BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

IN THE MATTER OF THE PASS-THROUGH APPLICATION OF DOMINION ENERGY UTAH FOR AN ADJUSTMENT IN RATES AND CHARGES FOR NATURAL GAS SERVICE IN UTAH	Docket No. 17-057-20

DIRECT TESTIMONY OF DAVID C. LANDWARD

FOR DOMINION ENERGY UTAH

January 31, 2018

DEU Exhibit 1.0

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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is David Christian Landward. My business address is 333 South State Street, Salt Lake City, Utah.

Q. What is your title and area of responsibility?

A. I am a Regulatory Analyst for Dominion Energy Utah ("Dominion Energy" or "Company"). My responsibilities include forecasting gas demand and customer growth and preparing the estimate of firm sales and transportation demand for a design peak day ("Design Peak Day") for the Company's Integrated Resource Plan ("IRP").

Q. What is your educational background and experience?

A. I have a Bachelor of Science degree in Mathematics and a Master of Statistics degree from the University of Utah. I have worked for Dominion Energy for the last 22 years. I began in meter reading and then worked in information technology before I joined Regulatory Affairs in 2008.

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

A. The purpose of my testimony is to explain how the Company calculated the Design-Peak-Day demand for the 2016-2017 heating season. I also discuss the variables used in calculating the Design-Peak-Day and the assumed conditions used to make that calculation. I also discuss the probability of a Design-Peak-Day event.

II. DESIGN DAY

Q. What is the purpose of modeling Design-Peak-Day demand?

A. The Company has an obligation to provide firm natural gas service to its firm sales and transportation customers, including during extreme, albeit rare, conditions. To fulfill this obligation, the Company must anticipate not only how to plan for system growth and operational needs, but it must plan for reasonably conceivable worst-case scenarios, including extreme cold weather conditions. The Design-Peak-Day demand calculation assists the Company to ensure that it will be able to provide service under all of these conditions.

Q. Please explain how the Company analyzes firm sales demand for a Design-Peak-Day.

A. Firm sales demand is determined separately from firm transportation demand. Sales demand is analyzed by estimating the statistical relationship between demand and explanatory variables known to affect it. A multivariate regression analysis of historic daily firm sales data since 2004 is conducted using the following independent variables: heating degree days, mean wind speed, maximum wind gust speed, day of the week, winter holiday indication, and prior day demand. The data show that each of these variables has a significant effect on demand, and the estimated effect of each can be used to predict demand when a particular value for each variable is assumed. The Company has offered detailed explanations of this modeling approach in various IRP workshops in the past, most recently in April of 2014.

Q. How does the Company analyze firm transportation demand for a Design-Peak-Day?

A. Total firm transportation demand on a Design-Peak-Day is assumed to be the total of all contractual firm demand at the time the determination is made. The Company provides firm service to each firm transportation customer up to a daily firm limit specified in the customer's service agreement. Any service beyond that daily limit is provided on an interruptible basis. To meet that contractual obligation on a Design-Peak-Day, the Company assumes that each firm transportation customer will consume gas up to the firm limit, and plans accordingly. Any transportation usage beyond the firm limit will be curtailed on a Design-Peak-Day.

Q. Please describe the conditions the Company assumes when estimating firm sales demand on a Design-Peak-Day.

A. Firm sales demand on a Design-Peak-Day is an estimate of total firm consumption for the gas day under extreme conditions that are rare but nevertheless reasonably conceivable. Because temperature is the key driver of firm gas demand, modeling a Design-Peak-Day scenario must begin with the determination of a mean daily temperature that exists within the low range of observed data. Once a daily mean temperature has been determined, the Company must estimate the maximum level of gas demand that could be required at that temperature. To arrive at that demand number, the Company must account for additional variables that drive gas demand. These variables include: wind speed, the day of the week and whether the day falls on a holiday, and demand on the day prior. The data show that, during the heating season, average demand rises as wind speeds increase. Additionally, average demand is higher on a Monday through Thursday and on a day that is not a winter holiday, specifically Thanksgiving, Christmas Eve, Christmas Day, or New Year's Day.

Q. What values did the Company use for each of these variables to estimate the Design-Peak-Day demand for the 2016/2017 heating season?

A. The Company used -5 degrees Fahrenheit as a Design-Peak-Day temperature, which is the expected minimum daily mean occurring on a one-in-twenty-year recurrence interval in the Salt Lake Region. The mean daily temperature in the Salt Lake Region has been at or below -

5 degrees seven times in the nearly 90 years of temperature history available to the Company. The likelihood of that occurrence in any given year is 5%. The likelihood of at least one occurrence over the next ten years is 40%. Though such an event is infrequent, the likelihood exists given the historical data. As discussed, the Company has an obligation to anticipate and prepare for just such an event. For the 2016/2017 heating season, the Company used the highest average (26 mph) and maximum gust speeds (47 mph) in the winter months observed in the data. The Company estimated a prior day usage of 882,609 Dth, using conditions derived by identifying the maximum value of the temperature and wind variables each year and computing the prior day's portion of that maximum value. The average portion across all years in the data is calculated for each variable and then applied to Design-Peak-Day conditions to derive prior day conditions. As noted, average daily demand is higher Monday through Thursday and on a day that is not a winter holiday. To ensure adequate supply, the Design-Peak-Day plan assumes that the design event occurs on such a day.

Q. **How does each of the variables you've identified affect your Design-Peak-Day calculation?**

A. Let me provide a simple example using the high-demand day from the 2016/2017 heating season. On the January 6, 2017, gas-day, sales customers used 974,095 Dth. I have outlined

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the conditions on that day in the table below. Note that these conditions are measured on a gas-day basis which extends from 8:00 A.M. to 8:00 A.M. of the following day:

1	Mean Temperature	4.5 degrees
2	Mean Wind Speed	4.6 miles per hour
3	Maximum Wind Speed	9 miles per hour
4	Day of week	Friday
5	Prior day usage	917,532 Dth

When I use the January 6, 2017 values for each of the 5 factors in the model, the estimated firm sales demand is 958,098 Dth. This is 15,997 Dth, or 1.6%, lower than the actual demand of 974,095 that occurred on that gas day.

Q. How do the actual conditions that occurred on January 6, 2017, compare with the values you used in your Design-Peak-Day calculation for the IRP estimated 2016/2017 heating season?

A. A comparison of the factors is shown in the table below:

		January 6, 2017	Design Peak Day
1	Mean Temperature	4.5 degrees	-5 degrees
2	Mean Wind Speed	4.6 miles per hour	26 mph
3	Maximum Wind Speed	9 miles per hour	47 miles per hour
4	Day of week	Friday	Mon-Thur, No Holiday
5	Prior day usage	917,532 Dth	882,609 Dth
6	Total Demand	947,095 Dth	1,316,588

Q. Please explain how these variables affect the Design-Peak-Day demand estimate.

A. I will address each factor and explain the effect of each on the Design-Peak-Day estimate.

Q. What effect does the temperature have on the Design-Peak-Day estimate?

A. The Design-Peak-Day temperature is an expected low mean temperature based on a one-in-twenty-year recurrence interval. The last time the temperature was near -5 degrees was in 1990. If, on January 6, 2017, temperatures had been -5 degrees rather than 4.5 degrees, the demand would have increased by 104,880 Dth to 1,048,291 Dth.

Q. Please discuss the effect that wind speed has on the estimated Design Peak Day demand?

A. Wind speed has a significant positive effect on gas demand. On average when other factors are accounted for, demand increases with an increase in wind speed. And the rate of increase intensifies as the temperature drops. In other words, the demand response to wind increases as it gets colder. The maximum winter-month wind speed of 47 mph and the average wind speed of 26 mph were assumed for Design-Peak-Day conditions.

Q. Why is it important to think about wind speed when comparing high demand days to a Design-Peak-Day?

A. While the temperatures were low during the high demand days, wind speeds were relatively low. The table below shows the average and maximum wind speed on the high-demand days for the last three years.

	Design Firm Sales	Actual Firm Sales	Actual Mean Temp	Actual Mean Wind	Actual Max Wind
2014/2015	1,285,857	996,189	12	5.4 mph	12 mph
2015/2016	1,305,701	880,378	10	3.8 mph	9 mph
2016/2017	1,316,588	974,095	6	4.6 mph	9 mph

Note that the highest firm sales demand occurred during the 2014/2015 heating season. Between the two days, the mean temperature on the 2014/2015 high demand day was six degrees warmer, and the Company was serving fewer customers on that day than it was on the 2016/2017 high demand day. However, the wind speed was higher, and consequently, the demand was as well. This illustrates the effect that wind speed alone can have on heating load.

Q. What effect does wind have on the Design-Peak-Day estimate?

A. When the average wind speed for the January 6, 2017 gas day of 4.6 mph is replaced with the design value of 26 mph, and the maximum sustained gust of 9 mph is likewise replaced with the design value of 47 mph, the estimated demand increases by 283,464 Dth.

Q. What effect does the day of the week have on the Design-Peak-Day estimate?

A. While the day of the week has a comparatively smaller effect on demand than wind or temperature, it is nonetheless a factor that has statistical significance and must be accounted for. When the model is adjusted to estimate demand under design wind and temperature conditions that occur on a weekday other than Friday and not on a holiday, the design-day estimate increases by 10,589 Dth.

Q. Please discuss prior-day usage.

A. Prior-day usage shows a strong positive correlation with contemporaneous usage. This means that when other factors are accounted for, an increase in usage on a given day generally precedes an increase in usage on the following day. This statistical relationship is referred to as first-order autocorrelation and must be accounted for in this type of analysis. A Design-Peak-Day scenario is not a forecast of usage at one step ahead of the end of a historical time series; rather, it is an isolated, extreme case that is not linked to a particular date. Nevertheless, to adequately estimate Design-Peak-Day demand the prior-day usage must be accounted for and therefore estimated. For the Design-Peak-Day scenario, a prior-day usage of 882,609 Dth was estimated from the same historical data using conditions derived by identifying the maximum value of the temperature and wind variables each year and computing the prior day's portion of that maximum value. The average portion across all years in the data is calculated for each variable and then applied to Design-Peak-Day conditions to derive prior-day conditions. These prior-day conditions are then used to statistically estimate an average demand under such conditions which then serves as the prior-day demand value for the estimation of Design-Peak-Day usage. If we use the January 6, 2017 day as an example, prior-day demand is lower than that seen on January 5, 2017. In other words, an estimate of demand on the January 6 gas day under actual conditions is higher by 14,687 Dth when the actual demand on the January 5 gas day is used instead of the estimated prior-day figure.

Q. Please summarize the result if you applied your Design-Peak-Day values to the circumstances that occurred on January 6, 2017.

A. The changes are shown in the table below:

	Scenario	Estimated Demand in Dth	Change in Dth
1	January 6, 2017 Estimate	958,098 Dth	-
2	Reduce Prior day usage to 882,609 Dth	943,411	(14,687)
3	Reduce temperature from 4.5 degrees to -5 degrees	1,048,291	104,880
4	Increase average wind speed from 4.6 to 26 mph and maximum gust speed from 9 to 47 mph	1,331,755	283,464
5	Change day of week from Friday to non-holiday weekday	1,342,344	10,589

Q. Are you confident that you have selected reasonable and appropriate values for each of the variables you have identified in your Design-Peak-Day Calculation?

A. Yes. I will discuss each variable below.

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A. Temperature.

Q. You've stated that the Company chose -5 degrees as the Design-Peak-Day mean temperature because it is a one-in-twenty-year event. How does this selection method compare with those employed by other utilities across the country?

A. It is very comparable. In 2009 the American Gas Association ("AGA") conducted a survey of its member utilities with questions regarding Design-Peak-Day demand. One of the questions asked participants about the method used to determine a Design-Peak-Day temperature. Thirteen of the twenty-one participating companies responded to the question.

Q. Please summarize the responses to that question.

A. The table below summarizes the responses.

Method	Number of utilities	Dominion Energy Temperature (degrees Fahrenheit)
1 in 20 year recurrence	2	-5.2
1 in 30 year recurrence	1	-7.7
1 in 35 year recurrence	1	-8.5
Lowest in 20 years	1	4.5
Lowest in 30 years	5	-4.0
Lowest on record	3	-11.0

Q. Based on your review of the AGA survey do you still believe that it is appropriate to use the -5 degrees temperature to calculate the Design-Peak-Day demand?

A. Yes. The Company's approach is reasonable when compared to those used by other utilities. It yields a temperature selection that satisfies the mandate to prepare for an event that is rare but, based on the data, could occur.

B. Wind.

Q. Are the Company's wind variables also reasonable?

A. Yes. The Company based its selection of wind speed on historical occurrences observed in winter months, independent of temperature. There are 7 instances of an average temperature at or below the Company's Design-Peak-Day temperature. The Company does not have wind-speed data for most of these instances. As I have explained in my testimony, wind speed has a strong positive effect on gas demand. In the absence of wind data associated with the data points of extreme low temperatures, it is reasonable for the Company to be prepared for wind speeds that have occurred during the winter months. For this reason, the Company assessed wind speeds independent of temperature, consistent with the task of planning for a worst-case wind scenario. The maximum wind speed of 47 mph occurred in February 16, 2011. The maximum average wind speed of 26 mph occurred on January 27, 2008. A summary of the maximum and mean wind speeds during winter months for the last 13 years is provided in the table below:

	Year	Maximum wind	Mean Wind
1	2004	33	22.6
2	2005	35	21.1
3	2006	35	19.8
4	2007	35	18.04
5	2008	36	25.7
6	2009	36	20.8
7	2010	36	21.7
8	2011	47	21.3
9	2012	38	23.4
10	2013	30	16.0
11	2014	38	18.6
12	2015	35	18.6
13	2016	36	17.2
14	2017	35	24.8

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Q. You are aware that in Docket No. 17-057-09, the Office of Consumer Services' (Office) expert, Jerome Mierzwa, raised concerns about the wind variables used in the Design-Peak-Day model. How do you respond?

A. Because there is very limited wind-speed data for extreme cold days, determining what the wind speeds will be on a Design Peak Day is challenging. The information the Company used as a surrogate for that data was the recorded high and average wind speeds that have actually occurred during the winter months. Mr. Mierzwa, by contrast, performed a correlation analysis using historical data. I believe that the results derived by both approaches are reasonable given the lack of data on extreme-low-temperature days. He raises valid points that should be considered going forward, and the Company supports engagement with the Office and other regulators to discuss, assess, and determine whether refinements should be made to the analysis in future IRP dockets.

Q. Can you summarize the statistical analysis done to estimate the effect of each variable addressed in your testimony and to assess the statistical significance of each?

A. Yes. The analysis is done using multivariate, ordinary least squares regression on data extending back to January 1, 2004. The coefficient estimate and statistical significance result of each variable is listed in the table below. A t-statistic value of approximately 2.0 or higher indicates statistical significance at the 5% alpha level. The coefficient estimates are updated annually as new data are added to the data set. Note that heating degree days (HDD) are modeled to capture the non-linear response of firm demand to an increase in HDD. This is done through exponentiation of the HDD variable. This derivation lowers the t-statistic of the non-exponentiated HDD value, but its significant effect is nonetheless verified by the tstatistics of the exponentiated values. Similarly, the mean wind speed is modeled with an interaction with HDD to capture its changing effect on firm sales as HDD increases. This interaction derivation also lowers the mean wind speed t-statistic, but its statistical significance is likewise verified by the t-statistic of the interaction term.

	Coefficient	Estimate	T-Statistic
1	Intercept	50916.91	32.870
2	Heating Degree Days (HDD)	60.21	0.218
3	HDD^2	417.67	16.350
4	HDD^3	-7.69	-9.479
5	HDD^4	0.05	5.956
6	Prior Day Demand	0.42	91.045
7	Friday	-10589.16	-11.15
8	Weekend	-10611.01	-14.42
9	Maximum Wind Gust (mph)	379.8	3.679
10	Mean Wind Speed (mph)	232.95	1.063
11	HDD*Mean Wind Speed	178.94	23.4
12	Holiday	-14675.04	-4.630
13	Adjusted R-squared Value: 0.9893	F-statistic: 4.036	

C. Day of Week

Q. Were the Company's day-of-the-week assumptions reasonable?

A. Yes. As I've explained earlier in my testimony, gas demand is higher on average on a day that is not a holiday, Friday, or weekend day. Because the Company needs to be prepared for the highest level of demand that may occur, it is prudent to assume a day of higher average demand.

D. Prior Day

Q. Is the Company's approach to estimating demand prior to a Design-Peak-Day reasonable?

A. As I have previously stated, the model must account for the prior day's demand level. While there are many plausible approaches, I believe that the approach used to estimate demand on the day prior to a Design-Peak-Day is sound and produces a reasonable result.

III. LIKELIHOOD OF OCCURRENCE

Q. You've stated that the Design-Peak-Day temperature of -5 degrees is a one-in-twenty-year event. Does this mean the event will occur once every twenty years?

A. No. The expression "one in twenty" refers to the probability of occurrence over a given observation period, not the actual expected rate of occurrence during a period. In other words, a one-in-twenty-year event should not be interpreted to mean that the event typically occurs once every twenty years. In fact, the event may occur multiple times in twenty years, or it may not occur at all in a twenty-year period. The interval is derived by dividing the number of times the event has occurred into the number of observed time intervals, plus 1. For instance, if an event occurs seven times over a period of 104 years, then the recurrence interval is calculated by dividing 7 into 105 (104 years plus 1). The result is 15, so the recurrence interval is one in fifteen.

Q. Please explain how the Company determined that the one-in-twenty-year mean temperature is -5 degrees Fahrenheit or less.

A. A one-in-twenty-year recurrence event has a 5% probability of occurring once in any given year. This is calculated by dividing 20 into 1. The event that is analyzed when determining a Design-Peak-Day temperature is that the lowest daily mean temperature observed in a year is at or below a certain point. This is called a Design-Peak-Day event. To determine the temperature point that corresponds to a Design-Peak-Day event probability of 5%, the Company fit the temperature data to a probability distribution and then used that distribution to derive the expected minimum mean temperature associated with a 5% likelihood. That expected mean temperature is -5 degrees. The minimum daily mean temperature observed during a year has been at or below that point five times in the Company's 89 years of temperature history. The lowest daily mean temperature in the data is -11 degrees and occurred in December of 1933. The daily mean last fell below -5 degrees in January of 1963. The mean temperature was -4 degrees in December of 1990. Using the simple recurrence interval calculation described previously, the recurrence interval for the event that the lowest daily-mean temperature for the year is at or below -5 degrees is one in eighteen years – a figure very close to the one-in-twenty-year recurrence from which the Design-Peak-Day temperature was derived using a probability distribution.

Q. Can you estimate the probability of a Design-Peak-Day event occurring at any point during the next ten years?

A. Yes. If it is assumed that the probability of a Design-Peak-Day event is independent of any prior occurrence of the event, then the binomial or Poisson distribution can be used to calculate the probability of the event occurring a given number of times within a specified time span. Using the probability of a Design-Peak-Day event of 5%, probabilities based on a fixed number of events in a 10-year period are listed in the table below:

Number of Occurrences	Probability
0	0.60
1	0.32
2	0.07
3	0.01
4	0.00

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The table is derived using the binomial distribution. It shows that the probability of a Design-Peak-Day event occurring at least once in a ten-year period is 40%. This is calculated by subtracting the probability of no occurrence during that period (.60) from one.

IV. MODEL ADEQUACY

Q. Do you believe that the approach to modeling daily sales demand is sound?

A. Yes. In my opinion, the statistical modeling used to estimate daily sales demand is sound and consistent with approaches used by other utilities.

Q. In your opinion, was it reasonable for the Company to rely on the results of the current Design-Peak-Day modeling approach in assessing whether it should procure the Peak-Hour Services?

A. Yes. The modeling approach described above has been used by the Company for years to calculate its Design-Peak-Day sales demand for its IRPs and to prepare information for related technical conferences. Therefore, in my opinion, the Company justifiably relied on this established modeling approach when it concluded that it has a Peak-Hour demand shortfall.

Q. Can you summarize your testimony?

A. The Company is charged with providing safe and reliable gas service under all conditions, including those that may be rare and extreme. The Company believes that prudence dictates preparation for a scenario that is extreme. To do otherwise would place customers at unreasonable risk of loss of service when such conditions occur. But the Company is also concerned with planning for a scenario that is reasonable yet remains within the tolerance of risk it is willing to assume on behalf of its customers. The method the Company employs for estimating Design-Peak-Day demand is rigorous and consistent with those used within the industry. But it is also a progressive process that continues to evolve and improve as more data is acquired and refinements to the modeling approach are explored.

Q. Does this conclude your testimony?

A. Yes.

State of Utah)
) ss.
County of Salt Lake)

I, David C. Landward, being first duly sworn on oath, state that the answers in the foregoing written testimony is true and correct to the best of my knowledge, information and belief. Except as stated in the testimony, any exhibits attached to the testimony were prepared by me or under my direction and supervision, and they are true and correct to the best of my knowledge, information and belief. Any exhibits not prepared by me or under my direction and supervision are true and correct copies of the documents they purport to be.

David C. Landward

SUBSCRIBED AND SWORN TO this 31st day of January, 2018.

Notary Public

LEORA N. PRICE
Notary Public State of Utah
My Commission Expires on:
August 19, 2018
Comm. Number: 677685