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.

A.17-10-____
(Filed October 2, 2017)

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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PREPARED DIRECT TESTIMONY
OF SHARIM CHAUDHURY

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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

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[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.

1 Acquisition department is responsible for meeting this demand, the forecast includes gas used by

2 SoCalGas and SDG&E themselves (i.e., Company-use gas) and lost and unaccounted for gas

3 ("LUAF").

4   The model used for forecasting SoCalGas' core demand is distinct from the model used

5 for forecasting SDG&E's core demand. SoCalGas' core demand model is based on the

6 derivation of estimated daily aggregated retail core demand as defined above because some areas

7 of SoCalGas' service territory still do not have advanced meter coverage and actual daily

8 consumption data for all retail core customers are not yet available.[2] Neither SoCalGas' Gas

9 Acquisition department nor any other market participants have access to these forecasting

10 models.

11   The forecasts are initially created using the Daily Load Forecast Model ("DLFM"), a

12 statistical model of daily retail core gas demand. As part of the forecasting process, the forecasts

13 are tracked and evaluated regularly and are at times adjusted by the Demand Forecasting Group

14 when it is determined that such an adjustment is likely to improve forecast accuracy. Research to

15 refine the DLFM and better understand SoCalGas' and SDG&E's gas demand is ongoing with

16 the aim of further improving forecast accuracy. The following sections describe the DLFM and

17 other parts of the forecasting process in more detail.

18   **A.   Variables in the DLFM**

19   **Forecast Variable: Aggregated Daily Retail Core Gas Demand**

20   Statistical forecasting models require historical data on the variable to be forecasted to

21 estimate and refine the model, as well as for tracking and adjusting the resulting forecasts. In the

22 case of the DLFM, historical data on aggregated retail core gas demand is required. Because

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[2] As described in the August, 2017 AMI Semiannual Report.
(https://socalgas.com/regulatory/A0809023.shtml).

1   some areas of SoCalGas' service territory still do not have advanced meter coverage and actual

2   measured daily consumption data for all retail core customers are not yet available, estimates of

3   daily retail core gas demand must be used in the forecasting process. These daily estimates are

4   residually derived by subtracting the measured daily gas demand of noncore customers and the

5   estimated daily gas demand of CAT customers from the measured daily total system gas

6   sendout.[3] Because estimates must be used when actual aggregated daily retail core consumption

7   data are unavailable, some amount of error is unavoidably introduced into the development of

8   daily retail core demand forecasting models for SoCalGas and the resulting forecasts.

9   SDG&E has completed its AMI system installation for its retail core customers and

10   sufficient historical AMI-based consumption data is available for SDG&E's retail core

11   customers. Therefore, for SDG&E, actual aggregated daily retail core demand data can be

12   derived for recent years from the customer-specific data that have been collected through

13   SDG&E's AMI system. Pursuant to D.16-12-015, since December 1, 2016, this AMI data has

14   been used in the forecasting process for SDG&E by developing a forecasting model using

15   historical AMI data from October 1, 2013 through September 30, 2016 for all SDG&E retail core

16   customers. Prior to December 1, 2016, the model used for forecasting SDG&E core demand was

17   based on estimated aggregated retail core demand data, as described above for SoCalGas.

18   The SDG&E daily retail core data is mainly composed of the sum of the usage data for

19   SDG&E's non-CAT residential, small business, and natural gas vehicle customers. To arrive at

20   the final retail core demand numbers, daily SDG&E Company-use gas and estimates of LUAF

21   gas are added to the AMI-based usage numbers.[4]

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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.

1	**Predictor Variables: Weather and Calendar Effects**
2	Cold weather is known to be a main driver of daily core gas demand due to its effects on
3	residential, small commercial and industrial customers' gas consumption. For the purposes of
4	retail core gas demand analysis and forecasting, cold weather is generally quantified by system-
5	wide heating degree days ("HDDs"), weighted by customer counts. HDDs are calculated as the
6	number of degrees that the daily average temperature is below 65 degrees Fahrenheit.[5]
7	Temperature data from 12 weather stations, sourced from a third party, is used to calculate the
8	HDDs experienced by SoCalGas' and SDG&E's customers. The estimated effect of HDDs on
9	retail core demand are incorporated into the DLFM.
10	Daily gas demand also follows patterns related to where the day falls on the calendar (day
11	of the week, month of the year, holidays, etc.). Estimates of these calendar effects are also
12	incorporated into the DLFM.
13	**B.** **Adjustment to Model Forecasts**
14	Manual adjustments to forecasts based on forecasting experience oftentimes can improve
15	upon the forecasts produced by a forecasting model. The daily retail core demand forecasts are
16	tracked and reviewed regularly. After review, the forecasts produced by the DLFM are
17	sometimes adjusted by the Demand Forecasting Group if it determines that the accuracy of future
18	forecasts will likely be improved.
19	**C.** **Update of Input Data and Model Parameters**
20	Retail core gas demand can change over time due to a variety of factors such as growth in
21	the number of meters served, increases in the energy efficiency of appliances and buildings, and
22	economic conditions. The DLFM is regularly re-evaluated using updated inputs so that the

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[5] The formula for determining the HDDs for a given day as follows: HDDs = max(0, 65 degree F – daily average temperature).

1   model produces forecasts based on current retail core customer demand behavior. Throughout

2   the year, the DLFM is updated to account for growth in the number of meters served. The

3   parameters in the DLFM are also re-estimated at least annually before the beginning of each new

4   winter heating season using updated data for retail core demand and the predictor variables.

5   **III.   SDG&E'S DAILY RETAIL CORE GAS DEMAND FORECAST PROCESS**
6   **ALREADY INCORPORATES AMI-BASED DAILY AGGREGATED RETAIL**
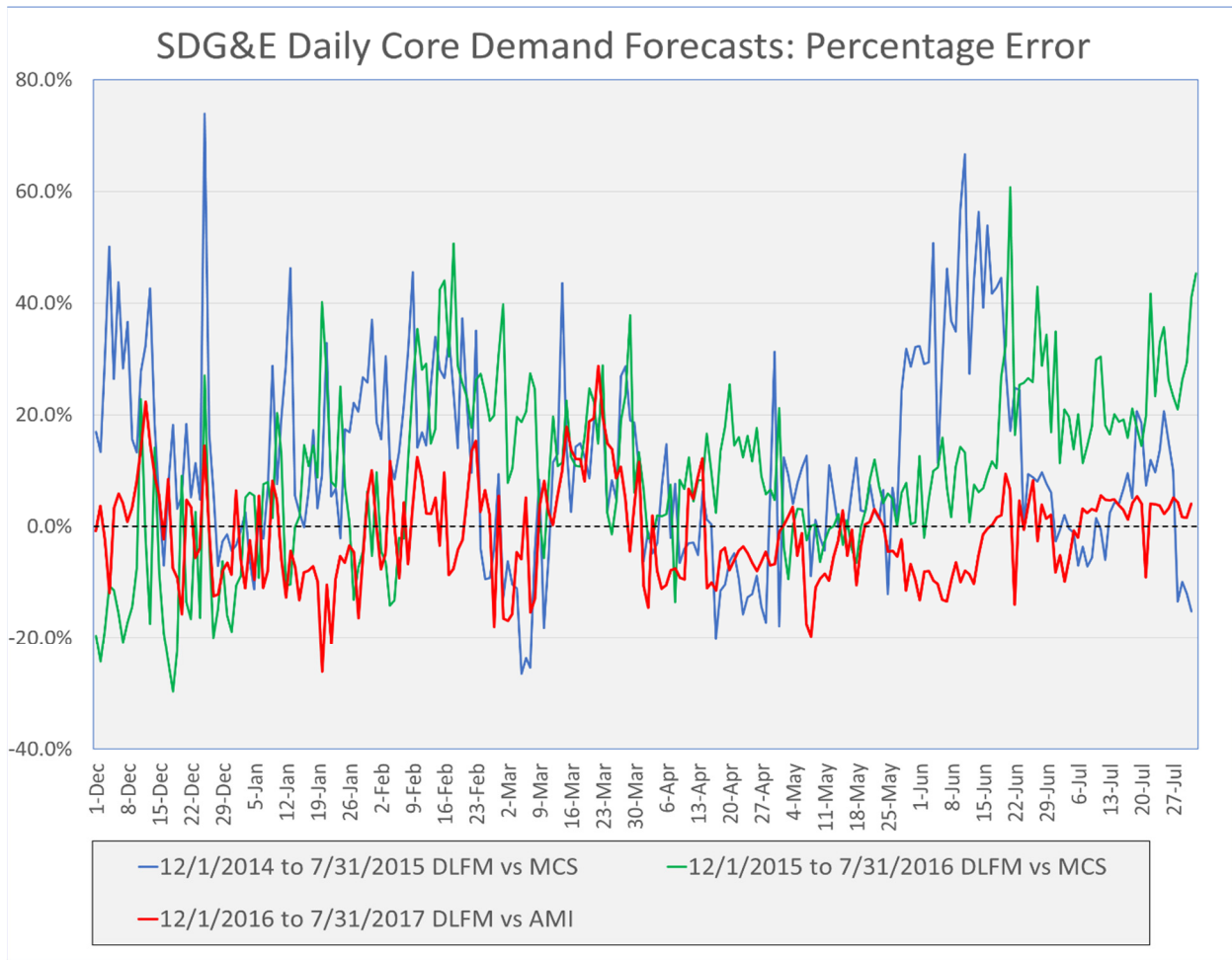7   **CORE CONSUMPTION DATA**

8   As discussed above, SDG&E has completed its AMI system installation for its retail core

9   customers, with the exception of a very small percentage of customers who opted not to install

10   AMI devices to their gas meters.[6] A sufficient history of AMI gas usage data is currently

11   available for all SDG&E retail core customers, allowing for its use in developing the DLFM. As

12   noted previously, since December 1, 2016, the Demand Forecasting Group has been using this

13   data in its forecasting process to develop, evaluate, and track the forecasts of SDG&E's retail

14   core gas demand.

15   Integrating SDG&E's AMI data into the forecasting process has improved the accuracy

16   of SDG&E's daily retail core gas demand forecasts as seen in the below plot of the percentage

17   errors[7] and corresponding mean absolute percentage errors ("MAPE").[8] The MAPE is a

18   commonly used metric to compare the accuracy of alternative forecasts; a lower MAPE value

19   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 $= \frac{forecast - actual}{actual} \times 100\%$

[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 $= \frac{1}{T}\sum_{t=1}^{T}\left|\frac{forecast_t - actual_t}{actual_t}\right| \times 100\%$

SDG&E Daily Core Demand Forecasts: Percentage Error

| Forecast Period	Retail core Consumption	MAPE
12/1/14 – 7/31/15	Estimated, Non-AMI	15.5%
12/1/15 – 7/31/16	Estimated, Non-AMI	14.8%
12/1/16 – 7/31/17	Actual AMI	7.3%

1	The lines represent the percentage error of the SDG&E daily retail core gas demand
2	forecasts over the months of December through the following July for the last three years (i.e.,
3	Dec 1, 2014 – July 31, 2015; Dec 1, 2015 – July 31, 2016; Dec 1, 2016 – July 31, 2017).[9,10] The
4	forecasts using AMI data (red line) are consistently more accurate (closer to zero percent error)
5	than the earlier forecasts (blue and green lines), which were based on estimated aggregated retail
6	core consumption data as described in Section II.A. above. The lower MAPE value for Dec 1,
7	2016 – July 31, 2017 corroborates that the forecasts have improved in the period using the AMI
8	data as compared to previous periods.
9	Since weather forecasts are one of the main inputs in the creation of SDG&E's daily
10	retail core gas demand forecasts, SDG&E investigated whether or not improvements in the
11	quality of the weather forecasts led to corresponding improvements in the gas demand forecasts
12	over the period in which the AMI data was used (Dec 1, 2016 – July 31, 2017). However, a plot
13	of the weather forecast percentage errors of the same time periods (i.e., Dec 1, 2014 – July 31,
14	2015; Dec 1, 2015 – July 31, 2016; Dec 1, 2016 – July 31, 2017) shows no discernable
15	difference between the percentage errors for each year. Furthermore, the MAPEs for each of the
16	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.

Daily SDG&E System Average Temperature Forecasts: Percentage Error
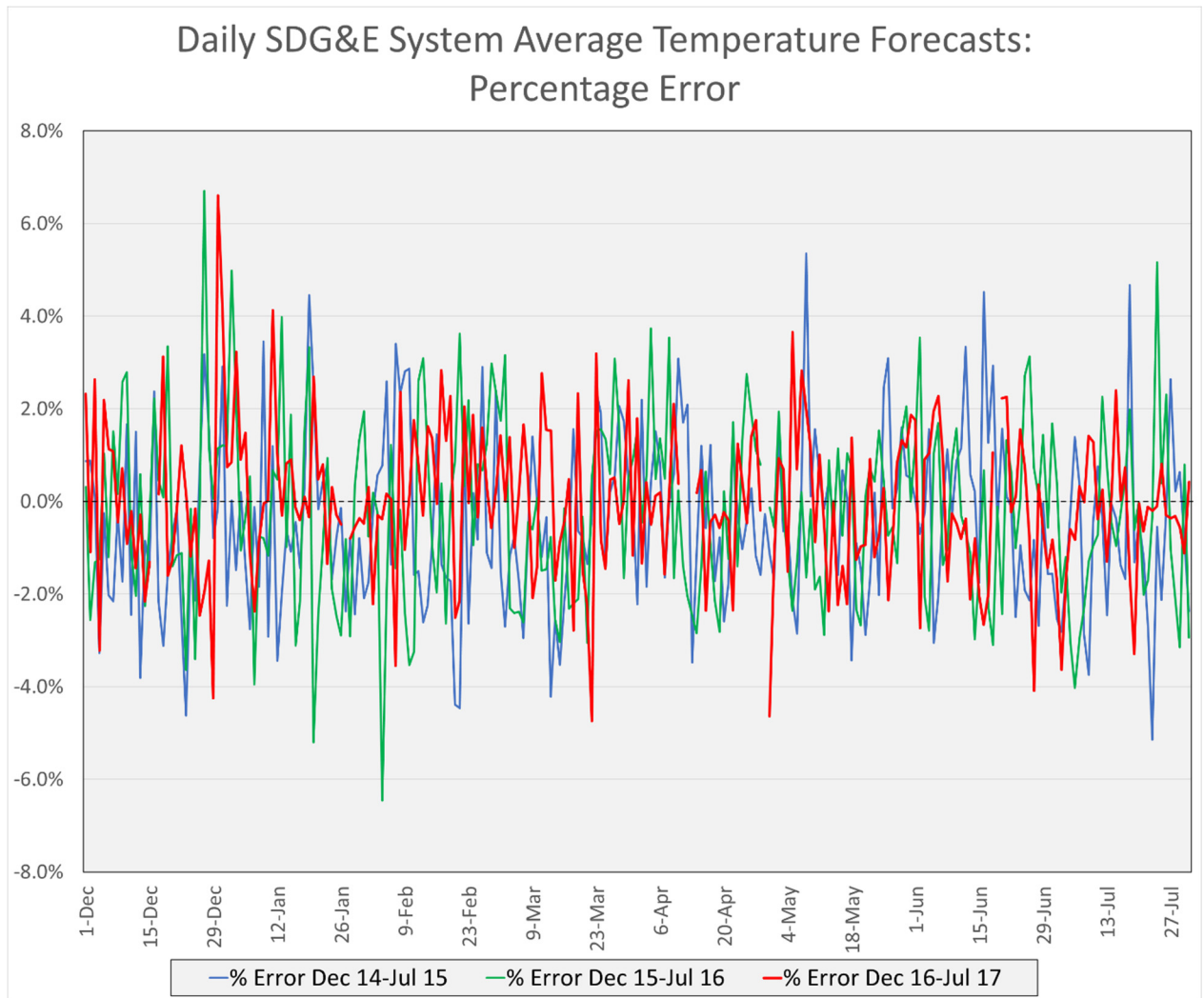
Forecast Period	Weather Forecast MAPE
12/1/14 – 7/31/15	1.52%
12/1/15 – 7/31/16	1.57%
12/1/16 – 7/31/17	1.24%

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.

1   **IV.   SOCALGAS PROPOSES TO INCORPORATE IN ITS FORECASTING**
2   **PROCESS AMI-BASED DATA AFTER AMI INSTALLATION IS COMPLETE**
3   **AND SUFFICIENT HISTORICAL AMI DATA IS AVAILABLE FOR**
4   **SOCALGAS' RETAIL CORE CUSTOMERS**

5   **A.   SoCalGas' AMI Installation is Not Yet Complete**

6   Although the bulk of the installations have occurred, some areas of SoCalGas' service

7   territory still do not have advanced meter coverage.[11] Without the AMI installations completed

8   in all areas, it is not possible to accurately measure SoCalGas' total actual daily retail core gas

9   usage. SoCalGas plans to continue to use estimates of aggregated retail core gas demand in the

10   forecasting process for SoCalGas because it currently does not have complete actual retail core

11   gas usage data.

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

14   SoCalGas and SDG&E propose that SoCalGas' AMI data be used in the DLFM when

15   SoCalGas' AMI installation is complete and sufficient historical AMI data is available for

16   SoCalGas' retail core customers with which to develop a statistical model.[12]   SoCalGas and

17   SDG&E are not requesting in this application any additional revenues to incorporate this

18   modification to the DLFM. After SoCalGas' AMI system is completely installed, a minimum of

19   one year of historical data is required to estimate the DLFM model parameters. Data collected

20   over a period of less than one year would be missing information about retail core gas use during

21   certain seasons, months, or holidays, which would make an estimation of the corresponding

22   calendar effects inadequate. The same would be true of any effects of weather on retail core gas

23   demand that vary with the time of year. Even with access to one full year of complete AMI data,

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[11] As described in the August, 2017 AMI Semiannual Report.
(https://socalgas.com/regulatory/A0809023.shtml).
[12] Pursuant to SoCalGas Schedule G-AMOP, residential customers may opt-out of having an Advanced
Meter installed.

1   some problems impacting forecasting performance would remain. Any unusual retail core

2   demand specific to that single year would be incorporated into the DLFM and the resulting

3   forecasts, potentially introducing forecast error until additional historical data is available.

4   Additional years of complete AMI data are likely to reduce this kind of error.[13] The use of

5   SoCalGas AMI data in the forecasting process is expected to be possible sometime in late 2019

6   or early 2020.

7   **V.   CONCLUSION**

8   SoCalGas' Demand Forecasting Group uses a combination of statistical forecasting and

9   years of experience to produce forecasts of SoCalGas and SDG&E's daily retail core gas demand

10 for use by SoCalGas' Gas Acquisition department to comply with Commission decisions. For

11 SDG&E, prior to the installation of SDG&E's AMI system, this process relied on estimates of

12 SDG&E's daily retail core gas demand. The availability of a sufficiently long history of

13 complete SDG&E AMI data enabled improvements in the forecasting process and the resulting

14 forecasts. However, SoCalGas' AMI installation is not complete and therefore SoCalGas does

15 not currently possess a sufficient history of complete AMI data. SoCalGas proposes that its AMI

16 data be used in the forecasting process once SoCalGas' AMI installation is complete and

17 sufficient historical AMI data is available for SoCalGas' retail core customers to develop a

18 statistical model.

19   This concludes my prepared direct testimony.

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[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.