SOUTHERN INDIANA GAS AND ELECTRIC COMP

D/B/A

VECTREN ENERGY DELIVERY OF INDIANA, INC.

CAUSE NO. 45052

VERIFIED DIRECT TESTIMONY

OF

GARY VICINUS

MANAGING DIRECTOR FOR UTILITIES, PACE GLOBAL

SPONSORING PETITIONER'S EXHIBIT NO. 7,
ATTACHMENTS GV-1 THROUGH GV-6

VERIFIED DIRECT TESTIMONY

OF

GARY VICINUS

MANAGING DIRECTOR FOR UTILITIES, PACE GLOBAL

Q. Please state your name and address.

A. My name is Gary Vicinus. My business address is 12700 Fair Lakes Circle, Suite 250, Fairfax, Virginia 22033.

Q. By whom are you employed and in what capacity?

A. I am a Managing Director for Utilities at Pace Global, a Siemens business.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South").

Q. What is the purpose of your testimony in this proceeding?

A. I will describe the use of a balanced scorecard approach to modeling risk in Vectren South's 2016 Integrated Resource Plan ("2016 IRP") and certain modifications incorporated by Pace Global to address concerns raised in the Final Director's Report from the Indiana Utility Regulatory Commission ("Commission") related to the scorecard.

Q. Please summarize your education and experience relevant to your testimony in this case.

A. A copy of my resume is attached in Petitioner's Exhibit No. 7, Attachment GV-1. My relevant education and experience are as follows: I have a Bachelor's degree from Virginia Tech and a Master's degree from North Carolina State University, majoring in economics. I spent several years at Carolina Power and Light Company working on fuel planning. Since 1980 I have worked as an energy consultant, primarily working with electric utilities on strategic planning, resource planning, environmental strategies, and market assessments. I have been an expert witness in a number of jurisdictions and have conducted a number of best practice assessments in utility planning. I have directed most of the resource planning studies performed by Pace Global over the past 15 years and directed the methodologies we have deployed over that period.

Q. Please summarize the history of your consulting relationship with Vectren South.

A. I have been advising Vectren South on resource planning activities for the past several years. First, I was involved with some environmental modeling work performed by Pace Global. Next, I was asked to moderate its stakeholder meetings for Vectren South's 2014 Integrated Resource Plan (IRP) and as a result I gained exposure to Vectren South's IRP planning process. In 2016, I was once again asked to moderate the stakeholder meetings for its 2016 IRP and in addition, I was asked to assist Vectren South in conducting scenario development to reflect a wide range of boundary conditions and a Risk Analysis that was requested by the Commission.

Q. Are you sponsoring any exhibits in this proceeding?

A. Yes, I am sponsoring the following exhibits:

- Petitioner's Exhibit No. 7, Attachment GV-1: Resume of Gary Vicinus
- Petitioner's Exhibit No. 7, Attachment GV-2: Litigation, Arbitration, Public Testimony, and Related Experience of Gary W. Vicinus
- Petitioner's Exhibit No. 7, Attachment GV-3: Balanced Scorecard (Figure 8.1 from page 233 of the Vectren South 2016 IRP)
- Petitioner's Exhibit No. 7, Attachment GV-4: Revised Balanced Scorecard

- Petitioner's Exhibit No. 7, Attachment GV-5: Descriptive Table of All 15 Portfolios from Vectren South 2016 IRP
- Petitioner's Exhibit No. 7, Attachment GV-6: 5 Year Rolling Average of Gas Prices from 200 Iterations

Q. Please summarize Pace Global's role in the 2016 Vectren South IRP process.

A. Pace Global contributed to the 2016 Vectren South IRP process in several key areas, including:

- helping structure Vectren South's IRP process to incorporate a risk analysis;
- assisting in the development of a base case and six alternative scenarios;
- providing power dispatch modeling to forecast power prices;
- conducting a comprehensive risk analysis, which included probabilistic modeling;
- facilitating public stakeholder meetings; and
- serving as an advisor to Vectren South throughout the IRP process.

Q. Please describe the other roles you performed in Vectren South's IRP.

A. I moderated each of the three stakeholder meetings and provided guidance to the Vectren South team throughout the process.

Q. Please describe Pace Global's recent experience and expertise in structuring and leading integrated resource planning for utilities such as Vectren South.

A. Pace Global is a leading consultant for integrated resource planning, with extensive experience in structuring and facilitating IRPs for utilities throughout the United States and Caribbean. The following list represents a selection of recent clients who have engaged Pace Global to contribute to their IRP processes: Minnesota Power

(Minnesota), Madison Gas & Electric (Wisconsin), Dominion Energy, Platte River Power Authority, Tucson Electric Power, Glendale Water and Power (California), City of Farmington NM (New Mexico), Los Alamos County (New Mexico), Caribbean Utilities Corporation (Grand Cayman), and Pasadena Water and Power (California).

Q. Please describe your role in helping to structure the IRP process.

A. I advised Vectren South on a staged process involving the selection of portfolios using a base case and several scenarios, and then applying a risk analysis to the selected portfolios to recommend a preferred portfolio.

Q. Please describe your role in developing the base (or reference) case and the six alternative scenarios.

A. Pace Global worked closely with Vectren South in selecting its scenarios. Using the Vectren South base case (which represents Vectren South's view of the "most likely" future conditions) as a starting point, we examined the expected changes in five key variables (load, natural gas prices, coal prices, carbon prices, capital costs) when three fundamental market drivers—regulatory change (a high and a low regulation scenario), technology change (a scenario with higher than expected technological change), and economic performance (both a high and a low economic growth scenario) change—are modulated. A total of five scenarios plus the base case (six total scenarios) were constructed from these three market drivers. In addition, a seventh scenario was developed by Vectren South that is equal to the base case in all ways except that this scenario adds 100 MWs of load beginning in 2024.

Independently, Vectren South had come up with a list of factors that it wanted to consider in defining its scenarios. Pace Global worked with Vectren South to ensure that key uncertainties were reflected in the seven scenarios (base, large load addition, high regulatory, low regulatory, high technology, high economy, low economy) used in the screening analysis. We developed a table that linked together the relationship between the five key variables and the seven scenarios. For example, when the economy performs poorly (the low economy case), load growth is lower than the base case and as a result, commodity prices are lower than the base case. Graphs that directionally describe the impacts on each variable over time for each scenario are provided as Figures 6.9 through 6.16 of Vectren South's IRP. *See* *Petitioner's Exhibit No. 5*, Attachment MAR-1. Independently, Vectren South and Pace Global assessed the likely directions of each variable relative to its value in the base case to ensure consistency in the scenarios. Modulating these three primary drivers serves as a means to adjust the five key variables in a methodical and internally consistent way. Pace Global provided a narrative description for each alternative scenario beginning with Section 6.2.1 on page 182 in the IRP document. Then Pace Global provided values for each of the variables in each of the six alternative scenarios around the base case for input into Burns & McDonnell's Strategist runs.

Q. How were the values of load, gas prices, coal prices, capital costs, and carbon prices determined for the alternative scenarios?

A. We developed distributions for load, gas prices and coal prices based upon a combination of historical and forecasted volatility analysis and expert judgment. For carbon prices, we used a number of scenarios we constructed to reflect the range of uncertainty and used them to fit a distribution, as no historical data exists for a national carbon price. We then adjusted values from the base case values to reflect the internally consistent scenarios that were jointly developed between Vectren South and Pace Global by adding or subtracting the amount by plus or minus one standard deviation from the mean value in select (near, mid and long term) years and interpolated results for remaining years.

Q. Why was one (1) standard deviation selected to help construct inputs for each scenario?

A. The stochastic distributions can be characterized as percentile ranges. For example, one standard deviation from the mean is the 84^{th} and the 16^{th} percentile of all possible values at a given point in time. At the 84th percentile price (which is $5.95/MMBtu in 2025 in 2015 dollars), we can make the following statement, "With 84% confidence, we can say that the price of natural gas will be at or below $5.95/MMBtu in 2025 or alternatively we can say that there is only a 16% chance that gas prices will exceed $5.95/MMBtu." The percentiles cannot be treated as one price path/one price trajectory, but rather the probability of being above or below that price in that one year.

So when we construct a scenario that reflects a sustained price at a given probability level (in our example, $5.95/MMBtu in 2025), the probability of natural gas prices remaining at that level over time is extremely low. For example if there is a 0.16 chance of higher prices in any one year, there is only a 0.16*0.16 or 2.56% chance (0.0256) of being above our forecast for two years in a row (if prices from one year to the next are independent). Because our price path remains at the +1 standard deviation path for the entire planning horizon, the path we use has a very low probability (even if prices from year to year are somewhat dependent). Hence our price trajectory is actually much more conservative than it might appear.

To illustrate this, please see Petitioner's Exhibit No. 7, Attachment GV-6, which shows a five year rolling average of the Vectren South High Gas Case compared with the rolling five year average of the 200 iterations of potential natural gas price paths. A rolling average is used because it averages the variability of the paths to more directly compare to our price projections. From this illustration, we see that the vast majority of price paths fall below the high gas case line.

Q. The Final Director's Report on the 2016 IRP inquired whether selecting two (2) standard deviations would have resulted in different portfolio selections. Do you have a response to that inquiry?

A. Yes, we do concur that considering a very low-probability price path (i.e., sustained extremely high prices at two standard deviations) for natural gas prices and other stochastic variables can tell us that a generation decision could change in the extreme case. However, our view is that planning decisions should be made on plausible boundaries rather than extreme conditions, which is reflected in our selection of one standard deviation rather than two or more.

Q. Please describe your role in conducting the risk analysis.

A. The first step in the process was to determine Vectren South's objectives and assign metrics to each of the objectives. Once that was completed, Pace Global developed distributions for each of the risk input variables, which consisted of historical analyses for each input and expert judgment, along with correlation coefficients for each of the key variables. Then a probabilistic model simulation (using Monte Carlo simulation software) was completed based on the developed inputs that generated 200 possible future simulated scenarios (iterations). Each portfolio was tested against each of the 200 iterations in our power dispatch model (AURORAxmp) as part of the broader MISO market to determine the dispatch and cost of the portfolios. For each portfolio, we computed the portfolio cost over time and then computed the Net Present Value (NPV) of costs over the planning horizon, the range of variation in costs across the 200 iterations (the standard deviation of the NPV) and other metrics.

Q. How does the risk assessment methodology used in Vectren South's 2016 IRP compare to Pace Global's recent experience with other utilities' integrated resource planning?

A. The risk assessment methodology that Pace Global uses in IRP engagements is comprehensive, internally consistent, methodical, and reproducible. We have been following and evolving these methodologies for conducting IRPs over the past 15 years. The IRP process we presented to Vectren South, which helped to inform and structure their own integrated resource planning process, is one we have been using with clients for many years, and it has been widely accepted by managements, stakeholders, and regulators (whether Boards, City Councils or Public Utility Commissions).

Q. Did all of these IRPs involve stochastics?

A. Not all of these IRPs involved stochastics. Some utilities preferred to use scenarios rather than stochastics to represent the risks to its portfolios. For example, Glendale Water and Power, Platte River Power Authority, and Caribbean Utilities Corporation used a scenario based approach, while others used stochastics. The principal difference is the number of scenarios or iterations. Using scenarios, only a handful of scenarios are considered, while in a stochastic risk assessment approximately 200 scenarios or iterations are evaluated. Other than that, the methodologies are the same.

Q. Please describe Pace Global's role in identifying and defining the objectives, metrics, and risks in order to select a preferred portfolio among many options.

A. Pace Global develops the process for defining objectives and metrics as a first step in developing a risk analysis. Many IRPs focus solely on least cost measures, but most utilities have multiple objectives, including cost, risks, reliability, environmental stewardship, and diversity. That said, each utility will view the critical metrics differently and the relative importance of each on the selection of the metrics. Hence, each utility will have a different set of objectives, priorities, and metrics for evaluating portfolio options. Vectren South ultimately selects the metrics and Pace Global advises on their applicability.

Q. Please summarize the risk analysis process used for the Vectren South 2016 IRP.

A. The process for addressing uncertainty and/or risk in long-term resource planning studies requires an integrated framework that takes into account uncertainty in load, the markets for natural gas and coal, capital costs for new generation (both fossil-fuel units and renewables), and carbon prices. The distributions of costs for each of these variables were developed using a combination of historical analyses of the variability of each factor, analyses of future market conditions, and expert judgment. The risk analysis was conducted on 15 different portfolios of generation resources as determined by Vectren South. The risk analysis subjected each portfolio to 200 iterations of variable market conditions using AURORAxmp. The resulting outcomes of this analysis include distributions of energy prices, portfolio costs, and revenues from specific generation assets.

The portfolios were ranked by a group of key metrics associated with Vectren South's objectives. The best group of performers for each metric was given a green color and the worst group of performers was given a red color; yellow was given to the group in between green and red. The final results were provided in the table in Petitioner's Exhibit No. 7, Attachment GV-4: Balanced Scorecard (also, see Figure 8.1 from page 233 of the

IRP). As described later in this testimony, we subsequently modified that approach for ranking the distributions to a more objective ranking process.

Q. Please describe each of the metrics selected for evaluating the portfolios in the Vectren South 2016 IRP and how they were applied.

A. The objectives that were used in the Vectren South 2016 IRP are industry standard, which Pace Global has used in many other IRPs. Select examples of other IRPs in which Pace Global used similar objectives and some or all of these metrics include Glendale Water and Power, City of Farmington NM, Los Alamos County, Caribbean Utilities Corporation, Tucson Electric Power, and Minnesota Power. The objectives include determining least customer costs, minimizing associated risk (range of costs), finding an appropriate cost-risk trade off, requiring adequate flexibility (balanced energy), reducing environmental impact, and addressing local economic impacts. Each of these objectives includes one or more metrics that ranked each of the portfolios. For example, for the cost objective, the NPV of total costs was ranked highest to lowest for each of the 15 portfolios. A detailed description and application for each of the metrics used in this Vectren South 2016 IRP are addressed in the following questions.

Q. Please provide the basis for using the NPV of costs.

A. A component of the cost metric includes the cost of new and existing generation assets. The cost metric was calculated using the NPV of total costs or generation related revenue requirements for each of the fifteen portfolios over a 20-year time horizon (2017-2036). This was the mean value of the 200 stochastic iterations. The costs related to the generating assets, which include the amortized capital costs, fixed and variable operations and maintenance expense, delivered fuel and market purchases, and sales to meet the total load requirements. It is important to note that this was the present value of energy procurement and was not an indicative component of the total rate structure. The portfolio with the lowest mean or average costs across all 200 iterations will facilitate lower customer rates, on average, than other portfolios. In the risk analysis prepared for the Vectren South 2016 IRP, the portfolios that were within 5% of the portfolio with the lowest expected cost (the NPV of revenue requirements) were given a green color, and the portfolios that were 10% or more expensive than the lowest cost portfolio were given a red color. As I mentioned earlier, we modified this approach to address the Director's report comments, as described later in this testimony.

Q. Please describe in detail each of the risk metrics in the risk analysis prepared for the Vectren South 2016 IRP.

A. The risk category contains four metrics. The first measure of risk is the volatility of the portfolio cost across the 200 iterations. The most commonly used measure of volatility is the standard deviation of the mean. In this case the risk metric was calculated as the standard deviation of the mean across all 200 iterations. The portfolios whose standard deviations of the mean were within 10% of the least volatile portfolio were given a green color. The portfolios that had standard deviations 15% or more than the lowest portfolio were given a red color.

The second measure of risk is exposure to volatilities in the wholesale energy market prices. The portfolio with the lowest average purchases from the market is less subject to market price volatility. When looking at the range of market purchases, those with less than 800 GWhs per year on average were given a green color and those above 1,200 GWhs were given a red color.

The third measure assesses the potential exposure to MISO capacity markets. Although the majority of portfolios are designed to meet MISO reserve margin targets under base case conditions, they each may fall short if demand growth is higher than expected. Note that some computer generated portfolios, such as Portfolio D, were created to meet a lower planning reserve margin requirement due to having a lower alternative sales and demand forecast. The average number of additional capacity purchases across all 200 iterations was computed to see which needed the most incremental capacity purchases. Portfolios purchasing less than 20 MW per year on average received a green color and those above 35 MW per year received a red color.

The fourth and final risk measure was remote generation risk. Portfolios with generation assets located away from Vectren South's service territory are exposed to greater risk of transmission congestion and outages. While this remains true, because it is hard to define remoteness within an RTO Zone and predict the level of congestion absent specific studies, we eliminated this measure in the modified approach described later in this testimony.

Q. Please describe the cost-risk trade-off as prepared for the Vectren South 2016 IRP.

A. The Cost-Risk trade-off shows the trade-offs between a least cost objective (NPV) and a least risky objective (standard deviation). The x-axis measures the NPV of expected revenue requirements to cover energy procurement, over the planning horizon, given in billions of dollars. The y-axis measures the uncertainties in the revenue requirement, given in standard deviation—a commonly measured dispersion around the mean—in the NPV of the same revenue requirement. The portfolios that did the best in this measure had the lowest expected cost and the lowest amount of volatility or standard deviation (see Figure 7.19 on page 229 of the IRP).

Q. Please describe the environmental metric as prepared for the Vectren South 2016 IRP.

A. The environmental metric is the percent reduction in carbon emissions from 2012 levels by 2030 and NOx/SOx from 2012-2015 levels by 2036. All portfolios reduce carbon emissions by more than 40% except for Portfolio A: Existing Portfolio. Additionally, all except for Portfolio A: Existing Portfolio reduce NOx/SOx levels by more than 80%.

Q. Please describe the balanced energy/flexibility metric as prepared for the Vectren South 2016 IRP.

A. Balance and flexibility are important objectives to ensure that Vectren South has a diverse generation mix that does not rely too heavily on the economics and viability of one technology or one site. In addition, portfolios with the greatest number of technologies are ranked higher than those with fewer numbers. Finally, portfolios with net sales provide flexibility to satisfy growth. In the modified approach described in this testimony, we eliminated the net sales metric to address a concern raised in the Director's report, which questioned why higher net sales are protection against unexpected change and posited that higher net sales could also indicate greater sunk costs associated with generation facilities.

The categories for the balanced energy/flexibility metric included: (1) the capacity in MW of the largest 24/7 (baseload) technology; (2) percent reliance on largest technology in 2036 on a GWh basis; (3) the number of technologies in the portfolios; and (4) net market sales. Those that had the largest number of technologies, the smallest reliance on both a MW and a Mwh basis on the largest technology and greater market sales were given green colors for that metric.

Q. Please describe the local economic impact metric as prepared for the Vectren South 2016 IRP.

A. The last metric is local economic impact to the community. Note that Pace Global did not prepare the economic impact study but did include the assessment in its risk analysis. This metric considers the impact of output reductions, job losses and tax losses to the local economy if local generation assets are closed. In addition, construction additions and operation of replacement generation were considered. Closing the FB Culley 3 site in 2024 would have an adverse economic impact to the local community. Building a combined cycle plant in Vectren South's service territory would minimize the impact to the community if the AB Brown Plant closed by 2024. The portfolios that did the best in this ranking minimized the negative economic impact to the community.

Q. Please describe why the AURORAxmp model was used for production cost modeling.

A. AURORAxmp was used as the primary tool for conducting Vectren South's risk assessment. AURORAxmp is an industry standard chronological unit commitment and dispatch model with an extensive presence throughout the electric power industry. The model uses a state of the art, mixed integer linear programing ("MILP") approach to capture details of power plant and transmission network operations while observing real world constraints, such as emission reduction targets, transmission and plant operation limitations, renewable energy availability, and mandatory portfolio targets. It is widely used by electric utilities, consulting agencies, and other stakeholders to forecast generator performance and economics, develop Integrated Resource Plans (IRP), forecast power market prices, and assess in detail the impact of regulations and market changes affecting the electric power industry. Key inputs to the model include load forecasts, power plant costs and operating characteristics (e.g. heat rates), fuel costs, fixed and variable operating costs, outage rates, emission rates, and capital costs. The model is able to assess the potential performance and capital cost of existing and prospective generation technologies and resources, and make resource addition and retirement decisions for economic, system reliability, and policy compliance reasons on a utility system, regional, or nationwide scale as needed. Outputs of the model include plant generation, gross margin, emissions, and a variety of other metrics, as needed.

Q. Please describe how each of the stochastic variables was integrated into the Vectren South 2016 IRP process.

A. The stochastic variables were created using industry standard mathematical approaches that are a normal part of Pace Global's forecasting service, which are then used in AURORAxmp as an input. A stochastic variable is defined as a variable whose range of possible values over time consists of numerical outcomes of a random phenomenon. A stochastic approach provides a more detailed characterization of the probability distribution of costs for any one variable around the reference or base case value. When these inputs are used in the AURORAxmp model, the resulting output of this process includes the power plants' dispatch and associated production costs over time across the 200 iterations. The stochastic variables used as inputs to AURORAxmp were load, gas prices, coal prices, carbon prices, and capitals costs for new generating units for a variety of technologies.

Load: To account for variations in electricity demand stemming from economic growth, weather, and energy efficiency and demand side management measures, Pace Global developed stochastic distributions around the load growth expectations for the Vectren South control area and the neighboring ISO zones. Pace Global's long-term load forecasting process is a two-step process that captures both the impact of historical load drivers such as economic growth and variability of weather (parametric step) and the impacts of energy efficiency penetration (quantum step) in constructing the average and peak demand outlook.

Gas: Pace Global developed natural gas stochastic distributions for Henry Hub and other basis points in MISO and elsewhere. These stochastic distributions are based on the base case view of natural gas prices with probability bands developed using a combination of historical volatility and mean reversion parameters, as well as a forward view of expected volatility. This includes Lebanon Hub in southwestern Ohio, which captures the dynamics of supply coming from the Marcellus and Utica shale plays.

Coal: Pace Global developed coal price stochastic distributions for the Central Appalachia, Northern Appalachia, Illinois, and Powder River basins. These stochastic distributions are based on a combination of historical volatility and mean reversion parameters.

Emissions: Pace Global developed uncertainty distributions around carbon compliance costs, which were used in the power dispatch modeling to capture the inherent risk associated with regulatory compliance requirements. The technique to develop carbon costs distributions, unlike the previous variables, is based on modeling future scenarios and fitting a curve to these scenarios, as there are no historical data sets to estimate the parameters for developing carbon costs distributions.

Capital Costs: Pace Global developed the uncertainty distributions for the cost of new entry generation units by technology types, which were used in the Aurora dispatch model for determining the economic new generation builds based on market signals. The methodology of developing the capital cost distributions is based on a base case view of future all-in capital costs, historical costs and volatilities, and a sampling of results to develop probability bands around the base case and captures our expert view of the additional uncertainty with each technology that factors in learning curve effects, improvements in technology over time, and other uncertain events. The new units modeled included both renewable and thermal assets.

Q. Please describe the balanced scorecard methodology and color rankings as prepared for the Vectren South 2016 IRP.

A. The concept of a scorecard is common to electric utilities, especially in risk and performance analyses, including as Enterprise Risk. The purpose of a scorecard is to account for the fact that utilities, stakeholders, and customers all have multiple objectives that they are trying to achieve in evaluating alternative portfolios. In the past, IRPs focused solely on least cost portfolios under expected market conditions, and tested very little sensitivity. One can certainly select one objective and subject the portfolios to a "rigorous" analysis of that one variable. But the Commission in Indiana (and many other states) has emphasized the importance of accounting for multiple objectives in order to better reflect the real world. *See* 170 IAC 4-7-8.

Customers care about risk, including the risk of staking future energy reliability, energy cost, and rate uncertainty on a single technology. A scorecard approach is something we have used for many years in all IRP engagements we have performed for utilities. As a result, it is an appropriate choice for an IRP that must evaluate portfolio choices against a number of different objectives. Pace Global has used this approach extensively for almost a decade in jurisdictions across the United States.

Q. Did you weigh the metrics differently in selecting the preferred portfolio, and if not why not?

A. We weighed each objective equally so as to avoid the perception of subjectivity. However, we did group like metrics together under one objective. For example, we had four different measures of risk (volatility which is the standard deviation of the mean NPV Revenue Requirement, exposure to volatilities in the wholesale energy market prices, exposure to MISO capacity market prices, and remote generation), which were averaged together for one risk metric.

Q. Why did you include a cost-risk trade-off metric?

A. The reason we included the combination of cost and risk in one measure is that there is sometimes a trade-off between a least expected cost portfolio and a more stable portfolio. By showing the trade-off one can see that some portfolios are clearly higher cost and higher risk. We believe this provides more insight into the selection of the recommended portfolio. This is something we have used for many years and even some utilities that do not use Pace Global have used (e.g. Indianapolis Power and Light).

Q. Did Vectren South prepare a cumulative probability chart to present the cost-risk trade-off?

A. No, Vectren South did not prepare a cumulative probability chart because we believe that the graphic we presented in the Vectren South 2016 IRP (Figure 7.19 on p. 229) shows relative trade-offs between least cost and stability objectives more effectively. We have used this metric in nearly all of the IRP work we have conducted across the country. It is similar to the presentation used in Indianapolis Power & Light Company's 2016 IRP. Moving out from the zero cost/zero risk point, there are clear but qualitative distinctions between portfolios with higher levels of expected cost and risk.

Further, using a cumulative probability distribution does not simplify the trade-offs. At the 50% level, the cumulative distribution is approximately the same as the expected cost metric. At the 95% level, the portfolios are indistinguishable. We believe our metric to be more appropriate.

Q. Have you read the Final Director's Report and some of the concerns regarding the risk analysis that was performed?

A. Yes, we have read the concerns raised in the Final Director's Report dated November 2, 2017.

Q. Can you please summarize the concerns?

A. Yes.

- First, the Director raised concerns that the distinction between rankings (red, yellow, green) was arbitrary due to a lack of distinction between the ratings.
- Second, the Director questioned whether higher net sales are always a protection against unexpected change.
- Third, the Director noted there was no definition of what constituted remote generation that would help the reader understand whether Vectren South considered the degree of remoteness or a requirement that generation be directly interconnected with Vectren South's transmission system.
- Fourth, the Director believed the limitation to one standard deviation in the development of scenarios could unreasonably constrain the potential range of resource portfolios that are subjected to the optimization process, which was addressed earlier in my testimony.
- Fifth, the Director wondered whether a cumulative probability chart would have been a better approach to present the cost-risk tradeoff which was addressed in the previous question.
- Sixth, the Director was unclear about how the thresholds were developed for exposure to the MISO capacity and energy markets

Q. Have you considered the extent to which it is prudent to modify the balanced scorecard analysis to address these issues?

A. Yes. While the original methodology is reliable, Vectren South and Pace Global decided to incorporate many of the comments into a revised scorecard to evaluate how they impacted the outcome. Our approach was not modified for the fourth, fifth and sixth observations for the reasons I explain elsewhere in this testimony.

Q. Please respond to the Director's concern about the use of the thresholds for exposure to the MISO capacity markets.

A. The Director's concern related to the explanation, not the fundamental principle that MISO capacity market exposure increases risk. There is no threshold for considering what a reasonable maximum exposure to these markets would be in the analysis. There is only limited experience in these markets to draw on, not enough to determine what is an appropriate level of exposure. We have noted that these markets are not very liquid and hence are quite volatile. Consequently, Vectren South's risk assessment increased the risk in proportion to the increase in reliance on the volatile capacity markets.

Clearly, capacity markets are volatile. While there is limited history, they are far more volatile than power markets. Moreover, this exposure is not captured in any of our other metrics. Hence, we believe that including this as a metric is both relevant and reasonable as a risk.

Q. What changes have you made to address the concerns of the use of colors in the balanced scorecard?

A. To make the selection of the portfolio more objective, we eliminated the original color scheme and assigned a numerical index to each metric between zero (0) and ten (10). For each metric, the portfolio that performed the worst was given a zero score, and the best portfolio was given a 10. The values given to the remaining portfolios were determined by the ratio of the difference between the value for the portfolio in comparison to the best and worst portfolios. In this way, the distinctions between metrics is purely objective – the greater the relative difference between portfolios in any metric, the greater the difference in the index value.

Q. Did you consider other changes to the risk analysis and balanced scorecard methodology?

A. Yes, we removed two metrics.

First, we removed the net sales metric. We recognize that the excess net sales metric is a controversial metric because, while it can provide flexibility, it could inadvertently favor generation that is larger than necessary to satisfy Vectren South's customers' needs.

Second, the remote generation metric was also removed. Vectren South concluded there would be less controversy with the scorecard if this metric was removed as opposed to articulating a definition of the metric. Vectren South continues to believe that distance is a concern, but concluded this factor is best evaluated with specific proposals since all forms of generation could potentially be remote.

Petitioner's Exhibit 7, Attachment GV-4 shows the result of these changes in the revised balanced scorecard.

Q. Did the revisions to the risk analysis indicate Vectren South should reconsider its preferred portfolio?

A. No. The portfolios in the Diversified with Coal group remain the portfolios that perform the best across all remaining metrics. Portfolio L (which is the preferred portfolio in the IRP study) and Portfolio K are the best among all the portfolios. The only difference between Portfolio L and Portfolio K is that Portfolio K has slightly more renewable installed capacity.

Q. What impacts did the revisions to the balanced scorecard have on the risk analysis?

A. These changes did not have significant impacts on the results. The top three best performing portfolios from a risk perspective (Portfolios K, D, and L) selected the F-class .05 fired natural gas combined cycle plant. The preferred portfolio (Portfolio L) remained in the top scoring position after the first two changes and remained within 1% of the top scoring portfolio once the third change was applied. Moreover, the first group of similar portfolios ("Diversified with Coal" or Portfolios L, K, and M) remains the top performing group of portfolios in the revised balanced scorecard in each of the three changes, indicating that maintaining a diversified fleet of coal, gas and renewables helps to minimize customer risk. The revisions result in Portfolio D falling more in line with Portfolio's L, K and M from a risk perspective. Vectren South witness Rice discusses why Vectren South continues to pursue Portfolio L.

Q. Does this complete your testimony?

A. Yes.

VERIFICATION

The undersigned, Gary Vicinus, affirms under the penalties of perjury that the answers in the foregoing Direct Testimony in Cause No. 45052 are true to the best of his knowledge, information and belief.

Gary Vicinus

Petitioner’s Exhibit No. 7, Attachment GV-1 (consisting of three pages):

Resume of Gary Vicinus:

Gary Vicinus

Pace Global Energy Business Advisory

Industry Experience: 41 years

Summary

Gary Vicinus is Managing Director at Pace Global Energy Business Advisory and leads the Utilities practice. He has extensive experience in the energy business as a management consultant, a coal and power expert and as an expert witness. He has been in the energy consulting business for 37 years and in the energy business for 41 years. His consulting experience has been focused on corporate strategy, strategic planning, resource planning, supply planning, electric restructuring, asset positioning, power and coal market assessments, coal and transportation contracting, risk integrated resource and fuel planning, risk quantification and as an expert witness on contracts, regulatory, damages and market matters. He developed Pace Global's RIRP methodology and overseen nearly all of Pace Global's work in resource planning.

Gary earned his B.A. from Virginia Polytechnic Institute and State University and his M.A. from North Carolina State University majoring in Economics.

Representative Experience

Energy Strategy, Risk Quantification and Planning

- Corporate strategy development for IOUs, developers, industrials, and marketing & trading company
- Business Transformation assessments for electric utilities
- Integrated Planning (GT&D) assessment for IOU
- Risk Integrated Resource Planning development for electric companies
- Strategic assessment of a banking institution affiliate of a major energy company
- Management reviews of restructuring plans of integrated electric utilities
- Oversight of a project to merge several retail businesses into one integrated unregulated business.
- Evaluation of the magnitude of uncovered contractual risks associated with the merger of two Midwestern entities, including both market risk and regulatory risk
- Electric utility management audits of electric utilities evaluating their preparation for deregulation, organizational reviews and operational efficiency
- Regulatory incentive mechanism analysis and benchmark evaluation
- Organizational studies for electric organizations
- Stranded cost evaluations and financial models of impacts of rate freezes on utility earnings

Market Assessments

- U.S. wholesale electric power outlook development
- Energy outlook services, including power and fuel assessments of markets in the U.S.
- Worldwide coal markets analysis
- Market price determinations and fuel supply availability assessments
- Environmental compliance and trading strategies, and emission market opportunities assessments

Contract Renegotiation Support

- Coal procurement support and contract negotiations for IOUs and utilities worldwide
- Captive mine, coal-related negotiations
- Multi-year, recurring contract negotiation support

Fuel Contracting, Procurement and Organizational Studies

- Strategic Plans
- Organizational reviews
- Feasibility studies
- Supply plans, policies and procedures creation
- Fuel procurement and fuel inventory studies
- Mine takeover, mine closing studies evaluations, captive mines
- Contract language, solicitation drafting, disputes
- Market rules and readiness for open access.
- Stranded and avoided costs
- Market price disputes
- Nuclear plant investment
- Environmental compliance strategies (including the CPP)
- Power plant performance & dispatch
- Power purchases and sales
- Damage assessments

Asset Valuations and Financial Assessments

- Valuations of coal, nuclear, and other generating assets in the U.S. and abroad
- Bid preparations for acquiring military assets
- Feasibility study for coal mine development project in underdeveloped country
- NUG contracts valuation and potential liability evaluation
- Granite operation valuation in a property litigation dispute
- Generating assets, fuel contracts and power contracts stranded value determination

Employment History

Siemens Industry, Inc. (2002 – current; Fairfax, VA)
Vicon Energy Consultants (2001; Centreville, VA)
ICF Resources (sub of ICF International Inc.) (1980 – 2001; Fairfax, VA)
Carolina Power and Light Company (1976-1980, Raleigh NC)

Petitioner's Exhibit No. 7, Attachment GV-2 (consisting of three pages):

Litigation, Arbitration, Public Testimony, and Related Experience of Gary W. Vicinus:

Litigation, Arbitration, Public Testimony, and Related Experience of Gary W. Vicinus

Audits

Performed and testified in several management audits of electric utilities, evaluating their preparation for deregulation, performing organizational reviews, and evaluating their operational efficiency

Reports filed with Commissions

- Minnesota Power study of environmental retrofits for a coal station
- Tucson Electric Power assessment of acquiring a unit of a power plant
- Caribbean Utilities Corporation integrated resource plan

Public Testimony

- For Public Service of New Mexico: Issues surrounding fuel contracts for the San Juan Generating Station
- For Public Utilities Commission of Ohio: Prudence of an extended Davis-Besse nuclear plant outage
- For Public Utilities Commission of Ohio: Management audits of fuel procurement practices and inventories, system dispatch, and environmental compliance of Monongahela Power (twice), Dayton Power and Light (twice), American Electric Power Company's subsidiary, Columbus Southern Coal Company (twice), and AEP's Ohio Power (twice)
- For Indiana Municipal Power Company before the Federal Energy Regulatory Commission ("FERC"): Prudence of AEP's coal procurement practices and market assessments for a contract dispute
- For New Jersey Board of Public Utilities: Reasonableness of Public Service Electric and Gas Company's stranded cost and, separately, its market restructuring filing, covering stranded costs, rate impacts, market power, readiness of market competition, and a variety of related issues
- Midwest Energy before the Kansas Public Service Commission on an Integrated Resource Plan developed for Mid-West Energy that resulted in investments in wind- and coal-fired generation
- For Kansas City Power and Light before the Missouri Public Service Commission concerning Coal inventories
- For Gulf Power before the Florida Public Service Commission concerning Coal inventories
- For New York State Electric and Gas before the New York State Corporation Commission: Prudence of coal procurement practices and investment in coal preparation plant
- For Rochester Gas and Electric before the New York State Corporation commission: Prudence of coal and oil procurement
- For Niagara Mohawk Corporation before the New York State Corporation Commission: Prudence of coal and oil and nuclear fuel issues
- For Houston Lighting and Power (now Reliant) before the Texas State Corporation Commission: Prudence of coal procurement practices
- For the Public Utilities Commission of Ohio: Coal procurement practices of Ohio Edison
- For Wisconsin Public Service Commission: Prudence of fuel procurement practices of Wisconsin Public Service Company (including inventories)
- For Wisconsin Citizens Utility Board before the Wisconsin Public Service Commission: Fuel procurement practices of Wisconsin Power and Light Company (including inventories)

Arbitrations and Litigations

- Impact of oil price escalation in relation to a coal contract dispute with BNSF and UP Railroads (for Grand River Dam Authority)

- Impact of MISO on power contract (Cleveland Cliffs)
- Testimony before the Surface Transportation Board on coal demand and rates for power stations on a hypothetical stand-alone railroad for AEP/Oklaunion
- Arbitration regarding market price re-opener (Northern Indiana PSC/Arch Mineral Coal Company)
- MMWEC in dispute with the City of Hull, Massachusetts and others in a dispute over the prudence o the Seabrook Nuclear Station (Massachusetts District Court)
- Valuation of a condemnation of property over granite rights (Department of Justice)
- Prudence of U.S. coal purchases (Taiwan Power Company/Control Juan) in Taiwan court
- Green Coal Company over coal contract dispute with a contractor (Pennsylvania District Court)
- Entergy in a dispute with the Union Pacific Railroad in Wyoming District Court over reliability, damages, the prudence of coal supplies, inventories and related issues
- Western Fuels in dispute with the Union Pacific Railroad in Kansas District Court over reliability, damages, the prudence of coal supplies, inventories, and related issues
- Illinois Power in a coal market price dispute with Arch Mineral Coal Company (arbitration)
- Arbitrator in dispute between Northern Indiana Public Service Company over a market price re-opener with Arch Mineral Coal Company (Missouri arbitration)
- Peter Kiewit over coal contract and environmental issues and market prices in dispute with Commonwealth Edison (now Exelon) - Wyoming District Court
- AEP Oklaunion before the Surface Transportation Board concerning litigation involving the reasonableness of its rail rates. Performed demand and revenue estimates in calculation of stand-alone railroad costs.
- Market price dispute arbitration (Taiwan Power/Pen Coal Holdings)
- Damages related to prudence of coal procurement issues (Glen Falls Cement Company in dispute with supplier)
- Ohio Valley Coal Company regarding a coal contract and market price dispute with AEP
- Dairyland Power on coal contract and market price issues with its coal supplier, Amax Coal Company (Wisconsin District Court)

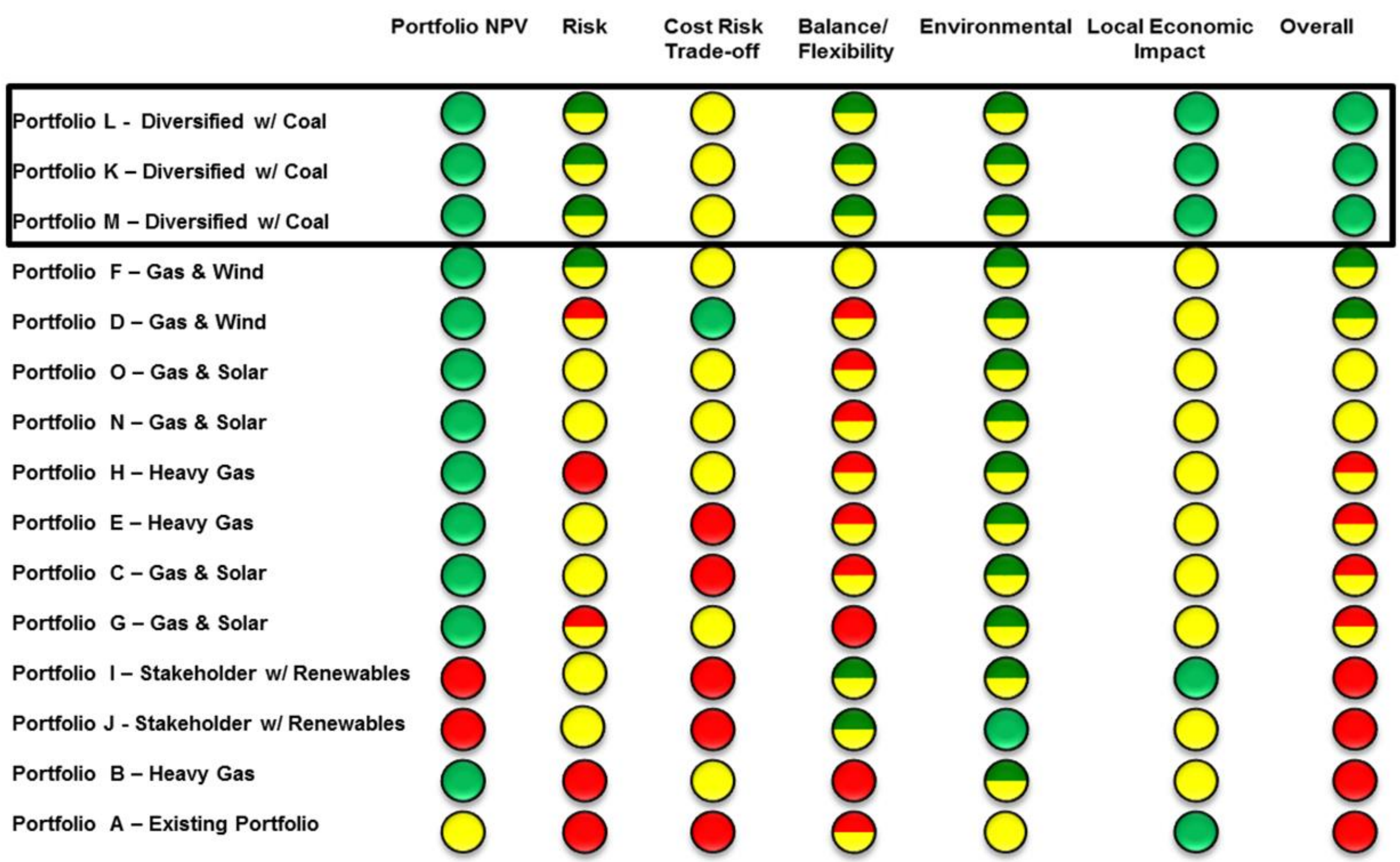
Testimony Support

- Drafted testimony for Tenaska in Consumers Power CCN filing for construction of a new power plant
- Power contract dispute over Rancho Seco Nuclear Plant agreement between two California utilities
- Prudence of coal procurement for captive mines in Utah before the Utah Public Utilities Commission
- Support for the Hopi Indians in coal contract issues with the Peabody Coal Company
- Supported the Governors' Energy Council (now Energy Office) in its review of the prudence of PPL's interest in the Limerick Nuclear Station

Petitioner's Exhibit No. 7, Attachment GV-3 (consisting of one page):

Balanced Scorecard (Figure 8.1 21 from page 233 of the Vectren South 2016 IRP):

Figure 8.1 – IRP Portfolio Balanced Scorecard



Petitioner's Exhibit No. 7, Attachment GV-4 (consisting of four pages):

Revised Balanced Scorecard:

Portfolio	Rank by Portfolio: Original Balanced Scorecard	Rank by Portfolio: Change 1: All Metrics 0-10	Rank by Portfolio: Change 2: No Net Sales	Rank by Portfolio: Change 3: No Remote Gen	Overall Score (0-10): Original Balanced Scorecard	Overall Score (0-10): Change 1: All Metrics 0-10	Overall Score (0-10): Change 2: No Net Sales	Overall Score (0-10): Change 3: No Remote Gen	% Change from Top Portfolio: Original Balanced Scorecard	% Change from Top Portfolio: Change 1: All Metrics 0-10	% Change from Top Portfolio: Change 2: No Net Sales	% Change from Top Portfolio: Change 3: No Remote Gen
L: Diversified w/ Coal	(green)	1	1	3	(green)	6.46	6.43	6.49	(green)	0.0%	0.0%	1.0%
K: Diversified w/ Coal	(green)	4	4	1	(green)	6.33	6.29	6.56	(green)	2.1%	2.3%	0.0%
M: Diversified w/ Coal	(green)	2	2	4	(green)	6.41	6.42	6.42	(green)	0.9%	0.3%	2.1%
F: Gas & Wind	(yellow/green)	5	5	5	(yellow/green)	5.56	5.39	5.68	(yellow/green)	14.0%	16.2%	13.4%
D: Gas & Wind	(yellow/green)	3	3	2	(yellow/green)	6.40	6.32	6.54	(yellow/green)	1.0%	1.7%	0.3%
O: Gas & Solar	(yellow)	7	8	8	(yellow)	5.41	5.32	5.27	(yellow)	16.4%	17.3%	19.7%
N: Gas & Solar	(yellow)	6	7	7	(yellow)	5.43	5.33	5.29	(yellow)	16.0%	17.1%	19.3%
C: Gas & Solar	(red/yellow)	14	13	14	(red/yellow)	4.44	4.31	4.30	(red/yellow)	31.3%	32.9%	34.4%
G: Gas and Solar	(red/yellow)	11	10	10	(red/yellow)	4.95	4.85	4.74	(red/yellow)	23.5%	24.6%	27.8%
H: Heavy Gas	(red/yellow)	9	9	9	(red/yellow)	5.17	5.08	4.99	(red/yellow)	20.0%	21.1%	23.9%
E: Heavy Gas	(red/yellow)	12	12	13	(red/yellow)	4.51	4.32	4.34	(red/yellow)	30.2%	32.8%	33.8%
B: Heavy Gas	(red)	10	11	11	(red)	4.95	4.79	4.70	(red)	23.4%	25.6%	28.3%
I: Stakeholde w/ Renewables	(red)	8	6	6	(red)	5.34	5.33	5.63	(red)	17.4%	17.1%	14.1%
J: Stakeholder w/ Renewables	(red)	13	14	12	(red)	4.44	4.30	4.54	(red)	31.3%	33.2%	30.8%
A: Existing Portfolio	(red)	15	15	15	(red)	4.00	4.24	4.03	(red)	38.2%	34.1%	38.5%

Group	Group Rank by Rank: Original Balanced Scorecard	Group Rank by Rank: Change 1	Group Rank by Rank: Change 2	Group Rank by Rank: Change 3	Group Rank by Score: Original Balanced Scorecard	Group Rank by Score: Change 1	Group Rank by Score: Change 2	Group Rank by Score: Change 3	Group Rank by % Change: Original Balanced Scorecard	Group Rank by % Change: Change 1	Group Rank by % Change: Change 2	Group Rank by % Change: Change 3
Group 1: Diversified w/ Coal	(green)	1	1	1	(green)	1	1	1	(green)	1	1	1
Group 2: Gas/Wind/Solar	(yellow)	2	2	2	(yellow)	2	2	2	(yellow)	2	2	2
Group 3: Gas Heavy	(red/yellow)	3	4	4	(red/yellow)	4	4	4	(red/yellow)	4	4	4
Group 4: Stakeholder	(red)	4	3	3	(red)	3	3	3	(red)	3	3	3
Group 5: Existing Portfolio	(red)	5	5	5	(red)	5	5	5	(red)	5	5	5

Change 1: All Metrics Put On a 0-10 Scale

Portfolios	Portfolio NPV	STD Above Lowest	Capacity Purchases	20 Year Average Market Purchases	Remote Gen Risk	Risk	Cost-Risk Trade-Off	Largest 24/7 Power Source	% Reliance Largest Tech	# of Tech-nologies	Net Sales	Balance/ Flexibility	Environment	Local Econ Impact	**Ranking (0-worst, 10-best)**	**Rank Order**
Weights	**17%**	25%	25%	25%	25%	**17%**	**17%**	25%	25%	25%	25%	**17%**	**17%**	**17%**		
L: Diversified w/ Coal	8.9	4.6	6.0	8.5	5.0	6.0	5.0	5.0	4.5	10.0	7.3	6.7	2.2	10.0	6.46	1
K: Diversified w/ Coal	9.2	5.1	5.7	8.6	0.0	4.8	5.0	5.0	4.7	10.0	7.5	6.8	2.2	10.0	6.33	4
M: Diversified w/ Coal	8.8	6.0	0.3	8.8	5.0	5.0	5.0	5.0	5.1	10.0	6.5	6.7	2.9	10.0	6.41	2
F: Gas & Wind	8.7	4.6	8.3	7.7	0.0	5.1	5.0	0.0	4.5	5.0	7.3	4.2	5.3	5.0	5.56	5
D: Gas & Wind	9.6	6.1	2.6	7.0	0.0	3.9	10.0	0.0	4.5	5.0	5.0	3.6	6.3	5.0	6.40	3
O: Gas & Solar	9.2	4.5	0.0	6.5	5.0	4.0	5.0	0.0	2.6	5.0	4.5	3.0	6.3	5.0	5.41	7
N: Gas & Solar	9.2	4.4	0.9	7.0	5.0	4.3	5.0	0.0	2.3	5.0	4.8	3.0	6.1	5.0	5.43	6
C: Gas & Solar	8.8	2.1	5.7	6.2	5.0	4.7	0.0	0.0	1.1	5.0	5.0	2.8	5.3	5.0	4.44	14
G: Gas and Solar	9.7	2.0	0.0	5.0	5.0	3.0	5.0	0.0	0.4	0.0	2.5	0.7	6.3	5.0	4.95	11
H: Heavy Gas	10.0	0.7	2.9	5.4	5.0	3.5	5.0	0.0	0.0	5.0	4.0	2.3	5.3	5.0	5.17	9
E: Heavy Gas	9.3	0.1	10.0	6.5	5.0	5.4	0.0	0.0	0.6	5.0	6.5	3.0	4.3	5.0	4.51	12
B: Heavy Gas	9.9	0.8	2.6	5.4	5.0	3.4	5.0	0.0	0.2	0.0	4.0	1.1	5.3	5.0	4.95	10
I: Stakeholde w/ Renewables	2.9	10.0	1.7	10.0	0.0	5.4	0.0	5.0	10.0	10.0	8.5	8.4	5.3	10.0	5.34	8
J: Stakeholder w/ Renewables	0.0	5.9	1.1	10.0	0.0	4.3	0.0	0.0	9.6	10.0	10.0	7.4	10.0	5.0	4.44	13
A: Existing Portfolio	8.4	0.0	0.0	0.0	5.0	1.3	0.0	10.0	2.3	5.0	0.0	4.3	0.0	10.0	4.00	15

Change 2: No Net Sales

Portfolios	Portfolio NPV	STD Above Lowest	Capacity Purchases	20 Year Average Market Purchases	Remote Gen Risk	Risk	Cost-Risk Trade-Off	Largest 24/7 Power Source	% Reliance Largest Tech	# of Tech-nologies	Net Sales	Balance/ Flexibility	Environment	Local Econ Impact	**Ranking (0-worst, 10-best)**	**Rank Order**
Weights	**17%**	25%	25%	25%	25%	**17%**	**17%**	33%	33%	33%	-	**17%**	**17%**	**17%**		
L: Diversified w/ Coal	8.9	4.6	6.0	8.5	5.0	6.0	5.0	5.0	4.5	10.0	-	6.5	2.2	10.0	6.43	1
K: Diversified w/ Coal	9.2	5.1	5.7	8.6	0.0	4.8	5.0	5.0	4.7	10.0	-	6.6	2.2	10.0	6.29	4
M: Diversified w/ Coal	8.8	6.0	0.3	8.8	5.0	5.0	5.0	5.0	5.1	10.0	-	6.7	2.9	10.0	6.42	2
F: Gas & Wind	8.7	4.6	8.3	7.7	0.0	5.1	5.0	0.0	4.5	5.0	-	3.2	5.3	5.0	5.39	5
D: Gas & Wind	9.6	6.1	2.6	7.0	0.0	3.9	10.0	0.0	4.5	5.0	-	3.2	6.3	5.0	6.32	3
O: Gas & Solar	9.2	4.5	0.0	6.5	5.0	4.0	5.0	0.0	2.6	5.0	-	2.5	6.3	5.0	5.32	8
N: Gas & Solar	9.2	4.4	0.9	7.0	5.0	4.3	5.0	0.0	2.3	5.0	-	2.4	6.1	5.0	5.33	7
C: Gas & Solar	8.8	2.1	5.7	6.2	5.0	4.7	0.0	0.0	1.1	5.0	-	2.0	5.3	5.0	4.31	13
G: Gas and Solar	9.7	2.0	0.0	5.0	5.0	3.0	5.0	0.0	0.4	0.0	-	0.1	6.3	5.0	4.85	10
H: Heavy Gas	10.0	0.7	2.9	5.4	5.0	3.5	5.0	0.0	0.0	5.0	-	1.7	5.3	5.0	5.08	9
E: Heavy Gas	9.3	0.1	10.0	6.5	5.0	5.4	0.0	0.0	0.6	5.0	-	1.9	4.3	5.0	4.32	12
B: Heavy Gas	9.9	0.8	2.6	5.4	5.0	3.4	5.0	0.0	0.2	0.0	-	0.1	5.3	5.0	4.79	11
I: Stakeholde w/ Renewables	2.9	10.0	1.7	10.0	0.0	5.4	0.0	5.0	10.0	10.0	-	8.3	5.3	10.0	5.33	6
J: Stakeholder w/ Renewables	0.0	5.9	1.1	10.0	0.0	4.3	0.0	0.0	9.6	10.0	-	6.5	10.0	5.0	4.30	14
A: Existing Portfolio	8.4	0.0	0.0	0.0	5.0	1.3	0.0	10.0	2.3	5.0	-	5.8	0.0	10.0	4.24	15

Change 3: No Remote Generation

Portfolios	Portfolio NPV	STD Above Lowest	Capacity Purchases	20 Year Average Market Purchases	Remote Gen Risk	Risk	Cost-Risk Trade-Off	Largest 24/7 Power Source	% Reliance Largest Tech	# of Tech-nologies	Net Sales	Balance/ Flexibility	Environment	Local Econ Impact	**Ranking (0-worst, 10-best)**	**Rank Order**
Weights	**17%**	33%	33%	33%	-	**17%**	**17%**	33%	33%	33%	-	**17%**	**17%**	**17%**		
L: Diversified w/ Coal	8.9	4.6	6.0	8.5	-	6.4	5.0	5.0	4.5	10.0	-	6.5	2.2	10.0	6.49	3
K: Diversified w/ Coal	9.2	5.1	5.7	8.6	-	6.5	5.0	5.0	4.7	10.0	-	6.6	2.2	10.0	6.56	1
M: Diversified w/ Coal	8.8	6.0	0.3	8.8	-	5.0	5.0	5.0	5.1	10.0	-	6.7	2.9	10.0	6.42	4
F: Gas & Wind	8.7	4.6	8.3	7.7	-	6.9	5.0	0.0	4.5	5.0	-	3.2	5.3	5.0	5.68	5
D: Gas & Wind	9.6	6.1	2.6	7.0	-	5.2	10.0	0.0	4.5	5.0	-	3.2	6.3	5.0	6.54	2
O: Gas & Solar	9.2	4.5	0.0	6.5	-	3.6	5.0	0.0	2.6	5.0	-	2.5	6.3	5.0	5.27	8
N: Gas & Solar	9.2	4.4	0.9	7.0	-	4.1	5.0	0.0	2.3	5.0	-	2.4	6.1	5.0	5.29	7
C: Gas & Solar	8.8	2.1	5.7	6.2	-	4.7	0.0	0.0	1.1	5.0	-	2.0	5.3	5.0	4.30	14
G: Gas and Solar	9.7	2.0	0.0	5.0	-	2.3	5.0	0.0	0.4	0.0	-	0.1	6.3	5.0	4.74	10
H: Heavy Gas	10.0	0.7	2.9	5.4	-	3.0	5.0	0.0	0.0	5.0	-	1.7	5.3	5.0	4.99	9
E: Heavy Gas	9.3	0.1	10.0	6.5	-	5.5	0.0	0.0	0.6	5.0	-	1.9	4.3	5.0	4.34	13
B: Heavy Gas	9.9	0.8	2.6	5.4	-	2.9	5.0	0.0	0.2	0.0	-	0.1	5.3	5.0	4.70	11
I: Stakeholde w/ Renewables	2.9	10.0	1.7	10.0	-	7.2	0.0	5.0	10.0	10.0	-	8.3	5.3	10.0	5.63	6
J: Stakeholder w/ Renewables	0.0	5.9	1.1	10.0	-	5.7	0.0	0.0	9.6	10.0	-	6.5	10.0	5.0	4.54	12
A: Existing Portfolio	8.4	0.0	0.0	0.0	-	0.0	0.0	10.0	2.3	5.0	-	5.8	0.0	10.0	4.03	15

Petitioner’s Exhibit No. 7, Attachment GV-5 (consisting of two pages):

Descriptive Table of All 15 Portfolios from Vectren 2016 IRP:

	Portfolio	Description	Additions	Retirements	Reason for Inclusion
A	Business As Usual (Continue Coal)	Continues current configuration of coal generating assets supplemented by market capacity purchases and a small measure of demand response	Simple Cycle Gas Turbine (220 MW); 4 MW solar	Exit Joint Operations Warrick 4 Coal (150 MW); Retire Northeast 1 & 2 Gas (20 MW)	Establish a baseline for comparison
B	Base Scenario (aka Gas Heavy) Portfolio (Optimized)	Includes extensive retirements of coal generating assets, largely replaced by natural gas generating assets	Combined Cycle Gas Turbine (889 MW); Simple Cycle Gas Turbine (220 MW); 40 MW solar	Exit Joint Operations Warrick 4 Coal (150 MW); Retire Northeast 1 & 2 Gas (20 MW); Retire AB Brown 1 & 2 (490 MW); Retire FB Culley 2 & 3 (360 MW); Retire Broadway Avenue Gas (65 MW)	Natural gas prices are currently very low and expected to remain competitive throughout the forecast period
C	Base + Large Load Scenario Portfolio (Optimized)	Examines large load growth that is met in part with EE, market capacity purchases, and DR	Combined Cycle Gas Turbine (889 MW); Simple Cycle Gas Turbine (220 MW); 72 MW solar	Same as above	Assess a larger than expected load growth
D	High Regulatory Scenario Portfolio (Optimized)	Provides a portfolio that is heavy on wind resources in order to comply with tight regulations	Combined Cycle Gas Turbine (889 MW); 4 MW solar; 400 MW wind	Same as above	One of the States-of-the-World scenarios
E	Low Regulatory Scenario Portfolio (Optimized)	Provides two SCGTs and one CCGT to meet expected future load in a low regulatory setting	Simple Cycle Gas Turbines (440 MW); Combined Cycle Gas Turbine (889 MW); 4 MW solar	Same as above	One of the States-of-the-World scenarios
F	High Economy Scenario Portfolio (Optimized)	Assumes a high load growth due to high economic growth, met in part with a mix of gas and renewables	Simple Cycle Gas Turbine (220 MW); Combined Cycle Gas Turbine (889 MW); 4 MW solar; 400 MW wind	Same as above	One of the States-of-the-World scenarios
G	Low Economy Scenario Portfolio (Optimized)	Assumes low load growth due to economic malaise, met in part with a large gas addition	Combined Cycle Gas Turbine (889 MW); 63 MW solar	Same as above	One of the States-of-the-World scenarios
H	High Technology Scenario Portfolio (Optimized)	Rapid technological development leads to high load growth and significant market capacity purchases	Simple Cycle Gas Turbine (220 MW); Combined Cycle Gas Turbine (889 MW); 13 MW solar	Same as above	One of the States-of-the-World scenarios

I	Stakeholder Portfolio	Fewer gas additions and significantly more renewable and storage additions	Combined Cycle Gas Turbine (330 MW); 904 MW solar; 1,000 MW wind; 100 MW battery; 30 MW CHP	Same as above	Stakeholder provided
J	Stakeholder Portfolio (Cease Coal 2024)	Fewer gas additions and significantly more renewable and storage additions	Combined Cycle Gas Turbine (330 MW); 804 MW solar; 1,200 MW wind; 100 MW battery; 30 MW CHP	Same as above	Stakeholder provided
K	FBC3, Fired Gas, & Renewables Portfolio	Balanced energy portfolio that keeps FB Culley 3 with CCR compliance, adds gas and renewables	Combined Cycle Gas Turbine (889 MW); 13 MW solar; 50 MW wind	Exit Joint Operations Warrick 4 Coal (150 MW); Retire Northeast 1 & 2 Gas (20 MW); Retire AB Brown 1 & 2 (490 MW); Retire FB Culley 2 (90 MW); Retire Broadway Avenue Gas (65 MW)	Provide a diverse mix of additions to replace retirements
L	FBC3, Fired Gas, Early Solar, & EE Portfolio	Balanced energy portfolio that keeps FB Culley 3 with CCR compliance, adds gas and renewables	Combined Cycle Gas Turbine (889 MW); 54 MW solar	Same as above	Provide a diverse mix of additions to replace retirements
M	FBC3, Unfired Gas .05, Early Solar, EE, & Renewables Portfolio	Balanced energy portfolio that keeps FB Culley 3 with CCR compliance, adds gas and solar both early and late in forecast	Combined Cycle Gas Turbine (700 MW); 172 MW solar	Same as above	Provide a diverse mix of additions to replace retirements
N	Unfired Gas Heavy with 50 MW Solar in 2019 Portfolio	Combines early solar with significant gas additions but without duct-firing	Simple Cycle Gas Turbine (220 MW); Combined Cycle Gas Turbine (700 MW); 272 MW solar	Exit Joint Operations Warrick 4 Coal (150 MW); Retire Northeast 1 & 2 Gas (20 MW); Retire AB Brown 1 & 2 (490 MW); Retire FB Culley 2 & 3 (360 MW); Retire Broadway Avenue Gas (65 MW)	Assess gas additions but without duct-firing for peaking or opportunistic market sales
O	Gas Portfolio with Renewables Portfolio	Assumes load growth will be met mostly with gas and solar additions	Combined Cycle Gas Turbine (889 MW); 331 MW solar	Same as above	Includes gas and solar which are both growing rapidly in the U.S.

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Petitioner's Exhibit No. 7, Attachment GV-6 (consisting of one page):

5 Year Rolling Average of Gas Prices from 200 Iterations: