State Water Project
Power Portfolio management
in an evolving power market

October 2020

The Department of Water Resources and The State Water Project (SWP)

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

State Water Project

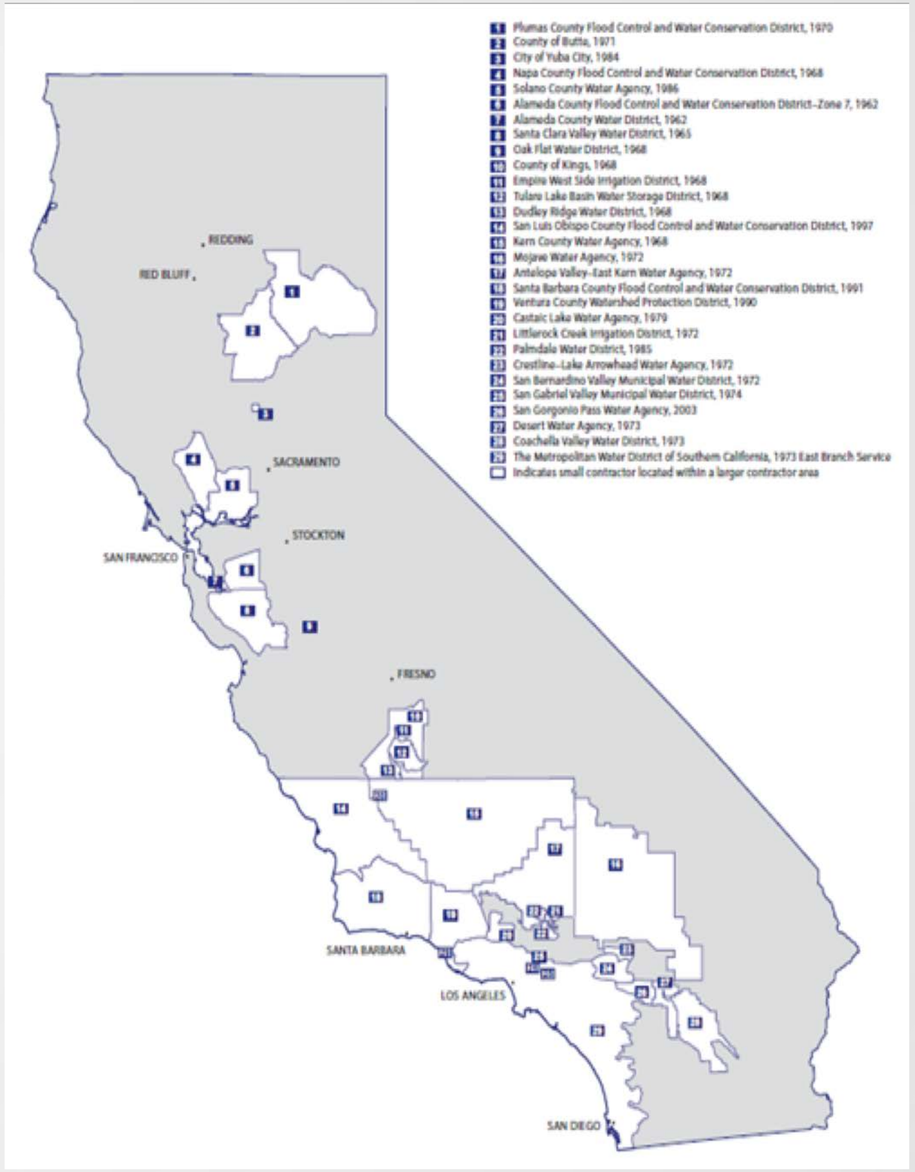
- Largest state-built and operated water and power system in the U.S.
  - 36 Storage Facilities
  - 21 Pumping Plants
  - 4 Pumping-generating Plants
  - 5 Hydroelectric Generating Plants
  - 700 miles of Canals and Pipelines

- Multiple Purposes and Benefits:
  - Water Supply
  - Flood Control
  - Fish and Wildlife Mitigation and Enhancement
  - Delta Water Quality and Outflow
  - Power Generation
  - Recreation

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

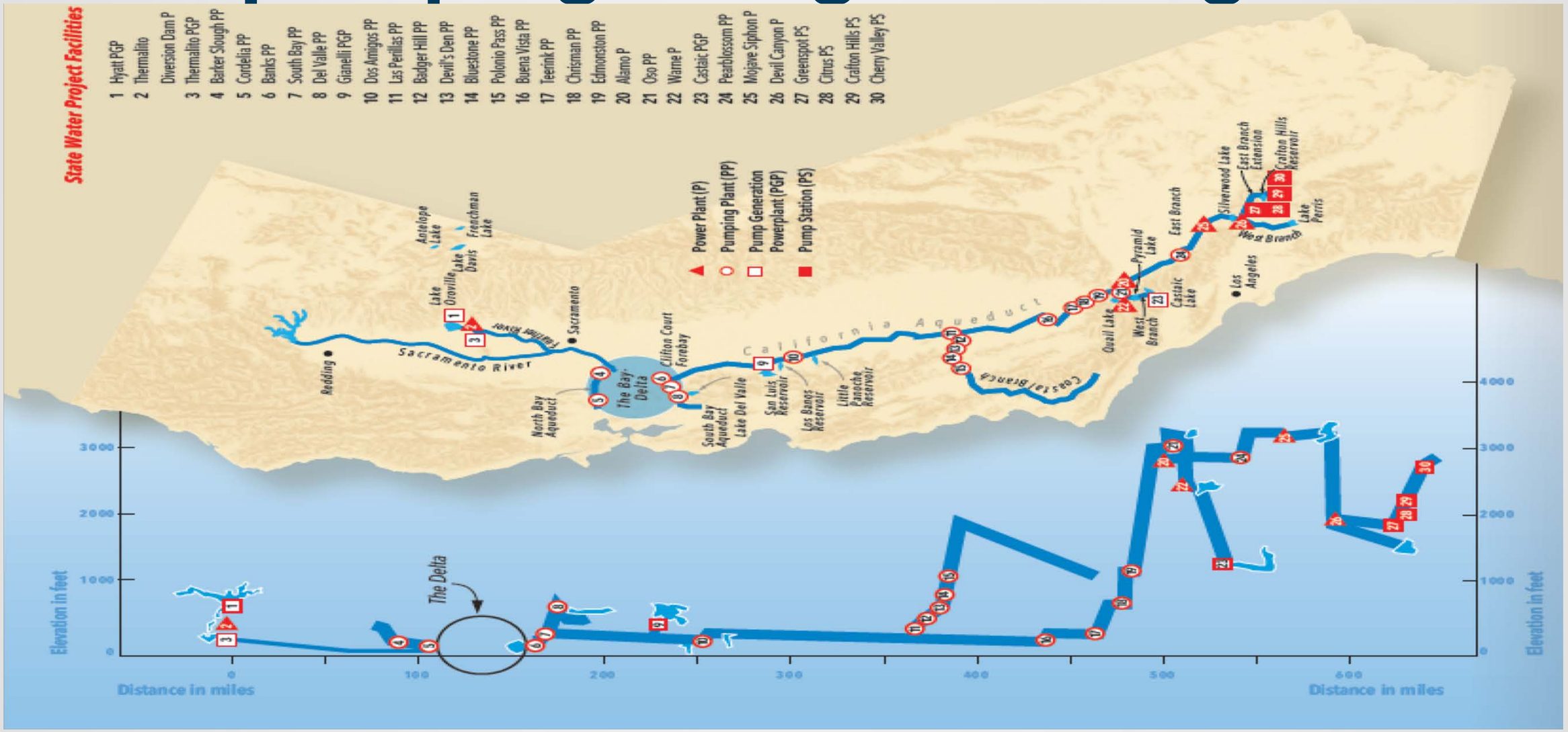
Who Receives water from the SWP

- Serves 27 million Californians and over 750,000 acres of farmland
- Water provided to 29 State Water Contractors (SWC)
- SWC are the public agencies who signed long-term water supply contracts to receive water from the SWP

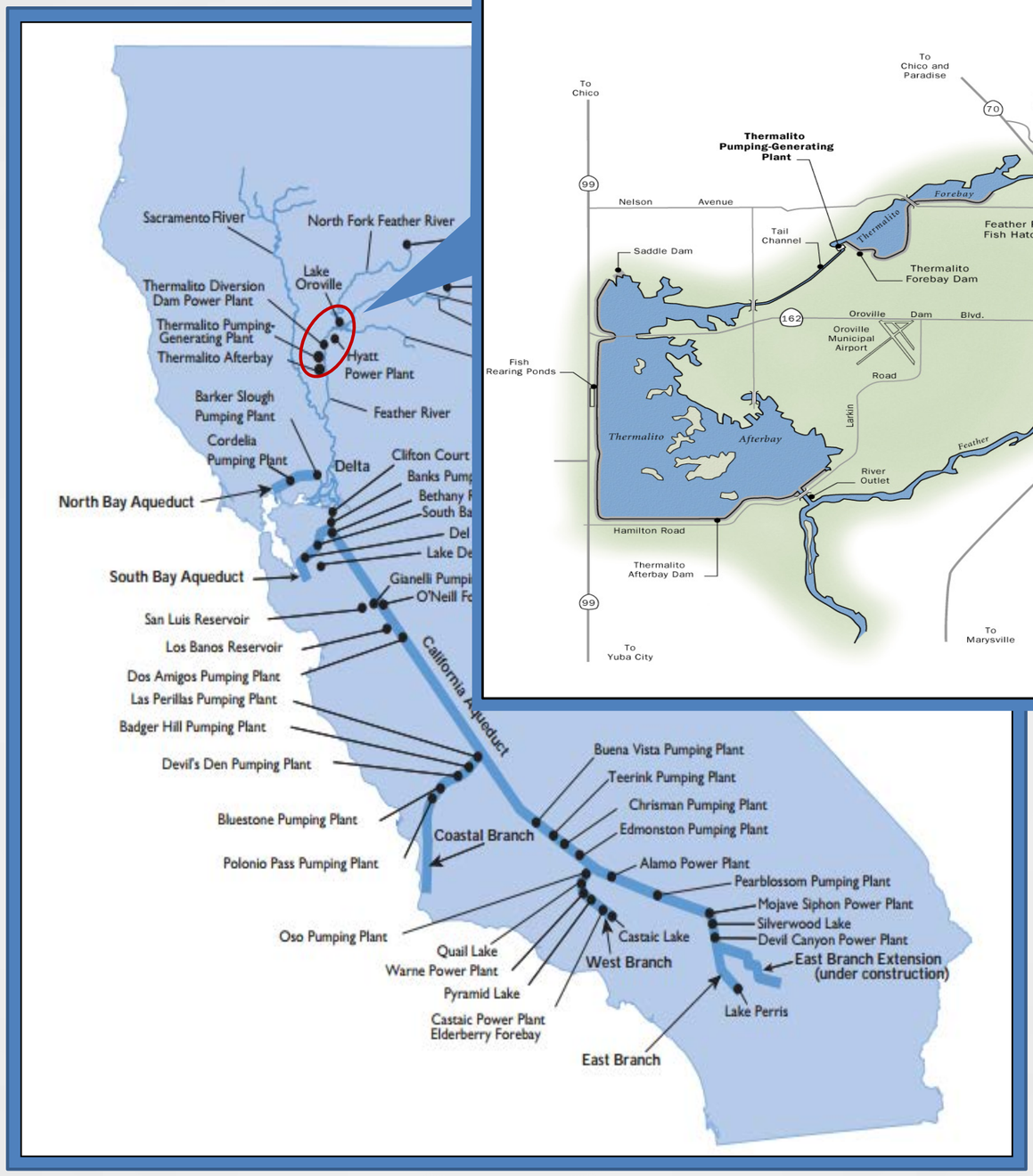


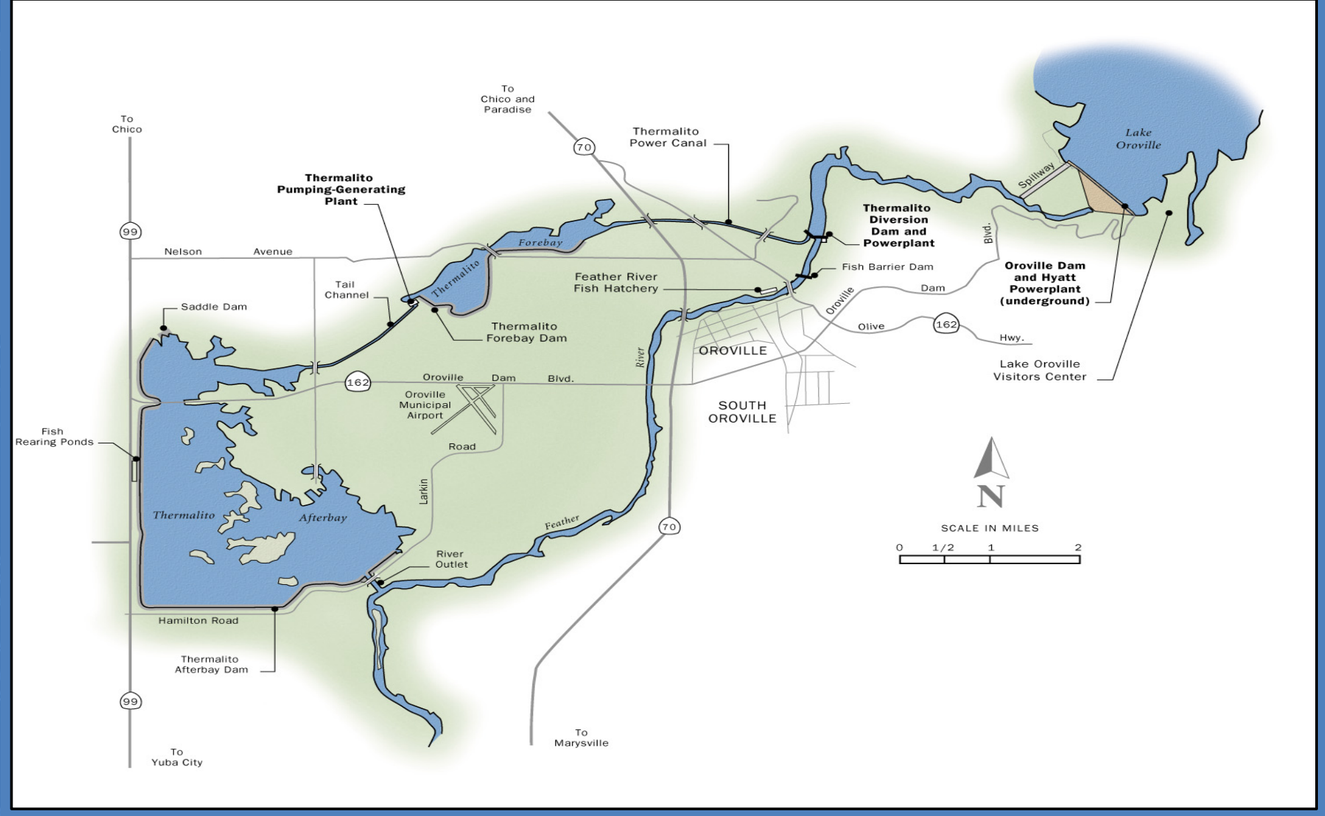
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SWP pumping and generating



CALIFORNIA DEPARTMENT OF
WATER RESOURCES





Lake Oroville

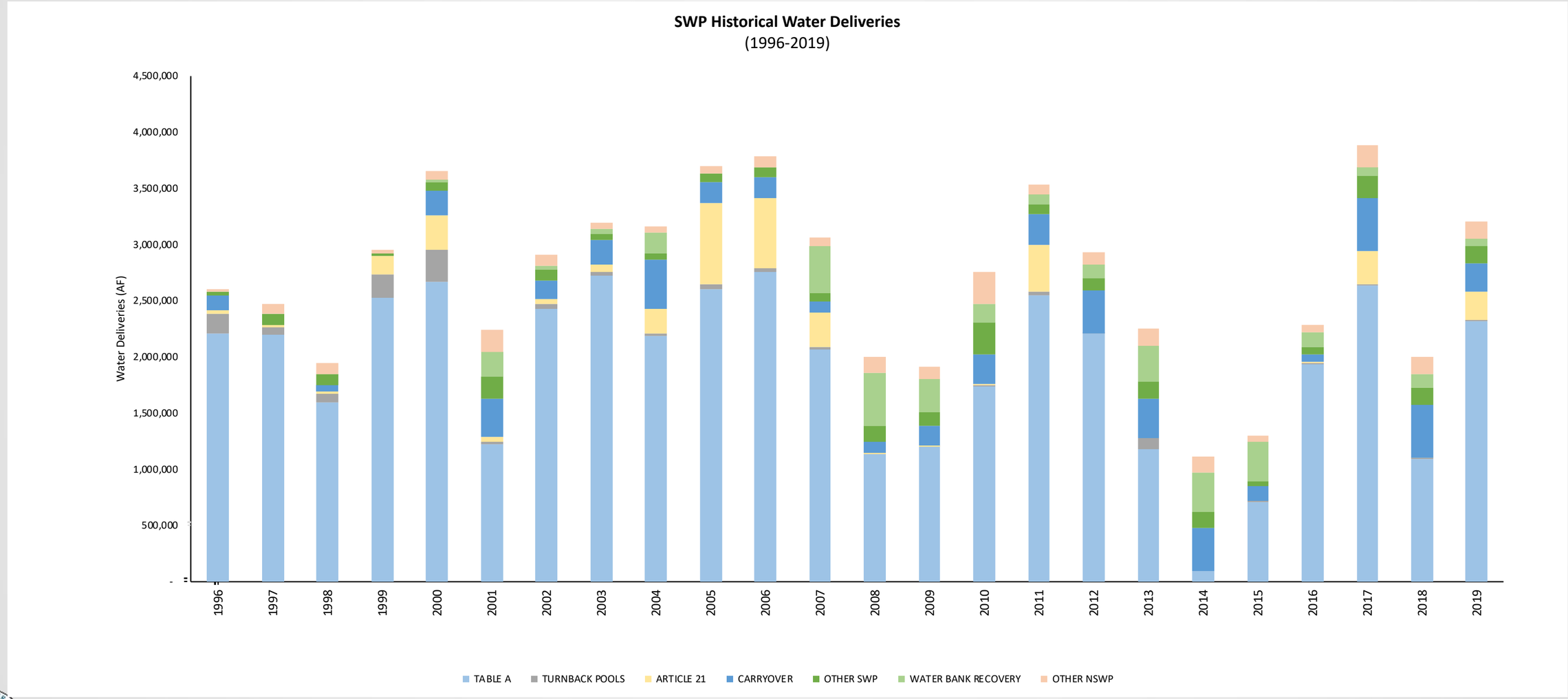
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

San Luis Reservoir

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SWP Power Portfolio management

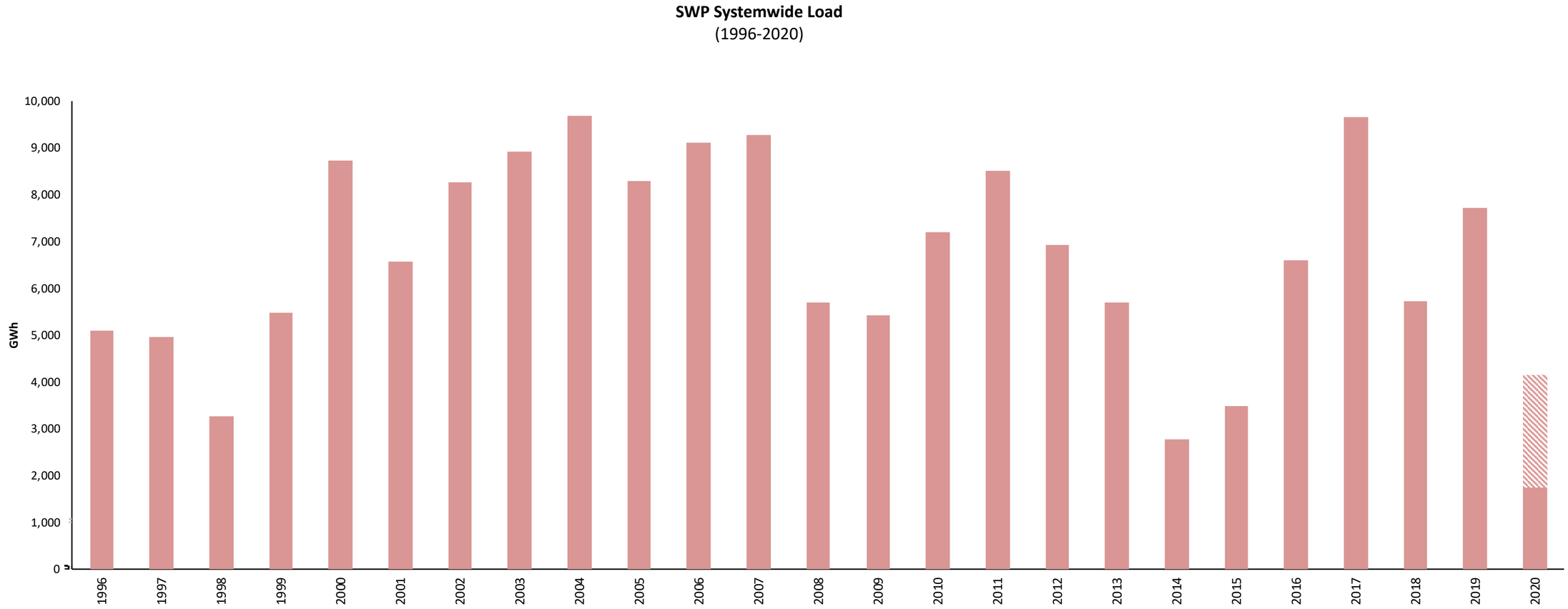
(SWC Demand Profile)



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SWP Power Portfolio management

(SWC Demand Profile)



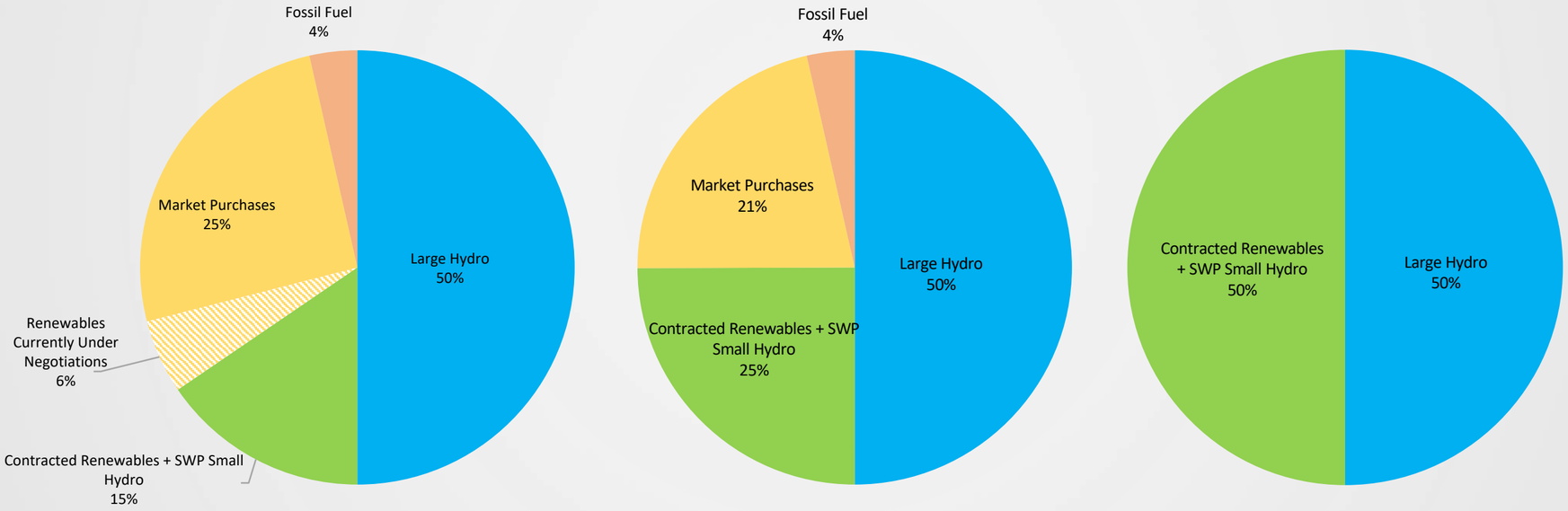
Note: Projected load from June through December 2020 shown in hatched bar.

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SWP Power Portfolio management

(Current and future resource mix)

- Approval of SB100 puts California on the path to 100% zero-emission electricity by 2045



2020

65% emissions free resources

2030

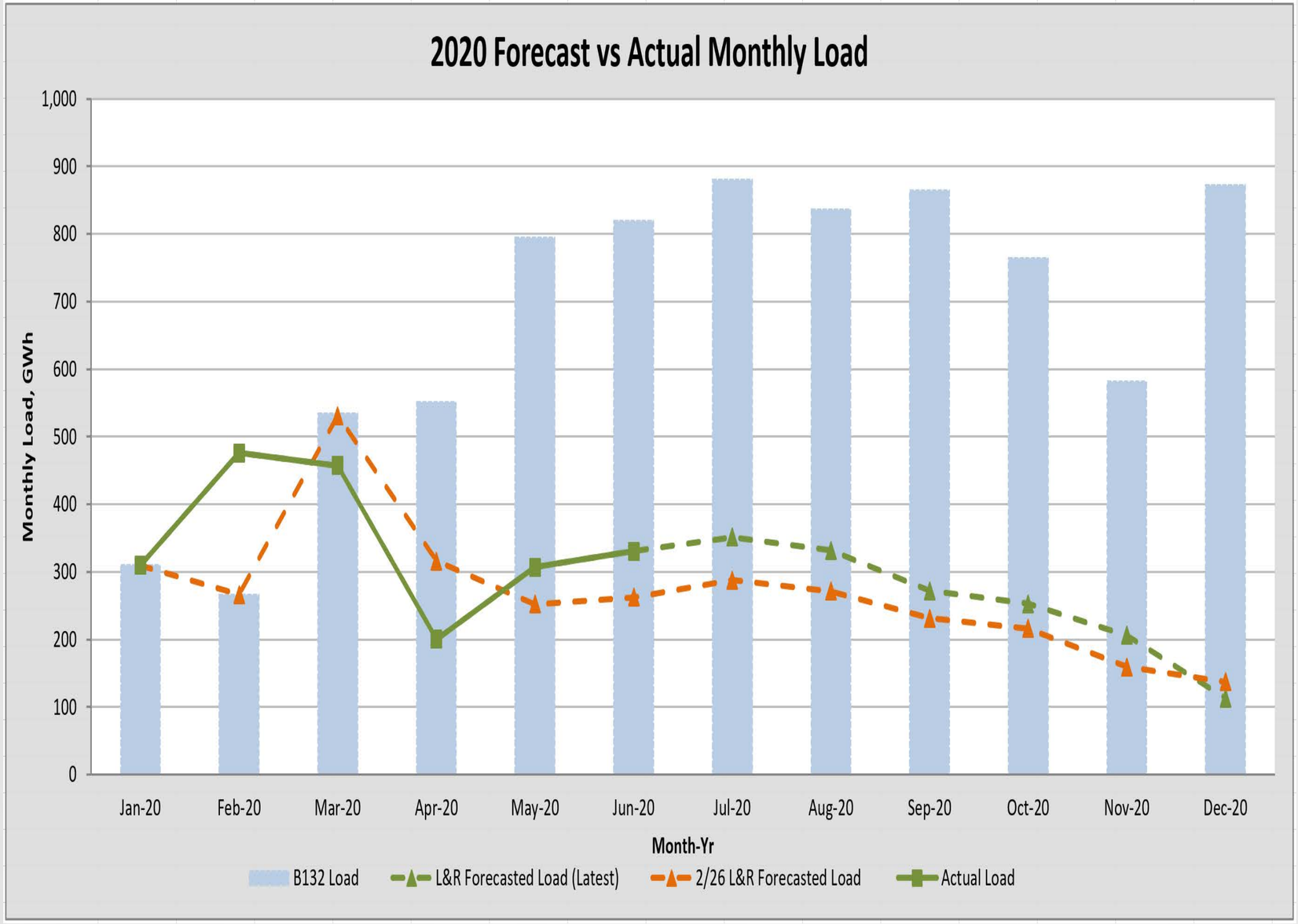
75% emissions free resources

2045

100% emissions free resources

CALIFORNIA DEPARTMENT OF
WATER RESOURCES

2020 Forecast Vs Actual Load



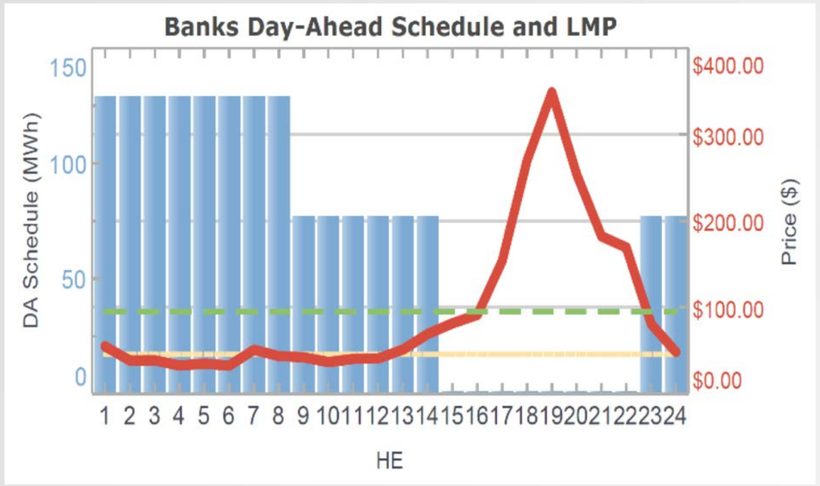
B132-20 Load Forecast:

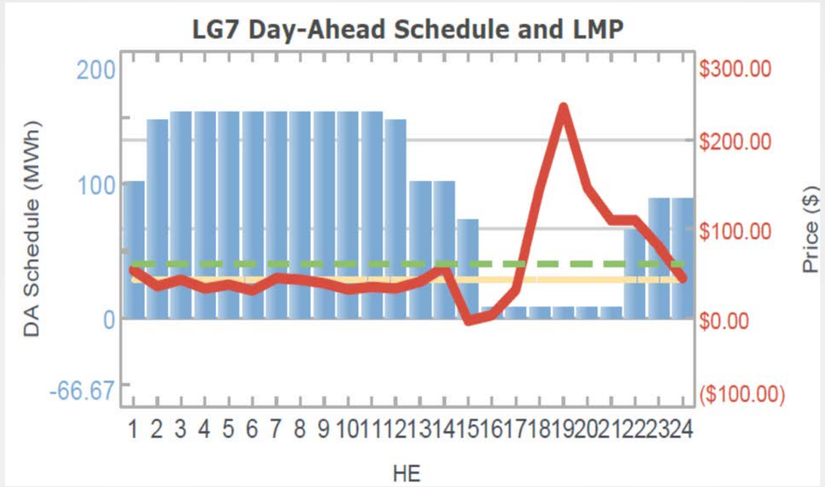
- 60% allocation (2.82 MAF) of water supply

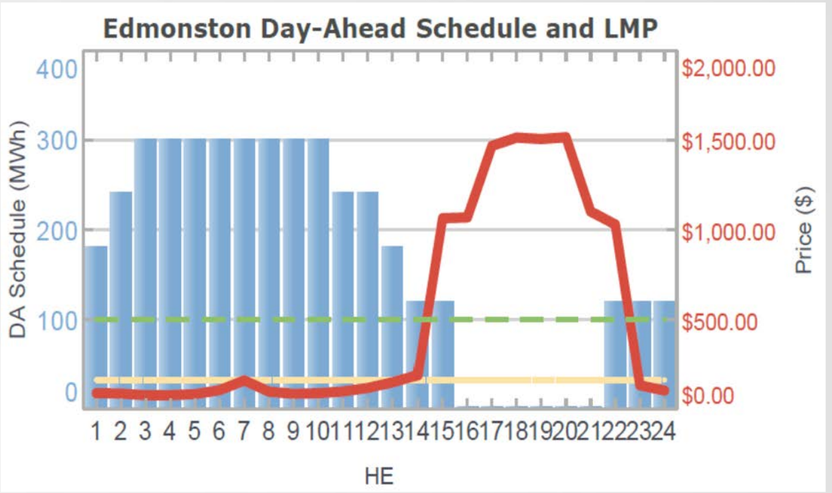
2020 Updated Load Forecast (as of July 24, 2020), 90% exceedance:

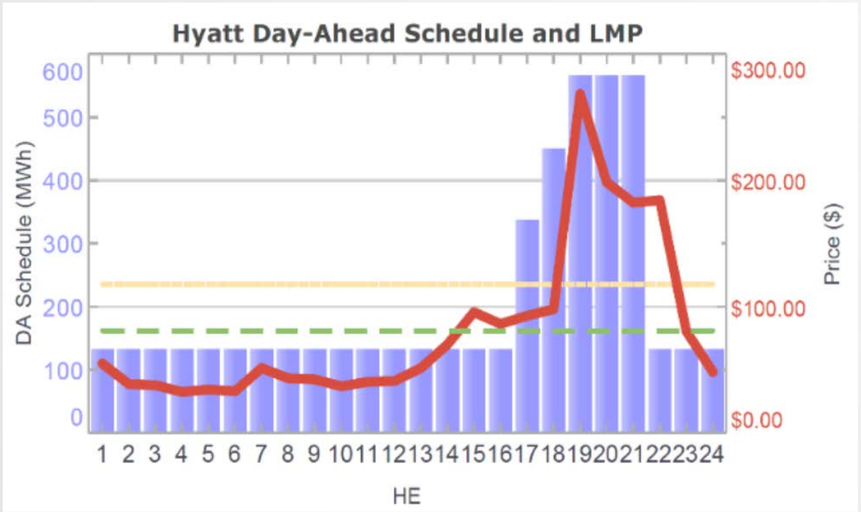
- 20% allocation of Table A SWP delivery
- Delivery consists of updated demands, loss estimates, and conveyance limitations
- Pumping Load ~ 3,607 GWh (yearly total), and 1,527 GWh for July through December 2020

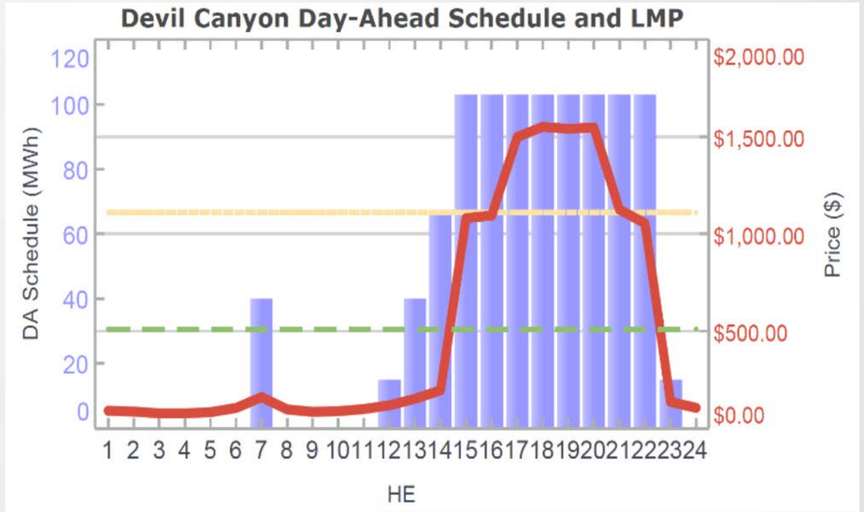
SWP load and generation response in supporting CAISO grid during the Heat Wave Emergency





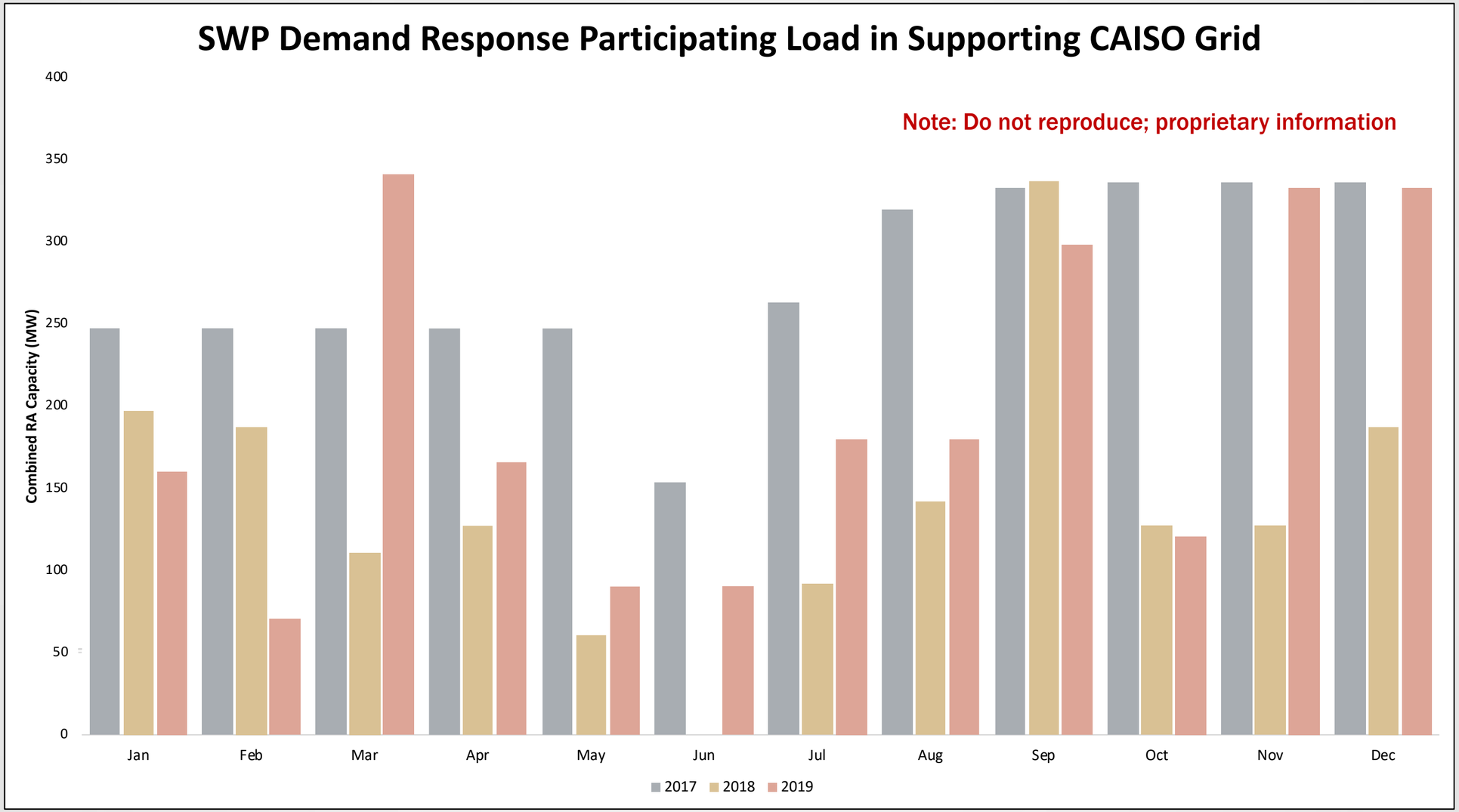






CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SWP Demand Response participating load in supporting caiso grid



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

SB49 - Flexible Resources Study

- DWR is assessing the potential of providing more market services to further help integrate renewable resources. DWR is investigating the following flexible operation strategies:
  - Optimizing operations of SWP generation and pumping plants
  - Real-Time Load Bidding of SWP pumps
  - Pumped Storage studies on SWP assets
  - Options for integrating more renewables generation
  - Integrating Battery-Storage with Renewables Resources
  - Offering more Ancillary Services into the power market
  - Retrofits to some pumping plants to provide more flexibility
  - Adding Pockets of Storage at strategic locations to decouple interdependencies of pumping plants

SB49 - Flexible Resources Study Schedule

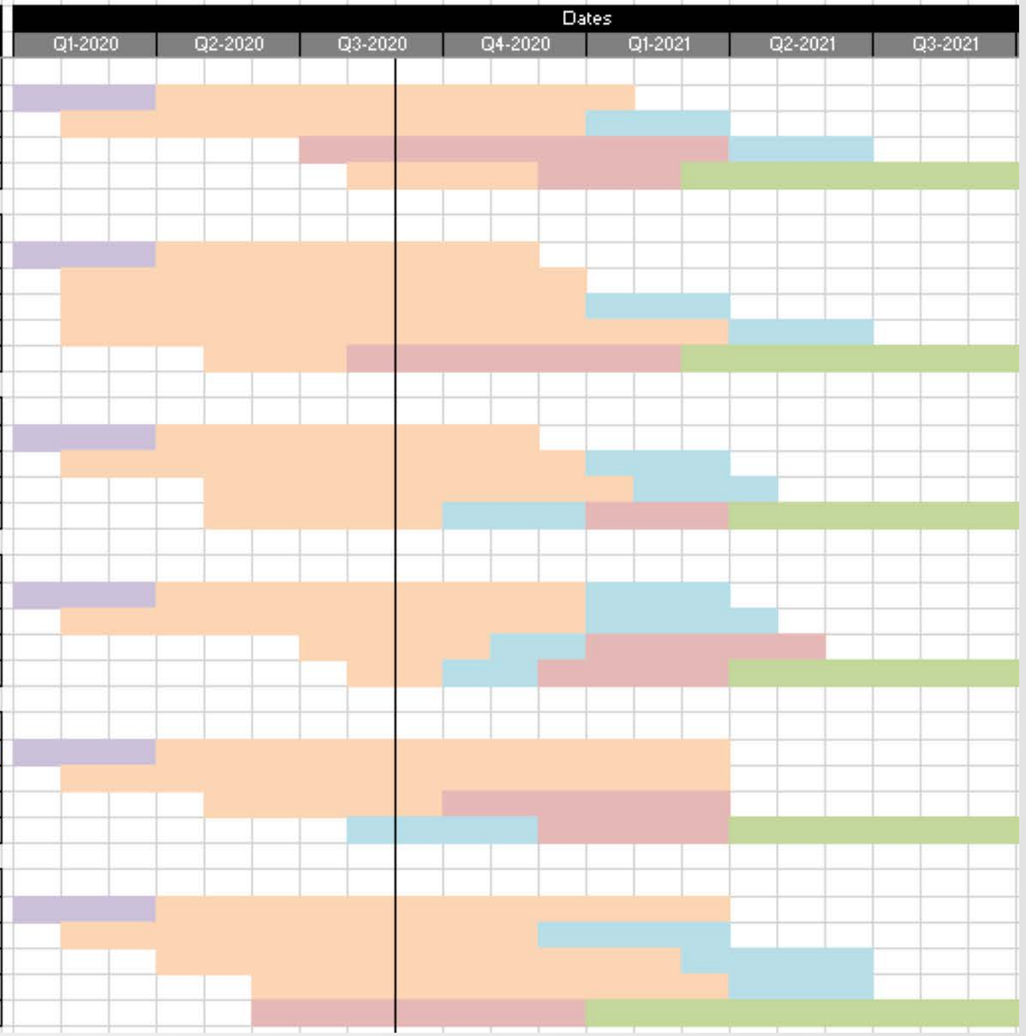
Q1 2020	Q2 2020	Q3 2020	Q4 2020	Q1 2021	Q2 2021	Q3 2021	Q4 2021
Initiate Reconnaissance and Scoping	***Identify Potential and formulate Operational Scenarios***		***Identify Potential and formulate Operational Scenarios***		***Perform Viability Assessment***	***Develop Preliminary Alternatives***	***Development of Assessment Report***

• Concepts Discussion
• Scoping Assessment planning tracks
• Identify Project Expectations
• Define deliverables
	• Historical SWP Operation Data Analysis
	• Energy Market Data Analysis
	• Model Development
	  • Hyatt Pump-back Model
	  • Hec-Ras Hydrodynamics model
	  • SWP Reoperation Optimization
			• Concepts/Planning tracks Investigation
			• Operational and Markets analysis
			• Analysis and Model Results
			• Portfolio and strategic fit
			• Cost Benefit Analysis
					• Concepts/ Planning tracks Investigation
					• Operational and Markets analysis
					• Analysis and Model Results
					• Portfolio and strategic fit
					• Cost Benefit Analysis
						• Finalize Viable Project Findings and Results
						• Report Opportunities and Challenges
							• Finalize Assessment report
							• Present assessment findings to Core and Expanded participants groups

			• Report Progress to Stakeholders and CWC	• Report Progress to Stakeholders and CWC	• Report Progress to Stakeholders and CWC		• Conduct meetings with Industry and Public

SB49 - Flexible Resources Study

State Water Project- Flexible Resources Study Planning Tracks	Target Date	Progress
4. Integrating Battery Storage with Renewable Resources	Oct-21	26%
A. Concept Discussion, Scoping, and Expectations	Jan-21	60%
B. Model Development - Storage Integration for load shifting	Mar-21	25%
C. Physical vs Battery Storage Integration Analysis	Jun-21	10%
D. Assessing feasibility, Timing and potential for Integrating BESS	Oct-21	10%
5. Retrofits to select pumping plants to provide more flexibility - Variable Speed Pump	Oct-21	36%
A. Concept Discussion, Scoping, and Expectations	Nov-20	60%
B. Review SWP Facilities and Retrofit Scope	Dec-20	60%
C. Review OEM Submitted Proposal	Mar-21	8%
D Assess Proposal - Economic Benefits Investigation	Jun-21	25%
E. Assess current and future Market design needs for VFD vs Revenue requirement of development	Oct-21	25%
6. SWP Hydraulic and Transient Modeling, and Aqueduct Stability	Oct-21	48%
A. Concept Discussion, Scoping, and Expectations	Nov-20	60%
B. HEC-RAS Model Development	Mar-21	70%
C. Operational/System Response Analysis of SWP Delivery System	Apr-21	30%
D. Identify SWP aqueduct Operational limits from add/drop pump load	Oct-21	30%
7. Real-Time Load Bidding - Offering More Ancillary Services –	Oct-21	34%
A. Concept Discussion, Scoping, and Expectations	Mar-21	25%
B. Model Development - Potential Improvements Investigation	Apr-21	60%
C. Assess current and future market opportunities and potential	May-21	30%
D. Consult with CAISO to identify need for capacity, seasonality, and location	Oct-21	20%
8. Adding Pockets of Storage at Strategic Locations	Oct-21	38%
A. Concept Discussion, scoping, and Expectations (HEC-RAS Model)	Mar-21	90%
B. HEC-RAS Model modifications to test added storage	Mar-21	20%
C. Perform Operational studies to assess increased SWP operational flexibility	Mar-21	20%
D. Viability Investigation of Adding New Pockets of Water Storage	Oct-21	20%
9. Integration of On-Site Solar generation at Pumping Plants- Behind The Meter (BTM)	Oct-21	22%
A. Concept Discussion, Scoping, and Expectations	Mar-21	45%
B. Assessment of potential Development	Mar-21	15%
C. Identifying viable SWP Pumping Plants for Integration	Jun-21	20%
D. Secure CAISO Buy in on concept	Jun-21	30%
E. Economic and GHG footprint, and Grid benefits Analysis	Oct-21	0%



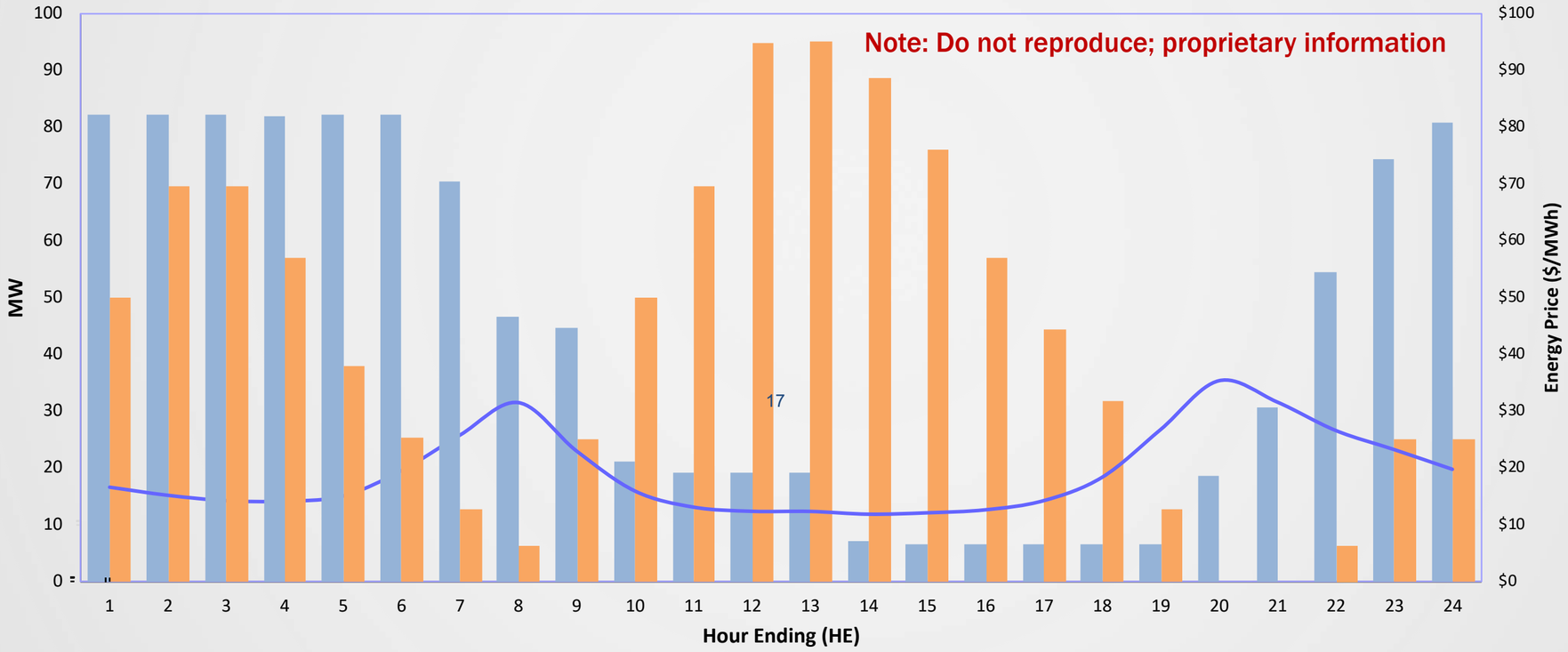
CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Flexible Resources Study

(Reoperations of Edmonston and Valley String)

Historical vs Optimized Load Dispatch for Buena Vista on Mar 10, 2004

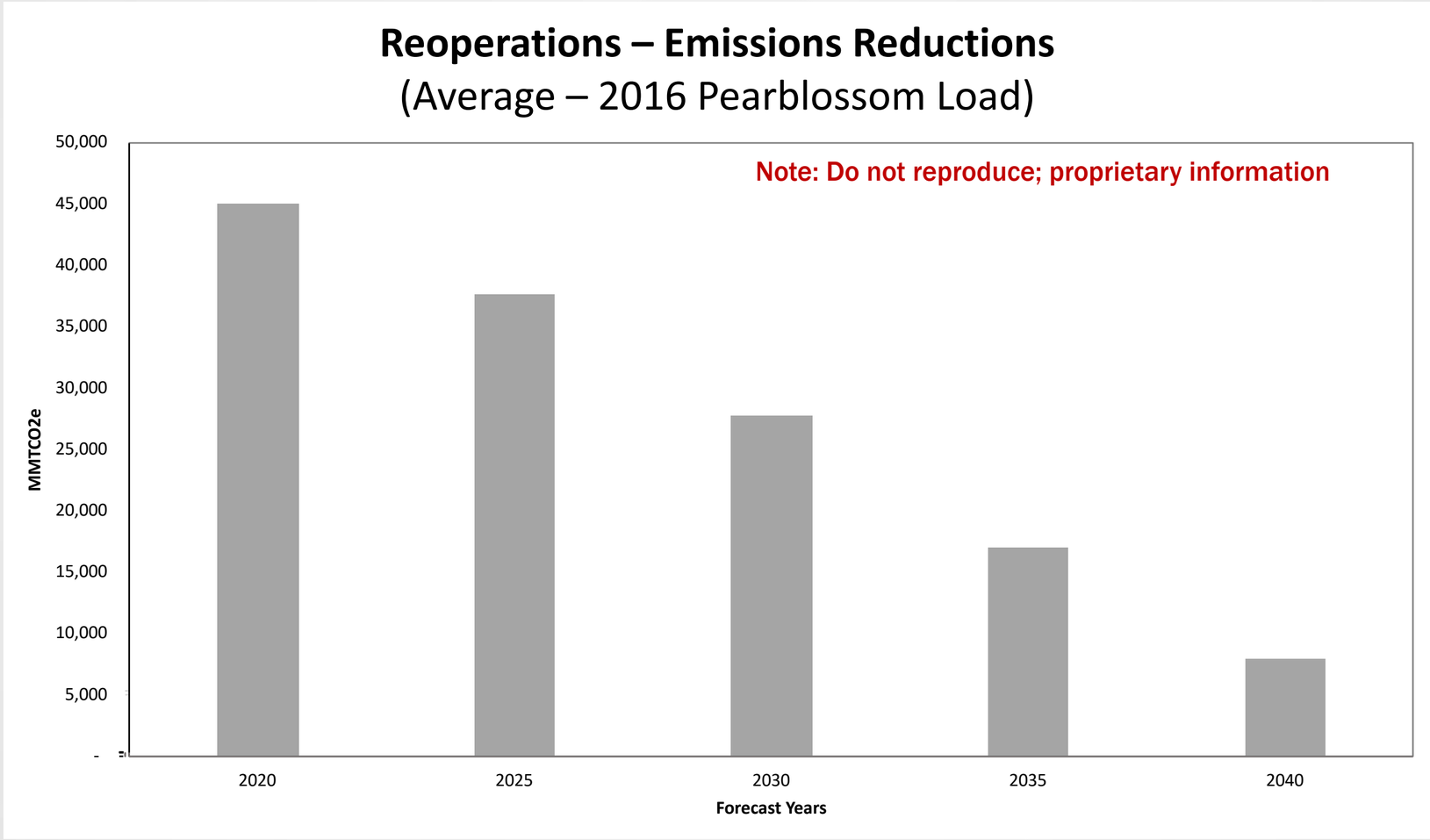
Valley String Avg. Energy Prices (March 2016)



CALIFORNIA DEPARTMENT OF WATER RESOURCES

Flexible Resources Study

(Reoperations of Pearblossom – emissions reductions)



CALIFORNIA DEPARTMENT OF
WATER RESOURCES

Flexible Resources Study

(Pumpback Reoperations of Hyatt-Thermalito)

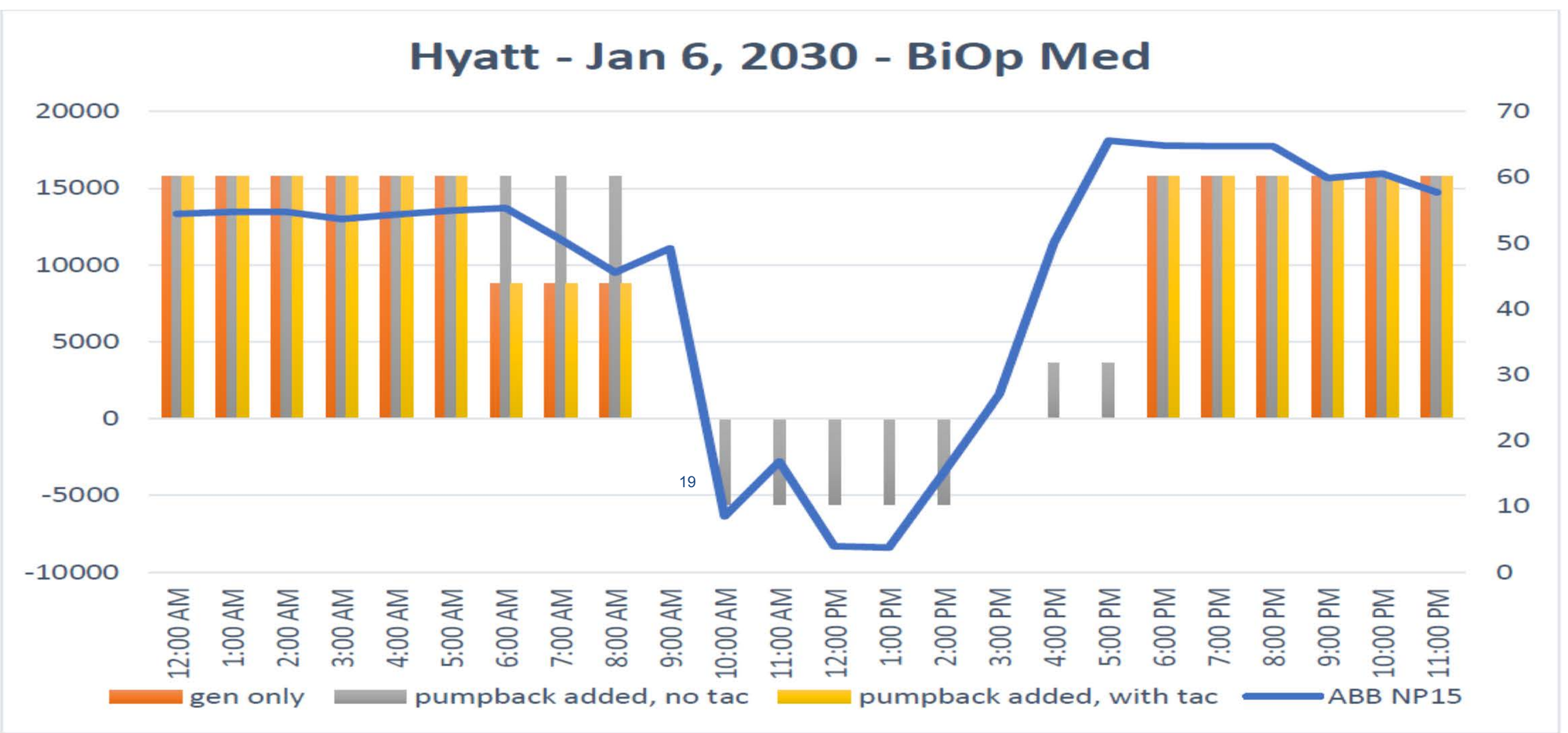


Figure 2.2. Example flow schedules resulting from the optimization for Jan 6, 2030.

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Flexible Resources Study

(Retrofits of some existing pumps to Variable speed pumps)

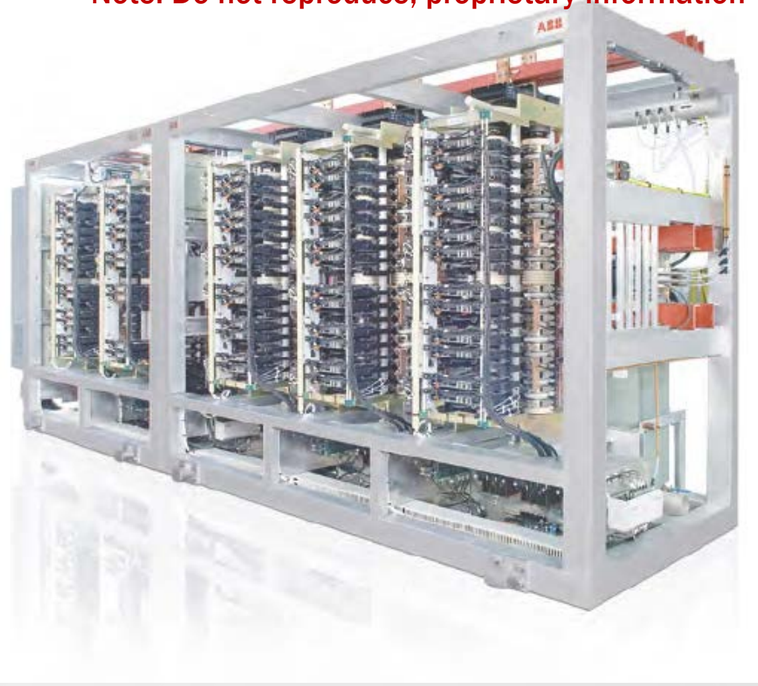
Grimsel 2 pumped-storage plant (Switzerland):

The concept of running the synchronous motor/generator at variable speed by feeding its stator with a variable frequency overcomes the limitations of the previous fixed-speed design, providing valuable operational benefits.

1. **Optimized use of excessive energy on the grid:** continuously adjustable energy consumption is provided in pump operation, increasing the amount of stored water.
2. **Quick start of the pump without water loss:** the unit in pump mode is now started by means of the converter within 60 seconds, thereby saving large amounts of valuable stored water.
3. **Reactive power compensation:** the power converter can be operated without the machine as a reactive power compensation system, offering up to 100MVar instantaneous support to the grid.

Because it was not necessary to modify the existing generator and step-up transformer, the installation of the frequency conversion unit was possible without impact on the plant's operation, and it's hookup caused minimum interruption of service.

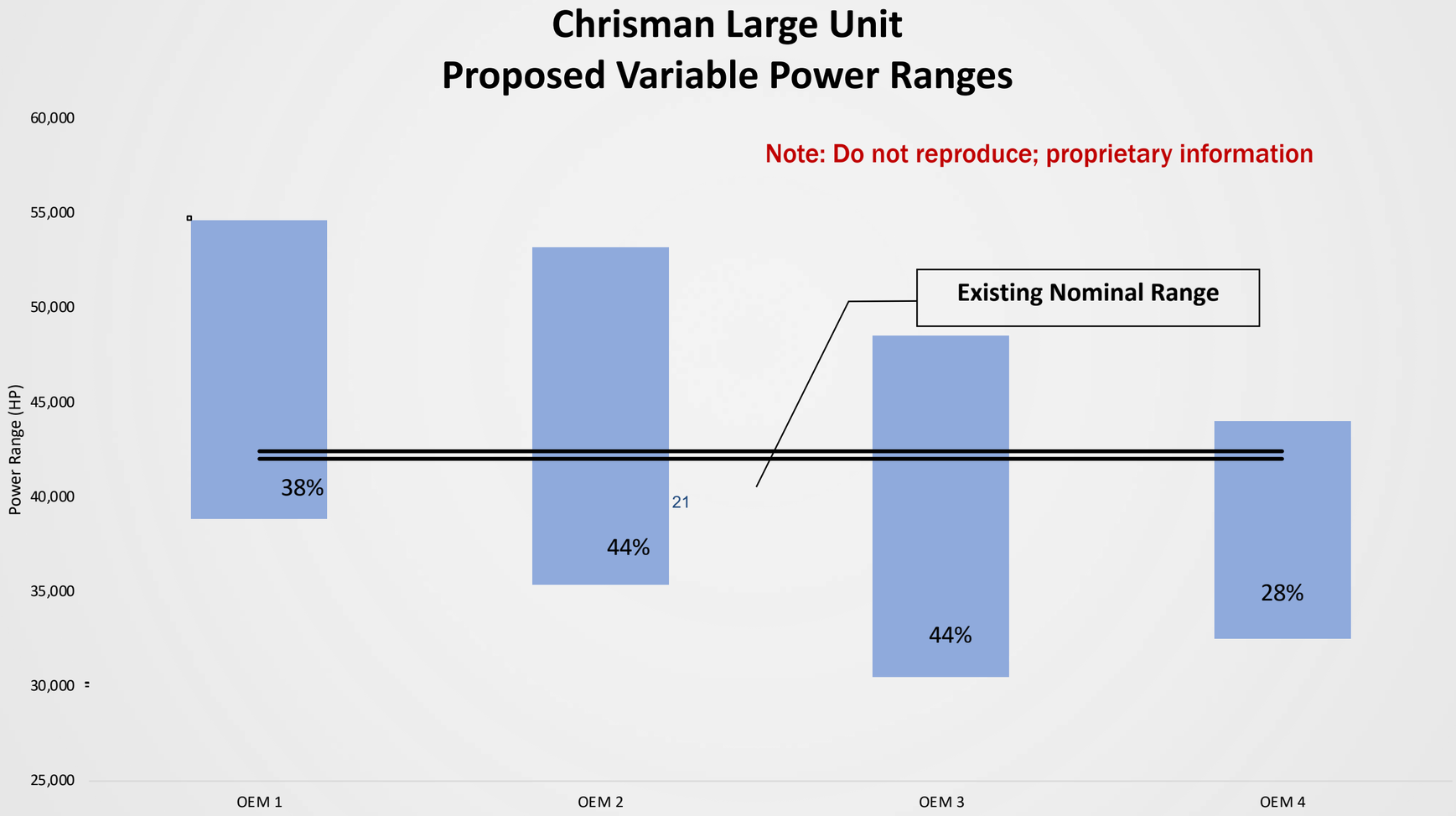
Note: Do not reproduce; proprietary information



Key data: PCS 8000 frequency converter at Grimsel 2	
Rated power	100 MVA
Input voltage, current	13.5 kV, 4650 A, 50 Hz
Output voltage, current for pump operation	10.8 - 13.5 kV, 4650 A, 40 - 51 Hz
Output voltage for start-up	0 - 13.5 kV, 0 - 51 Hz

Flexible Resources Study

(Retrofits of some existing pumps to Variable speed pumps)



CALIFORNIA DEPARTMENT OF WATER RESOURCES

Thank You

Questions?