WELCOME to:

Power Operations & Planning Training

For Internal MWD Training

Guidelines:

- By default, all participants are on mute. If you would like to speak, please raise your hand by clicking the hand icon at the bottom of your screen.
- Feel free to use the Q&A box at bottom of your screen to submit your questions to the panelists during the presentation. However, please note that questions will be answered at the end of the presentation.
- After the presentation, audio and camera use will be available for all participants to ask questions

Sit back, relax and enjoy

Sal Heredia

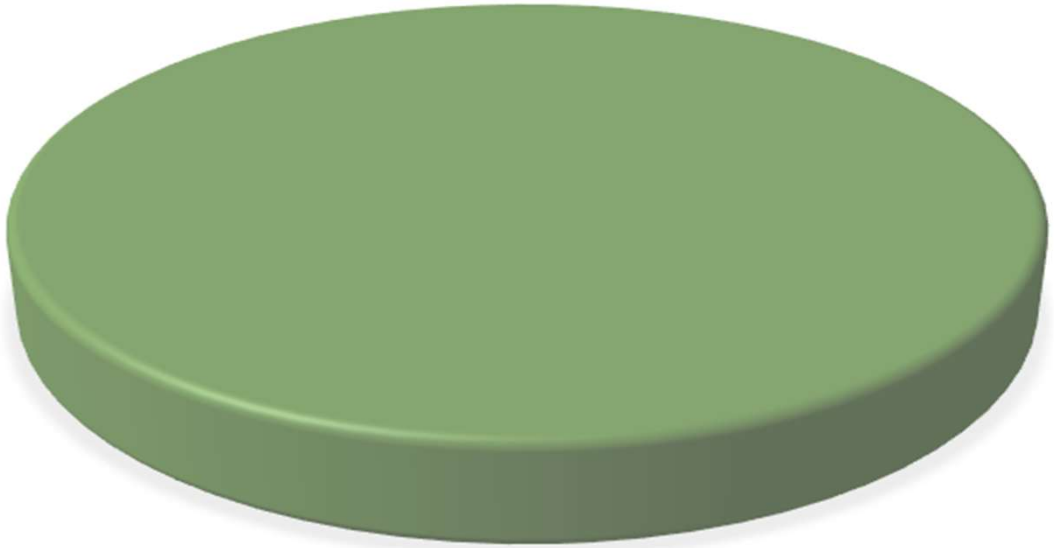
Why the CAISO needs Resource Adequacy Capacity & How Resource Adequacy works for MWD

Topics for Today

- **What Resource Adequacy is**
- **Why the CAISO needs Resource Adequacy**
- **How Resource Adequacy works for MWD**
- **Questions & Answers**

2021 CRA Resource Adequacy Value

MWD's CRA Annual RA Value: $24 Million



What is Resource Adequacy?

In the CAISO Market There Are 3 Types of Resource Adequacy Obligations…

1. System RA - 97% of obligation
2. Flex RA- 3% of obligation
3. Local RA- 0% of obligation

A Parallel Example…

Agency 1

Max Demand: 20 cfs

CWSO

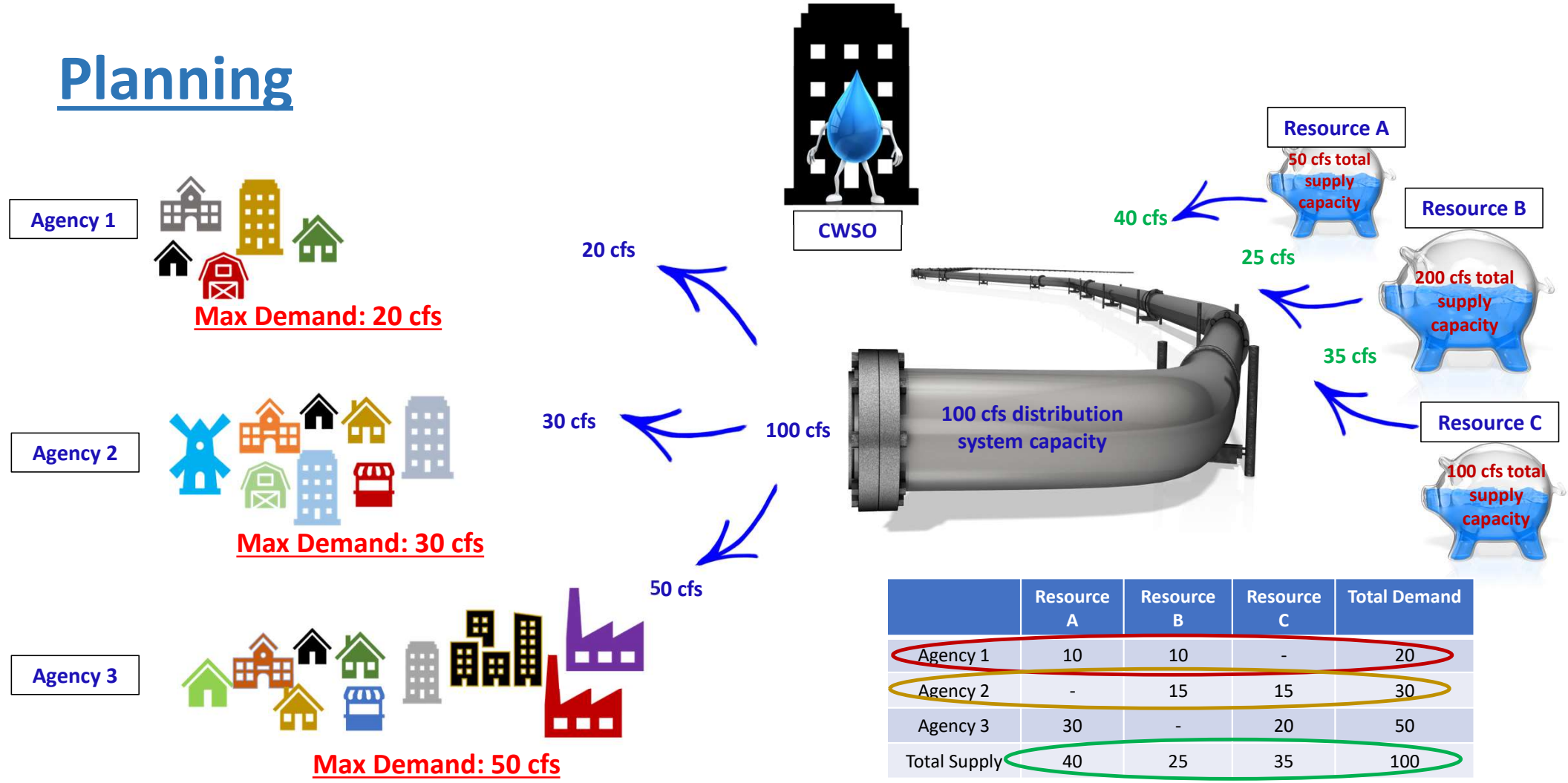
Agency 2

Max Demand: 30 cfs

Agency 3

Max Demand: 50 cfs

Planning



	Resource A	Resource B	Resource C	Total Demand
Agency 1	10	10	-	20
Agency 2	-	15	15	30
Agency 3	30	-	20	50
Total Supply	40	25	35	100

*units are cfs

Planning

LSE 1

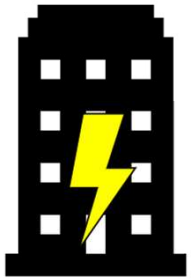
Max Demand: 20 MW

LSE 2

Max Demand: 30 MW

LSE 3

Max Demand: 50 MW



CAISO

20 MW

30 MW

50MW

100 MW

100 MW transmission capacity

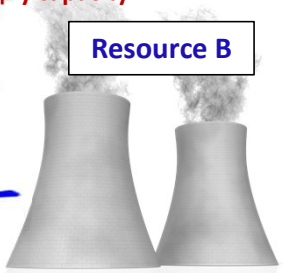
Resource A

50 MW generation supply capacity

40 MW

Resource B

25 MW



200 MW generation supply capacity

35 MW

Resource C

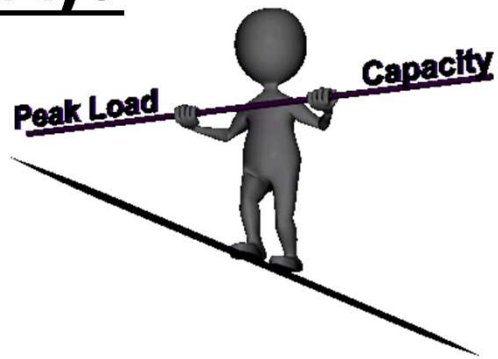
100 MW generation supply capacity

	Resource A	Resource B	Resource C	Total Demand
Agency 1	10	10	-	20
Agency 2	-	15	15	30
Agency 3	30	-	20	50
Total Capacity	40	25	35	100

*units are MW

What is Resource Adequacy (RA)?

- RA is the regulatory construct by which CAISO ensures there is enough generation capacity ("adequate resources") to meet peak electricity demand



- Load Serving Entities (LSEs) are required to demonstrate enough generation capacity to meet their share of the grid's peak demand, plus a little extra

- LSEs can either own or contract generation capacity to meet RA obligations- RA is priced in terms of $/kW-month

Some Highlights of RA…

- **RA process is based on having sufficient generation capacity available to meet peak demands at all times**

- **Generators may remain on standby until needed by the CAISO; in some cases, they may not be dispatched at all**

- **RA is an additional cost, but it is a tool that ensures grid reliability so the lights stay on for everyone**

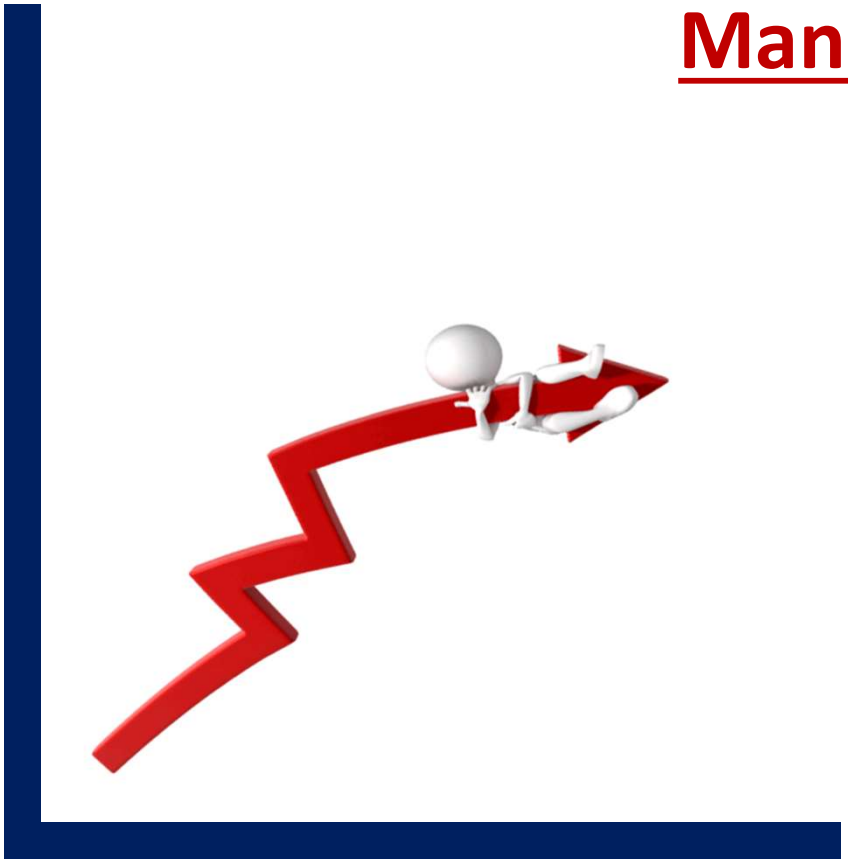
Why does CAISO need Resource Adequacy?

Grid Reliability

- Prevents power shortages and potential blackouts by making sure sufficient generation capacity is contracted to meet system peak demand

- RA is like managing your bank account- you want to have enough money not only to cover known expenses, but also the cost of unforeseen emergencies

Manage Power Price Spikes

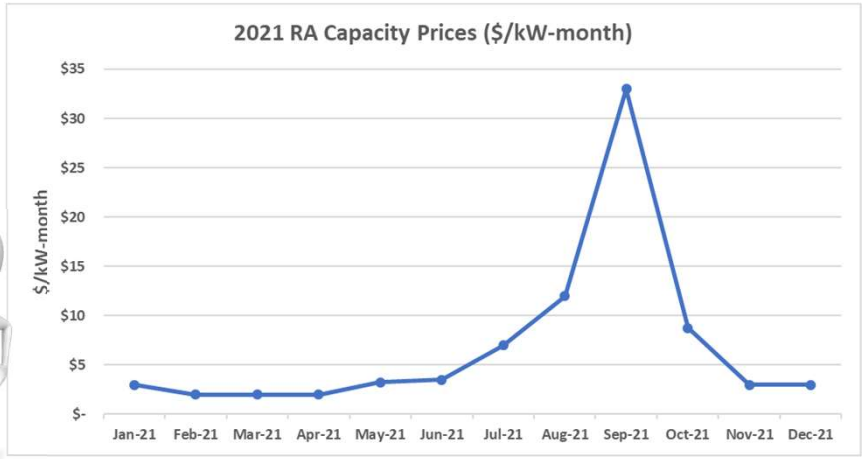


- Power, like any other good or commodity is also governed by the law of supply and demand
- RA capacity alleviates tight supply concerns
- RA capacity availability can directly affect the forward power market

Encourage Infrastructure Investment

- RA helps to counter power price volatility and offset "negative" pricing by providing steady stream cash flow

- RA is a mid and long-term planning process that helps indicate when and where new generation capacity will be needed



The RA process-How does Resource Adequacy work for MWD?

RA Process Timelines

September ahead of planning year

MWD submits projected monthly peak load ahead of RA planning year

October 31st ahead of planning year

MWD submits preliminary RA supply plans- annual filing

T-75

MWD submits updated peak load forecast (if necessary)

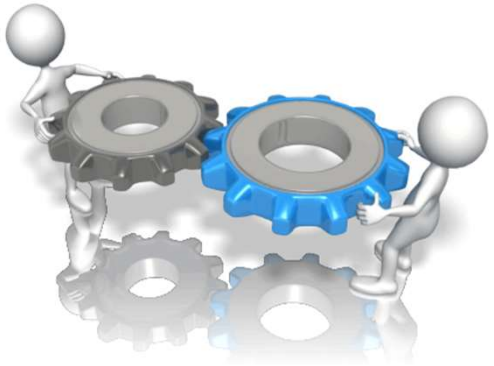
T-45

MWD submits updated RA supply plans (if necessary)

Determining Peak Load

- RA obligation is a function of peak load
- POP works with Water Ops to obtain CRA pumping forecast
  - Historical meter data allows us to use a pump flow forecast from Water Ops to estimate peak load in Megawatts
  - Coordination between POP and Water Ops required to assess peak load appropriately and not unnecessarily under/over-set our RA obligation

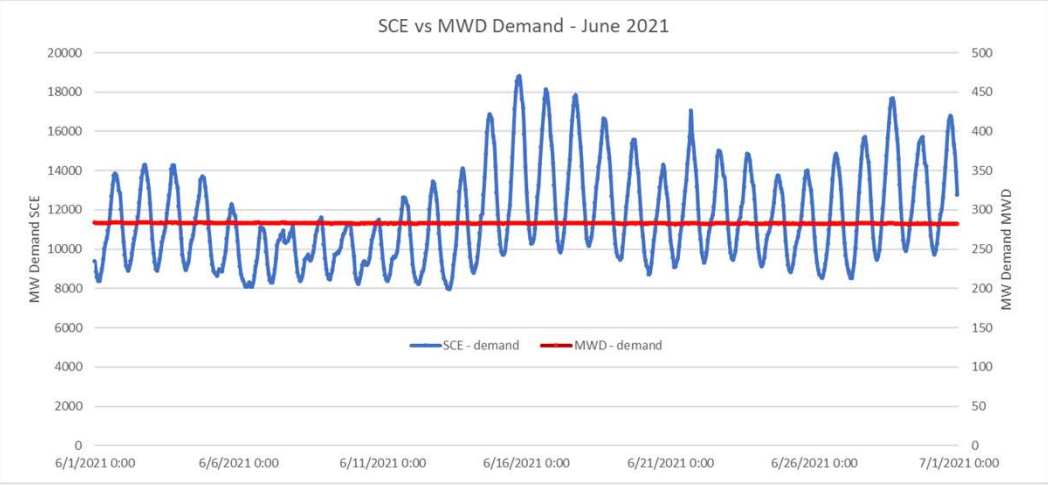
CRA Pump Flow	Megawatt Load (MW)
0	1
1	39
2	77
3	114
4	152
5	189
6	226
7	261
8	291



Calculating MWD's RA Obligation(s)

Forecasted Peak Demand (MW) × (100 % + **Planning Reserve Margin (%)**) = **RA Obligation (MW)**

- **Planning reserve margin is the percentage by which generation capacity exceeds projected peak demand**
  - **Accounts for unforeseen emergencies- generators outages, extreme weather etc.**
  - **15% reserve margin for most LSE's**
  - **MWD has a planning reserve margin of 5%**



MWD's RA Supply Resources

- **Hoover Capacity- MWD is entitled to 12.0515% of Hoover Dam's total generation capacity**
- **Parker Capacity- MWD is entitled to 50% of Parker Dam's total generation capacity**
- **Interruptible Load Credits- CAISO allows for MWD to claim RA credit for load that can be interrupted at Intake and Gene plants**
- **HEP Fleet- MWD can submit RA supply from HEPs that are not under contract and that are expected to generate during operational month**
- **Market Purchase- MWD can procure RA supply capacity in the bilateral market**


Hoover Dam

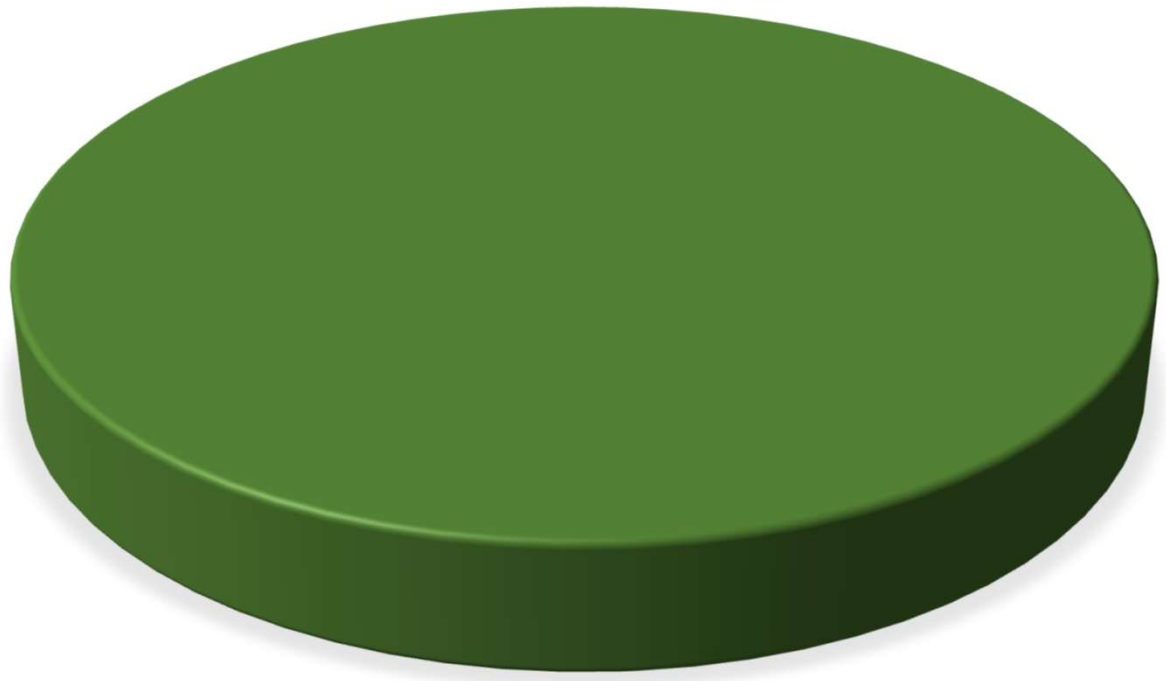

Parker Dam


Pumps at Intake


Yorba Linda HEP

2021 CRA RA Value

MWD's CRA Annual RA Value: $24M



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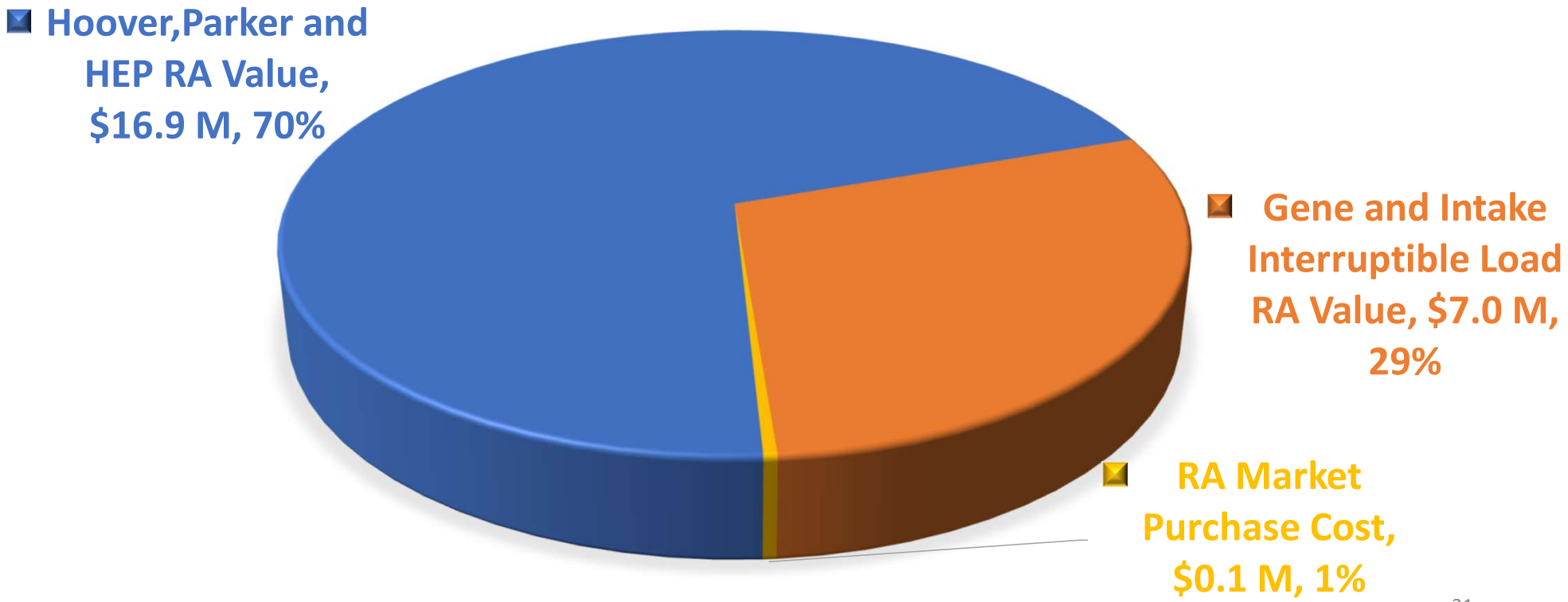
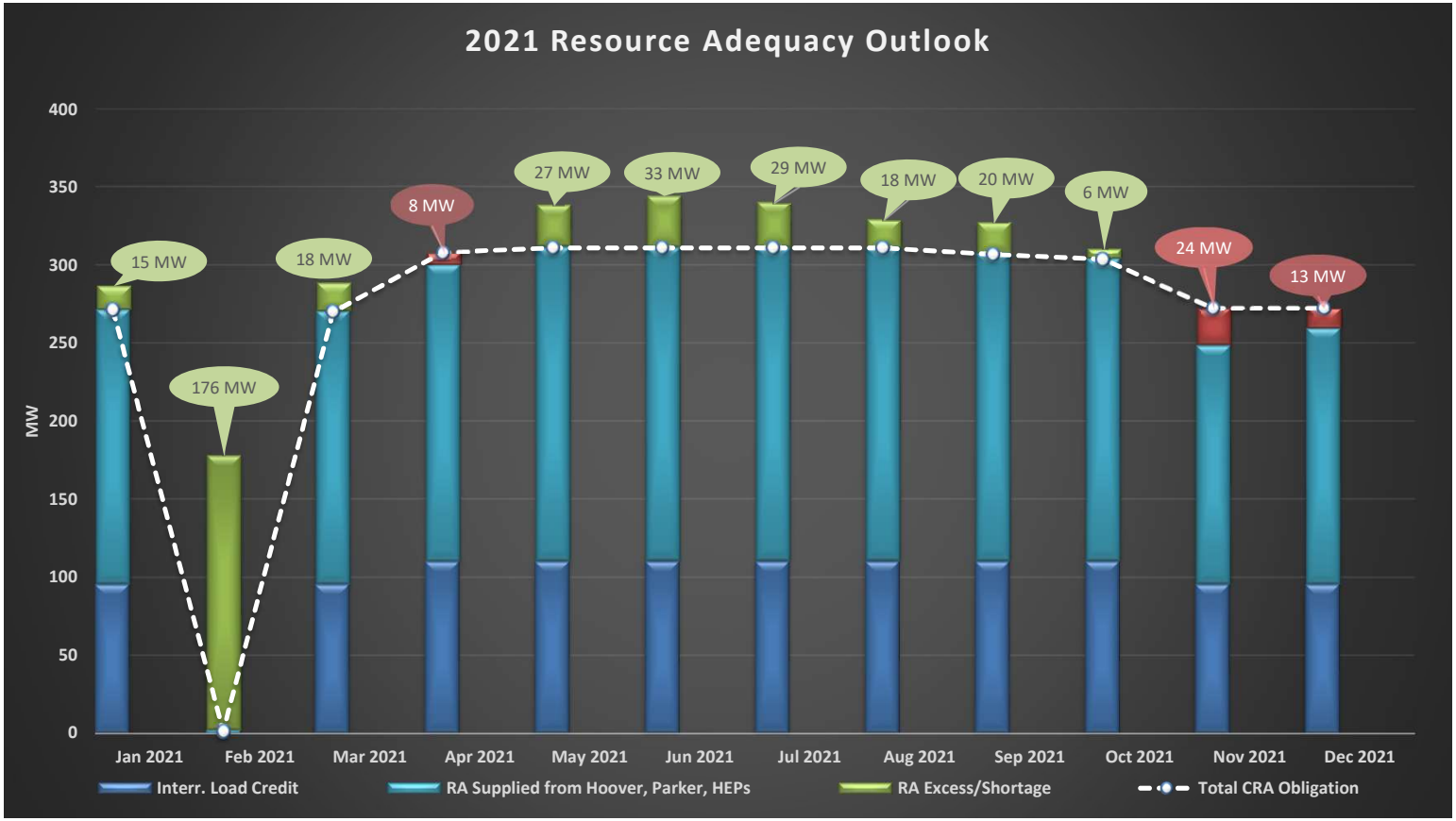




- **Pumping, resource capacity, and RA pricing vary by month, all of which affect RA cost potential**

Example- MWD's RA Planning Process for November 2021

Annual filing completed October 2021 showed CRA peak demand at 114 Annual filing completed October 2021 showed CRA peak demand at 114 MW for November 2021, reflective of maximum 3 pump flow

At T-75 , alternatively August 17, 2021, MWD submitted a peak load update for November of 261 MW, reflective of 7 pump flow

At T-45, which is on September 17, 2021, MWD is responsible for submitting the supply stack to meet the new RA obligation as set per the peak demand update executed at T-75

CRA Pump Flow	Megawatt Load (MW)
0	1
1	39
2	77
3	114
4	152
5	189
6	226
7	261
8	291

Calculating MWD's November 2021 RA Obligation(s)

Forecasted Peak Demand (MW) × (**100 %** + **Planning Reserve Margin (%)**) = **RA Obligation (MW)**

261 MW x (100% + 5%) = 275 MW

Quantifying RA Supply Resources- Hoover and Parker

- Hoover and Parker Generation Capacity
  - USBR's 24-Month provides total projected monthly generation capacity for each of these hydro resources
  - Most recent study show that for the month of November, Hoover and Parker are projected to have generation capacities of 861.1 MW and 92 MW, respectively

OPERATION PLAN FOR COLORADO RIVER SYSTEM RESERVOIRS
August 2021 24-Month Study
Most Probable Inflow*
Hoover Dam - Lake Mead

— BUREAU OF — RECLAMATION

Date	Power Release (1000 Ac-Ft)	Power Release (1000 CFS)	Reservoir Elev End of Month (Ft)	EOM Storage (1000 Ac-Ft)	Change In Storage (1000 Ac-Ft)	Hoover Static Head (Ft)	Hoover Gen Capacity MW	Hoover Gross Energy MKWH	Percent of Units Available	KWH/AF
Oct 2021	596	9.7	1065.78	8867	-115	418.31	1278.1	221.5	91	371.6
Nov 2021	624	10.5	1064.50	8768	-100	421.66	861.1	239.0	62	382.8
Dec 2021	513	8.3	1065.85	8873	105	419.28	910.0	195.1	65	380.1
Jan 2022	531	8.6	1068.81	9105	232	419.94	833.0	198.0	58	372.8
Feb 2022	610	11.0	1069.89	9191	85	420.49	927.9	230.6	65	378.2
Mar 2022	909	14.8	1067.89	9033	-158	417.46	1206.0	342.4	85	376.7
Apr 2022	964	16.2	1063.84	8717	-316	414.38	1136.0	359.5	82	372.8
May 2022	946	15.4	1059.44	8380	-337	410.32	1094.0	352.5	81	372.7
Jun 2022	906	15.2	1055.34	8073	-307	404.13	1315.0	328.6	100	362.6
Jul 2022	798	13.0	1053.83	7962	-111	401.68	1298.0	288.8	100	361.8
Aug 2022	766	12.5	1053.51	7939	-23	401.10	1281.0	275.6	100	359.8
Sep 2022	682	11.5	1051.90	7820	-118	400.79	1281.0	243.0	100	356.2
WY 2022	8846							3274.5		

OPERATION PLAN FOR COLORADO RIVER SYSTEM RESERVOIRS
August 2021 24-Month Study
Most Probable Inflow*
Parker Dam - Lake Havasu

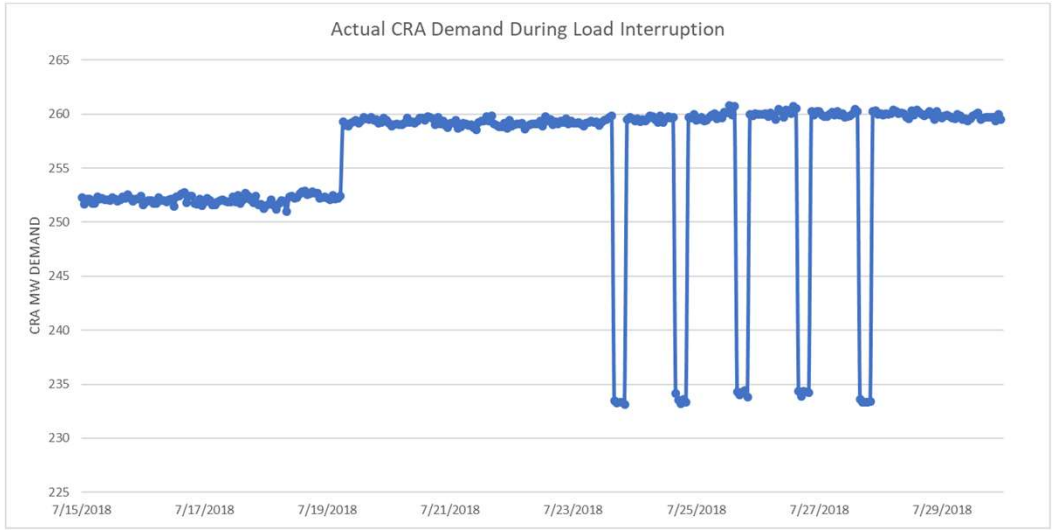
— BUREAU OF — RECLAMATION

Date	Power Release (1000 Ac-Ft)	Power Release (1000 CFS)	Reservoir Elev End of Month (Ft)	EOM Storage (1000 Ac-Ft)	Change In Storage (1000 Ac-Ft)	Parker Static Head (Ft)	Parker Gen Capacity MW	Parker Gross Energy MKWH	Percent of Units Available	KWH/AF
Oct 2021	461	7.5	447.50	571	0	76.14	92.9	30.3	77	65.8
Nov 2021	357	6.0	447.50	570	0	76.19	92.0	23.2	77	65.0
Dec 2021	242	3.9	446.50	552	-19	74.82	110.3	15.1	92	62.1
Jan 2022	302	4.9	446.50	552	0	75.12	93.9	19.1	78	63.5
Feb 2022	397	7.2	446.50	552	0	75.15	93.2	25.8	78	64.9
Mar 2022	613	10.0	446.70	555	4	74.01	120.0	39.7	100	64.7
Apr 2022	700	11.8	448.70	593	38	75.08	120.0	46.1	100	65.8
May 2022	682	11.1	448.70	593	0	76.05	120.0	45.3	100	66.4
Jun 2022	688	11.6	448.70	593	0	76.05	120.0	45.7	100	66.5
Jul 2022	663	10.8	448.00	580	-13	75.71	120.0	43.8	100	66.1
Aug 2022	602	9.8	447.50	571	-10	75.13	120.0	39.4	100	65.5
Sep 2022	510	8.6	447.50	570	0	74.89	120.0	33.2	100	65.0
WY 2022	6217							406.6		

Hoover: 861.1 MW total capacity * 12.0515% share = 103 MW available to MWD

Parker: 92 MW total capacity * 50% share = 46 MW available to MWD

Quantifying RA Supply Resources- Interruptible Load Credit



- Depending on reservoir levels, Intake and Gene pumps can be shut-off for varying periods of time while maintaining flow through the rest of the CRA

- The interruptible load credit calculation makes the following assumptions:
  - All pumps ON at Intake and Gene can be curtailed if needed upon request from the CAISO and per MWD's approval to do so
  - Under most pumping configurations, Intake plant "out-pumps" Gene plant and requires cycling of one pump at Intake periodically to maintain safe reservoir levels
  - The 5% Planning Reserve Margin can be applied to the interruptible load credit

Quantifying RA Supply Resources- Interruptible Load Credit

- Recall, peak flow on the CRA for November is forecasted to be 7 pumps
  - At 7 pump flow, and accounting for the need for periodic cycling of one pump at Intake, at any one instant there may be 6 or 7 pumps ON at Intake and 7 pumps ON at Gene
  - Conservatively then, at any one time a total of 13 pumps from Intake and Gene can be curtailed
- In general, each pump at Intake and Gene draw about 7 MW of power
- The Interruptible load credit is then calculated as follows:

(# of Curtailable Pumps) * (MW/pump) * (Reserve Margin Adder) = Interruptible Load Credit Available

13 pumps	*	7 MW/pump	*	105%	=	95 MW

Quantifying RA Supply Resources- MWD HEP Fleet

- **MWD can claim RA capacity from HEPs not currently under contract and still receive the revenue from power sales into the CAISO market**

Plant	Feeder	Design Capacity (megawatts)	Turbine Type	Design Head (feet)	Design Flow (cfs)	Design Percent Efficiency	Generator Type	Power Factor	Voltage (Volts)	Current (Amps)	RPM	Service Date
Corona	Lower Feeder	2.8	RFH	135	300	85	I	0.85	4,160	466	465	08/83
Coyote Creek	Lower Feeder	3.1	RFH	193	175	85	I	0.87	4,160	499	905	04/84
Etiwanda	Etiwanda Pipeline	23.9	IPV	625	530	na	S	na	13,800	na	240	06/94
Foothill	Foothill Feeder	9.1	RFV	180	300	87	I	0.84	4,160	466	605	04/81
Greg Avenue	East Valley Feeder	1.0	P/G	200	63	91	S	1.00	2,300	247	720	12/79
Lake Mathews	Lake Mathews Outlet	4.9	RFV	90	625	85	I	0.85	4,160	840	330	08/80
Perris	Lake View Pipeline	7.9	RFV	160	650	85	S	1.00	4,160	1,102	514	05/83
Red Mountain	San Diego Pipeline #5	5.9	RFV	220	350	86	S	1.00	4,160	819	900	03/86
Rio Hondo	Middle Feeder	1.9	RFH	220	110	80	I	0.87	4,160	305	1,205	03/84
San Dimas	Rialto Feeder	9.9	IPV	400	300	85	S	1.00	4,160	1,377	200	06/81
Sepulveda Canyon	Sepulveda Feeder	8.6	IPV	300	475	86	S	1.00	4,160	1,185	120	06/82
Temescal	Lower Feeder	2.8	RFH	135	300	83	I	0.85	4,160	466	605	07/83
Valley View	East Orange County Feeder #1	4.1	IPH	421	130	84	S	1.00	4,160	569	225	07/86
Venice	Sepulveda Feeder	10.1	RFV	280	475	87	S	1.00	4,160	1,405	600	08/82
Wadsworth	DVL Wadsworth Hydroelectric Plant	39.6	P/G	235	175 cfs per unit; total 2130 cfs	85 to 88% @ 235 ft head, 175 cfs flow and 450 rpm	S	0.90	6.9kV	431	150-450 (variable speed)	
Yorba Linda	Yorba Linda	5.1	IPV	200	340	83	S	1.00	4,160	706	120	11/81

November 2021 Total RA Supply

MWD's Hoover Capacity (MW)	MWD's Parker Capacity (MW)	Interruptible Load Credit Available (MW)	HEP Fleet RA (MW)	Total Supply Available (MW)
103	46	95	4	**248**

November 2021 RA Obligation

RA Obligation (MW)
275

RA Supply – RA Obligation = RA position

248 MW – 275 MW = -27 MW

November 2021 Total RA Supply- with RA Purchase

MWD's Hoover Capacity (MW)	MWD's Parker Capacity (MW)	Interruptible Load Credit Available (MW)	HEP Fleet RA (MW)	RA Purchase (MW)	Total Supply Available (MW)
103	46	95	4	27	275

November 2021 RA Obligation

RA Obligation (MW)
275

RA Supply – RA Obligation = RA position

275 MW – 275 MW = 0 MW

Summary

What is RA:

- Ensure generation capacity (capability) meets peak demand
- CAISO's role - coordination and oversight
- Each LSE must meet their share of peak demand, or RA obligation, by submitting supply plans
- CAISO only procures additional capacity if system deficit occurs

Why we need RA:

- Promotes grid reliability
- Helps control power price spikes
- Encourages infrastructure investment

How RA works for MWD:

- Process timelines- T-45 and T-75
- Peak load assessment and RA obligation calculations
- RA supply resources and quantifying their RA capacity- Hoover, Parker, interruptible load, HEP fleet

Additional Resources

- RESOURCE ADEQUACY PRIMER for STATE REGULATORS, July 2021
  - National Association of Regulatory Utility Commissioners
  - https://pubs.naruc.org/pub/752088A2-1866-DAAC-99FB-6EB5FEA73042