California ISO

# 2018

## SUMMER LOADS & RESOURCES ASSESSMENT

**May 9, 2018**

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# I. EXECUTIVE SUMMARY

The *2018 Summer Loads and Resources Assessment* provides an assessment of the upcoming summer supply and demand outlook for the California Independent System Operator (CAISO) balancing authority area. The CAISO works with state agencies, generation and transmission owners, load serving entities, and other balancing authorities to formulate the summer forecast and identify any issues regarding upcoming operating conditions. The Assessment considers the supply and demand conditions across the entire CAISO balancing authority area (representing about 80 percent of California).

To better assess summer operating conditions given the changing resource mix of higher levels of renewable resources and fewer conventional gas fired resources, the CAISO developed a robust probabilistic approach using a stochastic production simulation model to assess the system-wide supply and demand outlook on an hourly basis. The base platform is Energy Exemplar's PLEXOS® Integrated Energy Model (PLEXOS). The CAISO first published results based on PLEXOS production simulation studies in the 2016 Summer Assessment.

In its production simulation process, the CAISO runs 2,000 unique randomly generated scenarios – each representing a combination of forecasted summer hourly load profiles and renewable generation levels that are based on historic weather patterns. The simulation seeks the least cost solution to dispatch generation and curtailable demand to meet both energy and ancillary services requirements simultaneously.

### *2018 Modeling Enhancements*

PLEXOS was first used in the development of the 2016 Summer Assessment and the CAISO continues to improve the modeling methodology. The extreme high temperatures events during the 2017 summer led to the highest loads that the CAISO has experienced since 2006. This provided an opportunity to validate the model's results against actual high load conditions. As a result of that validation process a number of model enhancements were made to achieve model results that more closely align with the issues and limitations that CAISO operations faces during extreme high loads as well as more normal operating conditions. Noteworthy modeling enhancements that were made include the following:

- Use of historical unit by unit forced outage rates versus the more generic outage inputs that were developed for the PLEXOS model the CAISO used in the CPUC Long Term Planning Proceedings.
- Closer alignment of the ability to re-dispatch dynamic scheduled resources during real time operations.
- Removal of the day-ahead unit commitment process that committed units in the day-ahead to be available for meeting flexible capacity requirements the following day. The current CAISO market mechanisms would have to be enhanced to perform this functionality.
- A shift from reporting the minimum operating reserve margin to an Unloaded Capacity Margin, which more closely portrays the amount of capacity that operations can bring on line in a short period of time to deal with unexpected contingencies such as resource forced outages.

These enhancements are anticipated to produce results for the 2018 Assessment that more closely align with 2018 actual operating conditions. The 2018 Assessment's enhanced results show a much higher potential for challenging summer operating conditions than the results from the 2017 Assessment. This change is largely attributable to lower hydro conditions, a net reduction of 789 MW of dispatchable generation (837 MW of gas retirements and 48 MW of new gas generation), and model enhancements to more accurately represent the real-time operational issues the CAISO will likely face during normal and extreme operation conditions.

### *Peak Demand Forecast*

The CAISO 2018 1-in-2 peak demand forecast is 46,625 MW, which is 0.09 percent below the 2017 weather normalized peak demand of 46,669 MW. The slight decrease in the demand projection is a result of projected modest economic growth over 2017, further reduced by continuing load reductions from behind-the-meter solar installations and energy efficiency program impacts on peak demand. The CAISO 2018 1-in-10 peak demand forecast is 51,632 MW.

### *Hydro Conditions*

Hydro conditions for 2018 are below normal. As of April 2, 2018, the statewide snow water content for the California mountain regions was 51 percent of the April 1 average. While statewide large reservoir storage levels are near normal or above, snow water content is the more accurate measure of summer hydro capability. Based on the net qualifying generation capacity (NQC) values used in the model, only 8 percent of hydro capacity in the CAISO is located on a large reservoir. Of the hydro units within the CAISO, the majority of the capacity is located on smaller reservoirs that depend on snowmelt to operate. California hydroelectric capability will be below normal for 2018 providing less than normal hydro energy during the spring and summer seasons.

As of April 2, 2018, the Northwest River Forecast Center projected the April to August reservoir storage in the Dalles Dam on the Columbia River to be 118 percent of average. Summer 2018 water supply projections for the Pacific Northwest are similar to 2017 levels. There are no concerns with Pacific Northwest hydroelectric generation.

### *Available Generation and Demand Response*

The CAISO projects that 51,947 MW of NQC will be available for summer 2018. From June 1, 2017, to June 1, 2018, approximately 692 MW of additional generation is expected to reach commercial operation, with 40 MW in the southern portion of the CAISO system and 652 MW in the northern portion of the CAISO system. Of the 692 MW, approximately 60 percent is solar, 24 percent is biofuel, 7 percent is wind, 7 percent is gas, and 2 percent is hydro. During this same period, 860 MW of generation is expected to retire, 837 MW is gas and 23 MW is geothermal. Of the 837 MW of gas-fired generation, 67 percent is once-through cooled facilities.

Whenever the model depletes all available resources before meeting the load and ancillary service requirements the model will utilize demand response programs. The available Reliability Demand Response Resource (RDRR) and Proxy Demand Resource (PDR) in the CAISO market for 2018 is 1,763 MW.

*Simulation Results*

The modified modeling methodology used in the 2018 Assessment results are based on the model's calculation of hourly unloaded capacity. Loaded capacity is the generation capacity that is serving load. The unloaded capacity refers to online generation capacity that is not serving load and offline generation capacity that can come online in 20 minutes or less to serve load as well as curtailable demands such as demand response, interruptible pumping load, and aggregated participating load that can provide non-spinning reserve or demand reduction. In other words, the hourly unloaded capacity consists of unloaded and available resources, including operating reserves the system procures. The Unloaded Capacity Margin (UCM) is the excess of the available resources over the projected load expressed as a percentage on an hourly basis.

The model produces an UCM for each hour modeled. Taking into account the unloaded capacity margin for all of the 2,928 hours within each of the 2,000 summer scenarios, the unloaded capacity margin ranges from a high of 61 percent to – in a very small number of scenarios - a low of zero. The median[1] value of all unloaded capacity margin values is 23 percent (*Figure 1)*.

**Figure 1**

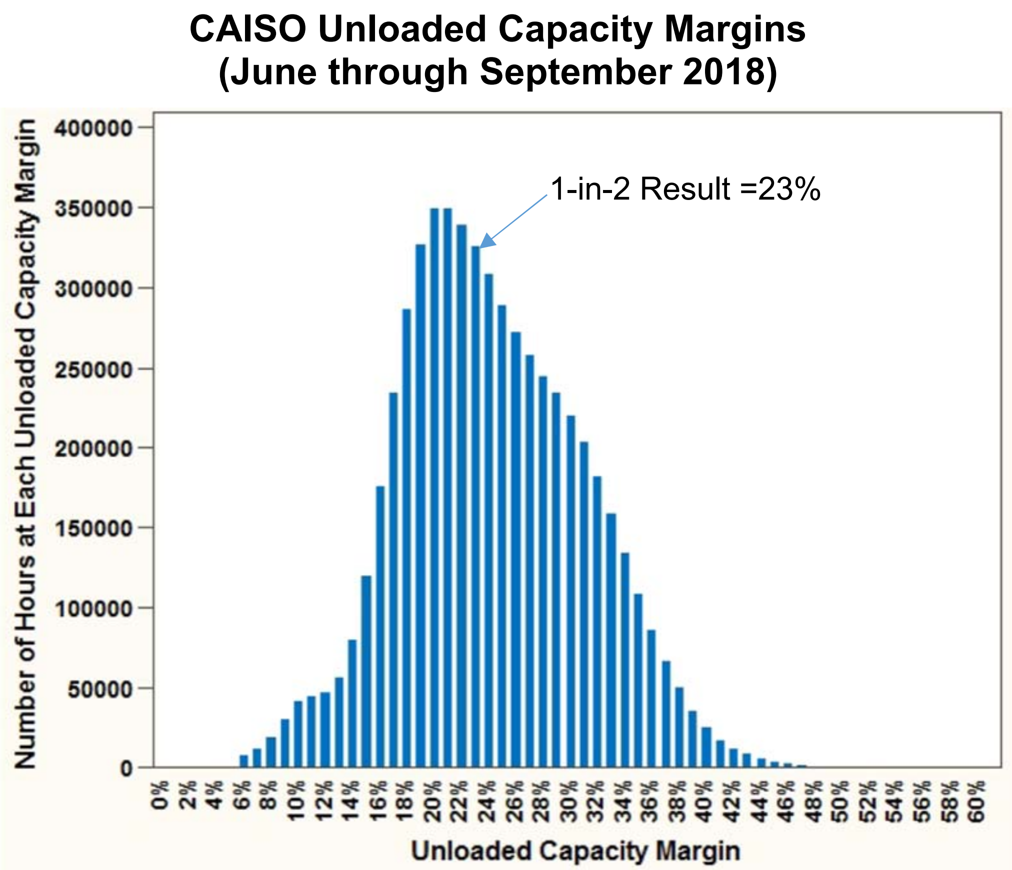



*Figure 1* shows the forecast of the UCMs over all 2,928 summer operating hours from all 2,000 scenarios.

[1] The median is the value that is in the middle of the model results data set, where there is a 50 percent probability that the result will be above the median and a 50 percent probability that the result will be below the median.

Whenever the UCM is at or below the level of the operating reserve requirement for any given hour (typically around 6 percent) the UCM is equivalent to the operating reserve requirement for that hour. *Figure 2* shows the range of UCM results that are at or below 6 percent and greater than 3 percent (i.e., operating reserves) for all 2,000 scenarios. If operating reserves fall within this range a Stage 2 Emergency[2] may be declared, which may require the CAISO to take out of market actions to secure additional reserves. Should CAISO system operating conditions go into the emergency stages, such as operating reserve shortfalls where non-spinning reserve requirement cannot be maintained or spinning reserve is depleted and operating reserve falls below minimum requirement, the CAISO will implement the mitigation operating plan to minimize loss of load in the CAISO BA area (described in the *Preparation for Summer Operation* section at the end of the *Executive Summary).*

As shown in *Figure 2*, over half of the 2,000 scenarios (1,055) produce at least one hour of potential Stage 2 Emergency conditions with the majority of these (767 = 541+226) being only 1-2 hours over the entire summer season.

**Figure 2**

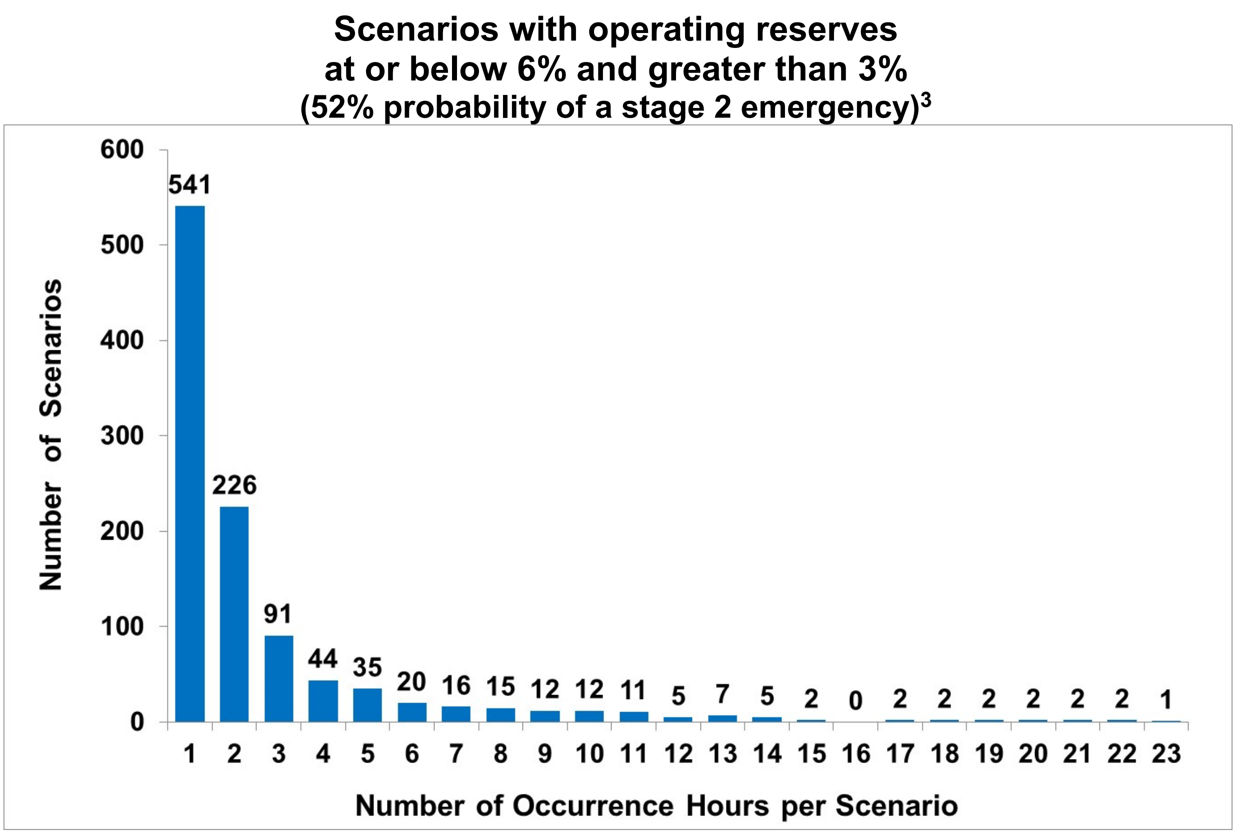



*Figure 2* shows scenario occurrences with operating reserves at or below 6% and greater than 3%

[2] Emergency Fact Sheet
[3] In these results shown in *Figure 2* demand response programs would have been utilized if needed to get to a 6 percent operating reserve margin and would be fully utilized in cases where the operating reserve margin is below 6 percent.

*Figure 3* shows the range where operating reserves for all 2,000 scenarios are at or below a 3 percent margin. If operating reserves fall within this range a Stage 3 Emergency may be declared. Under this more severe operating condition, the CAISO will issue a notice of potential load interruptions to utilities - whether actual interruptions would occur depends on the specific circumstances and potential for recovering reserves. As evident in *Figure 3*, only a relatively few number of scenarios (26 out of 2,000) produced an hour or more of potential Stage 3 Emergency.

**Figure 3**

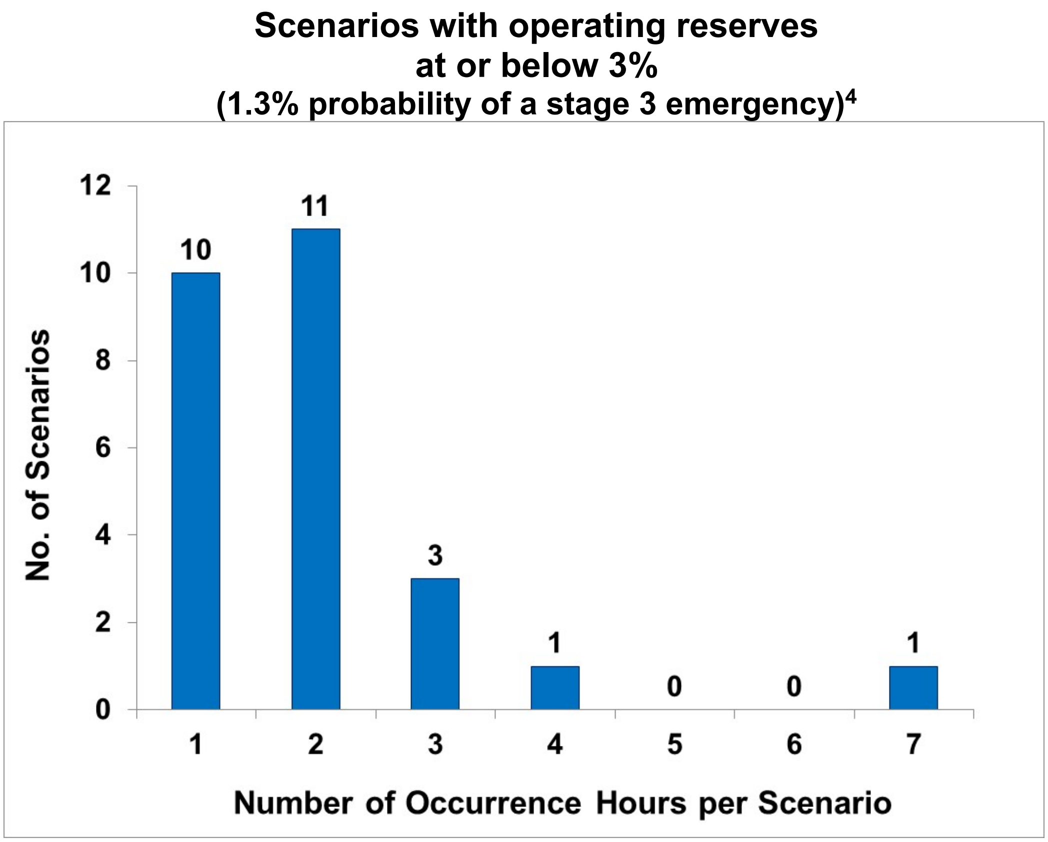



*Figure 3* shows scenario occurrences with operating reserves at or below 3%

To further assess resource adequacy for the summer period, the Minimum Unloaded Capacity Margin (MUCM) value, equal to the lowest unload capacity margin in all 2,928 summer hours[5] in each scenario, was found for each of the 2,000 scenarios. The MUCM values range from a high of 8.5 percent down to the lowest result of zero (*Figure 4*). The zero result represents the most extreme hourly supply and demand condition within the 2,000 scenarios considered. The median value is 6 percent.

[4] In all of the 26 occurrences shown in *Figure 3* the results include the full utilization of all demand response programs.

[5] The study period of June 1 through September 30 in each scenario represents 2928 hours.

**Figure 4**

**CAISO Minimum Unloaded Capacity Margin (June – September)**

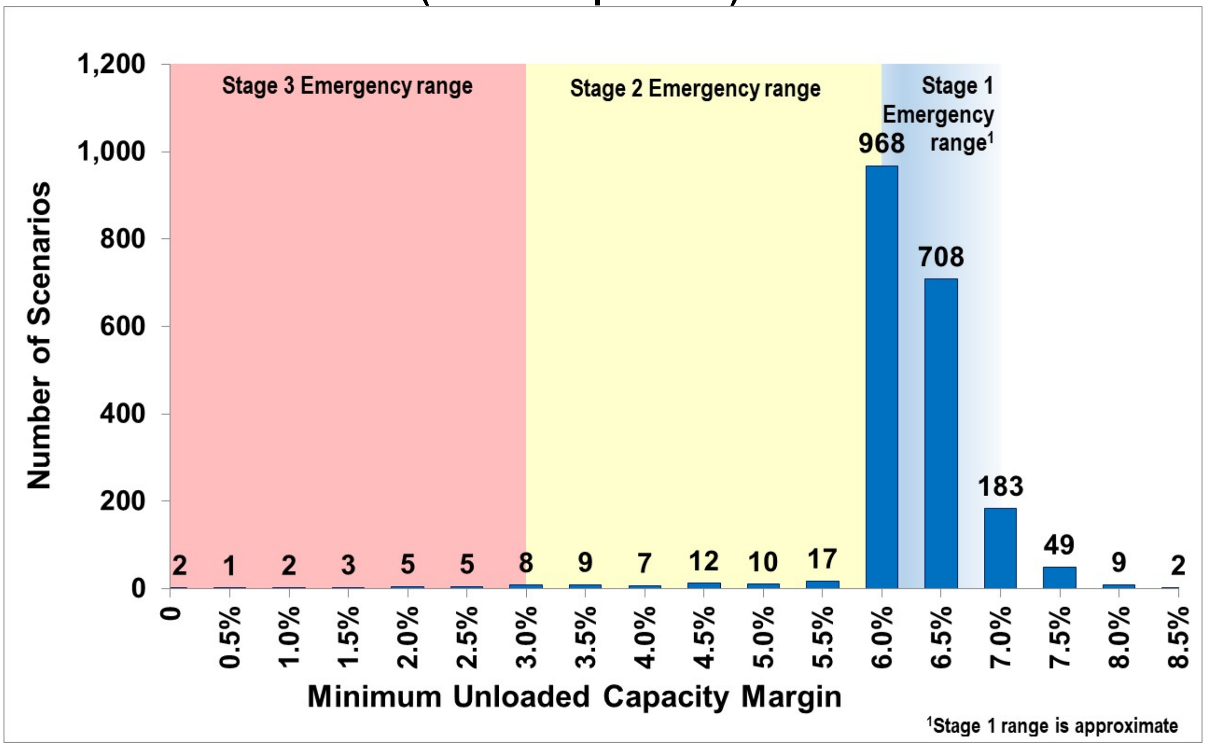



*Figure 4* shows forecast distribution of summer MUCM for the CAISO.

Figure 5 shows the distribution of the MUCM over the hours of the day in comparison to the hours of solar generation during the 2018 summer peak day. The MUCM has the highest level of occurrences at hour ending 20:00. *Figure 5* demonstrates the timing of 79 percent of the MUCM values fall in periods of low to zero solar generation.

**Figure 5**

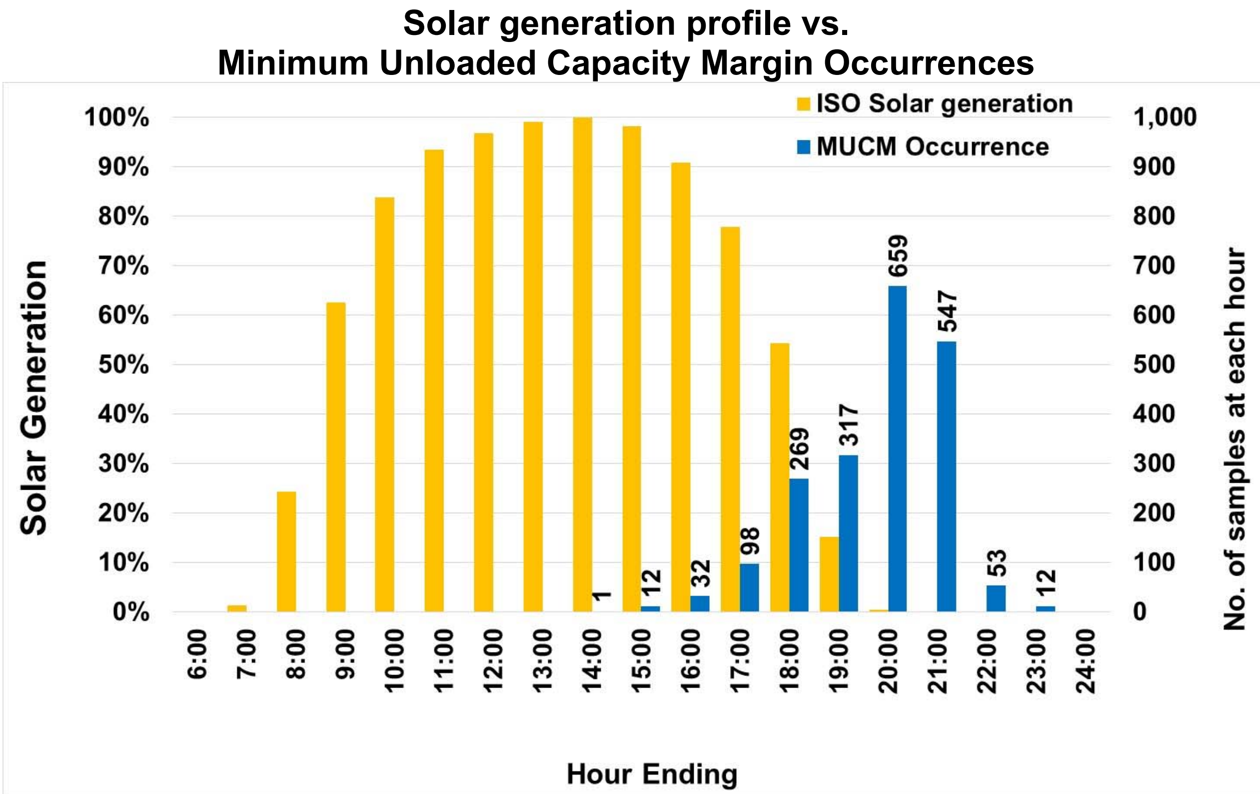



*Figure 5* shows solar generation profile vs. MUCM occurrence.

*Figure 6* shows the months where the MUCM dropped below 3 percent, the point of initiating a stage 3 emergency. Other than one occurrence in July, all occur in September. This is a function of the below normal hydro year where available hydro energy drops off in September and lower solar production in the late afternoon hours due to shorter daylight. The range of the CAISO load related to the occurrences in *Figure 6* is 45,356 to 50,080 MW.

**Figure 6**

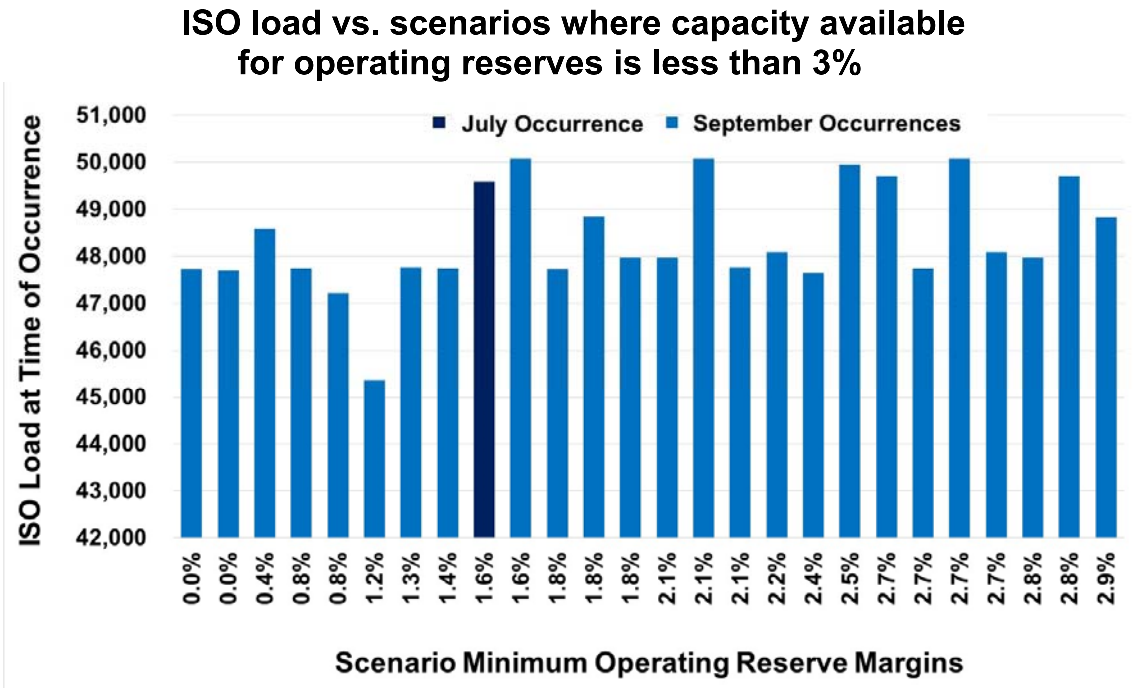



*Figure 6* shows CAISO load level vs. most extreme MUCM levels.

## *Once Through Cooled Generation*

The CAISO is also working closely with state agencies and once-through-cooled plant owners as plans are being implemented to comply with the clean water regulations to ensure electric grid reliability is maintained. About 7,182 MW of natural gas fired coastal power plants that use ocean water for cooling are slated to retire, be retrofitted or repowered. The bulk of the generation retirements forecasted are anticipated to occur in the 2018-2020 timeframe.

## *Impacts of the Aliso Canyon Gas Storage Operating Restrictions*

The results of the latest studies and recommendations by various state agencies on the operating restrictions of Aliso Canyon going forward and the projected impacts to electric system reliability are being assessed by the CAISO, Los Angeles Department of Water and Power, California Energy Commission and California Public Utilities Commission (Joint Agencies). The results of the Joint Agencies assessment for this summer and beyond will be presented in a report that is expected to be released in early May 2018.

The outlook for energy reliability in Southern California remains challenging due to uncertainty about the status of its natural gas system. The challenges to the gas system are greater than for the previous two summers and leave SoCalGas unable to meet demand on a 1-in-10 peak day without potentially having to curtail gas to the electric generators in the Southern California or using gas from the Aliso Canyon underground gas storage facility. The challenges stem primarily from continuing outages on as many as four key natural gas pipelines. The ability for the CAISO electric system in Southern California to maintain electric reliability at lower gas burn levels is the result of a combination of transmission upgrades and some generation retirements. As a result with even greater system risk to electricity reliability this summer than last, measures to mitigate the risk remain necessary.

The risk associated with the gas storage facility restrictions at the Aliso Canyon and other gas storage facilities to electric reliability is greater in the local reliability areas in Southern California than to the CAISO system. However, from a system perspective, the ability to re-supply from electric supply from sources not impacted by SoCalGas limitations may be more constrained then in previous years.

## *Conclusion*

Projections for 2018 show that the CAISO faces significant risk of encountering operating conditions that could result in operating reserve shortfalls. The increased risk in 2018 over 2017 is primarily a result of lower hydro conditions and the retirement of 789 MW of dispatchable gas generation that had been available in prior summers to meet high load conditions that persist after the solar generation ramps down in the late afternoon. The risk increases during late summer when hydro availability decreases as the snow runoff progressively declines through the runoff season and solar production declines in the late afternoon hours due to shorter days. The CAISO is at greatest operational risk if seasonal peak hot weather conditions occur in late August and early September.

## *Preparation for Summer Operation*

Producing this report and publicizing its results is one of many activities the CAISO undertakes each year to prepare for summer system operations. Other activities include coordinating meetings on summer preparedness with the Western Electricity Coordinating Council (WECC), California Department of Forestry and Fire Protection (Cal Fire), natural gas providers and neighboring balancing areas. The CAISO's ongoing relationships with these entities help to ensure everyone is prepared for potential times of system stress.

Should CAISO system operating conditions go into the emergency stages, such as operating reserve shortfalls where non-spinning reserve requirement cannot be maintained or spinning reserve is depleted and operating reserve falls below minimum requirement, the CAISO will implement the following mitigation operating plan to minimize loss of load in the CAISO BA area:

- Utilization of Flex Alert program, signaling that the CAISO expects high peak load condition. This program has been proven to reduce peak load in the CAISO BA Area.
- Utilization of CAISO Restricted Maintenance program. This program is intended to reduce potential forced outages; therefore, minimizing forced outage rate during the high peak load condition.
- Manual post-day ahead unit commitment and exceptional dispatch of resources under RA contract to ensure ability to serve load and meet flexible ramping capability requirements.
- Manual exceptional dispatch of intertie resource that have Resource Adequacy obligation to serve CAISO load.
- Utilization of Alert/Warning/Emergency (AWE) program.
- Utilization of Demand Response program including the Reliability Demand Response Resources (RDRR) under the "Warning" stage.
- Manual exceptional dispatch and utilization of back stop Capacity Procurement Mechanism for physically available resources that have un-contracted RA capacity.

# II. SUMMER 2017 REVIEW

## Demand

The recorded 2017 summer hourly average peak demand reached 49,900 MW[6] on 9/1/2017. Adjusting the load to normalized weather results in a peak load of 46,669 MW for the California Independent System Operator (CAISO) in 2017, which was an increase of 0.1 percent from the 2016 summer weather normalized peak demand of 46,602 MW. The 2017 annual peak demand for the Southern California zone (South of Path 26 or SP26) was 28,776 MW and for the Northern California zone (North of Path 26 or NP26) the annual peak demand reached 21,714 MW. The annual peak for SP26, CAISO, and NP26 peaks occurred on 9/1/2017 at hour ending 16:00, 17:00 and 18:00, respectively.

*Figure 7* shows CAISO, SP26 and NP26 actual monthly peak demand from 2008 to 2017. The CAISO summer peak dropped from 46,814 MW in 2008 to 45,809 MW in 2009 as demand moderated during the recession. Since 2009, peak demand fluctuations have been primarily due to changing economic conditions, changing demographics, and weather conditions unique to each year. More recently, peak demand has been significantly impacted by behind the meter solar installations and to a lesser extent, by increasing energy efficiency, the use of demand side management. The behind the meter solar capacity exceeded 1,000 MW in 2011 and is project to reach 6,600 MW by early summer 2018.

**Figure 7**

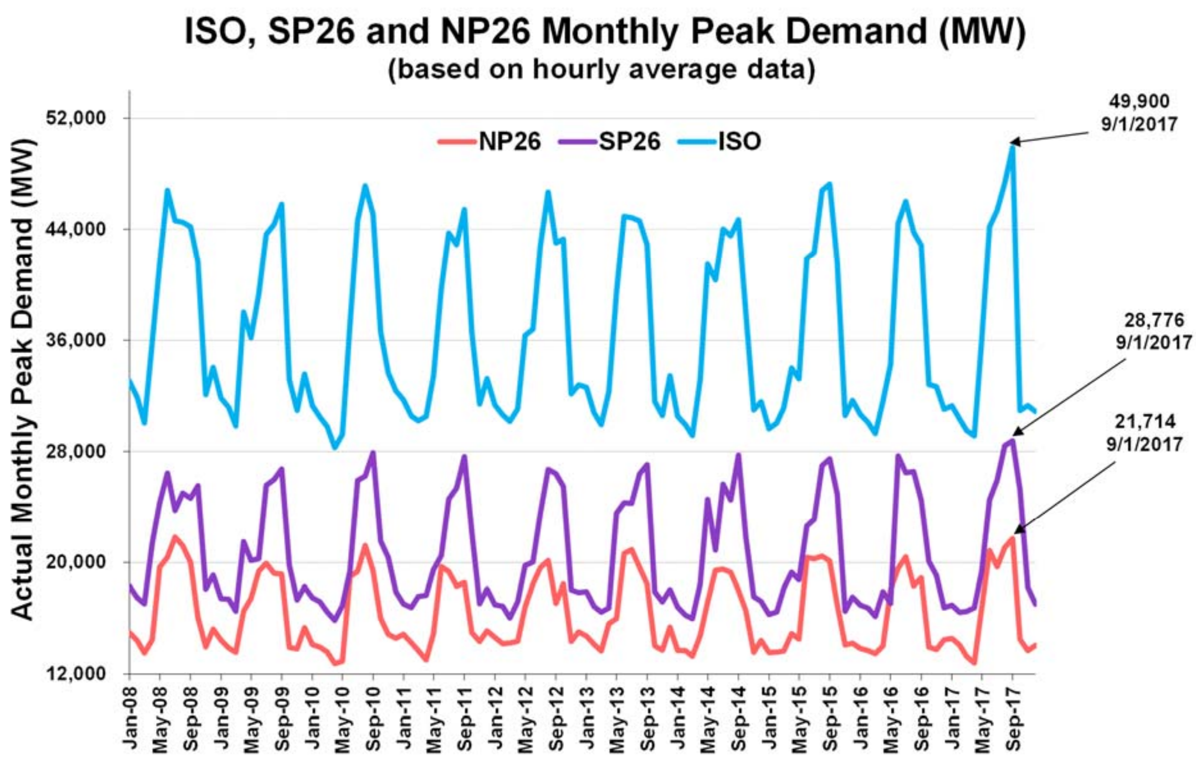



*Figure* 7 shows the CAISO balancing authority system peak and peaks for Northern and Southern California (2008-2017).

[6] All demand data represented in this report is hourly average demand.

*Table 1* shows the difference between 2017 actual peak demands, 2017 weather normalized peak and 2017 1-in-2 peak demand forecasts. The CAISO actual peak demand was 6 percent higher than the 1-in-2 peak demand forecasts due to actual weather conditions being 1-in-19 weather event. The weather normalized peak load for CAISO in 2017 was 46,669 MW.

The actual peak demand in Northern California was 4 percent higher than 1-in-2 peak demand forecasts for NP26. The weather at the time of the actual NP26 peak demand was a 1-in-19 weather event.

The actual peak demand in Southern California was 3 percent higher than the 1-in-2 forecast peak demand for SP26. The weather at the time of the SP26 peak demand was a 1-in-12 weather event.

**Table 1**

| 2017 ISO Actual, Weather Normalized and Forecast Peak | | | | | |
|---|---|---|---|---|---|
| Zone | Actual | Normalized | 1-in-2 Forecast | Actual vs. Forecast | Forecast vs. Normalized |
| NP26 | 21,714 | 20,794 | 20,791 | 4% | 0% |
| SP26 | 28,776 | 27,238 | 27,909 | 3% | 2% |
| ISO | 49,900 | 46,669 | 46,877 | 6% | 0% |

## Generation

Actual daily generation levels during June through September 2017 for the CAISO system and the SP26 and NP26 zones are shown in *Appendix A: 2017 Summer Supply and Demand Summary Graphs.*

## Interchange

*Figure 8* shows the 2017 CAISO peak demand and the net interchange over the weekday summer load period. There are numerous factors that determine the level of interchange between the CAISO and other balancing authorities at any given point in time. These factors typically include market dynamics, demand within various areas, day-ahead forecasts accuracy, generation availability, transmission congestion, hydro conditions, and more recently, levels of renewable generation. On any given day, the degree to which any one of these interrelated factors influence import levels can vary greatly. Actual daily Import levels during June through September 2017 for the CAISO system and the SP26 and NP26 zones are shown in *Appendix C: 2017 Summer Imports Summary Graphs*

**Figure 8**

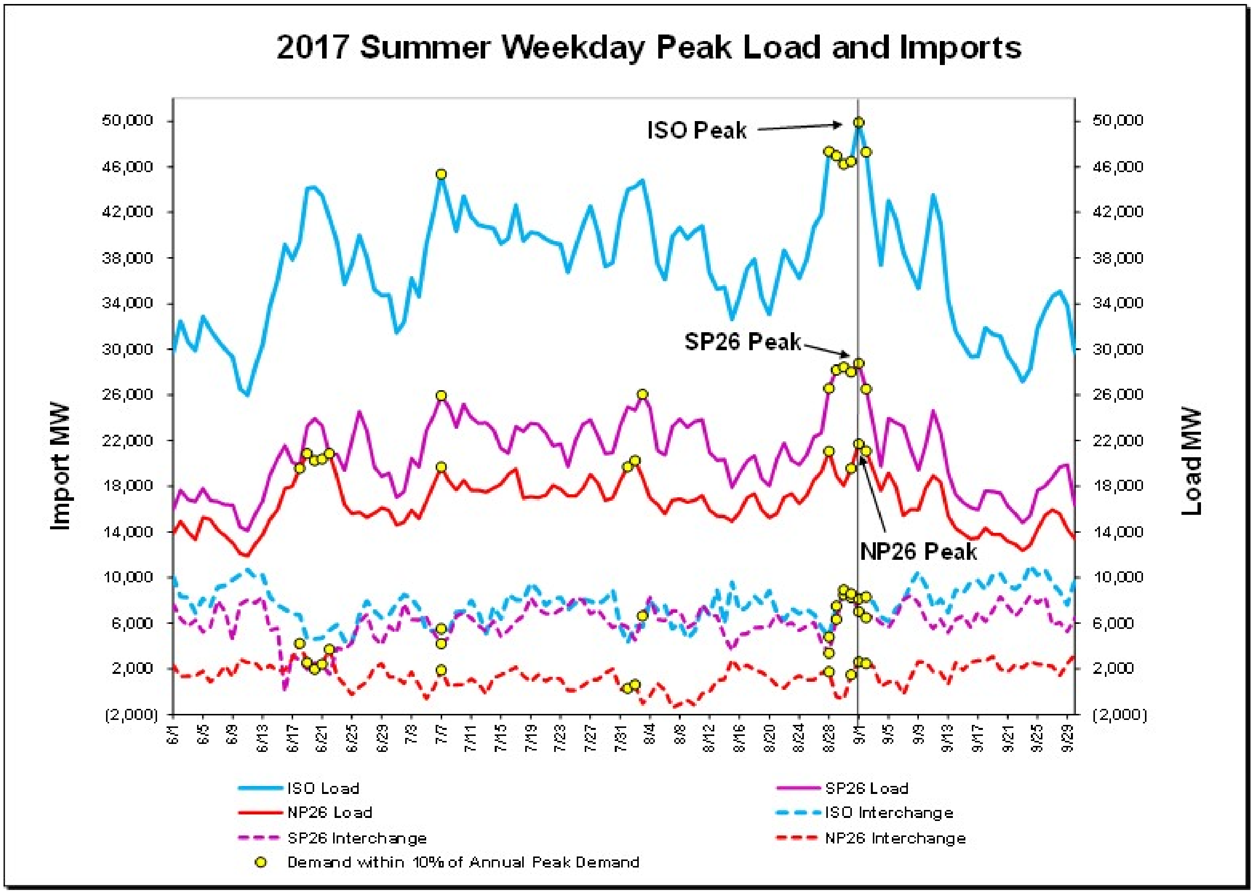



*Figure 8* shows the amount of imports at CAISO daily system peaks.

# III. SUMMER 2018 ASSESSMENT

## CAISO Loads

### *Annual Peak and Energy Forecast*

The CAISO's annual peak and energy forecast process has three steps. The first is to develop daily peak and energy forecast models for Pacific Gas Electric, Southern California Edison, and San Diego Gas & Electric in MetrixND®, the forecasting tool used by the CAISO. The inputs are historical loads, weather data, historical and forecast economic and demographic data, and calendar information. In the second step, a simulation program generates 161 weather scenarios using 23 years of historical weather data from 1995 through 2017. Each historical year has seven different weather scenarios so that each year has a scenario that starts on each of seven days of a week. Finally, 161 annual peaks are produced by combining the MetrixND® models with the 161 weather scenarios through a peak simulation process.

The historical loads are hourly average demand values sourced from the CAISO energy management system (EMS) from January 1, 2003 through September 30, 2017. Water delivery pump loads were not counted in the historical demand as they do not react to weather conditions in a similar fashion and are subject to interruption. Pump loads are added back into the forecast demand based on a range of typical pump loads during summer peak conditions.

The weather data comes from 24 weather stations located throughout large population centers within the CAISO balancing authority. Weather data used in the model include maximum, minimum and average temperatures, cooling degree days, heat index, relative humidity, solar radiation indexes, as well as a 631 three-day temperature weighting index.

The CAISO uses gross domestic product and population developed by Moody's Analytics for the metropolitan statistical areas within the CAISO as the economic and demographic indicators to the models. *Figure 9* shows five economic scenario forecasts developed by Moody's Analytics that represent different outlooks of how the economy could play out based on different assumptions such as consumer confidence and household spending, labor markets and credit conditions.

The baseline forecast is the median scenario wherein there is a 50 percent probability that the economy will perform better and a 50 percent probability that the economy will perform worse. Four other scenarios are defined below.

- Scenario 1 is a Stronger Near-Term Growth Scenario, which is designed so that there is a 10 percent probability that the economy will perform better than this scenario, broadly speaking, and a 90 percent probability that it will perform worse.
- Scenario 2 is a Slower Near-Term Growth Scenario in which there is a 75 percent probability that economic conditions will be better, broadly speaking, and a 25 percent probability that conditions will be worse.
- Scenario 3 is a Moderate Recession Scenario in which there is a 90 percent probability that the economy will perform better, broadly speaking, and a 10 percent probability that it will perform worse.
- Scenario 4 is a Protracted Slump Scenario in which there is a 96 percent probability that the economy will perform better, broadly speaking, and a 4 percent probability that it will perform worse.

Scenario 1 is more optimistic than the base case forecast while scenarios 2 through 4 are progressively more pessimistic. The range of divergence between the various scenarios began January 1, 2018. It is important to note that these forecasts are based on the Moody's gross domestic product forecasts released in December 2017. The gross domestic product data reflects actual historical data through Dec 31, 2016 (January 2017 and later historical data are estimates of actual GDP). Consequently, this forecast is based on the most current data available at that time. *Figure 10* shows CAISO 1-in-2 peak demand forecasts based on the five economic scenarios from Moody's Analytics.

**Figure 9**

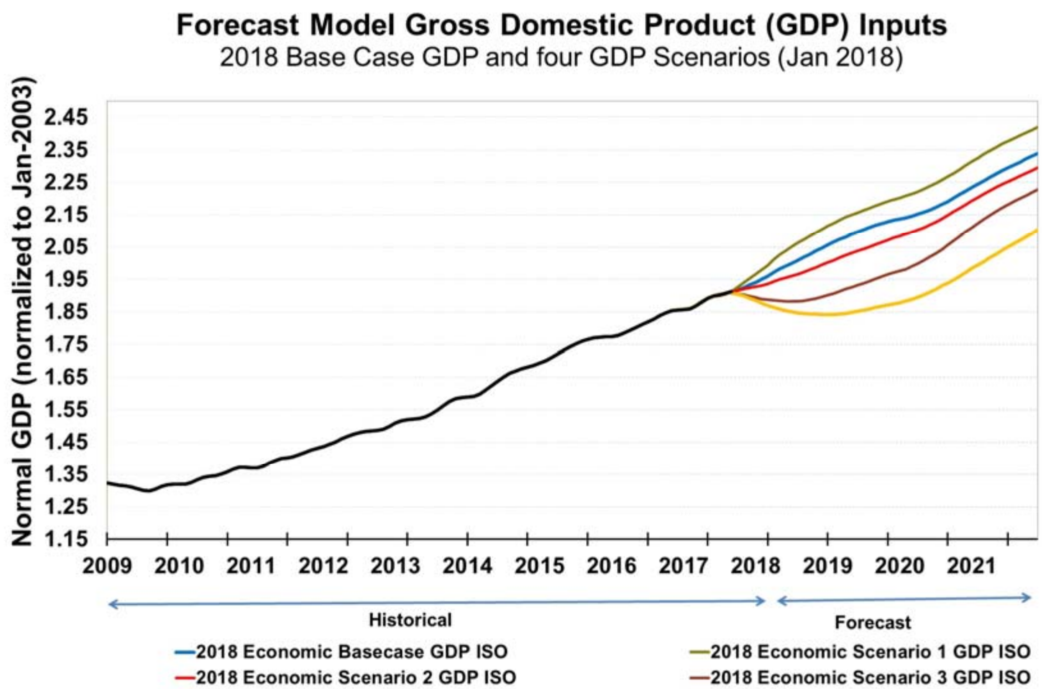
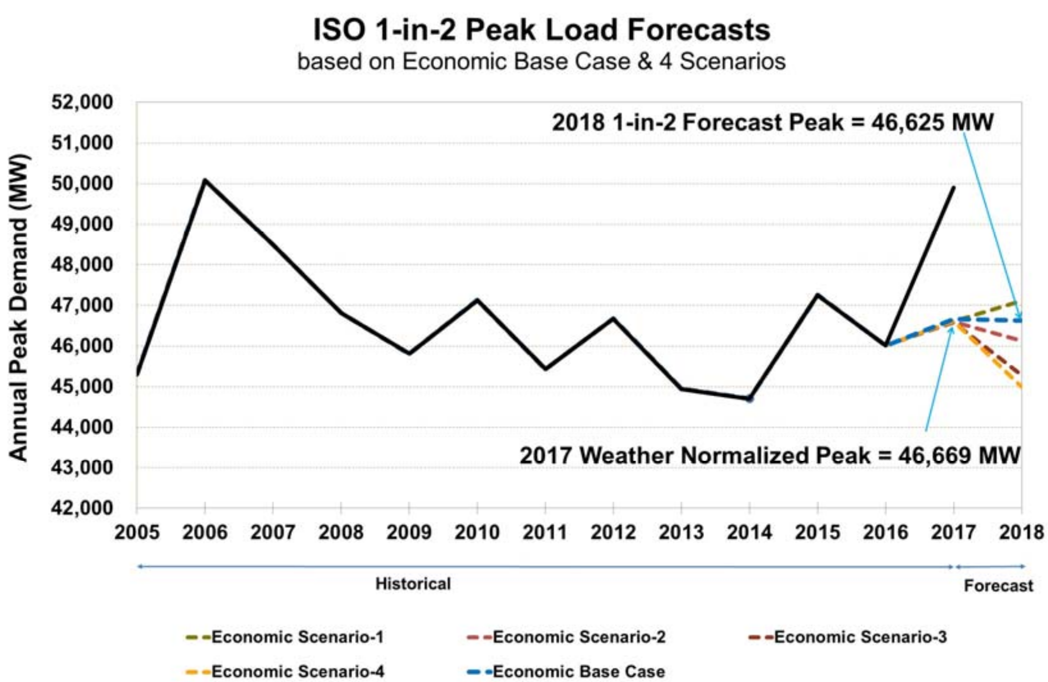



**Figure 10**



The 2018 base case forecasted gross load peak demand is a modest 0.09 percent decrease over the CAISO 2017 weather normalized peak demand. The slight decrease in the demand projection is a result of projected modest economic growth over 2017, based on the economic base case forecast from Moody's Analytics, reduced by continuing load reductions due to ongoing behind the meter solar installations and energy efficiency program impacts on peak demand. The 1-in-2, 1-in-5 and 1-in-10 peak load forecasts for 2018 are shown in *Table 2.*

**Table 2**

**2018 Gross Load Peak Demand Forecast**

| 2018 | ISO | SP26 | NP26 |
|---|---|---|---|
| 1-in-2 | 46,625 | 27,089 | 20,700 |
| 1-in-5 | 48,636 | 28,205 | 21,593 |
| 1-in-10 | 51,632 | 28,709 | 22,430 |

The net load is demand minus grid-connected wind and solar production. In other words the remaining load that the CAISO dispatched resources serves after the gross load has been reduced by the amount of energy production from renewable resources. Renewable resources have an energy profile based on the availability of the resource they utilize to produce energy (e.g. solar and wind). The net load is served by the resources that the CAISO is able to dispatch. *Table 3* shows the forecasted net-load peak demand for 2018.

**Table 3**

**2018 Net Load Peak Demand Forecast**

| 2018 | CAISO Net Load Forecast (MW) |
|---|---|
| 1-in-2 | 39,800 |
| 1-in-5 | 42,714 |
| 1-in-10 | 44,200 |
| Max | 48,168 |

## Hydro Generation

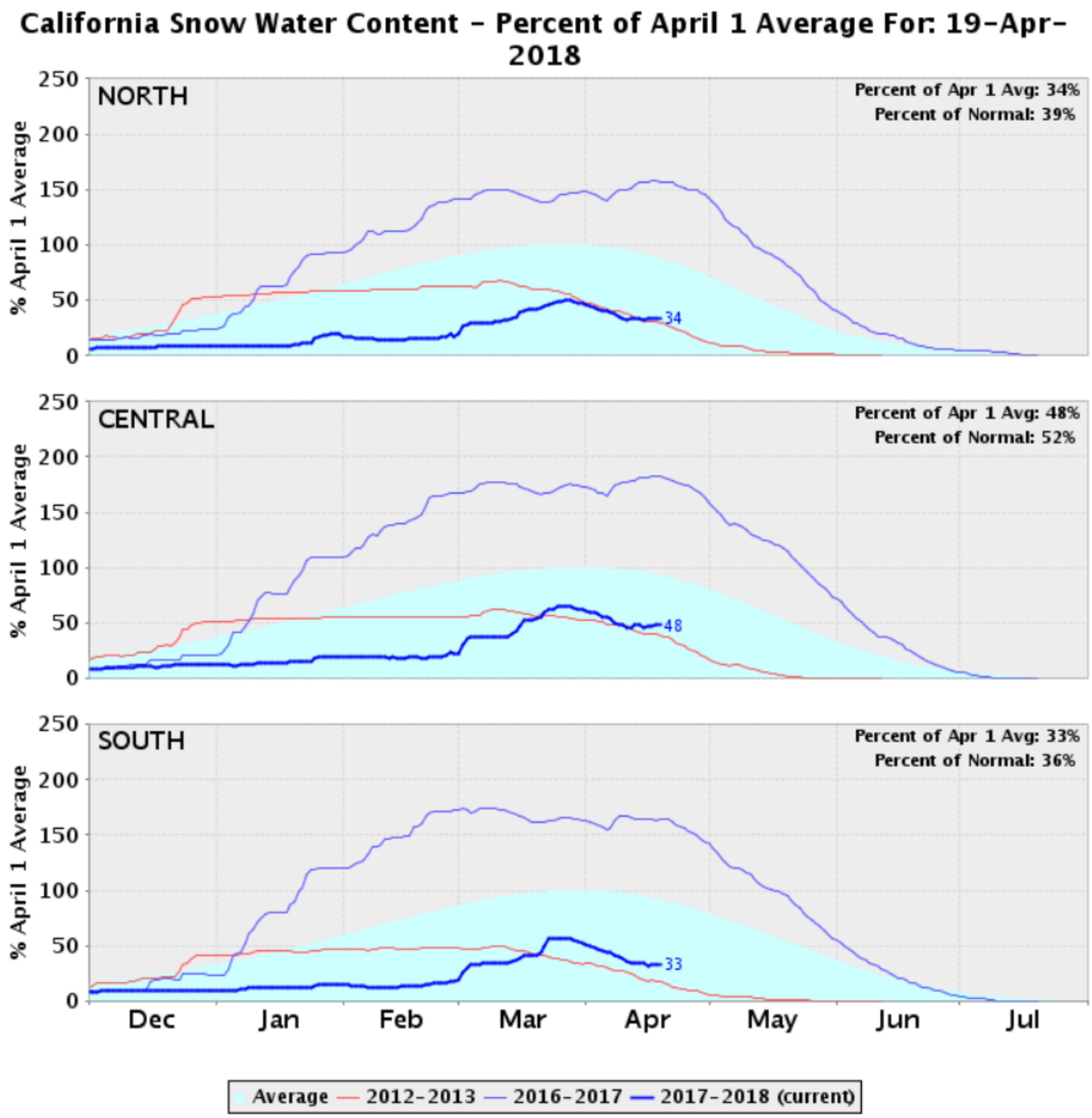
Hydro conditions for 2018 are below normal. As of April 2, 2018, the statewide snow water content for the California mountain regions was 51 percent of the April 1 average, which is close to the 2012 – 2013 hydro year levels *(Figure 11)*. North Sierra precipitation is 83 percent, San Joaquin precipitation is 76 percent of average, and Tulare Basin Precipitation is 62 percent of average *(Figures 12–14)*. While statewide large reservoir storage levels are near normal or above, snow water content is the more accurate measure of summer hydro capability. Based on the NQC values used in the model, only 8 percent of hydro capacity in the CAISO is located on a large reservoir. The majority of the capacity is located on smaller reservoirs or are run of river that are more dependent on snowmelt. California hydroelectric capability will be below normal for 2018 providing less than normal hydro energy during the spring and summer seasons.

As of April 2, 2018, the Northwest River Forecast Center projected the April to August reservoir storage in the Dalles Dam on the Columbia River to be 118 percent of average. Summer 2018 water supply projections for the Pacific Northwest are similar to 2017 levels. There are no concerns with Pacific Northwest hydroelectric generation.

The Hydro generation is modeled on an aggregated basis with two types, run-of-river and dispatchable hydro generation. Run-of-river hydro generation has a fixed generation profile derived from historical data for the north and the south. The dispatchable hydro generation is optimized subject to the daily energy limits and daily maximum values which are derived from historical data. Dispatchable hydro can provide ancillary services. Pump storage generators are modeled individually and are optimized subject to storage capacity, inflow and target limits, and cycling efficiency.

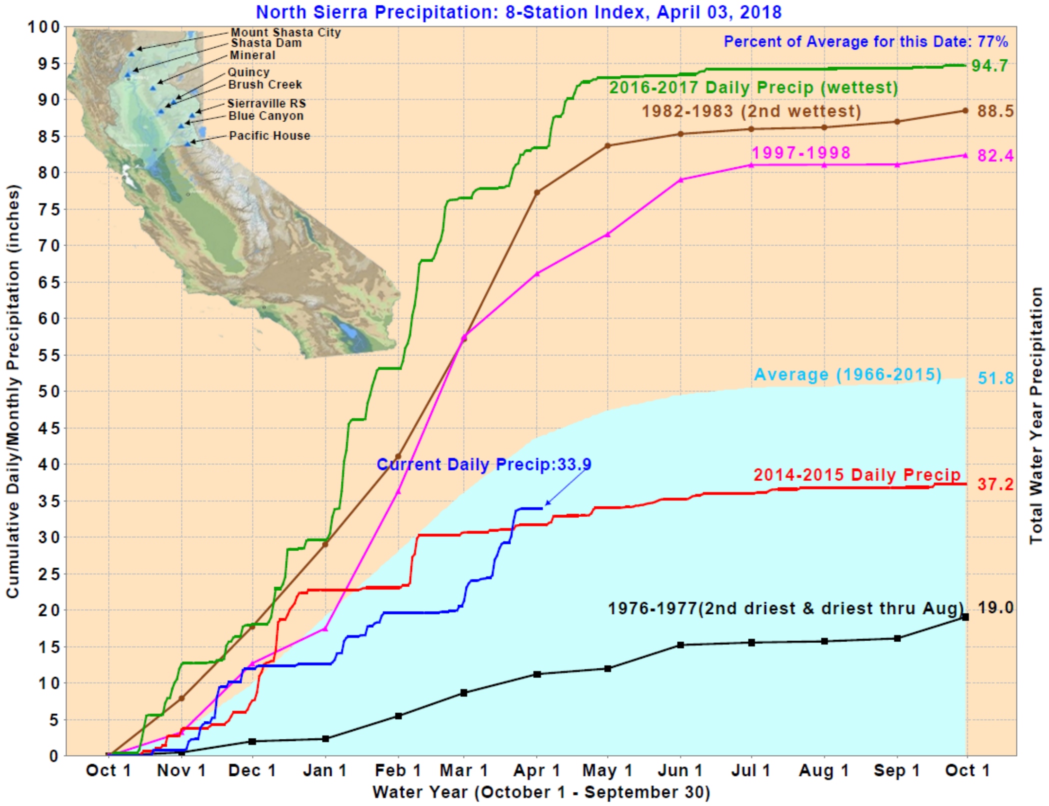
*Figure 11* shows the significant difference between the snow water content available for hydro generation during 2017 compared to 2018. Below normal hydro conditions will result in lower energy production throughout the summer, likely impacting September most heavily. *Figure 11* also shows that as of April 19, 2018, the 2017-2018 snow water content is similar to 2012 – 2013. The 2013 hydro generation profile was used in the 2018 modeling process.

**Figure 11**



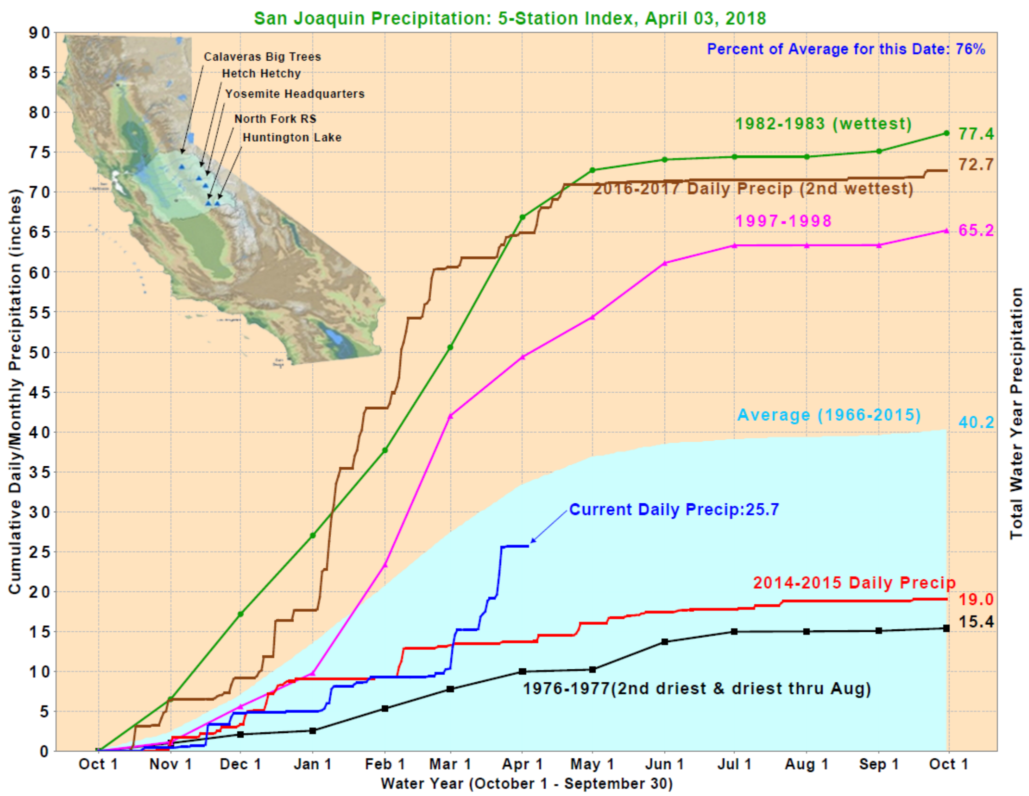

Source: California Department of Water Resources

## Figure 12



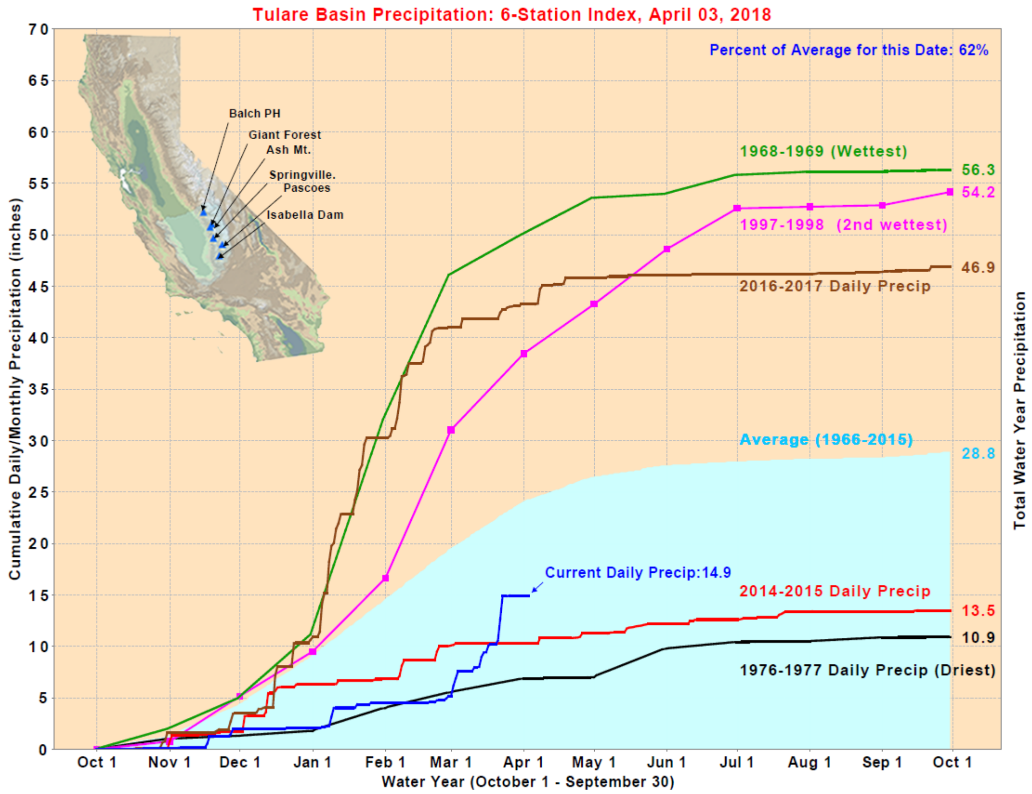

Source: California Department of Water Resources

## Figure 13




Source: California Department of Water Resources

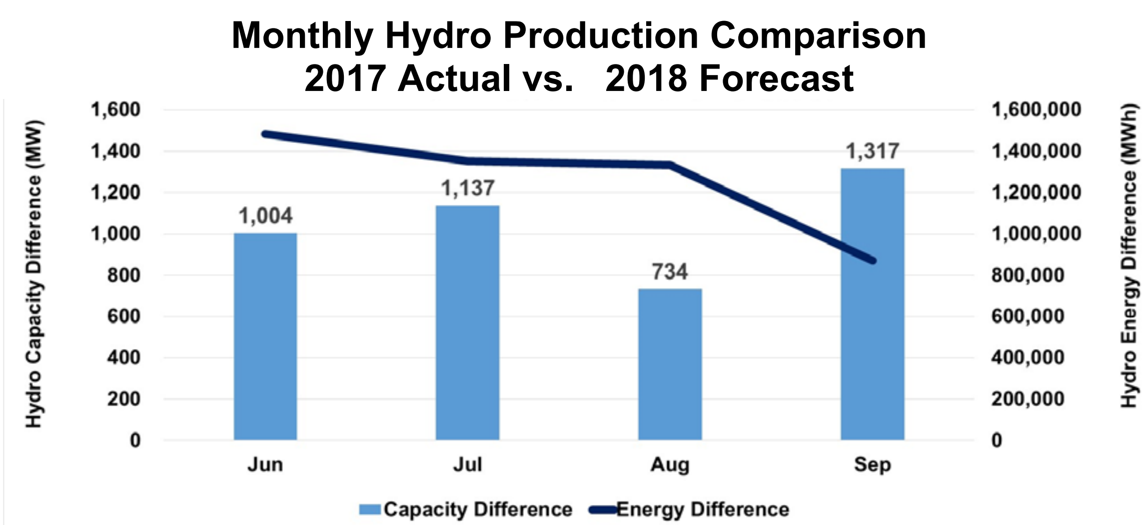
**Figure 14**




Source: California Department of Water Resources

*Figure 15* shows the difference between 2017 actual hydro energy and the maximum capacity production levels compared to the levels forecasted for 2018. The Forecast levels are based on the 2013 actual hydro generation levels because the 2018 snow water content is very close to the 2013 snow water content amounts across California. The differences shown in *Figure 15* demonstrate amount of the decreased hydro capacity and energy compared to 2017 levels, which will result in lower Unloaded Capacity Margins during the 2018 summer season, most significantly during September.

**Figure 15**



## Net Qualifying Capacity

The CAISO bases its operating reserves on the total net qualifying capacity (NQC) of its resource fleet. Total CAISO generation NQC for 2018 summer peak is estimated to be 51,947 MW using the final NQC list that was used for the California Public Utilities Commission (CPUC) and CAISO's resource adequacy program for compliance year 2018, which is posted on the CAISO website.[7] Generators who chose not to participate in the NQC process were added using the CAISO Master Control Area Generating Capability List, which is also posted on the CAISO website.[8]

Each year, the CPUC, California Energy Commission (CEC), and CAISO work together to develop the annual NQC values in the NQC list, which describes the amount of capacity that can be counted from each resource to meet Resource Adequacy (RA) requirements in the CPUC's and CAISO's RA programs. The NQC value for dispatchable resources depend on its demonstrated capacity and deliverability — the ability of the grid to deliver the generation to load centers. The CAISO determines the net qualifying capacity by testing and verifying as outlined in the CAISO tariff and the applicable business practice manual.

The largest generation resource fuel type is natural gas, accounting for 57.9 percent, and the second largest generation type is solar, which accounts for 15.8 percent. Hydro accounts for 15.1 percent. Wind, geothermal, and biofuel units make up about 6.2 percent. Nuclear generation is 4.4 percent while oil generation provides 0.3 percent. The overall resource NQC amount is shown in the NQC by fuel type chart in *Appendix D: 2018 CAISO Summer On-Peak NQC Fuel Type.*

## Generation Additions

*Table 4* shows the total NQC generation of 692 MW from new generation interconnected to the CAISO balancing authority that came online in the period from 6/1/2017 to 6/1/2018. This new NQC included 40 MW in SP26 (Southern California Edison (SCE), San Diego Gas & Electric (SDG&E)), and Valley Electric Association (VEA)) and 652 MW in NP26 (Pacific Gas & Electric (PG&E)).

**Table 4**

**Generation Additions (NQC MW)**
**From 6/1/2017 to 6/1/2018**

| Generation addition from 6/1/2017 to 6/1/2018 | | | | |
|---|---|---|---|---|
| **Fuel** | **PG&E** | **SCE** | **SDGE** | **ISO** |
| **Biofuel** | 165 | 0 | 0 | 165 |
| **Gas** | 48 | 0 | 0 | 48 |
| **Hydro** | 11 | 0 | 0 | 11 |
| **Solar** | 417 | 0 | 0 | 417 |
| **Wind** | 11 | 12 | 28 | 51 |
| **Total** | 652 | 12 | 28 | 692 |

[7] Final Net Qualifying Capacity Report for Compliance Year 2018: http://www.caiso.com/planning/Pages/ReliabilityRequirements/Default.aspx
[8] Master Control Area Generating Capability List: http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx (under Atlas Reference)

## Generation Retirements

*Table 5* shows the resources that have retired since June 1, 2017 and the resources that are expected to retire by June 1, 2018. The last column of *Table 5* shows resources that are once through cooled and subject to the State Water Resources Control Board policy on the use of coastal and estuarine waters for power plant cooling. For further details see the once through cooled Generation section later in this assessment. Of the 860 MW of generation that have or will retire by June 1, 2018, 669 MW are in SP26 and 191 MW are in NP26.

**Table 5**

**Generation Retirements (NQC MW)**
**From 6/1/2017 to 6/1/2018**

| Resource ID | Retirement Date | NDC | Fuel Type | PTO | OTC |
|---|---|---|---|---|---|
| BEARCN_2_UNITS | 5/22/2018 | 23 | Geothermal | PGAE | N |
| CONTAN_1_UNIT | 12/30/2017 | 28 | Natural Gas | PGAE | N |
| KEARNY_7_KY3 | 1/9/2018 | 61 | Natural Gas | SDGE | N |
| KNGCTY_6_UNITA1 | 12/31/2017 | 45 | Natural Gas | PGAE | N |
| LGHTHP_6_ICEGEN | 6/10/2017 | 48 | Natural Gas | SCE | N |
| MNDALY_7_UNIT 1 | 2/6/2018 | 215 | Natural Gas | SCE | Y |
| MNDALY_7_UNIT 2 | 2/6/2018 | 215 | Natural Gas | SCE | Y |
| MNDALY_7_UNIT 3 | 2/6/2018 | 130 | Natural Gas | SCE | N |
| SANJOA_1_UNIT 1 | 7/19/2017 | 49 | Natural Gas | PGAE | N |
| WOLFSK_1_UNITA1 | 12/31/2017 | 46 | Natural Gas | PGAE | N |

### *Stochastic Simulation Approach to Assess Supply and Demand*

The modeling methodology uses all capacity available within the CAISO balancing authority regardless of contractual arrangements to evaluate resource adequacy in order to understand how the system will respond under a broad range of operating conditions. While some resources may not receive contracts under the resource adequacy program, and may possibly contract with entities outside the CAISO for scheduled short-term exports, these resources are still considered available to the CAISO for the purposes of this assessment. Resources that are not under the resource adequacy program do not have must offer obligation to the CAISO Day Ahead and Real Time Market. The CAISO may be able to utilize these non-RA resources, if physically available, via the backstop Capacity Procurement Mechanism.

Conventional generation units such as gas and nuclear are individually modeled while non-dispatchable qualifying facilities (QFs), biofuel and geothermal generation are modeled using their fixed hourly generation profiles, which are developed based on the projected capacities and historical generation profiles on an aggregated basis.

In recent years, significant amounts of new renewable generation, especially solar, have reached commercial operation to meet the state's 33 percent Renewables Portfolio Standard (RPS) milestone by 2020 and the 50 percent requirement by 2030. To successfully meet the state's RPS goals, increasing amounts of flexible and fast responding resources must be available to integrate the growing amounts of variable resources. These increasing amounts of variable resources integrated with the CAISO grid pose unique challenges for CAISO operations and for the analytical tools used by the CAISO to assess near-term reliability.

As new renewable resources come on the system, CAISO reliability requirements have evolved from meeting the gross peak demand to meeting both net peak demand and flexible capacity requirements. The gross peak usually occurs at the hour ending of 16:00 or 17:00 while net peak occurs in the hour ending 19:00 to 21:00 timeframe where solar generation is close to zero. The CAISO's evolving net load profile – gross load minus transmission level interconnected solar and wind generation – has become known as the duck curve. The growing amount of photovoltaic solar generation that is interconnected to the CAISO grid continues to change the CAISO's net load profile and creates more challenges and uncertainty for CAISO operations. Photovoltaic solar generation located behind the customer meter is an additional impact, impacting the gross load and further decreasing the net load the CAISO serves. The result is a constantly increasing ramping requirement than what have been required from the generation fleet in the past, both in the upward and downward directions. Furthermore, solar generation does not provide significant power at the hours ending 19:00 to 21:00, which leads to reliance on gas and other non-solar generation after sunset. The continuing decline in gas generation as gas units retire is beginning to challenge the system supply's ability to meet the net peak demand after sunset.

To assess the changing resource needs from the increasing number of variable resources and declining fleet of dispatchable resources the CAISO continues to enhance its stochastic simulation model based on the Energy Exemplar PLEXOS® Integrated Energy Model. The CAISO uses PLEXOS to assess resource adequacy, modeling the availability of system resource capacity and system flexibility requirements. The simulation covers 35 WECC zones with 91 WECC interchange paths. The model uses a mixed-integer linear programing to determine the optimal generation dispatch. The model runs chronologically to dispatch energy, ancillary services and load following to seek the least cost co-optimized solution to meet the system demand and flexibility requirement simultaneously. Operational constraints include forced and planned outage rates, unit commitment parameters, minimum unit up and down times, unit heat rates, and ramp rates for each generator in the CAISO.

For hours in which supply is sufficient, the model determines how much unloaded capacity exists and calculates the Minimum Unloaded Capacity Margin based on the load and available resources, imports, and exports over the 2,928 hour summer profile. If supply is not sufficient, the model reports the unserved hours and unserved energy where demand exceeds supply.

### Generation Unavailability

Forced outages are generated for individual units on a random basis by PLEXOS using the unit's historical forced outage rate with a uniform distribution function based on 2015 through 2017 individual historical summer forced outages. Planned outages are sourced from the CAISO outage management system.

### Unit Commitment

The PLEXOS production simulation applies unit commitment constraints for generator startups and shutdowns, using the following criteria. While the generator is starting up, it cannot provide ancillary or load following services while ramping from initial synchronization to its minimum allowed operating capacity. Similarly, when a generator is in the process of shutting down it cannot provide ancillary or load following services once it has ramped down passed its minimum capacity threshold. Once a generator is committed, it must remain operating for its minimum run time before it can be shut down. After a generator has been shut down, it is not available for commitment again until it has been off for its specified minimum down time.

Once a generator is operating within its operating range (between its minimum and maximum capacity) it must meet the following criteria.

If a generator is ramping up:

- Regulation up, spinning, and non-spinning provided by the generator cannot exceed its 10-minute ramping up capability and unused capacity;
- Energy, regulation up, spinning, and non-spinning provided by the generator cannot exceed its 60-minute ramping capability and its available unused capacity.

During ramping down:

- Difference between its minimum capacity and its current operating point determine the amount of regulation-down and load following-down that can be provided by a generator.

Therefore, the model sets 60 minutes ramping time for energy and 10 minutes for ancillary services in each hour's simulation. Each dispatchable generator can run with a maximum ramp rate between its minimum and maximum capacity.

## Curtailable Demand

Curtailable Demand includes demand response, pumping load, and aggregated participating load that can provide non-spinning reserve or demand reduction. Curtailable demand reduce end-user loads in response to high prices, financial incentives, environmental conditions or reliability issues. They play an important role to offset the need for more generation and provide grid operators with additional flexibility in operating the system during periods of limited supply.

Demand response programs can be categorized as event based and non-event based. Non-event based demand response programs include real-time pricing and load shifting. Event based or dispatchable demand response programs are modeled as a supply side resources that have triggering conditions in the stochastic simulation model. Event-based demand response resources can be either on or off. They include base interruptible programs, aggregator managed portfolios, capacity bidding programs, demand bidding programs, smart AC, summer discount plans, and demand response contracts. The Reliability Demand Response Resources (RDRR) programs in the CAISO market are event-based programs that require the CAISO to declare a system warning before they can be utilized.

Whenever the model depletes all available resources before meeting the load and ancillary service requirements the model will utilize demand response programs. The available Reliability Demand Response Resource (RDRR) and Proxy Demand Resource (PDR) in the CAISO market for 2018 is 1,763 MW.

The Flex Alert program is a voluntary energy conservation program that alerts and advises consumers about how and when to conserve energy. The Flex Alert program continues to be a vital tool for the CAISO during periods of high peak demand or other stressed grid conditions to maintain system reliability. The alerts also serve as a signal that both non-event and event-based demand responses are needed.

## Interchange

The model simulated 35 WECC zones and 91 WECC interchange paths between zones, as shown in *Figure 16*. The zonal interchange path limits were set based on the WECC Path Rating Catalog. Transmission limits within the zones were not modeled and the model cannot provide results related to local capacity requirements. The transfer capabilities between any two adjacent zones reflected the maximum simultaneous transfer capabilities. In addition, a total CAISO maximum import limit was set based on historical import patterns. Exports from California was subject to the transmission limits of the export paths. Path 15 and Southern California Import Transmission (SCIT) nomogram constraint were enforced in the model.

**Figure 16**

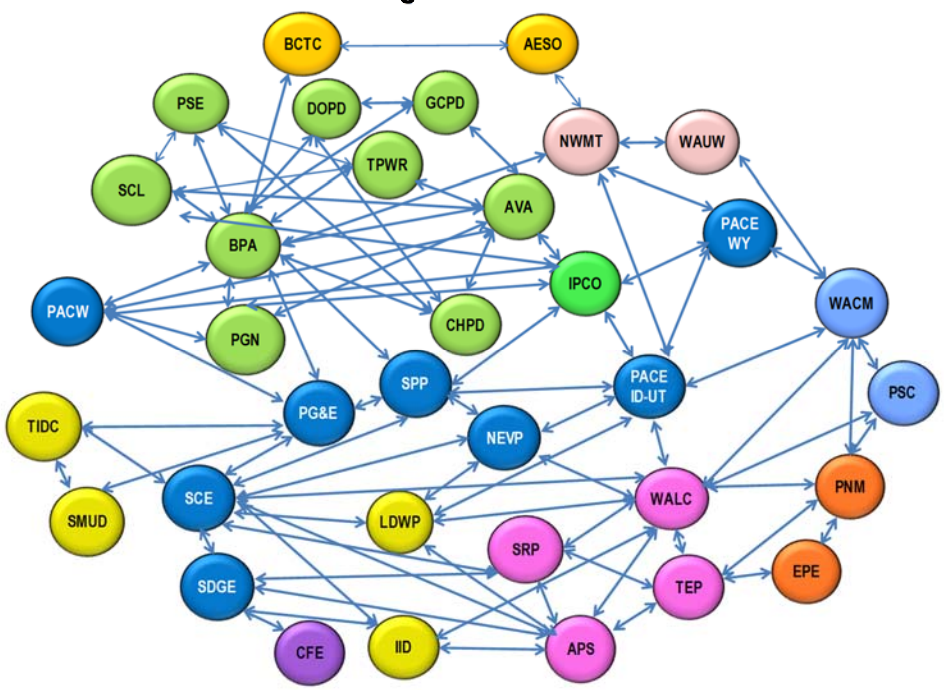



*Figure 16 Simulation covers WECC 35 Zones and 91 Paths*

## Stochastic Scenarios

In its production simulation process, the CAISO runs 2,000 unique scenarios generated randomly – each representing a combination of forecasted 8,760 hourly load profiles and renewable generation levels based on historic annual weather patterns. The CAISO uses a two-step process to generate the 2,000 random scenarios. The first step is to build three pools of load, wind and solar profiles. In this step, 15 years of historical hourly load profiles were matched with the 161 annual peak and annual energy forecasts to produce 161 hourly load scenarios in the load pool; 10 years of historical hourly wind capacity factors were multiplied with the projected wind capacity in 2018 to generate 10 hourly wind profiles in the wind pool; and 5 years of historical hourly solar capacity factors were multiplied with the projected solar capacity in 2018 to generate 5 hourly solar profiles in the solar pool. The second step is to randomly generate 2,000 scenarios from the load, wind and solar pools. One random draw from each of the load, wind and solar pools creates a scenario, which contains one load, wind, and solar profile. A total of 2,000 draws generates 2,000 scenarios from 8,050 possible scenarios (161 load profiles x 5 solar profiles x 10 wind profiles), illustrated in *Figure 17*.

Two thousand randomly drawn scenarios of load, wind and solar for PG&E, SCE, and SDG&E were developed based on the CAISO load forecast process while the load profiles for the rest of the 32 WECC zones were prepared based on a 1-in-2 peak and energy forecast from WECC. VEA is included in the SCE zone.

**Figure 17**

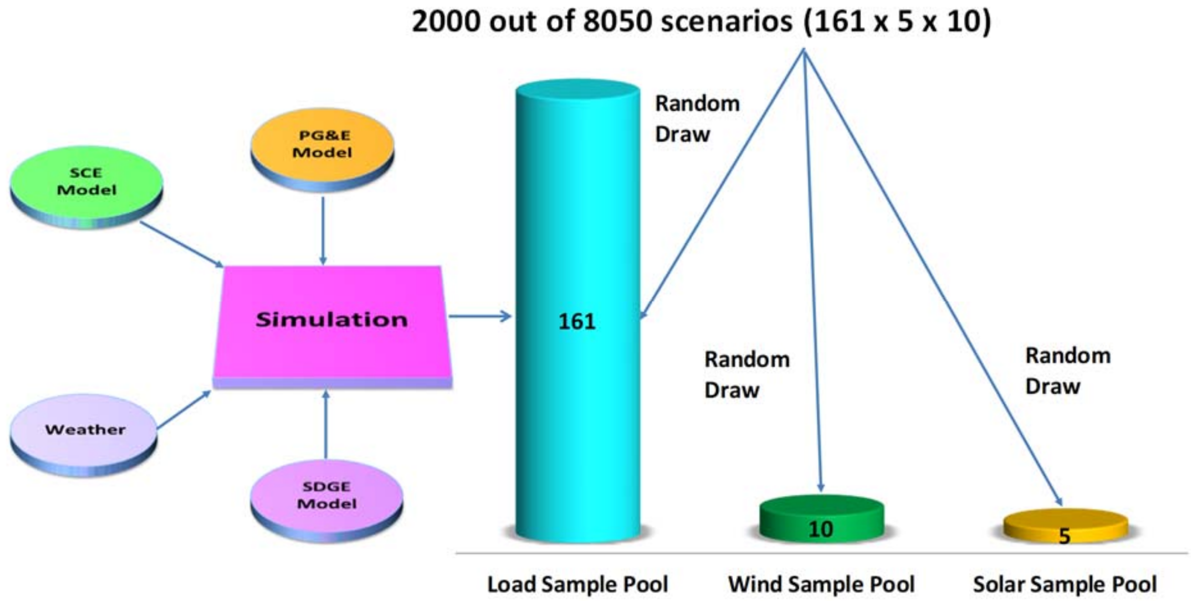



*Figure 17 2000* scenarios *of load, wind and solar are randomly selected from 8,050* scenarios

## Probabilistic Analysis

The PLEXOS stochastic model was applied to perform the 2018 summer loads and resources assessment study. The model used a mixed-integer linear programing to dispatch available resources to meet load demand and flexible capacity requirements. The simulation runs 2,000 scenarios on an hourly interval chronologically. Each scenario had a 2,928 hour profile from June 1 to September 30. The optimization time horizon was set as 24 hours. The end status of one optimization is used as the initial status of the next optimization

The PLEXOS stochastic model was first used in the development of the 2016 Summer Assessment and the CAISO continues to improve the modeling methodology. The extreme high temperatures events during the 2017 summer led to the highest loads that the CAISO has experienced since 2006. This provided an opportunity to validate the model's results against actual high load conditions. As a result of that validation process a number of model enhancements were made to achieve model results that more closely align with the issues and limitations that CAISO operations faces during extreme high loads as well as more normal operating conditions. Noteworthy modeling enhancements that were made include the following:

- Use of historical unit by unit forced outage rates versus the more generic outage inputs that were developed for the PLEXOS model the CAISO used in the CPUC Long Term Planning Proceedings.
- Closer alignment of the ability to re-dispatch dynamic scheduled resources during real time operations.

- Removal of the day-ahead unit commitment process that committed units in the day-ahead to be available for meeting flexible capacity requirements the following day. The current CAISO market mechanisms would have to be enhanced to perform this functionality.
- Changed from reporting the minimum operating reserve margin to a Minimum Unloaded Capacity Margin which more closely portrays the amount of capacity that operations can bring online in a short period of time to deal with unexpected contingencies such as resource forced outages.

These enhancements are anticipated to produce results for the 2018 Assessment that more closely align with 2018 actual results. While the 2018 Assessment's enhanced results are noticeably different from the results portrayed in the 2017 Assessment, the CAISO is confident the enhanced model more accurately represents the real time operational issues that the CAISO would face during normal and extreme operation conditions.

Loaded capacity is the generation capacity that is serving load. The unloaded capacity refers to online generation capacity which is not serving load and offline generation capacity from the day-ahead unit commitment process that can come online in 20 minutes or less — fast enough for operations call on to serve load if needed, as well as curtailable demand such as demand response, pumping load, and aggregated participating load that can provide non-spinning reserve or demand reduction. The Unloaded Capacity Margin (UCM) is applied to assess system reliability. The UCM is the projection of supply excess over projected demand on an hour basis that the model deems available plus available operating reserves.

For sufficient capacity and flexibility results, the model reports the summer Minimum Unloaded Capacity Margin (MUCM) for each 2,928 hour profile scenario based on load and available resources including curtailable demand, imports, and exports. Each of the 2,000 scenarios produce one MUCM value over the 2,928 hours from June 1 through September 30.

$$\text{UCM}(t) = \frac{Available\ Resources(t) + Import(t) - Export(t)}{Load(t)} - 1$$

$$\text{MUCM} = \text{Min}\,(UCM\,(1), \ldots, UCM\,(t), \ldots, UCM(2{,}928))$$

### Simulation Results

The model produces an UCM for each hour modeled. Taking into account the unloaded capacity margin for all of the 2,928 hours within each of the 2,000 summer scenarios, the UCM ranges from a high of 61 percent to – in a very small number of scenarios - a low of zero. The median[9] value of all unloaded capacity margin values is 23 percent (*Figure 18)*.

**Figure 18**

**CAISO Unloaded Capacity Margins (June through September 2018)**

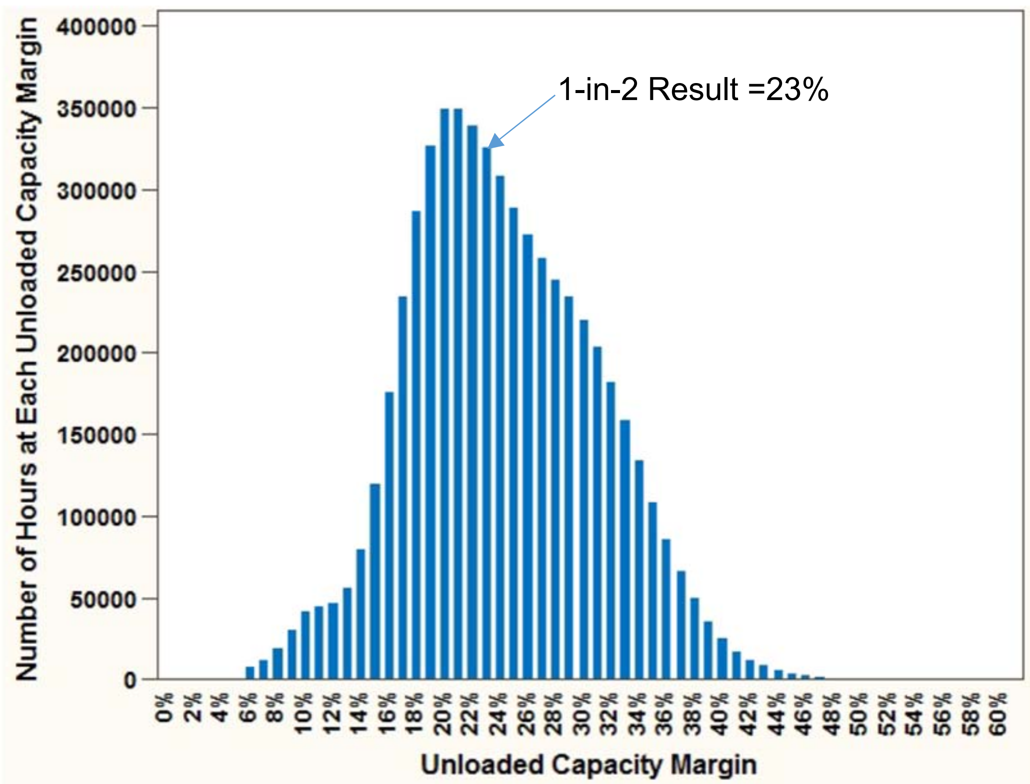



*Figure 18* shows the forecast of the UCMs over all 2,928 summer operating hours from all 2,000 scenarios.

The CAISO has developed a series of emergency stages[10] to communicate periods of low operating reserve conditions. A Stage 1 emergency is usually issued when the CAISO anticipate/forecast the system will not be able to maintain the required contingency reserve level, and there are insufficient additional resources (in or out of market) to maintain or recover the contingency reserves required. CAISO will usually issue a Stage 1 Emergency when the operating reserve is see-sawing above, then below the contingency reserve requirement and load continues to increase or energy supplies continues to decline. Stage 2 is an indication that all the steps available under a Stage 1 does not resolve or recover the reserve deficiency and the system is using non-spin reserves to meet load and spin

[9] The median is the value that is in the middle of the model results data set, where there is a 50 percent probability that the result will be above the median and a 50 percent probability that the result will be below the median.
[10] Emergency Fact Sheet

requirements, thereby making non-spin deficient and contingency reserve deficient. Stage 3 is an indication the system cannot maintain the spinning reserve requirement – generally 3 percent of load.

Whenever the UCM is at or below the level of the operating reserve requirement for any given hour (typically around 6 percent) the UCM is equivalent to operating reserve requirement for that hour. That may be the situation when the UCM is above 6 percent and is always the case whenever the UCM fall to or below 6 percent. *Figures 19* shows the range of UCM results that are at or below 6% and greater than 3% (i.e., operating reserves) for all 2,000 scenarios. If operating reserves fall within this range a Stage 2 Emergency[11] may be declared, which may require the CAISO to take out of market actions to secure additional reserves. Should CAISO system operating conditions go into the emergency stages, such as operating reserve shortfalls where non-spinning reserve requirement cannot be maintained or spinning reserve is depleted and operating reserve falls below minimum requirement, the CAISO will implement the mitigation operating plan to minimize loss of load in the CAISO BA area (described in the *Conclusion* section below*).*

As shown in *Figure 19*, over half of the 2,000 scenarios (1,055) produce at least one hour of potential Stage 2 Emergency with the majority of these (767 = 541+226) being only 1-2 hours over the entire summer season.

**Figure 19**

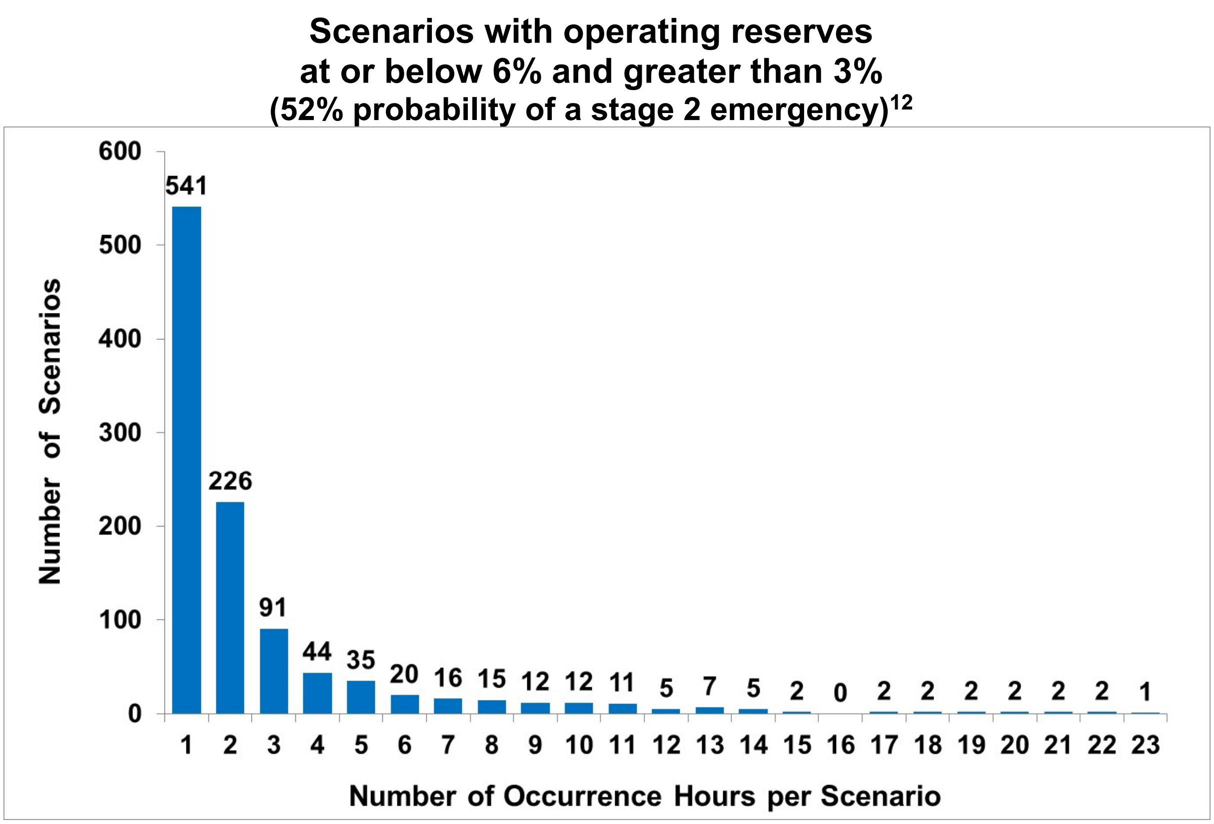



*Figure 19* shows scenario occurrences with operating reserves at or below 6% and greater than 3%

[11] Emergency Fact Sheet
[12] In these results shown in *Figure 19* demand response programs would have been utilized if needed to get to a 6 percent operating reserve margin and would be fully utilized in cases where the operating reserve margin is below 6 percent.

*Figure 20* shows the range where operating reserves for all 2,000 scenarios are at or below a 3 percent margin. If operating reserves fall within this range a Stage 3 Emergency may be declared. Under this more severe operating condition, the CAISO will issue a notice of potential load interruptions to utilities – whether actual interruptions would occur depends on the specific circumstances and potential for recovering reserves. As evident in *Figure 20*, only a relatively few number of scenarios (26 out of 2,000) produced an hour or more of potential Stage 3 Emergency.

**Figure 20**

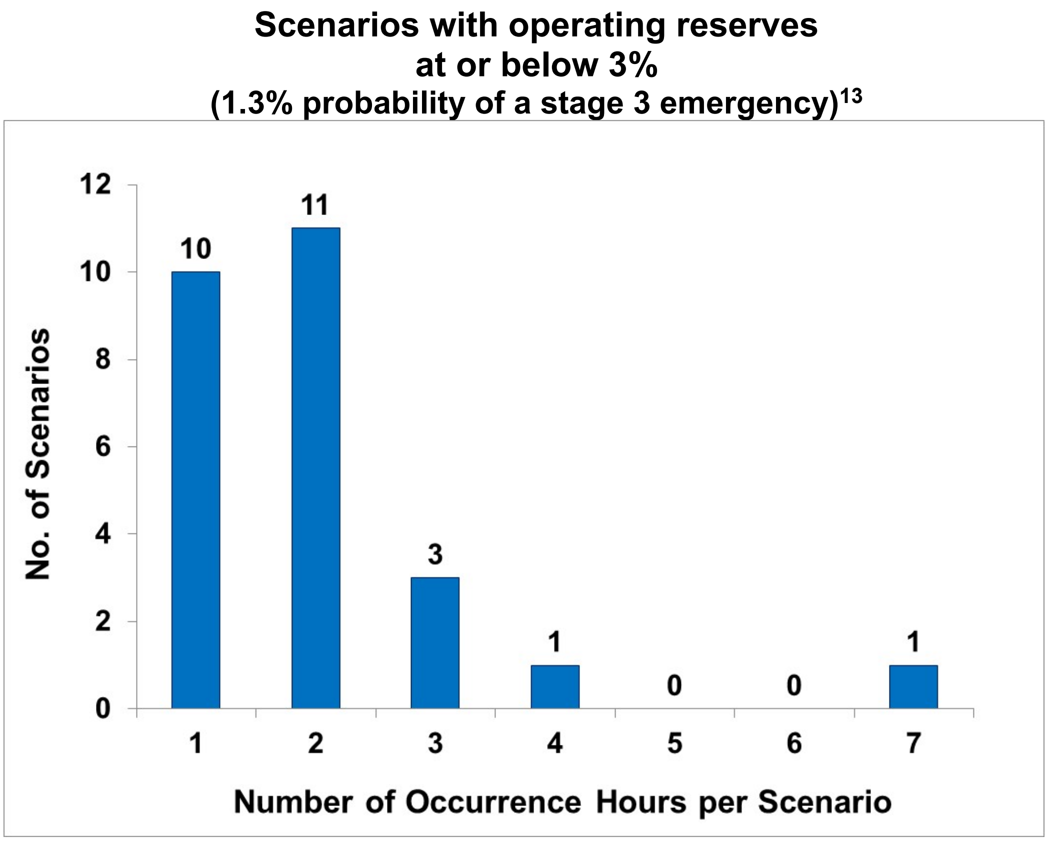



*Figure 20* shows scenario occurrences with operating reserves at or below 3%

To further assess resource adequacy for the summer period, the Minimum Unloaded Capacity Margin (MUCM) value, equal to the lowest unloaded capacity margin in all 2,928 summer hours[14] in each scenario, was found for each of the 2,000 scenarios. The MUCM values range from a high of 8.5 percent down to the lowest result of zero (*Figure 21*). The zero result represents the most extreme hourly supply and demand condition within the 2,000 scenarios considered. The median value is 6 percent.

[13] In all of the 26 occurrences shown in *Figure 20* the results include the full utilization of all demand response programs.

[14] The study period of June 1 through September 30 in each scenario represents 2928 hours.

**Figure 21**

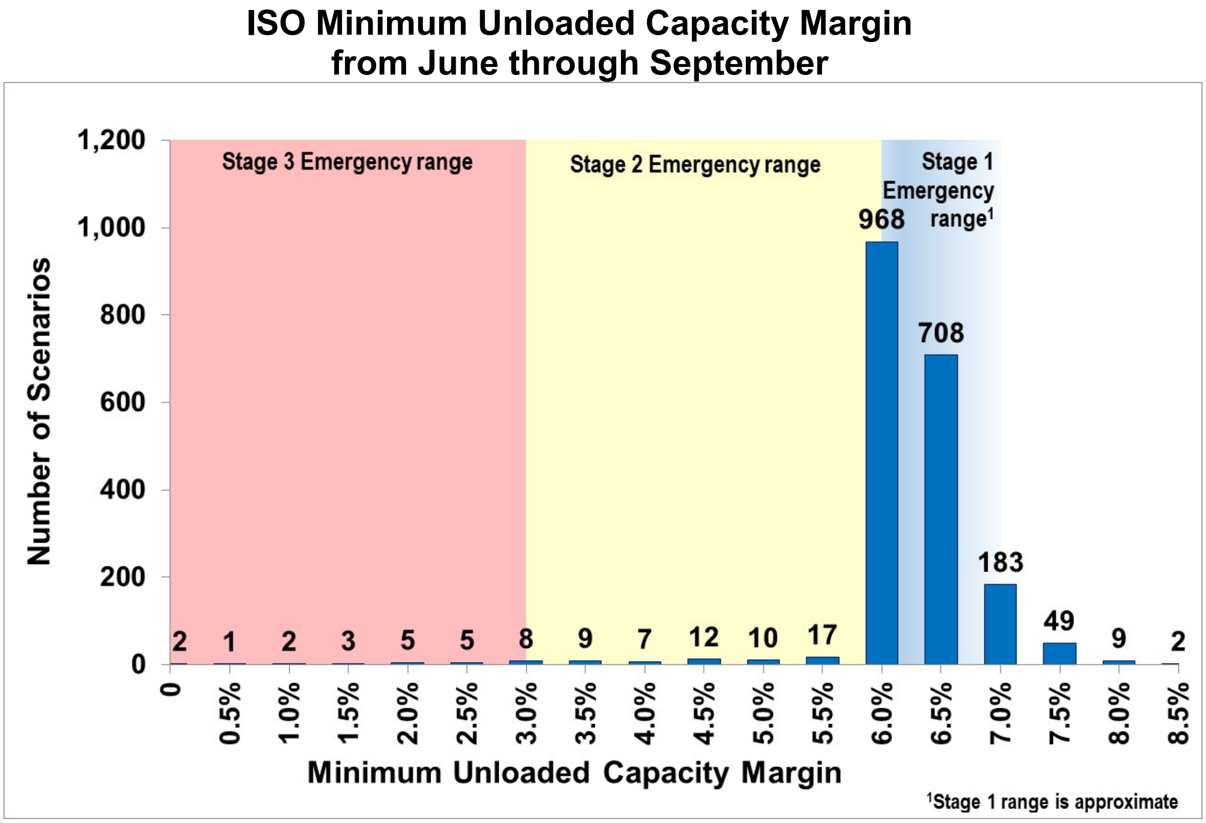



*Figure 21* shows forecasts of summer MUCM for the CAISO.

*Figure 22* shows the distribution of the MUCM over the hours of the day in comparison to the hours of solar generation during the 2018 summer peak day. The MUCM has the highest level of occurrences at hour ending 20:00. *Figure 22* demonstrates the timing of 79 percent of the MUCM values fall in periods of low to zero solar generation. The solar generation shape in the chart is the actual solar generation levels during the day of September 1, 2017, the day of the CAISO 2017 annual peak. The maximum solar generation for that day was 9,192 MW.

**Figure 22**

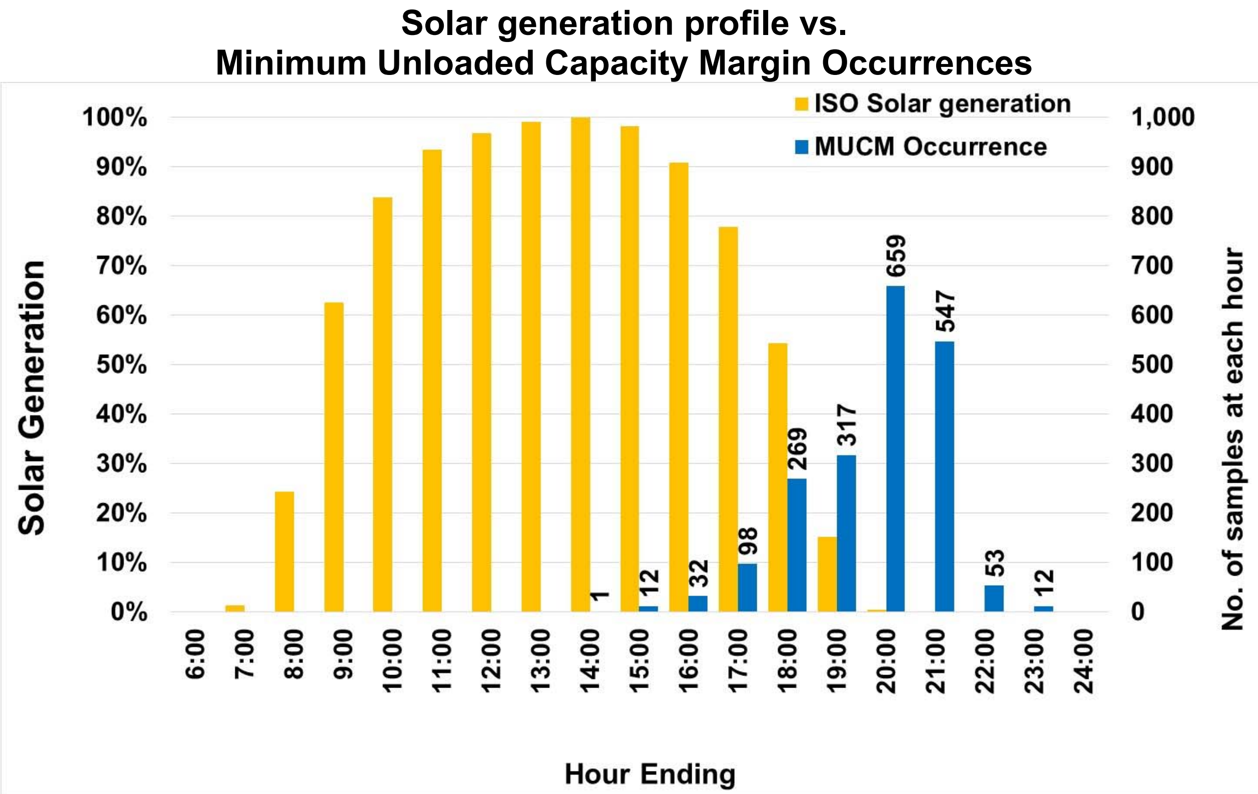



*Figure 22* shows solar generation profile vs. MUCM occurrence

*Figure 23* shows the months where the MUCM dropped below 3 percent, the point of initiating a stage 3 emergency. Other than one occurrence in July, all occur in September. This is a function of the below normal hydro year where available hydro energy drops off in September and lower solar production in the late afternoon hours due to shorter daylight. The range of the CAISO load related to the occurrences in *Figure 23* is 45,356 to 50,080 MW.

**Figure 23**

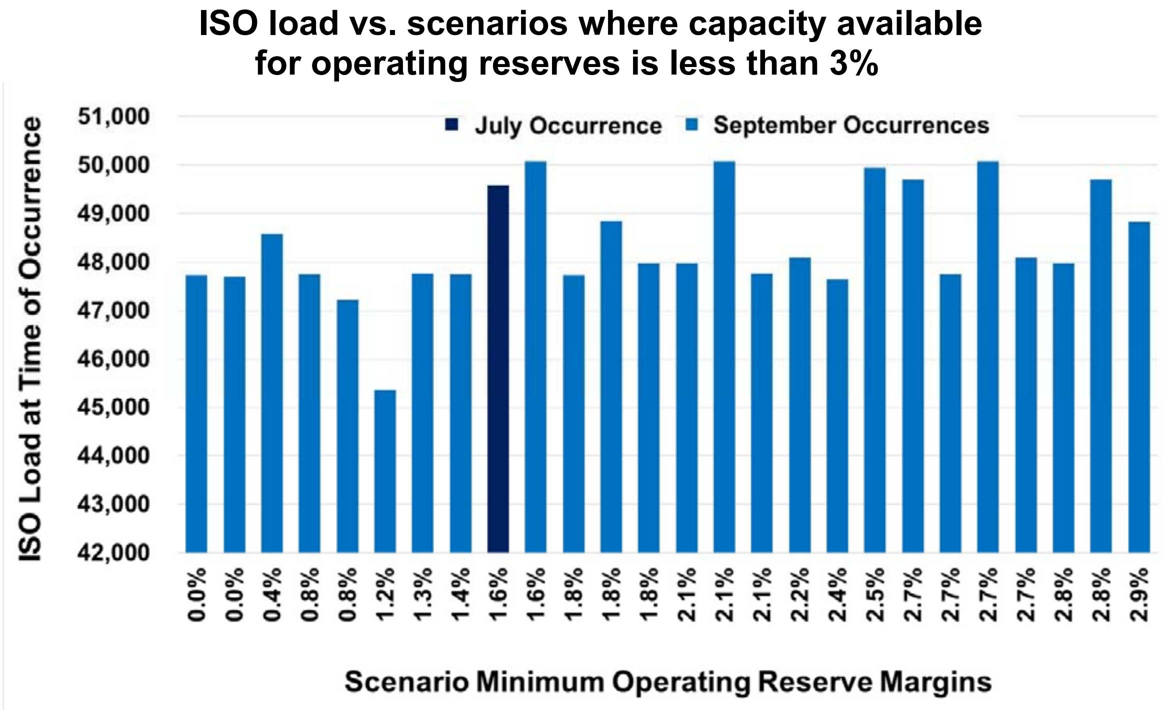



*Figure 23 shows CAISO load level vs. most extreme MUCM levels.*

## Impacts of the Aliso Canyon Gas Storage Operating Restrictions

Natural gas needs in Southern California are met by a combination of major gas pipelines, distribution gas infrastructure and gas storage facilities. Four major gas storage facilities are located in the Southern California Gas system, the largest of which is the Aliso Canyon facility located in Los Angeles County. Aliso Canyon and other gas storage facilities are used year-round to support the delivery of gas to core and non-core users. Among the non-core users are electric generators, which help meet electric demands throughout the region.

Following a significant natural gas leak in late 2015, the injection and withdrawal capabilities of the Aliso Canyon were severely restricted. These restrictions impacted the ability of pipeline operators to manage real-time natural gas supply and demand deviations, which in turn could have had impacts on the real-time flexibility of natural gas-fired electric generators in Southern California. This primarily impacted resources operated in the Southern California Gas Company (SoCalGas) and San Diego Gas and Electric (SDG&E) service areas, collectively referred to as the SoCalGas system.

Aliso Canyon directly supplies 17 gas-fired power plants with a combined total 9,800 MW of electric generation in the Los Angeles basin and indirectly impacts 48 plants with a combined total 20,120 MW of electric generation across Southern California. There are limitations in attempting to shift power supply from resources affected by Aliso Canyon to resources that are not affected because of certain factors, such as local generation requirements, transmission constraints and other resource availability issues.

The CAISO, Los Angeles Department of Water and Power, California Energy Commission and California Public Utilities Commission (Joint Agencies) published a second summer risk assessment and technical report in May 2017.[15] The assessment found summer reliability risks existed if the electric system was not fully available or gas (or electric) supplies were limited. The report noted that prolonged periods of hot weather and other unpredictable events could pose problems to electricity delivery

Continuation of mitigation measures developed in 2016 improved the outlook for energy reliability for the 2017 summer. The measures included SoCalGas adjusting natural gas balancing rules to provide stronger incentives for natural gas customers, such as electric generators, to align their natural gas schedules and burns. Furthermore, electric operators and gas system operators developed enhanced coordination procedures.

The CAISO implemented several operational tools and market mechanisms in summer 2016 to mitigate the electric system reliability risk posed by the restricted operations of Aliso Canyon. The CAISO proposed, and FERC temporarily approved[16], some tariff provisions until November 30, 2016 while approving others as permanent changes. Because Aliso Canyon remained under restricted operations over winter 2016–2017, the CAISO proposed, and FERC approved[17], extending most of the temporary tariff provisions through November 2017. In December 2017, the CAISO requested, and FERC approved[18], an extension of these measures for one year. These actions, in addition to relatively well-forecasted load and weather conditions during the 2017 summer, contributed to system reliability during that time.

On January 17, 2017, the Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR) announced that it had completed its comprehensive safety review of the Aliso Canyon Storage Facility. The safety review determined Aliso Canyon could operate in a reduced fashion. On February 15, 2017, SoCalGas released a Storage Safety Enhancement Plan[19] that was updated on February 17.[20]

In a July 19, 2017 open letter to SoCalGas and the public, the CPUC and the Division of Oil, Gas, and Geothermal Resources (DOGGR) announced that DOGGR had "determined that the risks of failures identified during the review have been addressed, that well integrity

[15] Aliso Canyon Risk Assessment Technical Report, May 19, 2017: http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-11/TN217639_20170519T104800_Aliso_Canyon_Risk_Assessment_Technical_Report_Summer_2017_Asses.pdf.

[16] Jun 1, 2016 FERC Order Accepting Tariff Revisions and Establishing a Technical Conference - Aliso Canyon (ER16-1649): http://www.caiso.com/Documents/Jun1_2016_OrderAcceptingTariffRevisions_Establishing_TechnicalConference_AlisoCanyon_ER16-1649.pdf

[17] Nov 28, 2016 FERC Order Accepting Tariff Amendment - Aliso Canyon Electric-Gas Coordination Phase 2 (ER17-110): http://www.caiso.com/Documents/Nov28_2016_OrderAcceptingTariffAmendment_AlisoCanyonElectricGasCoordinationPhase2_ER17-110.pdf.

[18] December 15, 2017 FERC Order Accepting Tariff Amendment to Re-Implement Expired Provisions – Aliso Canyon Gas-Electric Coordination Enhancements (ER18-375): http://www.caiso.com/Documents/Dec15_2017_OrderAccepting_Re-ImplementExpiredProvisions_AlisoCanyonGas-ElectricCoordination_ER18-375.pdf

[19] SoCalGas Letter to CPUC – SoCalGas Storage Safety Enhancement Plan, February 15, 2017: https://www.socalgas.com/1443740459585/02-15-17_SoCalGas_Letter-to-CPUC_SoCalGas-Storage-Safety-Enhancement-Pla....pdf

[20] SoCalGas Letter to CPUC – SoCalGas Storage Safety Enhancement Plan (Updated), February 17, 2017: https://www.socalgas.com/1443740471338/Storage-Safety-Enhancement-Plan-Update-2-17.pdf

has been verified, and injection at [Aliso] may safely resume."[21] SoCalGas began injecting gas into Aliso Canyon on August 1 up to approximately 28 percent of the facility's maximum capacity.

The results of the latest studies and recommendations by various state agencies on the operating restrictions of Aliso Canyon going forward and the projected impacts to electric system reliability are being assessed by the Joint Agencies. The results of the Joint Agencies assessment for this summer and beyond will be presented in a report that is expected to be released in early May 2018.

The outlook for energy reliability in Southern California remains challenging due to uncertainty about the status of its natural gas system. The challenges to the gas system are greater than for the previous two summers and leave SoCalGas unable to meet demand on a 1-in-10 peak day without potentially having to curtail gas to the electric generators in the Southern California or using gas from the Aliso Canyon underground gas storage facility. The challenges stem primarily from continuing outages on as many as four key natural gas pipelines. The ability for the CAISO electric system in Southern California to maintain electric reliability at lower gas burn levels is the result of a combination of transmission upgrades and some generation retirements. As a result with even greater system risk to electricity reliability this summer than last, measures to mitigate the risk remain necessary.

The risk associated with the gas storage facility restrictions at the Aliso Canyon and other gas storage facilities to electric reliability is greater in the local reliability areas in Southern California than to the CAISO system. However, from a system perspective, the ability to re-supply from electric supply from sources not impacted by SoCalGas limitations may be more constrained then in previous years.

## Once Through Cooled Generation

On May 4, 2010, the State Water Resources Control Board (SWRCB) adopted a policy on the use of coastal and estuarine waters for power plant cooling (Policy). The Policy applies to 19 power plants, some of which have already retired, that together had the ability to withdraw over 15 billion gallons per day from the state's coastal and estuarine waters using a single-pass system, also known as once-through cooling (OTC). *Table 6* shows the power plants that are subject to the Policy. Of the OTC units' 18,322 MW of generating capability affected by the policy, 8,900 MW are in compliance. The remaining 7,182 MW of generation will be required to repower, be retrofitted or retire by the end of 2020. Compliance for Diablo Canyon is subject to a pending study by a Water Board Review Committee for Nuclear Fueled Power Plants.

Statewide Advisory Committee on Cooling Water Intake Structures (SACCWIS) continues to assess the reliability impacts to the CAISO grid in the implementation of the OTC Policy. New generation resources which were interconnected to the CAISO grid have replaced 53 percent of the OTC capacity subject to the OTC policy and additional replacements are under way. Although some OTC units will retire ahead of their compliance dates, the majority of the OTC units are working on their replacement plans to comply with the Policy. A few OTC units may still require an extension under the OTC Policy's compliance schedule

[21] July 19, 2017 SB380 Findings and Concurrence Regarding the Safety of the Aliso Cany7on Gas Storage Facility: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/News_Room/News_and_Updates/OpenLettertoSoCalGasandPublic.pdf

if one or more uncertainties pose a threat to local or system reliability or if replacement infrastructure is not on a schedule that matches with the existing OTC compliance dates.

On August 15, 2017, the SWRCB approved the SACCWIS recommendation to extend the Encina Units 2-5 compliance date to December 31, 2018. The Carlsbad Energy Center, the replacement for Encina 2-5, is approximately 79 percent complete and all units are expected to be online by the end of 2018.

**Table 6**

**Generating Units Compliance with California Statewide Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling**

| Plant (Unit) | Owner | Final Compliance Date | Capacity (MW) | PTO Area |
|---|---|---|---|---|
| **Compliance Plan Yet to be Implemented (Natural Gas Fired)** | | | | |
| Encina Power Station Units 2-5 | NRG | 12/31/2018 | 840 | SDG&E |
| Moss Landing Units 1 and 2 | Dynegy | 12/31/2020 | 1,020 | PG&E |
| Huntington Beach Units 1-2 | AES | 12/31/2020 | 452 | SCE |
| Redondo Beach Units 5-8 | AES | 12/31/2020 | 1,343 | SCE |
| Alamitos Units 1-6 | AES | 12/31/2020 | 2,011 | SCE |
| Ormond Beach Units 1 and 2 | NRG | 12/31/2020 | 1,516 | SCE |
| | | **Total MW** | **7,182** | |
| **In Compliance** | | | | |
| Mandalay Units 1 and 2 | NRG | 2/6/2018 | 430 | SCE |
| Encina Power Station Units 1 | NRG | 5/8/2017 | 106 | SDG&E |
| Moss Landing Units 6 and 7 | Dynegy | 1/1/2017 | 1,500 | PG&E |
| Pittsburg Units 5, 6 and 7 | NRG | 12/31/2016 | 1,159 | PG&E |
| Huntington Beach Units 3-4[1] | AES | 12/7/2012 | 452 | SCE |
| Humboldt | PG&E | Sept. 2010 | 105 | PG&E |
| Potrero Unit 3 | GenOn | 2/28/2011 | 206 | PG&E |
| South Bay | Dynegy | 1/1/2011 | 702 | SDG&E |
| Contra Costa Units 6 and 7 | NRG | 5/1/2013 | 674 | PG&E |
| San Onofre Unit 2 & 3 | SCE | 6/7/2013 | 2,246 | SCE |
| El Segundo Units 3 | NRG | 7/1/2014 | 335 | SCE |
| El Segundo Units 4 | NRG | 12/31/2015 | 335 | SCE |
| Morro Bay Units 3 and 4 | Dynegy | 2/5/2014 | 650 | PG&E |
| | | **Total MW** | **8,900** | |
| **Compliance pending study by Water Board Review Committee for Nuclear Plants** | | | | |
| Diablo Canyon | PG&E | 12/31/2024 | 2,240 | PG&E |
| | | **Total MW** | **2,240** | |
| | | **Total of all OTC Units** | **18,322** | |

[1] HB Units 3-4 conversion into synchronous condensers, which requires operating the plant cooling system and will use ocean water at a rate of approximately 25% of the units operating in its prior mode.

## Conclusion

Projections for 2018 show that the CAISO faces significant risk of encountering operating conditions that could result in less than required operating reserves. The increased risk in 2018 over 2017 is primarily a result of lower hydro conditions and the retirement of dispatchable generation that had been available to meet high load conditions that persist after the solar generation ramps down in the late afternoon. The risk increases during late summer when hydro availability decreases as the snow runoff progressively declines through the runoff season. The CAISO is at greatest risk if seasonal peak producing hot weather occurs in late August and early September.

The 2018 PLEXOS stochastic simulation results show both system capacity and ancillary service shortages. Although the probability of a system capacity shortage resulting load shedding is very low, curtailment of firm load for a short period is possible. Most of those scenarios, 79 percent, fall in periods of low to zero solar generation. CAISO operations has procedures in place that can be used to facilitate the less extreme scenarios through out of market activities. However, in potential extreme weather cases the CAISO could be faced with the necessity of having to shed frim load. The probability of ancillary service shortage is higher, requiring operations to act more frequently to shore up declining and deficient operating reserve margins. With the existing resource fleet's limited ability to store and move solar generation to later hours of the day, and 2018's below normal hydro generation conditions the CAISO could be challenged in high load conditions in meeting net peak demand and ancillary serve requirements.

This Assessment is a system level assessment and does not provide results on local area resource adequacy issues. In addition, this Assessment does not include potential risks associated with transmission facility forced outages. Finally, the risks to electric reliability associated with the gas storage facility restrictions at the Aliso Canyon and other gas storage facilities is greater in the local reliability areas in Southern California than to the CAISO system and are not included in the modeling results.

The outlook for energy reliability in Southern California related to restrictions at the Aliso Canyon remain challenging due to uncertainty about the status of its natural gas system. The challenges related to this summer are greater than the previous two summers and leave SoCalGas unable to meet demand on a 1-in-10 peak day without using gas from the Aliso Canyon underground gas storage facility. The challenges stem primarily from continuing outages on as many as four key natural gas pipelines. With even greater risk to electricity reliability this summer than last, measures to mitigate the risk remain necessary.

The CAISO annually trains its grid operators to be prepared for system events, and to brush up on current operating procedures and utility best practices. Furthermore, the CAISO meets with WECC, Cal Fire, gas companies, and neighboring balancing authorities to discuss and coordinate on key areas. The CAISO fosters ongoing relationships with these organizations to ensure reliable operation of the market and grid during normal and critical periods.

Should CAISO system operating conditions go into the emergency stages, such as operating reserve shortfalls where non-spinning reserve requirement cannot be maintained or spinning reserve is depleted and operating reserve falls below minimum requirement, the CAISO will implement the following mitigation operating plan to minimize loss of load in the CAISO BA area:

- Utilization of Flex Alert program, signaling that the CAISO expects high peak load condition. This program has been proven to reduce peak load in the CAISO BA Area.
- Utilization of CAISO Restricted Maintenance program. This program is intended to reduce potential forced outages; therefore, minimizing forced outage rate during the high peak load condition.
- Manual post-day ahead unit commitment and exceptional dispatch of resources under RA contract to ensure ability to serve load and meet flexible ramping capability requirements.
- Manual exceptional dispatch of intertie resource that have Resource Adequacy obligation to serve CAISO load.
- Utilization of Alert/Warning/Emergency (AWE) program.
- Utilization of Demand Response program including the Reliability Demand Response Resources (RDRR) under the “Warning” stage.
- Manual exceptional dispatch and utilization of back stop Capacity Procurement Mechanism for physically available resources that have un-contracted RA capacity.

# IV. APPENDICES

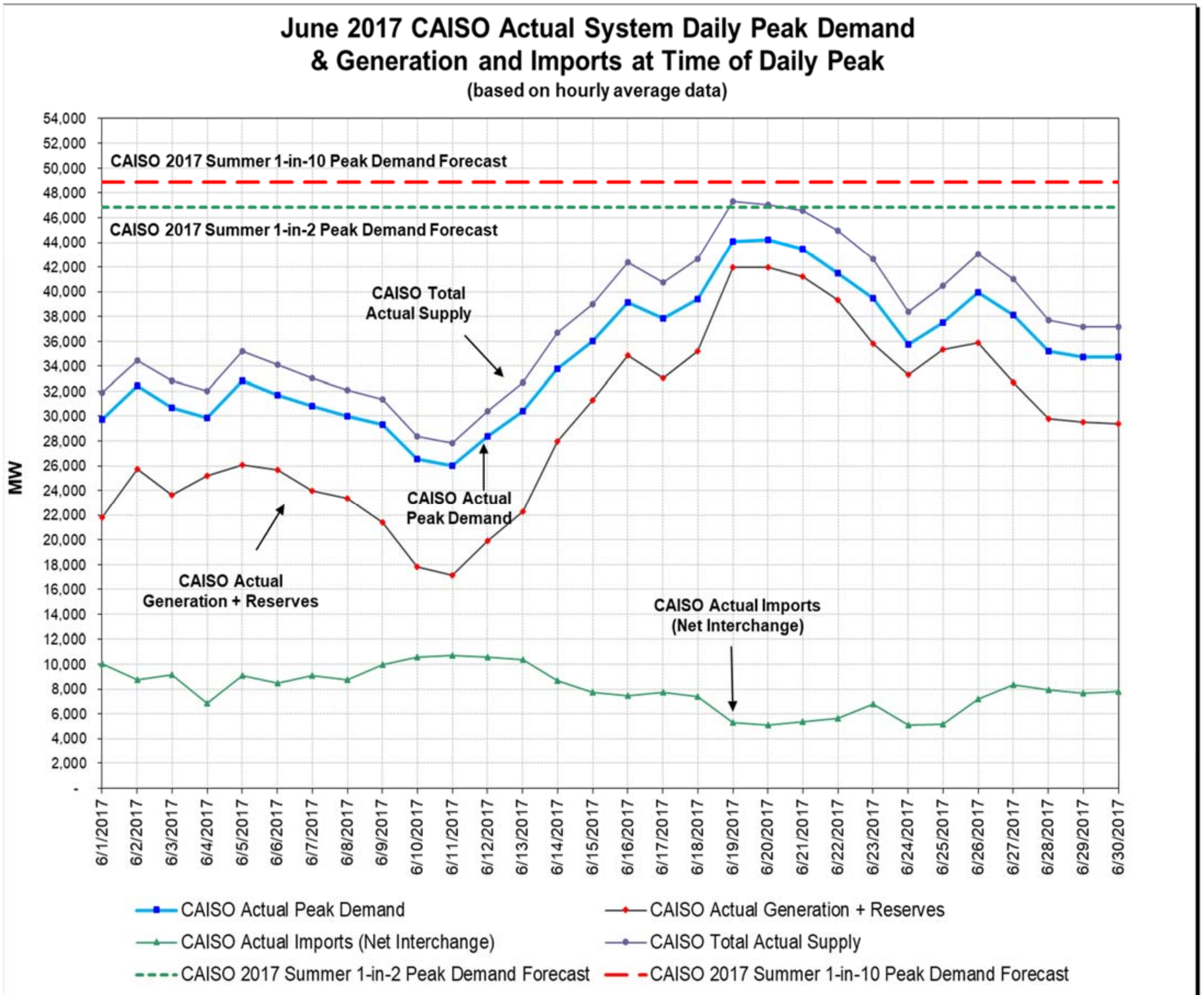
A. 2017 Summer Supply and Demand Summary Graphs

B. 2015 – 2017 Summer Generation Outage Graphs

C. 2017 Summer Imports Summary Graphs

D. 2018 CAISO Summer On-Peak NQC Fuel Type

## Appendix A: 2017 Summer Supply and Demand Summary Graphs



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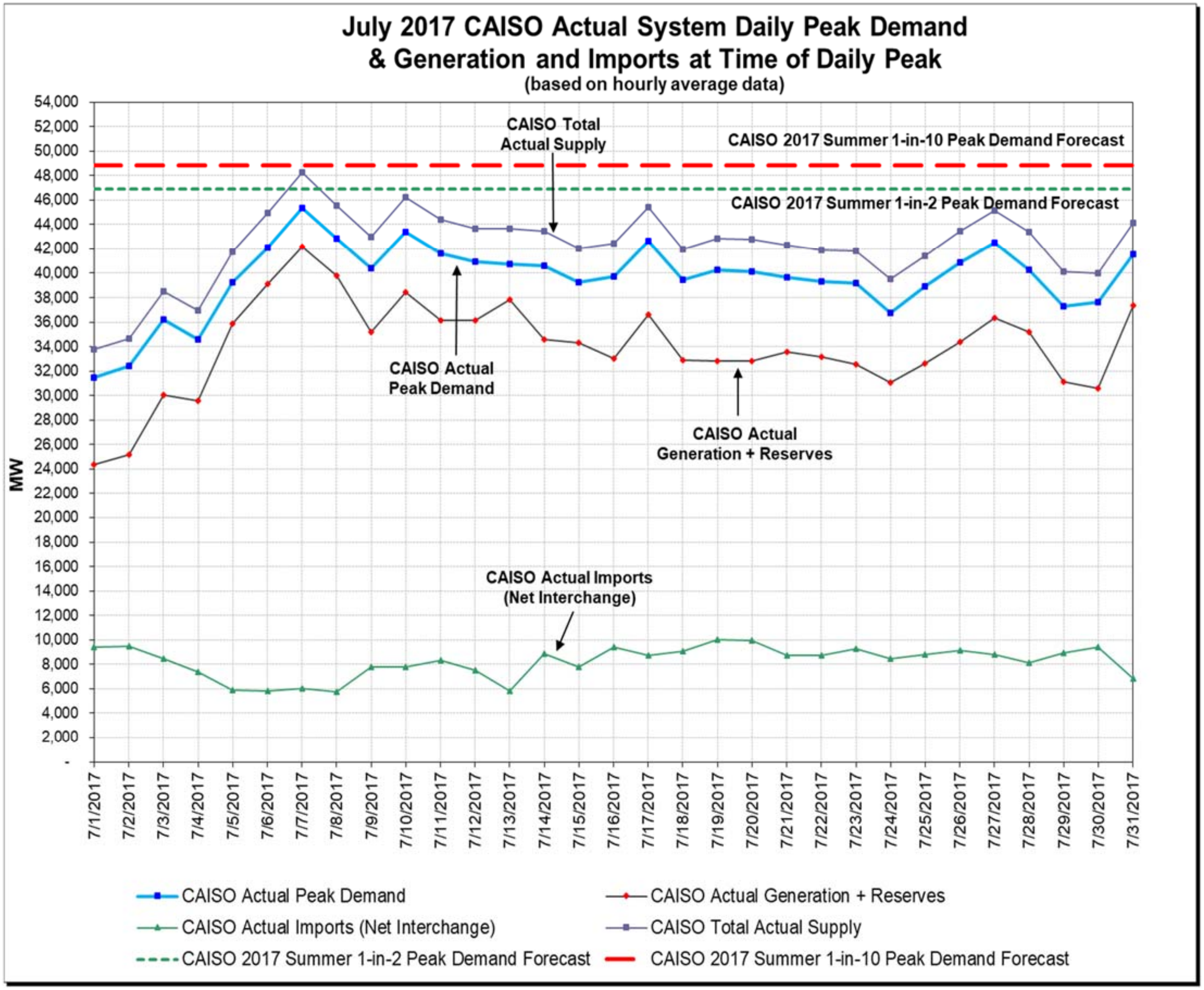

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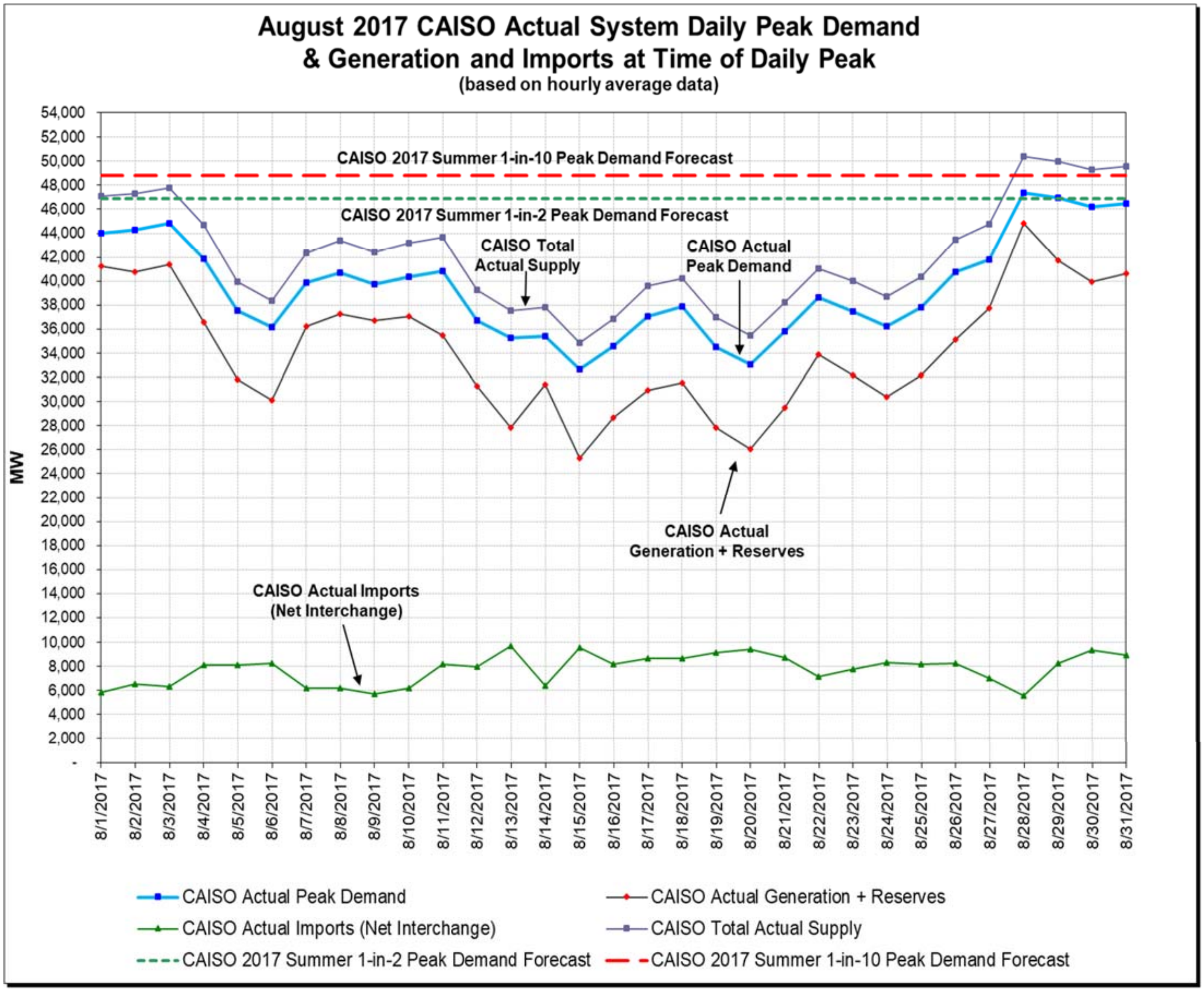

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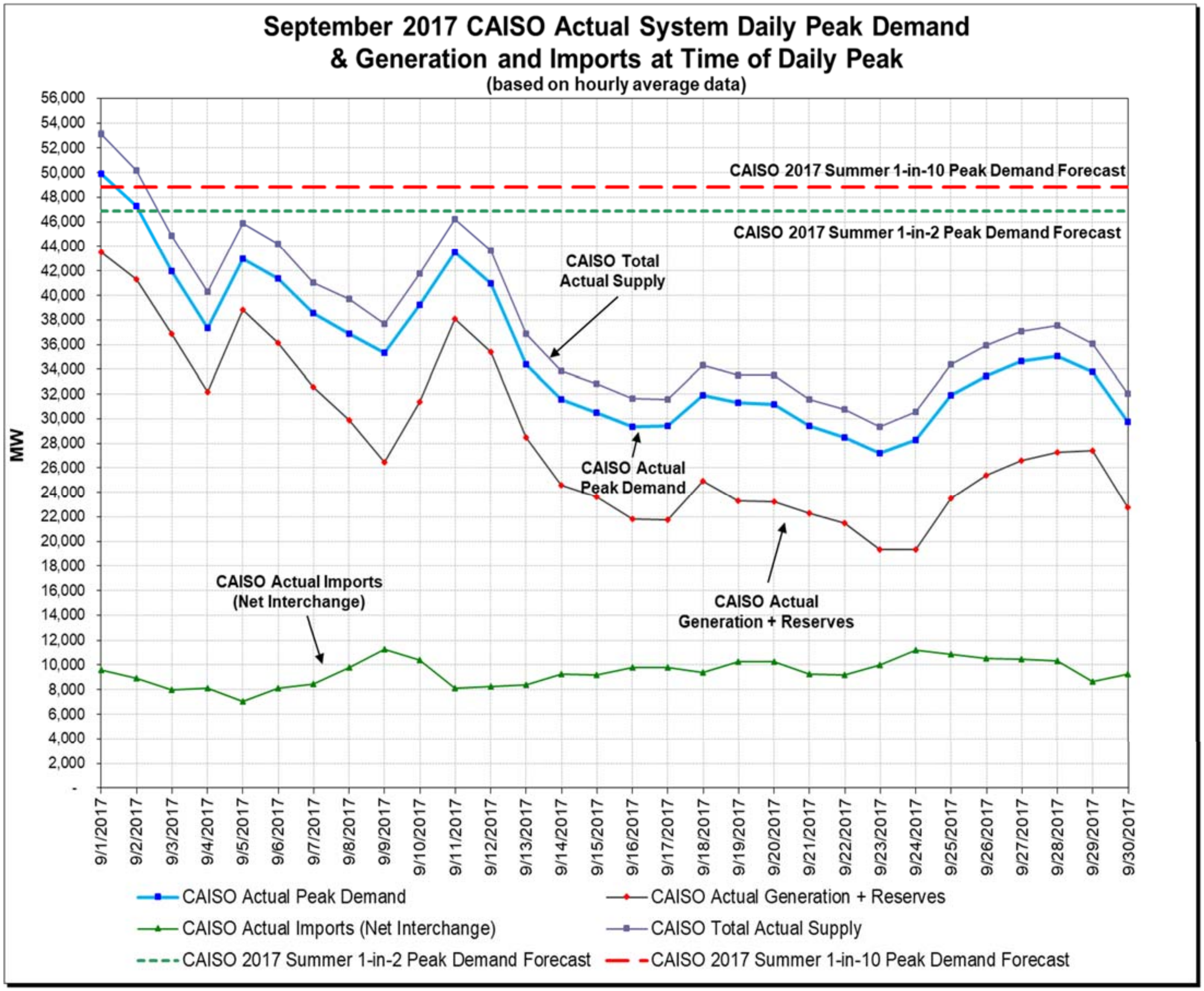

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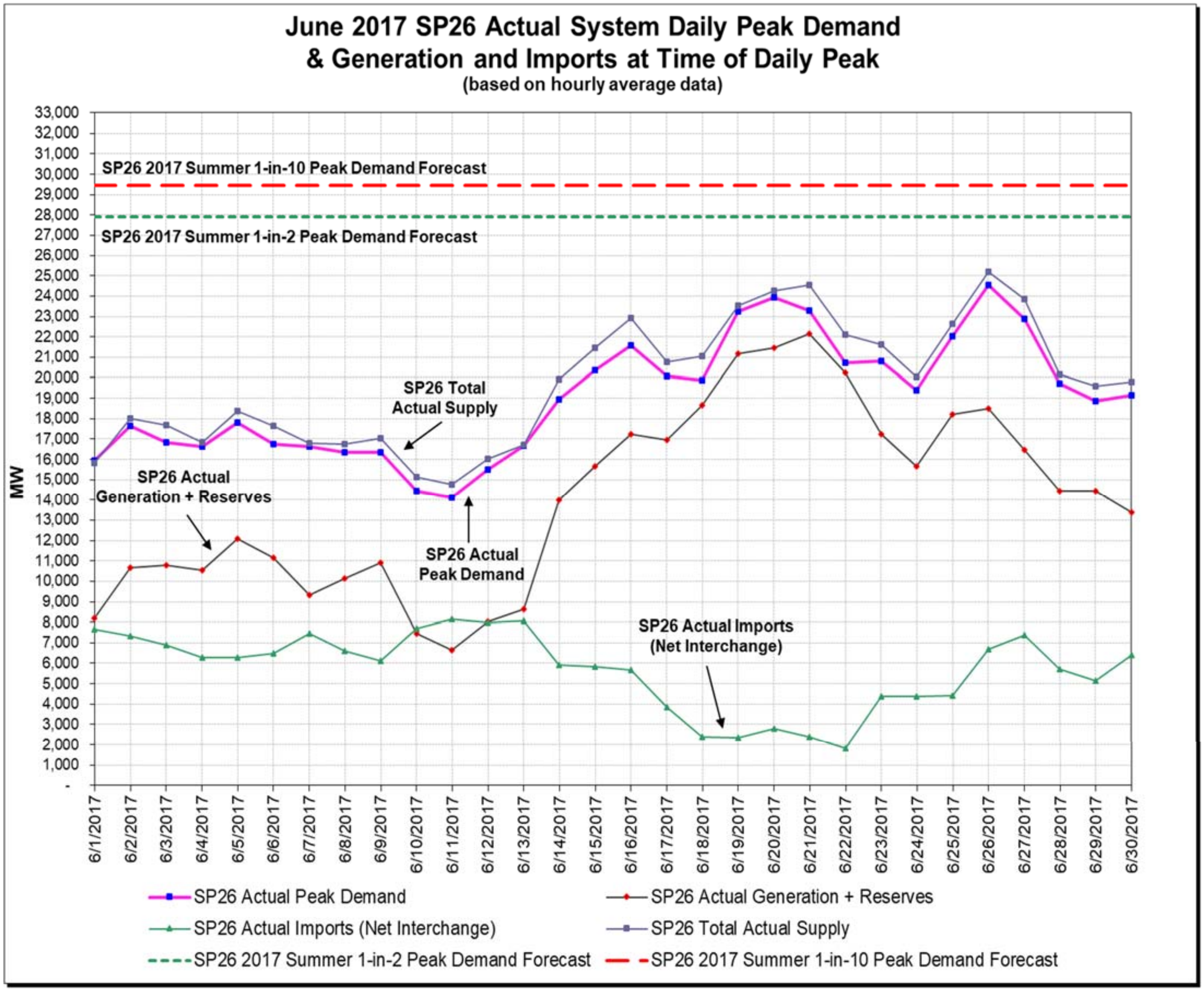

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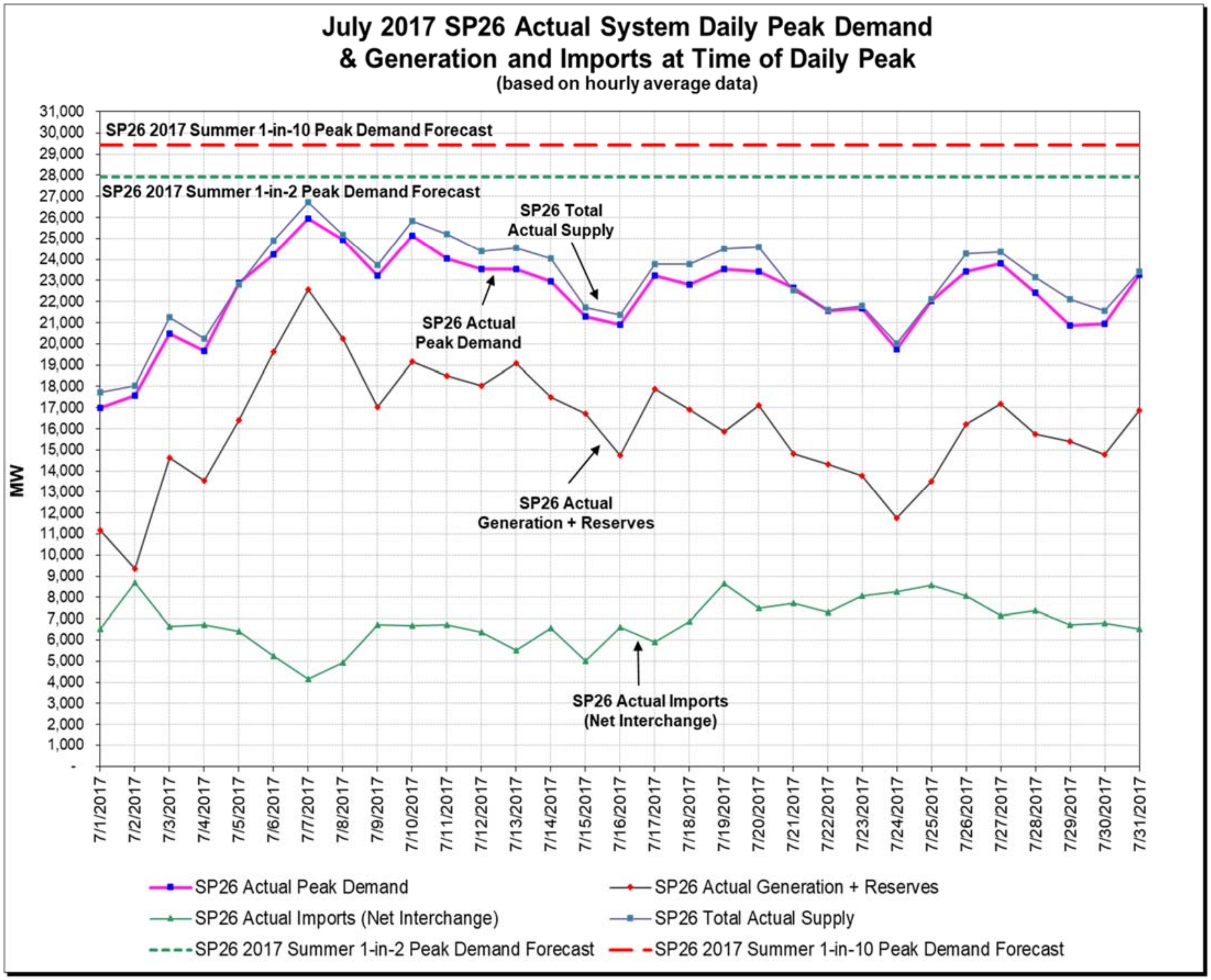

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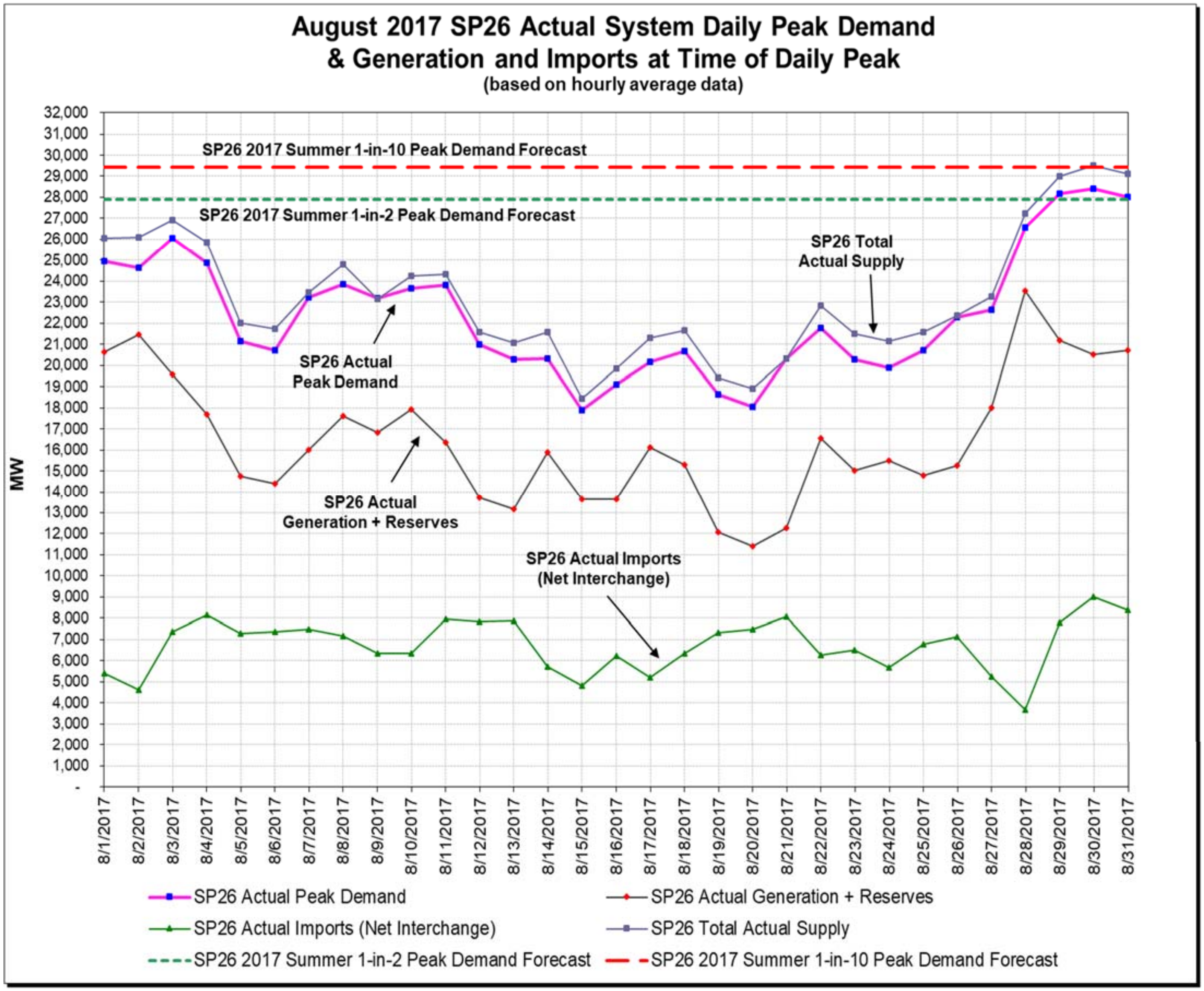

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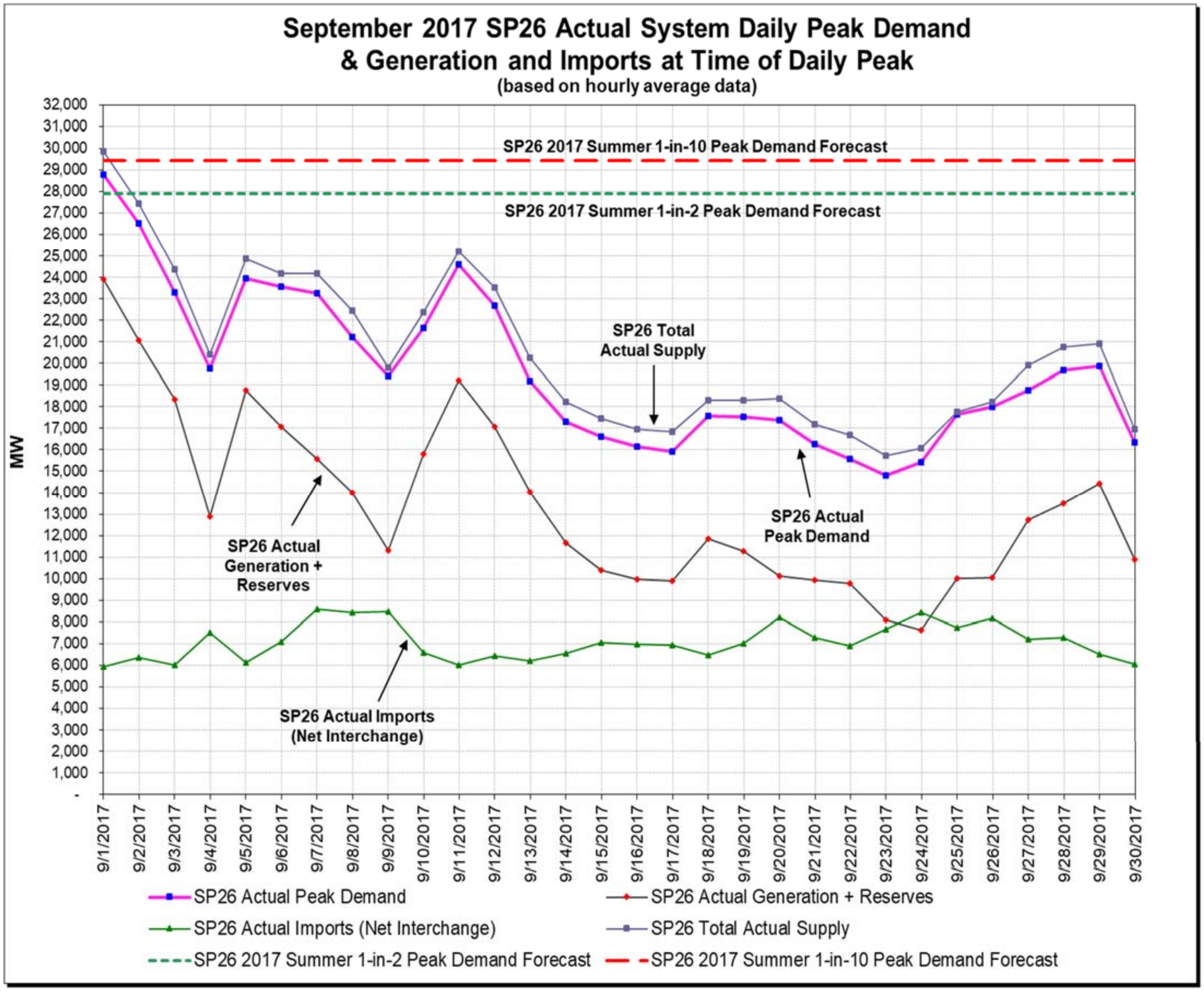

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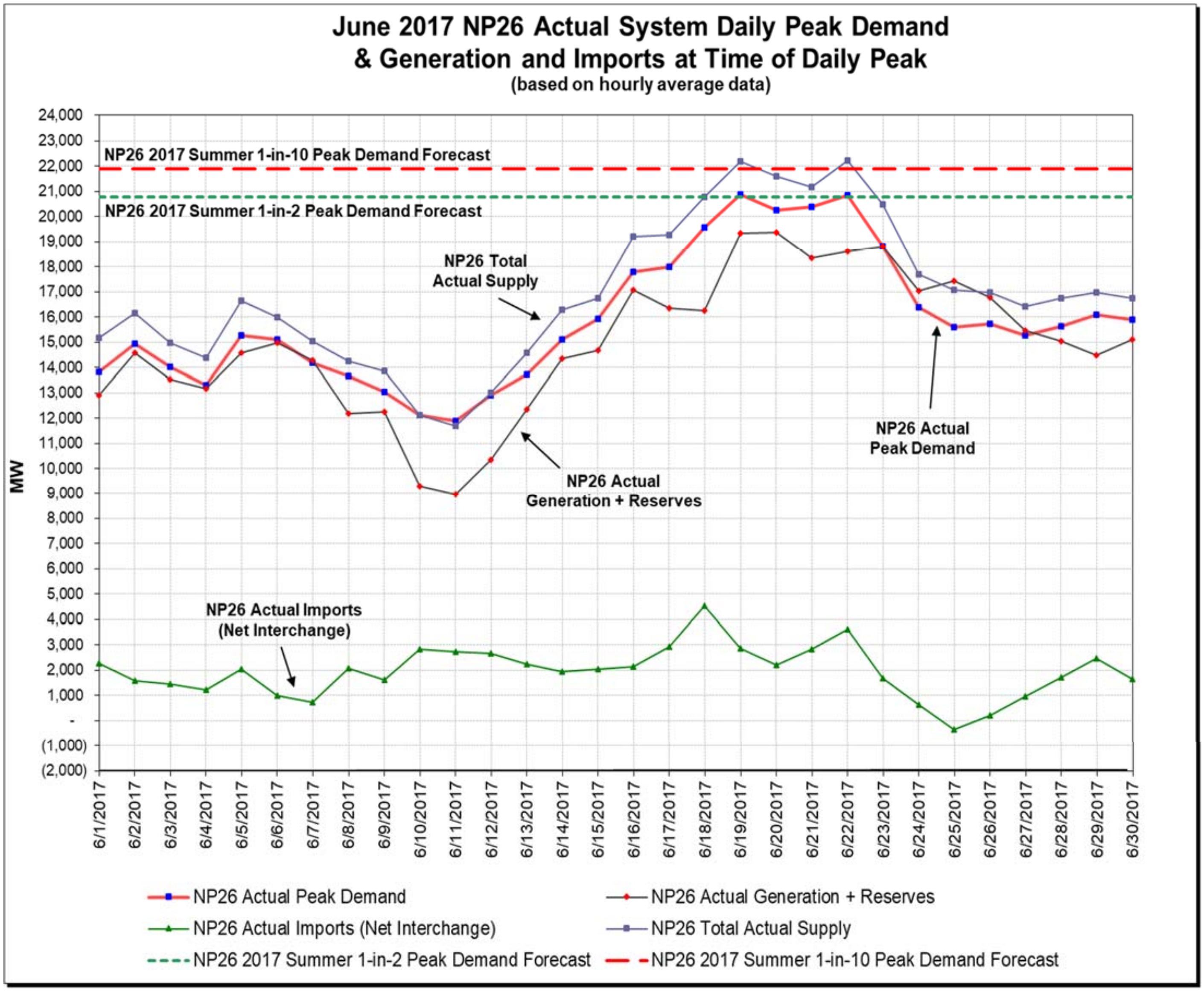

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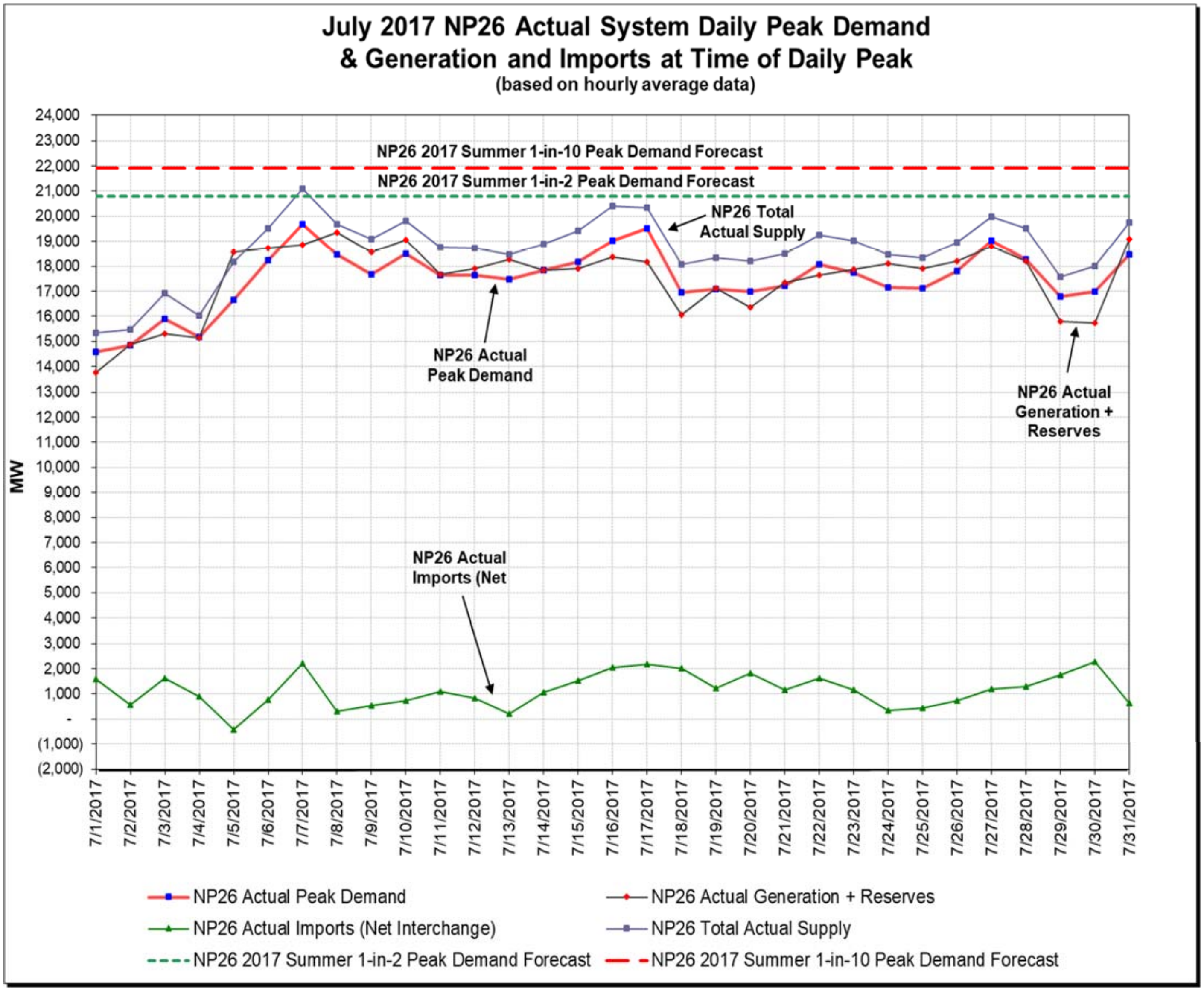

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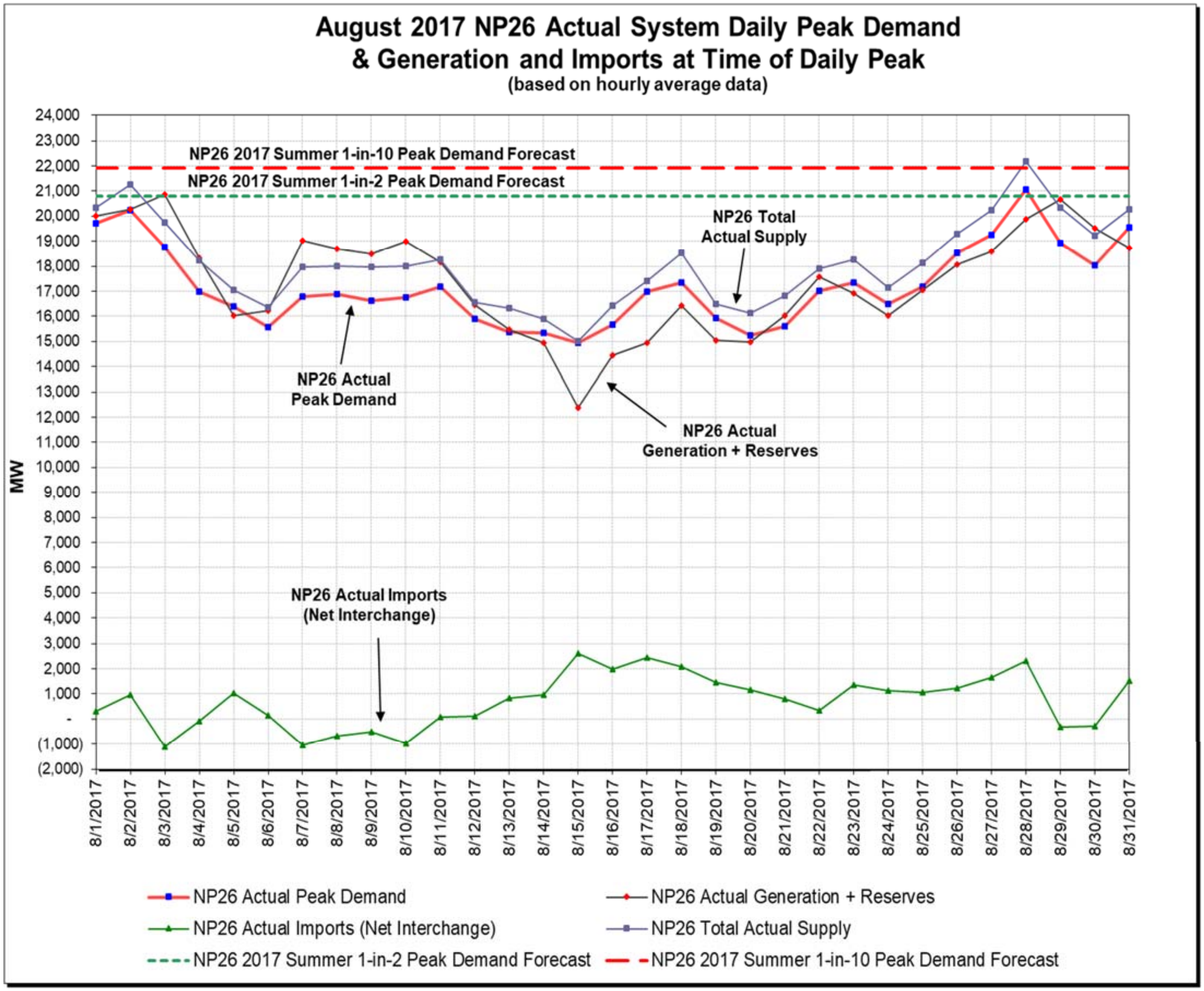

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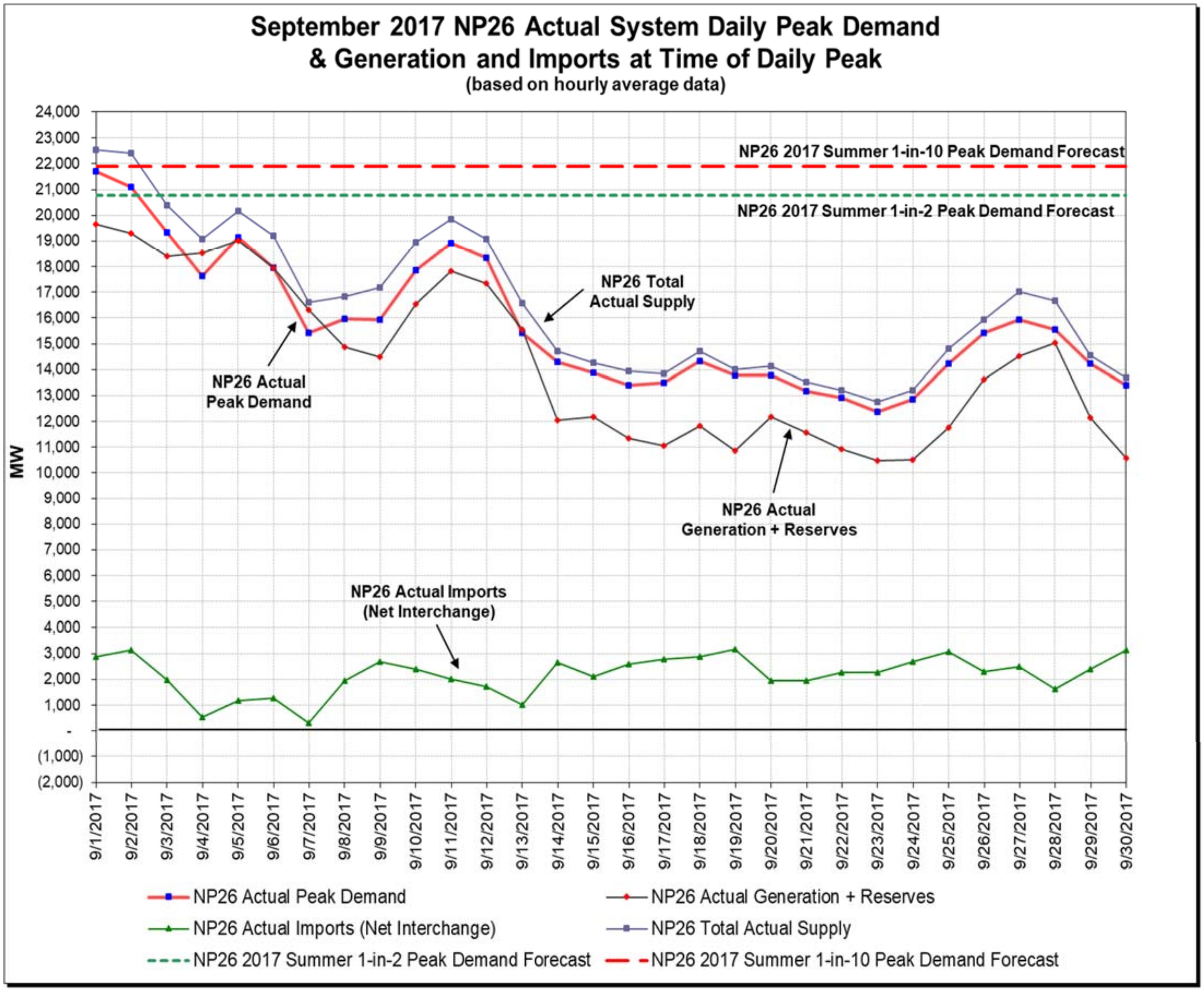
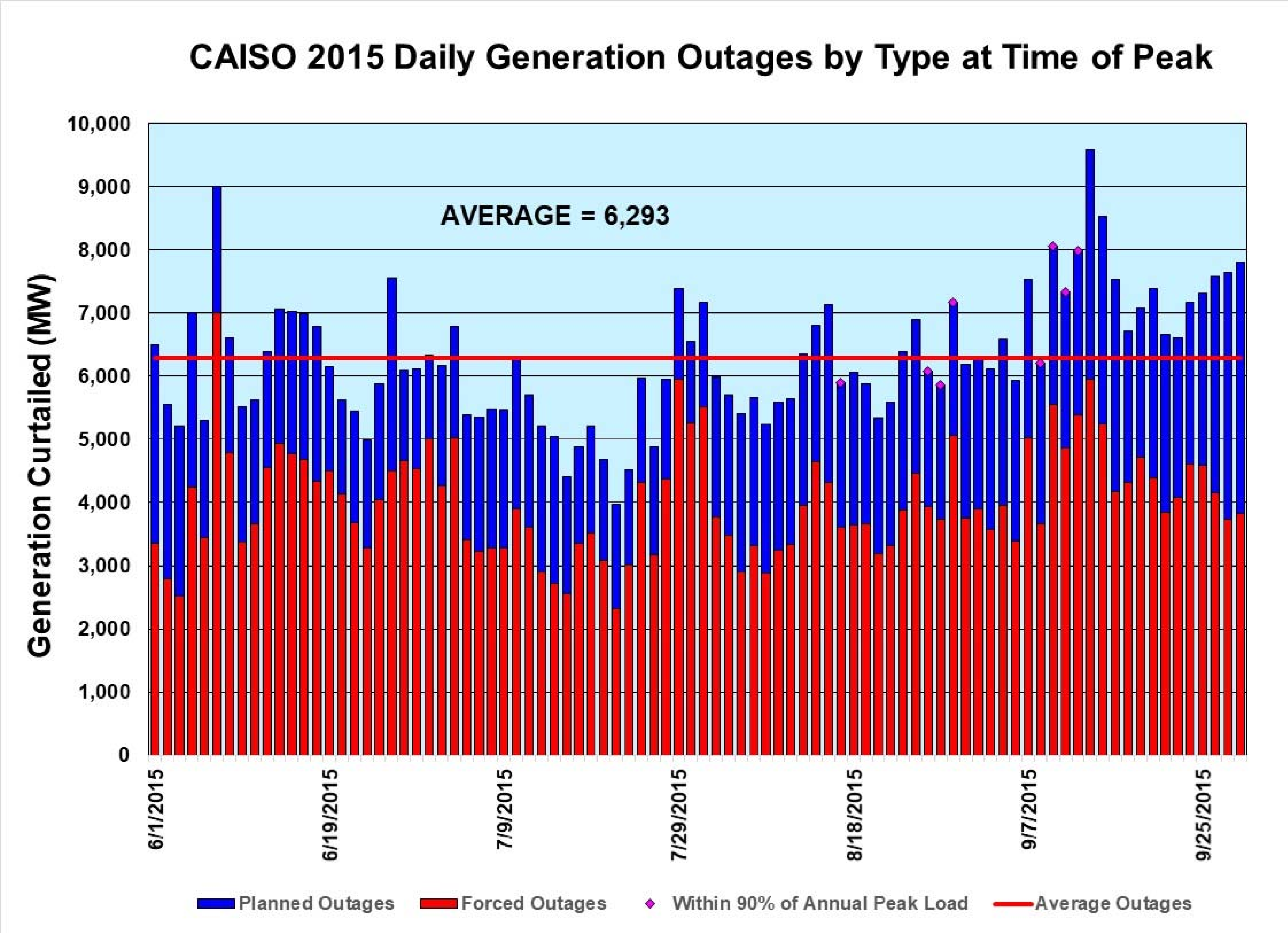


***Appendix B: 2015 – 2017 Summer Generation Outage Graphs***



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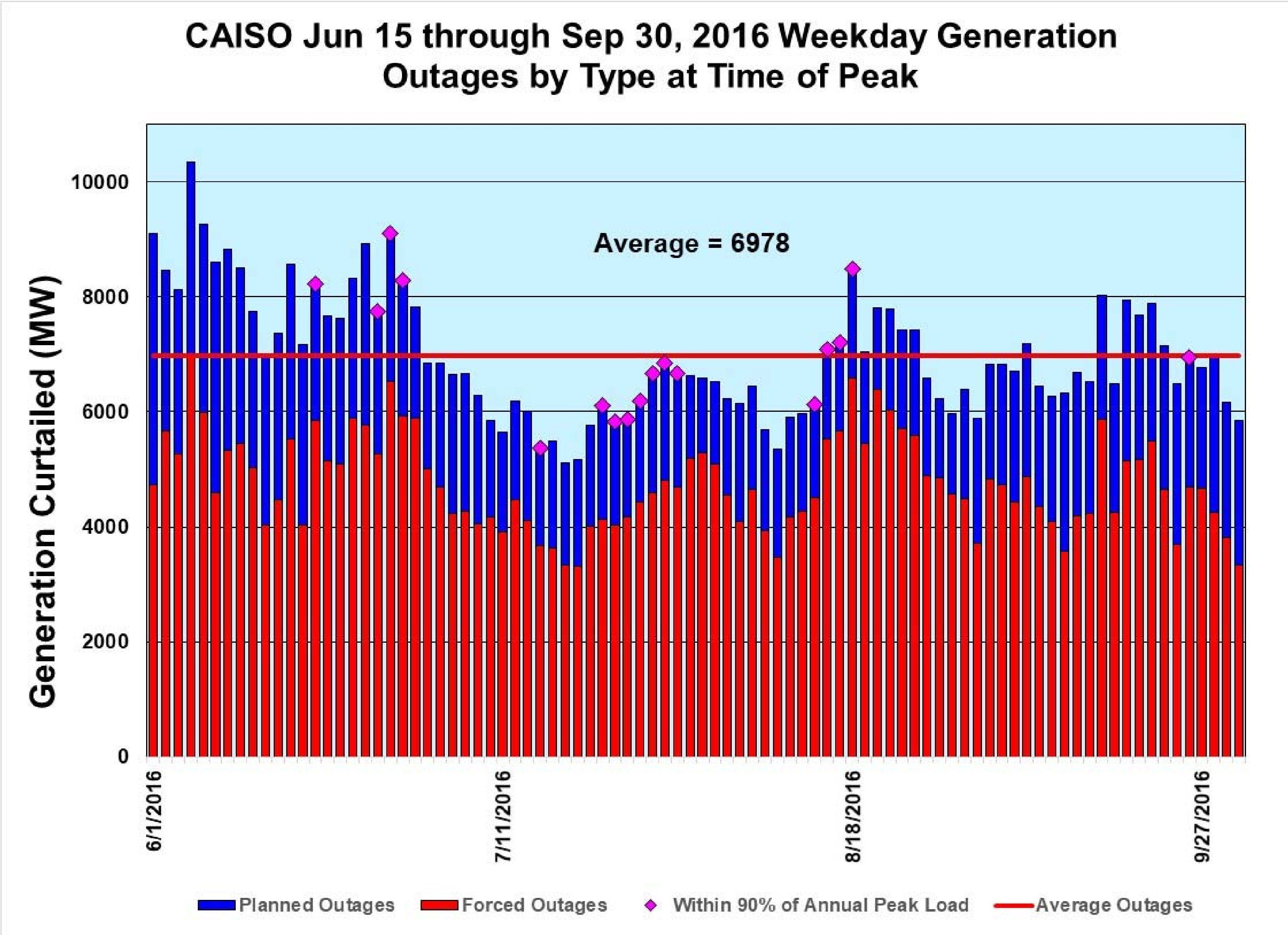

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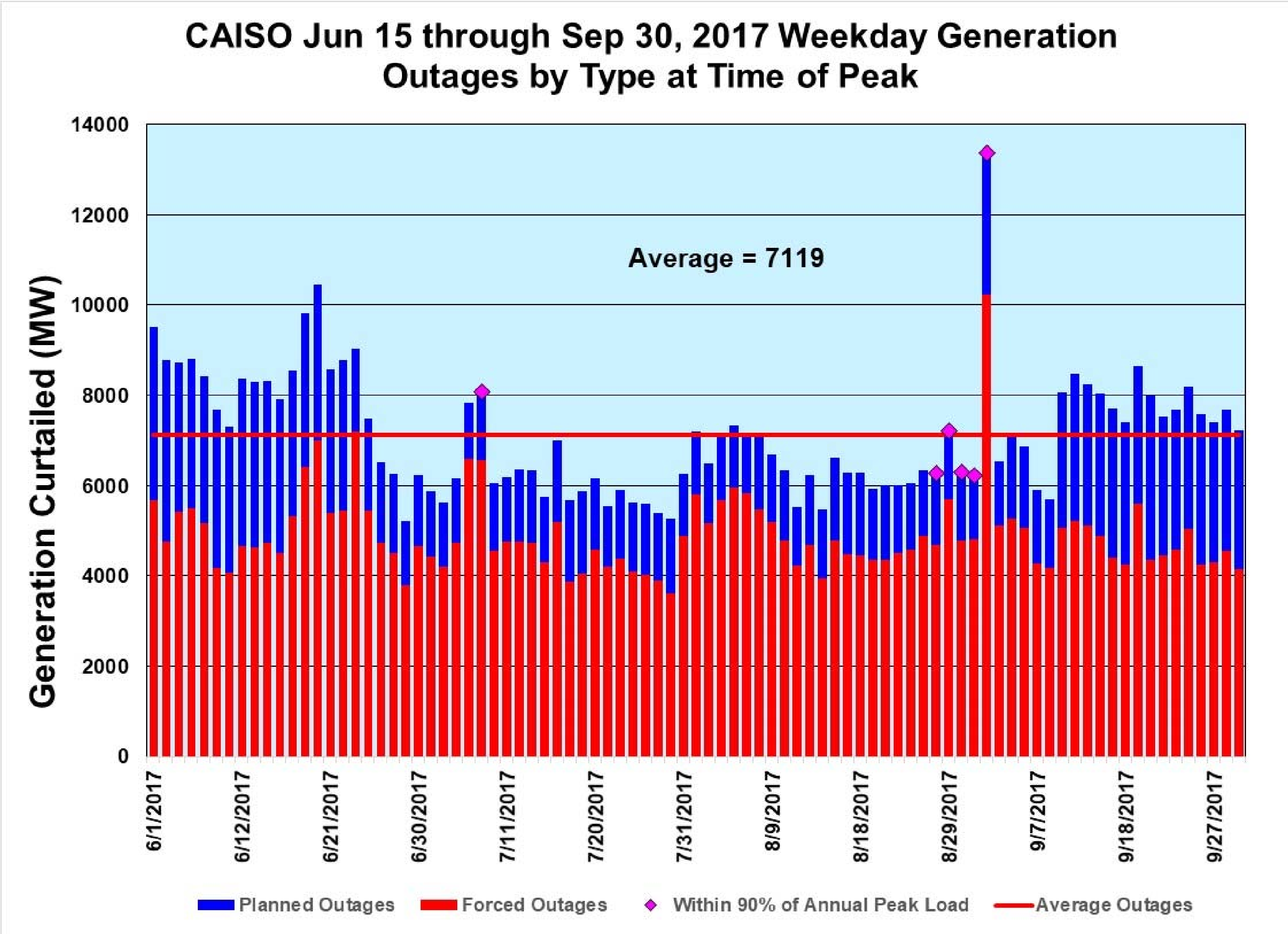
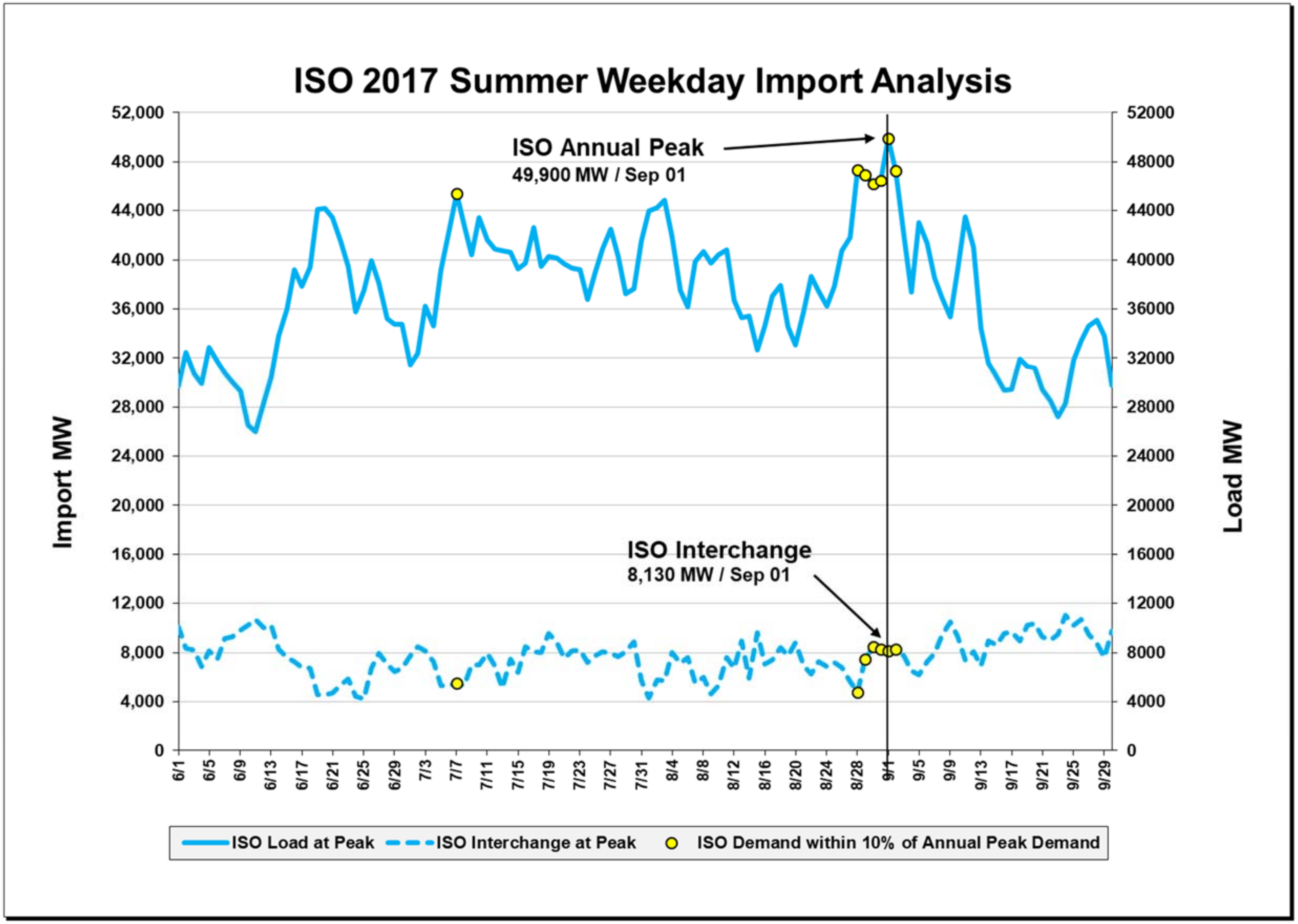


**Appendix C: 2017 Summer Imports Summary Graphs**



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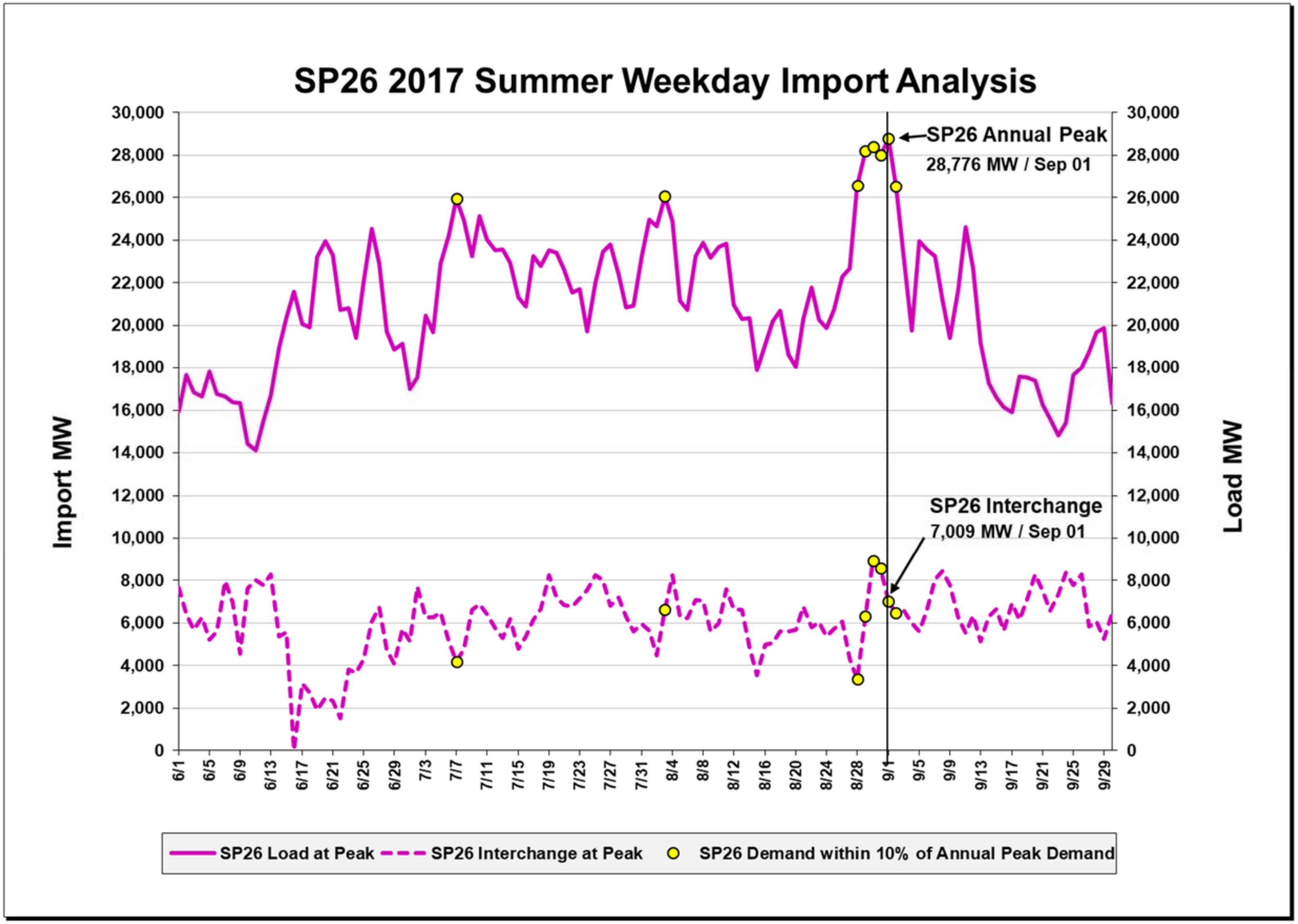

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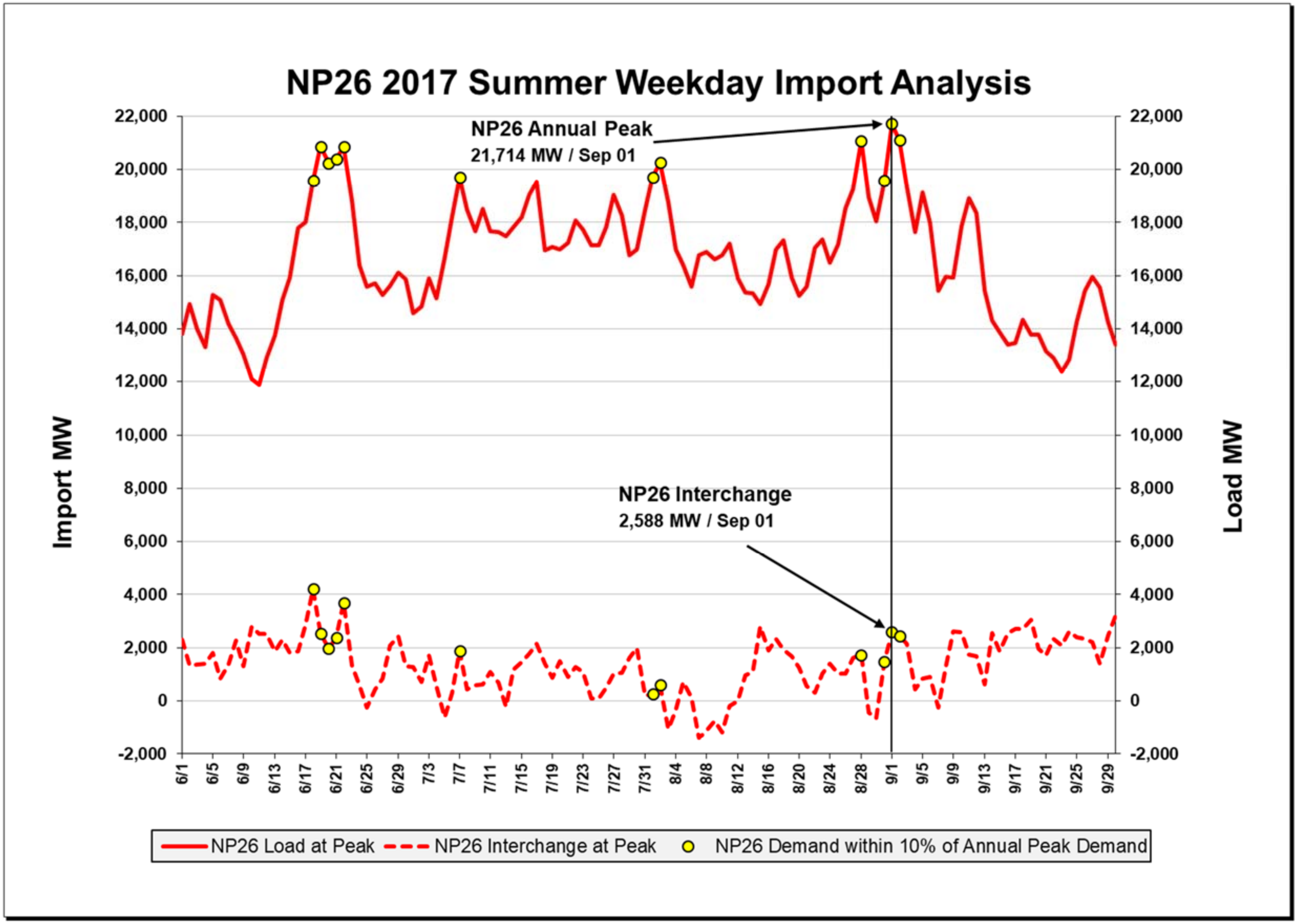

**Appendix D: 2018 CAISO Summer On-Peak NQC Fuel Type**