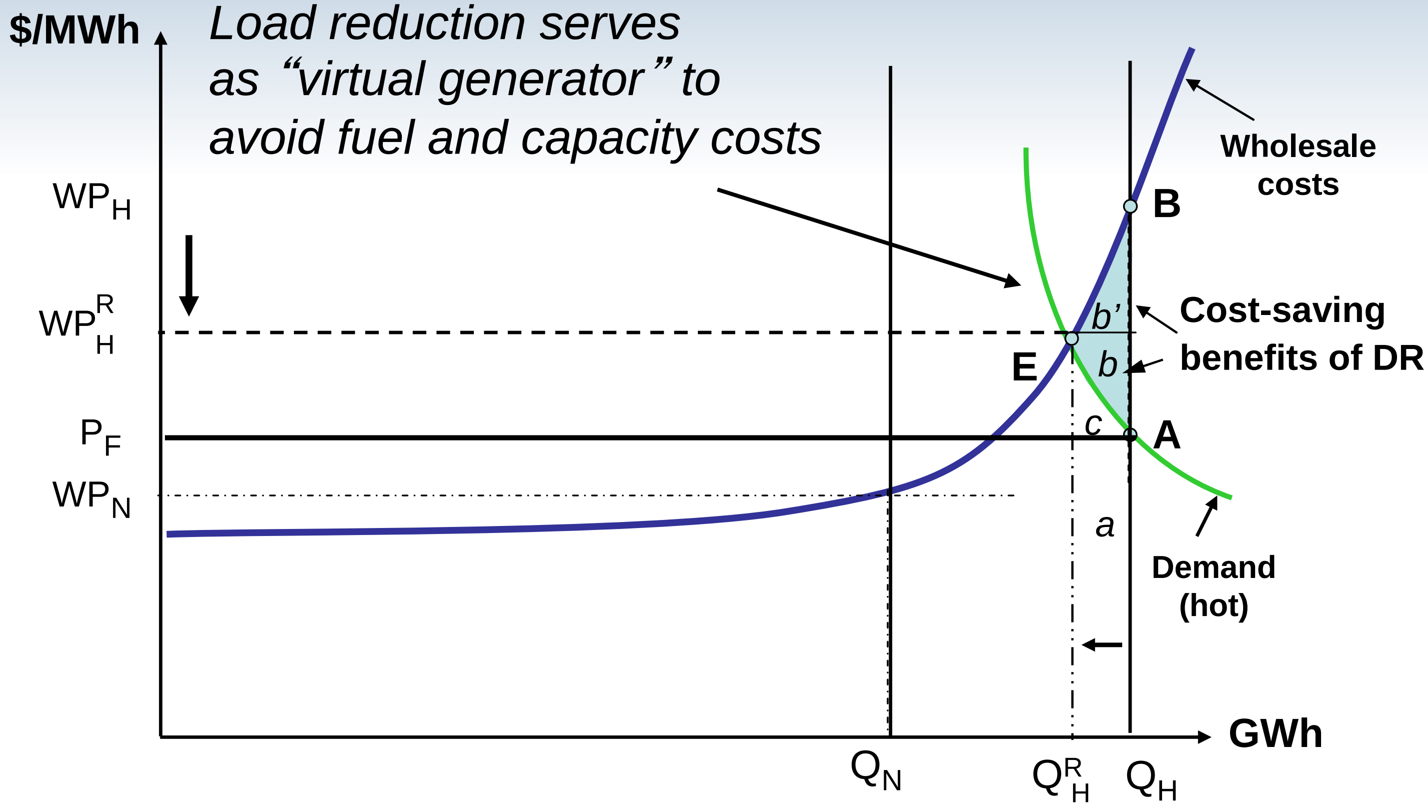


The Solution:
Retail Rates that Reflect Marginal Costs

- Marginal costs vary hourly, in real time
- Efficient retail prices reflect that variation
- Rate features can reduce consumers' uncertainty
  - Greater notice (day-ahead RTP)
  - Fixed prices most of time; variable only when most important (CPP, day-type TOU)
  - Price cap (RTP with price cap)
  - Financial hedges to guarantee fixed price on fixed quantity (RTP with hedging)

Effect of Responsive Demand:
Avoid uneconomic fuel & capacity costs

Supply and Demand in Summer Afternoon Hour



Incentives for Responsive Demand

- Marginal costs provide the basis for market-based incentives. With responsive demand…
  - ***Utility*** can avoid high marginal costs that exceed foregone revenue [*Increase in net revenue*]
  - ***Customers*** facing high prices reduce bill by more than foregone value of load reduction [*Increase in net benefits*]
- Win-win opportunity!

…But, Barriers to Efficient Retail Pricing

- Metering costs (not constraint for >200kW)
- Rate complexity
- Lack of incentives under regulation
- Concern about revenue impacts (recovering revenue requirements)
- Concern about bill impacts (distributional impacts on consumers)

Good design can help overcome barriers

Mechanisms for Achieving Responsive Demand

- **Pricing** approaches (Dynamic pricing)
  - **RTP** (hourly prices)
  - **CPP** – day/hour-ahead critical price(s) called to reflect market cost/reliability conditions
    - Combined with flat or TOU pricing
  - **Day-type TOU** – 3 levels, called day-ahead
- **Quantity** approaches – curtailable service
  - Reliability action needed on short notice

Cost Basis for Efficient Retail Rates

- Cost unbundling
  - Customer services
  - T & D facilities
  - Generation services (energy, reserves, transmission losses & constraints)
- Marginal costs of generation
  - Marginal energy costs
  - Marginal capacity/reliability costs
  - Marginal externality costs

Properties of Efficient Retail Rates

- Recover revenue requirements for *fixed costs*
  - Unbundled rates for T & D
  - Minimize price distortion to recover above-market generation costs (*e.g.*, DWR contracts)
- Set energy prices (no demand charges) to reflect *expected marginal generation costs*
  - Tradeoff between accuracy and uncertainty for fixed vs. dynamic prices
  - *Fixed* prices reflect higher expected cost & risk
  - *Dynamic* prices reflect marginal costs when most important
- Customer choice from limited menus

Efficient Pricing Rule

- Retail price in period *T*:

  $$P_T = \sum_h E\{Q_h * [P^E{}_h + RR_h * P^R{}_h]\} / \sum_h E\{Q_h\},$$

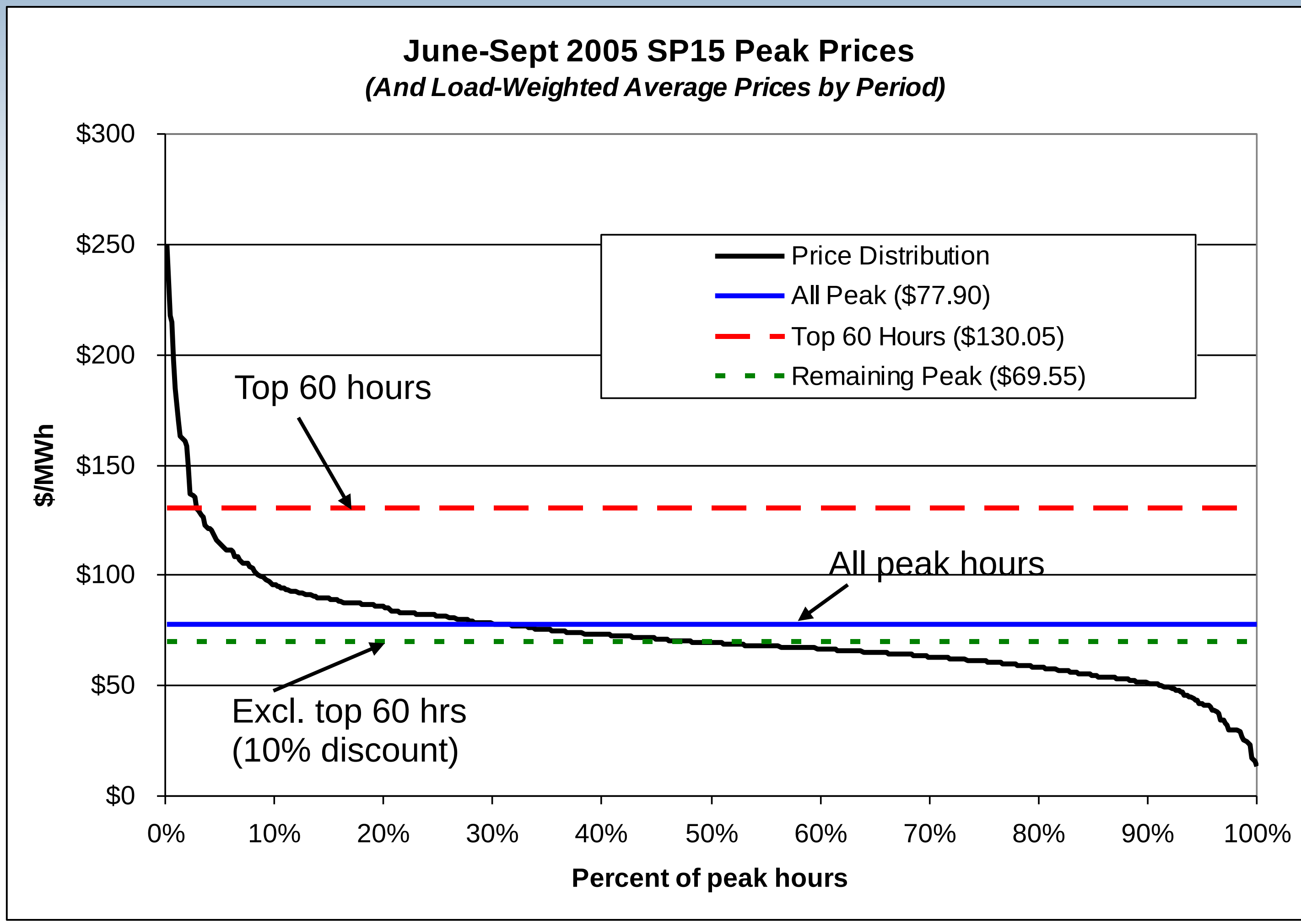
  where *h* is hours in *T*, RR is reserve requirement ratio, P^E and P^R are energy and reserves prices, and *E* is expected value

- P_T is *expected cost* to serve load in period T
- Implicit risk premium for fixed prices

Example: TOU with CPP

- Separate prices for --
  - *off-peak* period,
  - on-peak period, *except* top 1% of hours,
  - *top 1%* of hours (CPP)
- No concern about # of CPP events
  - Non-CPP peak prices cover expected costs in non-critical hour types
  - CPP prices cover costs when MC is high

Peak TOU & CPP Prices – Summer 2005



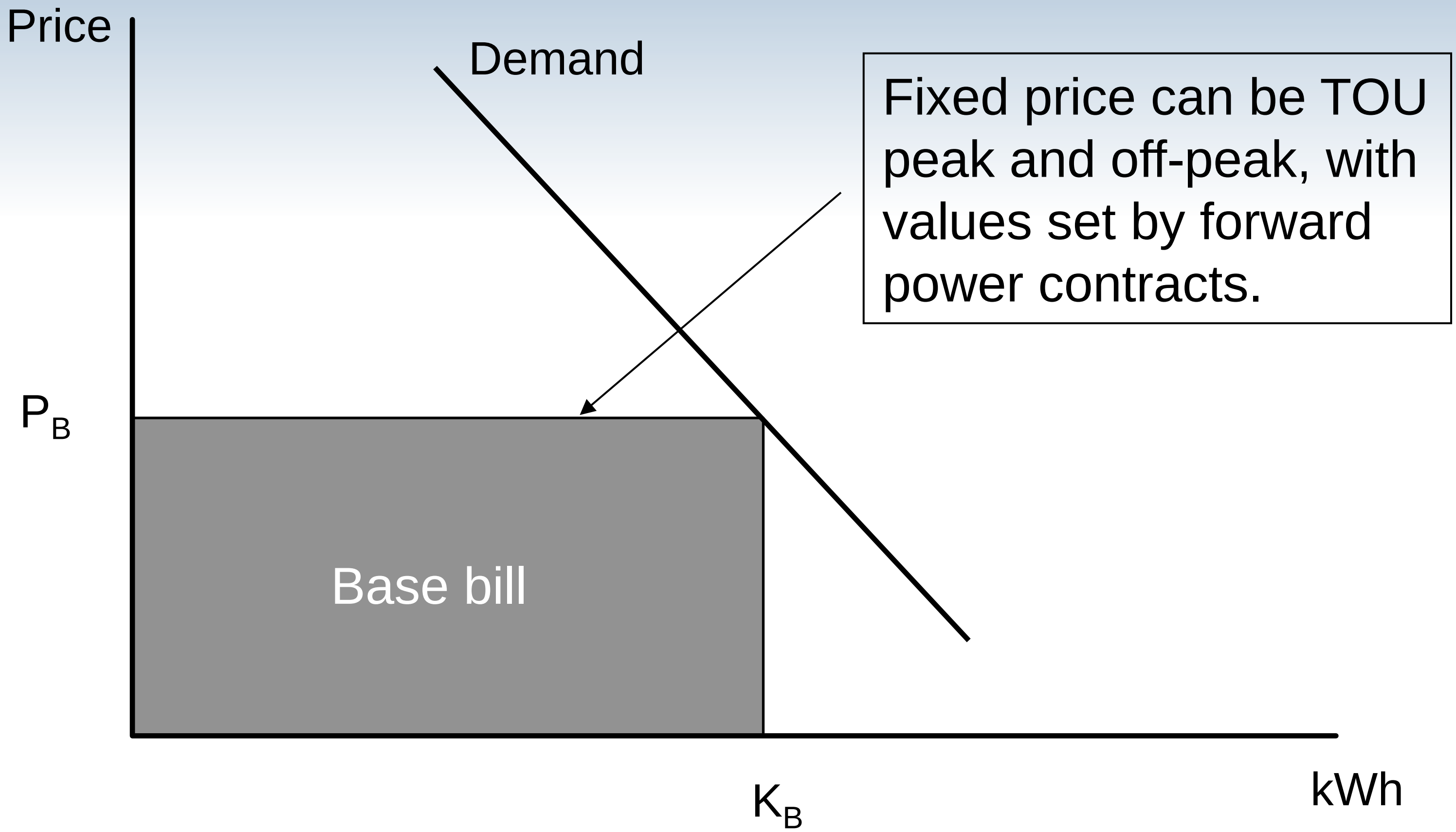
Reconciling Marginal Costs and Average (Accounting) Costs

- Under competition, reconciliation over time is reflected in generator profitability
- Under regulation, a variety of reconciliation methods have been proposed:
  - Ramsey (inverse-elasticity) pricing
  - Non-linear pricing
    - Block pricing
    - Two-part pricing – access charge & energy prices

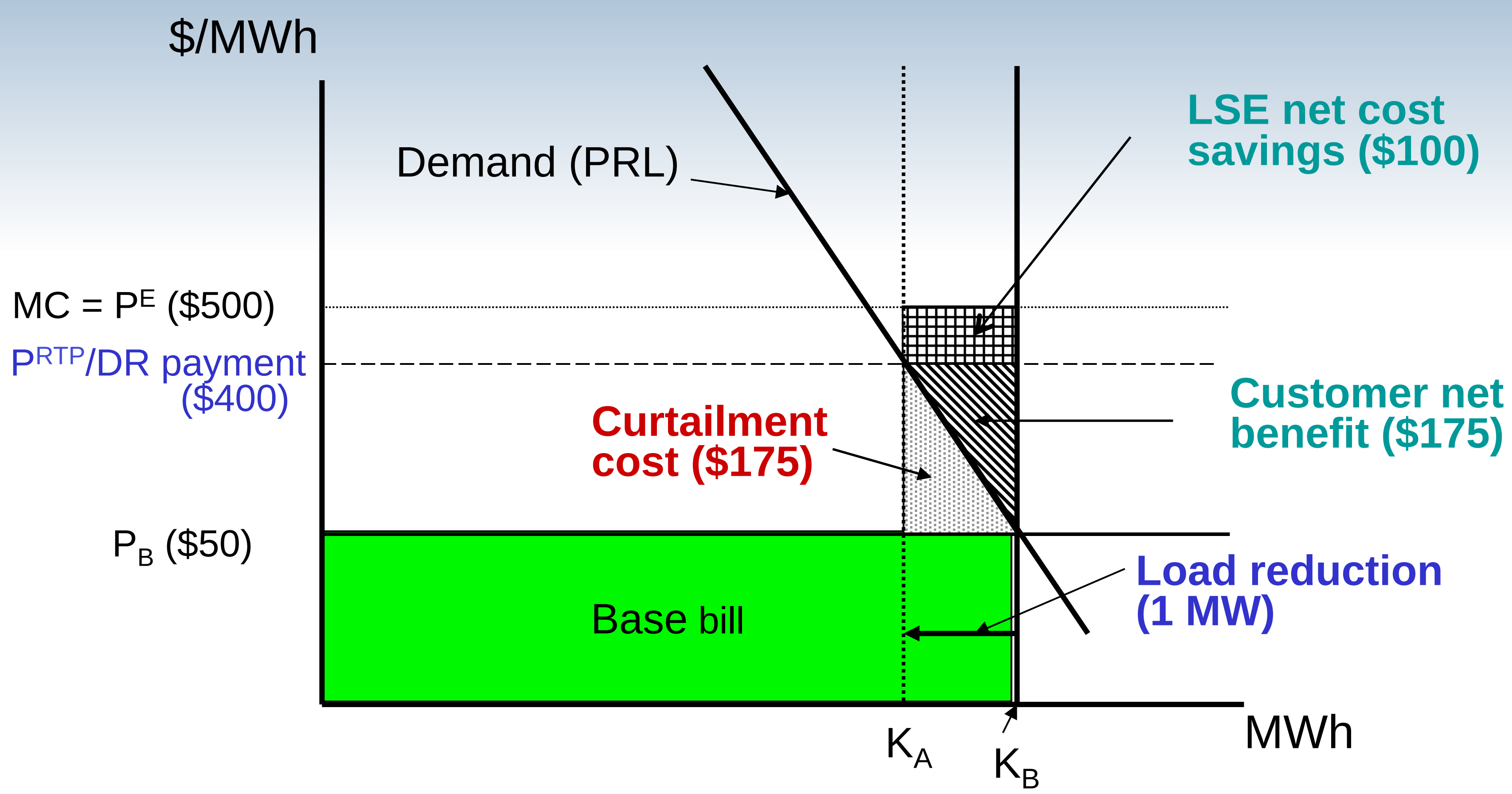
Example of Reconciling MC & AC – *Unbundled RTP with Hedging*

- Unbundled T&D rates apply to all current usage
- Fixed energy price applied to *baseline* load recovers allowed generation costs
- Marginal cost-based RTP prices apply to *deviations from baseline load*
- Demand response can benefit both consumers and the utility – not *"zero-sum game"*

Unbundled RTP with Financial Hedge:
Baseline hourly load billed at fixed price P_B



Sharing Benefits from Responsive Demand:
Consumer Response to Hour of High RTP Price



Example of *Unbundled RTP with Hedging* in Competitive Retail Markets

- **Constellation NewEnergy** has 6,000 MW of large customer load on similar products
  - Customers face hourly prices indexed to RTO day-ahead or real-time prices (*e.g.*, PJM, ERCOT)
  - Customer selects amount of load to be covered by fixed-price contracts
  - Balancing loads (above and below contract level) settled at indexed prices
- Natural pricing product for commodity with price volatility and existing forward markets

Efficient Curtailable Service

- Two benefits of curtailable service
  - *Insurance value* of operating reserves
  - *Operating value* of cost savings/reliability
- Two program types
  - *Traditional* – capacity (reserves) credit for mandatory curtailment (covers both sources of value)
  - *Performance-based* – smaller credit, *plus* payments for actual curtailments (similar to some DR programs)

Quantifying Curtailment Payments

- Maximum payments for insurance & operating value:
  - $PMT^{Ins} \leq \sum E\{Q^{Av} * (P^{NSR} - C^{Av})\} - C^{Fix}$
  - $PMT^{Op} \leq \sum Q^{Curt} * \max\{0, (P^{E} - P^{RET} - C^{Curt})\}$

    Q^{Av} & Q^{Curt} are Curtailable (Available) & Curtailed load,

    P^{NSR} , P^{E} & P^{RET} are prices of non-spin reserves, energy & retail; and

    C^{Av} , C^{Curt} & C^{Fix} are program costs that depend on curtailable load, actual load curtailed, and fixed

- *Performance-based* design aligns benefits to consumers and utility – pays for services actually delivered

Phase II Plan

Overall objectives:

1. **Where are we?** Assess existing retail rates in California, including proposed CPP & RTP
2. **What is the ultimate goal?** Develop "ideal" set of default and optional rates with appropriate incentives for efficiency & DR
3. **How do we get there?** Work with stakeholders to assess barriers and determine practical transition approach

Phase II Research Activities (1)

Determine objectives & case study

1. Identify issues and objectives – regulatory barriers and stakeholder objectives
2. Identify case study – Utility involvement crucial to success; need customer data
3. Identify candidate rate structures

Phase II Research Activities (2)

Review and data preparation

4. Review principle utility tariffs & proposed dynamic pricing rates
5. Develop marginal cost scenarios
6. Assemble customer load data
7. Develop price responsiveness assumptions

Phase II Research Activities (3)

Analysis and transition strategies

8. Develop energy prices based on conceptual framework
9. Evaluate recommended menus of rates
10. Review short-term & long-term options for transitioning to recommended rates

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