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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 Authority ("PCE") 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 Advanced Meter Infrastructure (AMI) data for PCE's San Mateo County customers. To best account for installations of DERs in recent years, adoption of EVs, and impacts of COVID, PCE bases its forecasts on the 3 most recent years of available historic data. For the current forecast, that is January 2022 – December 2024. 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 PCE's consultants.

PCE has developed a peak load forecast based on the 1-in-2 methodology recommended by the CEC and weather normalized historic load data since January 2022.

Definition of area for which forecast is developed

PCE's load forecast is developed for its service area, which includes Los Banos, all cities in San Mateo County, and the unincorporated areas of San Mateo County, not including customers who are receiving electricity service through a direct access provider or who have opted out of CCA service. About 98% of eligible customers in San Mateo County are PCE customers. This rate has remained flat for the past seven years and PCE assumes it will continue in the future.

PCE began serving the City of Los Banos in April 2022. The participation rate for City of Los Banos customers is approximately 85%. This load forecast includes the actual usage by City of Los Banos beginning in April 2022 and assumes that participation rates for City of Los Banos customers have stabilized since the enrollment in April 2022.

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 19 load profiles identified by Pacific Gas and Electric (PG&E):

- Small and medium commercial:
  - A1
  - A10
  - A6
  - BEV1
- Agricultural:
  - AG1A
  - AG1B
  - AG4A
  - AG4B
  - AG5A
  - AG5B
- Large Commercial
  - E19P
  - E19S
  - BEV2
- Industrial
  - E20P
  - E20S
  - E20T
- Street Lighting:
  - LS1
- Residential
  - RES
- Traffic Control
  - TC1

Description of method for forecast components

PCE's load forecast is specific to each of the 19 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. Growth in number of accounts is expected to be about 1% per year for residential and small commercial accounts. Growth in per account usage is expected to be about 0.5% per year for commercial, industrial, and residential accounts.

To best account for installations of DERs in recent years, adoption of EVs, and impacts of COVID, PCE bases its forecasts on the 3 most recent years of available historic data. For this forecast that is January 2022 – December 2024. In addition, PCE excludes from its analysis historic load data associated with customers who have departed to Direct Access. At this point, PCE does not expect additional customer departures to Direct Access service. PCE has completed enrollment of customers in its service territory and is not observing any additional opt-outs. At this point, it does not have immediate plans for new customer additions.

After making these adjustments to the historical data, baseline sales are forecasted by normalizing historical sales to typical weather years in both of PCE's territories. This is done by fitting regression models to the load-per-meter for each customer class at the month-hour level for both weekends and weekdays. The normalized load-per-meter is then scaled by the most recent data on meter counts in PCE's service territory. Finally, modest assumptions of flat growth rates in account growth and consumption growth based on recent observations scale these shapes over time.

Additional large loads that will be joining PCE's territory are then added to the baseline forecast based on usage profiles provided by these businesses. For the current forecast, PCE does not anticipate any significant large commercial loads or data centers to join its territory. At this time, PCE believes the expectation that data center load growth will be insignificant to be reasonable based on monitoring historic and recent trends in data center siting, and the characteristics of its service territory, including land availability and real estate costs. In addition, PCE has received no direct indication from PG&E, CEC staff, or its current large commercial customers, of anticipated data center or other large load growth in its service territory.

PCE then adjusts the forecast to account for the modeled load modifiers of light-duty electric vehicles and behind-the-meter solar and storage systems. In addition, PCE incorporates impacts of a small load modifying demand response program that it runs. The modeling of these load modifiers is discussed in more detail below in the "Additional Forecast Details" section, subsection "Known load growth projects and Other Load Modifier Impacts in Form 3".

PCE uses a weather-normalized peak load model to forecast the hourly load for a given maximum daily temperature that is selected based on the CEC's recommended 1-in-2 methodology.

PCE forecasts peak hourly loads using the same weather-normalized model discussed for baseline energy sales above. However, for the peak forecast PCE fits the model to maximum daily temperatures based on the CEC's recommended 1-in-2 methodology,

rather than TMY (typical meteorological year) data. All forecasted peak loads occur on weekdays, as observed in PCE's historical records.

To implement the 1-in-2 methodology to forecast peak temperatures, PCE uses temperature data from NOAA dating back to 1994 for Redwood City and Los Banos Weather Stations. From this dataset, PCE determines the median (50% exceedance, or "1-in-2") minimum and maximum daily max temperatures for each month. The load-per-meter is then fit to both the min and max temperatures for all months. For winter months (Nov – April), PCE finds that the minimum max temperature is the better predictor of the monthly peak load, i.e., peak load occurs on the coldest day of the month in winter months. For summer months (May-Oct), peak load occurs on the hottest day. PCE forecasts the baseline expected peak load for each month, for each hour of the day. PCE scales this by its account growth assumptions and adjusts the forecast by the average hourly profile of its load modifiers for weekdays for each month.

PCE is continually striving to improve its load forecasting methodology. PCE hopes to expand its modeling of load modifiers to extend to building electrification, energy efficiency, and medium/heavy duty EV charging. At this time, energy efficiency and building electrification are assumed to be a part of PCE's base forecast growth forecasts.

Challenges in load forecasting also stem from limited relevant historic data. With the recent COVID-19 pandemic, load patterns have significantly changed, increasing forecast uncertainty. As time progresses, additional post-COVID data are collected that help improve forecast accuracy in the post-COVID regime.

Report of past performance of the forecasting method

The table below provides a comparison of previous forecasts to actual annual peak and energy volume demand. Values reported in the table below do not include distribution losses. Actual values are summarized from billing-quality meter settlements provided by PCE's meter data management service provider. In general, the forecast performs reasonably well considering the relatively short period of historical data available.

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

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	3,304	3,334	562	576
2022	Submitted to PG&E ERRA forecast, Sep 2021	3,630	3,385	623	689
2023	Submitted to PG&E ERRA forecast, Feb 2022	3,568	3,373	595	616
2024	Submitted to PG&E ERRA forecast, Feb 2023	3,509	3,411	578	677

Additional Forecast Detail

Forecast calibration procedures

PCE's load forecast is based on a relatively short period of historical data from January 2022 through December 2024. Because of the relatively short period of observed data, none of the historic data is reserved for model testing and calibration. Instead, all of the historic data is used to develop the regression coefficients.

PCE performs load evaluation and forecast updates quarterly. During these updates, the most recent historical data is added to the regression.

Historical Peak and Projected Peak Loads

As discussed above in more detail, PCE 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 its service territories. See the section “Description of method for forecast components” for more details on peak load forecasting methods.

Energy and Peak Loss Estimates

PCE 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, PCE chooses to use a constant estimate of the loss factor. As PCE accumulates additional data, it may choose to increase the sophistication of its forecast loss factor. PCE does assume a loss factor of 2.5% for transmission losses and 0.5% for UFE losses, based on the standard values for the PG&E transmission area used in the Resource Adequacy program administered by the CPUC.

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

As noted above, PCE began serving City of Los Banos customers in April 2022 and finished enrolling customers in this territory in December 2022. PCE does not anticipate load growth by additional service territory expansion at this time.

As noted above, PCE excludes historical load data associated with customers who have departed to Direct Access from its analysis. At this point PCE does not expect additional customer departures to Direct Access service.

Weather Adjustment Procedures

PCE’s load forecast averages historic usage per account profile by month for the time period January 2022 through December 2024. Baseline sales are forecasted by normalizing historical sales to typical weather years in both of its territories.

PCE’s peak load forecast incorporates meteorological data, as described above. PCE uses temperature data from NOAA dating back to 1994 for Redwood City and Los Banos Weather Stations. From this dataset PCE determines the median (50% exceedance, or “1-in-2”) minimum and maximum daily max temperatures for each month. PCE also performs a linear regression between peak daily load and maximum daily temperature to determine a peak load to temperature relationship per meter in each load profile type. Using this regression model, PCE calculates the expected peak load for the 1-in-2

temperature estimate given the forecast of number of meters for each load profile type. This peak load forecast is performed for total PCE load, including Los Banos load in April 2022 and later.

Climate Change

Climate change will play an important role in future energy consumption patterns. PCE incorporates the effects of climate change by only using recent weather data for its 1-in-2 peak temperature forecast. PCE chooses to use data since 1994, despite having access to records of older data. While using less data reduces statistical robustness of the forecast, PCE believes 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

PCE forecasts two groups of load modifiers: light-duty EV charging and behind-the-meter solar plus storage installations. PCE has developed a long-term forecast for both of these load modifiers. In addition, PCE incorporates impacts of a small load modifying demand response program that it runs.

For EV charging, PCE uses policy-based forecasts of growth in the EV population based on CARB's Advanced Clean Cars II Regulation. PCE assumes charging profiles based on its fleet characteristics and rate schedule using NREL's EVI Pro-Lite Tool and the report "Low Energy: Estimating Electric Vehicle Electricity Use" (Burlig, Bushnell, Rapson & Wolfram, 2021) on EV charging in California. For BTM resources, PCE uses recent interconnection data to forecast new capacity installations in the short term by customer class and region via regression. In the long term, PCE assumes future installations in its service territory consistent with rooftop solar assumptions in NREL's Cambium model. PCE assumes a ratio of solar:storage consistent with historic installations in its service territory. PCE models the dispatch of the BTM storage equipment using the characteristics of its service territory, its rate schedules, and the NREL System Advisor Model tool. PCE has one load modifying demand response program currently active with Sunrun. This program is an aggregation of BTM storage resources and is discussed in more detail below.

As PCE's baseline forecast is done at the month-hour level, its forecasts for incremental BTM generation and EV charging load are all incremental to the prior year's same month, while its forecasts for new units (capacity of BTM generation, number of EVs) are incremental to the end of 2024. PCE then adjusts the baseline energy sales forecast with the load modifiers forecast to obtain its load forecast net of load modification.

Load modifier impacts in Form 3 do not include distribution, transmission, or UFE losses. Retail sales values on form 1.1b and peak demand values on form 1.3 are inclusive of load modification.

The discussion below is specific to the load modifying demand response program implemented via Sunrun.

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 PCE's service area is eligible to participate, including those who are not PCE customers.

Power rating, capacity, type, configuration (stand-alone/paired):

The power rating of almost all of the systems enrolled in this program will be either a 5kW/13.5kWh Tesla Powerwall, or a 5kW/9.3kWh LG Chem RESU 10H. Some installations include multiple Powerwalls or RESU 10Hs. Approximately 30% of the capacity of these systems will be reserved for unplanned outages. All systems enrolled will be solar+storage.

Terms of contractual obligations for procured resources, expected number of new interconnections, and installation timeline:

PCE's contract with Sunrun requires 1,000kW of load modification in 2022, and 1,500kW of load modification from 2023 – 2031. However, in 2022 there were delays in reaching the installed capacity targets. Sunrun owes PCE penalty payments for these types of shortfalls. Load modification in 2022 ranged between 136 kW and 756 kW. As of 2024, PCE is receiving the full 1500 kW of capacity, and therefore does not report incremental capacity for this program in Form 3.

Anticipated charge and discharge schedule of systems, operating criteria, and depth of discharge:

All systems will charge from solar during the weekend and weekdays, and will discharge 1/2 of their energy capacity in each hour during a specified 2-hr window designed to coincide with PCE's peak demand. Only the reserved capacity for unplanned outages remain at 9pm. The dispatch schedule for 2026 is:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HE 19-20	HE 19-20	HE 20-21	HE 20-21	HE 19-20	HE 18-19	HE 18-19	HE 18-19	HE 18-19	HE 18-19	HE 18-19	HE 18-19

Provide documentation of applicable tariff including time periods, rates, charges.

All residential rates are eligible for this program. PCE's rate details can be found here: https://www.peninsulacleanenergy.com/for-residents/

Funding sources:

Sunrun is a publicly traded business. Customers may purchase systems outright,or enter into a PPA with Sunrun.

PCE is only providing load modification forecast for programs currently active. At this time, PCE is not providing load modification forecasts for programs in development. Furthermore, PCE does not provide forecasts for load modifying programs administered by the IOUs. Any future programs that are developed will be consistent with federal, state, and local policies.