



Southern California Edison
Preferred Resources Pilot

**2016 Portfolio Design Report
Revision 2**

January 31, 2017

This page intentionally left blank.

Table of Contents

- 1. Executive Summary..... 5
- 2. Purpose 7
- 3. Background..... 8
 - a. Genesis of the Preferred Resources Pilot (PRP) Program 8
 - b. Johanna and Santiago Substation Areas 8
 - c. PRP Objectives 10
- 4. PRP Portfolio Design Process 11
 - a. Overall Process Definition and Components 11
 - b. Development of Starting Point Peak Load..... 11
 - Inputs..... 12
 - Assumptions..... 12
 - Methodology 12
 - Findings..... 13
 - c. Forecasting of the Distribution Load Growth..... 13
 - Inputs..... 13
 - Assumptions..... 13
 - Methodology 14
 - Findings..... 14
 - d. Fluctuations in Forecast 15
 - e. Development of Johanna and Santiago Substations 2022 Load Shapes..... 17
 - Inputs..... 17
 - Assumptions..... 17
 - Methodology 17
 - Findings..... 18
 - f. Development of Preferred Resources Attributes 19
 - Inputs..... 19
 - Assumptions..... 19
 - Methodology 20
 - Findings..... 20

- g. Determination of the Preferred Resources Selection for the PRP Portfolio 23
 - Inputs..... 23
 - Assumptions..... 23
 - Methodology 24
 - Findings..... 24
- 5. Conclusion 25
- 6. References..... 26
- 7. Appendices 27
- 8. Acronyms..... 31

1. Executive Summary

As California moves toward a low-carbon future, the State and SCE are increasingly looking to clean sources of energy to meet energy and reliability needs. Several performance assumptions have been made about clean energy resources, in particular by state agencies, to meet the needs resulting from the closure of the San Onofre Nuclear Generating Station (SONGS) and the impending retirement of nearby once-through cooling (OTC) power plants. SCE is faced with the unique opportunity, which is pursued through its Preferred Resources Pilot (PRP), to investigate if and how Preferred Resources will allow SCE to meet local needs at the distribution level and manage or offset projected electricity demand growth. This investigation is being carried out in South Orange County, an area, among others, affected by the closure of SONGS. In particular, the PRP is focused in the area served by Johanna and Santiago (J-S Region) substations.

As a whole, the PRP seeks to support SCE's grid modernization efforts, demonstrate the ability to acquire and deploy sufficient Preferred Resources in highly urban areas, provide SCE with insight into the locational value of Preferred Resources, improve the operations and integrations of Preferred Resources and facilitate greater customer choice for meeting their energy needs.

Two PRP Portfolio Design Reports (PDR) have been published since the launched of the PRP; in 2014 and 2015 respectively. This 2016 Portfolio Design Report updates the attributes information for the Preferred Resources needed to meet the expected incremental load growth – approximately 238 MW through 2022. For purposes of assessing the area needs, this PRP portfolio starts with the acquired Preferred Resources through yearend 2016 and identifies the remaining gaps to meet the expected peak load shape.

The current portfolio of 260 MW of acquired Preferred Resources can meet most of the potential 1 in 10 year, 2022 expected peak load growth. Meeting most of the forecast peak with the current acquired portfolio assumes load growth tracks to the current forecast, and all executed contracts are approved, come online and perform as expected. A 20 MW resource gap remains than can be met through ongoing programs or procurement efforts. Therefore, at this point, SCE will not pursue additional targeted solicitations to meet the objectives of the PRP.

Key 2016 Changes

- Expected 2022 load growth for Johanna and Santiago, combined, decreased from ~275 MW in 2015 to ~238 MW in 2016.
- Average load growth rate decreased to ~24 MW/year, a 3.5 MW dropped from 2015.
- The change in forecast is driven by a change in forecasting methodology whereby the evaluation determines if the new load of known projects will drive a new circuit peak.
- Based on the load shape analysis for Johanna, the number of events expected above the baseline decreased from 39 to 8 and for Santiago, the number of events expected decreased from 40 to 20. There are two key drivers affecting the changes in frequency of need: 1) the overall decrease in capacity need from a lower load forecast; and 2) a change in the load shape analysis which now scales only the two weeks around the yearly peak to the 2022 criteria projected load peak to simulate 1 in 10 heat storm condition. Previously the entire load shape was scaled up to a 1 in 10 heat storm condition.
- Given the acquired Preferred Resources and remaining resource gap, the portfolio size needed to meet the load growth is 280 MW, a 36% decrease from the 437 MW Recommended Portfolio in the 2015 Portfolio Design Report. A higher acquisition of

DR, the addition of hybrids coupled with a downward trending load forecast has resulted in a smaller portfolio need than prior PRP Portfolio Design Reports.

SCE will continue, as part of the annual planning process, to evaluate changes to the distribution forecast, and Preferred Resources deployment progress and delivery capabilities to ensure the right resources can meet the local area needs at the right time.

2. Purpose

This document describes the analysis and results associated with the PRP portfolio design process. The objective of this process is to provide guidance regarding the type and quantity of Preferred Resources to be acquired to manage load growth to net-zero in the J-S Region, the basis of which is described in the "Background" section below. The results consider the operational constraints — availability, duration, and intermittency — of the Preferred Resources.

For purposes of the PRP portfolio design, Preferred Resources include the following:

- Energy efficiency (EE) resources that are quantified based on ex-ante savings estimates as reported to the CPUC for those upgrades that can be directly tracked to the PRP location
- Demand response (DR) resources that are expected to deliver a measurable impact at a customer's meter during peak hours as monitored by the PRP measurement process.
- Eligible Renewable Resources (ERR), including Behind-the-Meter (BTM) renewable resources that are expected to reduce a customer's load and may deliver excess energy to the distribution grid, and In-Front-of-the Meter (IFOM) renewable resources that can either help meet load growth or provide resource adequacy benefits.
- Energy Storage (ES) resources that can either help meet load growth or provide resource adequacy.
- Combined Heat and Power (CHP) and Fuel Cells (FC) fueled by eligible renewable resources.

3. Background

a. Genesis of the Preferred Resources Pilot (PRP) Program

At the launch of the PRP in 2013, there was a concern Southern California's Western Los Angeles (LA) Basin could be particularly impacted by the retirement of SONGS and impending closure of OTC generating plants by 2020. The loss of these generating assets created capacity replacement needs that, if not met, could have challenged system reliability. These reliability concerns range from thermal overload to voltage collapse. Among other objectives, the PRP sought to offset load growth and defer the need for additional gas-fired generation.

In 2014, the CAISO released analysis showing that the Southwest sub-area of the Western LA Basin, which includes the Johanna and Santiago A-bank substations, is the most effective area to site resources in the Western LA Basin to meet the area's long-term local capacity needs. The PRP region is served by the Johanna and Santiago A-bank substations. In addition to being impacted by the retirement of generating plants previously mentioned, the PRP region is also experiencing population and business growth resulting in an increased peak demand.

Currently, there are mitigation actions being pursued to ensure reliability in the Western LA Basin. These actions include transmission projects and a portfolio of resources procured through SCE's and SDG&E's Local Capacity Requirements solicitations. Assuming these actions come to fruition and perform as expected, they should meet the reliability needs in the Western LA Basin through 2020, pending further findings from CAISO.

A unique opportunity exists for SCE through the implementation of the PRP to advance the use of Distributed Energy Resources (DERs) by determining the ability of locally sited Preferred Resources¹ (PRs) to offset the growing load in the PRP region and validate that PRs can deliver what is needed, when needed, and for as long as needed.

b. Johanna and Santiago Substation Areas

Table 3.1 and Figure 3.1 provide a general description and map of the J-S substations and supporting B-Banks, respectively. Figure 3.2 is a representation of SCE's transmission system in the area.

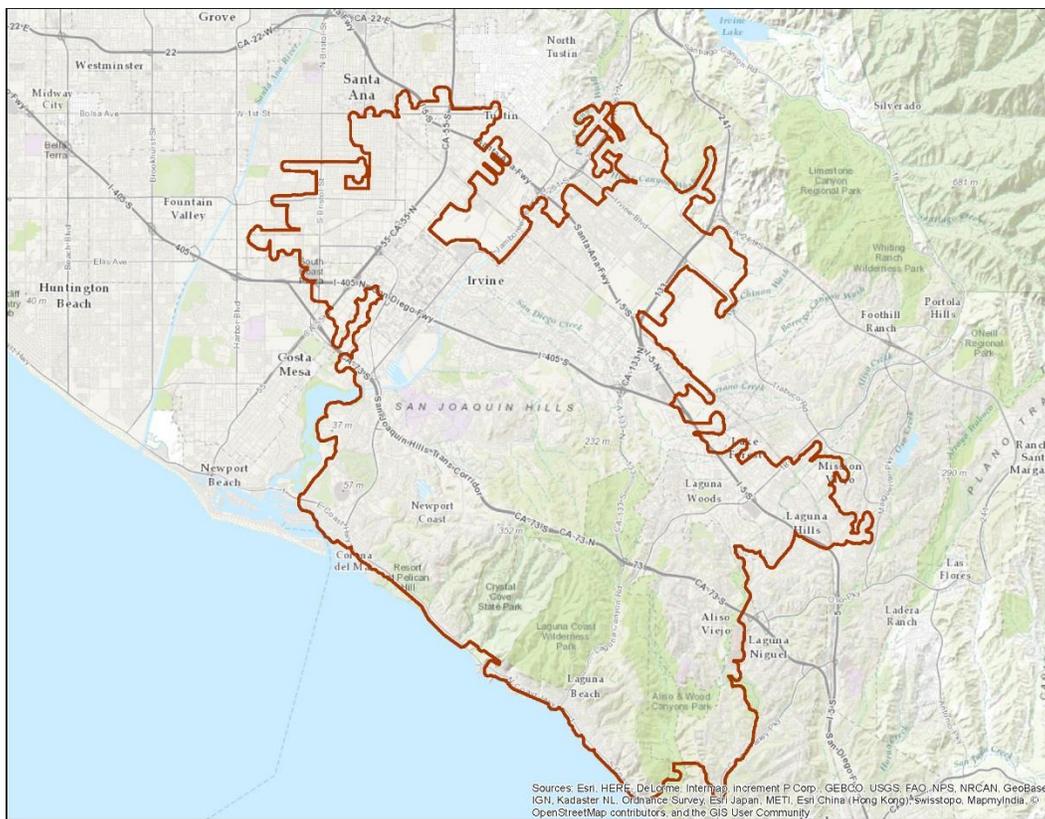
¹ Preferred resources are defined in the State's Energy Action Plan II, at page 2, as follows: "The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs. After cost-effective efficiency and demand response, we rely on renewable sources of power and distributed generation, such as combined heat and power (CHP) applications. To the extent efficiency, demand response, renewable resources, and distributed generation are unable to satisfy increasing energy and capacity needs, we support clean and efficient fossil-fired generation." Energy storage is a potential enabling technology, but is not a Preferred Resource because it stores power regardless of how that power is produced. However, in this document, similar to the CPUC decision, the PRP also includes energy storage in the category of preferred resources for ease of use unless otherwise noted. Additionally, the term distributed generation in this document refers to renewables and CHP interconnected at the distribution grid level, such as Solar PV in-front-of-the meter and behind-the-meter.

Table 3.1: General Description of Johanna and Santiago Substations

	Johanna	Santiago
2013 Peak Demand*	452.8 MW	819 MW
Customer Characterization	Primarily commercial	Mix of commercial and residential
Supporting 66/12 B-Banks (# of Circuits)	Cabrillo (19) Camden (7)	Borrego (8) Crown (10)
	Chestnut (14) Fairview (12)	Estrella (14) Irvine (8)
	Johanna (9)	MacArthur (10) Morro (5)
		Moulton (13) Niguel (7)
		Santiago (17)

* 2013 Peak demand value is based on recorded Criteria Project load obtained from SCE’s 2014-2023 A-Bank Plan and represents the current baseline to establish the point above which the PRP seeks to manage load growth to net zero.²

Figure 3.1: Map of J-S Region in Southern Orange County



² The Criteria Projected Load is the forecast starting point based upon recorded data adjusted up to the expected value in a 1 in 10 year heat storm. In further iterations of the PRP Portfolio Design Report the team will look into establishing the baseline based on peak power flow models to plan the amount of preferred resources needed to manage load growth to net zero.

c. PRP Objectives

The PRP seeks to:

- Support SCE's grid modernization efforts by designing, acquiring, implementing and measuring a portfolio of PRs to determine whether locally-sited PRs are able to offset the growing load in the PRP region.
- Demonstrate whether it is possible to acquire and deploy sufficient DERs in a highly localized manner in urban areas, including down to the circuit level.
- Provide SCE with insight into the locational value of DERs with targeted, local, technology neutral, competitive solicitations, as opposed to other sourcing options, such as territory-wide solicitations, programs, and tariffs.
- Develop new or revised processes for integrating and operationally managing DERs as they potentially become more than 20% of the resources serving the J-S Region.
- Facilitate customer choice for meeting their energy needs through cleaner resources by providing additional sourcing avenues through alternative energy service markets.

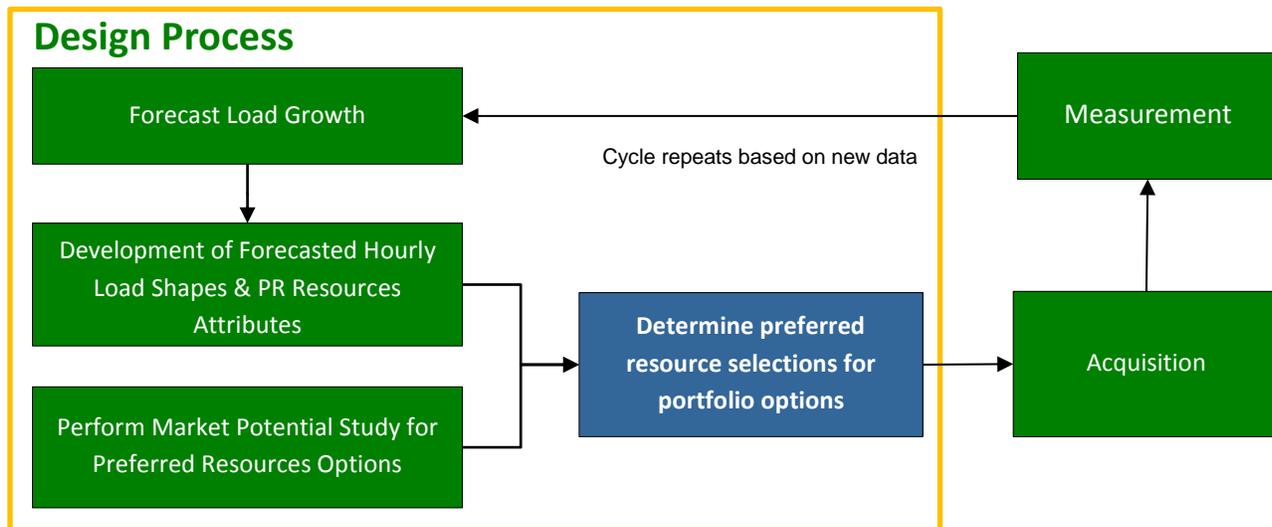
A key expected outcome from implementing a Preferred Resources portfolio to address local peak needs and meet local capacity requirements is that load-growth will be managed to net zero. Based on this 2016 portfolio design analysis, load in the J-S Region is expected to grow by ~24 MW/year through 2022. As Preferred Resources are added to the system, the PRP grid-level measurement of their performance will quantify the ability of Preferred Resources to manage load growth to net-zero.

4. PRP Portfolio Design Process

a. Overall Process Definition and Components

The objective of this process is to provide guidance regarding the type and quantity of Preferred Resources that will best meet the forecasted load needs in the J-S Region within the operational constraints of Preferred Resources (availability, duration, and intermittency). The steps involved in the portfolio design process are outlined in Figure 4.1 and described in more detail throughout this report. This design process is intended to be iterative. Both the addition of Preferred Resources and the development of new forecasts can trigger re-evaluation of the portfolio. Periodic re-evaluation of the entire process will be necessary to incorporate updates based on actual Preferred Resources performance measurements.

Figure 4.1: Preferred Resources Portfolio Design Process³



b. Development of Starting Point Peak Load

One of the first steps completed as part of the distribution load forecast process is a determination of the starting point peak (SPP) load. SPPs can be described as normalized peak demand values, where adjustments are made to recorded peaks based on the temperature, day of the year, abnormal conditions, generation, and other Preferred Resources (such as EE and DR) operating on the peak. The annual analysis leading to the development of SPPs for Johanna and Santiago was based on the following inputs and assumptions.

³ Market potential studies are located in the 2014 Portfolio Design Report Revision 0, starting on page 22 and the 2015 Portfolio Design Report Revision 1, starting on page 22. Both reports are available at on.sce.com/preferred-resources under Reports and Progress

Inputs

- **Raw Peak**: Raw trend data for 2015 summer peaks, obtained from the SCADA systems installed at Johanna and Santiago.
- **Temperature Adjusted**:
 - Daily effective temperature value, used to normalize peak loads for temperature impacts.
 - Mean peak effective temperature value, based on a historical assessment of yearly peak effective temperatures and used to adjust the peak load.⁴
- **Transfer/Abnormal Adjusted**: Data from transfers or abnormal events (such as outages) experienced during the 2015 summer peak season.
- **Date Adjusted**: A date/calendar normalization routine prorating load growth to adjust to the regular calendar year, based on the date the peak occurred in 2015 versus Sept. 15th (a constant date used to represent the end of summer for tool modeling and calculations).
- **Generation Adjusted**: Data on daily Solar Photovoltaic (PV) generation during the summer peak season, obtained from SCE's California Solar Initiative (CSI) team, grid interconnection data, and metered Solar PV generation data.
- **DR Adjusted**: DR load reduction during the 2015 summer peak season, based on values provided by SCE's DSM-DR programs.

Assumptions

- The difference between *daily* effective temperature and *mean peak* effective temperature, combined with a temperature sensitivity constant, contributes to the temperature adjustment.
- To ensure a conservative approach, the forecast assumes SCE will need to supply the "non-dependable" portion of Solar PV generation.⁵

Methodology

The SPP development process began by identifying a number of "raw" peaks from the SCADA system information. The peak values were then adjusted based on the difference between the daily effective temperature and the mean peak effective temperature. This step

⁴ Effective temperature is a calculated temperature value that more accurately represents a linear relationship between ambient temperature and peak demand.

⁵ The "non-dependable" and "dependable" Solar PV generation values were calculated by the Distribution Engineering team for Solar PV generators sized 1 MW or smaller. These calculations were based on a comprehensive Solar PV generation study which the team conducted across the SCE service territory to assess solar PV system output and intermittency (see Appendix A for graphic representations of the results). The portion of the Solar PV generation used as "dependable" is dependent on the timing of the peak demand at each circuit or substation. At the solar peak, Distribution Engineering has found that approximately 19% of Solar PV nameplate generation capacity can be considered "dependable" in SCE's service territory. The amount of PV counted as "dependable" might actually increase pending PRP measurement results. The "non-dependable" generation is the difference between the maximum output as a function of nameplate capacity and the "dependable" portion (minimum). For Solar PV generators sized larger than 1 MW, the Distribution Engineering team imputed the actual generation value based on SCADA information from substations. Since all 1 MW or greater generators are required to install telemetry, the system output can be measured. In situations where telemetry data is not available, the engineers may impute the information based on the same Solar PV study previously mentioned.

normalized the actual peaks to what would be expected if the temperature for the selected day was at the mean peak effective temperature. The peaks were then corrected for the effects of transfers and abnormal events, and also date-normalized, which prorated load growth based on the date the peaks occurred versus Sept. 15th. Next, a peak day was selected on which the adjusted peak demand best represented the typical peak demand of the corresponding substation.

Once the SPP day was selected, adjustments were made for actual conditions in the J-S Region.

Findings

Based on the methodology described above, the 2015 Starting Point Peak Load for the Johanna substation was determined to be 442 MW and for the Santiago substation was 812 MW. Compared to the 2014 SPP, the updated 2015 SPP is 10 MW and 12 MW higher for Johanna and Santiago, respectively. The 2013 SPP data is used as the summer peak baseline for the PRP.

c. Forecasting of the Distribution Load Growth

The next steps in the design process were forecasting load growth for the Johanna and Santiago substation areas and developing projected area peak loads through 2022.

Forecasting of load growth across SCE's service territory is an annual process conducted by SCE for distribution system planning purposes. The load growth forecasting and subsequent load projection process is a "bottom-up" process that aggregates expected load growth up from the circuit level to B and A substations:

Inputs

- Base growth, based on expected new load sources (that is, new residential, commercial, or industrial developments),
- "Dependable" Solar PV generation,
- Electric Vehicle (EV) impact based on information provided by the SCE Transportation Electrification team, as follows: EV nameplate data for each circuit, and demand curves for each year in the forecast with kilo-volt-amperes (KVA) demand implemented at the time of the circuit peak,
- Energy efficiency impact (based on the CEC's Codes and Standards Forecast and SCE's Energy Efficiency Programs Forecast), and
- Expected permanent load transfers. This input occurs after load growth forecasts are completed and is used to develop projected peak loads.

Assumptions

- Only "dependable" Solar PV generation is counted on for load growth projections.
- EE savings were proportionally allocated to the circuits based upon the energy usage of each sector (Agricultural, Commercial, Industrial, and Residential).
- A 1-in-5-year heat storm adjustment was used for A substation peak forecasting.

Methodology

In order to develop load growth forecasts, an assessment was conducted of all potential sources of load growth in the Johanna and Santiago substations through the year 2022, starting at the circuit and substation levels. This effort provided an estimate of the expected additional load SCE will likely need to serve. These incremental new loads can come from expected new residential, commercial, and industrial developments and projects. These incremental loads are evaluated to determine if the new loads growth (residential, commercial, agricultural, or industrial) coincide with the typical time of each substation and circuit peak. For the 2016 plan year, SCE incorporated the anticipated load profile for the new load from its load research team. By utilizing these load profiles, SCE was able to better correlate the impact of the new load to system needs. Historical growth trends in the area were also considered and adjustments made to the load growth number to reflect their impact. The outcome of this process is considered the "base" growth.

Subsequently, the forecasted "dependable" Solar PV generation and energy efficiency MWs were subtracted from the base growth, while the incremental increase in demand due to increasing penetration of EVs was added to the base growth. The net result of this step yielded the growth forecast for the J-S Region.

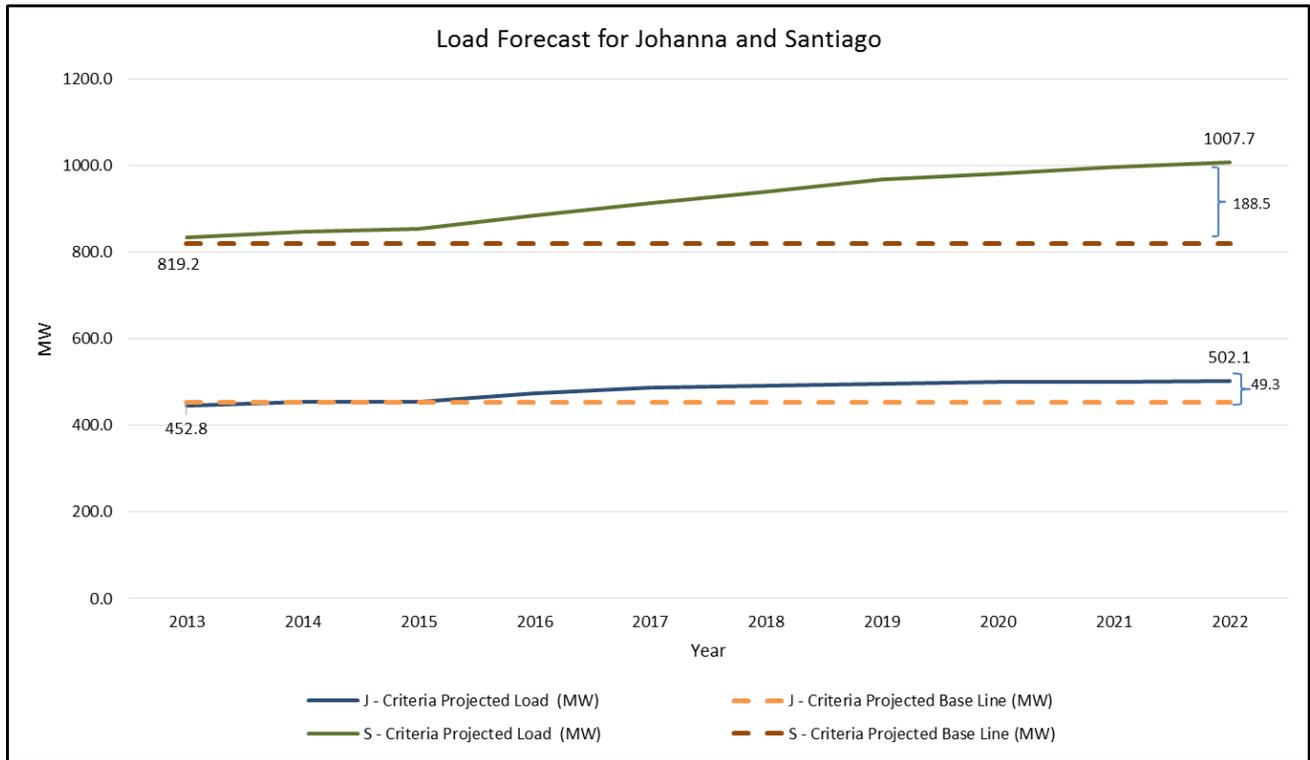
The next step in the process was to use the growth forecast values to develop projected loads for Johanna and Santiago through 2022. This was achieved by adding the growth forecast to the starting point peaks to develop the total projected loads. However, before finalizing the projected loads, two more adjustments were necessary:

- One adjustment involved accounting for any expected permanent load transfers by incorporating the impact of any such transfers into the projected loads.
- The other was to incorporate the 1-in-5-year heat storm adjustment to develop the final design criteria, based on the projected load forecasts for Johanna and Santiago. It should be noted that the 1-in-5-year heat storm adjustment may create a more conservative forecast.

Findings

Figure 4.2 provides a graphical representation of load growth in the J-S Region. These values show an approximate annual average load growth of ~24 MW for the two substation areas.

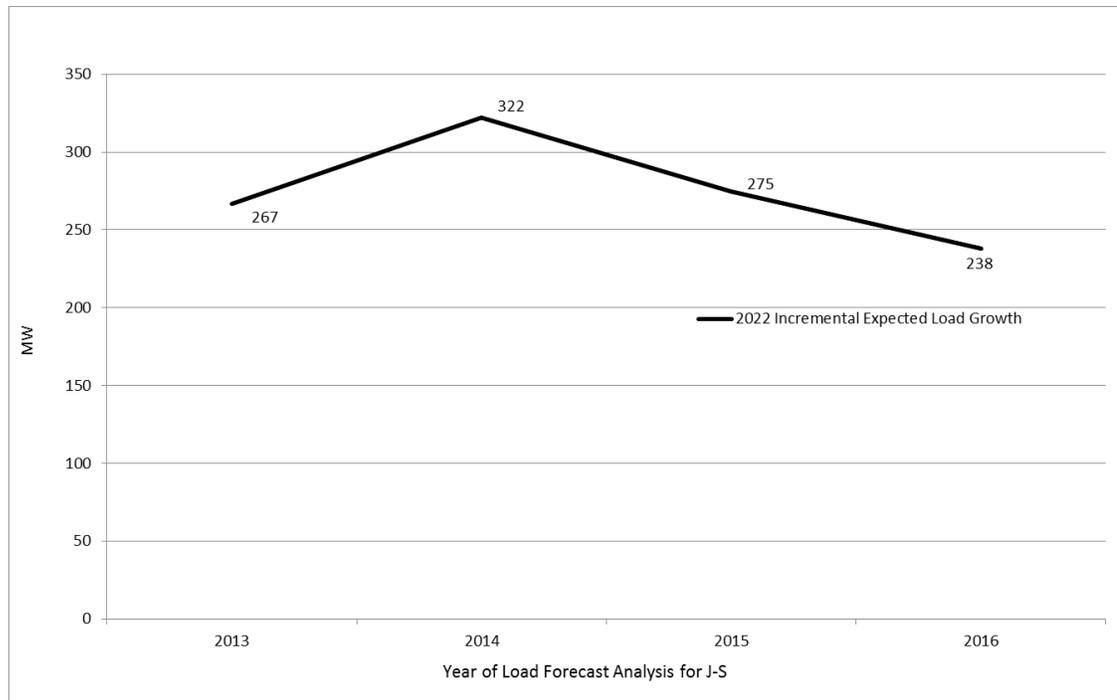
**Figure 4.2: Forecasted Criteria Projected Load Growth
— Johanna-Santiago Substation Region**



d. Fluctuations in Forecast

The load forecast discussed above is a key component of the PRP portfolio design process. Year to year fluctuations in the load forecast are to be expected in part as a result of changes in information about load growth projects, assumptions associated with distributed energy resources (DER) adoption rate and their impact on load, year over year temperature fluctuations, and economic and customer behavior changes. The expected incremental load forecast at the J-S substations has fluctuated since the launch of the PRP as depicted in Figure 4.3.

**Figure 4.3: Annual Incremental Load Growth above the 2013 Baseline
— Johanna-Santiago Substation Region**



As a new load forecast is completed, an analysis of the forecast is completed to better understand the key drivers impacting load. Following are key findings based on a year-over-year analysis of the J-S load forecast for the year 2022:

- After a sharp increase from a 2022 forecasted growth of 1,539 MW in the 2013 forecast to 1,594 MW in the 2014 forecast, the overall expected load growth in the J-S Region for the last two years has been declining.
- In 2014, forecasted load increased by 55 MW primarily due to new and updated known customer projects. Most of the new projects are residential developments.
- In 2015, forecasted load decreased 47 MW as a result of lower temperature adjustments in the starting point peak analysis, growth projects in 2014 not materializing, and an overall decrease in projected growth.
- In 2016, forecasted load decreased 37.2 MW as a result of now taking into account the coincidence of known load growth projects' demand and circuit peak to determine a projects actual contribution to the circuit peak.

Given the nature of forecast, SCE expects fluctuations in the forecast to continue. Nonetheless, significant load growth in the J-S Region and the opportunity to demonstrate PRs can offset load growth remains.

e. Development of Johanna and Santiago Substations 2022 Load Shapes

The next step in the process is the development of load shapes. Load shapes represent the fluctuating electrical demand over every hour of the day using the forecasted peak as the upper limit to the load shape. The forecasted load shapes enable the identification of hourly demand needs.

Inputs

- Distribution Criteria Projected Load (A-bank) forecasts for J-S Region through 2022.
- Historical substation-level hourly load data (peak) for Johanna and Santiago, based on SCADA system information for 2008.
- Distributed DG PV, EE, trending growth, known customer growth projects, and load transfers through 2022.

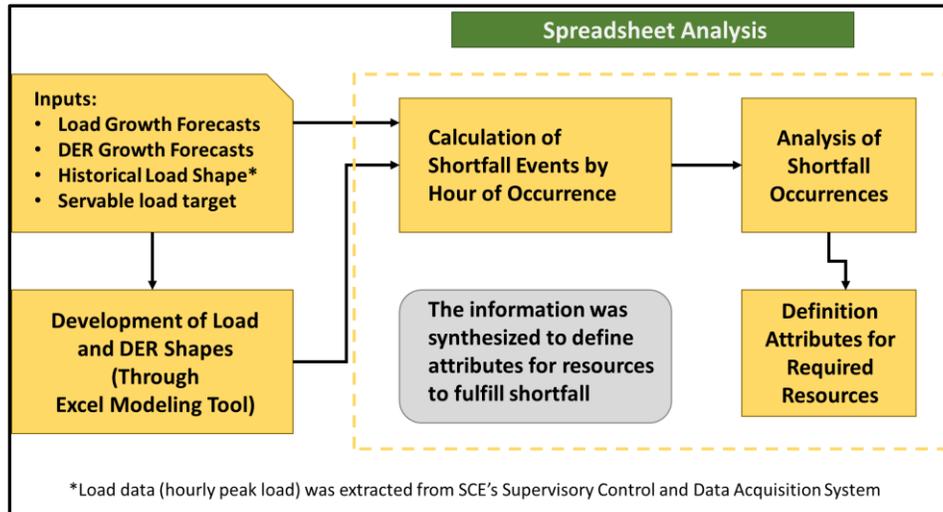
Assumptions

- For modeling purposes, sufficient resources exist to meet the Johanna and Santiago loads up to their respective historical peaks. Resources assumed included imports as well as local J-S supply and demand resources.
- For consistency, the historical 2008 load shape was used as the basis for developing forecasted future load shapes.
- To account for potential changes in future load shapes the forecast integrated separate forecasts for DG PV, EE, trending growth, and known growth projects
- Separate load shapes for Johanna and Santiago were developed (rather than a single "aggregated" J-S load shape), since at present there is limited ability to re-distribute load between the two substations.

Methodology

The J-S Region load was analyzed by scaling the region's 2008 recorded load to the 2015 starting point peak and then further scaling the load to the 2022 forecasted peak. This analysis was completed in SCE's circuit and substation load forecasting tool. The tool disaggregates the historical load into customer load, DG PV, and EV's. The customer load was further separated into trend growth and known customer growth. The load for each of these disaggregated components is forecasted separately to 2022 and then recombined and scaled to the 2022 normal weather projected peak. The two weeks around the yearly peak is then scaled to the 2022 criteria projected load peak. The criteria project load is a weather adjusted peak intended to simulate 1 in 10 year heat storm conditions. The entire process of defining forecasted load shapes and development of required attributes (described in the next section) can be seen in Figure 4.3.

Figure 4.3: Process Used for Development of Load Shapes and Resource Attributes



Findings

The updated forecasted 2022 load shapes for Johanna and Santiago are shown in Figures 4.4 and 4.5 below. These load shapes are further analyzed to identify the preferred resource attributes.

Figure 4.4: 2022 Forecasted Load Shape for Johanna Region

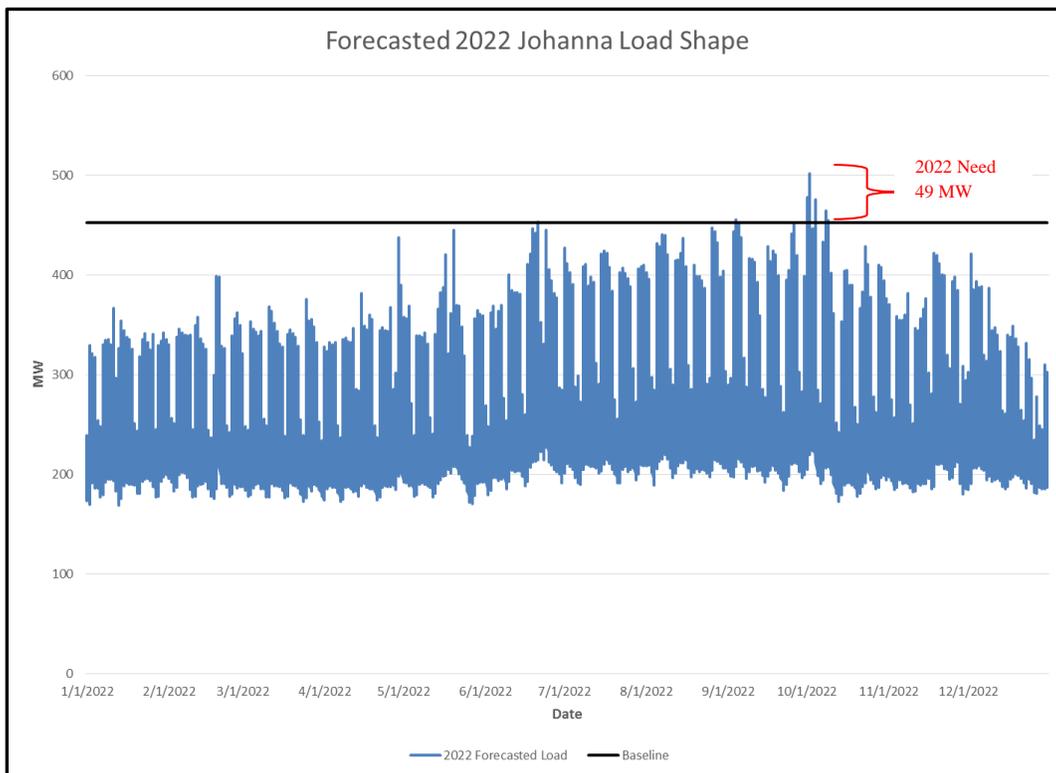
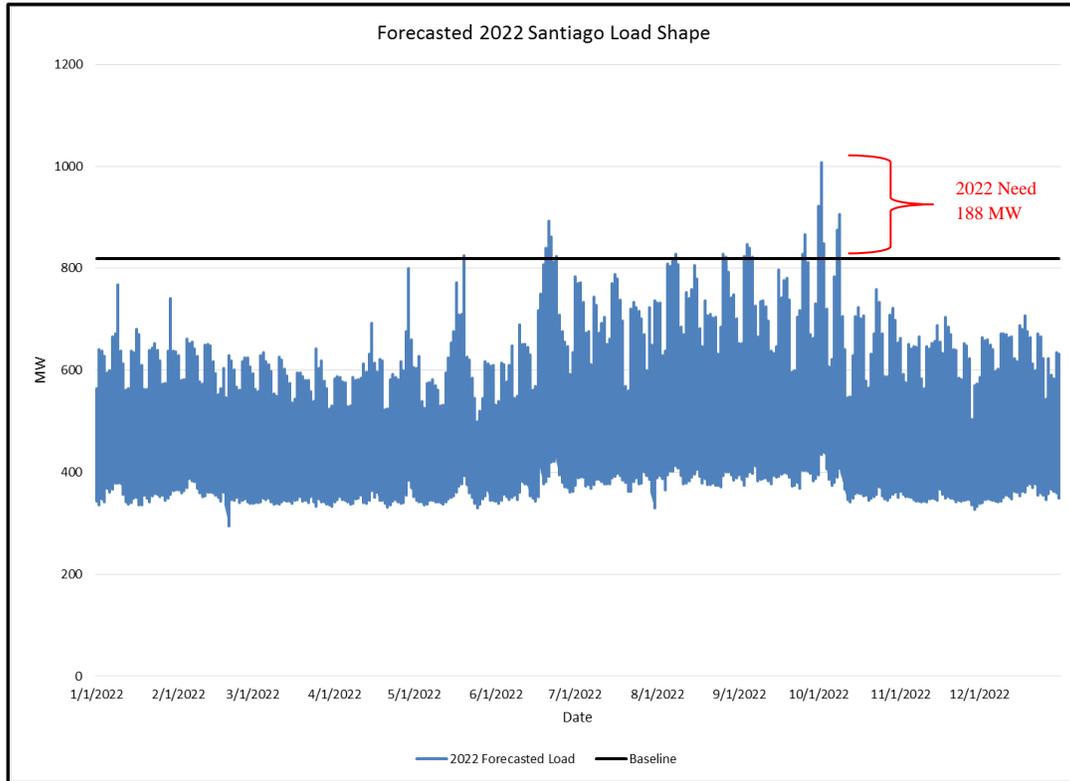


Figure 4.5: 2022 Forecasted Load Shape for Santiago Region



f. Development of Preferred Resources Attributes

Once the 2022 forecasted load shapes for Johanna and Santiago were developed, analysis is conduct of the demand above 2013 baseline. The demand above this line represents the incremental 2022 need to be served by Preferred Resources and defines the resource attributes (quantity, duration, frequency, timeframe / season, and time of day) required to meet those locational needs.

Inputs

- 2022 forecasted load shapes for Johanna and Santiago, and
- Criteria Projected Load forecast based on 2015-2024 A-Bank Plan.

Assumptions

- Sufficient resources exist to meet the Johanna and Santiago loads up to their respective 2013 Criteria Projected Load peak. This includes imports as well as local J-S supply and demand resources.
- To account for potential changes in future load shapes and patterns, and the limitations in using only seven years of historical data, the historical shape causing the most shortfall events was used.

- Separate resource attributes for Johanna and Santiago were developed (rather than a single aggregated J-S set of attributes), since at the time of the analysis there was limited ability to re-distribute load between the two substations.

Methodology

The analysis began with the 2022 forecasted load shapes for Johanna and Santiago, and subtracted the 2013 Criteria Projected Load for each respective substation. This process enabled isolation of that portion of each load shape that was above the substation's peak load. This portion of each load shape above the peak load represented the gap that needed to be offset and/or managed through the addition of Preferred Resources. The process and the peak load line are depicted in Figures 4.4 and 4.5, above.

Once the need portions of the load shapes were identified, the primary attributes were deduced from these "isolated" portions of the graphs, including the following:

- Quantity: number of MWs of Preferred Resources required
- Duration: 2 hours, 4 hours, 6 hours, or 8 hours of Preferred Resources required
- Frequency: number of times or days resources are required
- Timeframe/season: Preferred Resources requirements in different months and/or seasons of the year, and
- Time of Day: specific times.

This analysis provided "indicative" results which have an inherent degree of uncertainty because the analysis was based on inputs that include seven-year-forward peak forecasts and a limited volume of historical load shapes, with the assumption that these are representative of future loads. Recent refinements to the distribution forecast and load shape development methodologies are likely resulting in resource attribute needs that are more representative for a future state.

Findings

Key findings of the attribute analysis step include:

- Overall, the estimated value of the Johanna substation area need was found to be 49.3 MW of Preferred Resources by 2022, while the estimated value of the Santiago Region need was found to be 188.5 MW (as depicted in Figures 4.4 and 4.5, above).
- Table 4.4A identifies the MW, by duration, necessary to meet all forecasted need for 2022. Built from the bottom up, the MW required correlate to the duration of need, first for any need greater than 6 hours, then 4-6 hours, then 2-4 hours, and finally between 0-2 hours. The table also shows the number of events that correlate with the MW need. For instance, in Johanna, it's anticipated that 6 MW that can deliver for greater than 6 hours will be needed for minimally 8 days. A portfolio of Preferred Resources designed to meet the MWs required on Table 4.4A will also meet the expected load growth.
- Table 4.4B depicts the amount of MW required to meet any need in 2022 above the 2013 baseline — in other words, the expected load growth. SCE forecasts that in the year 2022 in the Johanna system there will be 8 days with a need of greater than 0- MW, 1 day with a need greater than 30 MW, and 1 days with a need greater than 45 MW.

- Figures 4.7 and 4.8 depict the 2022 hourly MW need for the forecasted peak day by respective substation.

Table 4.4A: 2022 Forecasted Peak Resource Attributes

2022 Forecasted Capacity Resource Attributes				
	Johanna		Santiago	
Duration	Days	MW	Days	MW
0-2 Hours	1	4	1	7
2-4 Hours	1	18	1	48
4-6 Hour	4	21	3	53
> 6 Hours	8	6	20	79

Table 4.4B: Forecasted MWs Required to Meet Any Need in 2022

Forecasted MW Required to Meet Any 2022 Need			
Johanna		Santiago	
MW Required	Days	MW Required	Days
> 60 MW	0	> 200 MW	0
> 45 MW	1	> 150 MW	1
> 30 MW	1	> 100 MW	2
> 0 MW	8	> 0 MW	20

Figure 4.7: Johanna Substation Hour-Ending Forecasted MW Need

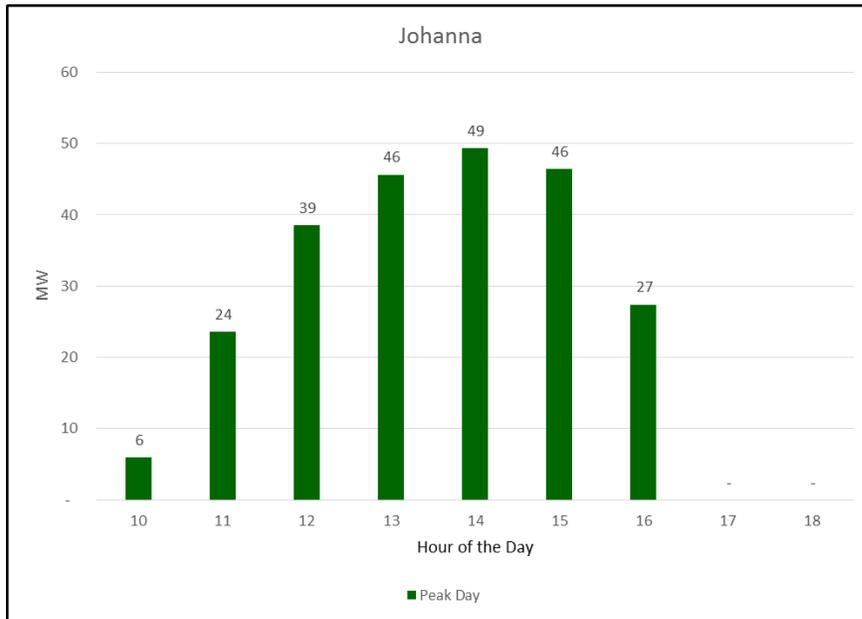
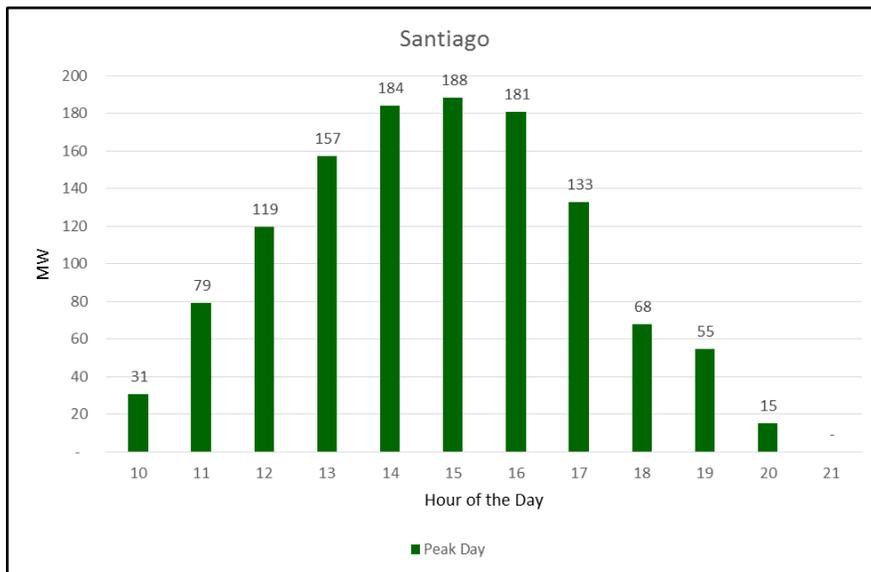


Figure 4.8: Santiago Substation Hour-Ending Forecasted MW Need



g. Determination of the Preferred Resources Selection for the PRP Portfolio

The final step in the portfolio design process involves a "best fit" selection of Preferred Resources to fill the gap between the 2013 baseline demand and the 2022 forecasted load shape based on the peak day demand. Since a portfolio of 260 MW of PRs, summarized by technology on Table 4.10, were already acquired, the small residual gap was evaluated to determine if changes were needed to the portfolio.

Inputs

- Required Preferred Resources by hour associated with the forecasted highest peak day in 2022, and
- Acquisition progress from January 1, 2014 – December 30, 2016.

Assumptions

- The preferred resource portfolio is aligned with the Loading Order.⁶
- Energy efficiency assumes a delivery profile based on HVAC and lighting technologies.
- DR is deployed in four-hour blocks and is used to reduce the peak. Based on the frequency of calls indicated by the attributes analysis, the DR product is expected to meet all of the 0-4 hour needs.
- A PV capacity factor or Solar PV load shape for BTM and IFOM was developed using the output in terms of percent of nameplate capacity at 15 minute intervals for approximately 40 behind-the-meter Solar PV systems in June through September 2014 and 2015 (see Appendix C). Using the standard deviation at each time interval, a 5th percentile curve was created (above which we would expect 95% of the data points to fall). The megawatts of PV procurement will be higher than the generation need to account for PV's capacity factor (and, therefore, the actual expected energy delivered to the grid rather than the nameplate capacity).
- Energy Storage assumes a 4-hour storage product that is dispatched incrementally in 4-hour blocks. Energy storage is used to reduce the peak when DR is not available or used to fill small gaps.

Table 4.10: PRP Acquisition Status to Date

Preferred Resource Type	MW ⁷
EE and PLS	72
DR (Load Reduction and Energy Storage)	73
Distributed Generation (BTM & IFOM)	39
Energy Storage (IFOM systems)	66
Hybrids	10
Total	260

⁶ See Footnote 1 above.

⁷ The MW amounts reflect the preferred resources acquired as of December 30, 2016. The amounts are approximate because utility program contributions are validated at yearend.

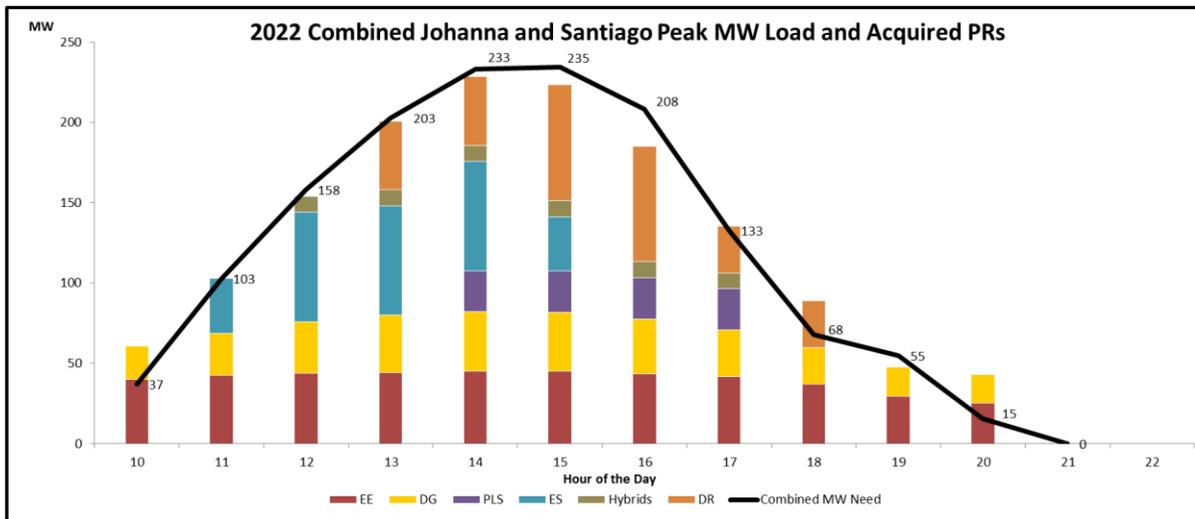
Methodology

The selection of best-fit Preferred Resources for the PRP portfolio was conducted by matching the acquired Preferred Resources by hour associated with the forecasted highest peak day in 2022.

Findings

- A portfolio of 280 MW of PRs can meet the expected 2022 load growth. This portfolio is 36% smaller compared to the 2015 PDR Recommended Portfolio of 437 MW. The reduction is due to the larger acquisition of DR, the acquisition of hybrids coupled and a downward trending load forecast. The portfolio has a residual resource net short in HE15 and HE16.
- The acquired portfolio depicted in Figures 4.10 results in a diverse portfolio of Preferred Resources that includes EE, DR, PLS, DG, ES and hybrids (DG and ES combined).
- While the acquired portfolio include a diverse mix of PRs, more than 67% is made up of some form of energy storage enabling DR, PLS or hybrids.

Figure 4.10: Recommended Case PRP Portfolio



5. Conclusion

The portfolio design processes and methodologies summarized in this report, including consideration of the operational constraints of the Preferred Resources (availability, duration, and intermittency), provide a sound approach for analyzing the type and quantity of Preferred Resources that can best meet the forecasted increase in J-S Region local demands.

Key conclusions from this process include:

- The 2022 J-S Region forecasted peak has decreased about 2% since the start of the PRP, from 1,539 MW to 1,510 MW. The incremental load growth has varied year to year due to updated information about construction projects, revised assumptions about distributed energy resources (DER) adoption rates and their impact on load, year over year temperature fluctuations, and economic and customer behavior changes.
- Key changes to the forecast and the load shape analysis had the greatest impact on the overall resource needs in the J-S Region, including:
 - Accounting for the coincidence impact of growth projects' to better determine the system needs.
 - A refined simulation of a 1 in 10 heat storm that scaled up to the 2022 criteria project peak only the two weeks around the historical peak instead of the entire annual recorded load.
- The forecast indicates there is one day where the peak need is 238 MW and two-three days where the resource need is expected to be up to 193 MW, in such cases, the contracted DR are capable of reducing the peak, assuming all other Preferred Resources contribute toward meeting the MW peak.
- The portfolio size needed to serve the 238 MW forecasted load growth in the PRP Region is about 280 MW based on:
 - Accounting for Preferred Resources time of day delivery limitations
 - Deploying the current 260 MW portfolio of acquired Preferred Resources, which assumes load growth tracks to the current forecast, and all executed contracts are approved, come online and perform as expected.
- The remaining 20 MW resource gap may be filled through deployment of PRs from SCE's DSM programs, additional contracted ES from additional ES RFOs, non-J-S specific Western LA Basin LCR contracts that overlap into the J-S Region, and natural adoption of Solar PV and ES, or generation assets that interconnect to either Johanna or Santiago.

The PRP Portfolio Design Report will be updated periodically to capture changes to the distribution forecast, progress on the deployment of acquired Preferred Resources and their performance capabilities.

6. References

2013 California Energy Efficiency Potential and Goals Study – Revised Draft. California Public Utilities Commission, November 26, 2013.

2009 California Residential Appliance Saturation Study. California Energy Commission, October 2010.

Commercial Saturation Survey. California Public Utilities Commission, August 2014.

Commercial Market Share Tracking Survey (CSS/CMST). California Public Utilities Commission, July 2014

7. Appendices

Appendix A. Results of SCE Distribution Engineering PV Study

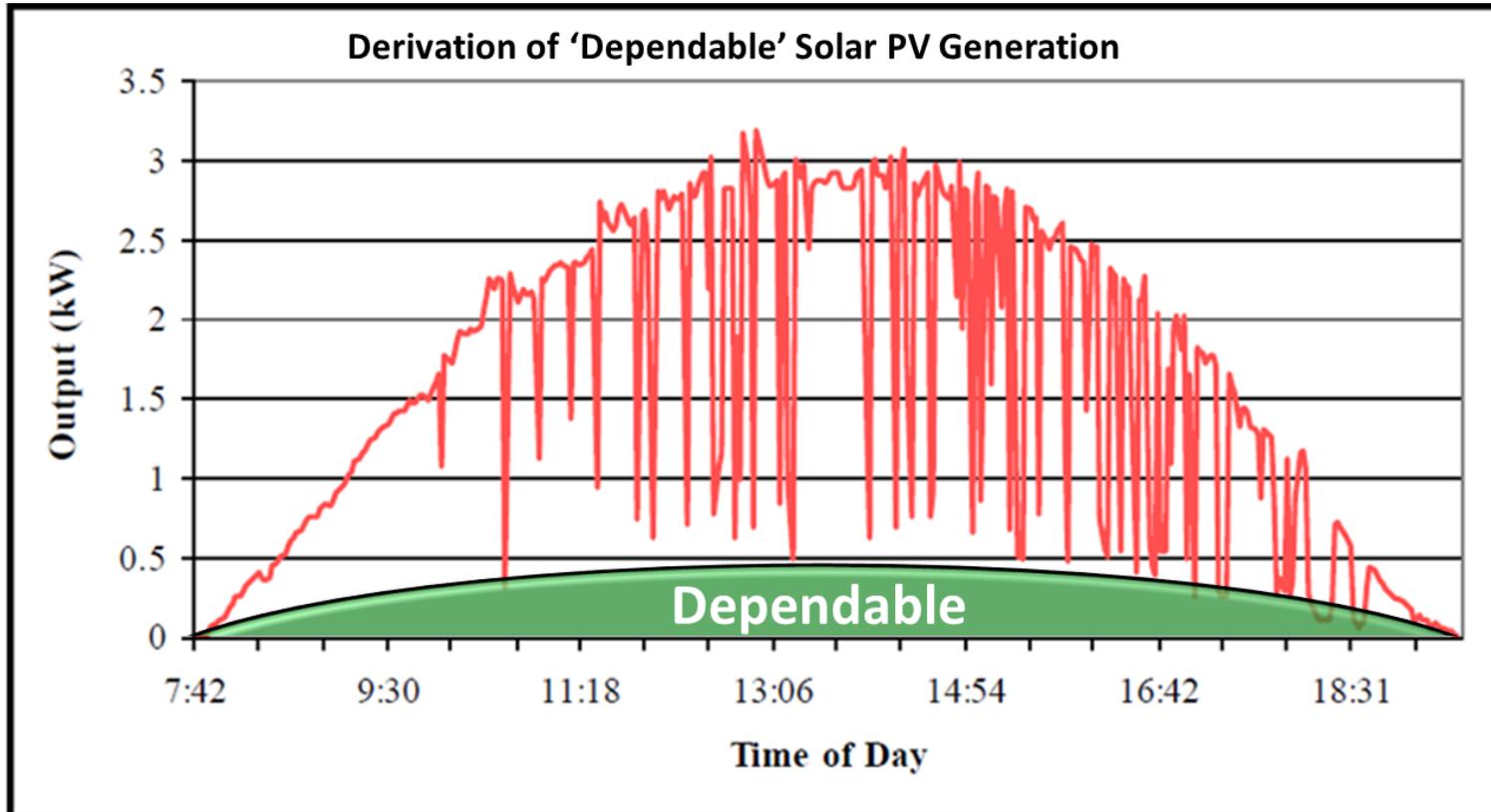
Page 28

Appendix B. Results of Solar PV measurement used to shape
Solar PV in development of portfolios

Page 30

Appendix A

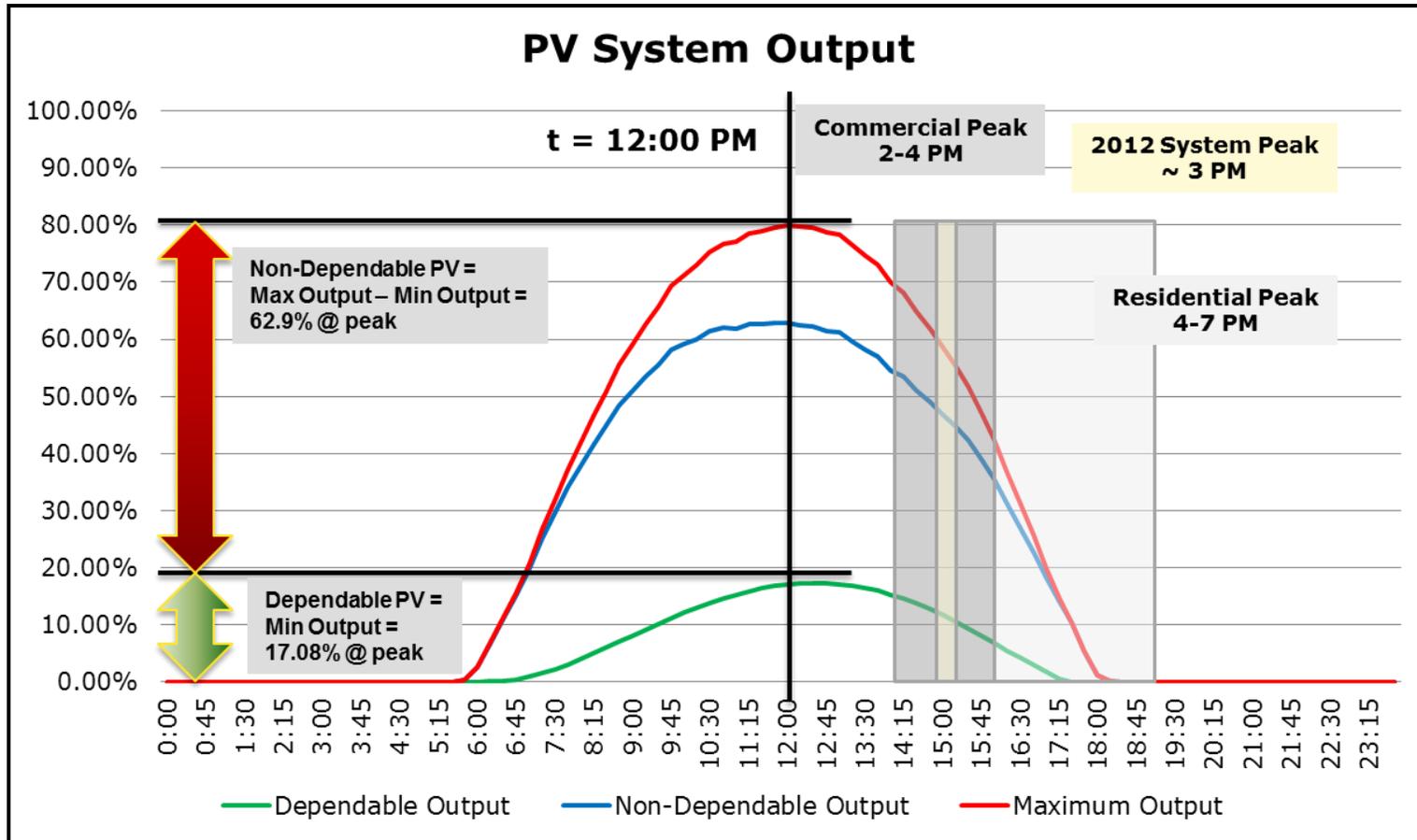
Results of SCE Distribution Engineering PV Study (continued on next page)



Source: CPUC California Solar Initiative 2009 Impact Evaluation

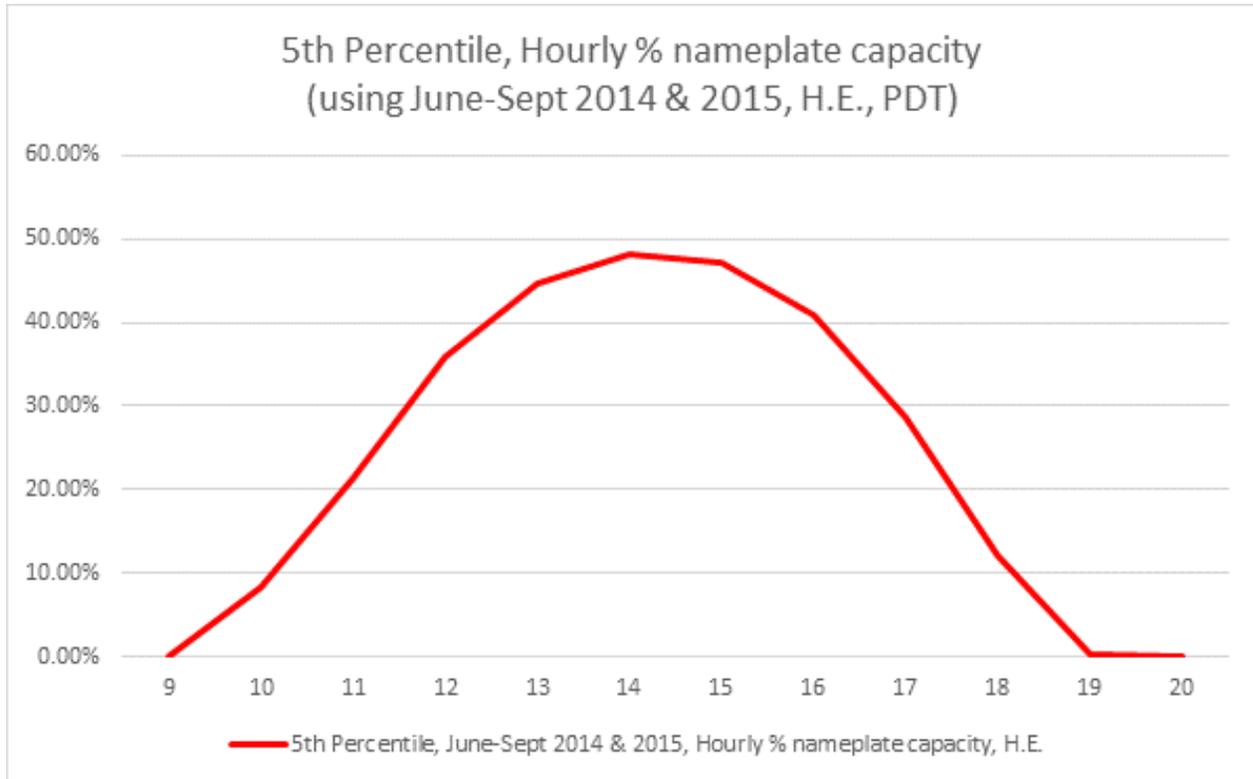
Appendix A

Results of SCE Distribution Engineering PV Study – (continued from previous page)



Appendix B

Results of Solar PV measurement



Traditionally, utility system planning activities use conservative assumptions to determine the contribution of future Solar PV installations to the peak need. In order to validate these conservative approaches and improve the confidence in the future performance of Solar PV, SCE completed a statistical analysis of historic Solar PV generation data particular to the J-S Region.

- SCE used two summers of “behind-the-meter” (customer-sited) Solar PV data from a subset of customers that report generation data via a separate meter on the solar array.
- The abnormalities were removed from the data, which was then used to calculate a curve of capacity factors at each hour, above which 95% of the Solar PV systems are typically generating, which is illustrated in the graph above.
- The PRP used the hourly capacity factors from this analysis (with a peak production of 48%) to shape the expected output of Solar PV accounted for in this portfolio design report.

Improving the planning assumptions for Solar PV resources will allow SCE to plan with statistical confidence and better account for contributions from Solar PV in order to better plan for system and resource needs.

8. Acronyms

AMI	Advanced Metering Infrastructure
BIP	Base Interruptible Program
BTM	Behind the Meter
CEUS	California Commercial End Use Survey
CHP	Combined Heat and Power
CMST	Commercial Market Share Tracking Survey
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
CSS	Commercial Saturation Survey
DR	Demand Response
DSM	Demand Side Management
ERR	Eligible Renewable Resource
EE	Energy Efficiency
ES	Energy Storage
EV	Electric Vehicle
FC	Fuel Cell
HVAC	Heating, Ventilation, and Air Conditioning
IFOM	In Front of the Meter
J-S	Areas Serviced by the Johanna and Santiago Substations
kVA	Kilo-volt-amperes
kWh	Kilowatt-hours
LCR	Local Capacity Requirement
MVA	Mega-volt-amperes
MW	Megawatts
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
OTC	Once Through Cooling
PDR	Portfolio Design Report

PLS	Permanent Load Shape
PR	Preferred Resources
PRP	Preferred Resources Pilot
PV	Photovoltaic
RASS	Residential Appliance Saturation Survey report
RTU	Rooftop Unit
SCADA	Supervisory Control and Data Acquisition
SONGS	San Onofre Nuclear Generating Station
SPP	Starting Point Peak