

Valuing Load Reduction in Restructured Markets

Supply Cost Curve
Regressions

Market Price vs. Value of
Load Reduction

Photovoltaic Case Study

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Research on California and Mid-Atlantic States (PJM Market)

- Results presented at three conferences
 - Pace University Law School energy conference 11/10/00
 - Natl. Assn. of State Utility Consumer Advocates (NASUCA) 11/15/00
 - Natl. Assn. of Energy Service Companies (NAESCO) 11/16/00
- Sponsorship
 - NAESCO and Pace Energy Project sponsored PJM research
 - The Utility Reform Network (TURN – a California consumer group) sponsored California research

Competitive Market (In Theory)

In a Perfect Market:

- The commodity can be stored.
- There is perfect information on price.
- There are no transaction costs.
- There are competitive options.

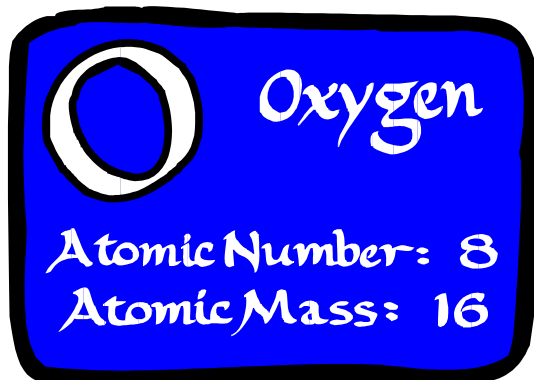
The Market Reality

- Electricity storage is very limited.
- Small customers receive no real price signals.
 - Load profiles
 - Do not know price until after electricity is used.
- Significant transaction costs, particularly for small customers, in seeking out competitive options.
- Developing oligopoly creates market power through strategic bidding.

"Electricity is just another commodity,



like oxygen is just another gas."



Reducing Demand Empowers Customers

- Two different ways to reduce demand
- Real-time customer response, based on prices
 - Ultimately computer automated
- Investments in:
 - Efficiency
 - Load Shifting
 - Distributed Generation behind the meter.

Load Reduction Reduces Prices for Everyone

- When consumption is reduced the market price is reduced for everyone.
- The Value of Load Reduction is greater than market price, once the price reduction is factored in.
- It can be analyzed using a quantitative framework.

Old World

versus

New World

- Price for last unit only set by last bid.
- Marginal Cost incurred for last most expensive unit only.
- Value of Load Reduction equal to last unit's marginal cost.

- Price for all units set by last bid in "Poolco" structure.
- Value of Load Reduction is equal to bid price for last unit *plus* increase in bid price for all other units (except last unit).

Methodology

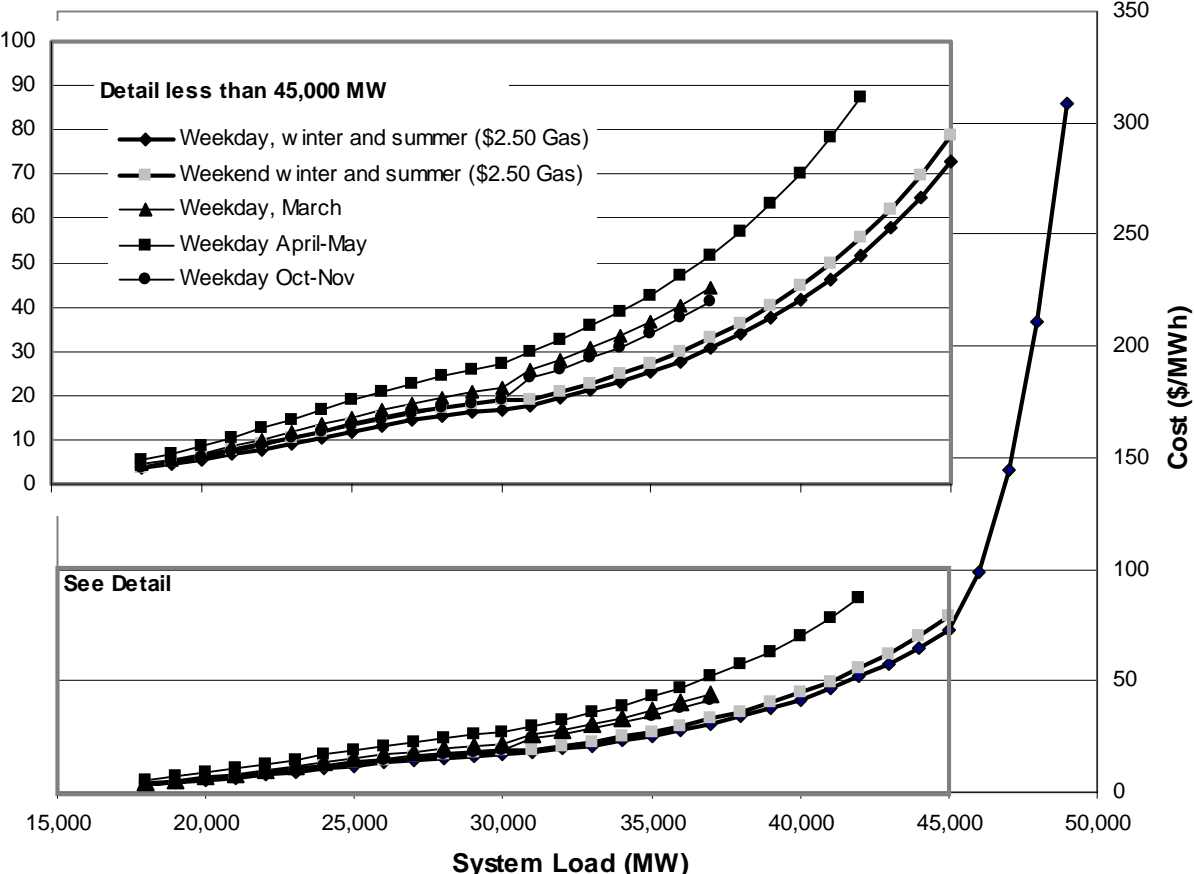
- Create Cost Curves relating market price to load.
- Calculate market price and value of load reduction as they vary by load level.
- Further analysis based on time-of-use periods or time pattern of savings from specific conservation or distributed generation options
 - Photovoltaic case study analyzed here

Methodology – Cost Curve

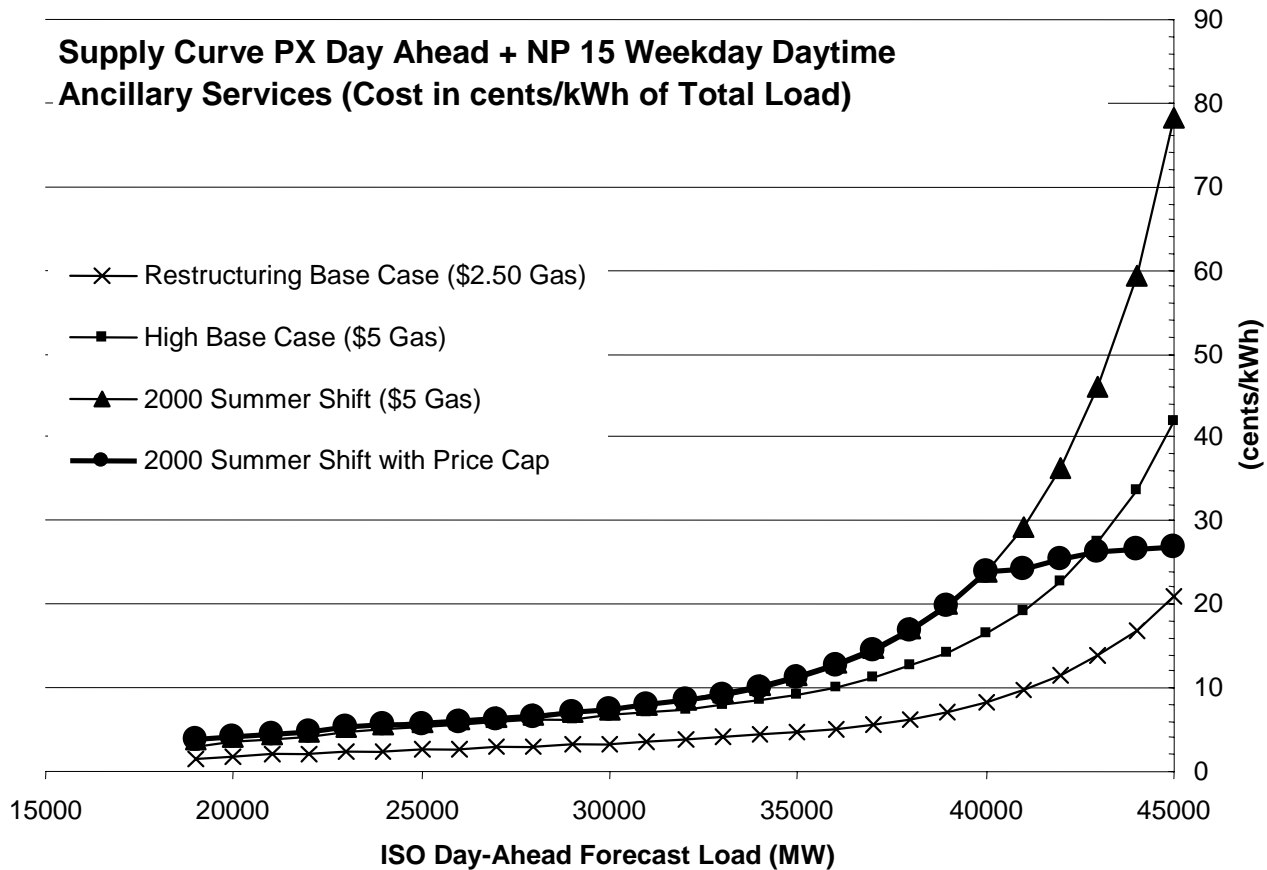
- Collect hourly market price and load data
- Create supply (cost) curve using regression analysis.
- Multiple equations may be needed to fit different portions of the curve.
- May obtain “family” of curves that vary by month, day of week, time of day.
- Ancillary services can be analyzed in same way (but only 2-8% of energy cost).

Mid-Atlantic States Supply Curves

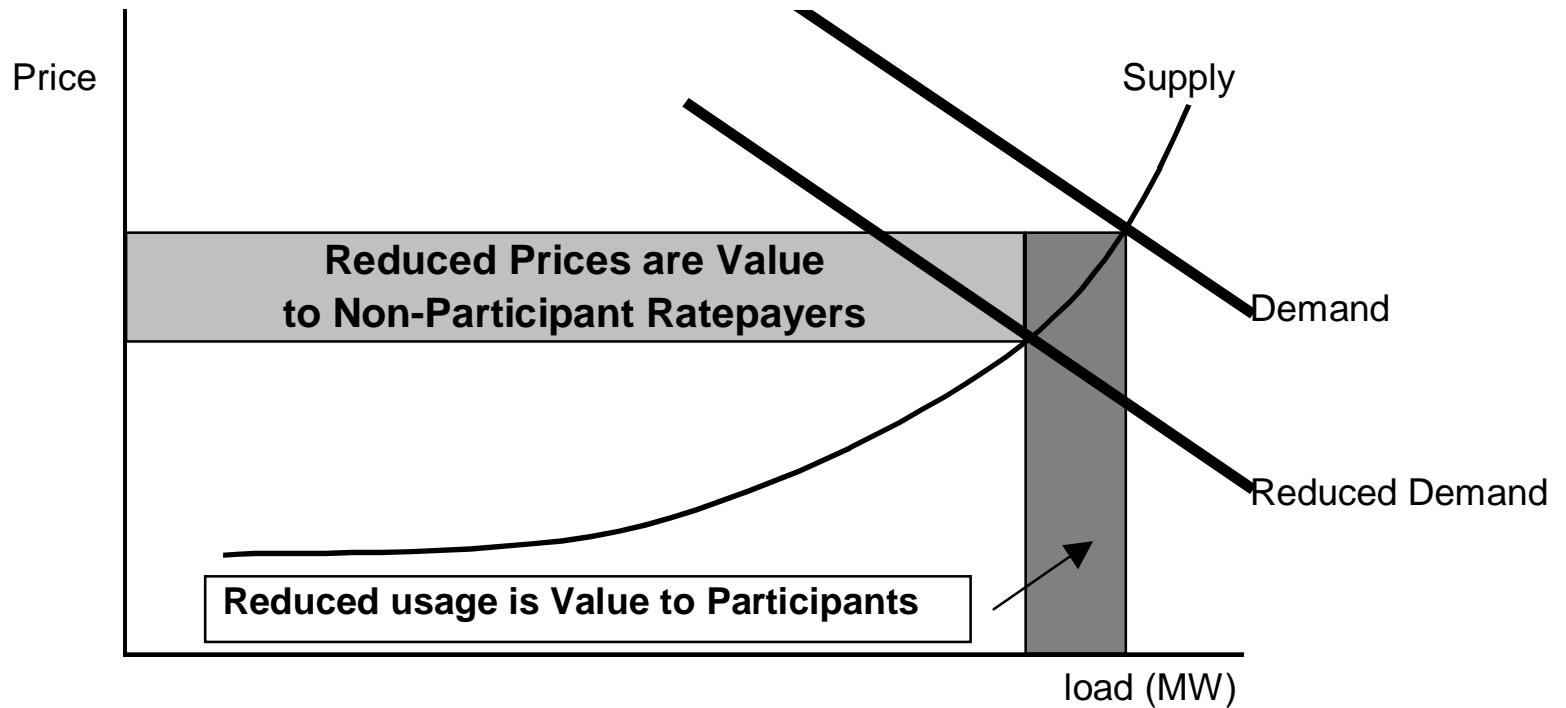
Comparison of Supply Curves



California Supply Curve



Methodology – Value of Load Reduction



Methodology – Value of Load Reduction – In Words

- Greater than Market Price
 - [(Market price at existing load X existing load)
 - MINUS
 - (Market price at reduced load X reduced load)]
 - DIVIDED BY
 - (existing load – reduced load)
- Adjust for hedging

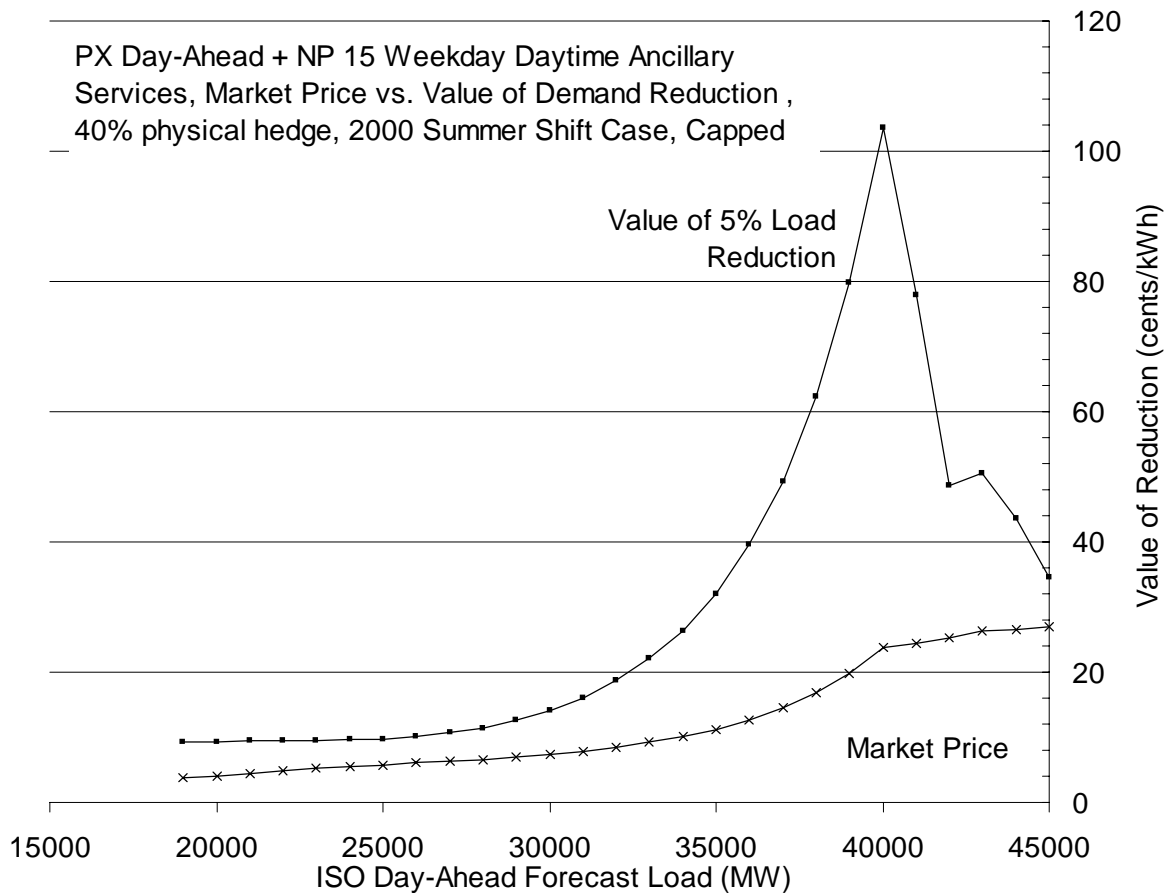
The Impact of Hedging on the Value of Load Reduction

- Physical versus Contractual Hedging
 - Each has different Impacts on the Value of Load Reduction
 - Physical hedging is based on generation sold on a cost basis
 - Contractual Hedging is based on an expectation of future market prices

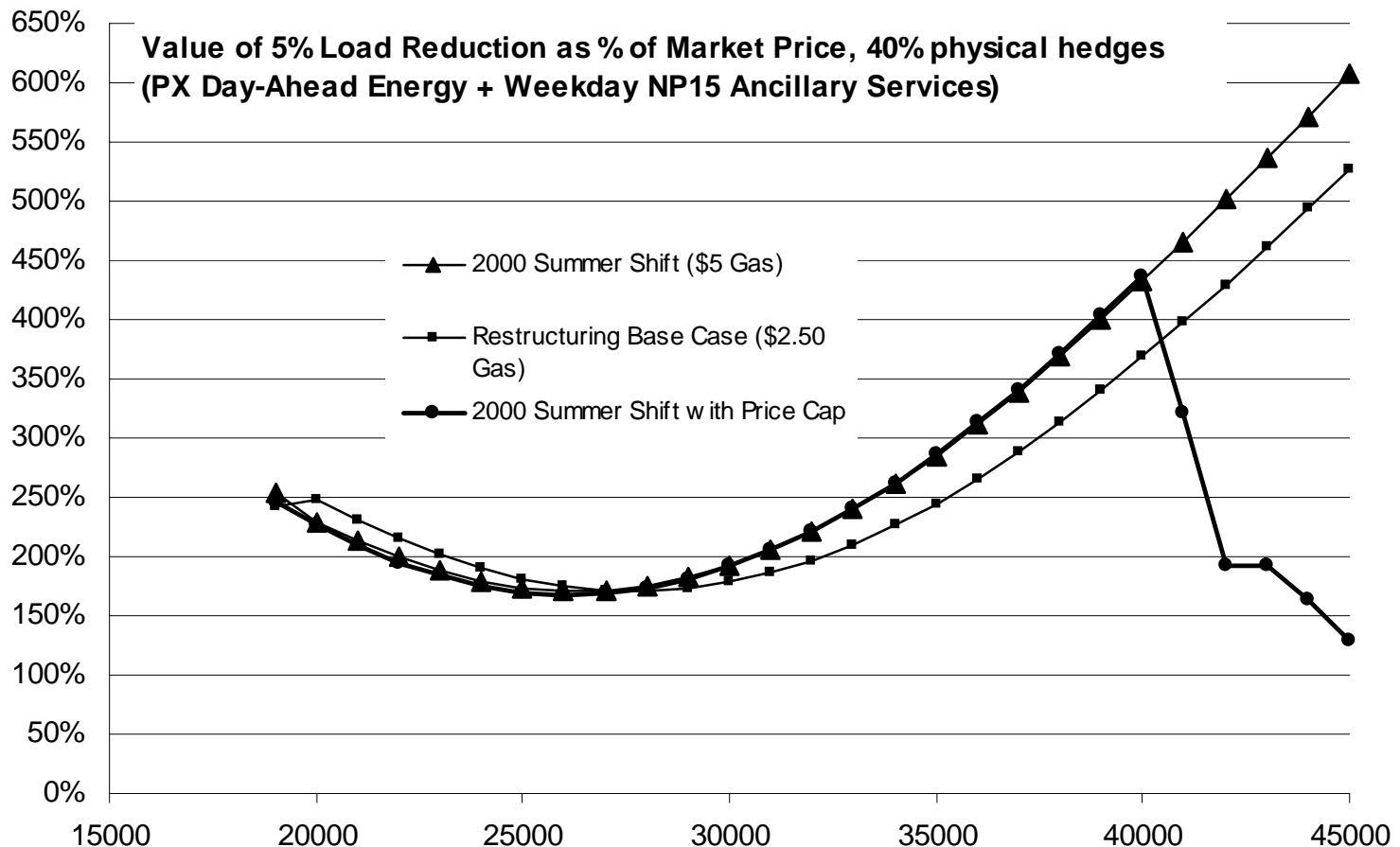
The Impact of Hedging – continued

- The difference between the Value of Load Reduction on Market Price is attenuated in the longer term.
 - Impacts the construction of new generation.
 - Impacts utility system operations through unit commitments.
- Assume a portion of supply is not exposed to pool price to consider these factors.

California Supply Curves – Value of Load Reduction

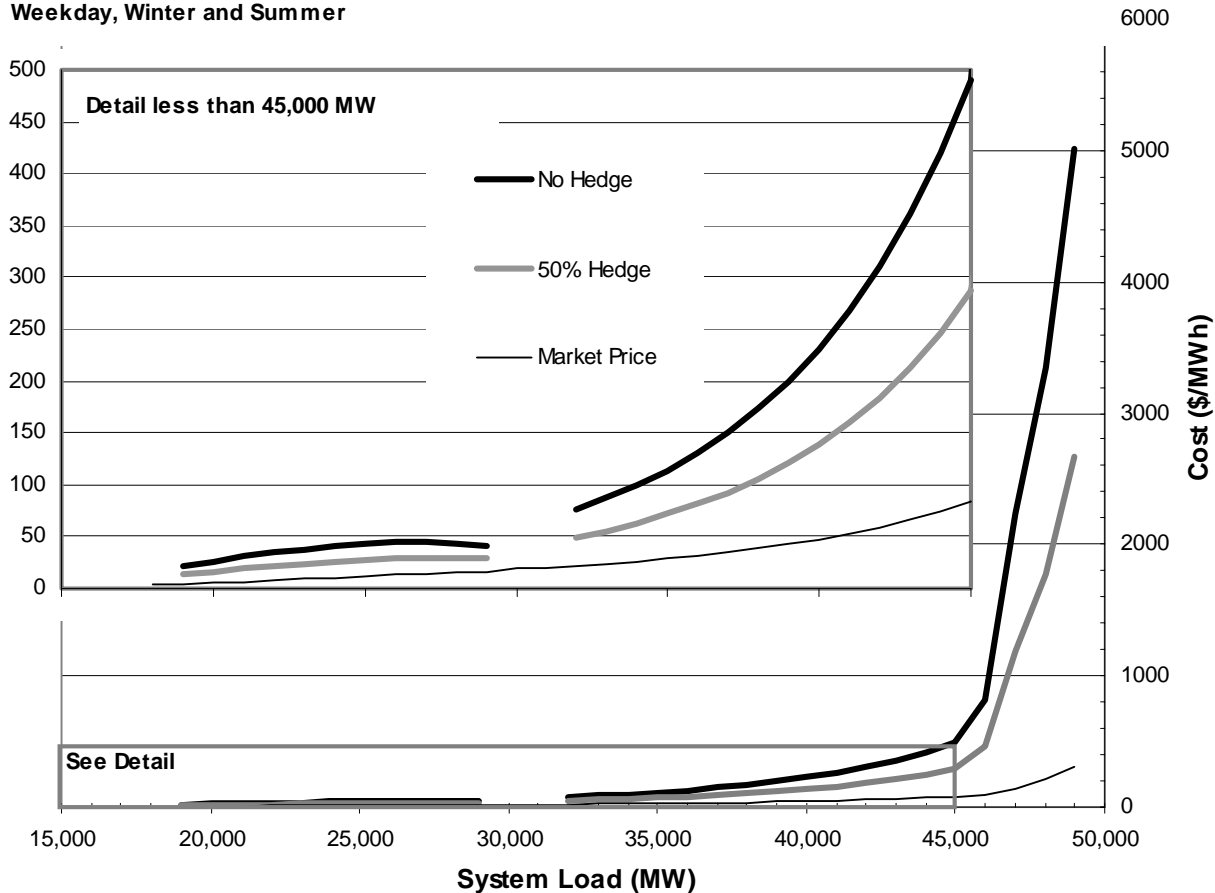


California Supply Curves – Value of Load Reduction as a Percent of Market Price

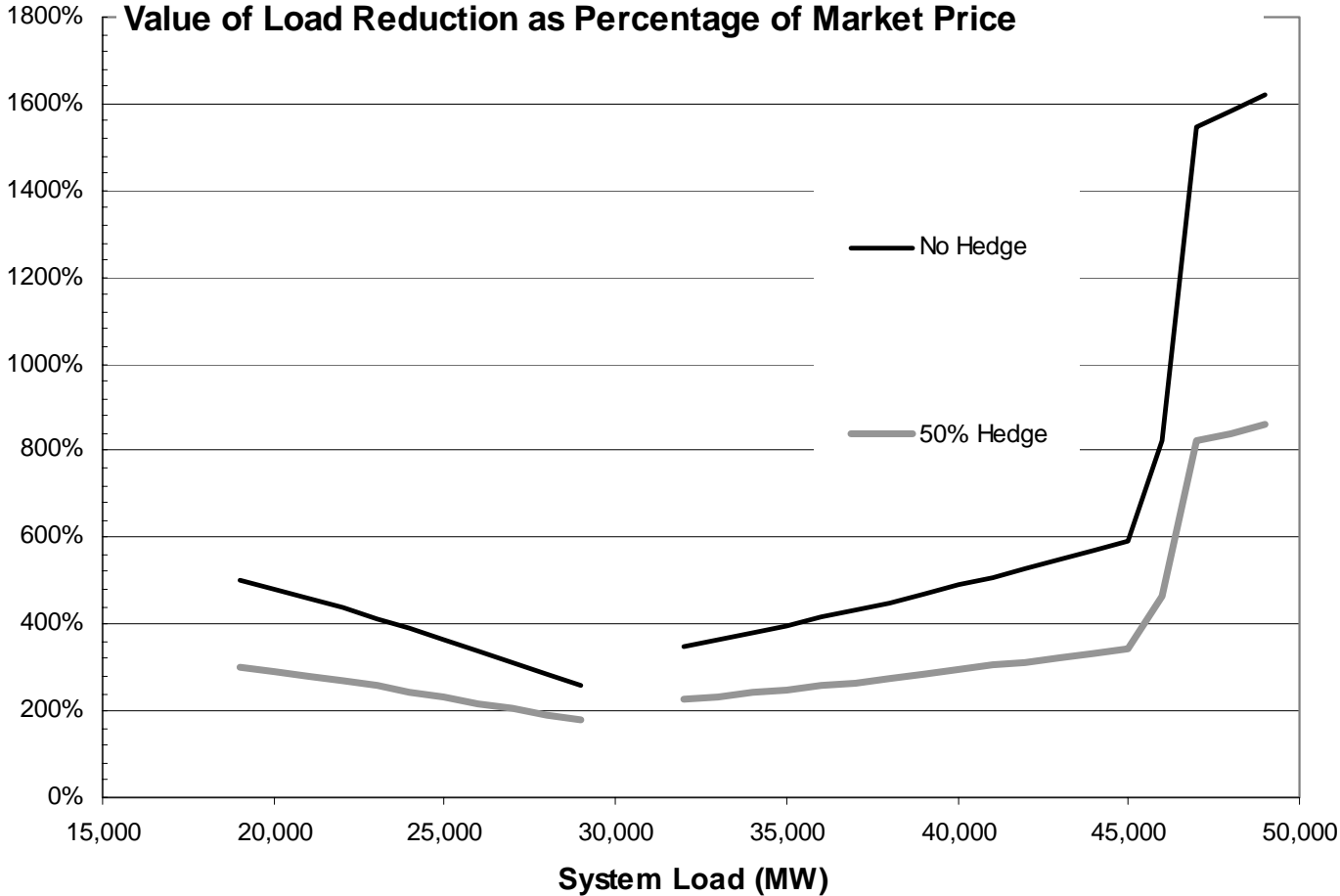


PJM Value of Load Reduction – Hedged versus Unhedged

Value of Load Reduction: No Hedging versus 50% Hedged
Weekday, Winter and Summer



PJM Relative Value of Load Reduction



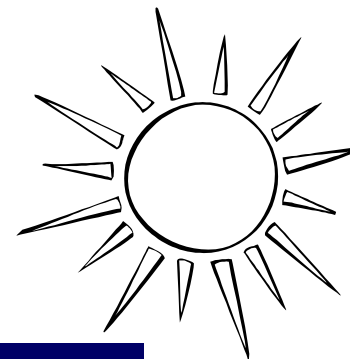
Valuing Photovoltaics



- Photovoltaic production data collected for two UPVG sites in Pennsylvania and California.
- Hourly market price and value of load reduction applied to photovoltaic generation.
- Weighted average of hourly generation calculated to value PV.

PV Characteristics

Sacramento Airport, California 134 kW

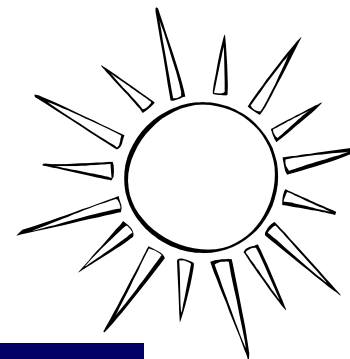


PV Generation	On-Peak	Mid-Peak	Off-Peak	Total
Summer	42%	26%	32%	100%
Winter		70%	30%	100%
Annual	29%	40%	31%	100%

PV Hours	On-Peak	Mid-Peak	Off-Peak	Total
Summer	17%	20%	62%	100%
Winter	0%	38%	62%	100%
Annual	10%	28%	62%	100%

PV Load Factor	On-Peak	Mid-Peak	Off-Peak	Total
Summer	55%	30%	12%	23%
Winter		27%	7%	15%
Annual	55%	28%	10%	19%

PV Characteristics – Plymouth Meeting, Pennsylvania Site

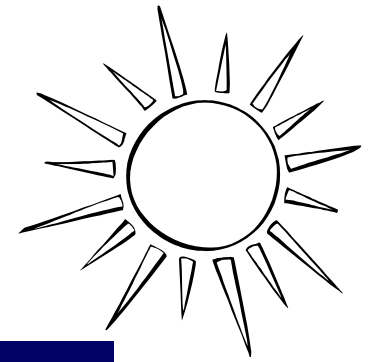


PV Generation	On-Peak	Mid-peak	Off-Peak	Total
Summer	35%	49%	16%	100%
Winter		83%	17%	100%
Annual	17%	67%	16%	100%

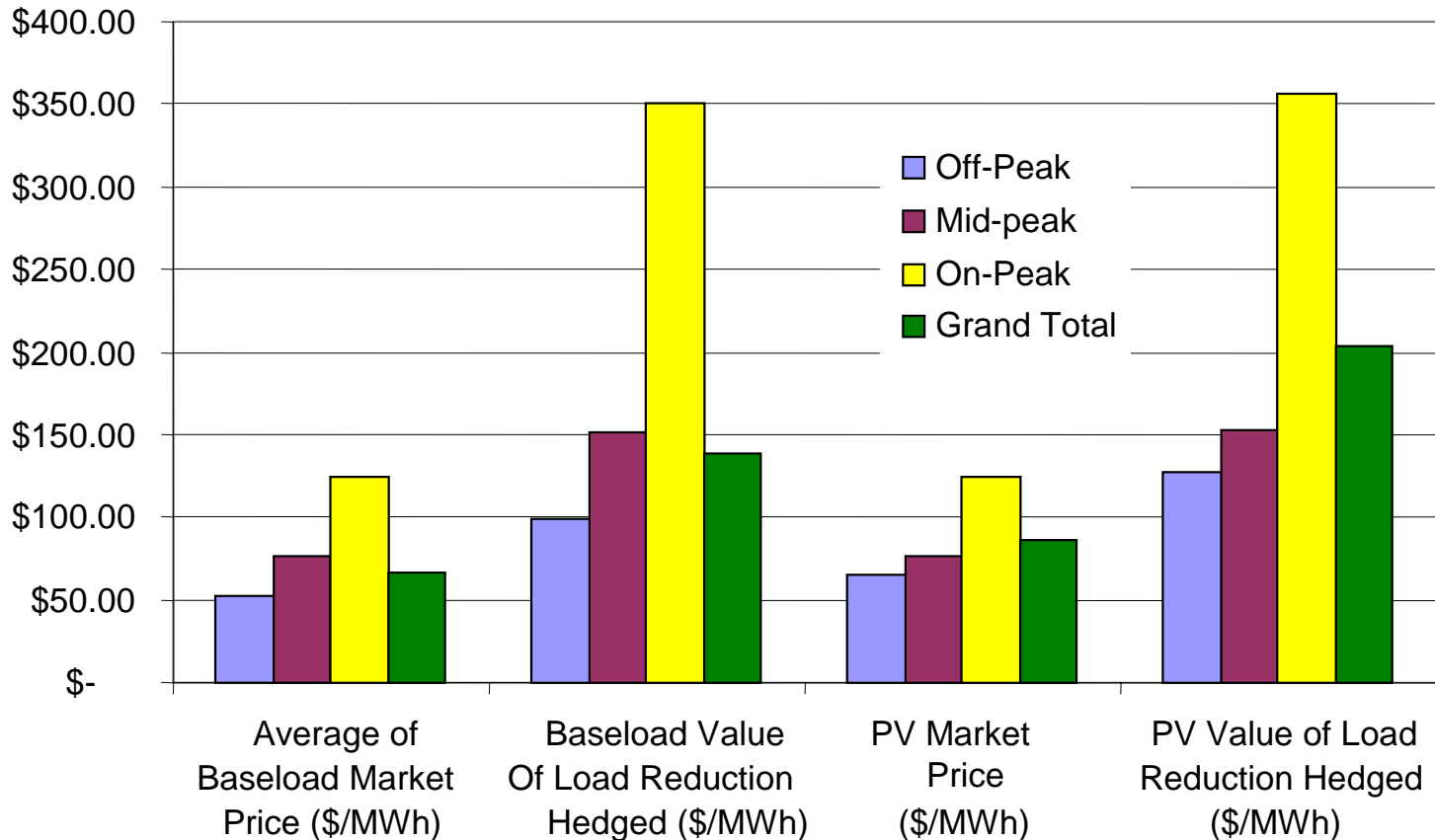
PV Load Factor	On-Peak	Mid-peak	Off-Peak	Total
Summer	38%	24%	7%	19%
Winter		17%	4%	11%
Annual	38%	19%	5%	14%

Value of Photovoltaics

Annual - Sacramento Airport, California



Market Price / Value of Load Reduction Comparison



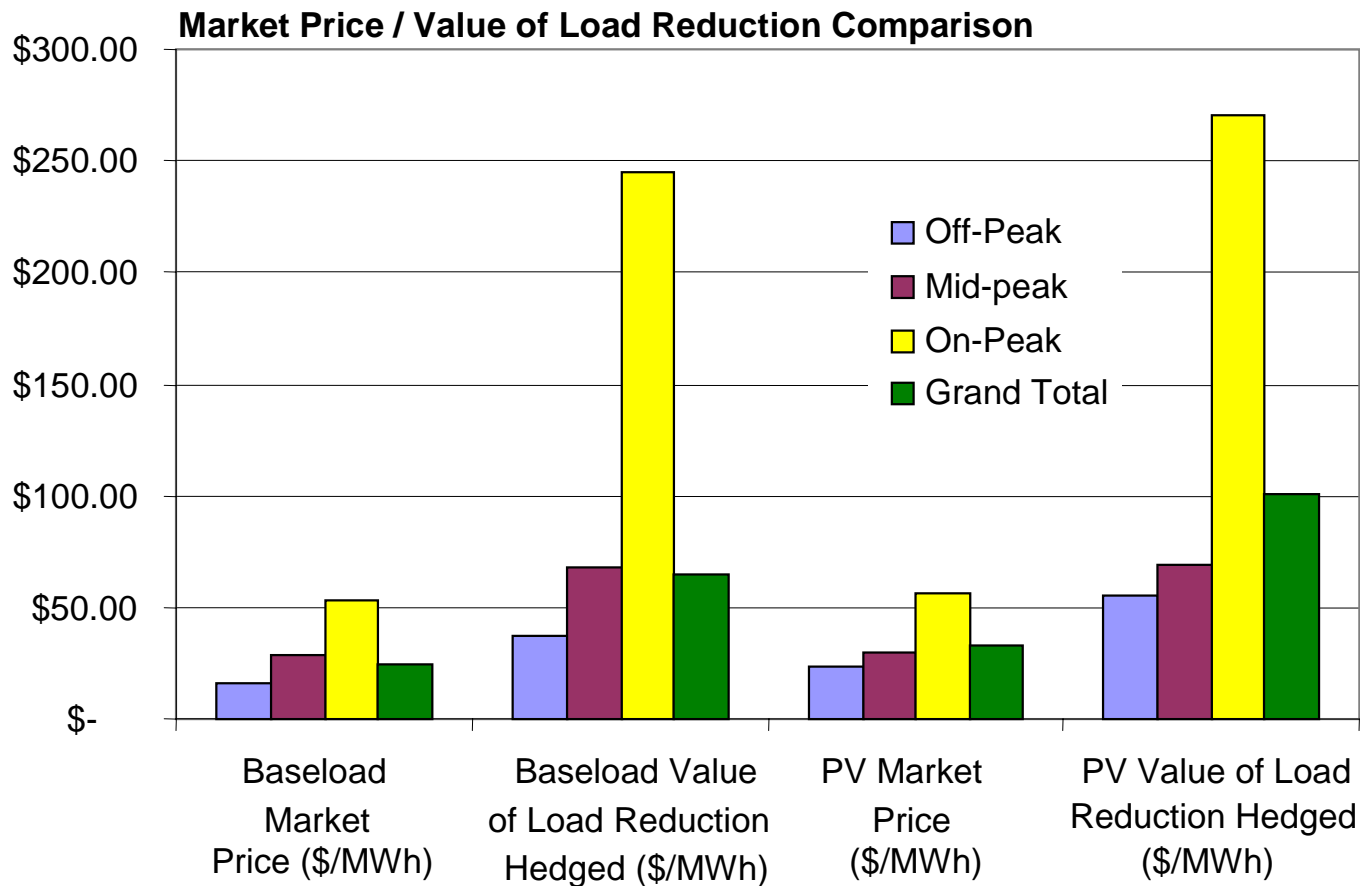
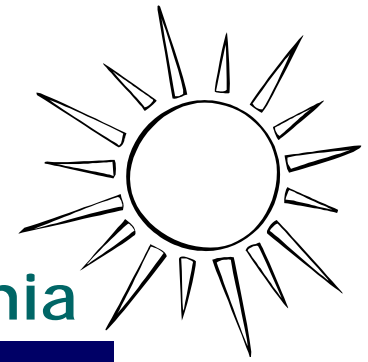
Value of Load Reduction vs. Market Price Sacramento Airport Project

- PV Market Price is 8.7 cents/kWh
- PV Value of Load Reduction is 20.2 cents/kWh

Data	Off-Peak	Mid-Peak	On-Peak	Grand Total
Average of Calculated Market Price (\$/MWh)	\$ 52.28	\$ 76.76	\$ 124.17	\$ 66.39
Value of Load Reduction Hedged (\$/MWh)	\$ 99.03	\$ 151.21	\$ 350.60	\$ 139.07
PV Revenue Calculated MP (\$/MWh)	\$ 65.42	\$ 76.28	\$ 124.88	\$ 86.75
PV Value of Load Reduction Hedged (\$/MWh)	\$ 127.86	\$ 152.75	\$ 355.96	\$ 202.91
	Off-Peak	Mid-Peak	On-Peak	Grand Total
Value of Load Reduction / Market Price	189%	197%	282%	209%
PV Value of Load Reduction / PV Revenue CMP	195%	200%	285%	234%

Value of Photovoltaics

Annual – Plymouth Meeting, Pennsylvania



Value of Load Reduction vs. Market Price Pennsylvania Project

- Market Price for PV Oct. '99 to Sept '00 is 3.3 cents/kWh
- PV Value of Load Reduction is 10 cents/kWh
- Prices and Value of Load Reduction were much higher in 1999

Data	Off-Peak	Mid-peak	On-Peak	Grand Total
Average of Calculated Market Price (\$/MWh)	\$ 15.93	\$ 28.22	\$ 52.76	\$ 24.28
Value of Load Reduction Hedged (\$/MWh)	\$ 36.81	\$ 68.15	\$ 245.12	\$ 65.11
PV Revenue Calculated MP (\$/MWh)	\$ 22.91	\$ 29.17	\$ 56.43	\$ 32.69
PV Value of Load Reduction Hedged (\$/MWh)	\$ 54.63	\$ 69.03	\$ 270.71	\$ 100.23

	Off-Peak	Mid-peak	On-Peak	Grand Total
Value of Load Reduction / Market Price	231%	242%	465%	268%
PV Value of Load Reduction / PV Revenue CMP	238%	237%	480%	307%

Findings

- Load Reduction Has Greater Value than Market Price
 - Twice (off-peak) to Five Times (peak)
 - Evident in both California and PJM
 - California Price Cap reduces differential
 - This result is structural because of the upwardly sloping supply curve.

Conclusions

- Don't Be Afraid to Invest in Energy Efficiency, Load Shifting and Distributed Generation
- Rate Increases from DSM Will Be Mitigated or Reversed by Reductions in Market Price
- Peak Reduction Has Highest Value
 - Air conditioner programs and photovoltaics
- High Fixed Charges in Rates Are Counter-Productive
 - Encourage Consumption and Raise Rates for Everyone
- Net Metering for Photovoltaics Is Justified by Higher Value of Load Reduction