

Evaluating the Risks and Returns of the Resource Portfolio Using the Investment Theories of Portfolio Planning

Janet Walrod, The Resource Planning Group

Today's highly competitive operating arenas for both supply procurements and market share heighten the risk of making financial expenditures and contractual commitments, since the expected future used to develop resource portfolios may never occur. This in turn can have a very definite and negative impact on a utility's rates and/or profits. Thus, planners need to quantify and weigh the potential impacts of different futures on a resource portfolio into their decisions, and make the necessary tradeoffs between risk and return.

Decisions on a preferred portfolio hinge on its ability to balance efficiency, effectiveness, and environmental responsiveness in a robust and competitive environment. Using deterministic models reflecting supply and demand analysis conducted individually may be inadequate. This proposed methodology offers a probabilistic approach to demand impacts and applies the theories of investment portfolio planning to differentiate among the resources in the portfolio, as well as among portfolios. Each resource's contribution to the overall risk and value of the portfolio is analyzed statistically under a number of different futures. By modifying sensitive demand, the scenario results are assessed to make any necessary tradeoffs.

These results proved meaningful for integrated resource planning (IRP) in a competitive environment and especially useful in evaluating incentive ratemaking approaches from both the utility and regulator perspective. Portfolio risk analysis also provided the means of minimizing risks through the diversification of the potential resources using accepted and well-documented theories.

While the example in this paper describes the development and analysis of a gas IRP, the methodologies are directly transferable to an electric utility. Since the Clean Air Act compliance may result in far different electric resource portfolios than ever before, or even with the increased competitiveness in traditional markets, this may be an especially useful approach. The intent is to provide planners with an accepted methodology that assesses risk, lends credence to their plans, and is easily reviewed by regulators.

Introduction

In the competitive markets within which LDCs operate, possibly the greatest overall risk is the impact on rate-payers and stockholders from poor resource investments. These investments can range from building facilities to buying demand-side management (DSM) resources, all of which are in turn subject to the risks of price volatility and economic activity. Prices and the general level of economic activity affect both the supply and demand side of their business, and are difficult to forecast, especially over the time frame of utility planning horizons. All too often the only approach has been a benefit/cost analysis based on a deterministic set of events. Yet, planners must factor uncertain exogenous events into their decisions and strategies on resource portfolios that meet the needs of a competitive marketplace. Dr. Michael Porter¹ put it best

when he wrote *the essence of strategy formulation is coping with competition. Whatever their collective strength, the corporate strategists' goal is to find a position in the industry where his or her company can best defend itself against these forces or can influence them in its favor. Knowledge of these underlying sources of competitive pressure provides the groundwork for a strategic agenda of action.*

To illustrate the proposed strategy to portfolio development, a hypothetical utility is described. While its resource investments are confined to supply and demand-side resources, it should be noted that the analysis could be extended to include less traditional resources such as

providing storage service, or even the impacts of activities such as commodity price hedging, as an example.

Methodology

Resource investments are initially measured for their contribution to margins, their relative weight in the portfolio, and any inherent risks that could dampen their performance due to the future uncertain events. A base case is established for a fictitious utility assuming a resource portfolio that consists of a number of supply resources, and two potential DSM resources. Each resource is initially valued on the basis of its net margin contribution (*return*), which is determined at the time rates are set. Margin includes both fixed overhead and a return on utility investment, and is the difference between retail rates and the resource's average cost. Using the base case as a springboard, the potential portfolio is then measured for the average return and variance of each resource, under a variety of differing scenarios, each representing a probable future. The parameters are integrated and analyzed using a simulation model and portfolio analysis to evaluate combinations of resource portfolios based upon these market scenarios, reflecting both uncertainties and utility goals. Scenario results may then be probabilistically-weighted to determine the overall expected return of a resource (or its risk) when ultimately choosing among resources, since the objective of this approach is to determine the portfolio that provides the highest value at minimal risk.

The variances of the returns are also calculated to assess the portfolio risk associated with each resource's overall return under future uncertainties. Portfolio theory advocates the benefits of a portfolio that is comprised of resources that have either an inverse or a non relationship with each other is increased. This is mathematically shown with a correlation analysis, which identifies the relationship between resources, and whether it is indicative of portfolio risk. Lastly, a portfolio analysis is demonstrated to quantify the overall risk of the portfolio and to provide a means of measuring the risk/return trade-offs of any number of resource combinations.

Since some resources are fully utilized under all conditions, while others may be underutilized, marginal resources are evaluated on the basis of their actual load factor recognizing that the lower it is, the higher its unit cost and the lower its margin contribution. Using the correlation results and these average values, the portfolio is adjusted to reflect the best combination of resources when uncertainty is taken into account.

Portfolio Planning

The financial community quantifies risk and return on individual securities and/or a portfolio of investments under generally accepted theories, two of which may be applicable to utility resource planning and is the focus of analysis. First, is that a diversified portfolio of resources can mitigate specific risks, which in the utility planning arena stems from price levels and changes in economic activity. Second, is that the risk and return balance within the portfolio can be determined from the attributes of each of the resources, how they interrelate, and their contribution to the expected overall risk and return of the portfolio under different futures.

Resource diversification for an LDC can include gas purchased from more than one geographic region, combinations of spot and firmly-contracted gas supplies, storage services, and/or DSM with varying profiles. While some options are more costly than others, a combined portfolio that is sufficiently broad may reduce potential risks. Not too long ago, LDCs often had to bear the cost and risk impacts associated with one source of supply and very few commodity options. Now, with unbundled services, LDCs can structure options even with only one pipeline to its citygate.

While most would agree that more resource options are better than less, the question then arises regarding which options and how much of each should be in the portfolio. Financial securities, for example, are near-cash assets; thus are resources that can readily be sold or traded. This is not necessarily the case for an LDC's resource portfolio. Although there is a great deal more flexibility in obtaining and relinquishing resources since FERC Order 636, resource portfolios still need to be carefully structured and reviewed because of the longer-term nature of the resource investments and the uncertainty of demand.

Listed in Table 1 are many of the key factors of the resource planning decisions which face LDCs today, some representing the tradeoff between risk and return.

Among the reliability and cost issues are risks that in some cases cannot be mitigated (e.g., production failures and the effectiveness of EBBs), and others that can only be reduced and/or eliminated at a cost to the utility. These issues, generally described as price and economic risks, are quantified as increases/decreases to specific demand within the series of scenarios to determine the best resource portfolio should these eventualities occur.

Table 1. Decisionmaking Factors

Reliability Issues	Cost Issues
Supply Deliverability and Adequacy	Spot Gas vs Firm Contract Gas
Capacity Release (EBBs) ²	Competitive Price Decrease for Alternative
Production Failures (Freeze-ups)	Gas Cost Increase
DSM Technical Performance	Economic Downturn
DSM Persistence	Free Riders
Design Weather	Hedging with Futures
Unexpected Growth	Bypass and Stranded Investments

Economic Value Versus Resource Cost

Each resource has a value that should be a positive contribution to the overall portfolio based on its return (or its reduction of risk) when all costs are considered. Typically, returns are net values determined by measuring the cost of the resource against the gas sales margins that it can generate. Firm supply contracts are sometimes structured with underlying firm transportation service to provide a desired quantity of gas supplied daily throughout the year, or possibly with a supply that is only firm during peak months. In either case, these and all resources are resold at a price that reflects the gas costs, a portion of the LDC's fixed overhead and intrasystem costs, and a return from its investment. Thus the resource's value could be described as the difference between the retail rate and the resource's cost. This same analogy can also be applied to other supply resources, such as company-owned storage and liquefied natural gas (LNG) facilities.

DSM resources have always been valued qualitatively based on their attributes resulting in positive environmental impacts and participant value through lowered energy bills, and quantitatively assessed on the basis of the avoided costs of the energy saved. Unfortunately for many utilities, this value has become the upper spending limit for DSM programs, which often have been fully underwritten by the utility's ratepayers. For this analysis, the value placed on DSM is its ability to release capacity that can be resold in a retail market or relinquished through the capacity release provisions of the pipeline. Its environmental benefits and savings to participants are not only maintained when the capacity is resold, these benefits could be increased if the increase in gas consumption results in a decrease in a less environmentally-benign energy source. In that event, more costly bills for participants are also reduced since they are then gas consumers. These and other values are discussed and evaluated with an example based on the fictitious LDC described below.

SureBet Gas Company

SureBet is typical of many LDCs with a customer mix that includes a predominance of residential customers, 65%, followed by 25% commercial customers, and 10% industrials. Annual sales of approximately 1000 Bbtus is comprised of two-thirds weather-sensitive load and one-third base load, with a potential design day of 75, or a -10°F temperature. (The design day provides a measure of the potential capacity requirements to meet its firm demand under extreme weather conditions.)

Under the resource assumptions found in Table 3, two energy sources are delivered through firm transportation and supply contracts (Supply 1, Supply2), and two transportation contracts are combined with spot purchases (Transport, Transport). Firm supply resources are also delivered through two storage services, both of which are tied to firm transportation contracts for delivery, and two peaking supplies. The average cost of gas assumes fixed, reservation, and demand charges that are fully allocated based on 100% load factor, which in actuality may be less. When the portfolio is analyzed against different futures, average costs will vary depending on the dispatchability of each resource, thus the changes in load factors determine the resources' true costs and resulting contributions to margin.

DSM is reflected in a weather-sensitive program (DSM1) and a non-weather-sensitive program (DSM2), both of which have load savings and total costs over a twenty year life that equate to a levelized cost of \$5.00/mmBtu, which is assumed fixed once the program is implemented. Typically, the resources are dispatched on the basis of variable costs, however, since DSM is being evaluated simultaneously with all other resources, and its cost are fixed once implemented, all resources are valued at full cost. All of these resources are analyzed and evaluated against an

array of different futures, each having an impact on one or more resources.

Scenario Analysis

The following scenarios depict possible futures and the incremental impact that they can have on the SureBet Company, and consist mainly of changes in price levels and economic activity

- Scenario 1:** Gas costs increase 5%, competitive fuels remain constant
- Scenario 2:** Gas costs decrease 5%, competitive fuels remain constant
- Scenario 3:** Economic level of activity increases (boom)
- Scenario 4:** Economic level of activity declines (bust)
- Scenario 5:** Scenario 1 and Scenario 3 simultaneously
- Scenario 6:** Scenario 1 and Scenario 4 simultaneously
- Scenario 7:** Scenario 2 and Scenario 3 simultaneously
- Scenario 8:** Scenario 2 and Scenario 4 simultaneously

Each of the eight scenarios can have both negative and positive impacts on a resource’s return. With an economic downturn, increases in conservation are assumed and industrial sales are expected to decline, for example, resulting in a decrease in marginal supplies. At the same time, gas prices could also drop in response to a decline in demand (Scenario 8), thus lessening the impact of lower economic activity. The worst case (Scenario 6) is

the combined impact of an economic decline coupled with a rise in gas costs relative to the alternative fuel. This could have a serious effect on new construction, as well as conversions to gas. It should be noted, however, that the estimates in this and some of the other categories represent changes in incremental load, not declines in total load. (See Table 2.)

Results

Risk and Return Analysis

Resource returns were calculated for each scenario based on the deviations of each from the base case estimated load factors. The volumes dispatched under the different scenarios vary from the base case as is evidenced by resulting unit costs that are much higher than anticipated. Since general price escalators were ignored in this analysis, these increased costs are attributable to the reallocation of fixed costs over fewer units dispatched, which caused unit costs to more than double in many cases. While one could assign a probability of occurrence to any of the individual scenarios, this analysis, assumes all have an equal chance of occurring.

The average unit cost for each resource is provided for comparison against the base case in Table 3; the average unit cost in column 4 is compiled from the eight scenarios. The difference between these estimates is the incremental return, which is also listed along with the standard deviation of the load estimates.

There are a number of noteworthy observations in these results. First, the negative results are indicative of underutilized capacity in some cases. This is seen with the average low load factors of Supply2, DSM2, Storage2, and

Table 2. Incremental Load Impacts

	Industrial Load	New Const. Conversions	DSM Load Savings	Sendout and Exp. growth	Interruptible Sales
Scenario 1	(10%)	(25%)	10%	(2%)	(25%)
Scenario 2	10%	25%	(10%)	2%	--
Scenario 3	12%	35%	(20%)	5%	25%
Scenario 4	(12%)	(35%)	15%	(5%)	(25%)
Scenario 5	2%	10%	(10%)	3%	--
Scenario 6	(22%)	(60%)	25%	(7%)	(50%)
Scenario 7	22%	60%	(30%)	7%	25%
Scenario 8	(2%)	(10%)	5%	(3%)	(25%)

Table 3. Resource Profiles

	Commodity Cost	Avg. Cost mmBtu ^(a)	Base Case Cost/unit	Avg. Cost/Unit	Increm. Return	Load Factor	Standard Deviation ^(b)
Supply1	\$2.30	\$2.76	\$2.88	\$2.90	(\$0.02)	77%	\$0.023
Supply2	\$2.35	\$2.78	\$4.31	\$6.12	(\$1.81)	11%	\$2.66
Transport1	\$2.10	\$2.49	\$2.49	\$2.49	--	100%	0
Transport2	\$2.10	\$2.49	\$2.49	\$2.51	(\$0.007)	96%	\$0.02
Storage1	\$2.10	\$2.89	\$2.89	\$2.89	--	100%	0
Storage2	\$2.50	\$3.29	\$3.57	\$3.73	(\$0.04)	64%	\$0.01
DSM1		\$5.00	\$5.00	\$8.18	(\$0.64)	61%	\$3.69
DSM2		\$5.00	\$5.00	\$6.86	(\$0.37)	73%	\$2.00
Peak1	\$2.50	\$4.50	\$7.42	\$8.54	(\$0.15)	33%	\$1.71
Peak2	\$6.00	\$7.00	\$8.27	\$8.90	(\$0.08)	35%	\$0.55

(a) Average full cost at 100% load factor.

(b) 4 standard deviations is a range representing 95% of the area under a normal distribution curve.

DSM1 resources. When DSM resources are evaluated simultaneously with supply resources, their high initial costs (which are levelized fixed cost per unit saved) result in a lower priority in the dispatch order. This in turn increases the average cost per unit over initial estimates. While peaking resources have high unit costs due to their low load factor, their flexibility and relatively low weight in the portfolio may justify their inclusion.

Both firm transportation contracts are fully utilized resulting in costs per unit that are at or near base case estimates in all scenarios. This is to be expected not only since a least-cost algorithm for dispatching supplies would choose these supplies over all others, but also because there are also two storage service contracts included in the analysis that must be refilled in the off-peak season. A review of the storage load factors indicates one has a more positive return than the other. Storage2 has an overall average that results in a decrease in return of \$.16 per mmBtu. Considering the flexibility of having this firm winter service, issues concerning reliability may outweigh its potential cost.

When it is assumed that retail rates are the result of revenue requirements based on the forecast of a base case scenario, then deviations from initial load factors increase or decrease the expected return from each resource accordingly. Supply 1, for example, has an average potential decrease in return of \$.02 per mmBtu. Yet, the dispersion of volumes sold in each of the scenarios is sufficiently narrow suggesting there is not a great deal of

uncertainty associated with this supply. The area represented by two standard deviations on either side of the mean (\$2.90), that is 95% of the area under the curve of a normally distributed data set, is plus or minus \$.046. The results for Supply2 are not as positive, however. Average volumes (not shown) are just over half of base case estimates resulting in increased costs of \$1.81 per mmBtu or conversely, an equivalent reduction in the return on this resource. The uncertainty associated with this supply is indicated by a standard deviation of \$2.66.

It is also important to note that some resources are not at 100% load factor even in the base case. While this may be due to any number of factors, when resources are being evaluated for their return, reducing or eliminating any unneeded resources should be a primary consideration. The results in this example point to a few resources that require additional evaluation in a portfolio analysis.

Poor load factors are a function of the annual quantity taken due to the mismatched profiles of supply and demand. In the SureBet example, the DSM2 resource, which is an energy efficiency program related to base use, has a better load factor than DSM1, a weather-sensitive program. This is possibly because DSM2 is reducing firm sendout requirements during the off-peak season when firm supplies are needed for storage refill requirements.

Applying the formula for portfolio risk, (found in the Portfolio Risk Analysis section) the overall return of this portfolio is (10.9%), with a risk factor of 2.0% as

represented by the standard deviation statistic; thus a variance of 4.0%. It is the derivation of the portfolio's variance that is central to the portfolio theory and is discussed in the next sections.

Correlation Analysis

When choosing among alternatives, there are usually resources that may be considered mutually exclusive since their contracted load factors are similar and they serve similar end-use markets. Firm supply service on a 365-day basis is often provided by more than one contract at comparable average costs, for example. At the same time, there are resources that form the cornerstone of the portfolio, fully utilized under any conditions, and these are the resources whose costs must be maintained. This is especially important for performance-based rates, where resources of this type may be carrying the weight of gas costs, thus hedging in the futures market becomes a viable strategy. Decisions on increasing or decreasing resources are often difficult in light of the overall dynamics in the marketplace for both the supply and corresponding demand over long contract lives.

Correlation analysis is an additional approach to this decision making. In this analysis, the relationships among all of the resources in a portfolio are quantified within a range of factors from -1, indicating a perfect negative correlation, to a +1, pointing to a positively-correlated relationship between two resources. Financial theorists indicate the risk of a portfolio depends not only on the risks of its securities considered in isolation, but also on the extent to which they are affected similarly or oppositely by underlying events. Thus, diversification can reduce the overall risk of the portfolio when the underlying resources are either inversely (negatively) related or

have no relationship. Stated alternatively, if Resource A and Resource B make up a portfolio, their risks are not necessarily the risk of the portfolio, as indicated in the portfolio variance formula in the next section. The correlation matrix depicted in Table 4 measure these relationships in the SureBet example, with the more positive statistics indicating that the two underlying resources tend to move together, thus are responding similarly to the market stimuli, which were the demand modifications in each of the eight scenarios.

It is apparent that both transportation contracts, which are being fully utilized, have little or no relationship with other resources. However, this is not true for some of the other resources. Since peaking supplies, by their nature, are the last supplies dispatched, they are utilized sporadically which is reflected in low load factors and high variability, and thus are largely excluded from the analysis. The four resources with low load factors described earlier may be detracting from the portfolio. Since Storage2 and DSM1 are mutually exclusive in that they are both peak season resources, a factor of .81 indicates the degree to which their returns are correlated. They should be tested to determine how much they contribute to the overall risk and return of the portfolio, and the change in one resource based on a change in the other. Similar results occur between Supply2 and DSM2, both of which provide 365-day service, and should also be analyzed further. While the correlation factor between DSM1 and Supply 1 is also high, it should be noted that these are not mutually exclusive resources since they serve different markets (weather-sensitive and base load).

The supply resources that come into question when choosing among alternatives can often be evaluated for inclusion in the portfolio with an analysis of their relationships.

Table 4. Correlation Matrix

	Supply1	Supply2	Transp1	Transp2	Storage1	Storage2	Peak1	Peak2	DSM1	DSM2
Supply1	1.00									
Supply2	0.94	1.00								
Transp1	0.45	0.61	1.00							
Transp2	0.17	0.17	0.12	1.00						
Storage1	0.00	0.00	0.00	0.00	1.00					
Storage2	0.85	0.15	0.66	-0.10	0.00	1.00				
Peak1	0.95	0.94	0.72	0.08	0.00	0.92	1.00			
Peak2	0.94	0.96	0.61	0.02	0.00	0.92	0.98	1.00		
DSM1	0.96	0.66	0.55	-0.08	0.00	0.81	0.78	0.76	1.00	
DSM2	0.66	0.36	0.38	-0.15	0.00	0.61	0.45	0.42	0.87	1.00

Uncertain futures point to the need for flexibility among resources, as well as the analytic tools necessary to make the risk/return tradeoffs. Correlation analysis provides a means of evaluating the relationships between resources and portfolio risk analysis calculates a value for the combined risk and return of a portfolio. This is illustrated in the next section where the objective would generally be, in this example, to lessen or eliminate the negative return while maintaining or reducing the risk factor. Each of the resources under evaluation were modified to measure their impact on the portfolio and are discussed in the next section.

Portfolio Risk Analysis

Central to the portfolio theory is the idea that while an individual resource(s) in a portfolio may have inherent risk, they may be combined so that they complement each other. When one resource's expected return is independent of another, or is high when the other is low, the overall risk of the portfolio is mitigated. While the total return of the portfolio is the weighted sum of the individual returns, the portfolio variance is less than the sum of its components. This is because while the variance of each resource is always positive, a mathematical truism, and ignores any interaction with other resources, the portfolio's variance is calculated from the covariances between the resources, which in turn is based on the range of correlation factors.

The formula for determining the variance of a portfolio and used in this example is :

$$V_p = \sum_{i=1}^N \sum_{j=1}^N X_i X_j C_{ij} \quad (1)$$

- where: V_p = the variance of return for the portfolio
- X_i = the proportion of the portfolio's value in resource i
- X_j = the proportion of the portfolio's value in resource j
- C_{ij} = the covariance between the return on resource i and resource j
- N = the number of securities

and the covariance = $(Cor_{ij}) (V_i) (V_j)$ or the correlation factor between the resource times the variance of each.

A sensitivity analysis was conducted on the four resources in question to determine their impact on the portfolio. As seen in Table 5, modifying any of the resources, in most instances, improves not only the return, which in this case reduces the losses, but also reduces the risk of the portfolio. With mutually-exclusive resources, eliminating or reducing contracted quantities in one improves the load

factor of the other. As the load factor approaches 100%, the variability in the return is being reduced, and thus the risk of the portfolio is being reduced, as this analysis indicated.

Table 5. Portfolio Statistics

	Return	Variance
Base Case	(10.9%)	+/- 4.1%
Increase DSM1, decrease Storage2	(9.3%)	+/- 3.5%
Increase Supply2, decrease DSM2	(15.4%)	+/- 2.7%
Eliminate DSM1 programs	(7.5%)	+/- .44%
Reduce Supply2 by one-third	(8.1%)	+/- 1.8%

Conclusions

In reasoning through this concept's application for resource planning, a number of conclusions were drawn. The portfolio planning concept can provide a framework for a true integrated analysis, since both supply- and demand-side resources are evaluated simultaneously. Also the exogenous forces shaping demand are accounted for in the analysis through their impact on various markets, which in turn are modeled to measure the changes that can occur to the unit costs of underlying supplies, and thus to a utility's retail rates and possibly its returns. This also appears to be a sound method for including and quantifying risk in resource portfolio planning, especially when the probabilities of the scenarios can be estimated. While each of the scenarios in this example were given equal weight, it is expected that the probability of occurrence will differ in reality and will differ as annual and biennial plans are developed. At the same time, resources that are being measured for portfolio impacts can also include activities such as hedging gas contracts, and estimating market prices of released capacity, for example.

The need for an all-encompassing approach to analysis is especially evident since the FERC's recent Order 636, and is most appropriate for utilities and regulators grappling with incentive ratemaking as an alternative to traditional approaches. Utility planners need to optimize the return on all resource investments while managing an acceptable level of risk. The portfolio approach to measuring this risk provides a benchmark against which any investment decisions can be evaluated to make the risk/return tradeoffs that are necessary.

As stated earlier, this concept is also well suited to electric utility planning, and could also include non-traditional resources such as SO₂ allowances, or even the impacts of increasing market competitiveness, both of which are important to the electric resource portfolio.

Endnotes

1. Dr. Porter, a professor at the Harvard Business School, has written a number of books and articles focused on competitive analysis and strategic planning.
2. Electronic Bulletin Boards are the mechanism through which capacity may be released or procured.

References

- Bails, D. E., and L. C. Peppers. 1982. *Business Fluctuations: Forecasting Techniques and Applications*. Prentice Hall Inc., Englewood Cliffs, NJ.
- Fama, E. F., 1976. *Foundations of Finance*. Basic Books Inc., New York, NY.
- Porter, M. E., *How Competitive Forces Shape Strategy*, Harvard Business Review, March-April 1979.
- Sharpe, W. F., 1978. *Investments*. Prentice Hall, Inc., Englewood Cliffs, NJ.