DOCKETED	
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Project Title:	Electricity and Natural Gas Demand Forecast
TN #:	227633
Document Title:	UPDATED Pasadena Water and Power Electricity and Natural Gas Forecast Forms Demand Form 4
Description:	PWP is pleased to submit an UPDATED Form 4, the Demand Forecast Methology, which is required under 19-IEPR-03 - Electricity and Natural Gas Demand Forecast
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Background

The City of Pasadena, Water and Power Department (also referred to as Pasadena Water and Power ("PWP") is pleased to provide a description of the demand forecast methodology for its peak demand, total system load and retail sales forecast, as part of the 2019 IEPR filing. Many of the public report and analysis PWP prepares, is available on the following website:

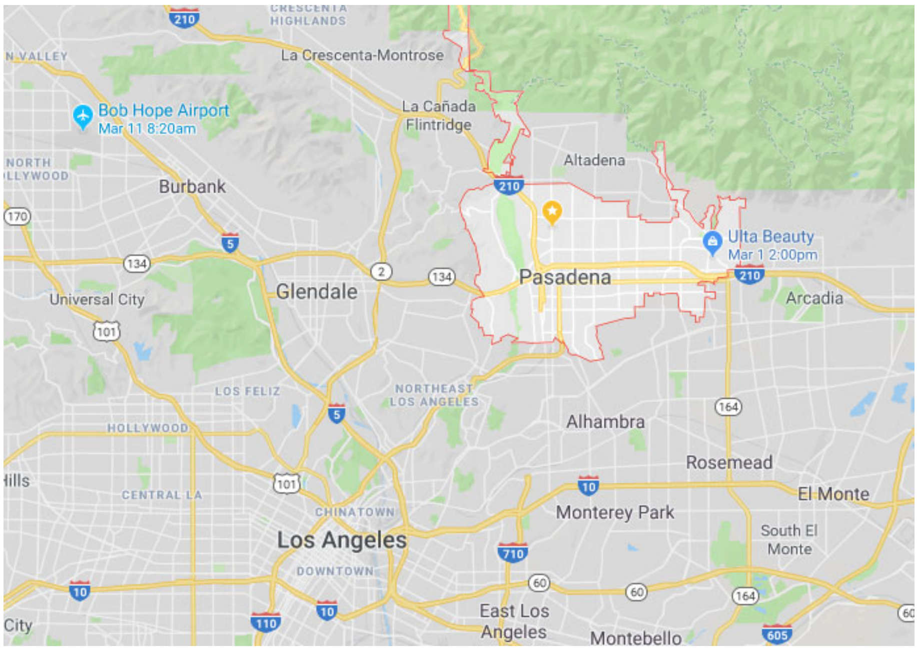
https://ww5.cityofpasadena.net/water-and-power/reportsanddocuments/

Area for the demand forecast methods and models

Map of Pasadena

The demand forecast was developed for the City of Pasadena, California city limits. The City of Pasadena is located in Los Angeles County, California. Below is a map of the City of Pasadena[1]:

Figure 1: Pasadena Map



Customer Class Definitions for Demand Forecast

The demand forecast references four customer class types- residential, commercial/industrial, city accounts and other. The customer classes are segmented into the categories listed on Table 1: PWP Customer Type and Rate Classifications, below. The City of Pasadena, Municipal Code defines the rate classifications, per Chapter 13.04- Power Rates and Regulations.

[1] https://www.google.com/maps/place/Pasadena,+CA/@34.1667615,-118.299331,11.25z/data=!4m5!3m4!1s0x80c2c2dc38330b51:0x52b41161ad18f4a!8m2!3d34.1477849!4d-118.1445155

Table 1: PWP Customer Type and Rate Classification

Customer Type	Description	Per Municipal Code[2]
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 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	Large and small businesses, non-profits, hospitals, institutions, 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	

2 https://library.municode.com/ca/pasadena/codes/code_of_ordinances?nodeId=TIT13UTSE_CH13.04PORARE&searchText

Method for Forecasting Electricity Demand Components

Peak Load

The peak demand development was part of PWP's Integrated Resource Plan ("IRP") filing with the CEC. The IRP required City Council or Board adoption by December 31, 2018 and PWP filed the IRP with the CEC on December 20, 2018. The following information is directly from the IRP, pages 65-68, which refers to the write up on Demand Forecast Methodology. Pace Global developed the methodology, as part of their contract with PWP's IRP vendor, Northwest Economic Research, LLC.

Demand Forecast Write-up per PWP IRP

Pace Global developed a deterministic Reference Case load forecast for PWP's service territory, including residential and commercial segments. The load forecasting process takes into consideration the historical determinants 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. The forecast followed a three-step process:

Step 1: Build an econometric model of the determinants of demand using historical weather, economic and seasonal dummy variables.

The relationships were built using multiple regression functions with historical monthly data for PWP's retail load for the period 2000-2017. Separate models were built for average monthly energy load and peak load. Pace Global used the Gross Domestic Product (GDP) data as an economic indicator for the Los Angeles metropolitan area, since it is available in the public domain.

Step 2: Build forecasts of the independent (exogenous) variables:

a. The most recent ten-year historical weather data produces a "normal" weather forecast
b. The most recent ten-year average growth rate extrapolates GDP for the forecast period

Step 3: Incorporate adjustments including:

a. Expected increase in Plug-in Electric Vehicles (PEVs) as discussed in the Transportation Electrification section
b. Energy Efficiency (EE) penetration levels and other DSM programs.
c. Known Load Changes.

Step 1 Details

Economic variables such as GDP and personal income normally are positively related to loads. Recently, however, in some markets this relationship seems to be changing (EIA and the Climate Institute).[3]

[3] https://www.eia.gov/todayinenergy/detail.php?id=33812; https://www.eia.gov/todayinenergy/detail.php?id=10491; https://thinkprogress.org/u-s-economic-growth-decouples-from-both-energy-and-electricity-use-16ae78732e59/.

Pace Global now observes a generally negative relationship between GDP and demand. This can be attributed to several factors, such as disruptive technological advances in energy efficiency penetration, lighting standards, and increases in distributed generation such as rooftop solar installations. This relationship has not been observed in rural areas, less affluent parts of the country and in places with a strong industrial load (since industrial load tends to be positively correlated with the GDP). Pasadena's load is residential and commercial. As GDP increases, so does the possibility of increased energy efficiency, distributed generation and other attributes that may decrease loads.

Step 2 Details

For the peak capacity load in MW, the following relationship was constructed:

> *Peak_Load_per_Customer = f (HDD, CDD, Humidity, GDP, EE_Program_MWh, Calendar Variables)*

Using these functions, the forecast of average and peak load per customer is obtained for 2018 to 2039. Using the customer count forecast data, the MW per customer values are converted into the service area level average and peak load forecasts. As a last step, PEV additions are factored in to derive the final average and peak load forecasts.

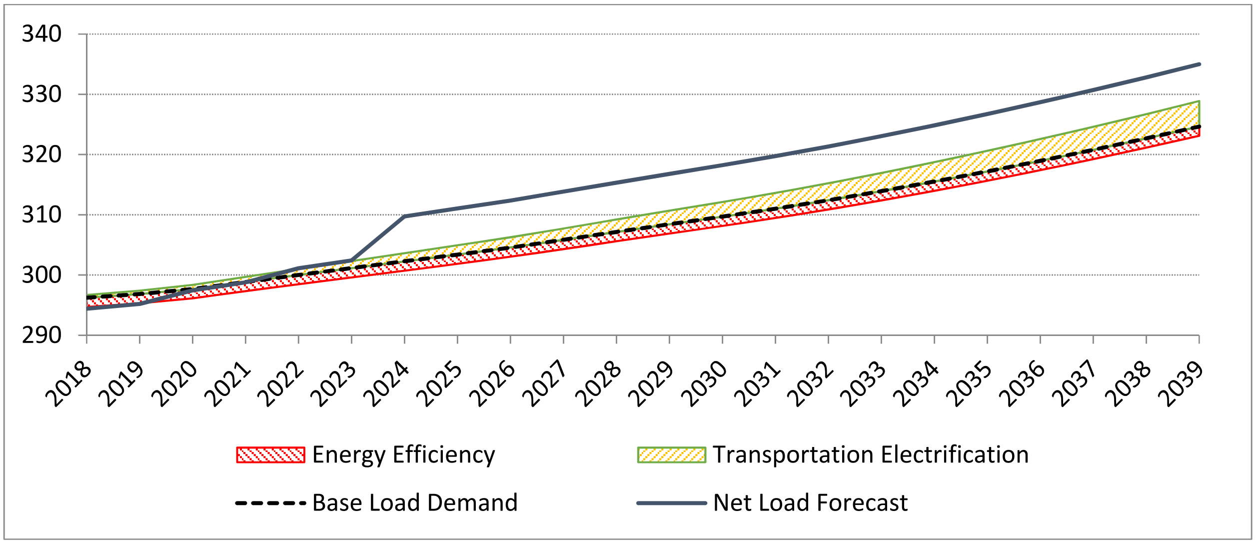
Step 3 Details

Step 3 of the load forecasting methodology describes the adjustments in the load forecast after using historical metered load in combination with various independent variables. These adjustments account for energy efficiency programs, transportation electrification, and Pasadena's known load impacts (additions and subtractions) from specific customers in their territory. These assumptions are based on PWP internal analysis rather than public forecasts. In this IRP, Pasadena expects a constant 13,500 MWh of energy and 2 MW of capacity to be reduced by energy efficiency programs annually in the study period. As an offset, transportation electrification load is expected to increase at a compound annual growth rate (CAGR) of 11.26% during the study period, resulting in an additional 4 MW of capacity by 2039. Pasadena's known load changes result in a reduction through 2019 but then begin to increase the load forecast from 2020 through the duration of the study period. Distributed generation (DG) is captured in the historical net-metered data but is not modeled as an additional reduction in load during the study period.

Assumptions

All load forecast data shown below are weather-normalized projections. The load forecast data below shows "net load" amounts that include reductions for energy efficiency and additions for transportation electrification and PWP known load additions. **Error! Reference source not found.** contains the resulting peak load forecasts, for the IRP.

Figure 2: PWP IRP Annual Peak Capacity Forecast



Source: Pasadena Water and Power; Pace Global

Demand Forecast – Other Regions

The demand forecast for other western U.S. regions is based on data received from the WECC.

Load Forecast Uncertainty

In California, policy is driving the state towards greater electrification and lower carbon emissions, but also toward greater energy efficiency. The balance of these forces is difficult to predict, especially because the policy climate is changing rapidly. Faster deployment of transportation and building electrification will contribute to larger load growth over time as well as a larger adoption of electric space cooling, which still has room for growth in California. On the other hand, growth of energy efficiency and demand response programs combined with stagnant economic growth could result in lower load growth over time.

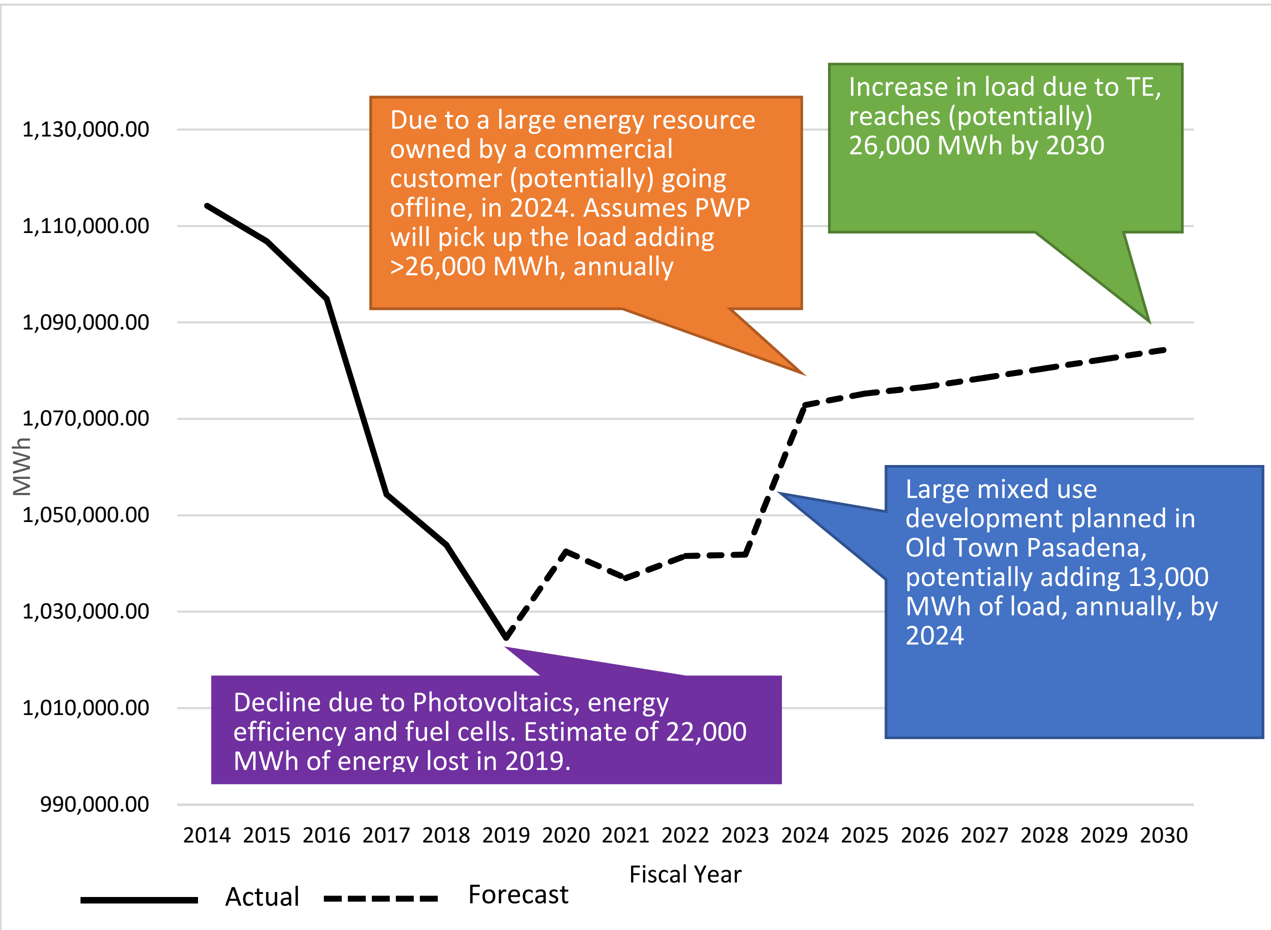
Policies that hinder or enable gas-to-electric switching in space/water heating, specifically those involving customer rebate incentives, are major drivers that will determine the trajectory of load growth over time. Furthermore, market structures for energy storage, electric vehicle charging, and energy arbitrage (through load control of water heaters and air-conditioning) will result in different trajectories of load growth.

Retail and System Load

PWP did not use the IRP dataset to develop the system load (also referred to as Net Energy Load "NEL," or gross load) and retail load forecast. After the development of the IRP system load forecast, PWP saw a sharp decline in retail load (as a result of photovoltaic "PV," fuel cell interconnections and loss of customers due to economic conditions). As a result, a new system and retail load was developed. It is important to note that the system load is 4% higher than the retail load. The 4% is due to historical distribution losses and is held constant for the load forecast study. Essentially, you would add another 4% to the retail load to get the system load. For example, if retail load was estimated at 1,000 GWh, then system load would be 1,000 GWh*1.04, to get 1,040 GWh, to account for distribution losses.

The forecast was developed for retail load (the billed retail sales) using historical data, coupled with planned project additions/subtractions and transportation electrification ("TE"). PWP did not separately account for energy efficiency on top of these adjustments, given the sharp decline PWP has seen over the last few months. Below is the graphic of the retail sales load forecast and actual data, with notes.

Figure 4: PWP Retail Sales Forecast



Details on Forecast by Customer Class (Retail Load)

Table 2: PWP Retail Load Forecast By Customer Class

Customer Class	Notes on forecast for FY 2020 and beyond
Residential Customers	Average of fiscal year 2019 forecast* and 2018 actual data, adjusted for future load additions or subtractions
Commercial Customers	Fiscal year 2019 forecast, adjusted for future load additions or subtractions
City Accounts	Fiscal year 2019 forecast, adjusted for future load additions or subtractions
Misc.	Fiscal year 2019 forecast
TE	Load forecast assumes a 2.3 million EV requirement for CA, by 2030. Assumes PWP only reaches 50% of their share of CA vehicles. PWP assumed to be .79% of California's registered vehicle population. For example, under this calculation, at .79% share of registered vehicles, Under its share of 2.3 million cars, PWP's soft target for # of EVs should be at 18,201 EVs by 2030, but PWP estimates 9,100 EVs. The difference in PWP expectations vs. forecast is due to the estimated # of EVs in PWP territory today.

**note, the FY 2019 data was developed using the FY 2019 actual data for July- December and adjusted by the same percentage January-June made up in FY 2018. For example, if the FY 18 data showed that July-December was 60% of the load, then the forecast for that rate class would be 40% additional load (based on the FY 2019 actual data) for the remainder of FY 2019. Overall, 54% of the load is estimated to capture July-December data, so the rest is estimated to be 46%, based on historical trends- specifically, FY 2018 loads.*

Planned Project Additions/Subtractions

Though these should be classified in a rate category, the IEPR requires this line item be reported separately. All of these items impact the commercial class only.

On a quarterly basis, PWP meets with the City Planning Department, Power Delivery Division, Key Accounts Manager and others, to discuss potential departing load (as well as potential load additions). The data is proprietary, in references to specific customer demands. The reason for this meeting is to understand the economic conditions of the City. At this meeting, there is a discussion on many items, including; planned projects, permits to construct and interconnection requests.

Transportation Electrification ("TE")

Though the TE load should be in a rate category, the IEPR requires this line item be reported separately. It is estimated that 70% of TE load impacts residential customer load and 30% of TE load impacts commercial customer load. Pasadena used its internal TE analysis, rather than the IRP analysis developed by Siemens. The TE forecast for the IEPR is from PWP Staff and is slightly different than the IRP forecast; the PWP and IRP consultant number have a variance of less than <1%.

- **<u>Assumptions for TE:</u>**
  - Assumes PWP's share of DMV registered vehicles in .79% (based on 2014/2015 data)
  - Assumes PWP only meets 50% of the CEC 1.5 EV cars assumption by 2025 (scales up to 2.3 million cars by 2030)
  - Assumes each EV uses 2,843 KWh annually
    - Based on average profiles of Tesla, Leaf, Volt, C-max, Bolt, Kia Soul EV, BMW i3, etc.
    - Assumes average of
      - 34 miles a day, 5 days a week, 49 weeks a year
      - 45% highway
      - 1,000 "other" miles, annually

Figure 5: PWP Transportation Electrification Forecast MWh Annually

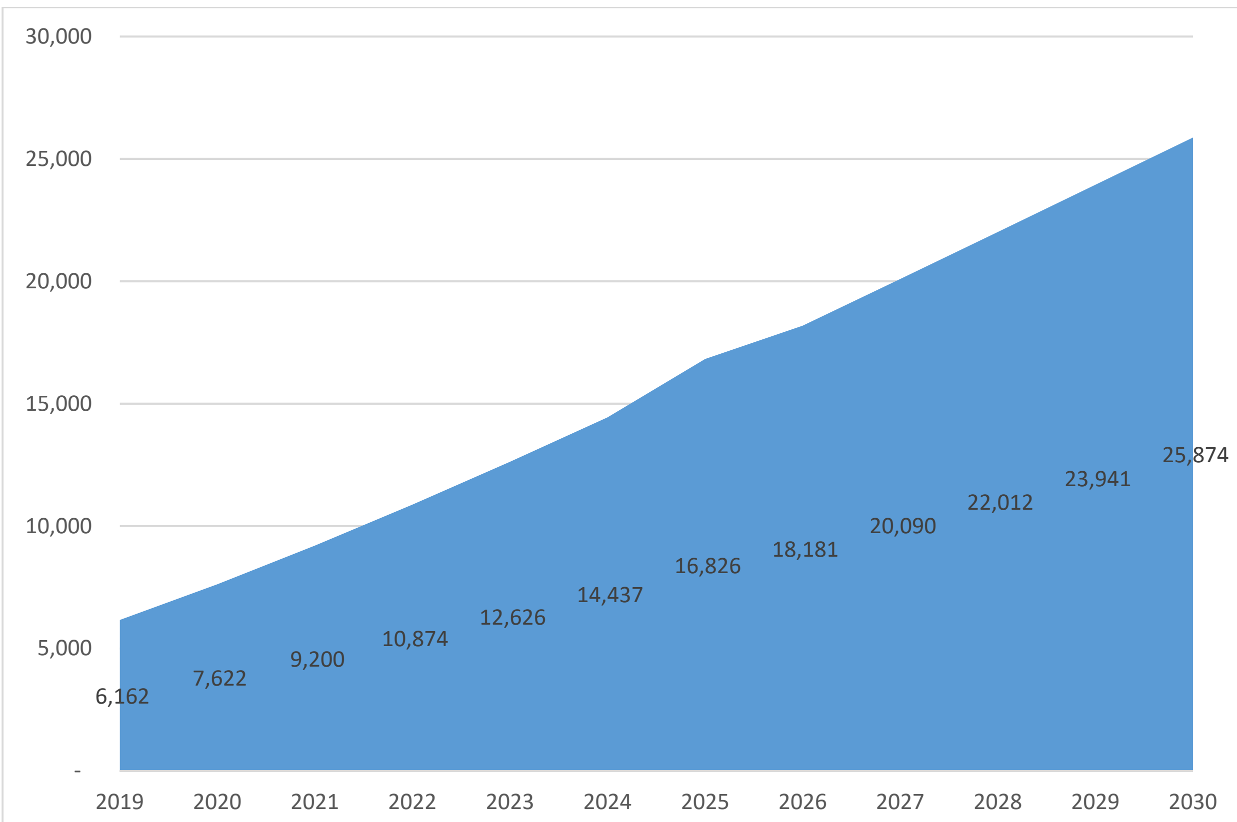
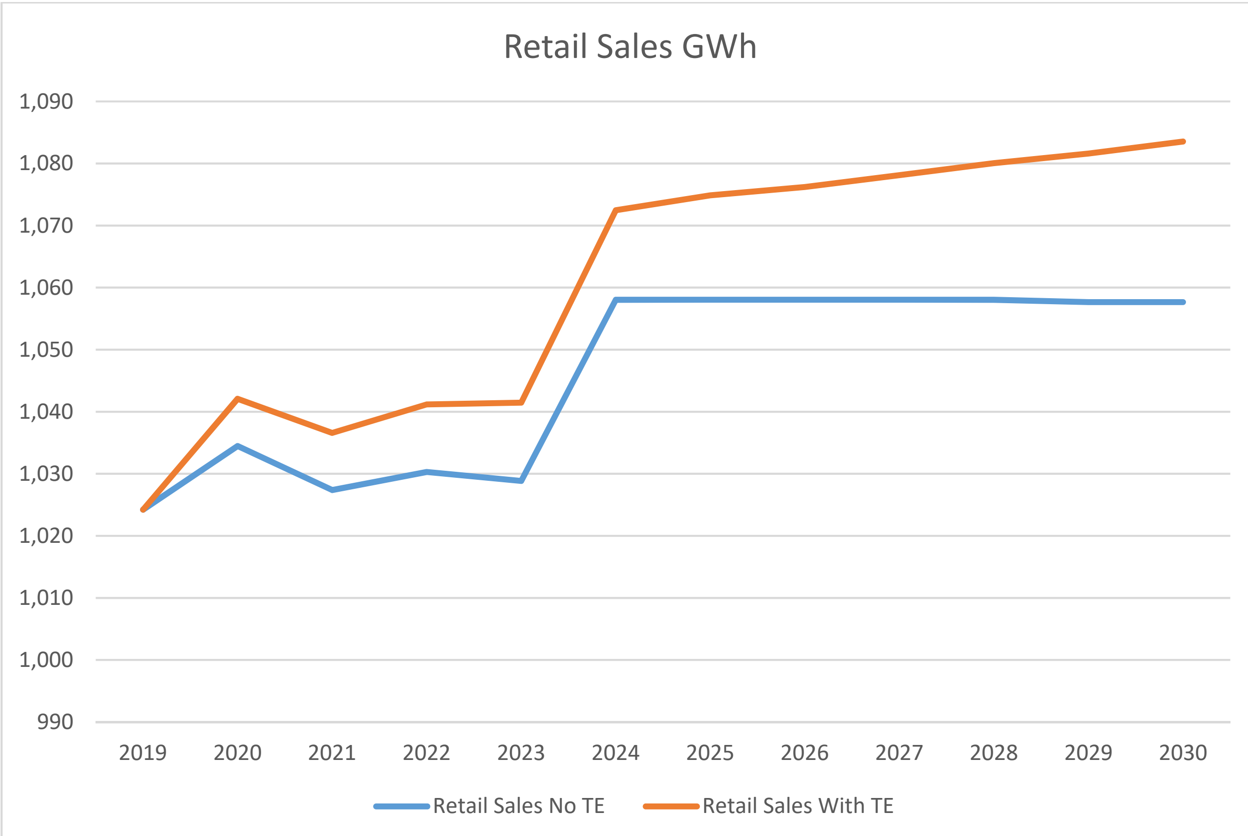


Figure 6: PWP Retail Sales Forecast GWh Annually



Energy Storage

Per the AB 2514 filing in 2017, PWP has no plans to add energy storage in the near future, due to the high price (compared to renewable resources), lack of information on how to dispose of the batteries and limited energy capability. In the PWP IRP, energy storage was not selected due to price. However, if the duration of the batteries and price were to improve, this may be a viable option in the future. The link to the PWP AB 2514 report is here: https://ww5.cityofpasadena.net/water-and-power/wp-content/uploads/sites/54/2017/08/EnergyStorageReport_2017.pdf

Differences Between Historical and Forecasted Growth Patterns

The retail and system load takes into account historical usage, coupled with planned (or reduced) load as result of communications with the Planning department, Power Delivery Division and Customer Relations Division and an in depth review of energy efficiency and load offsets due to PV installations.

Additional Forecast Details

Forecast Calibration Procedures

Peak Load

For the peak load, please refer to section "Method for Forecasting Electricity Demand Components-Peak Load," above.

System Load

For system load, the analysis was developed using excel and looking at historic data and using averages. Calibration, using graphs and comparing to historical data was used. As mentioned above, the retail load was developed and a 4% adjustment (on top of retail load) was added to develop the system load forecast. The 4% represents the PWP distribution losses.

Economic and Demographic Data

Peak Load

For the peak load, please refer to the section "Method for Forecasting Electricity Demand Components-Peak Load," above.

Retail Load

On a quarterly basis, PWP meets with the City Planning Department, Power Delivery Division, Key Accounts Manager and others, to discuss potential departing load (as well as potential load additions). The data is proprietary, in references to specific customer demands, but overall, below is an estimate of the annual load additions/subtractions as a result of these meetings. The reason for this meeting is to understand the economic conditions of the City. At this meeting, there is a discussion on many items, including; planned projects, permits to construct and interconnection requests.

Overall, PWP staff is seeing a major decline in system load due to efficiency (new buildings are using less load than the building or sites they are replacing), more customers are installing PV and other on-site energy usage. The planned additions are a results of on-site generation terminating for a major customer, a large project development in Central Pasadena, as well as increased transportation electrification efforts.

Historical Peak and Projected Peak Loads

For the peak load, please refer to the section "Method for Forecasting Electricity Demand Components-Peak Load," above.

Energy and Peak Loss Estimates

The estimation for distribution Losses is round 4%. This estimate is based on metered data at the sub-station versus the retails sales billed or metered to customers, using historical data.

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

PWP does not have any direct access customer and is not impacted by Community Choice Aggregation (CCA) since it is a publicly owned utility (POU). However, PWP is impacted by departing load through installation of PV installations, fuel cell installations and more efficiency. On a quarterly basis, PWP meets with the City Planning Department, Power Delivery Division, Key Accounts Manager and others, to discuss potential departing load (as well as potential load additions). The data is proprietary, in references to specific customer demands, but overall, below is an estimate of the annual load additions/subtractions as a result of these meetings.

Weather Adjustment Procedures

A normal weather projection of 1-in-2 was used for the peak forecast. Weather patterns were not directly used to forecast for total system load. As mentioned above, total system load was developed using historical data, adjusted for planned peak additions, subtractions and TE, only.

Hourly Loads by Subarea

An hourly load by subarea forecast was NOT developed or used and is not available.

Local Private Supply Estimates

Local private supply estimates, on an historical level are included in all past demand data and also included in the forecast. Estimated for local private supply are included in the analysis for planned peak projections and subtractions- this includes future fuel cells and PV installations (that PWP is aware of). No estimates or forecasts were developed to figure out additional local private supply- PWP only used data it is aware of, via permits and interconnection requests.

Energy Efficiency and Demand-Side Management

For planning purposes, a 13,500 annual load reduction as a result of energy efficiency is projected. However, due to a large decline in retail load, energy efficiency was captured through actual datasets and assumed to be consistent, annually.

Climate Change and Electrification

PWP developed a forecast for transportation electrification, using data available through the CEC. Please refer to the Transportation Electrification Section under "Method for Forecasting Electricity Demand Components," above for more details.