Managing Portfolios of DSM Resources and Reducing Regulatory Risks: A Case Study of Nevada

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ABSTRACT

This paper describes the methodology and introduces a tool for systematic analysis of risk and uncertainty in the context of a "portfolio" approach to evaluating demand-side management (DSM) investment decisions. It describes the application of the tool by Nevada Power Company/Sierra Pacific Power Company in their assessment and regulatory reporting of DSM activities and performance. The structure, various modules and algorithms used in the tool for calculation of DSM impacts, and the costs and benefits on an 8,760 (hours per year) basis are discussed. Various uncertainties of DSM from both supply and demand perspectives are discussed, and the methodology for their symmetric treatment in DSM resource assessment are explained.

The Portfolio Approach

Historically, investment decisions in energy efficiency resource acquisition have been made on a measure-by-measure basis. Technical assessments of technologies, performance and their associated costs have formed the basis for defining demand-side management (DSM) resource acquisition programs. Typically, program development consisted of first analyzing cost-effectiveness of individual measures, then combining the measures into programs.

Throughout the utility industry, DSM professionals are recognizing the importance of a "portfolio" approach, not only in designing programs, but also in evaluating the optimal mix of DSM resource options. Mirroring the financial industry's portfolio management theory, energy efficiency practitioners have begun to recognize the increasing relevance of diversification in program design and development and the way in which DSM is integrated in the utility resource mix.[1] This portfolio approach to energy efficiency program design and assessment involves factoring in uncertainties of DSM at various levels, including measures, programs, and bundles of programmatic initiatives. There are several advantages to using a portfolio approach for energy efficiency investment decisions.[2]

First, it helps to maximize resource procurement options. In many programs, such as weatherization and appliance rebates, multiple measures are combined to create a program. If each measure included in the program must be deemed cost effective on its own, the diversification benefits and the economies of joint delivery of the bundled program are ignored. The portfolio-based approach allows program designers to consider the optimal mix of measures

[1] For an ample discussion of the application of portfolio approach to electricity resource planning, see Awerbuch, Shimon and Martin Burger, "Applying Portfolio Theory to EU Electricity Planning and Policy-Making," IEA/EET Working Paper, February 2003.
[2] The California PUC, for example, has employed the approach as a basis for allocation of M&V resources to DSM programs being implemented in the state.

that together produce the most cost-effective programs. This may lead to the procurement of more energy efficiency resources than would have happened otherwise.

One relevant application of the portfolio approach is in integrated resource planning (IRP) and the way DSM resources are treated in planning processes. Due to the relatively small magnitude of individual DSM resource options, early approaches to IRP generally involved first subtracting the expected quantity of DSM from the load forecast before conducting an analysis of production (supply-side resources). As they grow in size and importance as a component of the utility's overall portfolio, it becomes increasingly important that the DSM resources are bundled together to enable side-by-side comparisons with other supply resources in IRP. This requires developing homogeneous portfolios of DSM resources that are large enough to be compared with typical supply options.

An additional – and perhaps more important – advantage of the portfolio approach is that it enables analysts to explicitly factor in and manage the potential risks of DSM resources. This is extremely relevant for IRP, as the availability and reliability of DSM should be considered along with those of supply resources.

Nevada Power/Sierra Pacific Experience

Nevada Power Company/Sierra Pacific Power Company (NPC/SPPC) has historically considered its DSM programs on a measure-by-measure basis. To meet the challenge of its expanding DSM offerings, the increasing regulatory reporting requirements, and the institution of utility share-holder incentives, in 2005 the utility sought out a new method for systematic economic and financial analysis of DSM programs and reporting the results to regulators on a consistent basis.

Like many other utilities, NPC/SPPC discontinued its DSM programs in the late 1990s due to uncertainties concerning the expected restructuring of the utility industry. The result was the near dismantling of the internal and external capabilities and external resources and infrastructure for delivery of DSM programs and services. With the halting of deregulation in Nevada in the late 1990s, NPC/SPPC began to build its programs again. Because these early programs were measure-specific and the associated investments were relatively small, they required rather simple cost-effectiveness analysis to satisfy the regulatory requirements.

Since 2001, the program offerings at NPC/SPPC have expanded rapidly, and investments in DSM are expected to increase dramatically in the next few years. This growth is expected to continue, as the increased interest in "green" approaches has led the state of Nevada to allow conservation as part of the mandated renewable portfolio standard. In 2005, the legislature passed Assembly Bill 03 that requiring that 6% of 2005 energy sales be supplied through renewables, rising to 20% by 2015. This law allows energy efficiency contributions up to one-quarter of the standard, therefore 5% of utility's sales by 2015. As NPC/SPPC programs have grown in size and complexity, the need for more advanced analytic tools and for program design, analysis, and regulatory reporting has become a priority.

With ever-increasing sophistication of energy efficiency analysis occurring in other states (such as California), it became important to Nevada regulators that NPC/SPPC analyze its programs at higher level of resolution and account for actual load impacts and daily variation in avoided cost. Additionally, Nevada utilities are allowed a shareholder incentive in the form of a rate-of-return (ROR) adjustment (ROR "kicker") on deferred DSM investments as an incentive to encourage DSM. NPC/SPPC was also interested in taking advantage of the opportunity to improve the sophistication of its approach to program planning and analysis by assessing combinations of measures and programs. Finally, standardized reports were needed for both internal and external purposes.

Portfolio Modeling

The result was the development of DSM Portfolio Manager, an MS Excel-based analysis and simulation tool for energy efficiency programs. Users can build programs from a built-in measure database and obtain cost-effectiveness results, run both scenarios and risk analysis around each measure, a program, or portfolio of programs using hourly (8,760) load profiles and forward price curves. DSM Portfolio Manager gives users the option to combine measures into programs and programs into portfolios (such as residential, commercial, industrial) and assess their outcomes under alternative assumptions. The model's capabilities are built with a focus on:

- Allowing a transparent and flexible cost effectiveness and tracking tool for DSM planners and program designers
- Incorporating standard algorithms for analyzing DSM results, including energy and demand impacts and environmental benefits
- Providing the means for tracking and standard internal and external reporting of DSM activities and performance
- Assessing and managing potential DSM risks due to various uncertainties concerning measure performance, market conditions, and avoided costs

Model Structure

As shown in Figure 1, DSM Portfolio Manager uses measures as the building block for programs and combines these programs into portfolios. It is built with three external modules, including two input databases (common assumptions and an interim database that contains program inputs and outputs) and one output database (final program data). By separating the calculation engine from the inputs and outputs, the model stays relatively small, thus optimizing computation time, and allows for common assumptions and model outputs to be easily tracked. Figure 2 illustrates the relationship between the primary model and the external databases.

Figure 1. Building Blocks of Portfolios

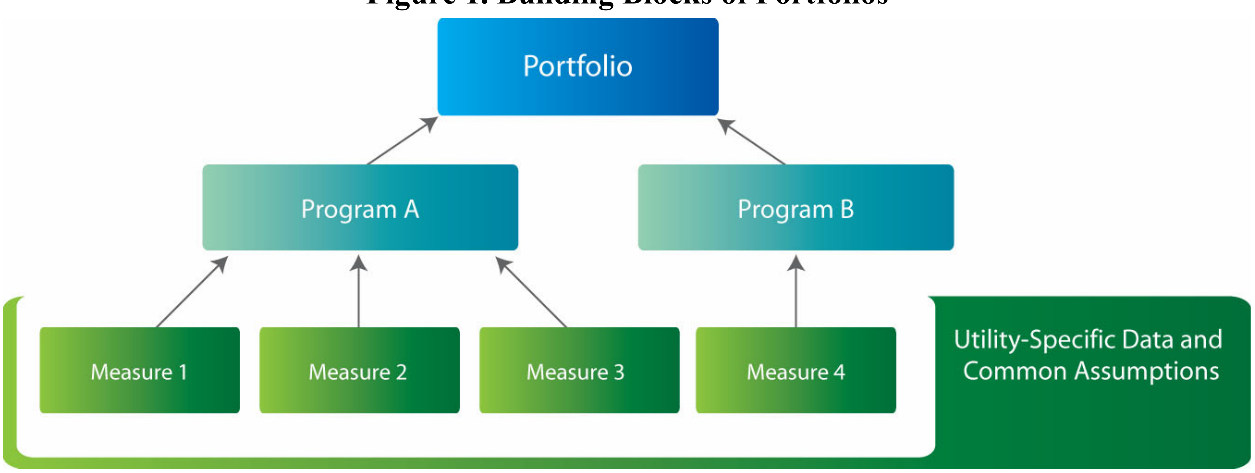
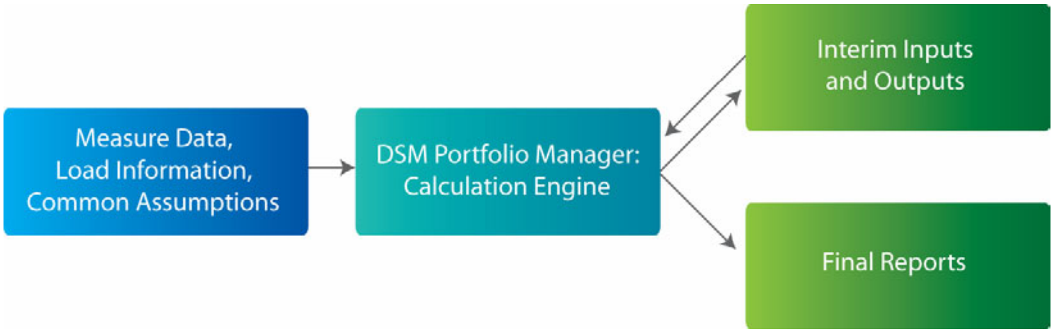


Figure 2. Model Structure and Basic Modules

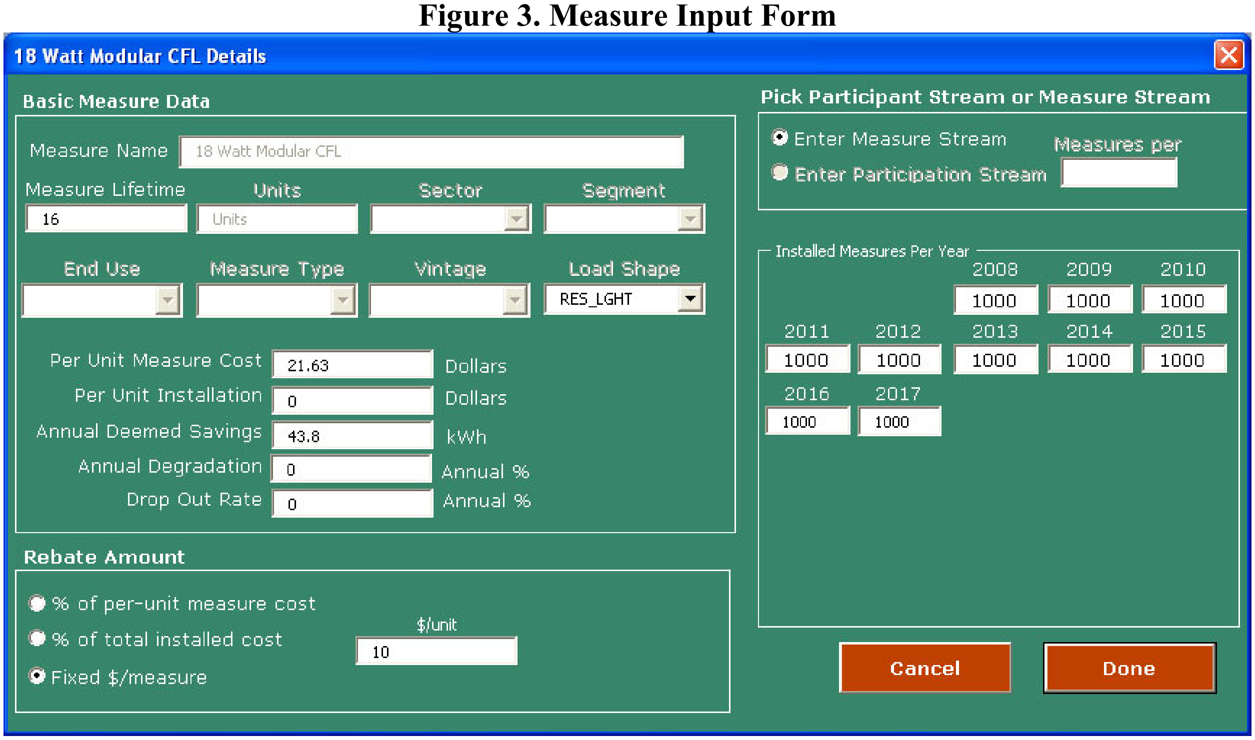


Input Database

Assumptions common to all programs are stored in the input database. These include hourly load shapes (by sector and end use) and DSM measures characteristics (by sector, segment, and vintage), annual hourly avoided energy costs (over the planning horizon), avoided capacity costs, environmental benefits, and economic/financial assumptions (e.g., cost of capital and escalators for various inputs such as retail rate, avoided cost, capacity costs and measure costs). Assumptions enabling the calculation of the ROR benefits, such as carrying charge, recovery period, rate case dates, and ROR rates, are also contained in the input database.

To facilitate data entry and to avoid errors and inconsistencies, all user interfaces are built in Visual Basic for Applications (VBA). For example, Figure 3 shows the measure input form, where the basic measure assumptions are pulled from the input database, and the user must input additional program-specific data such as rebate and participation levels.

Figure 3. Measure Input Form

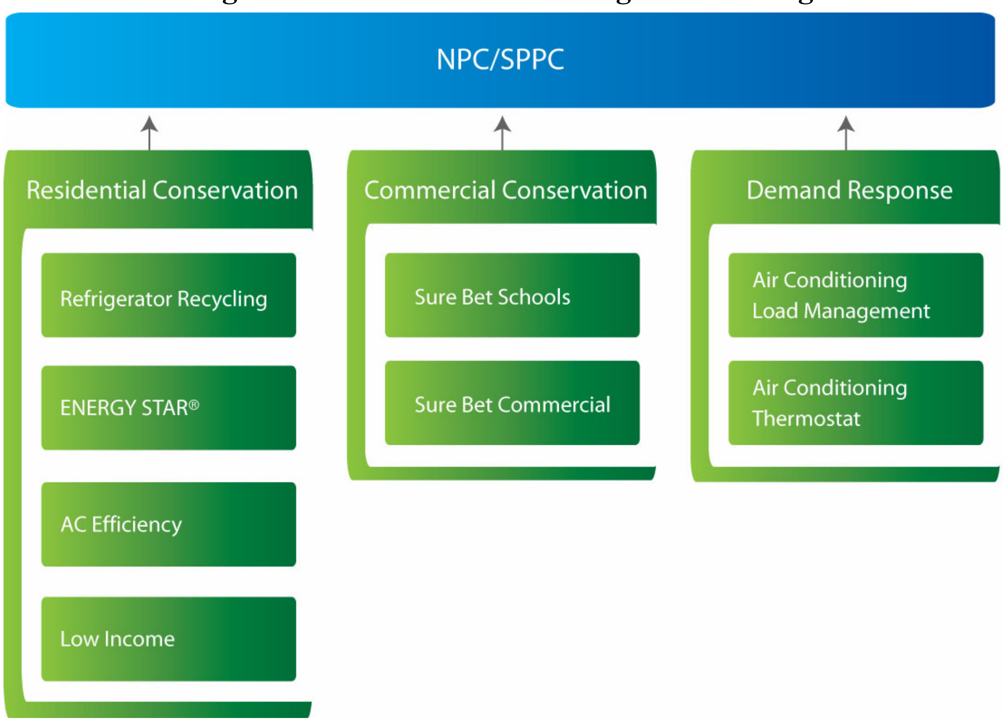


Building Programs and Portfolios

The primary functionality of the model is to allow users to quickly build programs from measures and to combine programs into portfolios. Using input forms, the user can build a program by defining its sector, providing various cost elements (acquisition, administration, operations, and maintenance) and choosing appropriate measures that comprise the programs. Similarly, input forms allow the user to choose the programs that constitute a defined portfolio.

NPC/SPPC currently offers eight energy efficiency and demand response programs, defined for either the Reno area (Sierra Pacific Power Company) or Las Vegas (Nevada Power Company). For the most recent regulatory filing, programs were developed using costs, incentives, measure savings, and participation data collected during implementation. In 2006, the utilities expect to analyze their DSM offerings as portfolios defined by region and by sector. (See Figure 4.)

Figure 4. NPC/SPPC DSM Program Offering



Analytic Modules

DSM Portfolio Manager uses the standard procedures for assessing cost effectiveness based on a the levelized cost of conserved energy (CCE) relative to supply alternatives. Depending on the perspective taken in the analysis, competing views about benefits can emerge. Each measure, program, or portfolio is analyzed from five conventional perspectives based on the standard protocols for calculation of cost-effectiveness of conservation programs:

- Total Resource Costs (TRC)
- Rate Impact Measure (RIM)
- Utility-Cost Test (UCT)

- Participant Cost Test (PCT)
- Societal Cost Test (SCT)

Potential benefits of demand-side management, relevant costs, and how each is allocated from the five perspectives are summarized in Table 1. To estimate avoided power supply costs, the model uses long-run forward price curves as a proxy for avoided costs and a typical-year for sector/end-use load profiles. Avoided transmission and distribution costs are calculated as a line-loss percentage, while bill reductions for participants is a function of the retail rate and energy savings. Environmental benefits may be incorporated as an adjustment factor (adder) or as a value per unit of avoided emission, using composite system emission profile. Program costs, including direct utility and participant costs and administrative expenses, are broken down to allow maximum flexibility and level of detail.

Table 1. Alternative Measures of Program Performance

Elements	TRC	RIM	UCT	PCT	SCT
Benefits					
Avoided Power Supply Costs	√	√	√		√
Avoided T&D Costs	√	√	√		√
Bill Reductions				√	
Environmental Adder					√
Costs					
Direct Utility DSM Costs	√	√	√		√
Direct Customer DSM Costs	√			√	√
Utility Program Administration	√	√	√		√
Lost Revenues		√			

Output Module

For NPC/SPPC, the reporting of outputs at the program and portfolio levels has multiple functions. The results must be detailed enough to provide representations of costs and benefits over time, but also provide summary data for easy comparison across programs. It is also important for the utility to maintain a record of all analyses to ensure consistency in regulatory reporting. In addition, because NPC/SPPC distinguishes between the internal reports used by program managers (internal) and the summary reports provided to regulators (external), DSM Portfolio Manager was built with two output databases. The interim, or internal, version is used by staff in program design and assessment, while the external version contains the final configuration for all reports filed with the Commission.

Figure 5 displays an example of summary results, which include basic statistics such as sector, start and end years, retail rate, and measure life. Financial data, such as discount and inflation rates, used to develop the outputs are summarized, as well as first year and net present values for key utility perspective results such as total costs, energy savings (kWh and value), cost of conserved energy and demand (kW) savings.

Figure 5. Summary Program Results

Name	Type	PrimarySector	Region	Start Year	End Year	Update Stamp	Energy Rate	Weighted Avg Measure Life
Res_Lighting	Program	Residential	North	2008	2010	5/17/2006	$ 0.10	16.0

Financial Data	
Discount Rate	8%
Inflation	2.40%
Retail Rate Escalator	2%
Avoided Cost Escalator	3%
Line Loss	8%
Avoided Capacity Cost ($/MW)	-
capacity cost escalator	5%
Measure Cost Escalator	2%

Utility Results	First Year	NPV
Total Costs	$14,763	$41,883
Energy Savings (kWh)	89,245	4,283,756
Energy Benefits ($)	$5,096	$147,267
Cost of Conserved Energy	$0.17	$0.025
Peak-period kW Impacts (Maximum)	16.0	
Peak-period kW Impact (Average)	10.19	

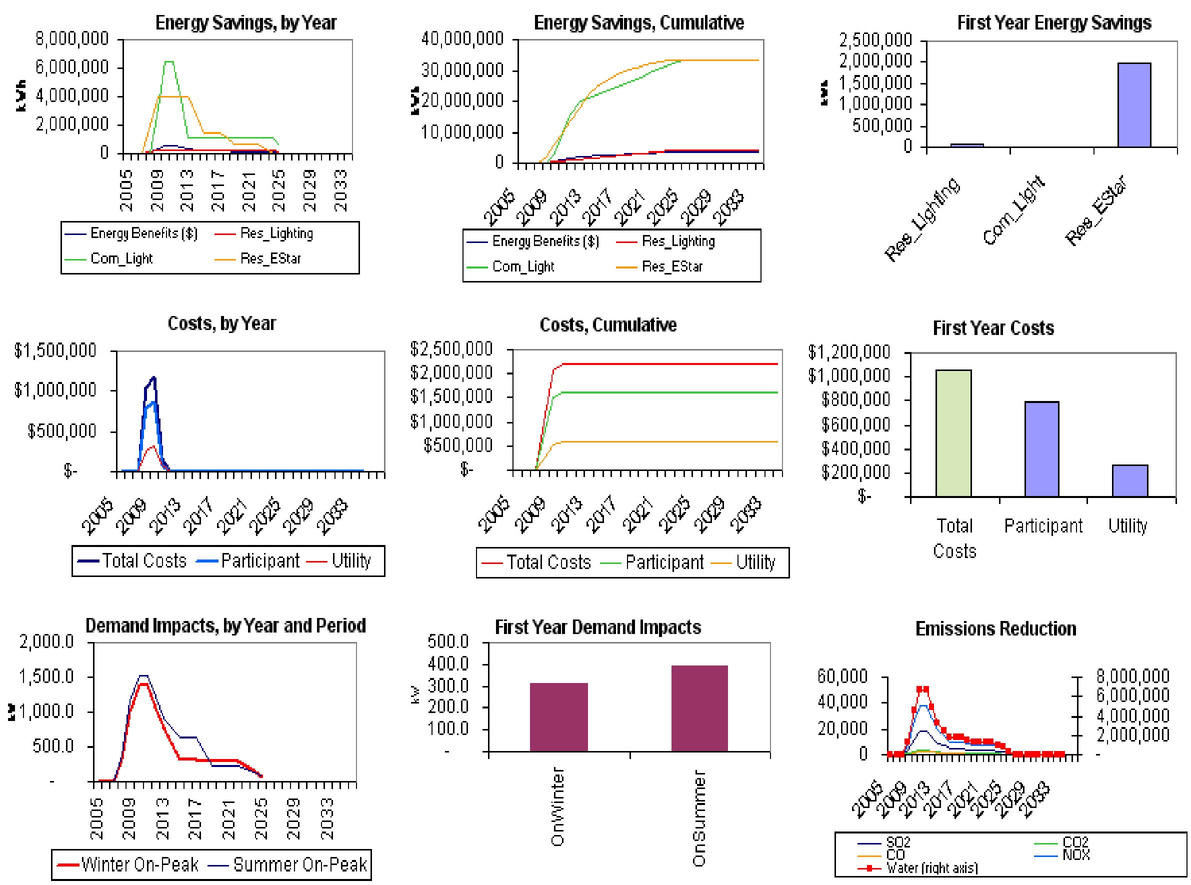
Budget	
2008	$14,763
2009	$15,117
2010	$15,480
2011	$0
2012	$0

Notes:

Stakeholder Perspectives	Benefits (NPV)	Costs (NPV)	Net Benefits	B/C Ratio	CCE
Total Resource (TRC)	$147,267	$112,349	$34,918	1.31	$0.067
Utility (UTC)	$147,267	$41,883	$105,384	3.52	$0.025
Participant (PCT)	$242,069	$70,467	$171,603	3.44	$0.042
Ratepayer Impact (RIM)	$147,267	$283,952	($136,685)	0.52	$0.169
Societal Cost	$181,608	$112,349	$69,258	1.62	$0.067

Figure 6 displays typical graphical reports customized to meet the needs of NPC/SPPC, including the annual energy savings (by measure, program or portfolio), annual costs, demand impacts, and emissions reductions.

Figure 6. Example Graphs Results



Treatment of Risk and Uncertainty

DSM resources, especially where the expected savings are linked to the utility's resource planning requirements, carry risks due to uncertainty in the determination of actual savings, and the persistence of the savings over the expected life of the conservation measure. These risks are a barrier to large-scale investments in such projects. In evaluating DSM risks, it is equally important to take into account supply-side uncertainties as they relate to calculation of avoided costs, especially when market prices are used to evaluate conservation. Clearly, fluctuations in avoided costs will directly affect the expected future value of conservation resources. However, the direction of these impacts depends on expectations of future movements in market prices. When market prices rise above the forecast levels, the value of conservation resources will increase. Conversely, lower future market prices will diminish the value of conservation investments.

In DSM Portfolio Manager, risks are treated symmetrically by explicitly taking into account both supply-side risks and demand-side risks. On the supply side (availability of DSM resources), they include technical (e.g., measure quality and reliability), behavioral (e.g., persistence of savings, free-ridership, spillover effects), and market risks (e.g., market penetration). The principal risk on the demand side (the need for DSM resources) is uncertainty concerning future avoided costs.

Risks in performance of energy efficiency measures may originate from a number of technical source, including measure failure, malfunction, measure removal, and degradation in quality. It is generally accepted that physical life in the field will differ from performance in the laboratory. Although enhanced measurement and verification procedures have significantly improved program designers' ability to determine energy savings of various conservation measures more accurately, recent evaluations of conservation programs in the country have shown that actual impacts of conservation measures often differ from design expectations.

Free-ridership and spillover effects are additional sources of uncertainty that need to be considered in portfolio design and management. Again, as with performance risks, the likely magnitudes of such behavioral uncertainties may be established through empirical evidence of evaluations for various DSM programs.

DSM Portfolio Manager has an internal risk simulator that quantifies the potential risks of DSM programs or portfolios. It provides options to create distributions around various risk factors.[3] Monte Carlo simulations are then run around these distributions to estimate costs, benefits, and benefit-cost ratios at the 95th percentile. The number of simulations and the "seed" value for the random number generator can be defined by the user.

NPC/SPPC plans to begin to analyze the risks associated with its portfolio of DSM resources next year. This is especially important as DSM begins to play a more significant role in its resource portfolio, as is the goal with the Nevada portfolio standard. Explicit treatment of potential risks of DSM and supply-side resources will allow the utility to create a more even playing field for integration of DSM into its standard portfolio design.

[3] In conventional portfolio theory, the range of uncertainty for risk parameters are based on the standard deviation (SD) of historical observations. In the context of DSM programs, ranges for risk parameters are ideally based on empirical evaluation results. The symmetrical uncertainties concerning avoided costs may be derives based on the standard deviation of historical market prices.