Valuing Demand Response Resources (DRR)
-- Update on IEA Project --

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Focus Task 4: IEA Task XIII Work

1. Develop a Benefit-Cost Framework that appropriately supports the economic case for DRR as part of a resource plan.
2. Develop "approaches" for determining the value of including DRR in a resource portfolio.
   - Correctly valuing DRR will produce a resource plan with the appropriate amount of DRR. (Note: Resource planning is where cost trade-offs between alternatives are examined.)
   - Differences in costs between plans is one estimate of the value putting a resource into the field (e.g., a plan with no DRR vs. a plan with DRR).
3. Ex-Post Evaluation of DRR – Discuss approaches for evaluating and verifying the benefits and costs of specific DRR put into the field.
   - Assess the economic value of to DRR as part of these ex post evaluations.
   - Take into account the longer-term impacts from DRR that might represent important components of total benefits (i.e., develop an annual average)?
   - What values justify maintaining DRR as a resource over the long term?

Identification of Benefits and Costs:

1. **Market-Wide Perspective**
2. **Private-Entity Perspective**

Market-Wide Benefits Categories

1. Market-wide price benefits:
   - Reduction in the average price of electricity in the spot market.
   - Reduced costs of electricity in bilateral transactions (over a 5 to 10 year period).
   - Reduced hedging costs (e.g., reduced cost of financial options).
2. Market-wide reliability benefits:
   - Increased overall reliability.
   - Insurance value – lowers costs of extreme events, i.e., low-probability, high-consequence events.
   - Real option values – creates flexibility to address future events.
   - Portfolio benefits – increase in resource diversity.
3. Other values (may be addressed by "side" calculations) …

Market-Wide Benefits Categories (cont.)

3. Other Values (cont.):
   - Reduced market power (situational and behavioral).
   - Overall Market Efficiency – better interaction of demand and supply provides appropriate incentives for the development and application of new technology thereby increasing overall productivity (e.g., 1% per year).
   - Customer Values:
     - Increase in customer choice.
     - Equity for those customers whose electricity use is flexible (an important attribute of demand is now valued).
     - Possible increase in services.
   - Environmental Values from more efficient resource use (???)
   - Other Values (???)

Benefit-Cost Studies: Recent Experience

Review: Planning Case Studies

1. Proxy unit methods, i.e., beat the costs of a gas turbine. Now, the value of DRR is the difference in costs between the two resources.
2. "Fit" a DRR unit into a supply-side planning model using program costs and MW reduction as the "production of a generating unit" with DRR values being the difference in market costs between two scenarios. (KCPL Study).
3. One example attempting to look at a market value versus private value test using a forward-looking 5-year period by a distribution company (NSTAR – SBC study)
4. Partial portfolio approaches using methods to determine value of call options and changes in portfolio risk as measured by "value at risk."
5. Several recent studies using probabilistic and Monte Carlo methods to explicitly address risk management and the role of DRR -- Northwest Power Planning Council Study (2004), Resource Adequacy filings by California IOUs (2004).

NWPPC Power Plan

- DRR Benefits recognized:
  - 5th *DRAFT* Power Plan first to treat DRR as a resource
  - Contributes to improved reliability and prevent outages;
  - Mitigates the risk of high market prices;
  - Helps stabilize electricity prices; and,
  - Reduces both cost and risk compared to developing new generation
- Modeling demand response (NWPPC).
  - A Monte Carlo simulation is run for all scenarios producing a cost distribution for each plan.
  - Model allows for 1,000 futures for each plan and multiple plans are analyzed to assess cost and risk differentials..
  - Risk management focuses on a type of Value At Risk (VAR), i.e., the average value for the worst 10% of the outcomes.
  - Model is run with and without DRR in the portfolio using the assumption that 2,000 MW of DRR could be developed by 2020.

NWPPC Comments:

- "Planning for the future requires assessing risk. This involves characterizing the key uncertainties the power system faces."
- "Can planners, through experience, analysis, and informed judgment, develop reasonable characterizations of future uncertainty that will help illuminate resource choices for the region? The Council believes the answer is 'yes'."
- Key uncertainties considered include:
  - Hydro availability
  - Load uncertainty
  - Plant availability
  - Fuel prices
  - Environmental regulation
  - Net imports, i.e., outside market resource development and sales/purchases.
  - Stress tests of extreme circumstances were included – "various sources of risk conspire to produce particularly harsh futures…"

NWPPC Predicted Value of DRR

- According to the model simulations:
  - DRR is used in 89% of the years in the study.
  - Less than 1% of DRR capacity is used in 79% of these years.
  - Less than 10% of DRR capacity is used in 90% of these years.
  - Only a few years show DRR used to near full capacity.
- Overall value:
  - Without DRR, the expected net present value increase in system costs is $100 million, while system risk increases by $500 million.
  - For constant levels of risk, the loss of DRR increases expected costs by about $300 to $500 million.
  - Without DRR, risks increase in the range of $400 million to $1 billion at given levels of expected cost.
- Policy recommendations
  - Develop 500 MW of DR over the next five years; and,
  - Develop up to 2,000 MW of DRR over the 20-year period.

Value of DRR

- What does this say about the value of DRR in a market?
  - For markets with integrated utilities?
  - For restructured markets with retail competition?
- DRR values include “insurance” and “portfolio” benefits.
  - These need to be calculated against “future scenario(s).”
  - Even in an organization that is not responsible for resource adequacy planning, determining a value for DRR requires:
    1. The development of future scenarios; and,
    2. The cost reductions attributable to DRR in those futures.
  - DRR values need to be measured against a long-term scenario to capture low-probability, high-consequence events.
  - Key DRR values can only be captured when uncertainty is dimensioned.

Where do we go from here?

- Work to better (i.e., more effectively) communicate of the benefits of DRR to reliability organizations, resource planners, regulators and other decision makers.
- Use the framework and structure common to the industry.
- Getting DRR into the field means estimating and supporting its value as a resource.

Implications

- Tools exist to assess portfolios of traditional and DRR options.
- This requires:
  1. Appropriate resource characterization.
  2. Representations of the uncertainty around key factors in the analysis.
- The challenge is to change perspectives and get planners to move out of their comfort zone:
  - Better (i.e., more accurate) representations of DRR resources; and,
  - Dimension and incorporate uncertainty.
- Representing uncertainty and the value of information over time is the key challenge as both contribute to the value of options and hedges; and therefore to the value of DRR.
- This is generally new to planners in the DRR context.

Steps in Valuing DRR

- Overall, the process will include developing “futures” / “scenarios” against which DRR will be valued.

  Step 1: Determine pivot factors influencing the market costs of electricity.

  Step 2: Develop the probability distributions, i.e., assess uncertainty around these factors and express that uncertainty via probability distributions.

  Step 3: Create the “futures” against which portfolios will be assessed, i.e., combine the probability distributions to create a joint probability surface.

  Step 4: Draw a set of discrete futures from the probability surface, i.e., each draw will include a value for each key factor (100 or more draws are likely to be needed).

  Step 5: Run each future through a resource planning (i.e., cost model) providing 100 (or more) costs that are incorporated into a distribution of costs for a given set of available resources.

  Step 6: Repeat Step 5 for different portfolio’s of resources to determine the cost differential and reliability differential for “with DRR” and “with-out DRR” portfolios.

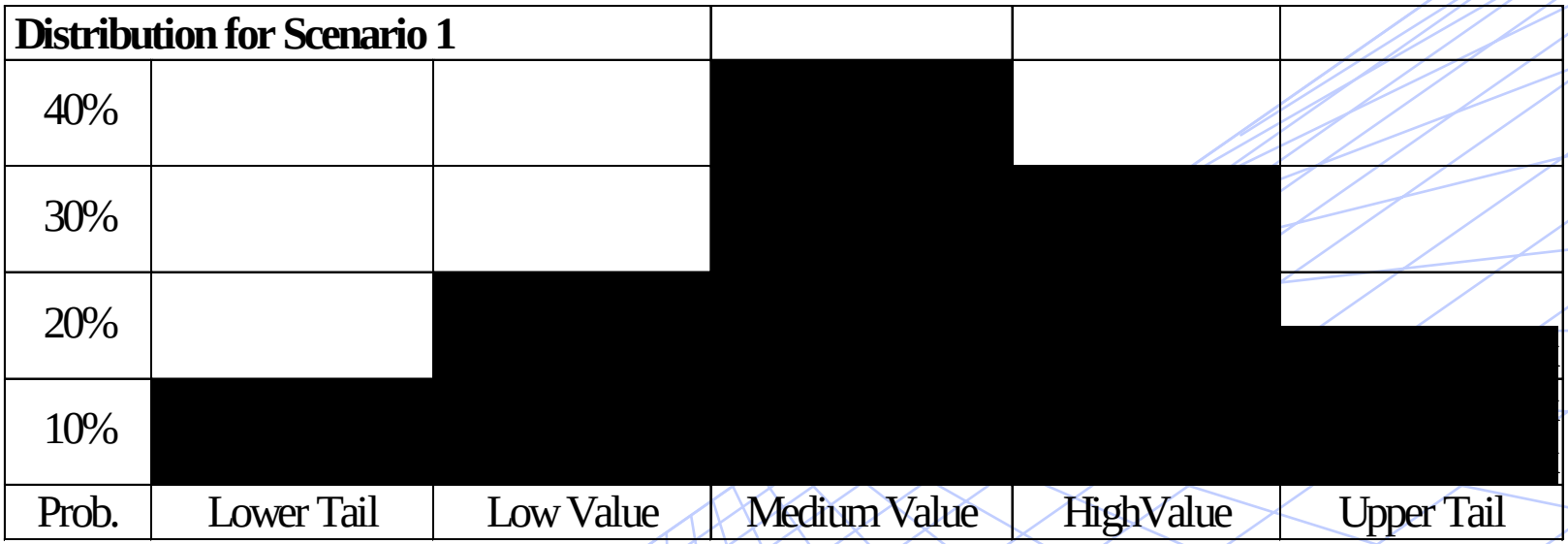
Tentative IEA Research Plan: Evaluate Four DRR Programs

- Model all DRR programs in a similar fashion as supply-side resources within a comprehensive resource planning framework.
- Programs to be examined:
  - Interruptible Program – Known amount of load reduction based on a two-hour call period.
  - Direct Load Control Program – Known amount of load reduction with 5 to 10 minutes for notification.
  - Pricing Program – Modeled as a resource using price elasticity factors to calculate demand reduction with uncertainty in response.
  - Dispatchable Purchase Transaction – A call option where the model looks at the "marginal system cost" and decides to "take" the purchase when that price is less than the marginal system cost.

Dimensioning Uncertainty in DRR Valuation

- Expressing and dimensioning uncertainty for use in analyses.
  - Uncertainty is what makes hedges and options valuable.
  - If we could use point estimates and were certain about their values, there is no need for options or hedges since the optimal solution would simply be picked.
  - Industry has used few tools to express uncertainty
- Key problem -- How to dimension uncertainty for use in planning analyses (simplest to more complex):
  1. Scenario analyses (low, medium and high cases)
  2. Range estimates -- construct confidence intervals based on key inputs.
  3. Range estimates with the range filled in with likelihood estimates to provide a rough-cut probability distribution.

Scenarios Versus Distributions



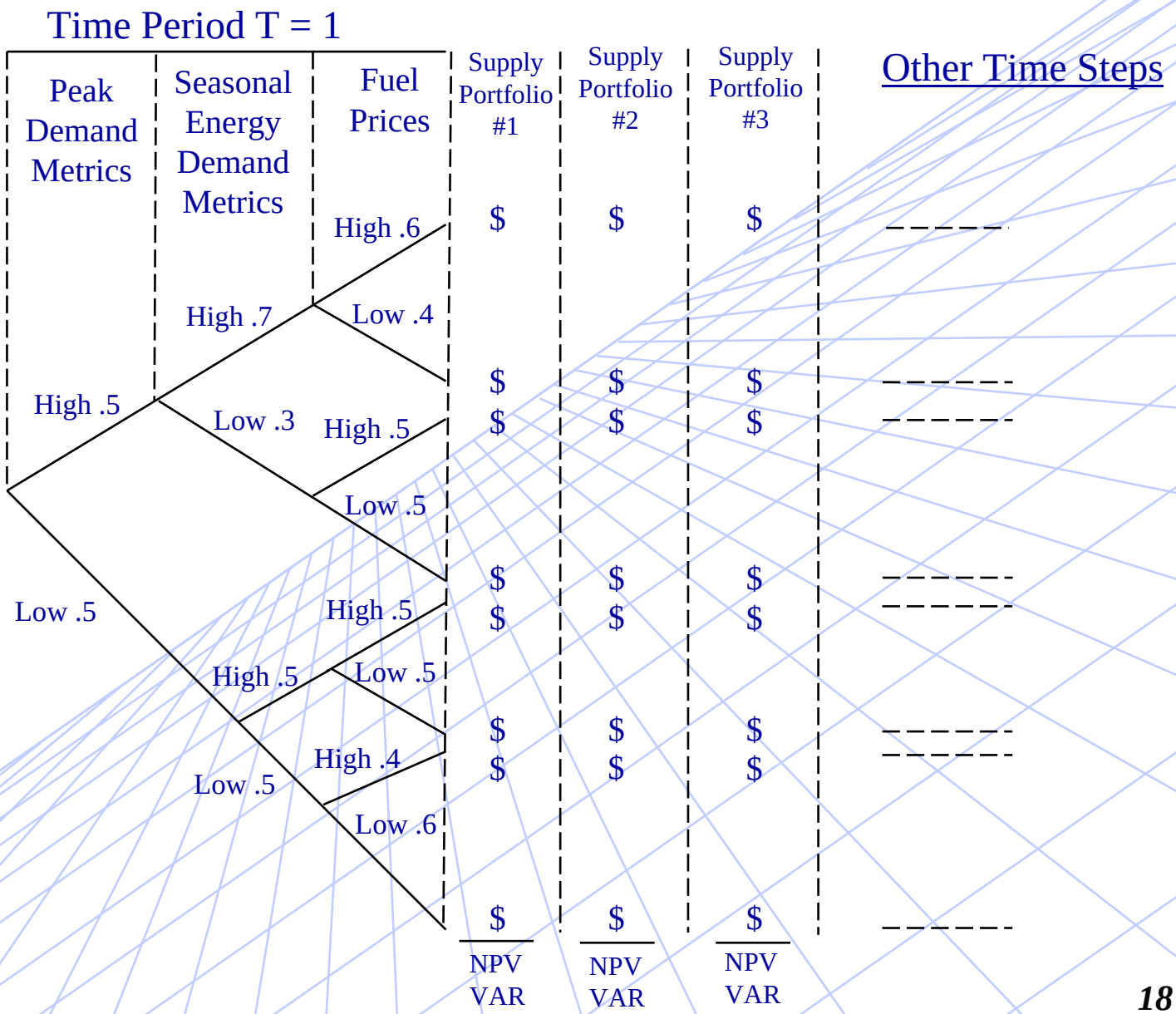
- An assessment about likelihoods of the different scenarios can provide additional, useful information.
- Individuals familiar with the market can supply the “best” available information on probabilities.
- These are derived from judgment, expert opinion and augmented by secondary research.
- End-result: A distribution is a better representation of the scenarios being assessed

Simplified Example -- Decision Tree

Objective:
Minimize Revenue Requirements over 10 years.

Time Step:
One-year steps over a 10-year period.

Proxy Example:
Real application would include distributions instead of single probability nodes.



Uses of Information

- Calculate reductions in electricity price (using resource costs as a proxy) from comparing different resource portfolios under uncertainty:
  1. No available DRR.
  2. Limited DRR options in portfolio.
  3. Aggressive DRR options in portfolio
- Calculate costs of achieving higher system reliability using each portfolio.
- Calculate risk management parameters – Value at Risk and/or the Loss Function.
  - What is the down-side of a resource portfolio selection?
  - The “loss function” is the distribution of costs (i.e., losses) that result from selecting a portfolio other than the optimal portfolio.

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