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Form 4 Demand Forecast Methods and Models

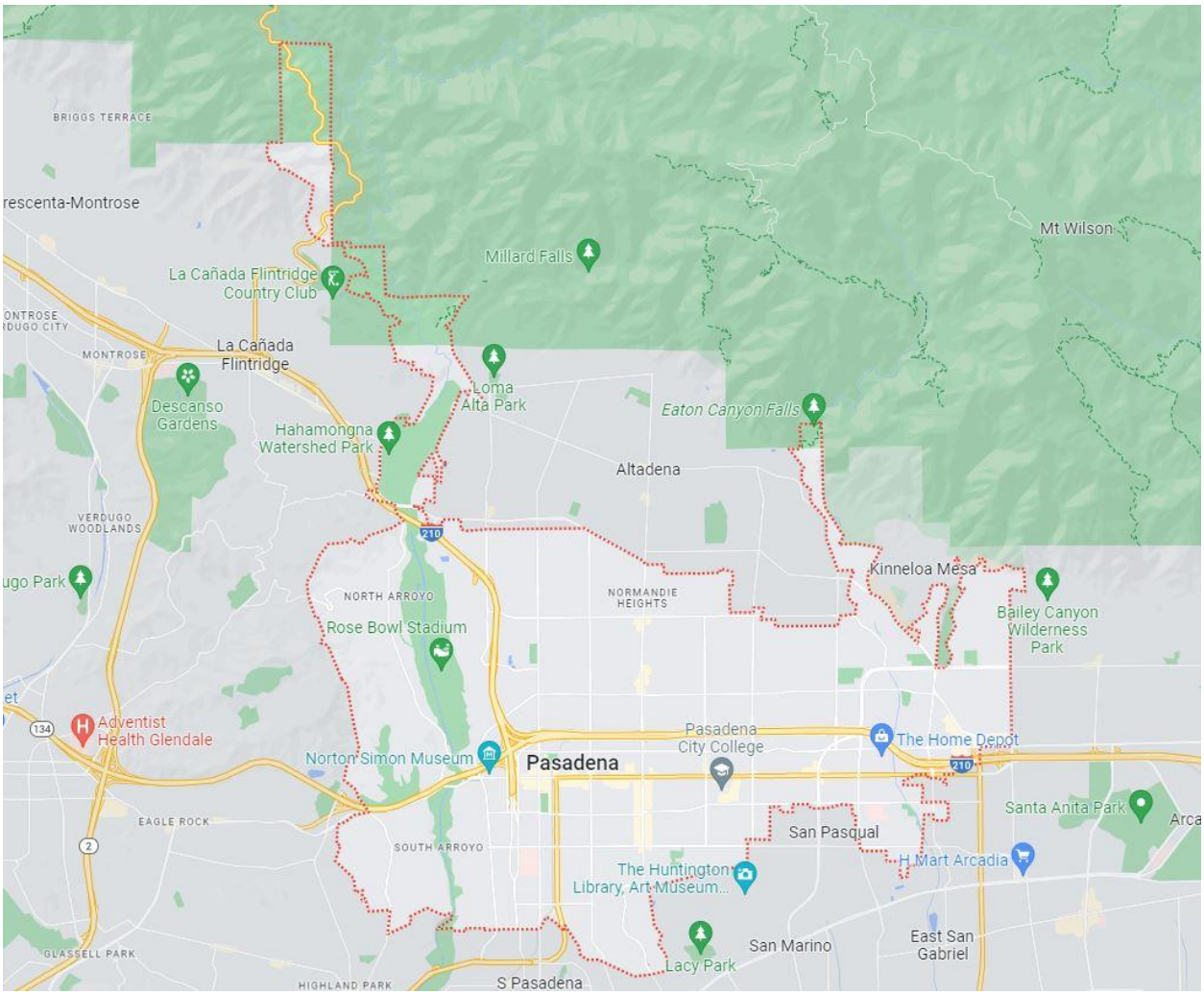
Background

The City of Pasadena, Water and Power Department, also referred to as Pasadena Water and Power ("PWP"), is pleased to provide description of the demand forecast methods, models, and data used to develop its peak demand, total system load and retail sales forecast.

Demand Forecast Methods and Models Area

The demand forecast was developed for the City of Pasadena, California city limits. The City of Pasadena is located in Los Angeles County, California.

Figure 1: Map of Pasadena



Customer Class Definitions For Demand Forecast

PWP provides electricity to more than 65,000 customers within Pasadena. The demand forecast references four customer class types including residential, commercial/industrial, city accounts and other. The customer classes are segmented into the categories listed on Table 1: Pasadena Water and

Power Customer Type and Rate Classifications, below. The City of Pasadena Municipal Code defines the rate classifications, per Chapter 13.04 – Power Rates and Regulations.

Table 1: Pasadena Water and Power Customer Type and Rate Classification

Customer Type	Description	Per Municipal Code
Residential	Single family and multi-family residential dwellings	Applies to separately metered single-family dwellings and to individual family accommodations. Applies to separately metered multi-family dwellings, including properties permitted as "live-work" space when used for residential purposes, and to individual family dwellings in multi-family dwellings. Multi-family dwellings are apartments, condominiums or town houses with at least four meters at the same physical location.
Industrial/ Commercial	Small commercial, Medium commercial – secondary and primary, Large commercial – secondary and primary, hospitals, institutions, non-profits, etc.	Applies to single-phase and 3-phase general service, including lighting and incidental small power, through a single meter. Applies to service below 30 kW demand. Applies to 3 phase general service, including power and lighting, measured with demand meter. Applies to service at 30 kW demand or greater, but less than 300 kW demand. Any customer served under this schedule whose monthly maximum demand has registered less than 30 kW or greater than 300 kW for twelve consecutive months is no longer eligible for service under this Schedule M-1 and must take service under another applicable rate schedule. This schedule is subject to meter availability. Applies to services metered and delivered at voltages less than 17 kV. Applies to 3 phase general service, including power and lighting, measured with demand meter. Applies to service at 30 kW demand or greater, but less than 300 kW demand. Any customer served under this schedule whose monthly maximum demand has registered less than 30 kW or greater than 300 kW for twelve consecutive months is no longer eligible for service under this Schedule M-2 and must take service under another applicable rate schedule. This schedule is subject to meter availability. Applies to services metered and delivered at voltages equal to or greater than 17 kV. Applies to 3 phase general service, including power and lighting, measured with demand meter. Applies to service at 300 kW demand or greater. Any customer served under this schedule whose monthly maximum demand has registered less than 300 kW for twelve consecutive months is no longer eligible for service under this Schedule L-1 and must take service under another applicable rate schedule. This schedule is subject to meter availability. Applies to services metered and delivered at voltages less than 17 kV. Applies to 3 phase general service, including power and lighting, measured with demand meter. Applies to service at 300 kW demand or greater. Any customer served under this schedule whose monthly maximum demand has registered less than 300 kW for twelve consecutive months is no longer eligible for service under this Schedule L-1 and must take service under another applicable rate schedule. This schedule is subject to meter availability. Applies to services metered and delivered at voltages equal to or greater than 17 kV.
City Accounts	All City accounts, including, but not limited to, parking garages (includes transportation electrification charging and garage lighting), street lights, department building energy usage, libraries, etc.	Applies to outdoor street, highway and area lights and traffic signals, whether publicly or privately owned, where the poles, electrolier standards and lighting equipment are owned by the customer. For such lights as are burned from 30 minutes after sunset to 30 minutes before sunrise, 4140 hours of service per year will be used for cost calculation purpose.
Misc./Other	Adjustments made (overall) by PWP finance, to account for unbilled customers. The Other Customers take data from the customers classes, listed above. No data is available is available in the Municipal Code	

Method for Forecasting Electricity Demand Components

The load forecasting process takes into consideration the historical factors of demand, such as weather and economic variables, as well as adjustments for customer additions, energy efficiency, Demand-Side Management (DSM), and electric vehicle usage. A load forecast aims to predict energy consumption and

peak load demand. The load forecast is the starting point for determining total energy, renewable energy, clean energy, and capacity requirements.

PWP has leveraged the California Energy Demand Forecast ("CED") that is a part of the California Energy Commission's Integrated Energy Policy Report ("IEPR") process. The CED is an hourly forecast of electricity demand in the future. PWP derived its load forecast from the CED Update, 2022-2035 that is part of the 2022 Integrated Energy Policy Report Update.

The 2022 CED updates economic, demographic, and rate data from 2021, and refreshes the IEPR's methods for scenario design and for modeling the growth of transportation electrification. The CED has hourly forecasts of electricity demand for four different entities: the three investor-owned utilities (PG&E, SCE, and SDG&E) and CAISO. The CED regards PWP as part of Southern California Edison ("SCE"), so PWP calculated PWP's load as a percentage of SCE's load in 2021. Then, as an initial forecast, the resulting hourly percentages were applied to the hourly CED forecast through 2035.

Historical data shows that PWP's service territory does not precisely mirror the load growth behavior of the larger SCE service territory. Therefore, when investigating the results of certain components, the IRP made modifications to the following:

- Additional Achievable Energy Efficiency ("AAEE")
- Additional Achievable Fuel Substitution ("AAFS")
- Distributed Storage
- Distributed Solar
- Time of Use (TOU) Rates
- Vehicle Electrification
- Climate Change

These changes were necessary to reflect PWP's historical experience with its load and its expectations for the future, considering given characteristics unique to PWP's service area. Changes to these components, and their impacts on the overall load forecast, are summarized briefly below:

Additional Achievable Energy Efficiency ("AAEE")

PWP is dedicated to offering customers a variety of programs and services to help them save energy and water, while keeping their bills manageable. PWP's current (and future) building code also incorporates the California Green Building Standards Code (CALGreen). The local building "reach code" goes beyond the state minimum requirements set forth in Title 24 and contains specific regulations for energy efficiency and water conservation.

In 2021, PWP, under the umbrella of the California Municipal Utilities Association (CMUA), hired GDS Associates, Inc. to study how much energy efficiency PWP could cost-effectively support in its territory. This study was the foundation for PWP's energy efficiency goals that the Pasadena City Council adopted in May 2021. For Fiscal Years 2022 through 2031, PWP's energy efficiency goal is to achieve 11,720 MWh per year in savings and 1.8 MW per year in demand reduction. For the load forecast, AAEE is energy efficiency that is likely to occur, but not yet committed.

Additional Achievable Fuel Substitution ("AAFS")

Additional Achievable Fuel Substitution ("AAFS") estimates the impacts of building electrification and fuel substitution on electricity demand. Fuel substitution refers to the replacement of fossil or renewable gas with electricity. PWP's IRP assumes the allocation of AAFS from the CED based on the load forecasting method with no adjustments applied. AAFS is estimated at 2% of CAISO metered load for the forecast.

Distributed Storage

In 2022, PWP had 1.4 MW of distributed storage. The CED suggested 0.5 MW across the residential and non-residential sectors for PWP in 2023. To calibrate the starting point, PWP's existing penetration was added to the IEPR forecast.

It is likely that distributed storage will be paired with distributed solar in the future. PWP estimated total storage adoption given its anticipated solar penetration and applied the rate of change embedded in that resulting penetration to its starting point. Overall, this method generated a larger distributed storage capacity than what the CED method estimated, and it produced an estimate more in line with expectations.

Distributed Solar

In 2022, PWP had 23 MW of distributed solar. Assuming an average installation size of 7 kW per residential rooftop, and 58,291 residential customers, approximately 6% of PWP's households had solar. However, the CED method attributed 52 MW of solar to PWP in 2023. PWP, as a dense urban area, is likely more space-constrained than SCE on the average. PWP's load forecast calculated the annual rate of change in the CED and applied it to PWP's 2022 starting point. Extrapolating forward, approximately 12% of households would have solar in 2030.

Time of Use ("TOU") Rates

The CED method used in the load forecast produced a forecast for the impact of TOU rates. As of 2023, PWP did not have advanced metering infrastructure ("AMI"). PWP needs AMI for TOU rates. PWP will, in turn, need some form of TOU rate to support any significant expansion of distributed solar and storage resources. PWP currently estimates that AMI will come online in its full capacity around 2030. Therefore, TOU impacts for PWP's forecast are only included in 2030 and beyond.

Vehicle Electrification

As of 2022, PWP had 9,254 electric-based vehicles registered across the eight zip codes in its service territory, which is approximately 7% of all vehicles in PWP's service territory. Assuming around 3 MWh per vehicle, per year (based on assumptions developed in PWP's 2021 IRP update), PWP's EV load is higher than what the CED would indicate. Consequently, PWP applied the CED's forecast for 2027 to Pasadena in 2023 to reflect this higher value. Looking forward, approximately 36% of light-duty vehicles in PWP's territory are expected to be electric in 2030, and 65% are expected to be electric by 2045. No adjustments were made to the CED's medium/heavy-duty EV forecast. Overall, EV charging is projected at 14% of PWP's CAISO metered energy in 2030 and 28% in 2045.

Climate Change

The CED forecast includes the potential load impacts associated with climate change. Overall, the CED looks at 30 years of history, with recent years selected more often. Per the IEPR, baseline peak and energy forecasts were weather-normalized, and future years were adjusted for anticipated modifications for climate change. Climate change increases overall load expectations. For the load forecast, the effect of climate change is about 0.3% of annual metered energy.