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# Form 4 Demand Forecast Methods and Models

Peninsula Clean Energy Authority

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## Overview of Electricity Demand Forecast Methods, Models, and Data

Peninsula Clean Energy has developed a load forecast to estimate future electricity demand using a linear regression model.

The load forecast is implemented in Python and relies on historic AMI data for Peninsula Clean Energy's San Mateo County customers since May 2017 and historic interval data for City of Los Banos customers since January 2018. Long-term load growth factors are based on reasonable growth rates for number of accounts and usage per account based on historical trends and recommended by Peninsula Clean Energy's consultants.

Peninsula Clean Energy has developed a peak load forecast based on the 1-in-2 methodology recommended by the CEC and weather normalized historic load data since May 2017.

## Definition of area for which forecast is developed

Peninsula Clean Energy's load forecast is developed for Peninsula Clean Energy's service area, which includes all cities in San Mateo County, and the unincorporated areas of San Mateo County, not including customers are receiving electricity service through a direct access provider or who have opted out of CCA service. About 97% of eligible customers in San Mateo County are Peninsula Clean Energy customers. This rate has remained flat for the past three years and we assume it will continue in the future.

Beginning in April 2022, Peninsula Clean Energy will begin serving the City of Los Banos. This load forecast includes the estimated usage by City of Los Banos beginning in April 2022, assuming a similar opt-out rate as seen in San Mateo County, ranging from 95% to 100% depending on customer class.

Load forecasted for current and known future Direct Access customers is not included in this forecast, i.e. Direct Access load has been subtracted from the forecast.

## Definition of customer classes

The forecast uses the 17 load profiles identified by Pacific Gas and Electric (PG&E):

- Small and medium commercial:
  - A1
  - A10
  - A6
- Agricultural:
  - AG1A
  - AG1B
  - AG4A

- AG4B
- AG5A
- AG5B
- Large Commercial
  - E19P
  - E19S
- Industrial
  - E20S
  - E20T
- Street Lighting:
  - LS1
- Residential
  - RES
- Traffic Control
  - TC1

## Description of method for forecast components

Peninsula Clean Energy’s load forecast is specific to each of the 17 load profiles or “profile types” identified above. The forecast is based on average hourly profiles for each profile type and varies by month and weekday/weekend. The forecast uses a simple weather normalization method by averaging historic data normalized for number of accounts. Growth in number of accounts is expected to be about 0.5% per year for residential and small and medium commercial accounts. Growth in per account usage is expected to be about 0.5% per year for commercial and residential accounts.

Beginning in March 2020 Peninsula Clean Energy has observed significant changes in load due to the coronavirus pandemic. Overall, Peninsula Clean Energy’s load decreased 4% in 2020 relative to pre-pandemic forecasts, and is on track to be 5% reduced from pre-pandemic forecasts for 2021. We have observed a decrease in commercial and industrial load, an increase in residential load, and changes to C&I and residential load shapes due to the coronavirus pandemic. No major changes in agricultural, traffic control, or street lighting load has been observed. To account for these significant changes, Peninsula Clean Energy has developed a pandemic adjustment factor to apply to the “pre-pandemic” forecast method described in more detail below. The pandemic adjustment is calculated for each of the 17 profile types on an hourly basis for each weekday, specific to each season (Winter, Spring, Summer, and Fall). The pandemic adjustment is based on observed load patterns between March 2020 and April 2021 and uses a linear regression.

Based on current vaccination rates and lifting of many restrictions in California, Peninsula Clean Energy expected the effects of the pandemic to decrease over the course of the 12-month period of July 1, 2021 to July 1, 2022. Beginning in July 2022, Peninsula Clean Energy predicts a “new normal” load pattern to manifest. Peninsula Clean Energy expects some small permanent load reduction to persist as a result of the economic recession associated with the pandemic. (The phenomenon of small permanent load reductions persisting following economic recessions has been observed previously in California, for example following the 2001 and 2008 recessions.) Peninsula Clean Energy expects the “new normal” load to be about 2-3% below pre-pandemic forecasts.

To develop the peak load forecast, Peninsula Clean Energy uses historic weather data for Peninsula Clean Energy’s service territory, specifically the Redwood City Station (USC00047339), available from NOAA. Peninsula Clean Energy implements a temperature forecast method called a “1-in-2” method, as described and recommended by the CEC for peak load forecast. The method is designed to predict a maximum temperature that has a 1-in-2 chance of occurring each year. We implement a monthly version of this 1-in-2 method. We calculate the median of the monthly maximum daily temperature over the last 50 years (i.e. the maximum monthly temperature expected to occur in that month in at least 50% of years, or in about every 1 in 2 years). The period of the last 50 years was chosen over a longer or older period to best represent the effects of climate change, since temperatures have been trending warmer for the past century. Peninsula Clean Energy uses this forecast 1-in-2 temperature to forecast peak load by weather normalizing historic load to historic maximum daily temperatures using a second order polynomial regression. The results are scaled to the expected future number of accounts.

Currently Peninsula Clean Energy’s load forecast is based on a regression method which is a type of simple econometric model. Peninsula Clean Energy is interested in increasing the sophistication of its load forecasting by incorporating economic forecasts and customer behavior modeling. Peninsula Clean Energy will continue to develop its load forecast and provide updates on its status. Peninsula Clean Energy does not utilize sophisticated aggregate econometric methods.

## Discussion of the reasonableness of differences between historical and forecasted growth patterns

Peninsula Clean Energy considers the changes in forecasted growth patterns to be reasonable considering the available data and recent trends due to the coronavirus pandemic. Peninsula Clean Energy performs a quarterly load evaluation and forecast update which is used for internal planning and budgeting purposes. Peninsula Clean Energy will continue to monitor customer demand and update the forecast as appropriate.

## Report of past performance of the forecasting method

The table below provides a comparison of previous forecasts to actual annual weather-adjusted peak and energy demand. Values reported in the table below do not include distribution losses. Actual values are summarized from initial (“T+8”) billing-quality meter settlements provided by Peninsula Clean Energy’s meter data management service provider. In general, the forecast performs reasonably well considering the relatively short period of historical data available.

Year	Forecast	Forecast Annual Energy (GWh)	Actual Annual Energy (GWh)	Forecast Peak Load (MW)	Actual Peak Load (MW)
2018	Submitted to PG&E for ERRA forecast, Feb 2017	3,675	3,525	658	624
2019	Submitted to PG&E for ERRA forecast, Feb 2018	3,609	3,563	702	675
2020	Submitted to PG&E for ERRA forecast, Feb 2019	3,462	3,442	561	625

2020	Updated May 2020 (includes pandemic adjustment)	3,455	3,442	618	625
2021	Submitted to PG&E ERRA forecast, Sep 2020	1,335 (Jan – May)	1,378 (Jan – May)	562 (Jan – May)	576 (Jan – May)

Peninsula Clean Energy considers the submitted forecast to be reasonable considering the available data and recent trends in economics and demographics. Although the submitted forecast does not explicitly account for factors such as energy prices, demand-side management technology and programs, state policy trends or climate change, Peninsula Clean Energy considers the forecast to be reasonable in terms of those factors. Peninsula Clean Energy will continue to monitor customer demand and update the forecast as appropriate.

## Additional Forecast Detail

### Forecast calibration procedures

Peninsula Clean Energy’s pre-pandemic forecast is based on a regression of historic data. Because of the relatively short period of observed data (May 2017 through February 2020), none of the historic data is reserved for model testing and calibration. Instead, all of the pre-pandemic data is used to develop the regression coefficients.

Peninsula Clean Energy compares the pre-pandemic forecast to observed loads during the pandemic (March 2020 through April 2021) to determine an average seasonal-hourly-weekday/weekend calibration factor for each of the 17 profile types. This pandemic adjustment factor is added to the pre-pandemic forecast for future years to calibrate the pre-pandemic forecast to current trends.

With the recent vaccination rates and lifting of some restrictions, Peninsula Clean Energy is expecting load to recover to close to pre-pandemic forecast levels. To account for this load recovery, we linearly reduce the pandemic adjustment factor in the forecast load from July 2021 to July 2022. Starting in July 2022, we are forecasting the load will reach a “new normal” which will be about 2-3% below the pre-pandemic load forecast. As discussed above, the permanent load reduction of 2-3% is consistent with the permanent load reduction observed in previous economic recessions in California.

### Historical Peak and Projected Peak Loads

As discussed above in more detail, Peninsula Clean Energy uses historic AMI data to determine historic peak loads by customer class. Peninsula Clean Energy implements the 1-in-2 temperature forecast method recommended by the CEC and uses that temperature forecast to forecast peak load based on weather-normalized load patterns in Peninsula Clean Energy’s service territories.

### Energy and Peak Loss Estimates

Peninsula Clean Energy assumes a distribution loss factor of 6.5%. The historic loss factors varies by time of day and season, but on average has been about 6.5%. Given the relatively short period of observed data, Peninsula Clean Energy chooses to use a constant estimate of the loss factor. As we accumulate additional data, we may choose to increase the sophistication of our forecast loss factor. Peninsula

Clean Energy does not assume any transmission or UFE losses, since we do not have access to data on those types of losses specific to our service area.

### Estimates of Direct Access, Community Choice Aggregation, and other Departed Load

As noted above, Peninsula Clean Energy will begin serving City of Los Banos customers in April 2022. To forecast energy and peak load for City of Los Banos, Peninsula Clean Energy is using Item 17 reports from PG&E for 2018, 2019, and 2020 (through August 2020), which reports historic hourly and 15-minute data for City of Los Banos customers.

Peninsula Clean Energy's load forecast accounts for customers that will depart to Direct Access service providers. PG&E has provided information on which customers will depart and forecasts of future customers likely to depart in regular updates. The most recent update was provided by PG&E in March 2021, and includes estimates for San Mateo County customer departures as well as City of Los Banos customer departures. Based on the data provided by PG&E, Peninsula Clean Energy expects the following customer load to depart to Direct Access, and we have subtracted the associated forecast load from our load forecast:

- 42,000 MWh/year of load from commercial and industrial customers in 2021
- 14,000 MWh/year of load from commercial and industrial customers in 2022 (includes both San Mateo County customers and Los Banos customers)

### Weather Adjustment Procedures

Peninsula Clean Energy's load forecast averages historic usage per account profiles by month for the observed time period of May 2017 through February 2020. By averaging monthly profiles between different years, there is a simple weather normalization incorporated into the load forecast. At this time, Peninsula Clean Energy's energy load forecast does not explicitly incorporate meteorological data.

Peninsula Clean Energy's peak load forecast does incorporate meteorological data, as described above. Data from the Redwood City Station (USC00047339) is used, specifically the maximum daily temperature. In order to implement the 1-in-2 temperature estimate, we calculate the median of the maximum daily temperature by month. We also perform a second order regression between peak daily load and maximum daily temperature to determine a peak load to temperature relationship. Using this regression model, we calculate the expected peak load for the 1-in-2 temperature estimate. This peak load forecast is performed for total Peninsula Clean Energy load, including Los Banos load in April 2022 and later. In order to disaggregate this forecast into specific profile types as requested, we take the 5 most similar days (based on maximum daily temperature by month) in the historic record and use the actual proportion of load from each profile type for the load in the peak load hour to estimate forecast peak load by profile type.

### Climate Change

Climate change will play an important role in future energy consumption patterns. Peninsula Clean Energy incorporates the effects of climate change by only using recent weather data for our 1-in-2 peak temperature forecast. We choose to use the most recent 50 years of weather data, despite having a record of older data available. While using less data reduces statistical robustness of the forecast, we believe that it more accurately reflects likely future weather patterns than using older data.

### Known load growth projects and Other Load Modifier Impacts in Form 3

Peninsula Clean Energy is not reporting any load growth projects in Form 3.

Peninsula Clean Energy has provided load modification estimates associated with its current active program with Sunrun in Form 3. The Sunrun program is a residential program and is currently limited to single family home owners and multi-family building owners. Any residential owner within Peninsula Clean Energy's service area is eligible to participate, including those who are not Peninsula Clean Energy customers.

Peninsula Clean Energy's load modification program with Sunrun consists of solar plus storage installations on participant's homes that will be configured to discharge the storage to provide load modification on weekdays during the four-hour peak window (either 4pm to 8pm or 5pm to 9pm). Sunrun is committed to installing solar+storage systems that amounts to 900kW of load modification by January 1, 2022 and 1,500 kW by January 1, 2023. Sunrun has enrolled 80 of their existing customers into the load modification program, has enrolled 17 new customers in 2021 so far, and, is forecasted to enroll 362 more customers throughout 2021. This forecast is based on the average load modification volumes Sunrun has gotten so far from the current customer base, extrapolated up to the 900kW load modification for 2021 amount which closely reflects Sunrun's contractual obligation to Peninsula Clean Energy. The load modification program's capacity increases to 1,500 kW in 2022, with corresponding increases in solar and storage installations and participation.

The installed systems will displace energy demand based on the generation of the photovoltaic (PV) solar. The program is estimated to install approximately 2,615 kW of PV solar in 2021, with an additional 1,569 kW in 2022. We use NREL's PVWatts tool to estimate the energy production from the forecast installed capacity. This forecast energy production is subtracted from Peninsula Clean Energy's submitted load forecast.

The installed systems will displace peak demand based on the discharge of the batteries. Peninsula Clean Energy's peak load has historically occurred on weekdays between 4pm and 9pm, and Peninsula Clean Energy expects this timing of the peak to continue in the future. Therefore, the load modification from this program is expected to be coincident with Peninsula Clean Energy's peak demand for the foreseeable future. The load modification estimates have been incorporated into Peninsula Clean Energy's peak demand forecast on Form 1.3.

The forecasted load modification energy and peak load effects do not take into account factors such as price elasticity, fuel prices, market conditions or relevant rate schedules. As the program continues, if we determine that such factors are having a significant effect on program performance, we will update the forecast as appropriate.

The program began in summer of 2020, and we are monitoring program performance. So far the program performance has been consistent with our expectations. We will continue to monitor program performance and update our forecast based on available data.

Peninsula Clean Energy is only providing load modification forecast for programs currently active. At this time, we are not providing load modification forecasts for programs in development. Any future programs we develop will be consistent with federal, state, and local policies.