DOCKETED	
Docket Number:	21-ESR-01
Project Title:	Energy System Reliability
TN #:	241145
Document Title:	Staff Paper - Updated 2022 Summer Supply Stack Analysis
Description:	N/A
Filer:	Courtney Wagner
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	1/11/2022 3:09:00 PM
Docketed Date:	1/11/2022

California Energy Commission

STAFF PAPER

2022 Summer Stack Analysis Update

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January 2022| CEC-200-2021-006-UPDT

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ABSTRACT

The Summer 2022 Stack Analysis Report Update (Stack Analysis Update) provides near-term situational awareness on the potential impacts of a west-wide extreme weather event and prolonged drought in the critical months of July through September 2022. The analysis provides a reference point for consideration in energy reliability-related actions that the state may take.

The California Energy Commission's Stack Analysis Tool is used to identify the potential for a shortfall in planned resources and the amounts and duration of contingency resources that may be needed. This update includes changes in underlying assumptions for supply and demand since the first Summer 2022 analysis was published in August 2021 and reflects the significant progress made in the addition of new resources in 2021. The analysis continues to show the potential need for contingencies under extreme weather events in September, although at a much lower level than previously assessed.

Keywords: Stack analysis, system reliability, short-term reliability, summer 2022, supply resources, extreme weather, electricity system planning

Please use the following citation for this report:

Tanghetti, Angela, and Craig, Hannah. 2022. *2022 Summer Stack Analysis Update*. California Energy Commission. Publication Number: CEC-200-2021-006-UPDT.

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EXECUTIVE SUMMARY

Extreme heat events in 2020 impacted the western United States, straining the electric system in the California Independent System Operator (California ISO) territory and resulting in rotating outages on two days in August. The California ISO, California Energy Commission (CEC), and California Public Utilities Commission (CPUC) conducted a Root Cause Analysis[1] of the events and identified the need for the three entities to assess potential impacts of climate change-induced heat events and improve resource planning to better prepare for summer reliability.

In response, the CEC developed an hourly stack analysis to assess supply conditions against average and extreme weather conditions for the key months of July through September. The hourly stack analysis tool supplements traditional planning methods and is intended to provide a high-level assessment of the potential for resource shortfalls under an extreme weather event and the contingency resources that might be needed to make up the shortfall.

The CEC first published a Summer 2022 Stack Analysis on July 30, 2021.[2] That analysis provided a preliminary assessment of Summer 2022 and showed a need for contingency resources in the early evening hours if an extreme heat event occurred in July, August, or September. There have been many developments on supply and demand since that version was published.

The Summer 2022 Stack Analysis Update includes current information on resources, including new procurements required of load serving entities by the CPUC and other resources that were projected to come online but have experienced delays. The analysis also includes improved estimates of demand, including climate change impacts. Significant improvements are shown from previous projections, with energy shortfalls only during September 2022 under the extreme weather planning reserve margin of 22.5 percent. This analysis projects potential need for contingency resources during a few hours in September 2022 that could range from 200 megawatts (MW) to 2,400 MW. These resources may be required to ensure electric system reliability for peak and net-peak hours during summer 2022 under extreme weather events.

1 Root Cause Analysis Mid-August 2020 Extreme Heat Wave http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf#search=root%20cause%20analysis

2 https://www.energy.ca.gov/media/5924

Background

In 2020, extreme heat events impacted the western United States and strained electric system operations in California, resulting in rotating outages on August 14 and 15, 2020. The Final Root Cause Analysis (RCA)—prepared for Governor Gavin Newsom by the California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Independent System Operator (California ISO) and published January 13, 2021—detailed three root causes behind the outages and identified actions to be taken by the three entities to reduce the potential for grid outages, like those that occurred in August 2020. The RCA required the CEC to develop and publish a multiyear, statewide summer assessment to provide information to support reliability planning and maintain situational awareness of potential impacts to grid reliability under extreme conditions.

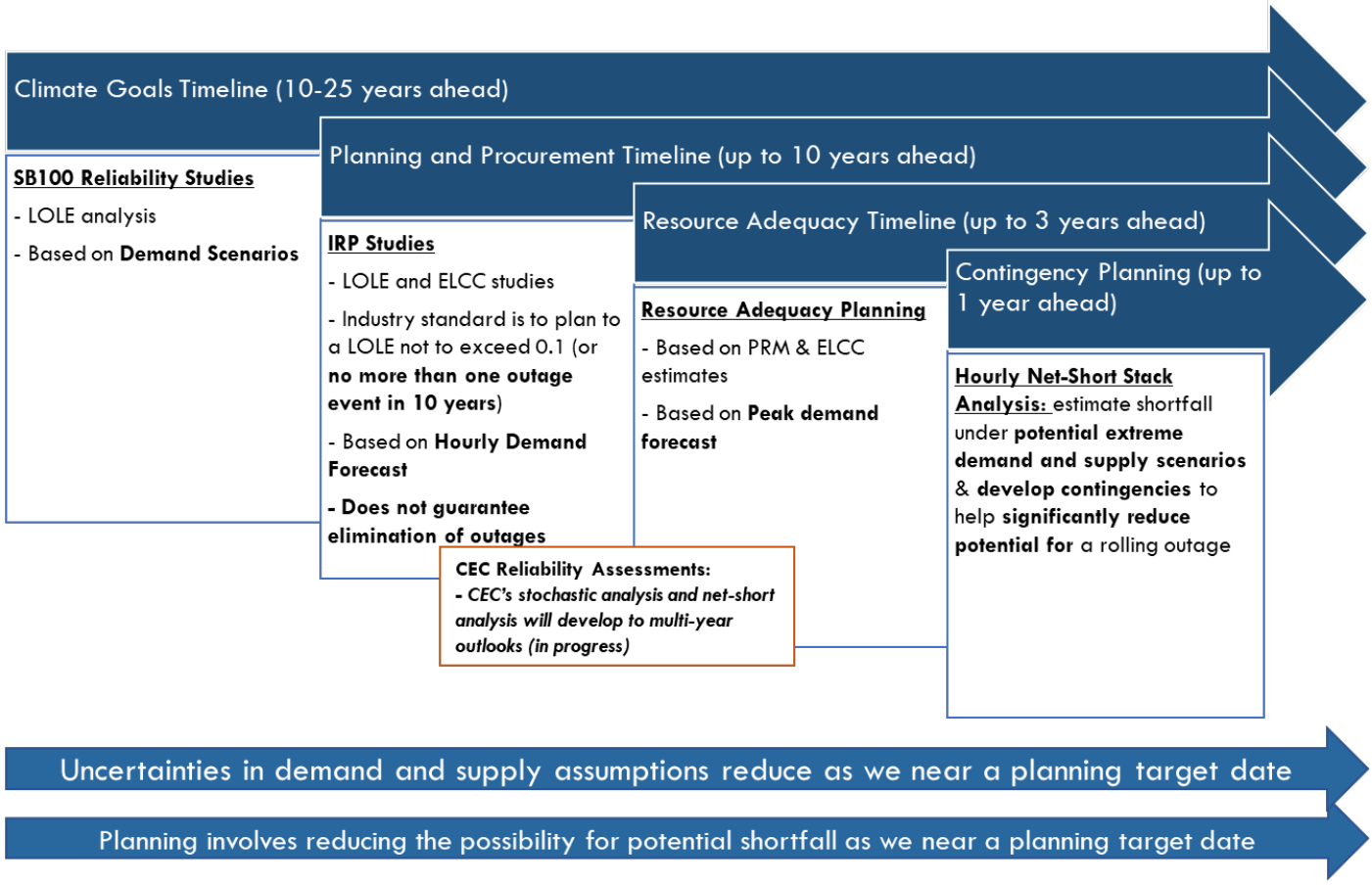
In response, the CEC began developing two reliability assessment products: 1) hourly stack analyses to help support contingency planning and 2) probabilistic loss-of-load-expectation (LOLE) analyses to help support long-term policy studies and midterm procurement planning. The hourly stack analysis assesses supply conditions against average and extreme weather conditions as individual scenarios using two different planning reserve margins to capture demand and supply conditions. The hourly stack analysis supplements traditional planning methods and is only intended to provide a snapshot of a worst-case scenario on the California ISO system to inform the need to prepare for contingencies. The extreme scenario is developed to capture extreme conditions. While some shortfalls may be best addressed by additional procurement, the intent of this hourly stack analysis is not to determine whether traditional procurement is needed. Traditional planning tools, such as LOLE analysis combined with hourly stack analyses, can provide a more robust picture to determine the balance between traditional procurement and contingency resources.

In this document, the CEC has updated the outlook for summer 2022 under extreme supply-and-demand conditions. This outlook includes an update of the existing supply, proposed new supply, hydro condition derates, and demand projections for 2022. The 2022 Hourly Stack Analysis will be revised in the first and second quarters of 2022 as new information becomes available.

Reliability Analysis Across Planning Horizons

While reliability analysis has always been a core component of electric sector planning, the challenges on the electric grid in recent years brings into focus the need for a complete picture of reliability risks across all time horizons. The specific purpose, type of analysis, and details change as the target year approaches. The more near-term the analysis, the less uncertainty there is in supply and demand and the greater the focus is on reducing the probability of realized supply shortfalls.

Figure 1: Reliability Analysis Across Planning Horizons



Long-term studies, such as the 2021 Joint Agency SB 100 Report (De León, Chapter 312, Statutes of 2018), are focused on developing directional portfolios to meet long-term climate goals. There is significant uncertainty in demand and potential supply, so the goal of reliability studies is to determine whether the magnitude and type of resources in the portfolio are reasonable to maintain reliability.

In the planning studies, which typically have a 10-year planning horizon, portfolios are developed to provide guidance to procurements and to inform critical planning processes. The goals of reliability studies are to determine the resources needed to avoid significant risk of supply shortfalls while balancing the cost of absolute reliability. Reliability is typically assessed through an LOLE analysis, a probabilistic analysis incorporating a distribution of demand profiles, wind and solar profiles, and randomized forced outages to determine the probability of a supply shortfall. The typical standard for the analysis to target an LOLE probability of less than 0.1, or approximately of less than one outage every 10 years.

A portfolio meeting the LOLE standard by itself does not eliminate the probability of realized outages for several reasons. First, by definition, the 1-in-10-year standard does not eliminate the probability of outages. Second, the actualized probability of outages may be different than the model suggests if the inputs do not reflect actual conditions in the given year. For example, if the model assumes an average hydroelectric (hydro) year across all years, but drought conditions are present, the probability of a loss of load event may be higher. Another example is if the distribution of demand profiles is wider or more extreme due to climate

change but is not captured in the dataset that relies on historical data, the probability of a loss of load event may also be higher.

In the contingency planning time frame, a year to days ahead, the reliability analysis develops a situational awareness of available supply and demand to prepare contingency resources should conditions be tight. With changing resource supply conditions in California and the West and with increasingly extreme weather conditions due to climate change, this time frame has come into greater focus. In response to the 2020 rotating outages, the CEC developed an hourly stack analysis to evaluate potential shortfalls that could occur during an extreme heat event, particularly as the state experiences drought and wildfires.

Chapter 1: Summer 2022 Hourly Stack Analysis Update

This outlook is an hourly evaluation of anticipated supply, which is then compared to projected hourly demand for the peak day of each month, July through September. The comparison is depicted in a bar chart format that stacks the resources expected to be available in each hour and compares the total against the projected demand under average weather conditions and an extreme weather event.

The 2021 Summer Stack Analysis was published in July 2021 and was based on information available at the time about resources anticipated to be online in 2021 and 2022. The foundational data on resources comes from California ISO's Net Qualifying Capacity (NQC) data. The CEC used the November 2020 NQC list to create the 2021 Summer Stack and the preliminary 2022 Summer Stack (both published in July 2021). However, there have been substantial changes in available resources since then, based on additional procurements directed by the CPUC. This update shows significant progress made in new resource additions in 2021 that improve the outlook for summer 2022 (Table 1). Table 1 gives both the nameplate capacity that has come online and the qualifying capacity value for August based on the CPUCs technology factors, which are used to estimate the qualifying capacity for various technologies given their nameplate capacity.

Table 1: New Resources Online November 2020-September 2021

Resource Type	MW NQC Online by 10/2021 August Tech Factors	Nameplate Capacity
Energy Storage	1,230	1,230
Solar	364	1,376
Wind	69	340
Geothermal	9	12
Small Hydro	2	15
Total	1,674	3,019

Source: CPUC Staff

Chapter 2: Summer 2022 Input Assumption Updates

Assumptions about demand and available resources in 2022 are based on the best available data. Demand is based on the Draft 2021 Integrated Energy Policy Report California Energy Demand (2021 CED)[3] hourly projections and will be updated after the 2021 CED is adopted in early 2022. Available supply projections are based on the California ISO NQC list for 2022, with modifications based on anticipated new resources, planned retirements, and potential drought impacts persisting in 2022. Supply assumptions are intended to reflect physical resource availability and may not necessarily reflect resource adequacy or other contracts. This section provides an overview of the inputs and assumptions followed by Table 2 and 3, which have more detailed information on inputs and assumptions.

Analysis Inputs and Assumptions

The following is a summary of the key input assumptions and updates made to the adopted analysis.

- **Demand**: Generally, the stack uses the most recently adopted demand projections. For this update, the analysis uses the Draft CED Hourly Demand projections for summer 2022 monthly peak days.[4] These demand projections are not final and may change before being adopted. The stack will be updated with the final adopted demand projections for 2022. These are outlined in Table 2.
- **Planning Reserve Margin (PRM)**: The traditional industry standard 15 percent PRM is considered, as well as a 22.5 percent PRM. The higher PRM considers the potential increase from climate change and extreme weather events that impact demand and the forced outage rates for supply-side resources. While the CED projections include the impact of climate change, they do not include projections for extreme weather events, such as those experienced during the summer of 2020.
- **California ISO October 2021 NQC list**: Existing resource projections for 2022 are based on this list including resources online by August 2021. These additional resources are outlined in Table 3. The October 2021 NQC list is used since it is the first non-preliminary version published. This version of the list will serve as the basis for all updates to the 2022 stack analysis tool. Keeping the existing portfolio static, with this version of the California ISO NQC list, will allow better tracking of resources projected to come online prior to summer 2022.

3 Draft CED 2021 Hourly California ISO Forecast https://efiling.energy.ca.gov/GetDocument.aspx?tn=240987

4 https://efiling.energy.ca.gov/GetDocument.aspx?tn=240987

- **Resource Updates**: CPUC staff provided updates on new resources and procurement expected from September 2021 to summer 2022 (incremental to the October 2021 NQC list). These are outlined in Table 3.
- **Demand Response (DR):** The investor-owned utility (IOU) DR monthly projections are published by the CPUC in their Load Impact Protocol Reports. The RCA identified that these projections were not fully realized and, as a result, this resource was derated by 40 percent in previous versions of the summer stack analysis. However, the CPUC directed the IOUs to update DR projections and therefore a derate is no longer necessary. The Publicly Owned Utility (POU) DR projections included in the analysis are based on actual summer 2021 monthly showings. These are outlined in Table 3.
- **Resource Adequacy (RA) Imports and POU Liquidated Damage Firm Imports**: Updated to include 2021 RA showings. A six-year rolling average was used consistent with the approach used in the California ISO summer 2021 stack analysis. This rolling average covers the years 2016-2021. These are outlined in Table 3.
- **Hydro Capacity**: Hydro capacity is sourced from the October 2021 NQC list. Projections for summer 2022 hydro capacity may be revised during the second quarter of 2022 with improved information on hydrologic conditions provided by the California Department of Water Resources (DWR). The October 2021 NQC values for hydro capacity are about 250 to 600 MW lower compared to November 2020 NQC hydro capacity used in the previous summer stack analysis, depending on the month. The 2022 summer hydro NQC capacity represents an average of three years (2018–2020) generation for non-dispatchable hydro resources or 10 years (2011–2020) generation for dispatchable hydro resources.[5] This averaging may overestimate performance in a prolonged drought year, as observed in 2021. Therefore, an additional hydro capacity derate of about 500 MW, depending on the month, is included and represents hydro capacity if the drought persists into 2022. This assumption will be revised, if needed, with the help of DWR in the second quarter of 2022.
- **Use of Hourly Profiles for Wind**: The CEC developed wind profiles corresponding to a high-load day. See the Hourly Wind and Solar Shapes Section for more details. This method is an improvement over previous stack analyses, which used effective load carrying capacity values or technology factors, as opposed to hourly wind profiles.

5 https://www.cpuc.ca.gov/-/media/cpuc-website/files/legacyfiles/q/6442466773-qc-manual-2020.pdf. Page 18.

Table 2: Demand-Side Assumptions

Demand Category	Assumptions
Base Demand	Hourly projections for summer 2022 monthly peak days from the Draft 2021 CED.[6]
Drought Adjustment to Demand	No projections are included for this update. However, this may be updated during the second quarter of 2022 after California water agencies assess summer water delivery projections.

Source: California Energy Commission staff

6 https://efiling.energy.ca.gov/GetDocument.aspx?tn=240987

Table 3: Supply-Side Assumptions

Supply Category	Assumptions
Baseline Resources	2022 projected monthly NQC values from California ISO October 2021 NQC List. Solar and wind resources are converted to an hourly shape based on method described in the next section.
Hydro Drought Derate	500 MW derate over October 2021 NQC. This additional derate assumes the drought will persist in 2022.[7]
Imports	Average 2016-2021 California ISO RA showings plus POU 2021 firm liquidated damage contracts 6,005 MW July 6,439 MW August 6,560 MW September
Demand Response	IOU and POU totals include line losses. IOU is derated according to the CPUC Load Impact Protocol[8] [9] [10] and POU DR is not derated. 1,419 MW July 1,460 MW August 1,467 MW September
Retirements	No new retirements beyond those accounted for in the NQC list
CPUC Procurement Between September 2021 and 2022	CPUC Procurement of 2,723 MW by July 2022 CPUC Procurement of 3,379 MW by August 2022 CPUC Procurement of 3,379 MW by September 2022

Source: California Energy Commission staff

7 Climate Prediction Center: Seasonal Drought Outlook (noaa.gov) projects drought to persist but improve slightly in first quarter 2022

8 https://www.cpuc.ca.gov/-/media/cpuc-website/files/legacyfiles/p/6442465531-public-version-revised-pge-completed-fy2020-dr-lip-allocations-for-py2021-2023-v2.xlsx

9 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/resource-adequacy-compliance-materials/for-sdge-to-complete----fy2021-dr-lip-allocations-for-py2022-2024_jun152021_sdge-response.xlsx

10 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/resource-adequacy-compliance-materials/for-sce-to-complete----fy2021-dr-lip-allocations-for-py2022-2024---final---redacted.xlsx

Table 4: PRM Assumptions

Demand Curve	PRM Assumptions
Extreme Weather	22.5% PRM: 6% for Operating Reserves 7.5% for Outages 9% for demand variability (similar to 2020 demand variability from a 1-in-2 forecast)
Average Weather	15% PRM: 6% for Operating Reserves 5% for Outages 4% for demand variability

Source: California Energy Commission staff

Hourly Wind and Solar Shapes

Hourly wind and solar shapes were developed from California ISO-wide aggregated generation profiles, normalized to installed capacity, for each hour from 2014-2020. Using historic hourly demand data from the California ISO Oasis website, the median wind value for each hour of the day was calculated based on the five highest-load days of each month for each year 2014-2020. The 20th percentile for wind is calculated similarly. The profiles are a weighted average of the median and the 20th percentile, with 80 percent of the weight going to the median and 20 percent to the 20th percentile. This weighting method is similar to the NQC approach for projecting non-dispatchable hydro capacity.

Hourly Profile = (0.2 x 20th Percentile) + (0.8 x Median)

Table 5: Wind and Solar Hourly Profile

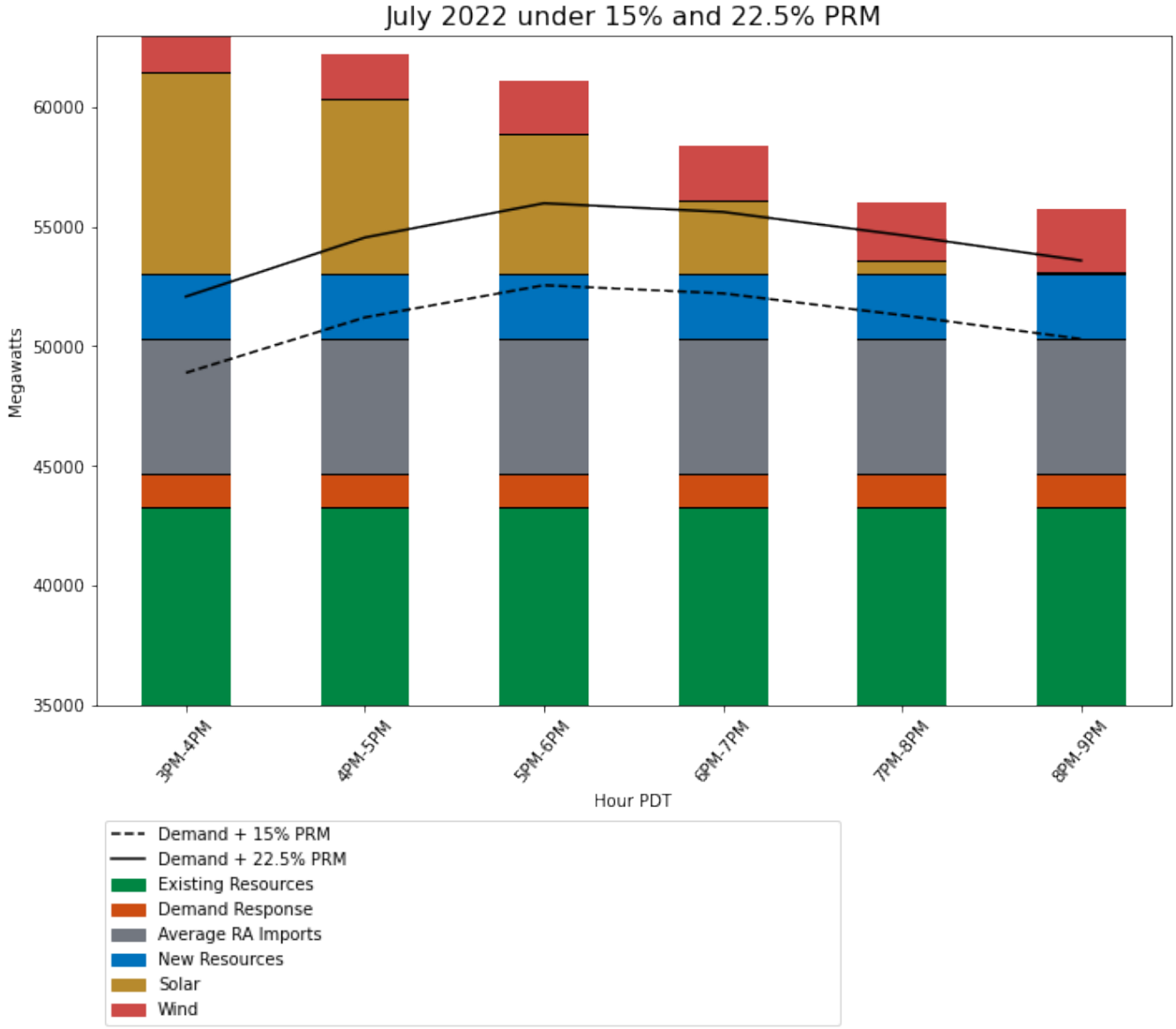
Wind	Month			Solar	Month		
Time PDT	Jul	Aug	Sep	Time PDT	Jul	Aug	Sep
3PM-4PM	0.23	0.20	0.09	3PM-4PM	0.77	0.75	0.69
4PM-5PM	0.31	0.23	0.11	4PM-5PM	0.67	0.64	0.56
5PM-6PM	0.37	0.26	0.12	5PM-6PM	0.53	0.45	0.31
6PM-7PM	0.38	0.29	0.16	6PM-7PM	0.28	0.17	0.06
7PM-8PM	0.41	0.33	0.19	7PM-8PM	0.05	0.01	0.00
8PM-9PM	0.44	0.38	0.23	8PM-9PM	0.00	0.00	0.00

Source: California Energy Commission staff

Chapter 3: Results

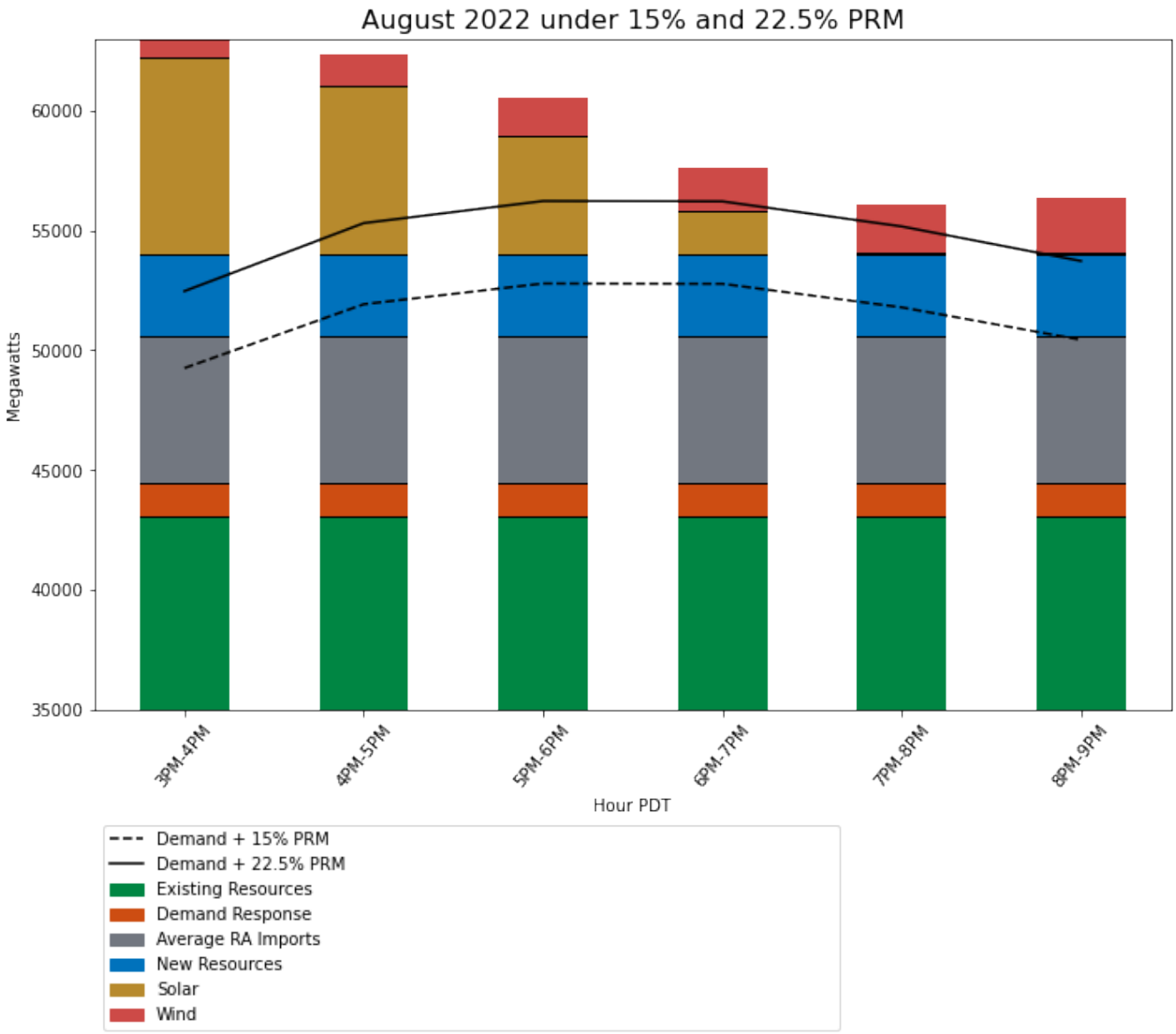
With the updates outlined above, the 2022 Summer Stack Analysis tool projects better conditions in 2022 compared to the July 2021 published version of the stack analysis. There is no longer a projected need for contingencies in July and August; however, there remains a potential need for contingencies in September under an extreme heat event, but at smaller levels than previously reported. Figures 2-5 display July, August, and September 2022 hourly results, respectively. The potential contingency need ranges from just over 200 MW to 2400 MW, assuming a 22.5 percent demand curve. Under a 15 percent demand curve, no contingencies are projected to be required.

Figure 2: July 2022 Stack Update (Draft CED 2021)



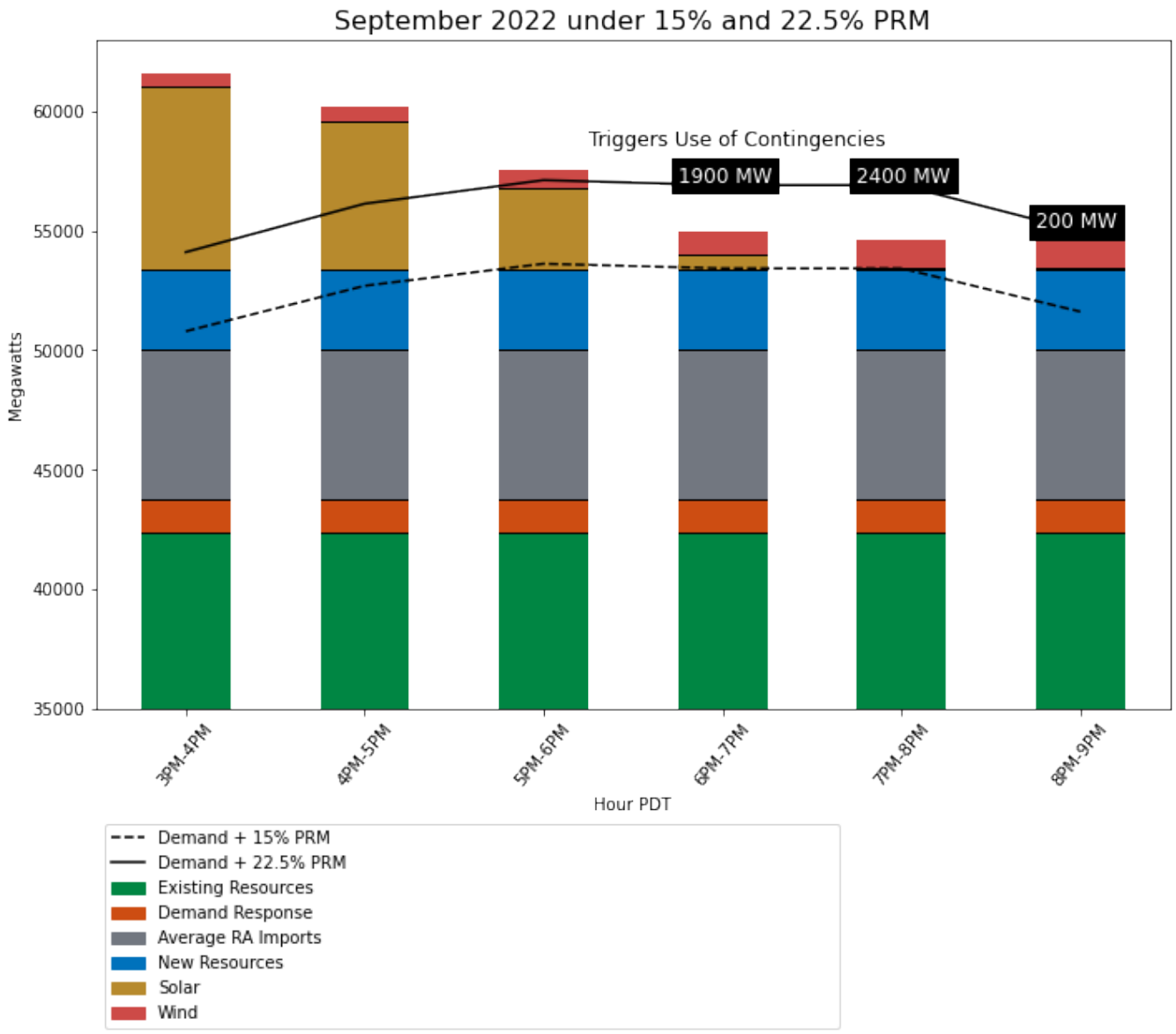
Source: California Energy Commission

Figure 3: August 2022 Stack Update (Draft CED 2021)



Source: California Energy Commission

Figure 4: September 2022 Stack Update (Draft CED 2021)



Source: California Energy Commission

Chapter 4: Contingency Resources

The three energy institutions have collectively identified potential contingency resources that can be called upon in the event of an electricity supply shortfall. These contingency resources are above and beyond those routinely available and are generally called upon only in the extreme case of system outages:

- **Voluntary Customer Conservation** – Californians have shown a willingness to voluntarily reduce energy use during critical periods. This can be a low-cost and low greenhouse gas emission option to support the grid. To initiate voluntary conservation, the California ISO issues Flex Alerts in advance of a potential shortage. The alerts provide advice for customers to make the most impactful reductions and can include increasing thermostat temperatures, avoiding the use of major appliances, and turning off unnecessary lights. California ISO initiates the alerts, which are further broadcast by the CEC and CPUC. While a statewide Flex Alert program has been unfunded in recent years, the CPUC has funded a 2-year $24 million campaign to educate customers about the positive impacts of electricity conservation and inform them of when electricity demand is high, and conservation is needed.

- **Additional Generation and Load Reductions** – In addition to voluntary conservation from customers, there are other potential generation sources and load reductions that the state can draw on, typically from larger customers who are not already participating in demand response programs. An example partner is the California Department of Water Resources (DWR) operator of the State Water Project (SWP), a system of water storage facilities, pumping and generating plants, and pipeline and canal infrastructure that delivers water throughout the state. Through DWR operational controls, the SWP can offer California ISO additional electric generation and load reduction during peak periods with sufficient notice. California ISO and CEC coordinate with DWR to make additional generation and load reduction available, as needed. However, for summer 2022, DWR has identified that drought conditions have severely limited their ability to provide additional support during a contingency event.

  The CEC, in coordination with the Governor's Office, has developed a network to reach other major end users to identify potential load reduction. This network includes large state government users (for example, Department of General Services, the University of California system) and large commercial, retail, and industrial customers. In the event of an energy emergency, the CEC coordinates with the Governor's Office to identify and request reductions available from this network.

- **Emergency Load Reduction Program (ELRP)** – The CPUC's ELRP provides compensation for certain customers that provide additional load reduction during an

energy emergency.[11] This program is being piloted in 2021 and 2022, after which the CPUC will determine whether the program should continue. The California ISO and CEC coordinate with the IOUs to track potentially available load reductions under this program before and during an emergency event.

- **Imports from Other California Balancing Authorities** – Non-California ISO balancing authorities in the state can potentially provide additional available generation as imports to the California ISO territory, as they did during the 2020 heatwave. Prior to an emergency, the California ISO and CEC coordinate with partner balancing authorities to alert them of a need and track available generation that they can provide. During an emergency, the California ISO as the balancing authority will coordinate with other balancing authorities directly.

- **Additional Thermal Generation** – Some thermal power plants may have the ability to generate additional capacity beyond permit limits/restrictions in an emergency. Realizing additional generation is not a certainty and depends on a variety of factors and conditions at each individual facility. Some generators may also be able to generate additional capacity beyond their interconnection limitations. In emergency circumstances, temporary permit relief can be achieved through a Governor's Emergency Order or through an Emergency Order from the U.S. Department of Energy. The CEC and California ISO coordinate on identifying where actions such as an emergency order would enable additional generation.

The California ISO may be able to use its backstop authority either prior to or during the operational timeframe. The California ISO tariff provides for a capacity procurement mechanism (CPM) pursuant to manually identifying additional resources or due to a "significant event," such as a substantial event, or a combination of events, that is determined by the California ISO to either result in a material difference from what was assumed in the resource adequacy program or produce a material change in system conditions that causes, or threatens to cause, a failure to meet reliability criteria.

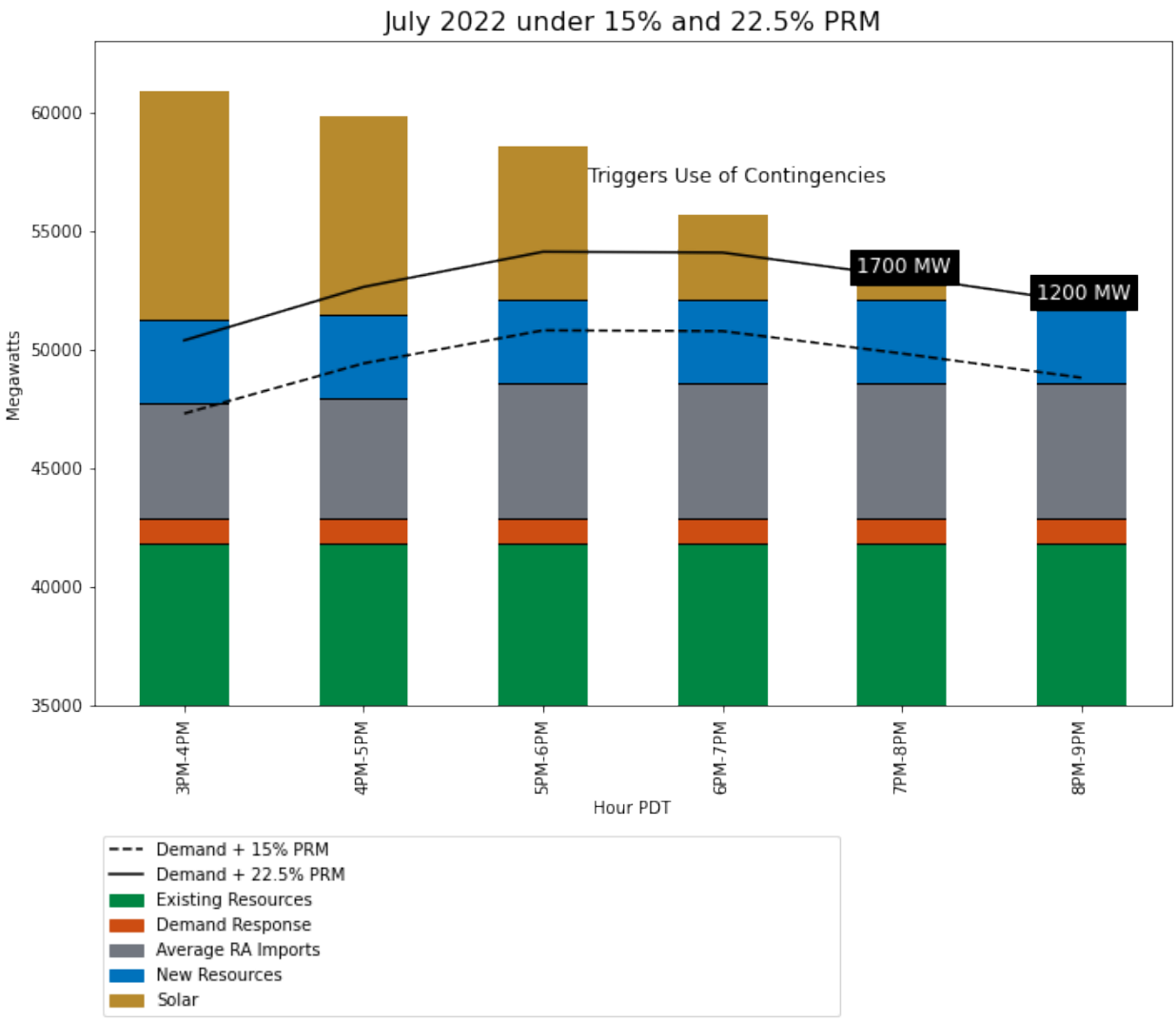
11 CPUC Decision 21-03-056, March 25, 2021 Decision Directing Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company to Take Actions to Prepare for Potential Extreme Weather in The Summers Of 2021 And 2022

Conclusions

The Summer 2022 Stack Analysis Update identifies an improved outlook for summer 2022, however there continues to be a risk of potential energy shortfalls under an extreme weather planning reserve margin during the month of September 2022. This analysis projects that an additional 200 MW to 2,400 MW of contingency resources may be required to ensure electric system reliability for peak and net-peak hours during summer 2022 under extreme weather events.

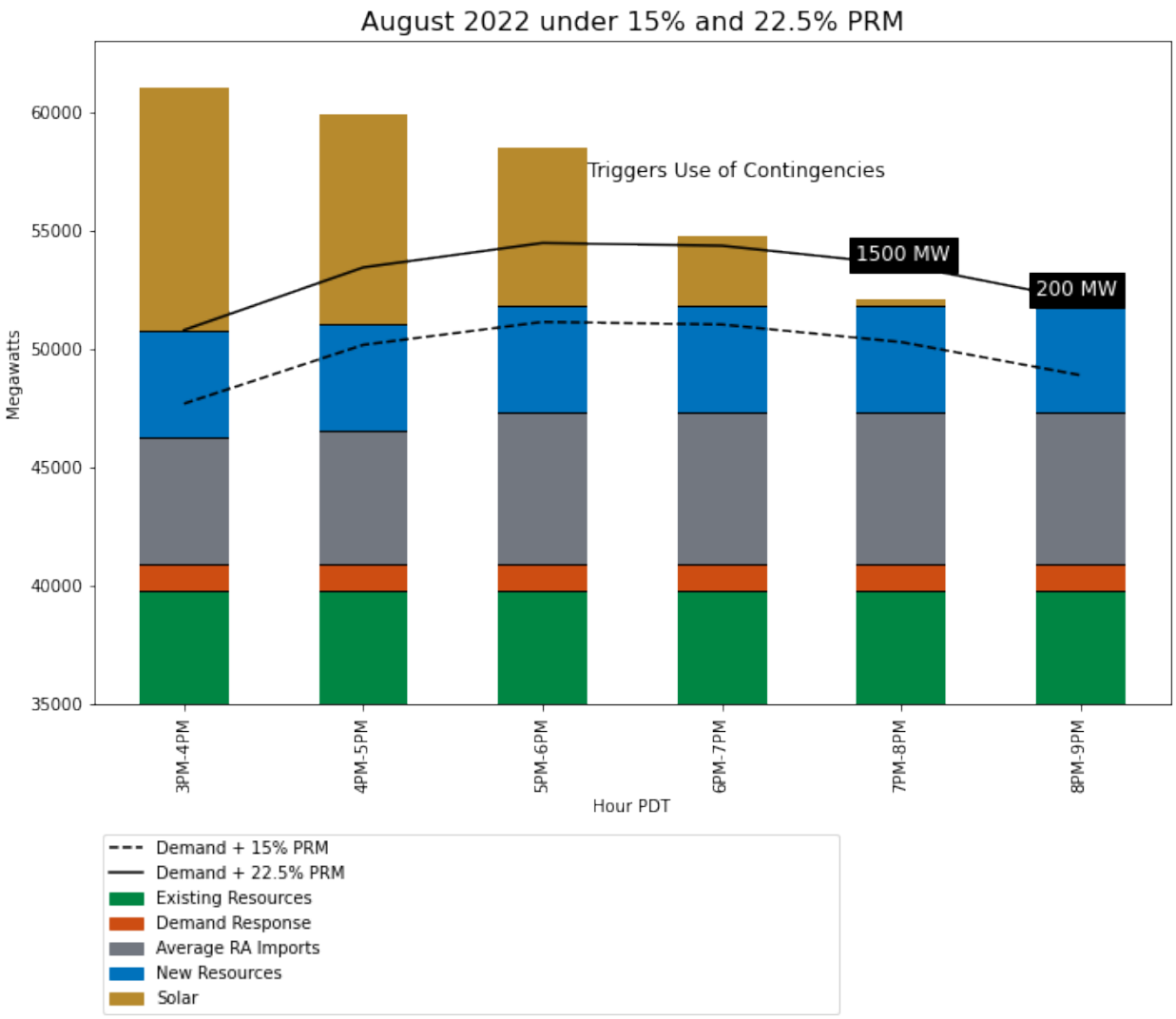
Appendix A: Adopted September 2021 Stack Analysis Tool Results

Figure A-1: July 2022 Stack Analysis



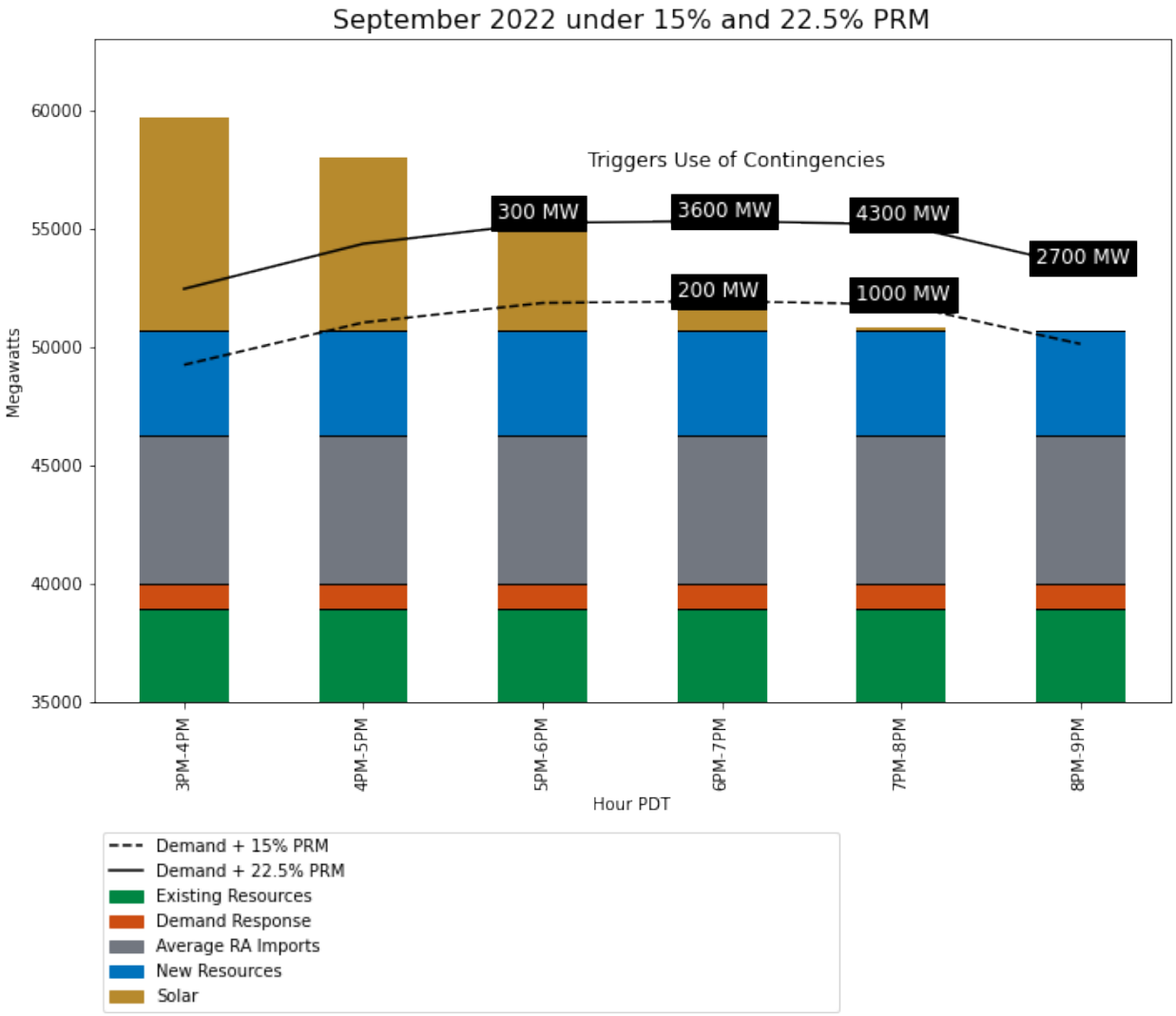
Source: California Energy Commission staff September 2021

Figure A-2: August 2022 Stack Analysis



Source: California Energy Commission staff September 2021

Figure A-3: September 2022 Stack Analysis



Source: California Energy Commission staff September 2021