BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE APPLICATION OF NEW MEXICO GAS COMPANY, INC. FOR APPROVAL OF REVISIONS TO ITS RATES, RULES, AND CHARGES PURSUANT TO ADVICE NOTICE NO. 78	)	**Case No. 19-00317-UT**
NEW MEXICO GAS COMPANY, INC.	)	
Applicant.	)	

DIRECT TESTIMONY AND EXHIBITS

OF

DEIRDRE M. KANN, Ph.D.

December 23, 2019

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Deirdre M. Kann, and my business address is Department of Earth and Planetary Sciences, MSCO3-2040, University of New Mexico, Albuquerque, New Mexico.

Q. BY WHOM ARE YOU CURRENTLY EMPLOYED, WHAT IS YOUR POSITION, AND WHAT ARE YOUR RESPONSIBILITIES WITH THAT EMPLOYER?

A. I am self-employed as a consultant in atmospheric and weather-related sciences. I am also a part-time instructor at the University of New Mexico, and most recently taught Meteorology for the Department of Earth and Planetary Sciences.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL BACKGROUND.

A. I received a Bachelor of Science in mathematics with a minor in geography from Towson University (formerly Towson State University); a Master of Science in geography (meteorology concentrate) from Northern Illinois University; and a Doctor of Philosophy in atmospheric sciences from Purdue University. After obtaining my Ph.D., I worked for the National Meteorological Center (now the National Center for Environmental Prediction) for eight years in various positions, including: 1) Postdoctoral Scientist; 2) Research Meteorologist; and 3) Senior Research Scientist. I was then employed by the National Weather Service and worked for 22 years as the Science and Operations Officer for the Albuquerque National Weather Service Forecast Office.

I have co-authored nine manuscripts in professional journals, and a recent article for a non-technical weather publication. I have also taught classes at four universities: University of New Mexico, Johns Hopkins University (Continuing Education), Kishwaukee College, and Northern Illinois University. For additional details relating to my professional background, please see NMGC Exhibit DMK-1.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION ("NMPRC" OR THE "COMMISSION")?

A. Yes. I submitted written testimony in NMPRC Case No. 18-00038-UT.

Q. WHY WERE YOU ENGAGED BY NEW MEXICO GAS COMPANY, INC. AND WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. New Mexico Gas Company, Inc. ("NMGC" or the "Company") hired me to conduct analyses of weather and climate data. I was asked to evaluate climate data to estimate the climate component of expected natural gas consumption, which is based, in part, on weather during the heating season. For this investigation, I analyzed weather and climate data since 1971 (when available) at several sites in New Mexico at or near the population centers in NMGC's service area. Projected energy consumption is related to temperatures during the heating season, specifically, by the degree to which temperatures are above or below a specified threshold. Therefore, computation of the expected departures from a base state is an integral component of projected consumption. My analyses were completed using Heating Degree Day ("HDD") data obtained from the National Center for Environmental Information ("NCEI") (formerly the National Climatic Data Center). The results of my investigation are summarized in this testimony and described in more detail in NMGC Exhibit DMK-2.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. In my analyses, I tested three different normals and averages to examine estimates of anticipated values of annual HDDs. The normals and averages I tested were: 1) 30-year normals computed by the NCEI; 2) 30-year "most recent" averages; and 3) previous 10-year averages. Data from every site I examined shows a positive temperature trend since 1971, with a corresponding negative trend in HDDs. The amount of warming varies from site-to-site, and year-to-year variability exists. Analyses for nine sites in New Mexico show that, at this particular time, the "most recent" 30-year average and the 10-year average show an improvement over the use of NCEI 30-year normal, however, the 10-year average is most accurate, resulting in the smallest average error rate. In addition, observations at new sites are more readily available going back 10 years rather than 30 years. For these reasons, I conclude that it is preferable to use the 10-year average as an estimate of future HDDs.

Q. WHAT IS A CLIMATE NORMAL?

A. By convention of the World Meteorological Organization, climate normals are three-decade averages of a number of climatological variables, for example, temperature or HDDs. Climate normals are regularly used to place observed climate or weather conditions into a historical context. In this regard, observations can be compared to the normal or base value. For a given period, values tend to fluctuate around the normal such that the terms above and below normal are used to describe a specific observation or event. Climate normals are essential to planning in areas including energy supply and consumption.

Q. IS THERE AN ESTABLISHED STANDARD FOR CALCULATING CLIMATE NORMALS?

A. For many years, climate normals were computed for 30-year periods. These three-decade averages are updated for locations in the United States every 10 years by the National Oceanographic and Atmospheric Administration's NCEI. The World Meteorological Organization supports this strategy for maintaining the 30-year normal for locations across the globe. In order to compute climate normals, an observational network of stations with well-maintained equipment and complete records is required.

The NCEI computes 30-year climate normals for numerous sites across the country, and HDDs are one of the many variables for which a normal is calculated. The current NCEI normals represent the period from 1981-2010 while the previous NCEI normals were for the period 1971-2000. Therefore, all climate observations since 2010 are not represented in the current NCEI normal.

It is important to note that a 30-year normal computed by NCEI is not just a mathematical average of available data. NCEI uses sophisticated statistical techniques to account for missing data and questionable data, a complicated and lengthy process. When the NCEI normals are updated to include a new decade, the process takes two to three years.

For a "stationary" climate, a climate that is not changing or is changing very slowly, a 30-year normal is useful to describe the climate of a specific location and can be extended to predict the future state of the climate. However, with the well-documented warming trend, a sign of a "non-stationary" climate, a 30-year normal can still be valuable as a measure of the historic record, but it is less useful as a predictor of the future state of the climate, which is the purpose of my work in this case. This is more significant at this time since the NCEI 30-year normal represents a period that ended nine years ago.

Q. PLEASE DESCRIBE THE THREE NORMALS AND AVERAGES YOU COMPARED IN YOUR ANALYSES.

A. NCEI normals of HDDs for the period 1981-2010 were the first estimates I used in my analyses. Because the normals do not incorporate observations after 2010, I computed a recent 30-year average using HDD values obtained from NCEI to be used as the second estimate. Finally, I calculated the average of HDDs from the previous ten years to be used as an estimate of expected HDDs. All three averages were tested as estimates of the HDDs from 2010 through 2019, or the 10-year test period.

Q. WHAT ARE HDDS?

A. HDDs are values of temperature departures from a base value and are used as indicators of energy/fuel consumption. Simply stated, HDDs are computed to assess how cold it has been. By definition, one HDD is assigned for each degree that the daily mean temperature is below 65°F. Daily mean temperature is defined as the arithmetic average of the maximum and minimum temperature for a day (and not the average of hourly observations when available). For example, a day with a mean temperature of 40°F would be assigned 25 HDDs (65 – 40) while any day with a mean temperature of 65°F or greater would have zero HDDs. HDDs were developed to relate temperatures to energy demands. HDDs are particularly valuable when they are summed over the course of a season. This provides information on the degree of temperature departures for the season and allows comparison to other seasons or years.

HDDs are lowest in the summer months and peak in winter months. Thus, when examined over a year-long period, a heating year is defined as the period from July 1 through June 30 the following calendar year such that a single winter season is included in the annual value of HDDs. In New Mexico, the range of annual values of HDDs is large and related to location, with HDDs across the northern higher terrain more than double the HDD values associated with south central and eastern locales.

Q. WHY IS IT NECESSARY TO ANALYZE HISTORICAL RECORDS OF HDDS?

A. Historic or past values of HDDs are used as predictors of future energy consumption, so the statistics associated with data records including variability and averages can be used to define a historical perspective. Annual variability in temperatures, as well as HDDs, is a component of natural climate variability.

Examination of a historical record quantifies the degree to which temperatures/HDDs vary over an extended period. Because NMGC serves a large area of New Mexico, it is important to analyze HDDs at a number of locations within the service area. The analyses are then tested to determine the appropriate method of calculating HDD estimates.

Q. DO OBSERVED TEMPERATURE TRENDS SIGNIFICANTLY AFFECT CLIMATOLOGICAL ESTIMATES OF FUTURE HDDS?

A. Absolutely. Global climate change in the form of positive temperature trends, or a consistent pattern of change in temperatures, makes long-term climatological normals less accurate as predictors. They can also be unrepresentative of the current climate. U.S. temperatures (and global temperatures as well) show consistent warming over the past three to four decades. Therefore, a 30-year normal temperature used as an estimate of a future temperature is likely to be too cool, resulting in a cool bias. Warming temperatures correspond to a decrease in HDDs, and a 30-year normal HDD used to estimate a future HDD would likely be too high.

Q. DID YOU ANALYZE 30-YEAR WEATHER VERSUS 10-YEAR WEATHER FOR CONDITIONS IN NEW MEXICO?

A. Yes. Similar to results and recommendations recently published, I found that a shorter average of 10 years resulted in the most accurate forecasts of HDDs for the test period of 2010-2019. Using a "most recent" 30-year average also produced an improvement over the NCEI normals, but the average error was still larger than that of the 10-year average.

Q. WOULD YOU PLEASE DESCRIBE THE APPROACH YOU USED IN YOUR ANALYSES?

A. To complete the analyses, I obtained monthly values of HDDs since 1971 (or the earliest date possible) from nine New Mexico climate stations in or near Albuquerque, Gallup, Farmington, Los Alamos, Roswell, Artesia, Tucumcari, Truth or Consequences, and Las Cruces. For each site, monthly HDD values were summed for the 12-month period from July 1 through June 30 to determine HDD accumulations for heating years. For all but two stations, these accumulations were calculated for heating years 1971-1972 through 2018-2019. The heating year values for each site were analyzed using a linear regression, resulting in a line that illustrates the trend for each data series. Similar to temperature, annual values of HDDs are fairly variable from year to year – some years are cool, while others are warm. These year-to-year changes were smoothed by computing 10-year running averages for each year to depict variability over longer time periods.

I then evaluated how well the NCEI normals, the most recent 30-year averages, and previous 10-year averages can be used as predictors of HDDs by computing the differences between the observed HDDs and the three "estimates." The sign and magnitude of the differences is referred to as the bias, or the difference between the expected number of HDDs and actual number of HDDs. The calculations were completed for a 10-year test period for heating years ending in June of 2010 through June of 2019.

Because biases of opposite sign, but similar size, result in a small average value, absolute errors that consider the magnitude of error, but not the sign, were also calculated. Biases and absolute errors for the test period for each data series (individual stations) were summed and averaged to summarize results for each station.

Q. HOW DID YOU CHOOSE THE SITES YOU USED IN YOUR ANALYSES?

A. Weather and climate information is available for a number of sites across New Mexico and for this study, I initially considered over 140 stations. For a station to be suitable for this study, the siting needed to be in or close to the NMGC service area. More importantly, it was imperative to choose sites that had not moved significantly in location, had no significant equipment changes, and had very complete data records with a minimal amount of missing data. Many sites located at FAA airports have multi-year periods of missing data, including Farmington, Santa Fe, and Clayton. Other sites in New Mexico which previously had long and complete data records are now inactive or closed, including Taos, Clovis, and Alamogordo. Additionally, some stations had intermittent periods of missing data, with too many missing monthly averages to be considered appropriate for this study. Though it is important to select sites near population centers within the Company's service area, the inclusion of rural stations near population centers minimizes the chance of a change in temperatures due to urbanization. After checking stations for location and complete or nearly complete data records, out of the approximately 140 considered, only nine had complete enough records to be appropriate for this study. The monthly HDD values for those nine sites were obtained from NCEI, as were the 30-year normal values for the period 1981-2010, which is the most recent 30-year period available from NCEI.

Q. WHY IS IT NECESSARY TO EXAMINE HDD DATA FROM MULTIPLE SITES?

A. New Mexico covers a large area of just over 120,000 square miles and is characterized by diverse terrain with significant elevation ranges. The considerable areal expanse combined with terrain results in a wide range of climate conditions across the State. Large-scale dynamics produce a majority of the weather patterns which impact the State, while local factors including terrain features, elevation, and surface type also contribute to the resulting climate regimes across the State. Any one site would not be representative of all areas in the Company's service area, and changes observed at one location cannot be assumed to have occurred at another.

Urbanization has been shown to impact climate statistics at some locations, most often in the form of temperature increases due to heat absorption by buildings, asphalt parking lots and roads, industry emissions, and decreased vegetation. However, the majority of observation sites in New Mexico are not in locations influenced by urbanization, including most of the sites used for this report. The Albuquerque station would be most likely to be impacted by urbanization, but the observation site is not located in the most urbanized area of the city. A small contribution from urban impacts is possible, although positive temperature trends are evident in both urban and rural sites.

It is also interesting to note that rural stations separated by relatively short distances can have fairly significant differences in the magnitude of observed trends. For all these reasons, multiple sites across the State must be analyzed.

Q. ARE THE SITES YOU USED IN THIS STUDY REPRESENTATIVE OF THE CLIMATE IN NMGC'S SERVICE TERRITORY?

A. Yes. When selecting sites for this study, considerable effort was focused on finding stations that would represent the broad expanse and diversity of NMGC's service area. Station locations represent the middle, and south central valleys, the eastern plains, the northern mountains, and the northwest plateau. Station sites also include both urban and rural settings, similar to NMGC's service territory.

Q. PLEASE DESCRIBE RECENT TEMPERATURE TRENDS IN NEW MEXICO.

A. Numerous scientific agencies and universities have documented a positive trend in global temperatures, although magnitudes vary from location to location. New Mexico has seen greater warming than many other states and a majority of recent years have seen temperatures well-above the NCEI 30-year normal of 1981-2010. According to studies, the average annual temperature has increased about 0.6˚F per decade or approximately 3˚F, over the last 50 years.

Q. WILL THIS TREND CONTINUE?

A. The warming trend in New Mexico is well-documented, as it is for much of the globe. Warming has been observed in all seasons in New Mexico, and while the least amount of warming has been observed in the winter, some of the greatest increases have occurred in the spring seasons. Regression analyses result in a linear value of temperature increases, from which future warming can be inferred. Additionally, advanced climate models developed and supported by numerous government, private, and educational entities consistently show warming (and a decrease in HDDs) to continue at least through the mid-21st century, and likely longer. I agree with the majority of climate experts whose research has shown temperature increases are likely to continue.

Climate models depict warming on relatively large spatial scales, but due to relatively coarse resolutions the resulting predictions are not always on a regional scale. While climate models continue to improve, at this point the most appropriate basis for determining expected HDD values for energy regulatory purposes is to use statistics derived from the recent local observations within the service area.

Q. GIVEN YOUR RESPONSE ABOVE, HOW CAN YOU EXPLAIN THE COLDER CONDITIONS OBSERVED DURING THE COOL SEASON OF 2018-2019?

A. During the most recent winter/spring season, New Mexico saw cooler temperatures for much of the period when compared to previous years. For the State, the average temperature for the seven-month period from October 2018 through April 2019 was cooler than every similar period since 2010. This decrease in temperatures was, in part, associated with natural climate variability. Sea surface temperatures in the eastern Pacific Ocean were warmer than normal (El Niño event), which can increase the odds for cooler and wetter winters and springs in New Mexico. Despite the noted cooler temperatures, the seasonal averages were actually near normal.

Year-to-year variability will still be present in historical records despite the positive temperature trends.

Q. DO OTHER CLIMATE SCIENTISTS AGREE WITH YOUR ASSESSMENT?

A. Yes. Many research studies and the NCEI have concluded that 30-year normals updated every 10 years are no longer useful for the decision-making processes for which they were intended because they can be unrepresentative of the current climate, as well as the future climate. They also noted a need for the development of new normals using more complex statistical techniques and/or shorter averaging periods. When NCEI updated the 1971-2000 normals for the period 1981-2010, the decade of 2001-2010 was warmer than the decade that was dropped from the 30-year period (1971-1980) for many locations in New Mexico (see table on page 7 of NMGC Exhibit DMK-2). Thus, the new normals were generally warmer, a clear sign of a warming trend and a non-stationary climate. The current decade has seen continued increased temperatures and the next set of climate normals (1991-2020) will reflect this warming trend.

NCEI has since developed a set of "supplemental" monthly temperature normals with averages over 5-, 10-, 15- and 20-years, as well as other normals obtained using other statistical methods, and maintains these additional normals on their website. NCEI advises users to consider using an alternative normal due to the observed climate change. These normals, however, are still limited to the 30-year period that ends in 2010. NCEI has also taken a proactive role of engaging the energy industry to evaluate the current use of climate normals and the energy industry's need for alternative climate normals.

Recent research has shown that shorter averaging periods such as 10- or 15-year can yield more accurate estimates of future conditions. The National Oceanic and Atmospheric Administration's Climate Prediction Center now uses shorter, annually-updated averaging periods for their forecasts of seasonally average temperatures.

Q. COULD 10-YEAR WEATHER BECOME AN EVEN MORE ACCURATE PREDICTOR OF HDDS IN THE FUTURE?

A. Yes. If the warming trend in New Mexico continues, which is likely, 30-year weather will become an even less accurate predictor of future HDD estimates for the reasons described above. While the use of 30-year normals will continue to be an important component of climate-based studies, including the evaluation of climate trends, shorter periods such as 10 years can provide even more accurate estimates, and NCEI is developing normals for these shorter periods.

Q. ARE THERE ANY OTHER FACTORS THAT INFLUENCED YOUR CONCLUSION THAT 10-YEAR DATA IS MORE APPROPRIATE?

A. Yes, another consideration in my analyses was the availability of accurate weather data for each base period. When completing statistics for specific stations, sites with long and complete data records are required so that there are sufficient observations to analyze the impact of various averaging periods. Even stations that have a long observational record are difficult to use if there are breaks in the observations increasing the percentage of missing data, or if the site was moved a substantial distance. Unfortunately, when examining the data records for a sufficiently long period (a start date of at least 1981), there are many New Mexico stations with missing data. Missing data greatly limited the number of sites I could use in my analyses.

Conversely, some new observation networks have records for a shorter period and cannot be used in a 30-year analysis. However, newer stations located in more populated areas within NMGC's service area but with shorter observational records could be employed when assessing future energy needs.

Q. WHAT DO YOU CONCLUDE REGARDING THE APPROPRIATE LENGTH OF CLIMATOLOGICAL BASE PERIOD FOR ESTIMATING HDDS OVER THE NEXT SEVERAL YEARS?

A. In my opinion, the most recent 10-year averages are superior estimates of past weather compared to the NCEI normals, and are also more accurate than the most recent 30-year average. The statistical analyses described here demonstrate that the most recent 10-year average tends to be more representative of current climate than 30-year averages, and significantly better than the NCEI normals. Finally, the lack of availability of 30-year data limits the number of sites that can be used. In addition to being more accurate, the use of a 10-year period would allow for the use of more stations with shorter data records, which could be useful in populated areas not included in my analyses.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.