Western Area Power Administration

Hydropower Resource Update

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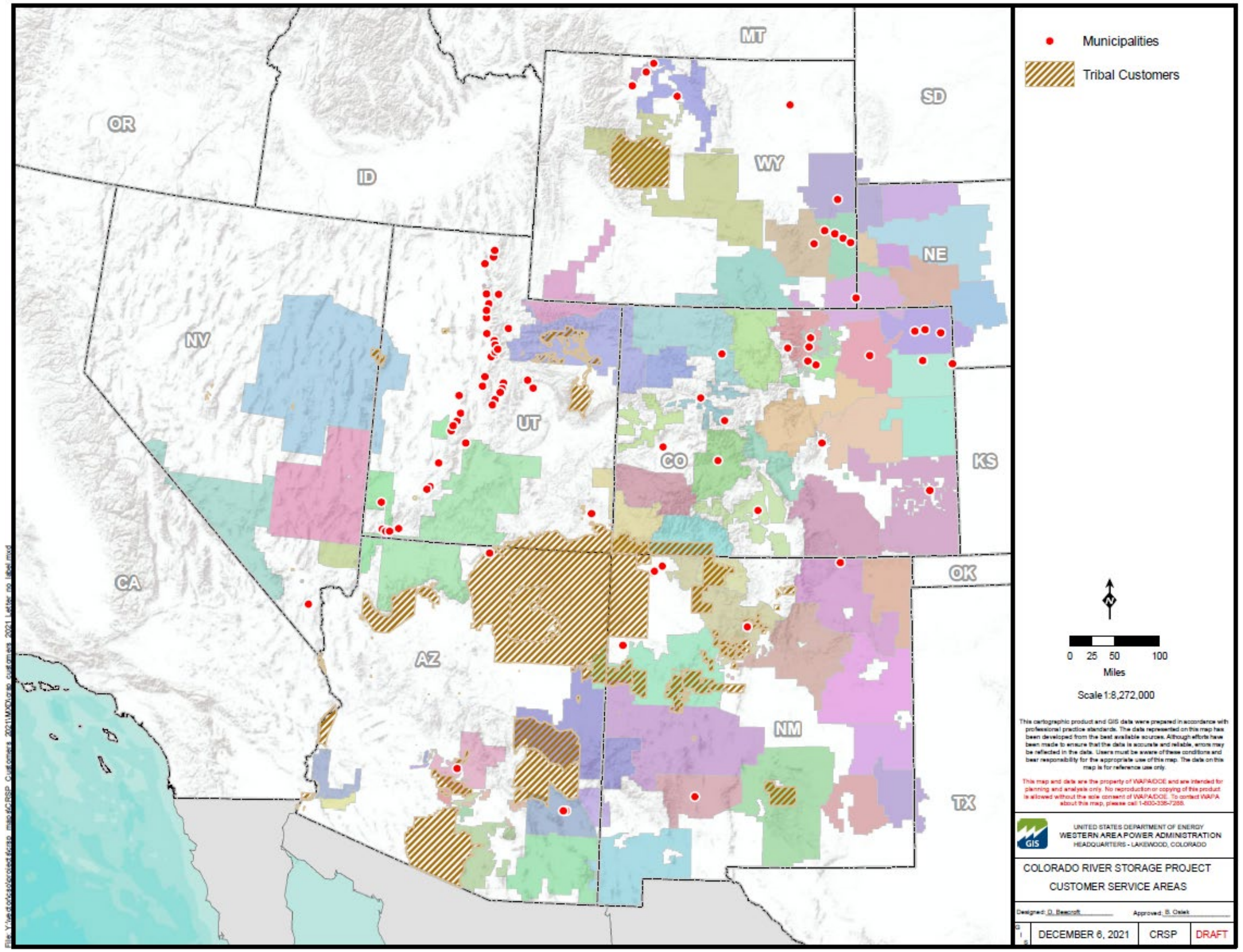
TWG Meeting

April 11, 2024

Outline

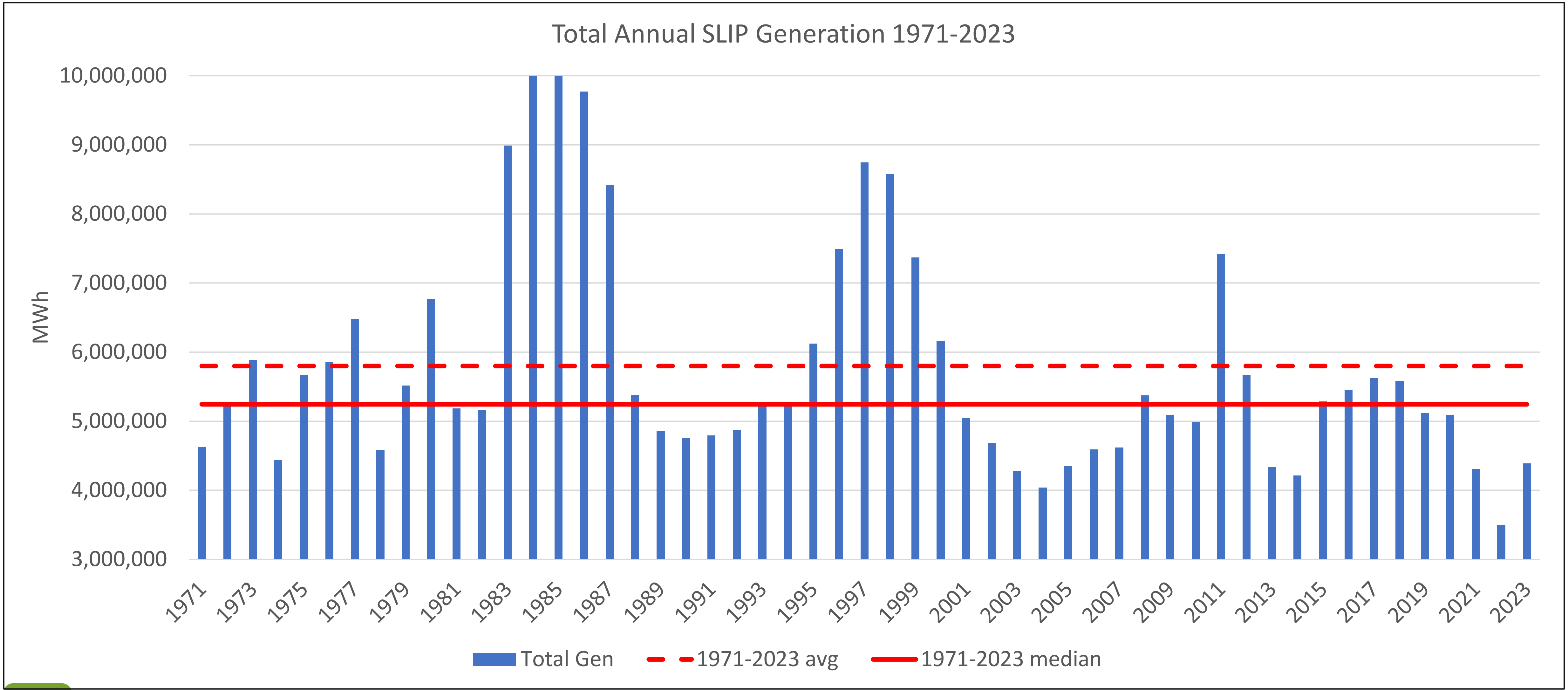
- Hydropower elements
- CRSP generation 1971-2023
- WY 2023 CRSP generation
- Glen Canyon Dam generation
- New rate action
- DSA
- Experiments
- Basin fund
- Current activities



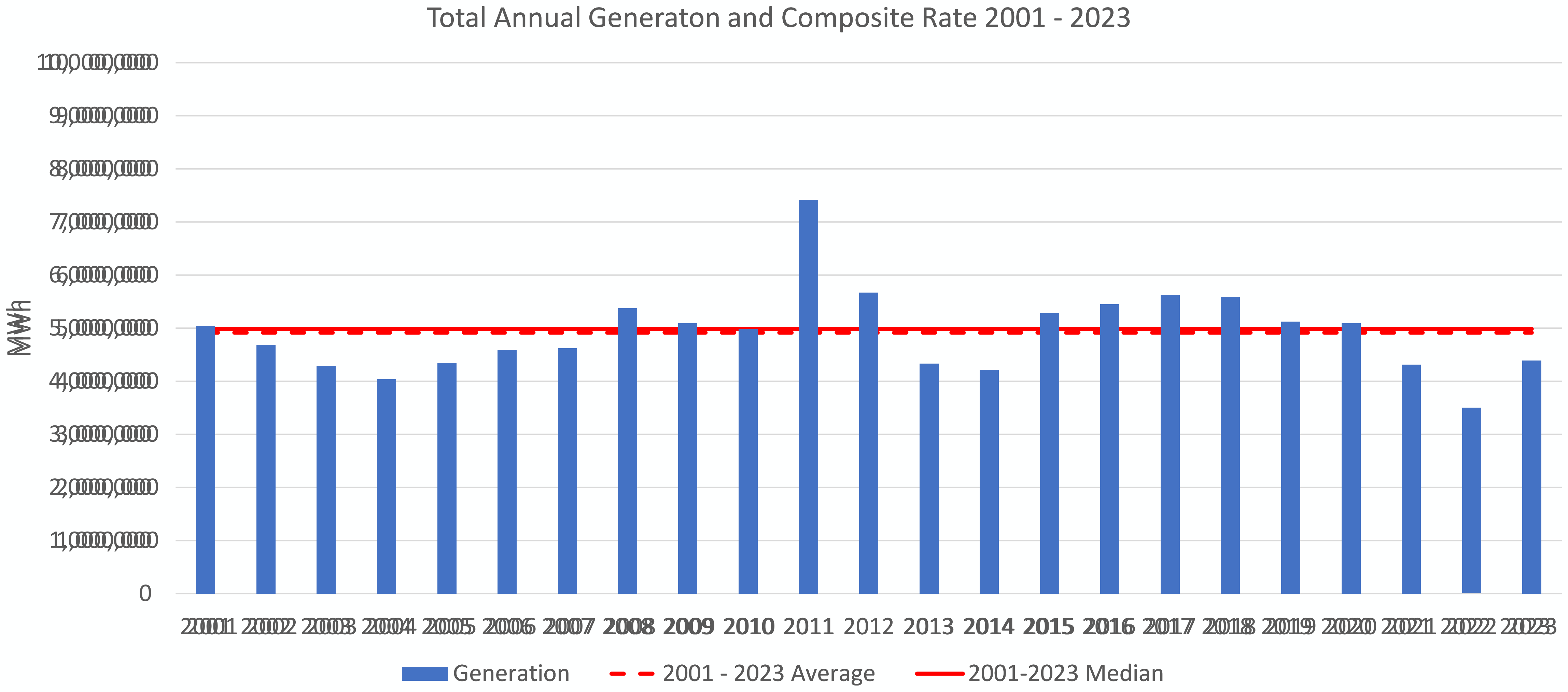
Hydropower Elements

- Capacity
- Transmission
- Resource adequacy
- Emissions
- Pricing (LMPs)
- Electrical emergencies
- Rates (wholesale and retail)
- Non-use value
- Tribal benefits
- Ancillary services
- Availability of replacement power
- Basin fund
- Amount and value of generation

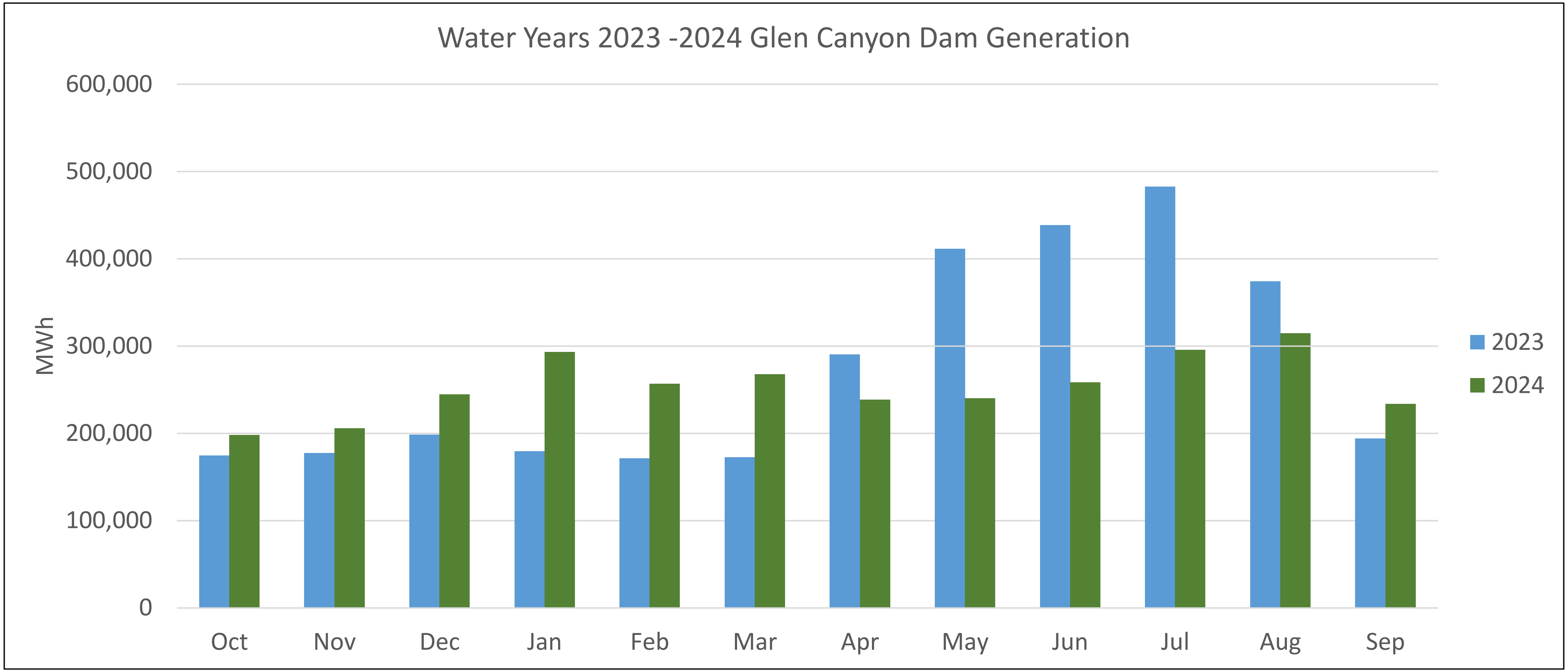
Water Year 1971-2023 Generation

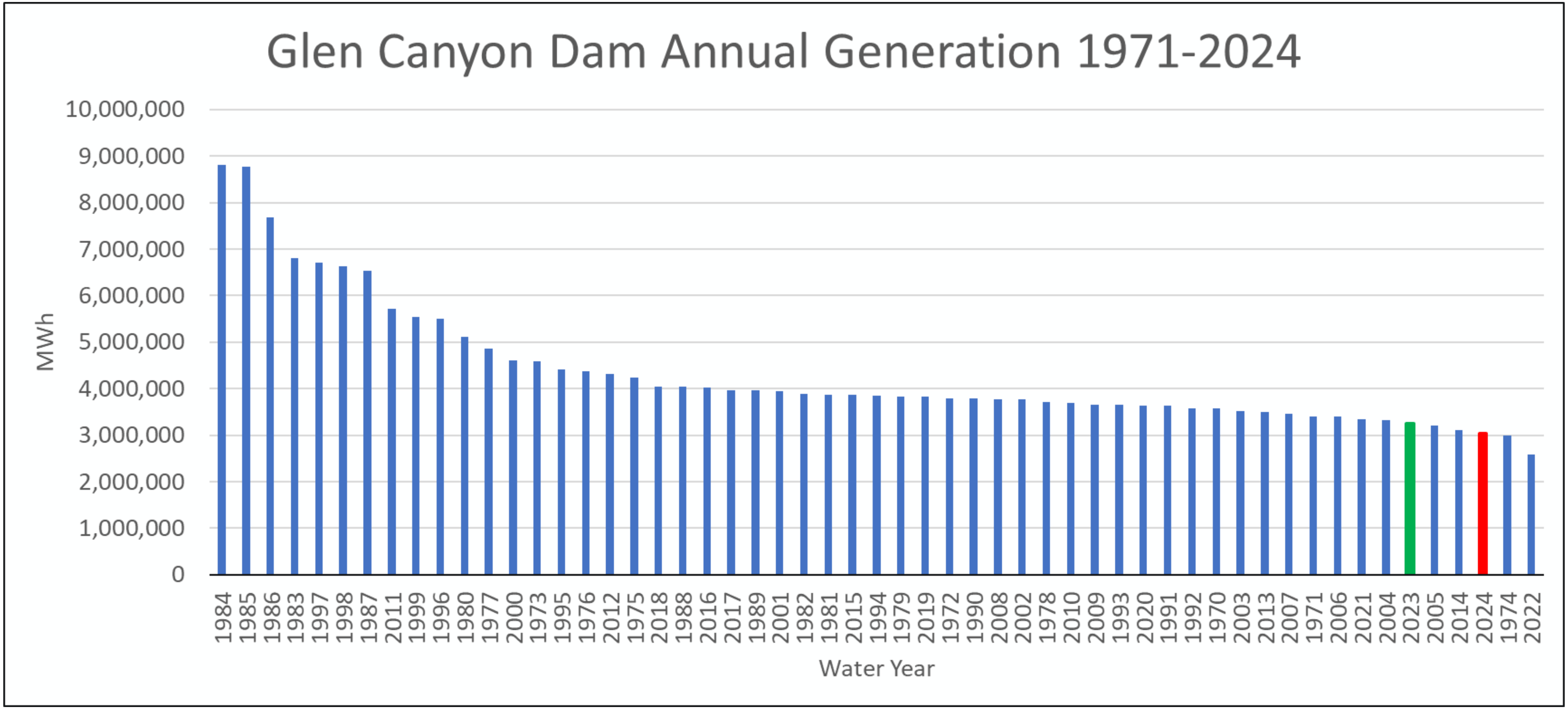


WY23 Generation (cont.)



Glen Canyon Dam Generation WYs 23-24

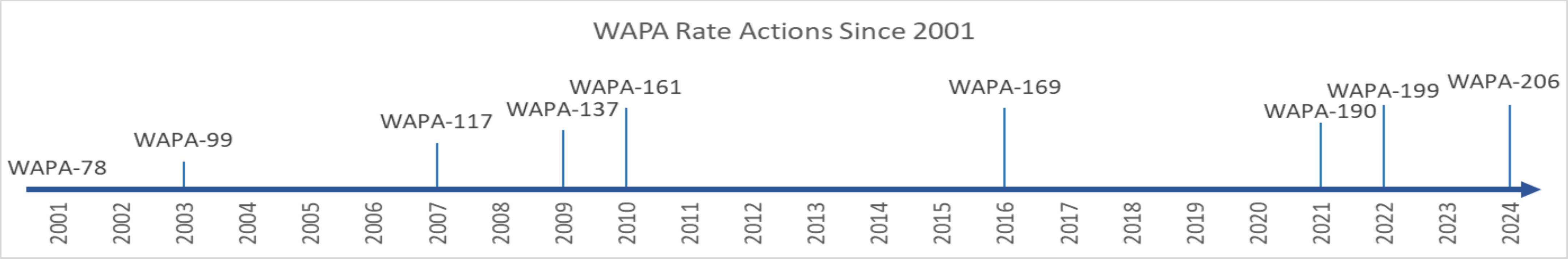




Glen Canyon Dam Annual Generation 1971-2024
MWh
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1984 1985 1986 1983 1997 1998 1987 2011 1999 1996 1980 1977 2000 1973 1995 1976 2012 1975 2018 1988 2016 2017 1989 2001 1982 1981 2015 1994 1979 2019 1972 1990 2008 2002 1978 2010 2009 1993 2020 1991 1992 1970 2003 2013 2007 1971 2006 2021 2004 2023 2005 2014 2024 1974 2022
Water Year

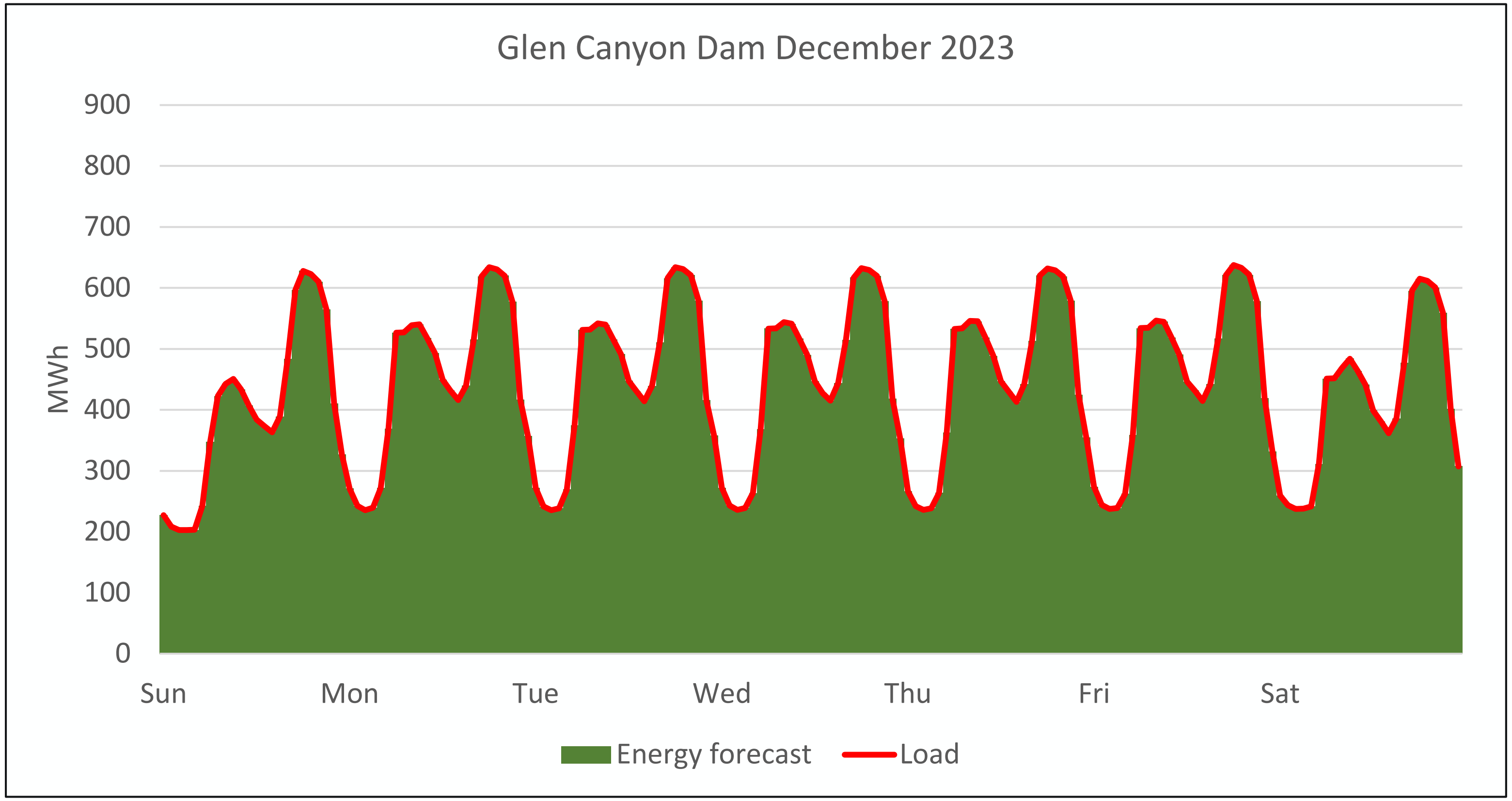
New Rate Action

- WAPA-199
  - Implemented December 2021
  - Avoid a 50% rate increase by reducing purchase power
  - Two-year rate
  - Increased energy rate from 12.19 mills/kWh to 12.36 mills/kWh
  - Increased capacity rate from $4.85 to $5.25/kW-month
  - Deliverable Sales Amount (DSA) concept established
- WAPA-206
  - Implemented January 1, 2024
  - Five-year rate
  - No changes to rates
  - Continued DSA implementation

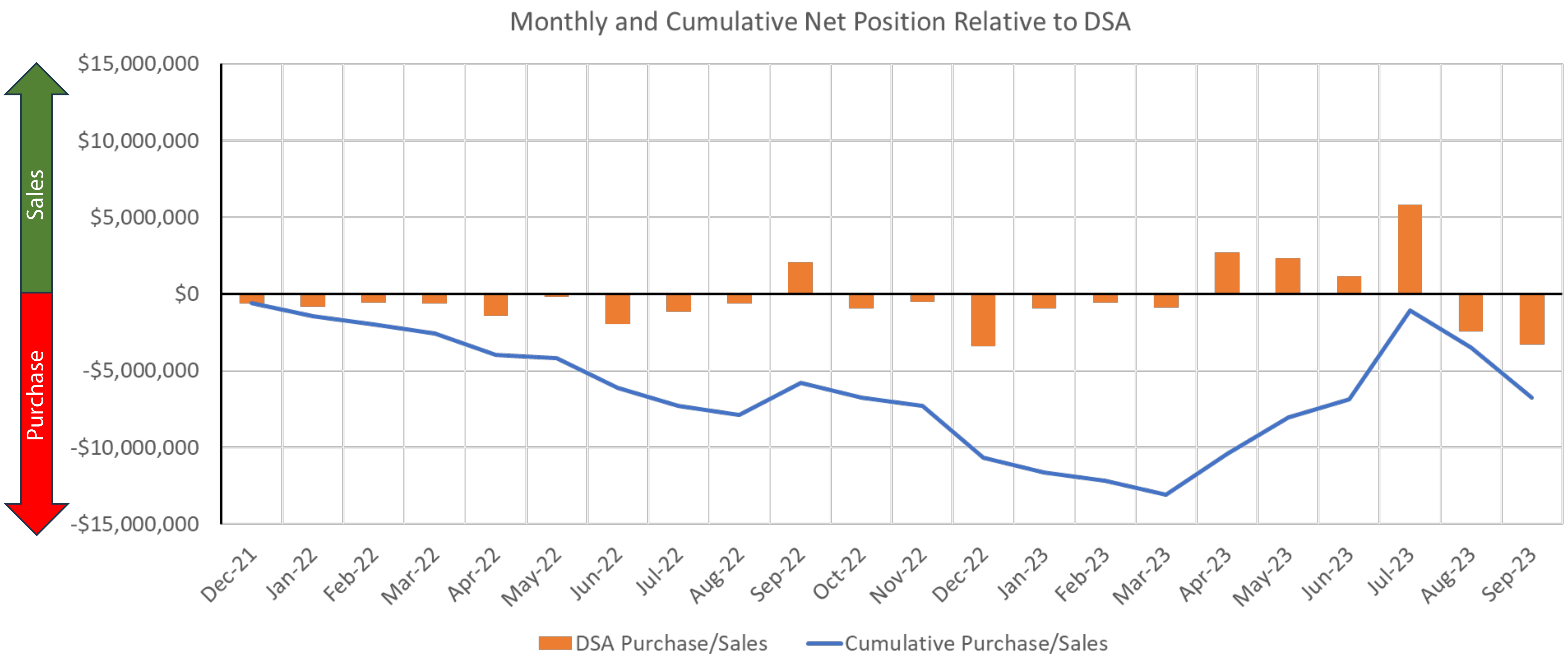


What is DSA?

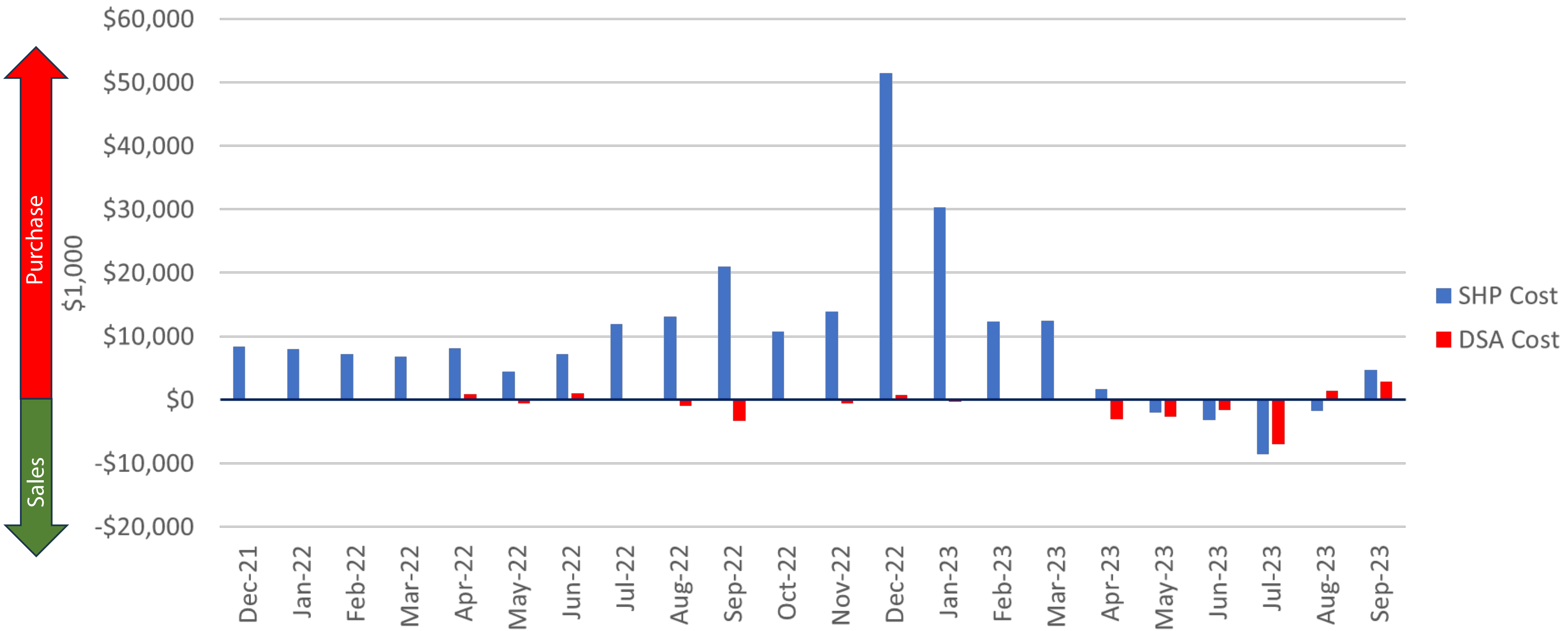
- Deliverable Sales Amount
- Forecasted quarterly
  - Aug, Nov, Feb, May
- Firm to forecasted energy and capacity amount.
- Energy above forecasted amount offered to customers or sold to the market.
- No change to minimum schedule requirement.
- Example December 2023
  - Purchased about $0.616 million
    - 25 GWh
  - Avoided $5.4 million in firm purchases
    - 109 GWh



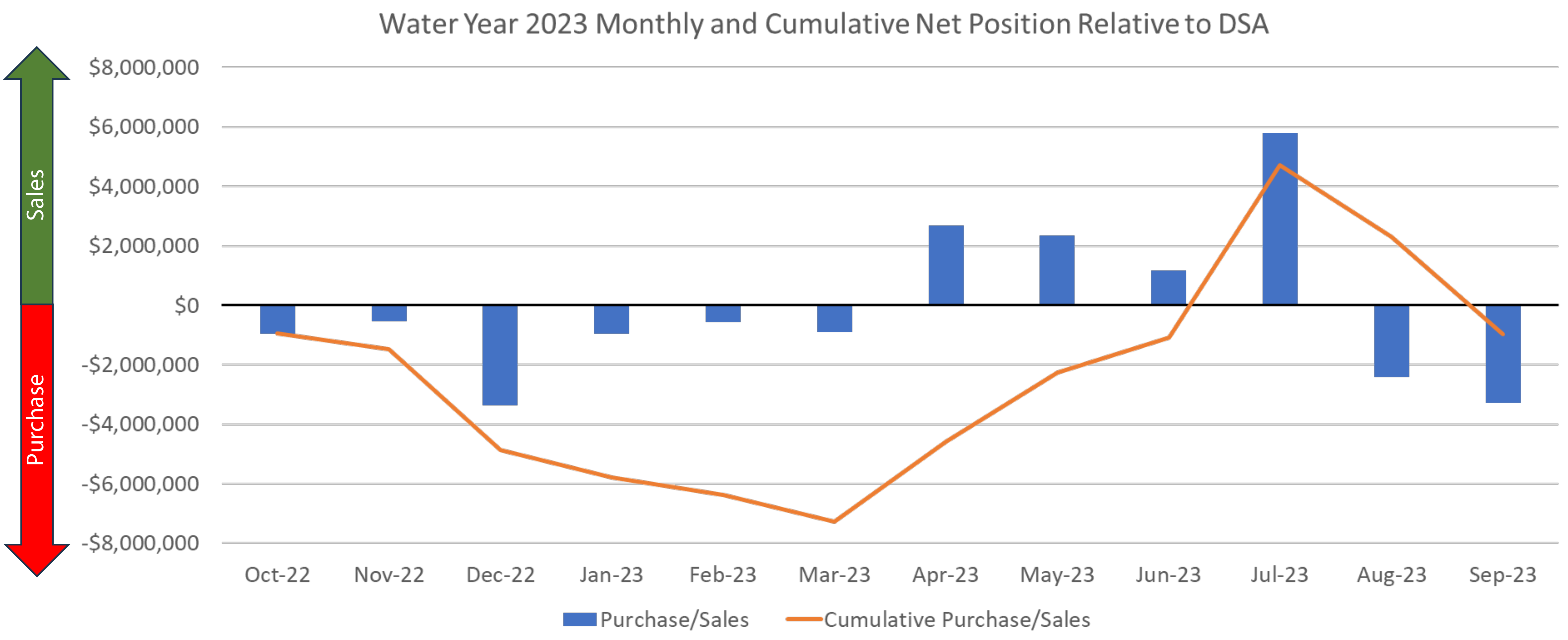
DSA Performance



SHP vs DSA Purchases December 2021 - September 2023



Avoided cost ≈ $211 million


Water Year 2023 Monthly and Cumulative Net Position Relative to DSA
Sales
Purchase
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
-$2,000,000
-$4,000,000
-$6,000,000
-$8,000,000
Oct-22
Nov-22
Dec-22
Jan-23
Feb-23
Mar-23
Apr-23
May-23
Jun-23
Jul-23
Aug-23
Sep-23
Purchase/Sales
Cumulative Purchase/Sales

Reservoir Elevation Matters

- Higher reservoir elevation increases unit efficiency in converting water flow into energy
- When the reservoir is full (3,700 ft), it takes about 1.9 acre-feet of water to generate 1 MWh or energy
- At 3,600 ft, it takes abut 2.3 acre-feet to generate 1 MWh
- At 3,500 ft that number rises to 2.9 acre feet to generate 1 MWh

Water year	Annual volume (maf)	Avg elevation	Energy produced (GWh)	Percent difference
2023	8.491	3,545.61	3,321	NA
1991	8.491	3,632.41	3,946	19%
1985	8.491	3,687.85	4,390	32%
2024	8.491	3,569.59	3,570	7%

Experiments

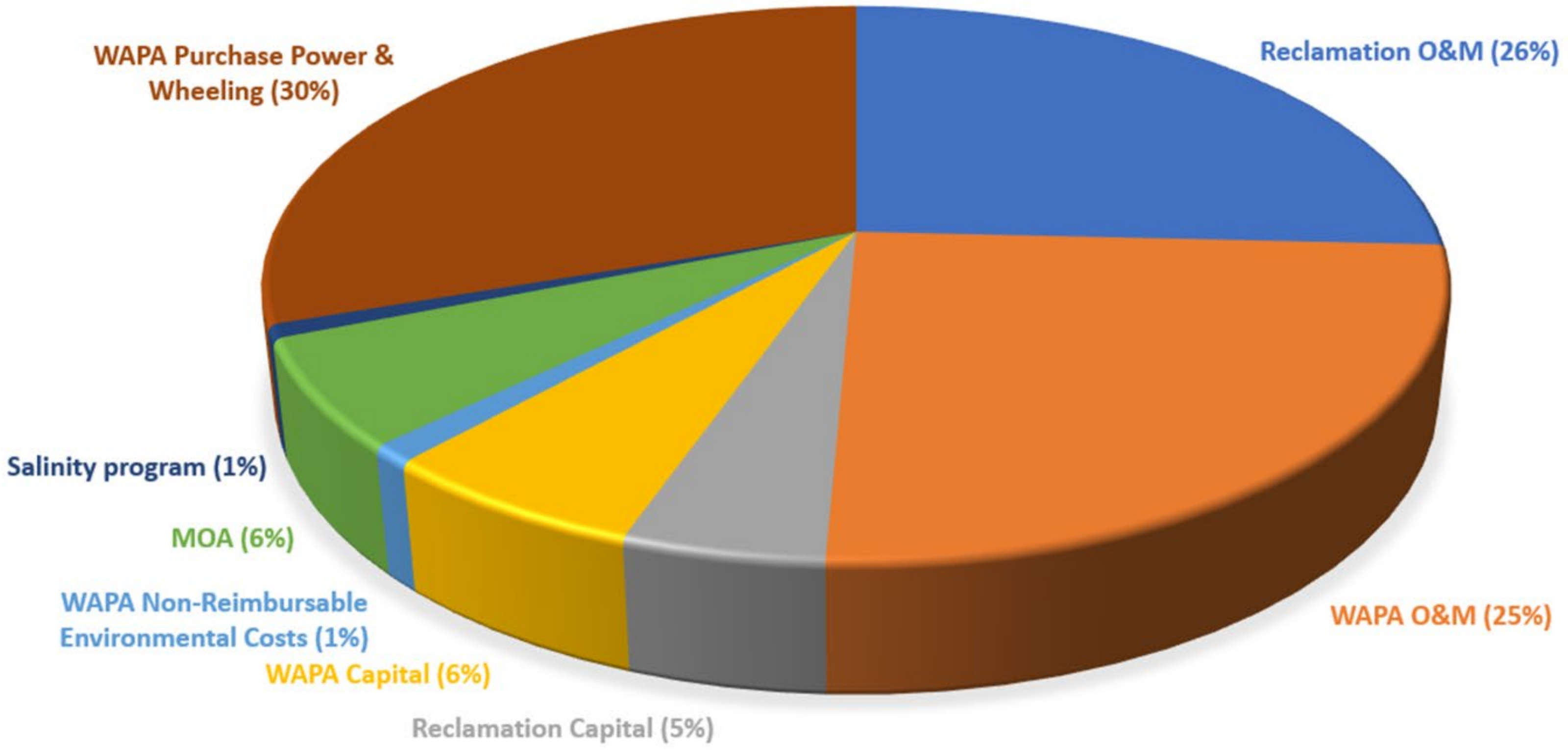
Experiment	Estimated cost ($M)	Observed cost ($M)	Observed - Estimated ($M)	Observed percent difference
High Flow Experiments (HFEs)				
2012*		1.92		
2013	1.74	2.59	0.85	49.0%
2014	1.75	2.10	0.35	20.1%
2016	1.40	1.15	-0.25	-17.9%
2018	0.92	1.30	0.38	40.7%
2023	1.48	**	**	**
Macroinvertebrate Flows				
2018	0.34	0.17	-0.17	-50.6%
2019	0.33	0.33	-0.005	-1.5%
2020	0.41	0.94	0.533	130.6%
2022	1.40	1.15	-0.247	-17.6%

*Includes cost of fall steady flow

**Cost estimate not complete

Basin Fund

Where is Basin Fund Cash Going?



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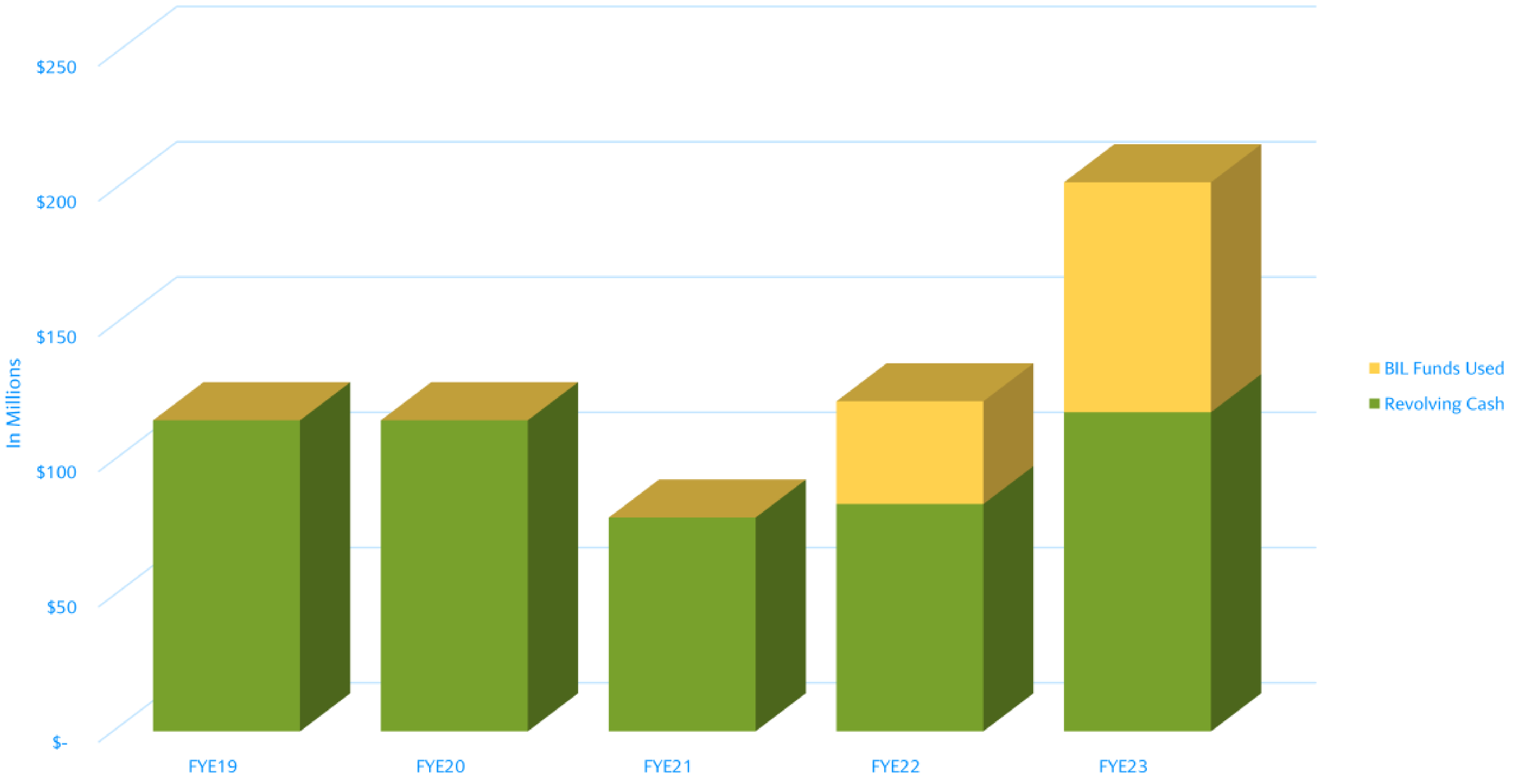
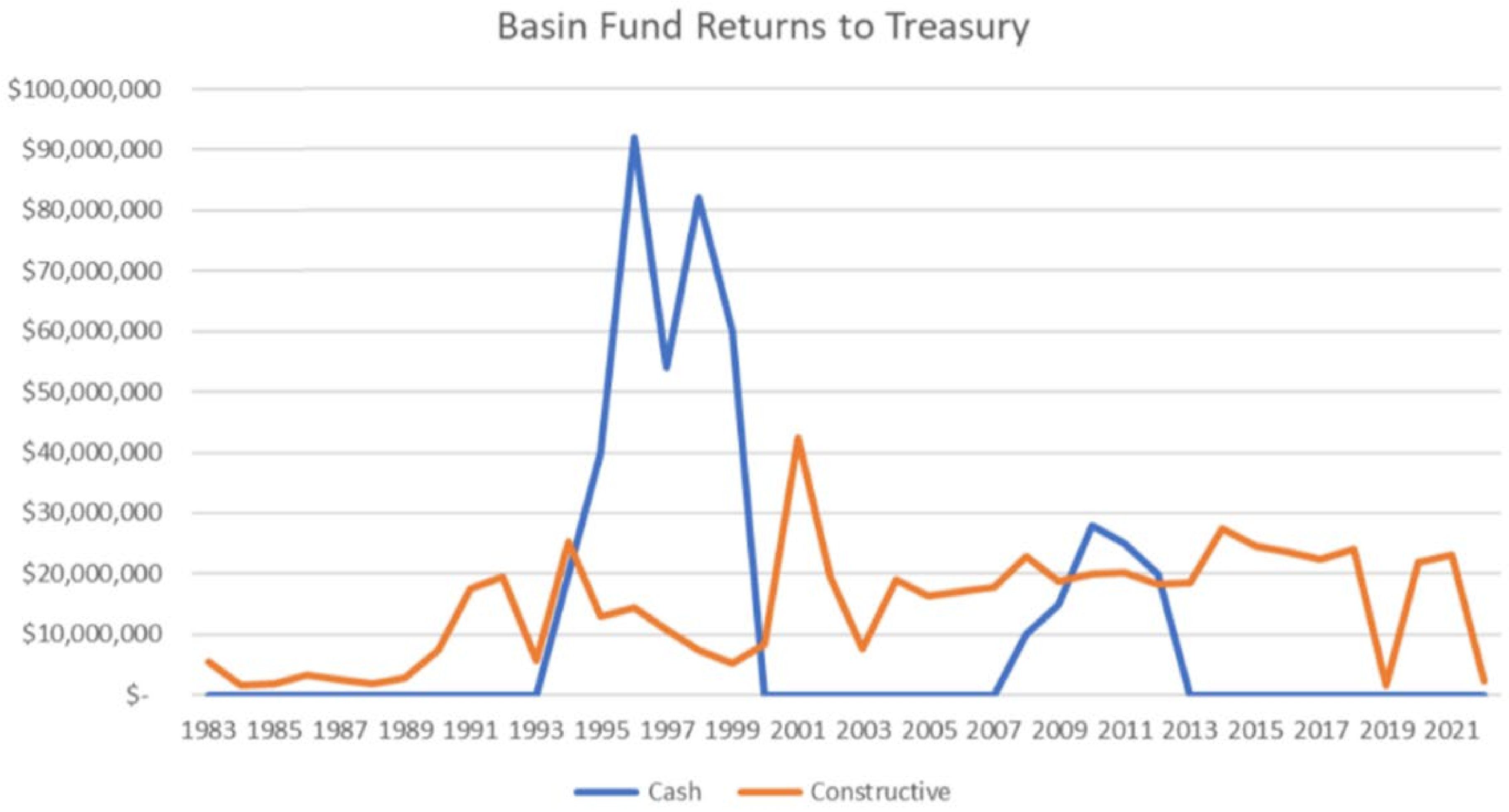
Basin Fund Balances (End of FY)

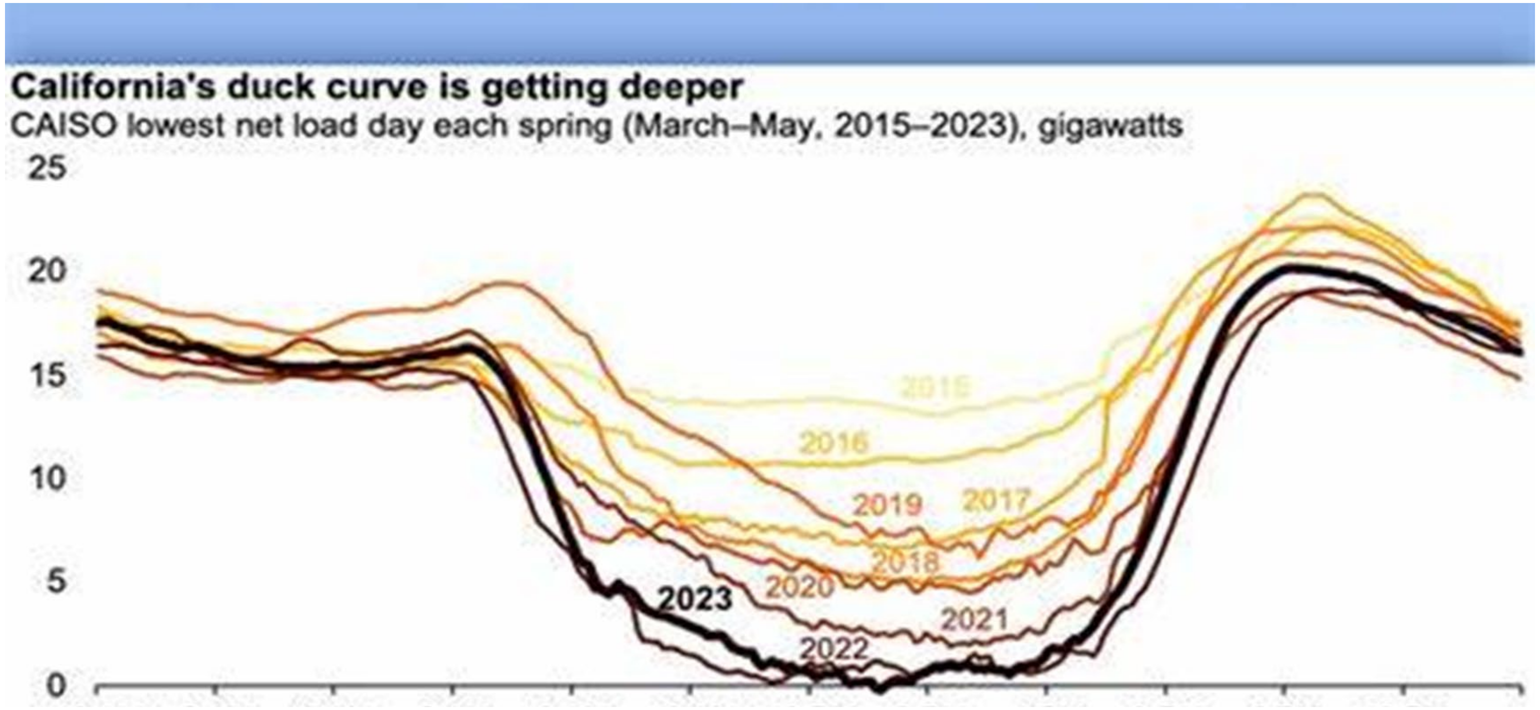


Basin Fund Returns



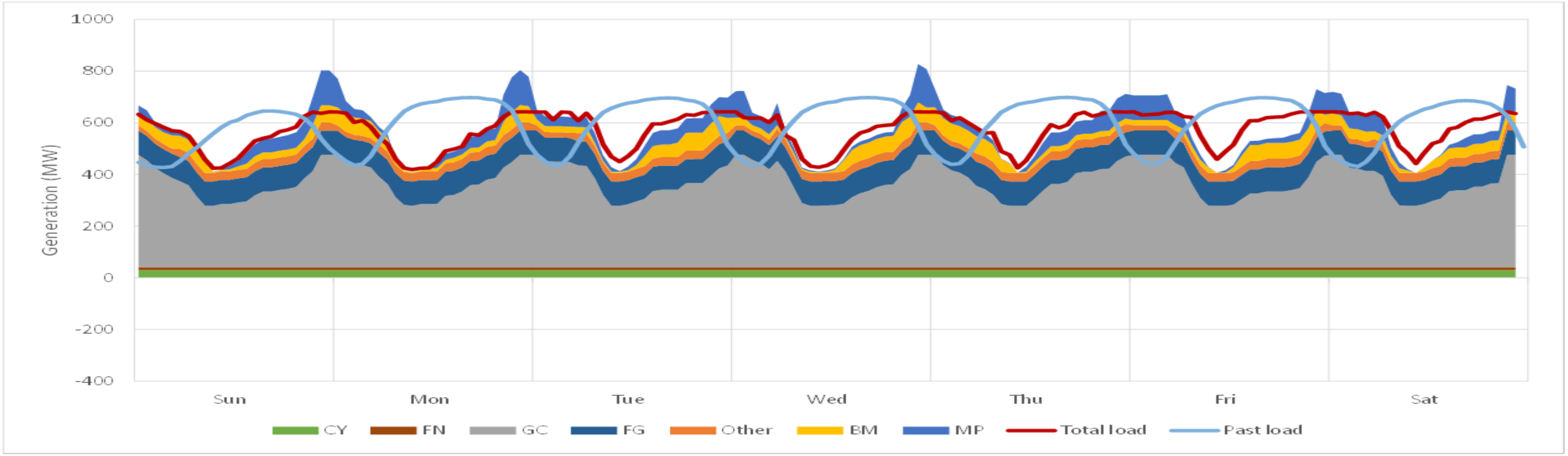
Future CRSP Power Scheduling

- Aridification/drought is causing reductions in generation at Glen Canyon Dam
- Addition of non-dispatchable renewable resources is changing the way customers schedule CRSP power.
- Customers are increasingly scheduling CRSP power to meet "net demand" (retail demand minus solar/wind power)
- Can WAPA meet customer load with the anticipated changes in customer schedules?



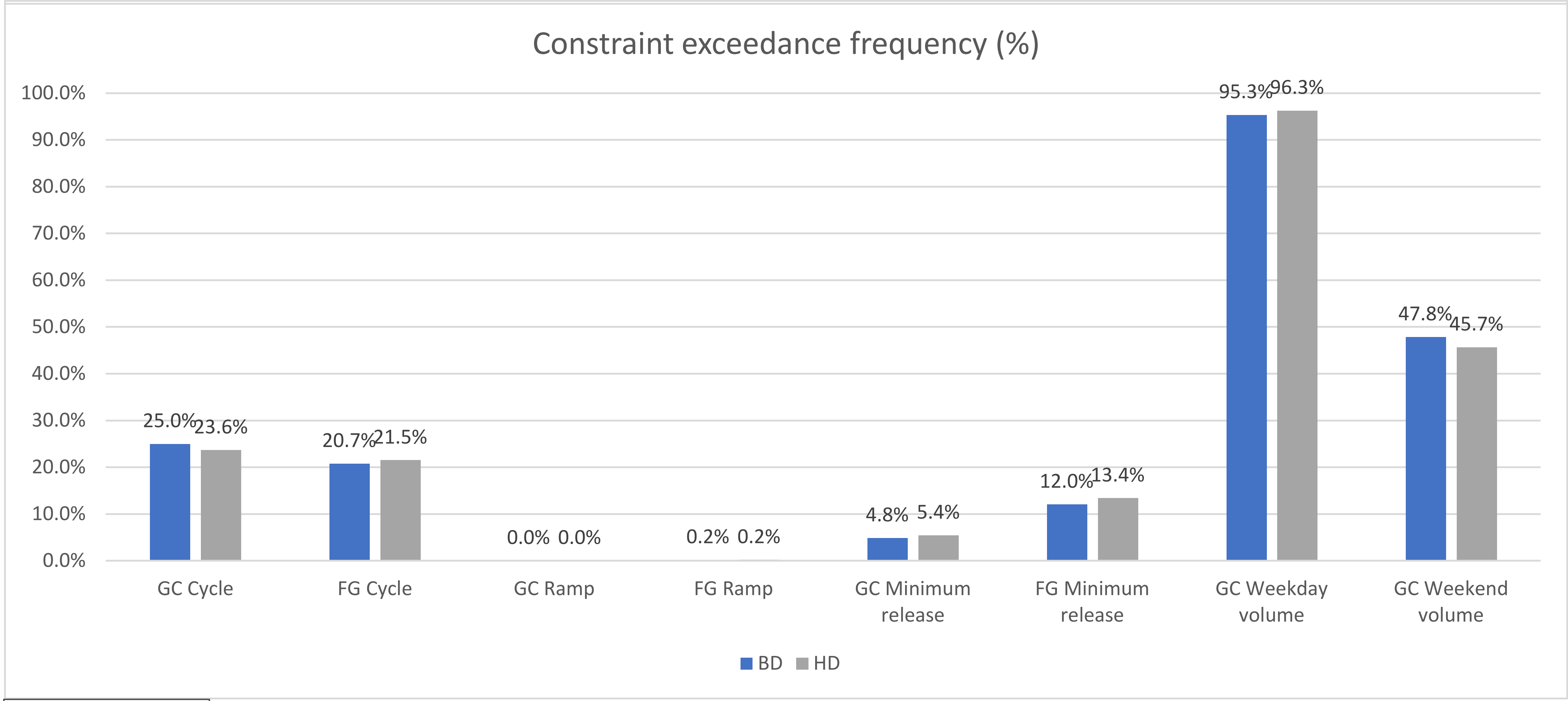
Operating Criteria and Agreements Considered

- Environmental Criteria
  - Minimum release rate (GC, FG)
  - Maximum ramp up/down (GC, FG)
  - Maximum 24-hr change (GC)
- Unwritten Agreements
  - Same volume of water release each day of the week (GC)
  - 85% rule for Saturday and Sunday (GC)
  - Simple/double cycle pattern (GC, FG)



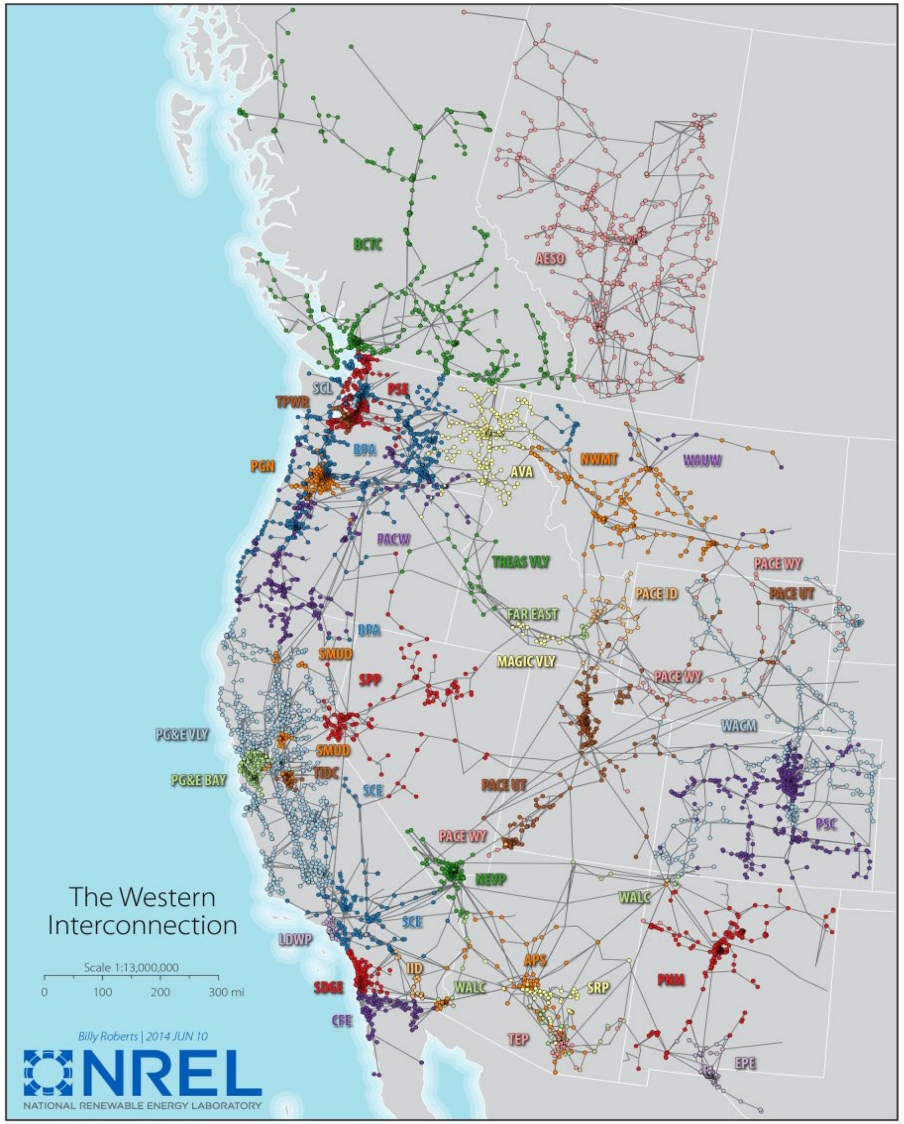
Phase 1 Results

	Option 1	Option 2	Option 3	Option 4
Purchases/sales allowed	✓			
Operating criteria strictly enforced	✓	✓		✓
Unwritten agreements strictly enforced	✓			
Keep current load scheduling rules for CRSP customer	✓	✓	✓	
Can CRSP resources meet load?	Yes	Most of the time	Yes	Yes


Constraint exceedance frequency (%)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
25.0%
23.6%
20.7%
21.5%
0.0%
0.0%
0.2%
0.2%
4.8%
5.4%
12.0%
13.4%
95.3%
96.3%
47.8%
45.7%
GC Cycle
FG Cycle
GC Ramp
FG Ramp
GC Minimum release
FG Minimum release
GC Weekday volume
GC Weekend volume
BD
HD

Plexos Reconfiguration

- PLEXOS
  - WECC-wide model
  - Simulates operation of electric power system hourly or subhourly
- GCD is small when considered in the context of the entire western interconnection.
- NREL worked with the Plexos developers to reduce the WI footprint down to balancing authorities that are impacted by Glen Canyon Dam generation.
- Only generators that could reasonably respond to a reduction/loss of GC generation were considered as sources of replacement power.



Phase 2

Objectives:

- Determine the consequences of the loss of power generation at GCD and to model the feasibility of mitigating the loss of GCD power through the joint/companion (hybrid) operation of GCD with another renewable generator.

Research questions:

- What is the capability of GCD to provide capacity for ancillary services at reduced capacity and generation?
- What are the impacts to the Salt River Project exchange?
- Is replacement energy available?
- Is the existing transmission grid capacity capable of getting replacement energy (if available) to federal delivery points?
- Would the need to transmit replacement power “stress” regional transmission lines?
- Are reserves and regulating capacity available elsewhere to support grid reliability?
- Could the joint or hybrid operation of a utility-sized solar generating station mitigate the loss of GCD energy?

GTMax Update

- Generation and Transmission Maximization model
  - Models flow of electricity, water, and money
  - Produces “optimal” hourly generation patterns for 1 week each month
- GTMax SuperLite
  - Same mathematical formulation
  - Allowed for multiple scenario analysis over multiple years
  - Multithread
- Used for short and long-term planning
  - Daily patterns
  - Purchase power estimates
  - Impacts of operational changes
  - Resource availability (energy and capacity)

GTMax Update

- Analyses have become much larger and more complex (e.g., post-2026 EIS) exceeding Excel's capabilities
- Same hydropower scheduling logic as current GTMax SL
- Single Excel-based user interface with a Python-based algorithm and solver
  - GTMax SL used an ensemble of spreadsheets with Excel formula-based algorithm and a Lingo-based solver
- Faster (~100x) run time with native multi-threading capability
  - GTMax SL took 10s-10min per run with the need for an add-on tool to use multithreading
- Case study size only limited by the computer RAM (~5M runs on a standard machine)
  - GTMax SL was limited by Excel spreadsheet row limit

Post-2026

- Hydropower modelling to begin April 2024
  - Argonne National Lab
- 1,200 traces over 30+ years
  - 432,000 months per trace
  - Over 315 million hours per trace
- Challenges
  - Number of traces
    - Modelling time
    - Data volume
  - Difficult to anticipate changes in the electric system over 30 years
    - scheduling
  - Energy pricing

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