EPC-16-029: Water/Energy Bank

Shifting of California State Water Project Pumping Using Aquifer Storage

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Questions to Answer

Can Department of Water Resources (DWR) State Water Project (SWP) pumping be:

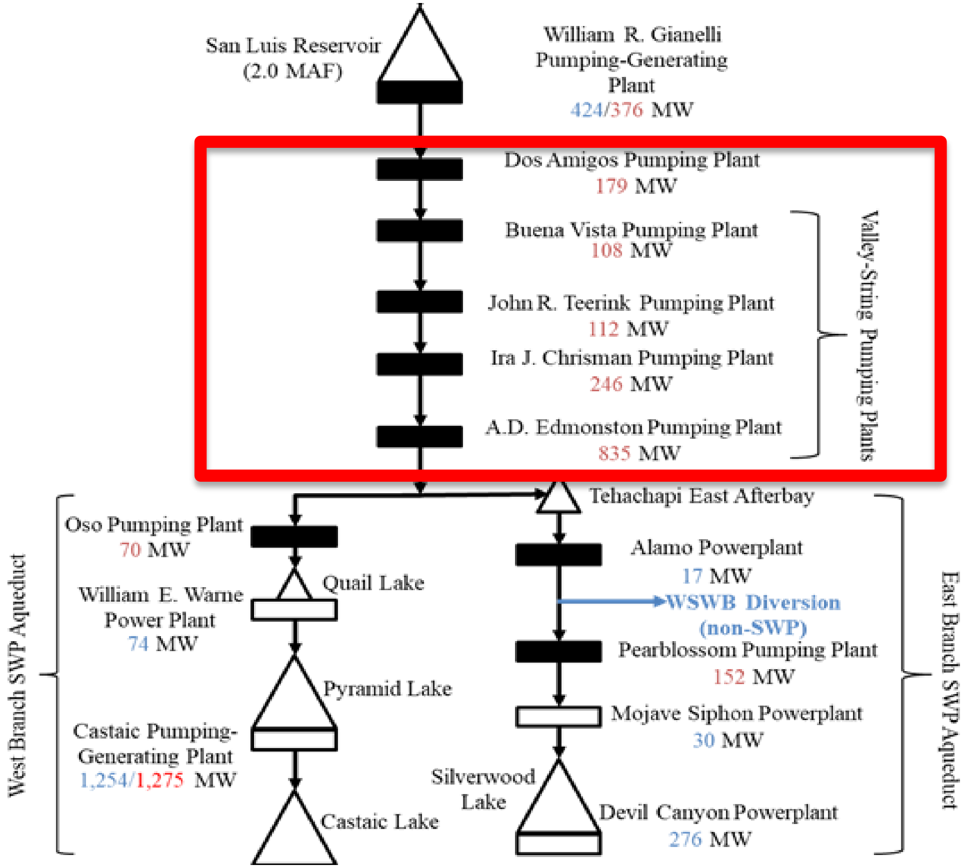
- increased during spring over-generation periods?
- decreased during summer peak demand periods?

Goals

1. Shift SWP pumping from high to low demand periods
   - Seasonal shift storage
     - Increasing pumping in spring
     - San Luis Reservoir to Willow Springs Water Bank (WSWB) aquifer storage
   - Summer peak-demand shift
     - Dos Amigos, Buena Vista, Teerink, Chrisman, and Edmonston pumping facilities
     - Use excess solar power to pump water out of aquifer storage
2. Preserve all aspects of SWP water delivery
   - Timing, quantity, reliability

State Water Project Facilities

SWP facilities Central Valley



SWP schematic of facilities

Historical Analysis

- Approach
  - Evaluate DWR historical operations at Edmonston
  - Characterize existing DWR practice of load shifting
  - Determine potential additional load shifting
- Data
  - 10 years of hourly summer data: July-September, 2008-2017
- Conclusions
  - Confirmed that DWR historically managed SWP operations to reduce energy use during peak hours.
  - Historical mean average summer use of power 596 MW, reduced to 321 MW during peak-power demand periods.
  - Summer peak power demand could be further reduced to 113 MW from 321 MW, assuming hourly ramping rate was increased to 4 pumps on/off.

Project Methodology

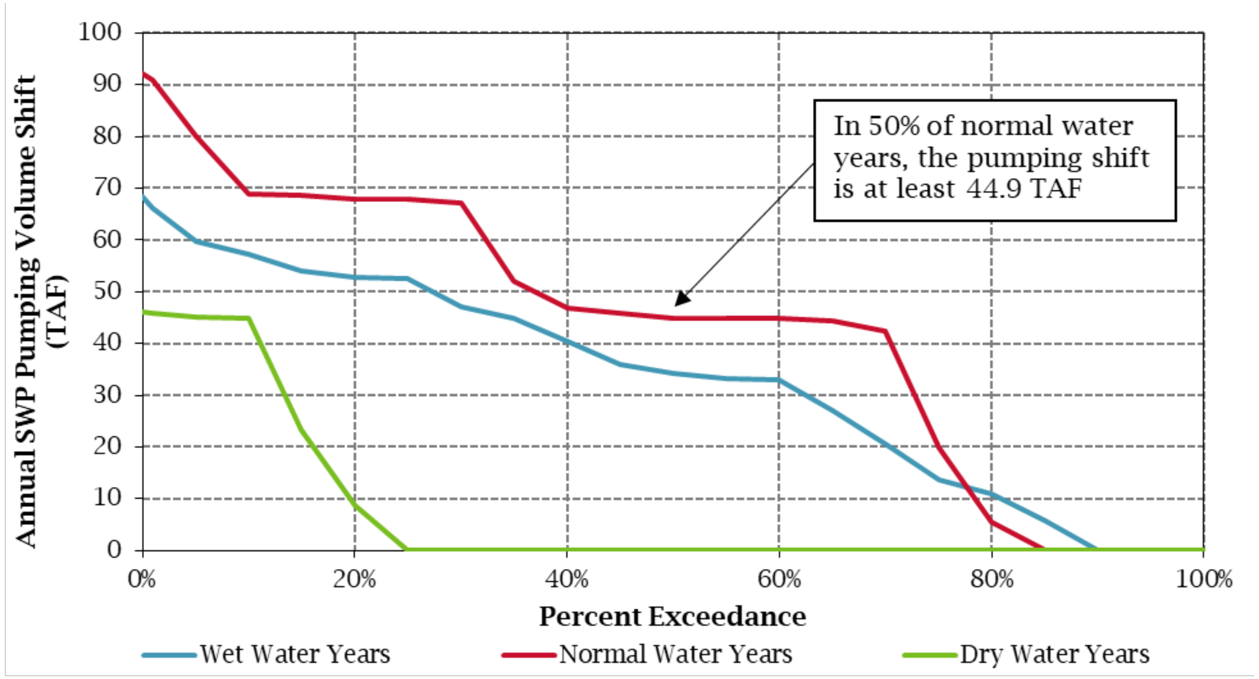
Objective

- Reduce pumping during peak hours in summer
- Target: 6 hours per day load-free

Methods

- Determined the amount of water shift from reducing SWP valley-string pumping (up to 6 hours/day) during peak demand periods.
- Determined whether this amount of water can be placed into WSWB storage during the spring.
- Ability to seasonally-shift limited by WSWB recharge and extraction capacity and SWP aqueduct and facility capacity.
- Total energy costs for water-movement (SWP and WSWB) were computed.

Pumping Volume Shift



Project Methodology

Table 1: Summary of Baseline and Water-Energy Bank Operations for Year 1940

Month	WSWB Monthly Operations		SWP Pumping Volume Shift (TAF)	WSWB and SWP Net Energy Shift (GWh)
	Baseline	Water-Energy Bank		
January	NEUTRAL	NEUTRAL	0.0	0.0
February	NEUTRAL	RECHARGE	16.9	56.3
March	NEUTRAL	RECHARGE	23.8	77.9
April	NEUTRAL	RECHARGE	23.0	81.7
May	NEUTRAL	RECHARGE	23.8	84.5
June	NEUTRAL	EXTRACTION	-0.5	-1.3
July	RECHARGE	EXTRACTION	-33.4	-101.8
August	RECHARGE	EXTRACTION	-38.9	-116.8
September	NEUTRAL	EXTRACTION	-14.7	-33.5
October	NEUTRAL	NEUTRAL	0.0	0.0
November	NEUTRAL	NEUTRAL	0.0	0.0
December	NEUTRAL	NEUTRAL	0.0	0.0

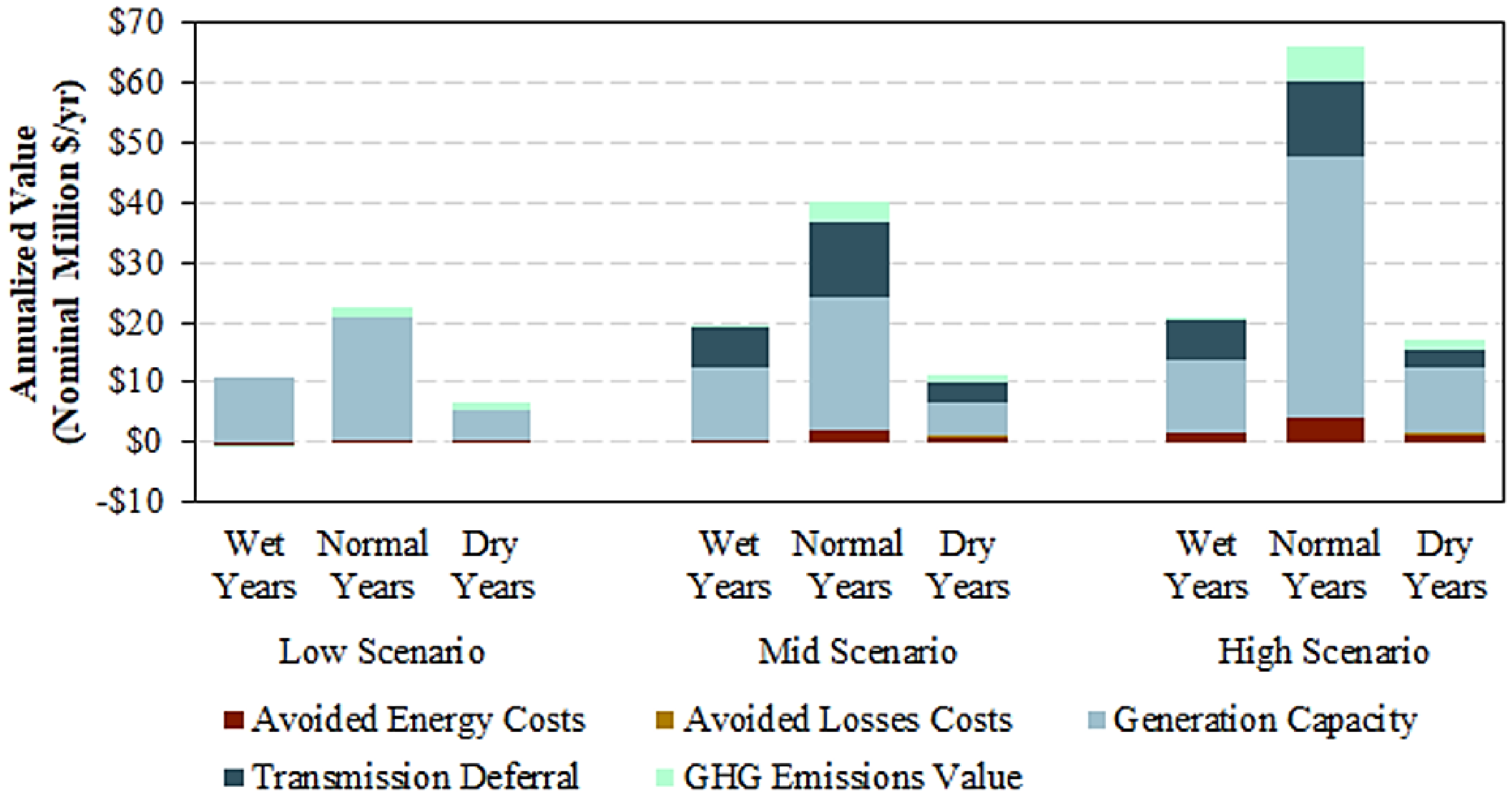
Extraction: WSWB is extracting water out of storage. Recharge: WSWB is recharging water into storage. Neutral: WSWB is idle and is not recharging or extracting water. Spring pre-delivery months are green shading; summer shift months are blue.

Avoided Costs

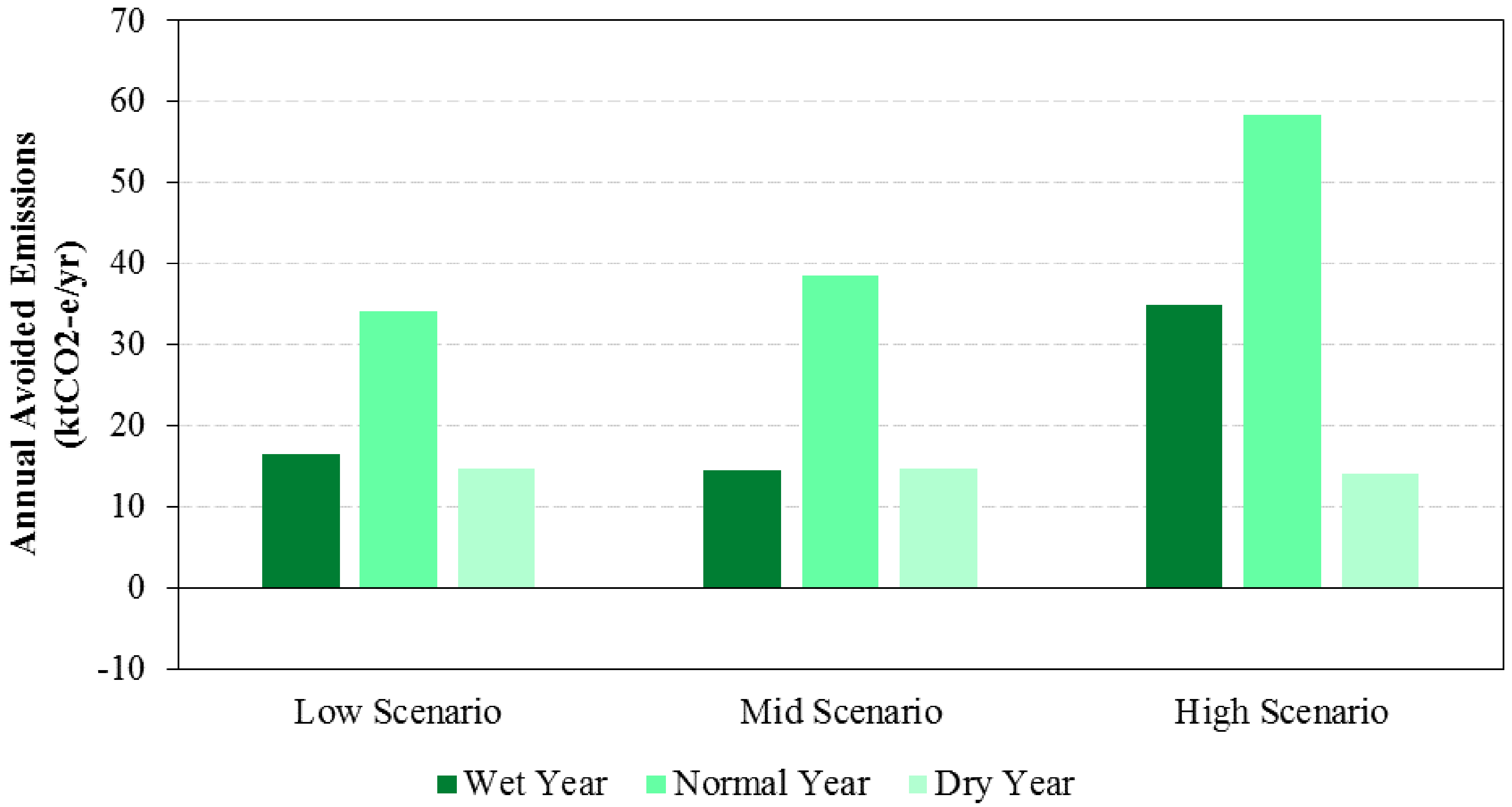
- Economic value calculated in the following fields
  - Avoided Wholesale Energy Costs
  - Avoided Losses
  - Generation Capacity Value
  - Transmission Deferral Value
- Results are the difference from Spill Capture and Water-Energy Bank Scenarios
- The analysis assumed an Edmonston ramping rate of no more then 4 pumps on/off per hour

DWR Avoided Costs

Figure 23: Total Avoided Cost Value for Each Water Year Type in Each Curtailment Scenario, Annualized During 2020-2040

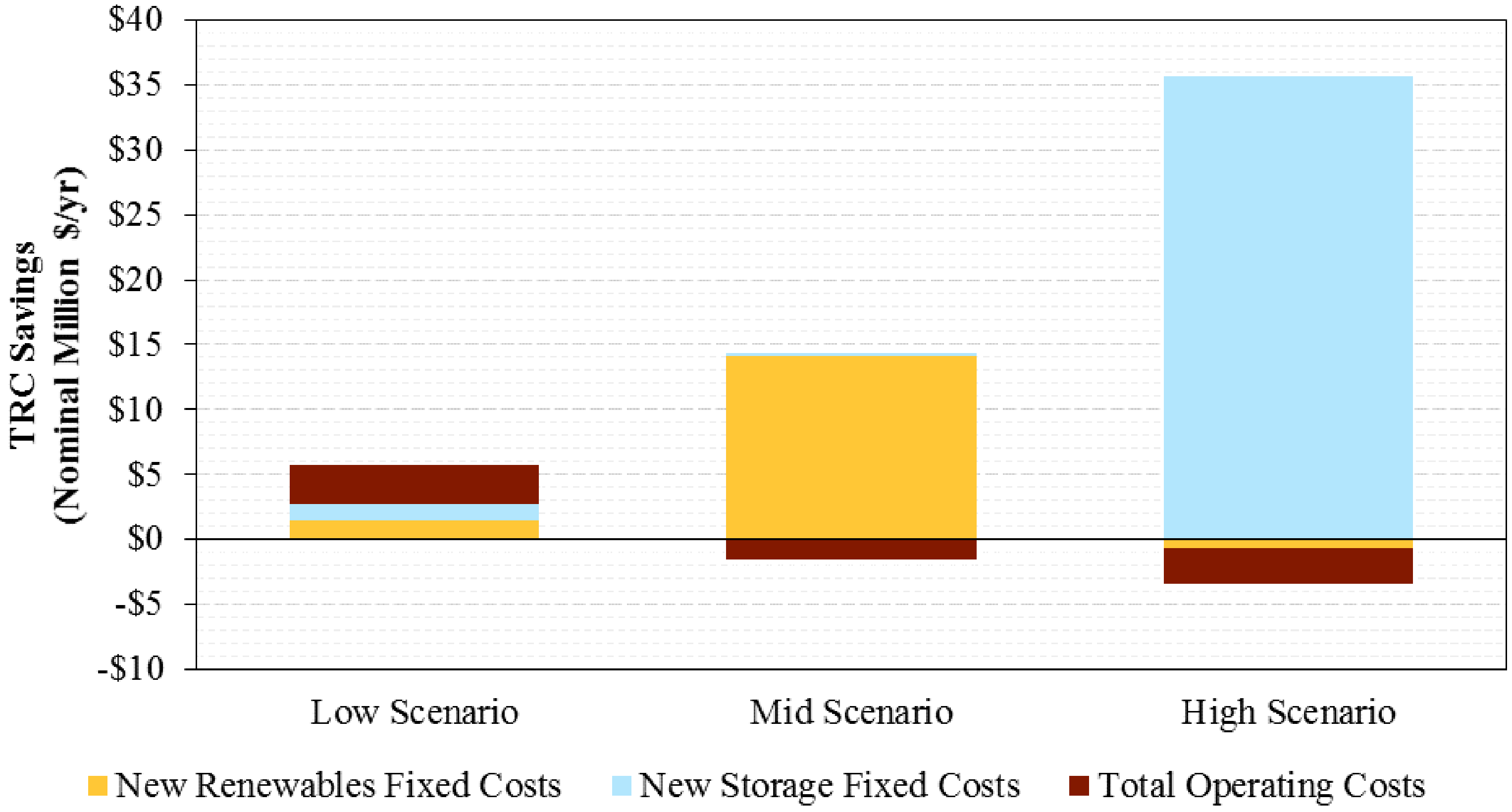


Avoided Emissions



RESOLVE Framework

Flexible load value is driven by reduced procurement of renewables and storage, as well as operational cost savings



Benefits of the Water-Energy Bank

- Peak power reductions
  - 300 MW on average summer days
  - 1.5 GW potential instantaneous load shed
- Willow Springs Water Bank
  - TOU cost savings
- DWR
  - energy cost reductions
  - Demand response program benefits
  - Operational flexibility in capacity planning
- Load serving entity and system benefits
  - Deferred transmission costs
- GHG reduction benefits
  - Demand flexibility offsets enable increased penetration of renewable resources
  - 16,000 metric tons of CO_2 annually, based on the mid-curtailment scenario

Conclusions

Analysis Framework	Average Total Avoided Cost Value ($ million/yr)		
	Low-Curtailment	Mid-Curtailment	High-Curtailment
Avoided Cost Analysis Framework	$13	$23	$38
RESOLVE Framework	$5	$7	$21

- WSWB is proposing to operate the aquifer storage using renewable energy
  - 40 MW on-site solar, 5 MW on-site hydropower
  - 98,000 MWh/yr generated (53,400 MWh/yr used)
- Shifting SWP valley-string pumping out of high-cost periods by storing water in aquifer storage and extracting it during low-cost periods appears feasible.
- Generation capacity, transmission deferral and demand response benefits are the most significant potential benefits.