



# August 2020 Blackouts in CAISO

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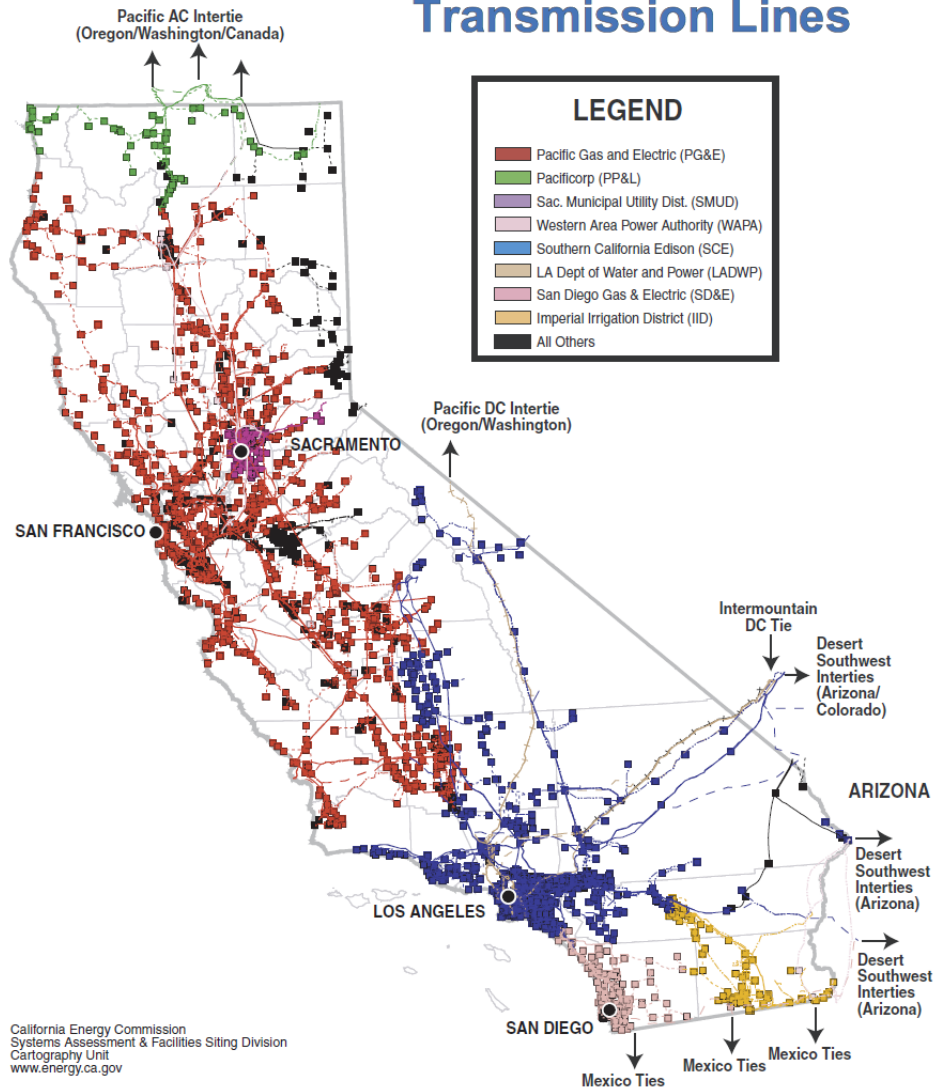
Image Credit: Gene Blevins/Reuters

# Agenda

- ❑ California ISO (CAISO) System Characteristics
  - Geographic Configuration and Interties
  - Seasonal Loads
  - Capacity by Energy Sources
  - Imports
- ❑ Blackouts (aka “Load Sheds”) in August 2020
  - “CAISO 2020 Summer Loads and Resources Assessment”
  - Sequence of Events
  - Realized Operating Reserves
  - Estimated Resource Adequacy
- ❑ Restoration Challenges After System Collapse
  - Secondary Fuel Sources for Gas-Fired Generators
  - Electric-Gas Interdependence
  - Essential Reliability Services
- ❑ Data-Based Observations

# **CAISO System Characteristics**

## California's Major Electric Transmission Lines

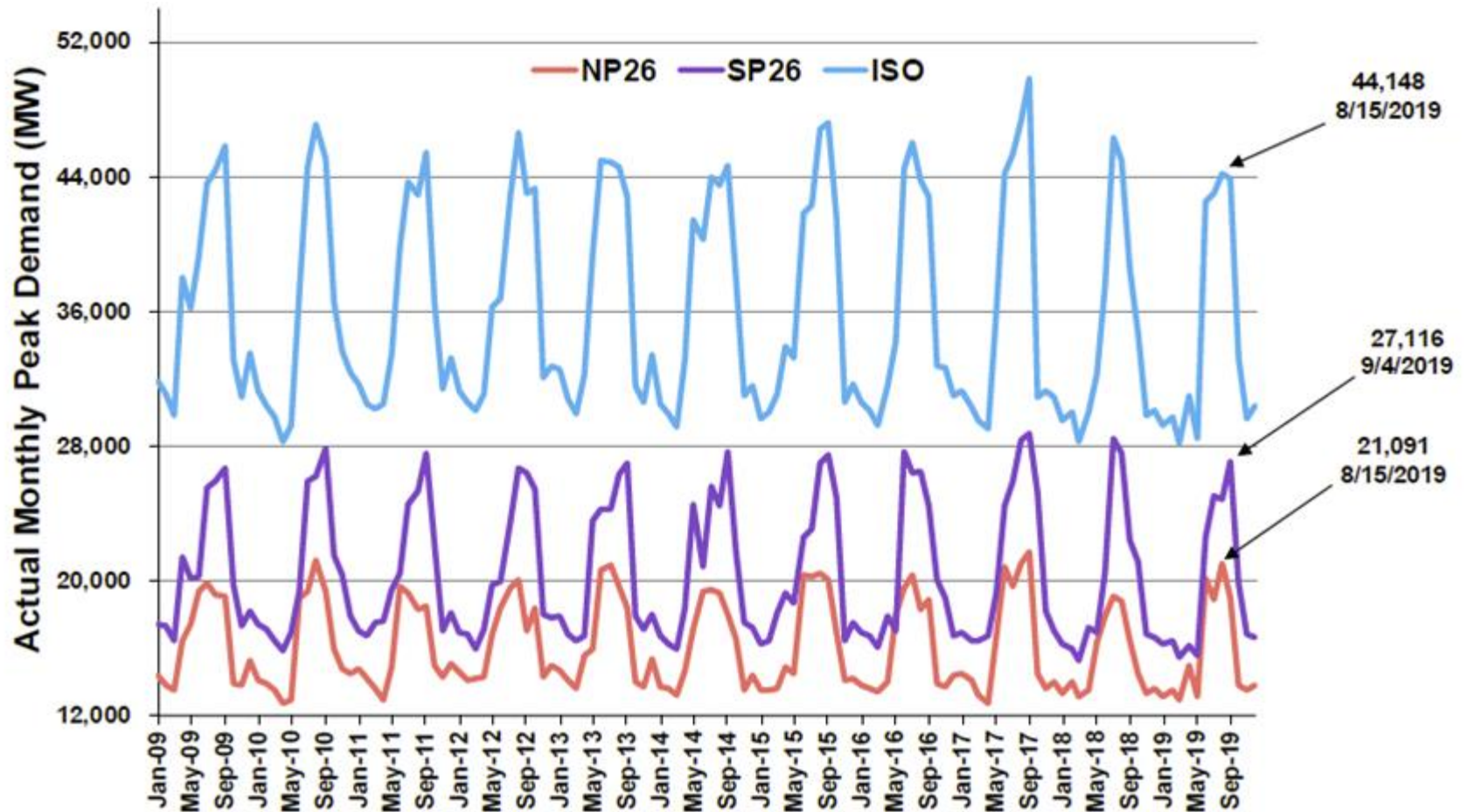


California Energy Commission  
Systems Assessment & Facilities Siting Division  
Cartography Unit  
[www.energy.ca.gov](http://www.energy.ca.gov)

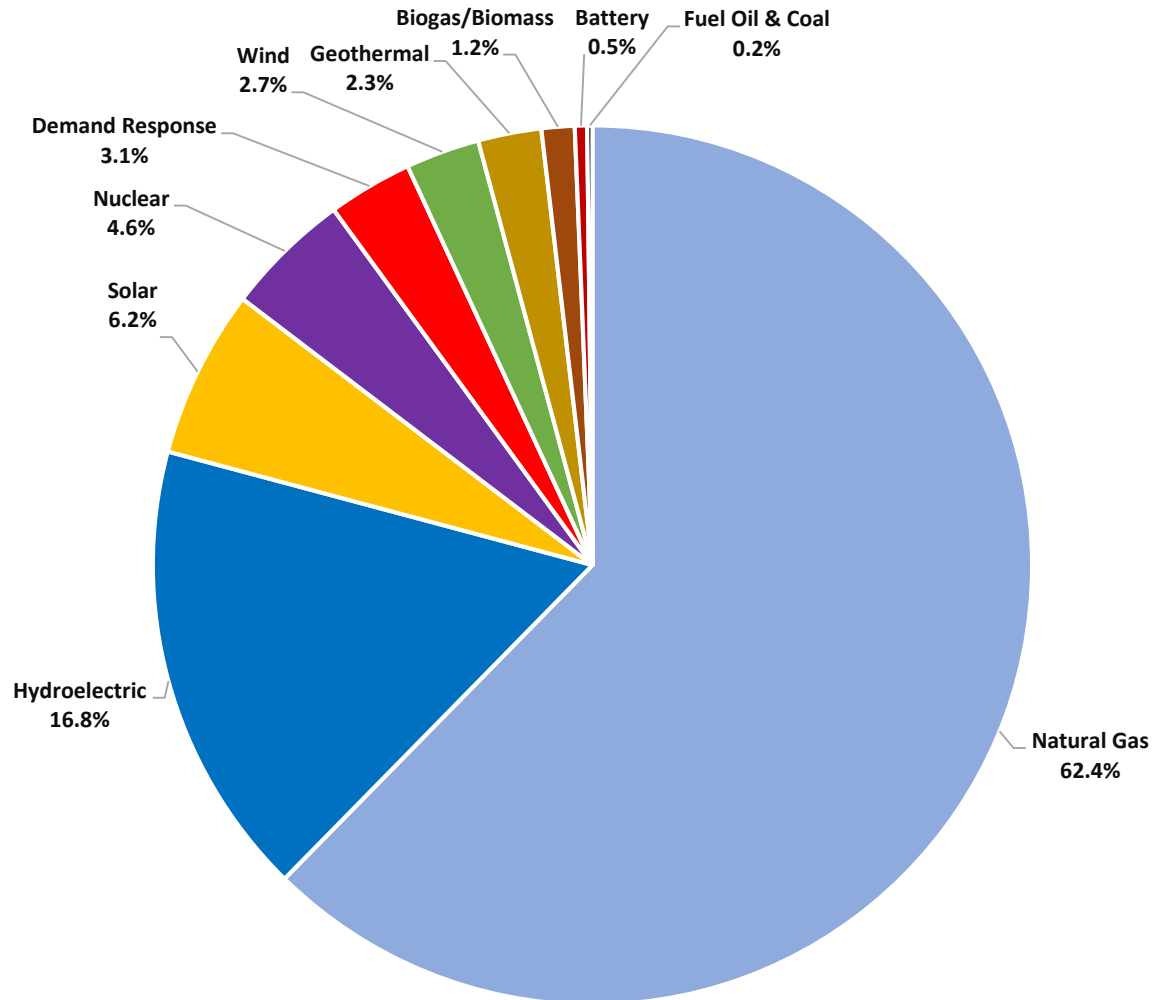
To inquire about ordering this map or information on  
other types of maps call the map line at (916) 654-4182 or  
E-Mail: [JGILBREA@ENERGY.STATE.CA.US](mailto:JGILBREA@ENERGY.STATE.CA.US)  
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## CAISO, North California (NP), and South California (SP) Load Profiles



## CAISO Net Qualified Capacity for August 2020—49.2 GW



## CAISO Imports Often Below 7 GW During Peak Loads

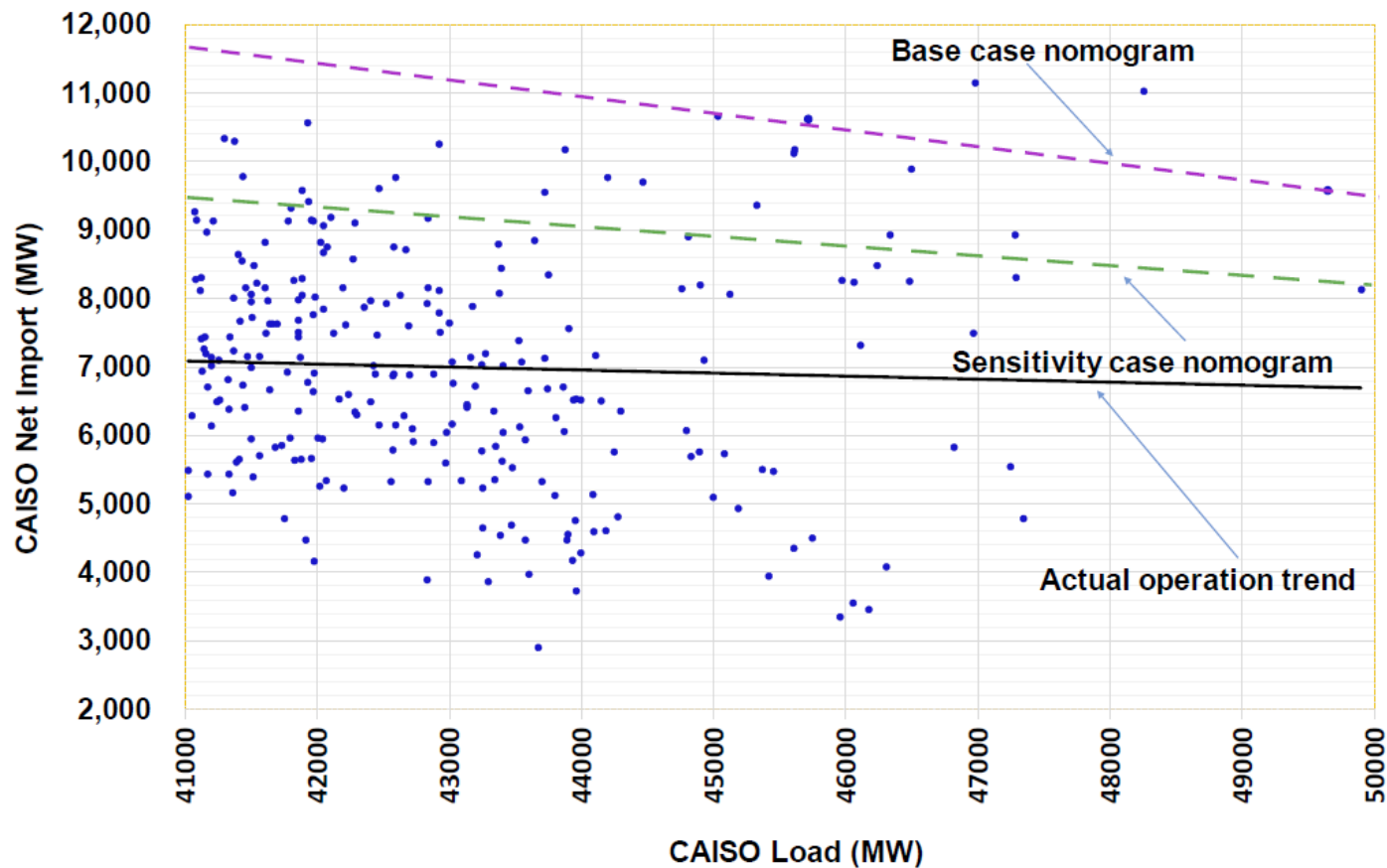


Figure 1 shows CAISO net imports at time of daily peaks above 41,000 MW vs. CAISO load from 2017 to 2019.

## Key Points on CAISO System

- ❑ “Northern Path” Is Principally PG&E
- ❑ “Southern Path” Is Principally Southern California Edison and San Diego Gas & Electric
- ❑ CAISO Has Critical Interties With Grids in Other States
- ❑ Big Difference Between Summer Peak Load and Other Times of Year
- ❑ 62.4% of CAISO Capacity Is Gas-Fired
- ❑ Solar (6.2%), Wind (2.7%), and Hydro (16.8%) Capacity Not Always Available
- ❑ CASIO Imports Historically Less When Peak Load Is High



# **Blackouts in August 2020**

## **CAISO 2020 Summer Loads and Resources Assessment**

- ❑ “The base case results show that the CAISO has a low probability of experiencing operating conditions that would lead to shedding firm load in summer 2020.”
- ❑ “[I]f a heat wave occurs that impacts a broader area than the CAISO, the availability of surplus energy to import into the CAISO could be diminished.”
- ❑ “While the CAISO has a low probability of a system capacity shortfall, there is a material risk of shortfalls in load following up capacity, particularly in the late afternoon when solar generation is near or at zero and net imports diminish from neighboring BAs while system demand is increasing.”

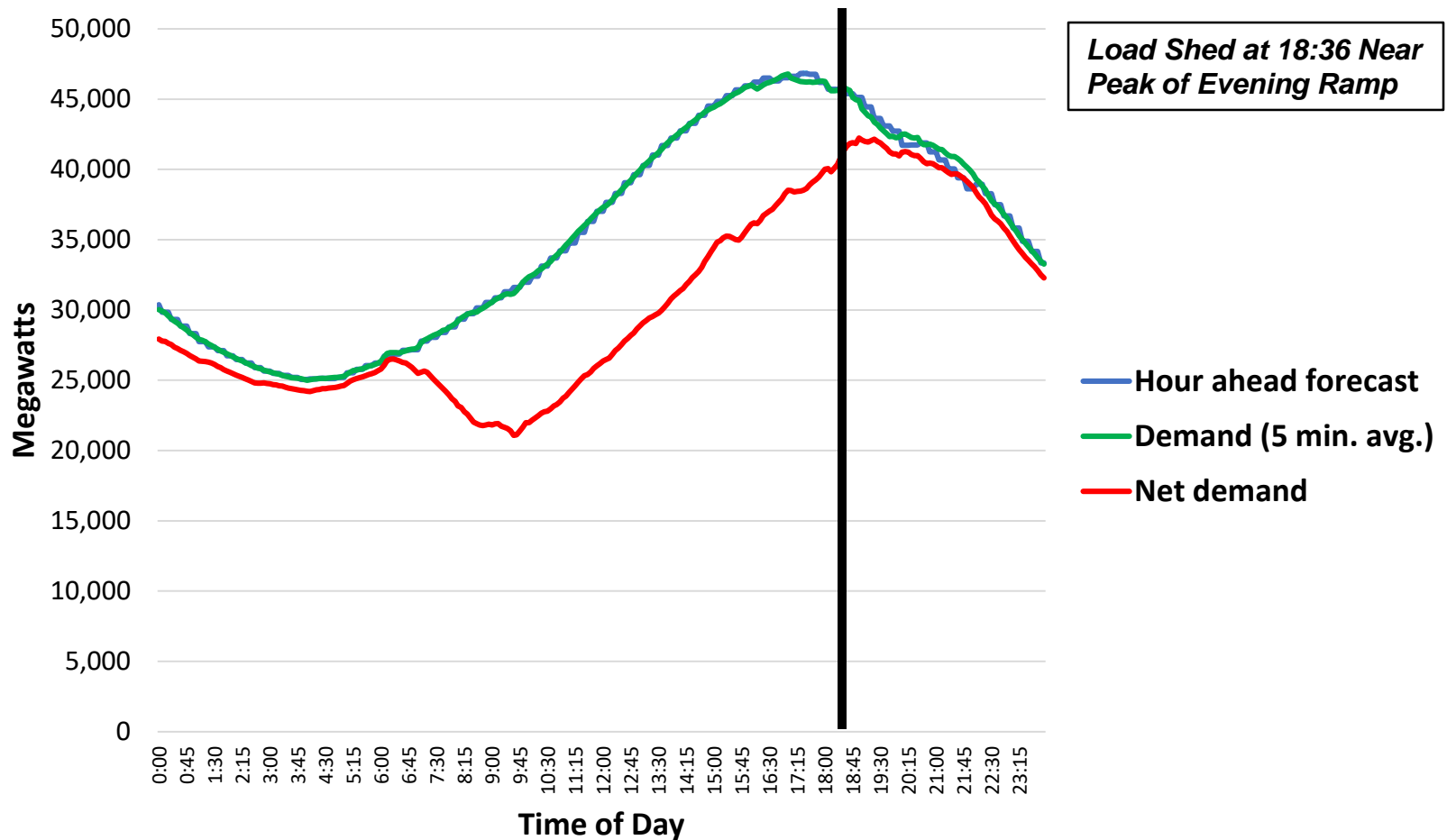
## Sequence of events Friday August 14

12:00 p.m.	Unable to secure additional energy, a Warning was issued effective 12:00 p.m. through midnight
2:56 p.m.	Loss of generation – 475 MW
2:58 p.m.	Dispatched contingency reserves to recover
3:20 p.m.	Forecasting a shortage of energy for next few hours - Declared CAISO Stage 2 Emergency, began procuring Emergency Assistance from external entities
5:15 p.m.	Dispatched approximately 800 MW of demand response to maintain load and resource balance
6:36 p.m.	Unable to maintain load and contingency reserve obligation – ordered 500 MW of load shed pro-rata to CAISO Utility Distribution Companies (UDC's) – Stage 3 Emergency declared
6:46 p.m.	Ordered an additional 500 MW of load shed pro-rata to CAISO UDC's
7:56 p.m.	Load decreased and resources were adequate to meet CAISO load and contingency reserve obligations. Ordered all load to be restored.

## Sequence of events Saturday August 15

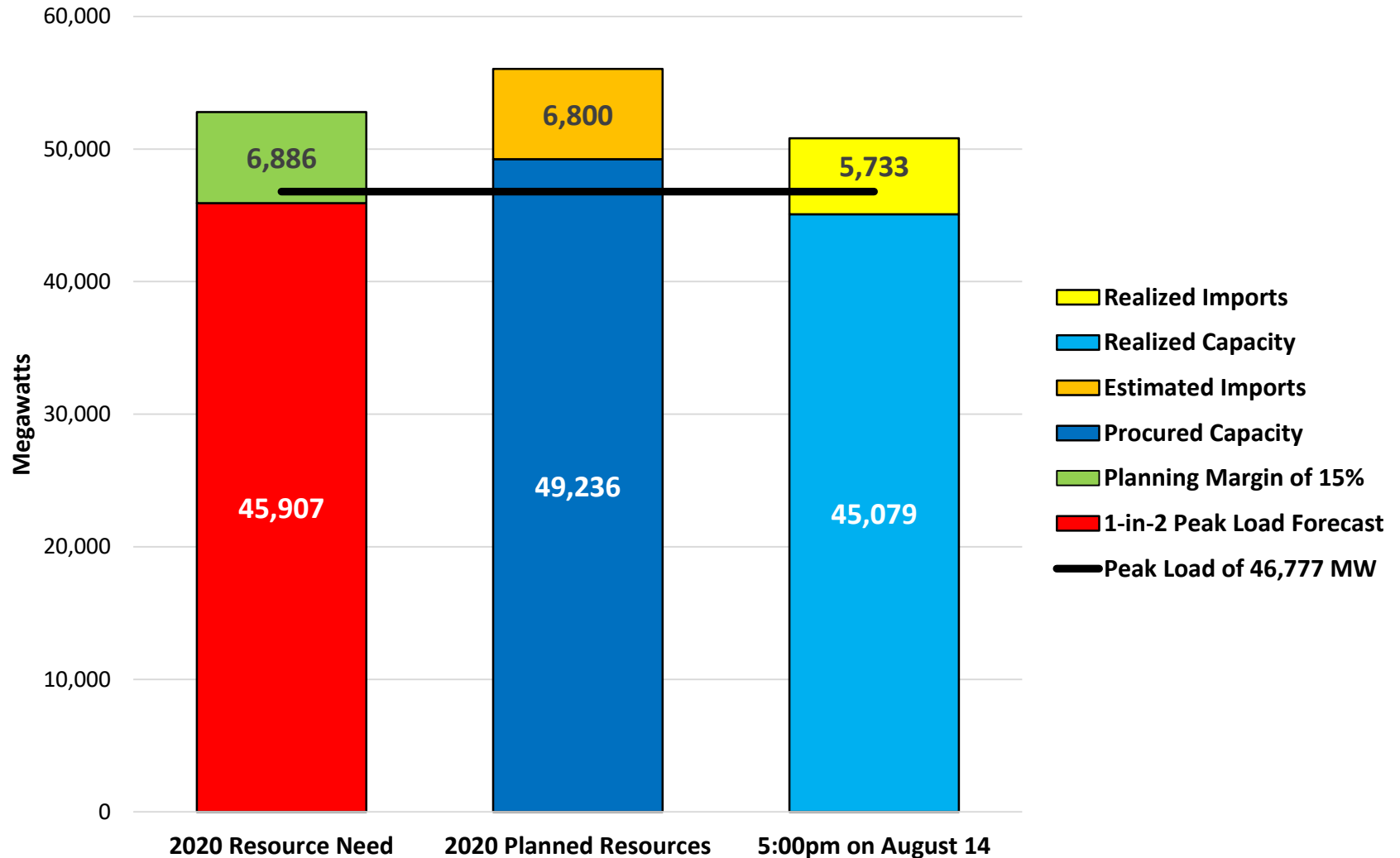
4:10 p.m. to 5:10 p.m.	Total wind output increased quickly requiring other generation to ramp down quickly
5:10 p.m. to 6:05 p.m.	Total wind decreased quickly requiring other generation to ramp up quickly. CAISO ACE was -1421 MW.
6:13 p.m.	While recovering our ACE, a generator ramped down quickly from 400 MW.
6:25 p.m.	Ordered 470 MW of load shed pro-rat from UDC's
6:47 p.m.	Received Emergency Assistance, wind ramped back up, load began to trend down, additional resources available. Ordered all load be restored.

## CAISO Demand on August 14, 2020

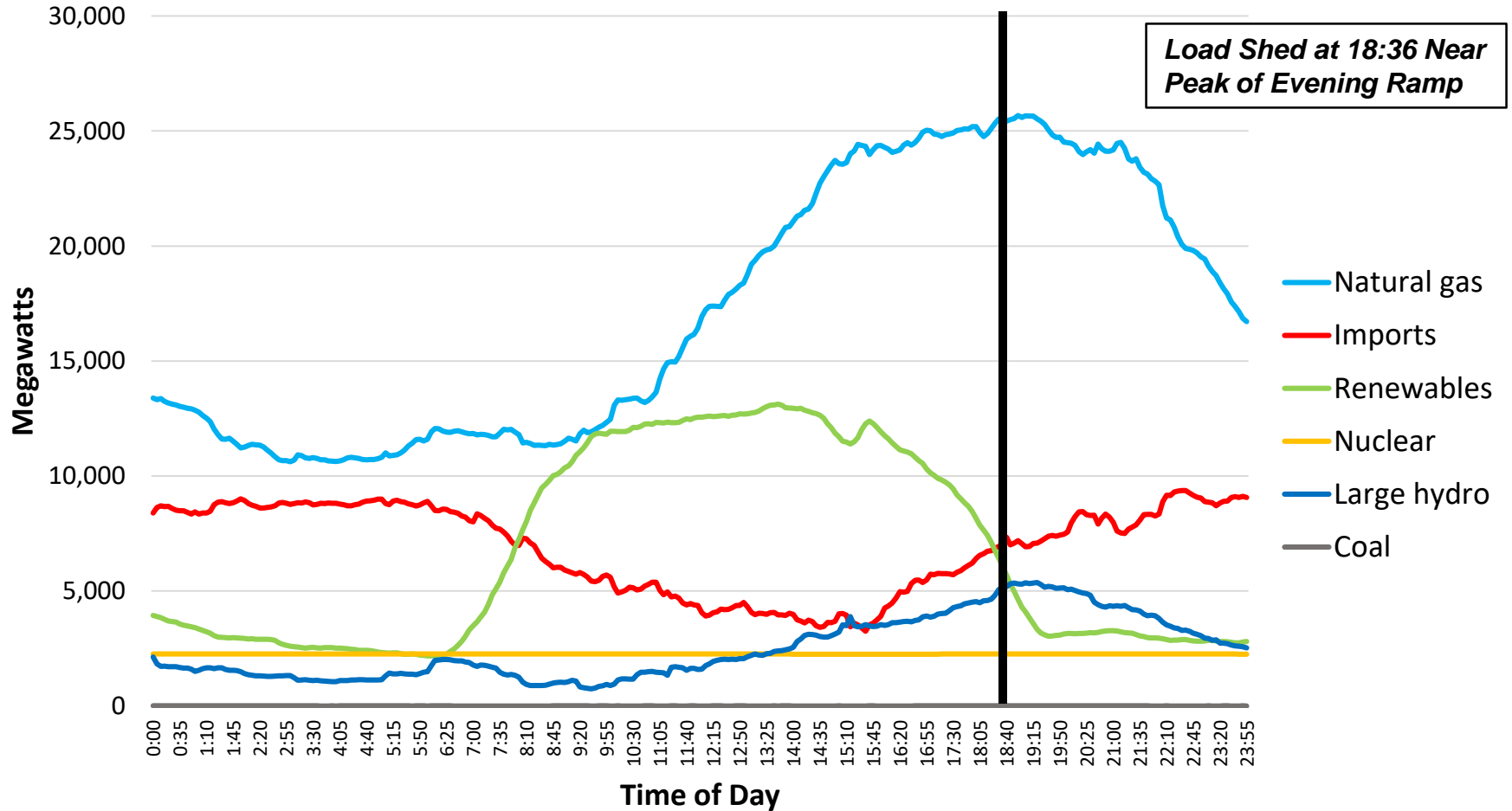


Source: CAISO website; <https://www.caiso.com/TodaysOutlook/Pages/demand.html>

## Peak Load at 5:00pm on August 14, 2020 Compared to Resources

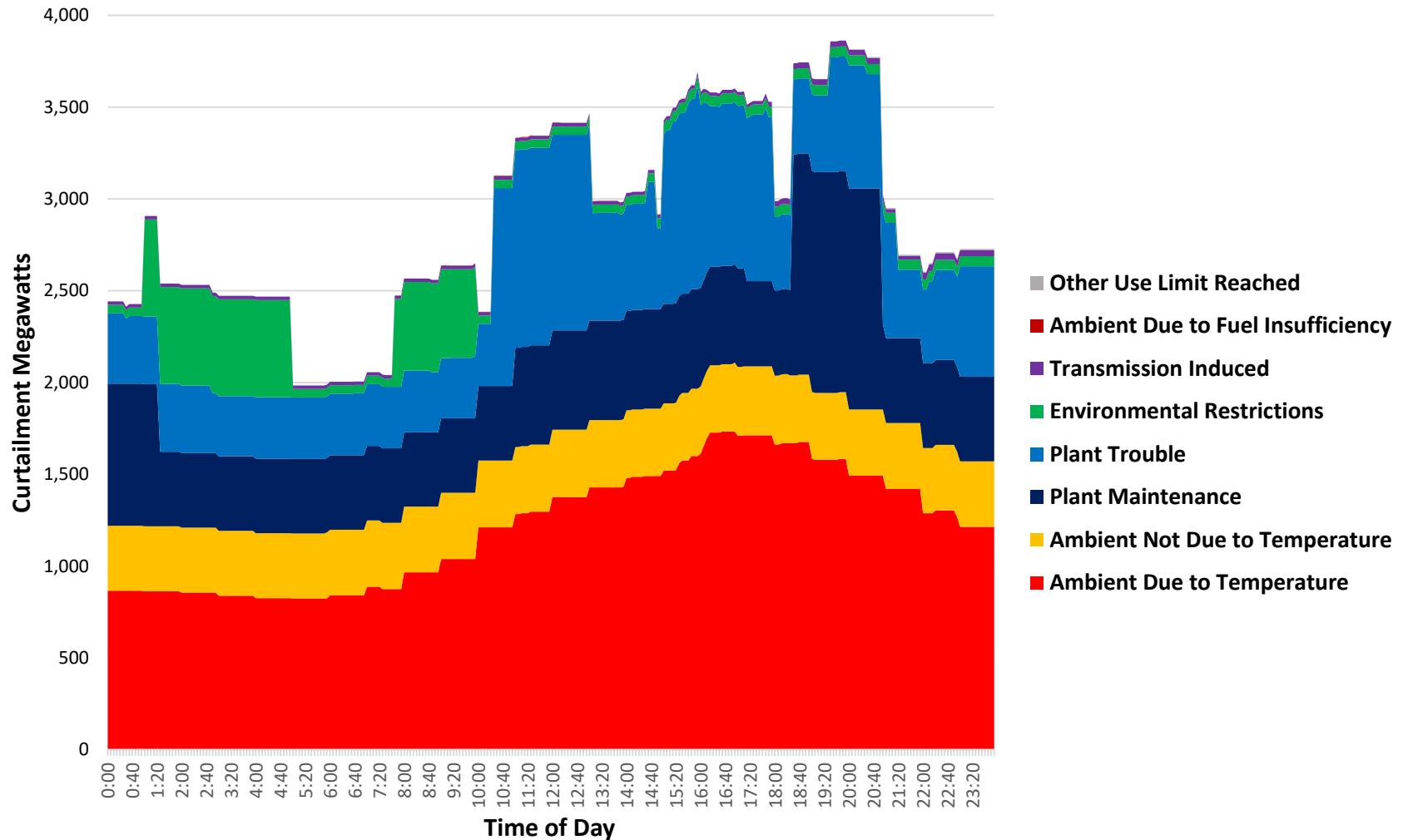


## CAISO Supply on August 14, 2020



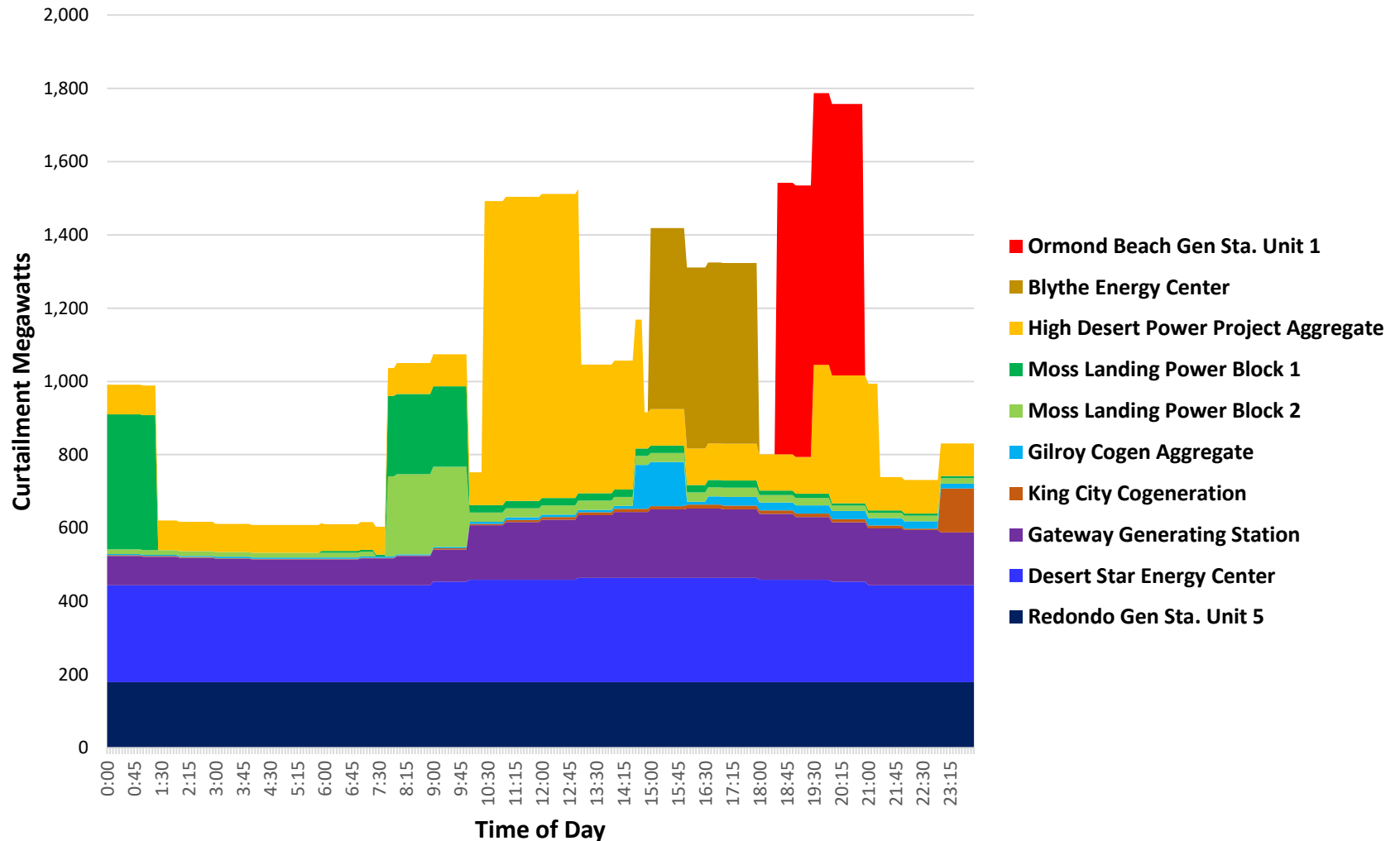
Source: CAISO website: <https://www.caiso.com/TodaysOutlook/Pages/supply.html>

## Forced Thermal Plant Outages in CAISO on August 14, 2020

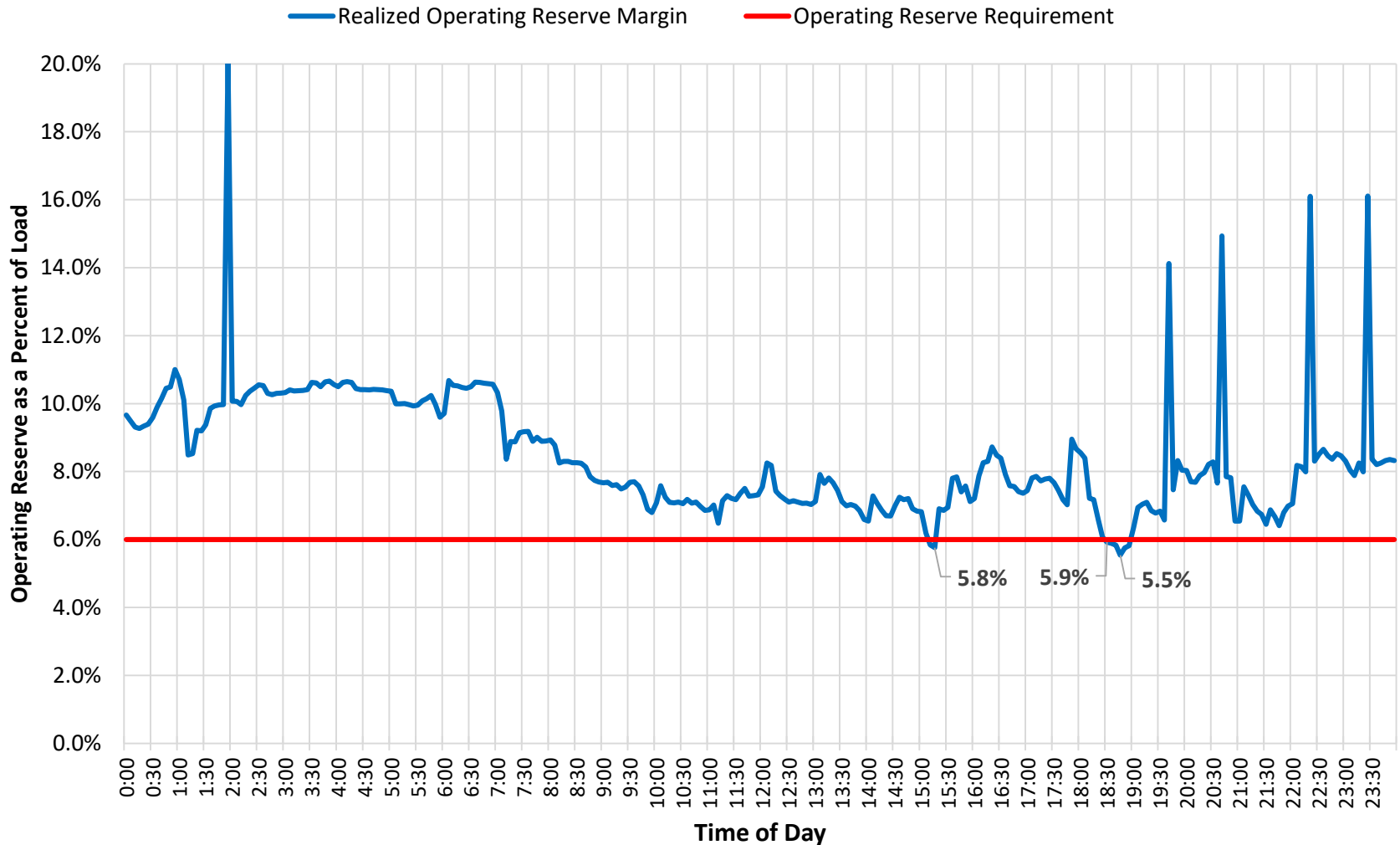




## Sequence of Major Forced Outages in CAISO on August 14, 2020



## CAISO Operating Reserves on August 14, 2020



<b>Alternative Estimate of CAISO Resource Adequacy on August 14, 2020</b>			
	Megawatts		
	<b>6:25pm</b>	<b>6:30pm</b>	<b>7:30pm</b>
Net Qualified Capacity Excluding Solar, Wind, Hydro	36,573	36,573	36,573
Planned Outages Excluding Solar, Wind, Hydro, Imports	(388)	(388)	(388)
Forced Outages Excluding Solar, Wind, Hydro, Imports	(2,997)	(3,739)	(3,859)
Deployed Demand Response	(800)	(800)	(800)
Total Firm Capacity	32,387	31,646	31,526
Solar Generation	3,798	3,460	195
Wind Generation	1,058	1,050	990
Hydroelectric	5,194	5,440	5,528
Imports	6,873	6,920	7,270
Total Non-Firm Capacity & Imports	16,923	16,870	13,983
Total Capacity & Imports	49,310	48,516	45,509
Total Demand (Net of Demand Response and Load Sheds)	(45,743)	(45,857)	(42,941)
Operating Reserve	3,567	2,659	2,568
Operating Reserve (Percent)	7.8%	5.8%	6.0%
Largest Contingency (Diablo Canyon Nuclear Plant)	2,264	2,265	2,266
Operating Reserve Less Largest Contingency	1,303	394	302

## Key Points on Blackouts In August 2020

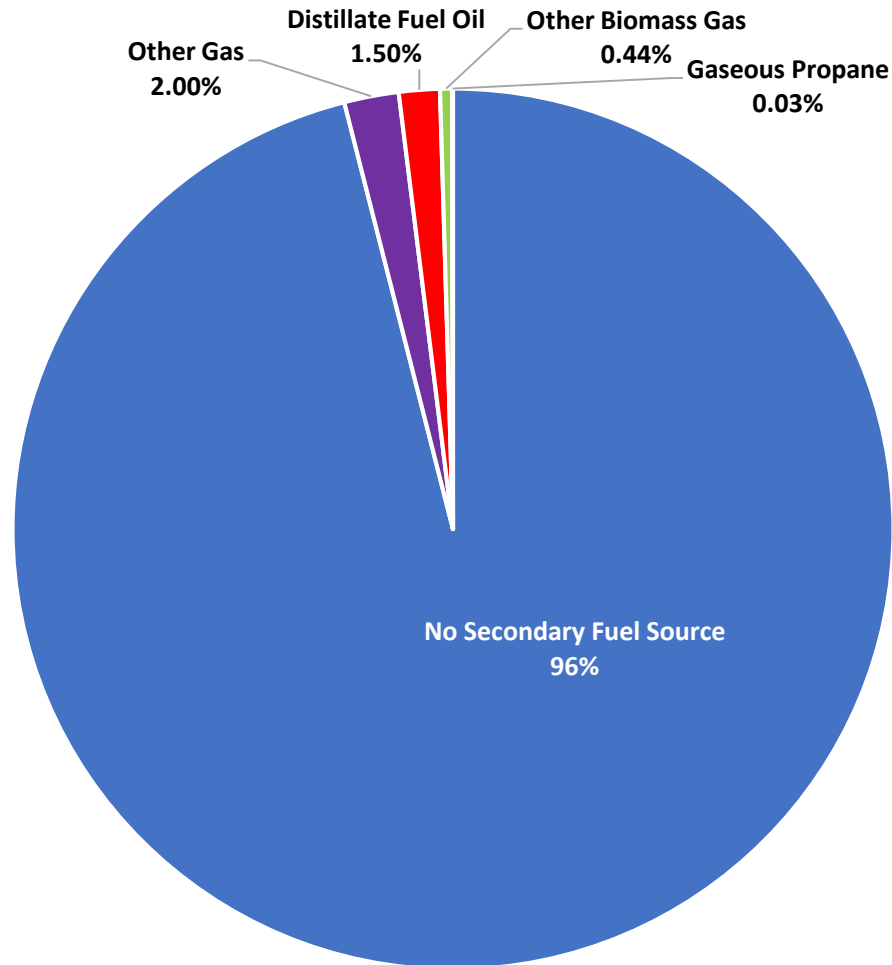
- ❑ CAISO Predicted Risk (But Not Probability) of Load Sheds/Blackouts During Summer Heatwaves
- ❑ Imports Were Constrained
- ❑ Hydroelectric Constrained Because of Reservoir Levels
- ❑ Large Forced Outages at Gas-Fired Plants
- ❑ Solar Generation Rapidly Fell During Evening Hours
- ❑ Wind Generation Variable and Unpredictable
- ❑ Committed Generator Capacity Less Than Realized Need



CAISO Grid Operator Ordered Rolling Blackouts

# **Restoration Challenges After System Collapse**

## Secondary Fuel Sources for CAISO Gas-Fired Plants



## 2020 California Gas Report

- ❑ “If core supplies are insufficient to meet core demand, PG&E can divert gas from noncore customers, including [Electric Generation] EG customers, to meet it.”
- ❑ “Since little, if any, alternate fuel-burn capability exists today, supply diversions from the noncore would necessitate those noncore customers to curtail operations.”
- ❑ “The implication for the future is that under supply-shortfall conditions—such as an [Abnormal Peak Day] APD—a significant portion of [Electric Generation] EG customers could be shut down with the impact on electric system reliability left as an uncertainty.”

## PG&E Natural Gas System in California



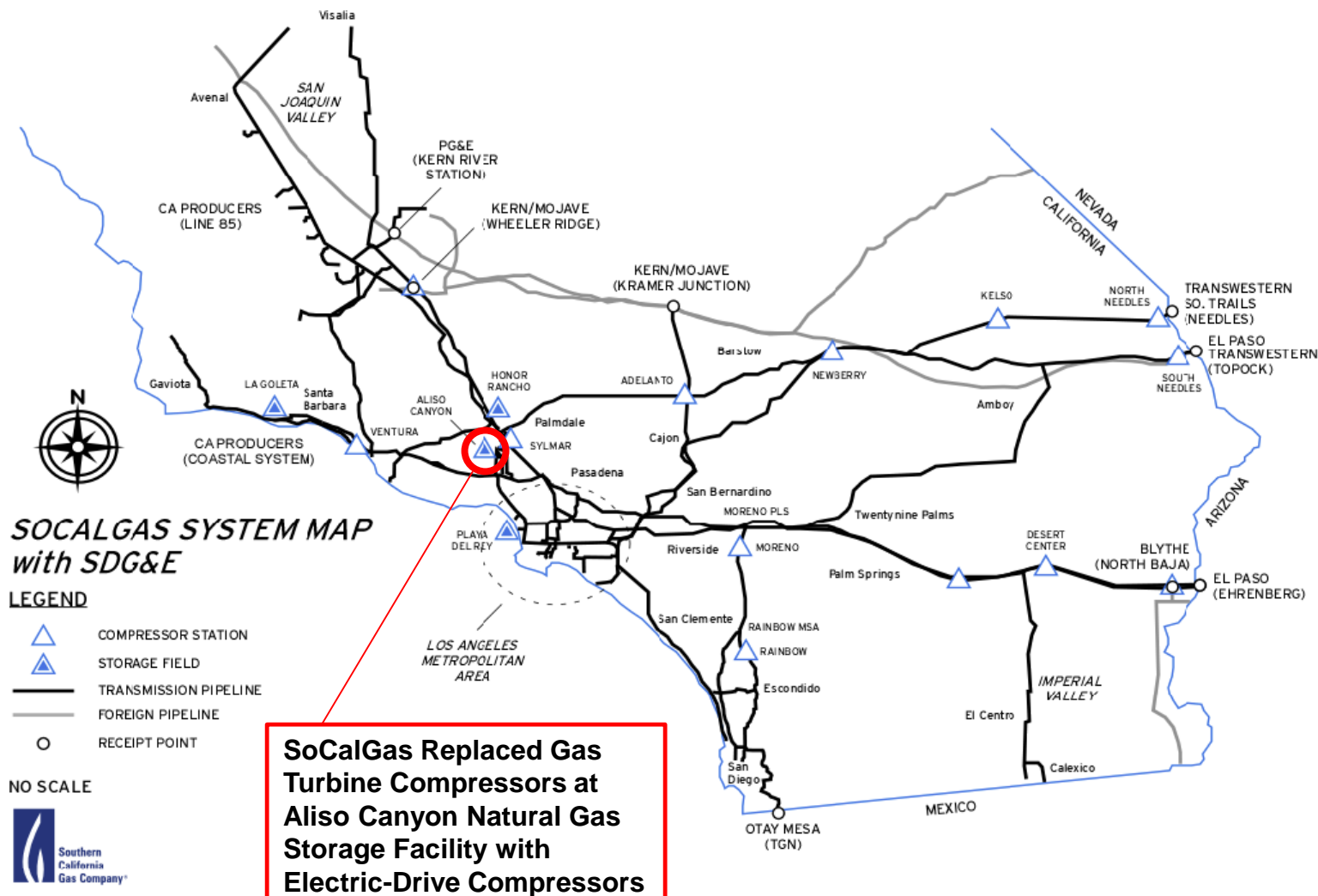
- **Northern California Generators Are Dependent on PG&E Natural Gas Pipelines**
- **At the Delevan Compressor Station, 2 Out of 3 Compressors Are Electric-Drive**
- **At the Bethany Compressor Station, Both Compressors Are Electric-Drive**
- **These Electric-Drive Compressors Are In Turn Dependent on the PG&E Transmission System**

Adapted from PG&E "California Pipeline/Storage Facilities" on [www.pge.com](http://www.pge.com)



## **2020 California Gas Report**

- ❑ “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.”



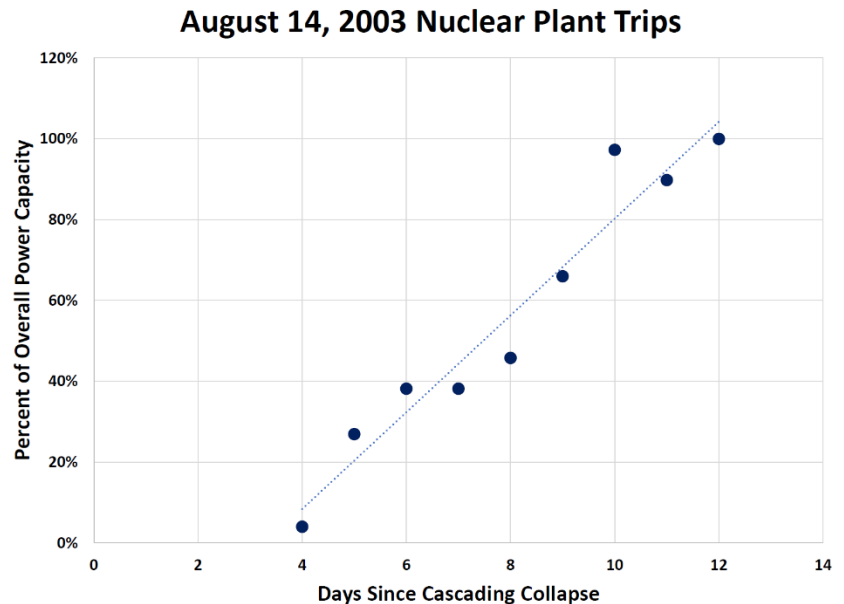
# Diablo Canyon Nuclear Plant

2,256 MW Dual-Unit Plant Provides  
Reactive Power & Frequency Response



Image Credit: Tracy Adams

Diablo Canyon Forced Outage Expected  
After System Collapse Causes Plant Trip



Source: U.S. Nuclear Regulatory Commission, Foundation for Resilient Societies Analysis

## **Key Points on CAISO System Restoration**

- ❑ 96% of CAISO Gas-Fired Capacity Has No Backup Energy Source and Is Dependent on “Just-In-Time” Fuel
- ❑ Electric-Gas Interdependence
  - PG&E Pipeline in North
  - Aliso Canyon Natural Gas Storage Facility In South
- ❑ Diablo Canyon Nuclear Plant Likely Not Available for System Restoration

## Data-Based Observations

- ❑ Stress on CAISO System Occurred Near Sunset
  - Rapidly Falling Solar Generation
- ❑ Dispatchable Capacity Had Large Forced Outages
- ❑ Imports Not Sufficient To Replace Local Capacity
- ❑ Result: Operating Reserves Dipped Below Planning Margin
- ❑ Blackouts Occurred in CAISO Two Days in a Row
  - Recent Experience Shows This Is Not a “Low Probability”
  - Root Causes Not Clear From Data Available From CAISO
- ❑ System Restoration Risks
  - Lack of Dual-Fuel Plants
  - Electric-Gas Interdependence
  - Reactive Power and Frequency Response

# About the Foundation for Resilient Societies

- ❑ Thank you for your attention to the important issue of electric reliability for the state of California.
- ❑ The Foundation for Resilient Societies is a non-profit organization engaged in scientific research and education with the goal of protecting technologically-advanced societies from infrequently occurring natural and man-made disasters.
- ❑ Learn more about us on our website:  
[www.resilientsocieties.org](http://www.resilientsocieties.org)
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