# Demand –Side Management (DSM): Future Role in Energy Markets

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# Customer Response

- Demand-Side Management (DSM) is customer response.
- Changing energy use in response to market factors including:
  - Conservation – Use less across many hours.
  - Demand Response – Use less when prices and/or production costs are high.
  - Load management -- Shifting demand from high price to low price periods.
- Efficient markets require the appropriate interaction of demand and supply – inelastic demand let's the supply-side set prices.
- The history in electric industry is one of cost-based administered pricing in retail markets with average rates that often ignore highly variable supply-side costs, i.e., wholesale electricity costs.

# Demand-Side Management: Defined

- "DSM" includes energy efficiency (EE) and demand response (DR):
  - Energy conservation investments in EE to reduce bills (many options).
  - Event-based load response tied to operator notification:
    - Traditional large customer interruptible programs tied to reliability triggers.
    - Direct load control programs (water heaters or AC units, even some C&I loads)
  - Event-based price response to operator notification:
    - Time of use pricing with event-based critical peak pricing.
    - Day-Ahead hourly pricing on called "event days."
  - Non-event based price response (independent of any operator):
    - TOU rates every day (programs becoming more targeted and granular)
    - Day-Ahead hourly pricing every day
    - Real-time pricing (actual daily markets)

# Prominent Commentators

In listening to the debate on DSM and its role in future resource plans, comments that seem to characterize the discussion are:

- An Energy Trading Company CEO – *"I suppose you think that, on our board, half the directors do all the work and the other half do nothing. As a matter of fact, the reverse is true."*
- Dan Quayle (former U.S. Vice President) – *"I stand by all my misstatements."*
- Gerald Ford (former U.S. President) – *"Things are more like they are now than they have ever been."*
- Richard Nixon (former U.S. President) – *"I was not lying. I just said things that later on seemed untrue."*

The myths and facts about DSM as a resource often get intertwined.

# DSM History – Two Boom Periods

- Activities have been continuous in many regions, but two "boom" periods in DSM can be identified.
- First Boom: 1980s to mid-1990s after the Oil Embargos:

***Causes:***

- Response to higher energy prices.
- Forecasts for increasing oil and natural gas prices.
- Great interest in EE and EE incentive policies, but not much interest in DR.

***End Factors:***

- Energy costs declined in real terms as supply increased in response to higher prices.
- Few utility rate cases (some utilities went 10 or more years between rate cases).
- Restructuring of wholesale and retail markets – NOW, the competitive market will take care of all cost effective DSM investments.
  - ***Restructuring never had a chance with default pricing and fixed transitional rates (and other reasons).***

# Two Boom Periods

- Second Boom: 2000 through today (and beyond?)

  ***Causes:***

  – Energy costs (oil and gas) – input fuels to electric generation.

  – Energy cost volatility – price spikes

  – Infrastructure – transmission & pipeline constraints

  – Working through gas-fired merchant plant build-up (still working through capacity boom in some regions but 2 to 4 years out shortfalls look likely).

  – Environmental uncertainties (carbon constraints, mercury, etc.) are making costs of fossil plants, particularly coal, extremely uncertain.

  – Energy market uncertainties are pervasive – EE and DR are viewed as hedges against a wide range of risks.

# Today's DSM Environment

- EE is now being considered in regions that have never aggressively pursued this option.
  - Managing price and volumetric risks now seen as a major issue.
  - Integrated utilities now looking at these options as "tariffed programs."
  - Concern over a new regime of rising fuel costs (gas, oil and coal).
- Linking wholesale and retail markets through appropriate pricing seen as important for the industry.
  - Leads to more pricing-types of solutions.
  - Reflected in Energy Policy Act (EPAct) in the U.S.
- EE and DR becoming viewed as integrated solution, i.e., part of the same spectrum of services.
  - But some EE supporters resist DR investments and EE/DR integration.
  - Overall, more DR being considered than in last "boom".

# Today's DSM Environment (cont.)

- More states spending substantive amounts on DSM.
- More states and utilities actively supporting new DR:
  - System-reliability based DR – interruptible customers tied to notification.
  - Price-based DR - customers make choices in response to price signals.
- Incentives for DSM investment returning after nearly disappearing in many regions (restructuring one reason for demise of incentives).
- Renewables (particularly wind) increasingly seen as viable alternatives (but, planners are assuming small amounts (e.g., 5%) of the wind capacity being used as the estimate available on peak).
- Resource planning now seen as a process for procuring lowest cost resources **AND** as a process for managing price and quantity risks.
  - DSM options now being viewed as a "resource" that diversifies the portfolio and provides a physical hedge against different uncertainties.

# Importance of DSM Pricing Options

- Developing initiatives that allow customers to respond to prices (directly or to good proxies) is critical to the industry.
- It can be argued that industry change/restructuring has actually reduced the price responsiveness of demand.
  - Non-market, flat prices continued as part of standard offer or default supply services.
  - A freeze on electric tariffs including tariffed load management programs.
  - No innovative offerings from competitive providers, given existing regulated rates.
- If the industry does not price what is scarce -- on-peak electricity use -- how can we:
  - Have efficient resource allocation in markets?
  - Incent innovation – get technology companies to invest in energy management technologies?
  - Improve productivity in one of the most capital intensive industries?

# EE and DR Considerations

- Does Canada have more or less DSM potential than the U.S.?
  - Easy to say the U.S. has more potential, but I am not sure.
  - Expenditure targets often set for US utilities and cost-effective EE opportunities still remain once budgets exhausted.
  - Do people respond to prices or to their "budget" for energy?
    - Customers often invest in EE and DR because they say it gives them the ability to manage their energy bills.
    - With time differentiated pricing, if prices go up, they can adjust use to maintain budgets.
  - Bounded rationality or agenda setting – putting EE and DR on a customer's agenda as part of the many things they may consider doing is first step toward action (i.e., you need awareness first).
  - Assessing the baseline is important, e.g., current energy-using equipment, building practices and behaviors may be the key factors rather than energy prices differences.

# Issue: Setting DSM Targets

- Conducting technical potential studies may be as important for program planning and evaluation as they are for setting DSM targets.
- Available potential that can be attained by a DSM program changes over time and by technology focus (e.g., motors).
- Growth in electricity/gas demands and the need for new resources – increases focus on cost-effective new resources like DSM.
- Existing infrastructure to deliver programs, e.g., # of certified energy auditors *(important consideration that is sometimes overlooked).*
- Jurisdictions conducting extensive analyses of DSM potential come up with different answers.
    - Texas - 10% of annual growth to be met by DSM.
    - Illinois - proposed sustainable energy plan starts at 10% but ramps up to 25% of growth.

# DSM Targets – Resource Planning Methods

- Several jurisdictions (ID, BC, IA, WA) view DSM as a resource and consider expenditures to be made on DSM as part of the resource planning process.
- DSM is treated as a resource to be compared to supply-side resources in planning models and studies – it is not an "add-on study."
- Vermont considering resource planning, i.e., "all cost effective DSM", as an overlay to current approach.
- ADVANTAGES – Better frames an appropriate set of questions about the role of DSM:
  - What is the value of DSM as risk management tool ( hedging against energy costs, environmental compliance, system performance risks, etc.).
  - Can DSM create portfolio diversity and what is the value of this diversity.
  - Increasing the price-elasticity of demand enhances economic efficiency and reduces potential supply-side market power.

# Issue – DSM Incentives

Experience shows that utility incentives do impact the delivery of DSM.

Concept: *A utility should not be made worse off financially by implementing successful DSM programs*.

1. Lost margins due to lower sales of electricity and/or gas should be removed as a disincentive to utilities.
2. The impact of additional incentives to meet or exceed DSM targets seems to be positive.
   - Massachusetts - shareholders earn up to 5% after tax return on annual costs based on a sliding scale of achieving 70% to 130% of targets.
   - Minnesota - provides incentives after 91% of the goal achieved.
3. Modest positive incentives appear to meaningfully impact DSM program performance. Why? Reasons not fully proven, but:
   - Allows DSM personnel to make some contribution to margins.
   - Also allows Management to set targets to judge the DSM department.

# Issue: Monitoring and Evaluation

- Need processes to assess quality of DSM accomplishments:
  - Don't mistake activity for results – DSM experience is important.
  - Evaluation is often under-planned.
  - Full contribution of DSM success may be understated due to not quantifying market-wide impacts.
  - Can quantify some DSM impacts; others may not be able to be quantified.
  - Accountability is one key to successful EE and DR programs – and must be established at the outset.
  - Hard to predict actual in-field impacts of DSM – so monitor and evaluate.
  - Arguing that evaluation just takes dollars away from implementing EE measures into the field simply ignores the reality of program accountability and successful design.

# Monitoring and Evaluation (cont.)

- Types of evaluation:
  - *Process* – looks at program implementation processes
  - *Market* – tracks changes in markets (e.g., HVAC or motors)
  - *Impact* – looks at attributable kWh and therm savings.
- Baseline: Setting the baseline is part of program planning and tracking; updating it is part of program implementation.
  - Need to determine what to measure the program against.
  - Data needed from implementation, e.g., the equipment replaced by a program.
  - Stay in contact with trade allies to assess whether to modify baseline.
- Benefits: Evaluation costs are often more than offset by reduced implementation costs.

# Keys to Monitoring and Evaluation

1. Identify success factors during program design, i.e., how should the program should be measured.
2. Consider data collection for evaluation during program design and leverage with program implementation where possible – maximize learning as part of implementation.
   - Program tracking during implementation is essential – participant contact data, program drop outs, market information, what was taken out and what was installed at a site, customer costs, etc.
   - Ongoing assessments are integral to program delivery.
   - Stand-alone evaluations conducted after several years does not work.
3. Ex-post evaluation necessary to confirm that what is believed to be happening in the field is actually happening, i.e., ensure you are getting the impacts expected.
4. Need two-way feedback between evaluation and implementation.

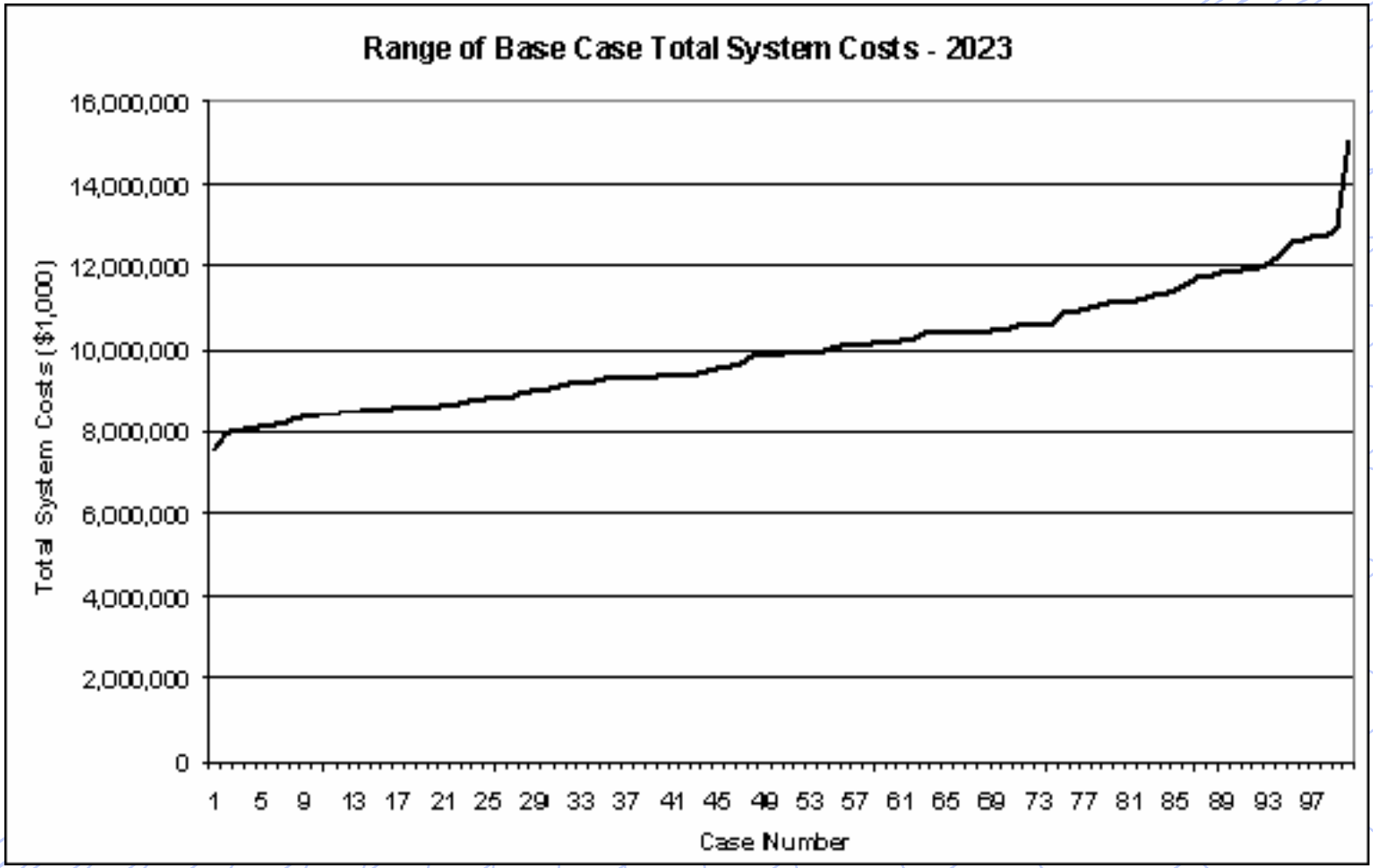
# DSM & Pricing: Back to the Bottom Line

- If we don't set prices at appropriate levels, how will we determine which investments in EE are cost-effective?
- If we don't "price what's scarce" (e.g., peak-period commodity), how do we incent appropriate practices and innovation?
- If we don't price what's scarce, how do we improve resource allocation and load factors in a very capital-intensive industry?
- *Issues:*
  - Uncertainties from restructuring & bifurcation of incentives to implement DSM across the different restructured industry entities discouraged investment in DSM infrastructure.
  - Wholesale competition has been encouraged, but it can be argued that price elasticity and demand response capabilities have actually decreased in recent years.
  - This creates a disconnect between wholesale and retail markets.

# Robust Planning with EE and DR

- New perspectives are needed to better represent key inputs to resource planning both on the supply-side and demand-side:
  - Represent uncertainty in key inputs that influence system costs using distributions.
  - Examine correlations across inputs (e.g., oil & gas fuel costs, hydro availability) and over time for a single input (e.g., peak demand).
  - Represent these uncertainties using a Monte Carlo model with 100 futures drawn and each "future" assessed in resource planning model.
- Appropriate resource characterization – supply-side and demand-side (energy efficiency, event-based DR and pricing options) what can they really deliver and at what price?.
- Incorporate "time steps" and "value of information" to assess the value of flexibility contained in different plans.
- Now, we need to work with distributions of outcomes from of resource planning activities – **LET'S LOOK AT AN EXAMPLE ….**

# System Cost Range for the Base Case with Uncertainty Bounded



# Ranges of System Costs by Year

- Generally, a 100% increase from low to high in system costs over time.

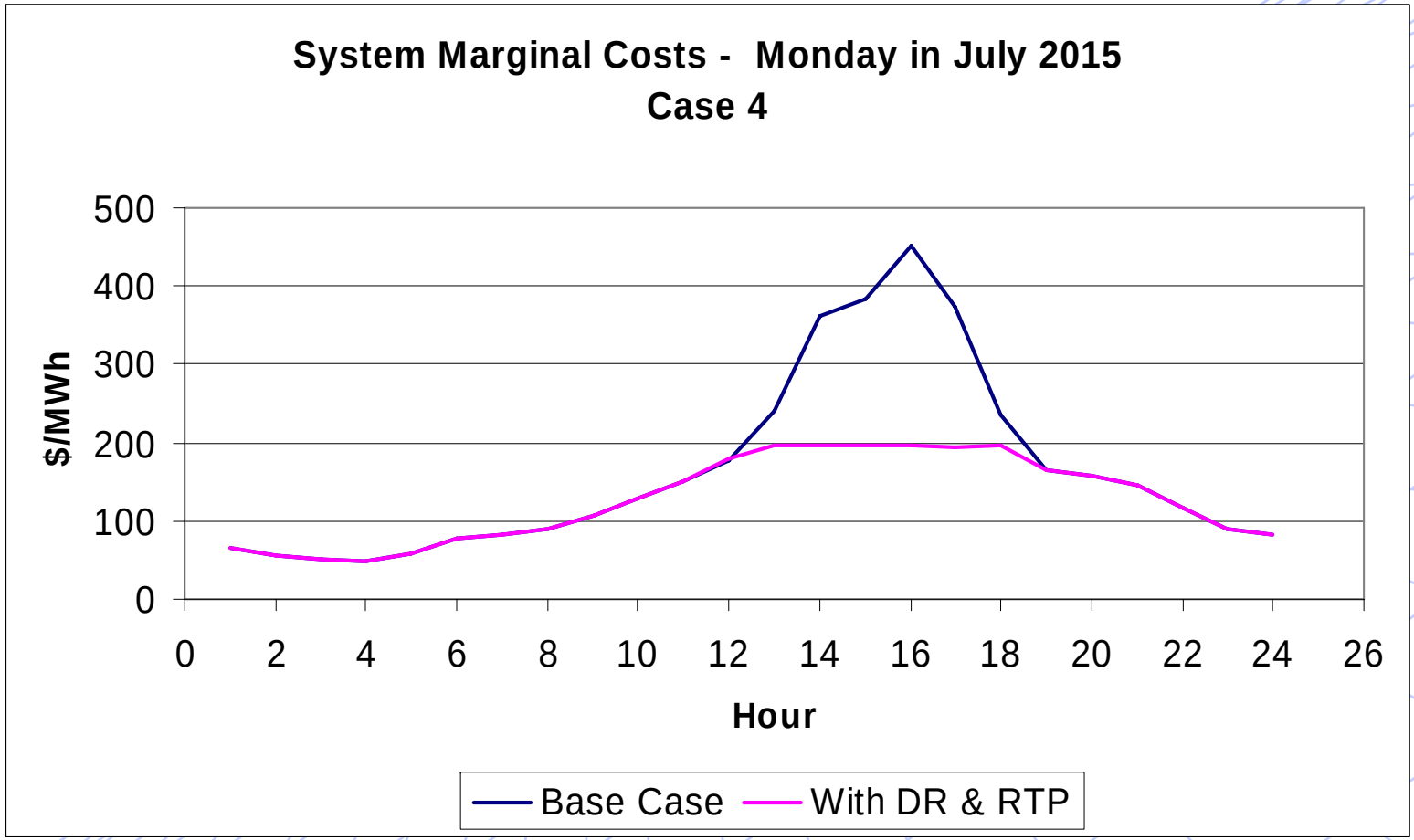
Ranges of System Costs for Select Years

| Range of Total System Costs for Selected Years - Base Case ($ Billions) | | | | | | |
|---|---|---|---|---|---|---|
| Year | 2010 | 2012 | 2015 | 2018 | 2020 | 2023 |
| Maximum | 7.7 | 8.2 | 10.2 | 10.3 | 12.4 | 15.0 |
| Minimum | 3.5 | 3.8 | 5.1 | 5.6 | 6.5 | 7.5 |
| Range | 4.2 | 4.5 | 5.1 | 4.6 | 5.9 | 7.5 |
| Ratio | 118.5% | 118.8% | 101.7% | 82.2% | 89.9% | 99.3% |

# Demand-Side Resource Programs

- Five DSR programs were modeled:
  - 1) large customer interruptible,
  - 2) mass market direct load control,
  - 3) dispatchable purchase transaction (day-ahead bid program),
  - 4) time of use with event-based Critical Peak Pricing (CPP) and
  - 5) Real-time pricing variants (the only non-event based program).
- The MW capacities of the programs were calculated to start at a low value in 2005, grow at a quick rate in the first ten years to a level of about 4% of peak demand, and thereafter grow at a slightly higher rate than the peak demand.
- DRR costs, economics, availability and capacity data were developed as inputs to the resource planning model based on specific product designs.

# System Marginal Cost – Stress Case



# Overall Risk Profile

- The addition of DR changed the risk profile associated with the planning scenarios.
- There were significant savings when looking at value at risk (VAR) at 90th percentile (VAR90) and 95th percentile (VAR95). Results for the three scenarios are shown below.

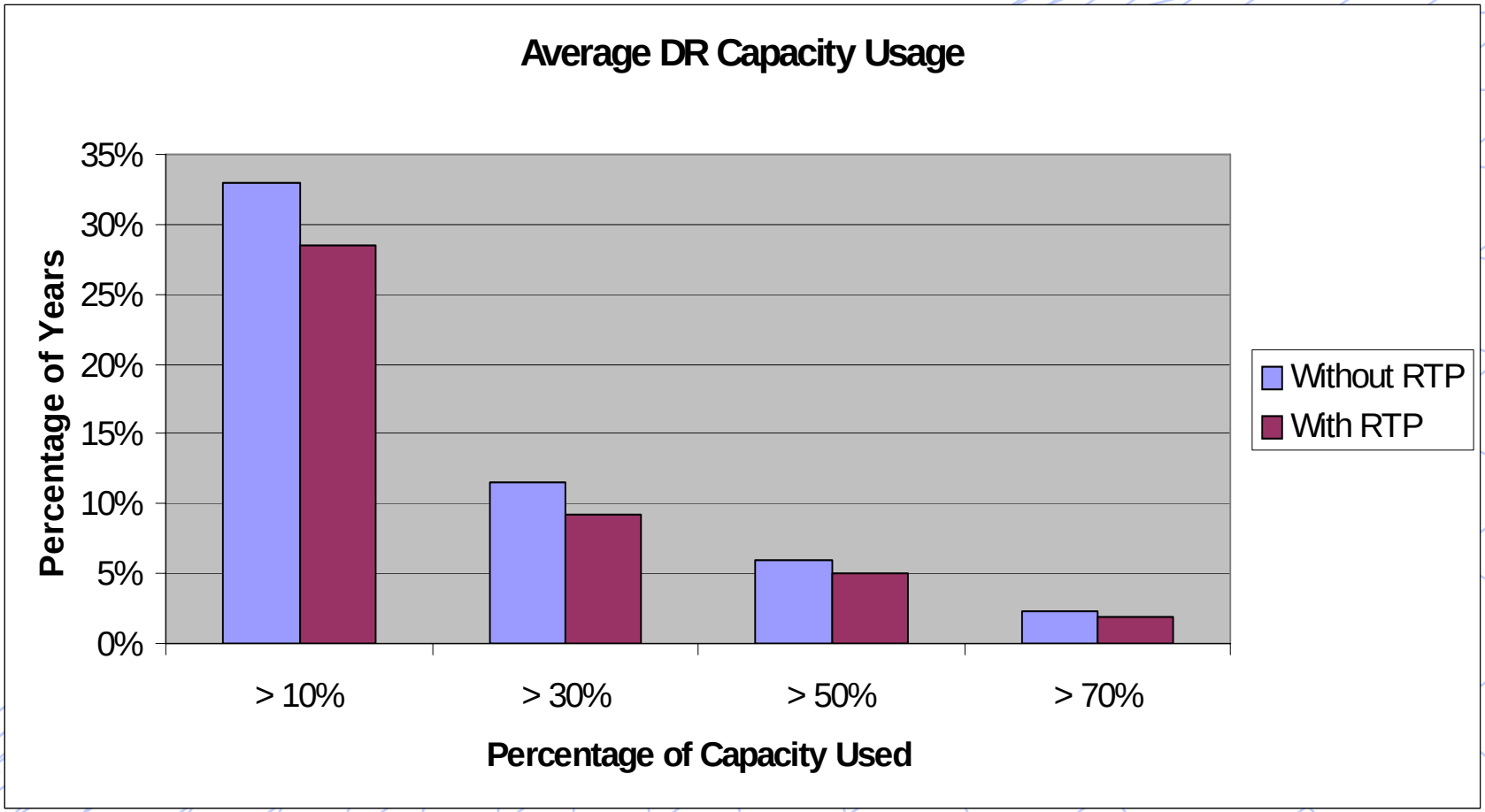
| Risk Metrics – Reduced System Costs at Risk ($M) | | |
|---|---|---|
| | VAR 90 | VAR 95 |
| DR No Pricing | 213 | 238 |
| DR with Peak-Period Pricing | 924 | 966 |
| DR with aggressive RTP | 2,673 | 2,766 |

# Use of Event-Based DR Resources in this Case Study

- Small amounts of event-based DR used in most years, large amounts, infrequently – about once every four to five years to mitigate costs of low-probability / high consequence events.
- Magnitudes and growth in DR over time was fixed, and called upon only when economic.
- Given DR can be ramped up as needed, could better size DR products to fit need in the system.
  - The scenario examined turned out to represent an "overbuild of DR" for this system, i.e., the same benefits could have been obtained with a smaller amount of DR.
- A more efficient DR product design could further increase net benefits of DR.

# Effect of RTP on Event-Based DR Programs – A portfolio works!

- Adding non-event based pricing (RTP) meant the three callable programs were used less—**BUT, impact not as significant as might be expected:**



# Customer Preferences and Risk Management

- Is managing future risks an obligation of regulators, energy companies and resource planners?
- Are customers willing to pay a bit more on average for more predictable prices and less price volatility in the future?
- How is this taken into account today?
- With EE and DR you pay a bit less now, but can also get a sizeable reduction in risk (i.e., free insurance) – IF:
  - Adverse events happen.
  - Energy prices increase at the same time weather becomes extreme.
  - AND, there are system constraints (transmission or forced outages).
  - There are often positive correlations among the above factors resulting in 1 in 10 year events happening every 4 to 5 years.

# Considerations for the Future

- Developing DSM or the demand-side of the electric market is important for market for efficiency.
  - Require quality in demand-side resource acquisition – it can be difficult;
  - But, building an IGCC coal plant with supporting infrastructure on time and on budget is also difficult.
- Building demand-side infrastructure is important – this involves practices (building and specification), availability of efficient equipment, skilled practitioners, as well as verification and evaluation.
- Price signals (or proxies) providing an incentive to manage what is scarce AND enabling customer response to those signals is needed.
- Is there a rationale that justifies not moving in this direction?
- DSM provides flexibility and balances out supply-side risks.
- Bottom Line -- *Energy needs will be met at a lower overall cost and with lower price volatility.*

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# DISCUSSION