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<td><strong>Docket Number:</strong></td>
<td>19-OIR-01</td>
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<tr>
<td><strong>Project Title:</strong></td>
<td>Load Management Rulemaking</td>
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<tr>
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<td>Presentation - Shifting of California State Water Project Pumping Using Aquifer Storage</td>
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<tr>
<td><strong>Description:</strong></td>
<td>Presentation by Chie Hong Yee Yang on the results of an EPIC-funded study (EPC-16-029) to shift seasonal electricity loads using the California State Water Project's Aquifer Storage</td>
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<tr>
<td><strong>Filer:</strong></td>
<td>Karen Herter</td>
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<td><strong>Organization:</strong></td>
<td>California Energy Commission</td>
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<td><strong>Submitter Role:</strong></td>
<td>Commission Staff</td>
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EPC-16-029: Water/Energy Bank

Shifting of California State Water Project Pumping Using Aquifer Storage

Chie Hong Yee
January 14, 2020
California Energy Commission
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.
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

In 50% of normal water years, the pumping shift is at least 44.9 TAF.
### Table 1: Summary of Baseline and Water-Energy Bank Operations for Year 1940

<table>
<thead>
<tr>
<th>Month</th>
<th>WSWB Monthly Operations</th>
<th>SWP Pumping Volume Shift (TAF)</th>
<th>WSWB and SWP Net Energy Shift (GWh)</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Water-Energy Bank</td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>NEUTRAL</td>
<td>NEUTRAL</td>
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</tr>
<tr>
<td>February</td>
<td>NEUTRAL</td>
<td>RECHARGE</td>
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</tr>
<tr>
<td>March</td>
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<td>RECHARGE</td>
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</tr>
<tr>
<td>April</td>
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<td>RECHARGE</td>
<td>23.0</td>
</tr>
<tr>
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</tr>
<tr>
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<tr>
<td>July</td>
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<td>EXTRACTION</td>
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<tr>
<td>August</td>
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<td>EXTRACTION</td>
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<tr>
<td>September</td>
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<td>EXTRACTION</td>
<td>-14.7</td>
</tr>
<tr>
<td>October</td>
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<tr>
<td>November</td>
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<td>NEUTRAL</td>
<td>0.0</td>
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<tr>
<td>December</td>
<td>NEUTRAL</td>
<td>NEUTRAL</td>
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*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 than 4 pumps on/off per hour
Figure 23: Total Avoided Cost Value for Each Water Year Type in Each Curtailment Scenario, Annualized During 2020-2040
Avoided Emissions

![Graph showing avoided emissions in different scenarios (Low, Mid, High) with data for wet, normal, and dry years.](image-url)
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 CO2 annually, based on the mid-curtailment scenario
Conclusions

- 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.

### Analysis Framework

<table>
<thead>
<tr>
<th>Analysis Framework</th>
<th>Average Total Avoided Cost Value ($ million/yr)</th>
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<tr>
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<tr>
<td><strong>Avoided Cost Analysis Framework</strong></td>
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