Application No:    A.17-10-
Exhibit No.:
Witness:    Sharim Chaudhury

Application of Southern California Gas Company
(U 904 G) and San Diego Gas & Electric Company
(U 902 G) Regarding Feasibility of Incorporating
Advanced Meter Data Into the Core Balancing
Process.

PREPARED DIRECT TESTIMONY OF

SHARIM CHAUDHURY

ON BEHALF OF

SOUTHERN CALIFORNIA GAS COMPANY
SAN DIEGO GAS & ELECTRIC COMPANY

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

October 2, 2017
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I. PURPOSE

The purpose of my prepared direct testimony on behalf of Southern California Gas Company (“SoCalGas”) and San Diego Gas & Electric Company (“SDG&E”) is to: (1) describe the daily aggregated gas demand forecasting process that creates the forecasts that SoCalGas’ Gas Acquisition department must balance against, (2) discuss how daily gas consumption data collected through SDG&E’s Advanced Meter Infrastructure (“AMI”) systems are being used in the forecasting process, and (3) propose that SoCalGas’ AMI data be used in the forecasting process when SoCalGas’ AMI installation is complete and sufficient historical AMI data is available for SoCalGas’ retail core customers with which to develop a statistical model.

II. DAILY RETAIL CORE GAS DEMAND FORECASTING PROCESS FOR SOCALGAS AND SDG&E

Pursuant to Decision (“D.”) 07-12-019 and D.16-12-015, SoCalGas’ Demand Forecasting Group produces forecasts of daily gas demand (midnight to midnight Pacific Standard Time) for use by SoCalGas’ Gas Acquisition department.¹ Daily forecasts are provided by SoCalGas’ Demand Forecasting Group for the same flow day and the four upcoming flow days. The forecasts address “retail core” gas demand, which is the sum of the gas demands of residential, small commercial and industrial, and natural gas vehicle customers, excluding those who choose Core Aggregation Transportation (“CAT”) service. Additionally, because SoCalGas’ Gas

¹ Decision D.07-12-019 established the balancing of the core to a forecast of daily core gas demand. As explained on p. 110 in paragraph 48 of the Findings of Fact: “Because it is not physically possible for SoCalGas to obtain real-time usage information from each core customer, the core must balance to a forecast.” Ordering paragraph 9 of Decision D.16-12-015 required that SoCalGas’ Gas Acquisition department balance Gas Day supply (7:00 am to 7:00 am Pacific standard Time) to a forecast, provided by SoCalGas’ Demand Forecasting Group, of Measurement Day demand (midnight to midnight Pacific Standard Time) based on the most recent weather available as of 7:00am of that day.
Acquisition department is responsible for meeting this demand, the forecast includes gas used by
SoCalGas and SDG&E themselves (i.e., Company-use gas) and lost and unaccounted for gas
(“LUAF”).

The model used for forecasting SoCalGas’ core demand is distinct from the model used
for forecasting SDG&E’s core demand. SoCalGas’ core demand model is based on the
derivation of estimated daily aggregated retail core demand as defined above because some areas
of SoCalGas’ service territory still do not have advanced meter coverage and actual daily
consumption data for all retail core customers are not yet available. Neither SoCalGas’ Gas
Acquisition department nor any other market participants have access to these forecasting
models.

The forecasts are initially created using the Daily Load Forecast Model (“DLFM”), a
statistical model of daily retail core gas demand. As part of the forecasting process, the forecasts
are tracked and evaluated regularly and are at times adjusted by the Demand Forecasting Group
when it is determined that such an adjustment is likely to improve forecast accuracy. Research to
refine the DLFM and better understand SoCalGas’ and SDG&E’s gas demand is ongoing with
the aim of further improving forecast accuracy. The following sections describe the DLFM and
other parts of the forecasting process in more detail.

A. Variables in the DLFM

Forecast Variable: Aggregated Daily Retail Core Gas Demand

Statistical forecasting models require historical data on the variable to be forecasted to
estimate and refine the model, as well as for tracking and adjusting the resulting forecasts. In the
case of the DLFM, historical data on aggregated retail core gas demand is required. Because

some areas of SoCalGas’ service territory still do not have advanced meter coverage and actual measured daily consumption data for all retail core customers are not yet available, estimates of daily retail core gas demand must be used in the forecasting process. These daily estimates are residually derived by subtracting the measured daily gas demand of noncore customers and the estimated daily gas demand of CAT customers from the measured daily total system gas sendout. Because estimates must be used when actual aggregated daily retail core consumption data are unavailable, some amount of error is unavoidably introduced into the development of daily retail core demand forecasting models for SoCalGas and the resulting forecasts.

SDG&E has completed its AMI system installation for its retail core customers and sufficient historical AMI-based consumption data is available for SDG&E’s retail core customers. Therefore, for SDG&E, actual aggregated daily retail core demand data can be derived for recent years from the customer-specific data that have been collected through SDG&E’s AMI system. Pursuant to D.16-12-015, since December 1, 2016, this AMI data has been used in the forecasting process for SDG&E by developing a forecasting model using historical AMI data from October 1, 2013 through September 30, 2016 for all SDG&E retail core customers. Prior to December 1, 2016, the model used for forecasting SDG&E core demand was based on estimated aggregated retail core demand data, as described above for SoCalGas.

The SDG&E daily retail core data is mainly composed of the sum of the usage data for SDG&E’s non-CAT residential, small business, and natural gas vehicle customers. To arrive at the final retail core demand numbers, daily SDG&E Company-use gas and estimates of LUAF gas are added to the AMI-based usage numbers.

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3 The estimated gas demand of CAT customers is based on historical data for CAT customers which is adjusted for meter growth.

4 Since Company-use gas and LUAF represent a very small portion of retail core demand, these estimates add little error to the overall daily retail core demand data.
Predictor Variables: Weather and Calendar Effects

Cold weather is known to be a main driver of daily core gas demand due to its effects on residential, small commercial and industrial customers’ gas consumption. For the purposes of retail core gas demand analysis and forecasting, cold weather is generally quantified by system-wide heating degree days (“HDDs”), weighted by customer counts. HDDs are calculated as the number of degrees that the daily average temperature is below 65 degrees Fahrenheit.\(^5\)

Temperature data from 12 weather stations, sourced from a third party, is used to calculate the HDDs experienced by SoCalGas’ and SDG&E’s customers. The estimated effect of HDDs on retail core demand are incorporated into the DLFM.

Daily gas demand also follows patterns related to where the day falls on the calendar (day of the week, month of the year, holidays, etc.). Estimates of these calendar effects are also incorporated into the DLFM.

B. Adjustment to Model Forecasts

Manual adjustments to forecasts based on forecasting experience oftentimes can improve upon the forecasts produced by a forecasting model. The daily retail core demand forecasts are tracked and reviewed regularly. After review, the forecasts produced by the DLFM are sometimes adjusted by the Demand Forecasting Group if it determines that the accuracy of future forecasts will likely be improved.

C. Update of Input Data and Model Parameters

Retail core gas demand can change over time due to a variety of factors such as growth in the number of meters served, increases in the energy efficiency of appliances and buildings, and economic conditions. The DLFM is regularly re-evaluated using updated inputs so that the

\(^5\) The formula for determining the HDDs for a given day as follows: $HDDs = \max(0, 65 \text{ degree F} - \text{daily average temperature})$. 

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model produces forecasts based on current retail core customer demand behavior. Throughout the year, the DLFM is updated to account for growth in the number of meters served. The parameters in the DLFM are also re-estimated at least annually before the beginning of each new winter heating season using updated data for retail core demand and the predictor variables.

III. SDG&E’S DAILY RETAIL CORE GAS DEMAND FORECAST PROCESS
ALREADY INCORPORATES AMI-BASED DAILY AGGREGATED RETAIL CORE CONSUMPTION DATA

As discussed above, SDG&E has completed its AMI system installation for its retail core customers, with the exception of a very small percentage of customers who opted not to install AMI devices to their gas meters. A sufficient history of AMI gas usage data is currently available for all SDG&E retail core customers, allowing for its use in developing the DLFM. As noted previously, since December 1, 2016, the Demand Forecasting Group has been using this data in its forecasting process to develop, evaluate, and track the forecasts of SDG&E’s retail core gas demand.

Integrating SDG&E’s AMI data into the forecasting process has improved the accuracy of SDG&E’s daily retail core gas demand forecasts as seen in the below plot of the percentage errors and corresponding mean absolute percentage errors (“MAPE”). The MAPE is a commonly used metric to compare the accuracy of alternative forecasts; a lower MAPE value reflects a more accurate forecast.

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6 Pursuant to SDG&E Schedule G-SMOP, residential customers may opt-out of having a AMI gas meter installed.

7 For each forecast, the percentage error was calculated as follows: Percent Error = \( \frac{\text{forecast} - \text{actual}}{\text{actual}} \times 100\% \)

8 MAPE is defined as the mean of the absolute values of the percentage errors of the forecasts. The equation for MAPE for a set of forecasts of size T is: MAPE = \( \frac{1}{T} \sum_{t=1}^{T} \left| \frac{\text{forecast}_t - \text{actual}_t}{\text{actual}_t} \right| \times 100\% \)
<table>
<thead>
<tr>
<th>Forecast Period</th>
<th>Retail core Consumption</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/1/14 – 7/31/15</td>
<td>Estimated, Non-AMI</td>
<td>15.5%</td>
</tr>
<tr>
<td>12/1/15 – 7/31/16</td>
<td>Estimated, Non-AMI</td>
<td>14.8%</td>
</tr>
<tr>
<td>12/1/16 – 7/31/17</td>
<td>Actual AMI</td>
<td>7.3%</td>
</tr>
</tbody>
</table>
The lines represent the percentage error of the SDG&E daily retail core gas demand forecasts over the months of December through the following July for the last three years (i.e., Dec 1, 2014 – July 31, 2015; Dec 1, 2015 – July 31, 2016; Dec 1, 2016 – July 31, 2017). The forecasts using AMI data (red line) are consistently more accurate (closer to zero percent error) than the earlier forecasts (blue and green lines), which were based on estimated aggregated retail core consumption data as described in Section II.A. above. The lower MAPE value for Dec 1, 2016 – July 31, 2017 corroborates that the forecasts have improved in the period using the AMI data as compared to previous periods.

Since weather forecasts are one of the main inputs in the creation of SDG&E’s daily retail core gas demand forecasts, SDG&E investigated whether or not improvements in the quality of the weather forecasts led to corresponding improvements in the gas demand forecasts over the period in which the AMI data was used (Dec 1, 2016 – July 31, 2017). However, a plot of the weather forecast percentage errors of the same time periods (i.e., Dec 1, 2014 – July 31, 2015; Dec 1, 2015 – July 31, 2016; Dec 1, 2016 – July 31, 2017) shows no discernable difference between the percentage errors for each year. Furthermore, the MAPEs for each of the periods are also quite similar.

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9 The periods were chosen to begin in December to coincide with the month in which the AMI-based SDG&E forecasting process was implemented (i.e., December 2016). The periods end in July because that was the last full month for which data was available at the time of the analysis.

10 Forecast errors for Dec 1, 2014 – July 31 2015 and Dec 1, 2015 – July 31 2016 were calculated based on estimated actual daily retail core consumption data and not directly-measured AMI-based data. Because the forecasts were developed and tracked using estimated actual data, the forecast errors must also be calculated using estimated actual data.
Therefore, the improved accuracy of SDG&E’s daily retail core gas demand forecasts cannot be attributed to improvements in the quality of the weather forecasts. Rather, SoCalGas and SDG&E attribute the improved accuracy of SDG&E’s daily retail core demand forecasts to the integration of SDG&E’s AMI data into the forecasting process.
IV. SOCALGAS PROPOSES TO INCORPORATE IN ITS FORECASTING PROCESS AMI-BASED DATA AFTER AMI INSTALLATION IS COMPLETE AND SUFFICIENT HISTORICAL AMI DATA IS AVAILABLE FOR SOCALGAS' RETAIL CORE CUSTOMERS

A. SoCalGas' AMI Installation is Not Yet Complete

Although the bulk of the installations have occurred, some areas of SoCalGas’ service territory still do not have advanced meter coverage.\(^\text{11}\) Without the AMI installations completed in all areas, it is not possible to accurately measure SoCalGas’ total actual daily retail core gas usage. SoCalGas plans to continue to use estimates of aggregated retail core gas demand in the forecasting process for SoCalGas because it currently does not have complete actual retail core gas usage data.

B. It is Likely that SoCalGas Will Be Able to Develop an AMI-Based DLFM in Late 2019 Or Early 2020

SoCalGas and SDG&E propose that SoCalGas’ AMI data be used in the DLFM when SoCalGas’ AMI installation is complete and sufficient historical AMI data is available for SoCalGas’ retail core customers with which to develop a statistical model.\(^\text{12}\) SoCalGas and SDG&E are not requesting in this application any additional revenues to incorporate this modification to the DLFM. After SoCalGas’ AMI system is completely installed, a minimum of one year of historical data is required to estimate the DLFM model parameters. Data collected over a period of less than one year would be missing information about retail core gas use during certain seasons, months, or holidays, which would make an estimation of the corresponding calendar effects inadequate. The same would be true of any effects of weather on retail core gas demand that vary with the time of year. Even with access to one full year of complete AMI data,

\(^\text{12}\) Pursuant to SoCalGas Schedule G-AMOP, residential customers may opt-out of having an Advanced Meter installed.
some problems impacting forecasting performance would remain. Any unusual retail core
demand specific to that single year would be incorporated into the DLFM and the resulting
forecasts, potentially introducing forecast error until additional historical data is available.
Additional years of complete AMI data are likely to reduce this kind of error.\textsuperscript{13} The use of
SoCalGas AMI data in the forecasting process is expected to be possible sometime in late 2019
or early 2020.

V. CONCLUSION

SoCalGas’ Demand Forecasting Group uses a combination of statistical forecasting and
years of experience to produce forecasts of SoCalGas and SDG&E’s daily retail core gas demand
for use by SoCalGas’ Gas Acquisition department to comply with Commission decisions. For
SDG&E, prior to the installation of SDG&E’s AMI system, this process relied on estimates of
SDG&E’s daily retail core gas demand. The availability of a sufficiently long history of
complete SDG&E AMI data enabled improvements in the forecasting process and the resulting
forecasts. However, SoCalGas’ AMI installation is not complete and therefore SoCalGas does
not currently possess a sufficient history of complete AMI data. SoCalGas proposes that its AMI
data be used in the forecasting process once SoCalGas’ AMI installation is complete and
sufficient historical AMI data is available for SoCalGas’ retail core customers to develop a
statistical model.

This concludes my prepared direct testimony.

\textsuperscript{13} The forecasting model for SDG&E was developed using 3 years of complete AMI-based data.
VI. QUALIFICATIONS

My name is Iftekharul (Sharim) Chaudhury. I am employed by SoCalGas and SDG&E as the Rate Design and Demand Forecasting Manager within the Regulatory Affairs Department, which supports gas regulatory activities of both SoCalGas and SDG&E. My business address is 555 West Fifth Street, Los Angeles, California, 90013-1011. I hold a Bachelor of Arts degree in Economics from Illinois State University. I received my Masters and Ph.D. degrees in Economics from the University of California, San Diego.

I have held my current position managing the rates group since August 2014, and have been managing the demand forecasting group since April 2013. Prior to joining SoCalGas, I worked at Southern California Edison Company from June 1999 to March 2013, holding several positions of increasing responsibility, from Senior Analyst to Manager of Price Forecasting to Manager of Long-Term Demand Forecasting. From October 1998 to May 1999, I worked at National Economic Research Associates (NERA) as a Senior Consultant. Prior to joining NERA, I worked at SoCalGas from 1991 to 1998, holding several positions of increasing responsibility, starting as Marketing Analyst to Senior Economist in the Rate Design group to Manager of Rate Design. I also worked for about a year at the California Energy Commission (CEC) in the Demand Analysis Office.

I have previously testified before the California Public Utilities Commission.