

Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
February 9-10, 2011

Agenda Item

Post-ROD Economic Analysis

Action Requested

✓ This is an information item.

Presenter

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Previous Action Taken

In August 2010, AMWG charged TWG with moving forward to develop a number of economic-related tasks. Western committed to provide some non-AMP funding to support development of a power economics base case to be peer-reviewed through GCMRC's process.

Relevant Science

This information is presented coincident with an expansion of the AMP economic program. See TWG recommendations on a proposed socioeconomic plan for 2011 – 2014. The Post ROD report supplements economic information found in the 2005 SCORE report, which can be found at <http://www.gcmrc.gov/products/score/2005/score.htm>.

Background Information

The Grand Canyon Monitoring and Research Center's 2005 SCORE report summarized the condition of key resources in the Grand Canyon following implementation of Modified Low Fluctuating Flow operations at Glen Canyon Dam. Among its findings, the report noted that no ex-post economic analysis had been completed.

In response, Western tasked Argonne National Laboratory (ANL) to determine the economic impact of the operational changes made to Glen Canyon Dam after implementing the ROD for the 1995 GCD EIS. The resulting report summarizes the economic impact of the environmental restrictions placed on Glen Canyon Dam in February 1997. This impact is the result of additional construction, changes in fuel uses and dispatch from existing facilities and added costs for purchased power. The method used for the analysis is comparable to the method used to estimate the economic impact of the GCD ROD in the 1995 EIS.

The ANL report concludes that actual economic impact of the Post-ROD operations at Glen Canyon Dam is very similar to the expected impact reported in the GCD EIS (after adjusting for inflation). Specifically, the report concludes that implementing the GCD ROD had an average annual economic impact of \$33.9 million in 1991 dollars, or \$50 million in 2009 dollars. The 1995 GCD EIS estimated that anticipated annual economic impacts of restricted operations would range from approximately \$15.1 million to \$44.2 million in 1991 dollars.

Supplemental/Sensitivity Analysis

As part of this Post-ROD analysis, scientists found that in 2000 and 2001, electricity market prices in the Western US experienced large price spikes and swings, resulting in a significant increase in the economic impact of the ROD in those two years. Most economists believe that the price spikes in these two years were a result of market manipulation and don't reflect actual economic values. Following this logic, Argonne conducted a sensitivity analysis in which it used electrical prices to estimate the economic impact of the GCD ROD that does not include these price "hikes." This sensitivity case estimated the GCD ROD economic impacts had an annual average cost of \$26 million in 1991 dollars or \$38 million in 2009 dollars.

Power Economic Analysis of Operational Restrictions at Glen Canyon Dam

In February, 1997, the operating criteria for Glen Canyon Dam were changed. Operation was restricted to a Modified Low Fluctuating Flow as described in the *Operation of Glen Canyon Dam, Colorado River Storage Project, Arizona, Final Environmental Impact Statement, March, 1995*. These restrictions reduced the operating flexibility of the hydroelectric power plant and therefore the economic value of the electricity it produced. The Environmental Impact Statement provided impact information to support the Record of Decision governing dam operations. The impact analysis included an examination of operating criteria alternatives on power system economics. The EIS estimated that anticipated annual power economic impacts of restricted operations would range from approximately \$22.4 million to \$65.5 million (2009 dollars).

This report summarizes actual (1997-2005) power economic impacts compared to predicted impacts resulting from the decision to restrict operations at GCD by implementing MLFF operations.

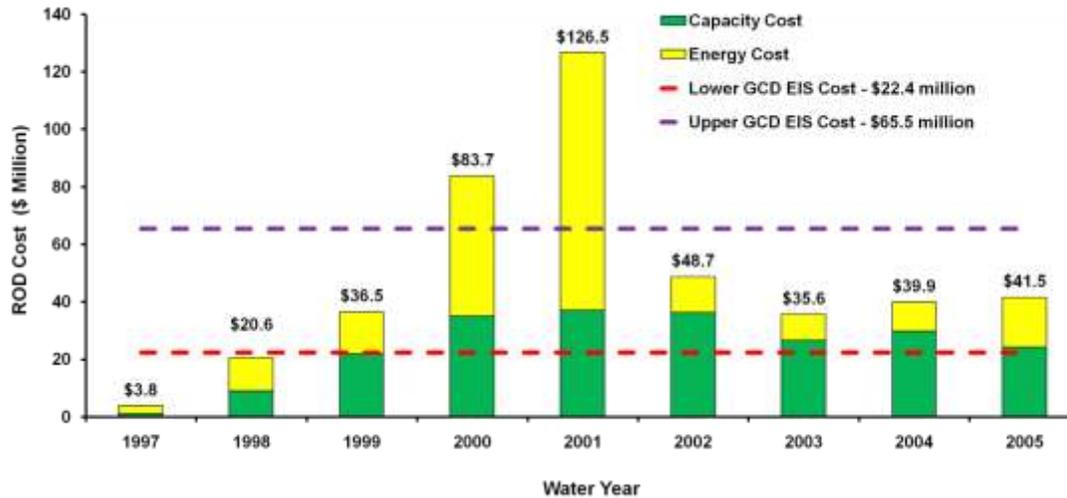
RESULTS

- The analysis concludes that implementing the GCD ROD had an average annual economic impact of \$50 million (2009 dollars).
- Total economic impact of restricted operations is more than \$435 million for the nine-year study period. These costs are separated into energy and capacity costs, as shown on the chart below. Both the lower- and upper-bound of costs calculated in the EIS are also displayed for comparison.
- After MLFF was implemented, Western modified its customer contract commitments. This resulted in a shift of market risk and cost impacts from Western to its customers.



CONCLUSIONS

- Restricting operations at GCD, which tends to shift water releases and power generation from times when electricity prices are high to times when electricity prices are low, has had a significant power economic impact.
- The experimental releases required by the ROD also contributed significantly to the total economic impact.

**Economic Costs of Implementing Operational Restrictions at Glen Canyon Dam,
1997-2005****ADDITIONAL DETAILS**

- Using aggregate customer hourly energy requests from large as well as small representative Western customers, hourly operation of the Upper Colorado River hydropower system was simulated by the Generation and Transmission Maximization (GTMax) model.
- Differences in capacity and energy impacts between the “without operating restrictions” and the “with operating restrictions” scenarios measure the economic cost of implementing the GCDEIS operating criteria. The “with operating restrictions” scenario included experimental releases required by the ROD, while the “without operating restrictions” scenario had no experimental releases.
- The capacity value used in this study was based on the price of short-term capacity purchases; that value was derived from Reclamation’s (2007) *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*. The value of capacity is the amount of capacity in each scenario multiplied by the short-term capacity price.
- A sensitivity study was used in an effort to isolate the extreme market prices for power in the West in 2000 and 2001. The sensitivity case estimated that the economic impact was lower compared to actual expenses recorded by Western and its customers. From an economist’s view, implementing the ROD cost about \$10 million less per year during the study period because market prices paid in 2000 and 2001 were significantly higher than the economic value of the electricity sold.
- The full report is available at www.wapa.gov/crsp/newsrsp/default.htm

Ex post Economic Analysis of the Electrical Power System Impacts of Environmental Restrictions at Glen Canyon Dam Following the 1996 Record of Decision

**Prepared for Western Area Power Administration by:
Thomas D. Veselka and Les Poch
Center for Energy, Environmental, and Economic
Systems Analysis (CEEESA)
Decision and Information Sciences Division (DIS)
Argonne National Laboratory**

Ex Post Study Objectives

- Conduct an economic analysis of the GCD ROD's impact on the electrical power system
- Compare the impact of the GCD ROD with the predicted impact completed for the GCD EIS
- Prepare an electrical power system context for the LTEMP EIS

Glen Canyon Dam EIS:

Analysis of power system impacts

- An ex ante economic analysis, described in the GCD EIS, 1995
- Estimated impacts of MLFF and the other EIS alternatives
- 1991 data were used and impacts were estimated for 20 future years
- Economic impact estimated using two methods. Average annual impact:
 - \$15 million (Hydro method)
 - \$41 million (CROD method)
 - » [both are 1991 \$]

Ex Post Power System Analysis

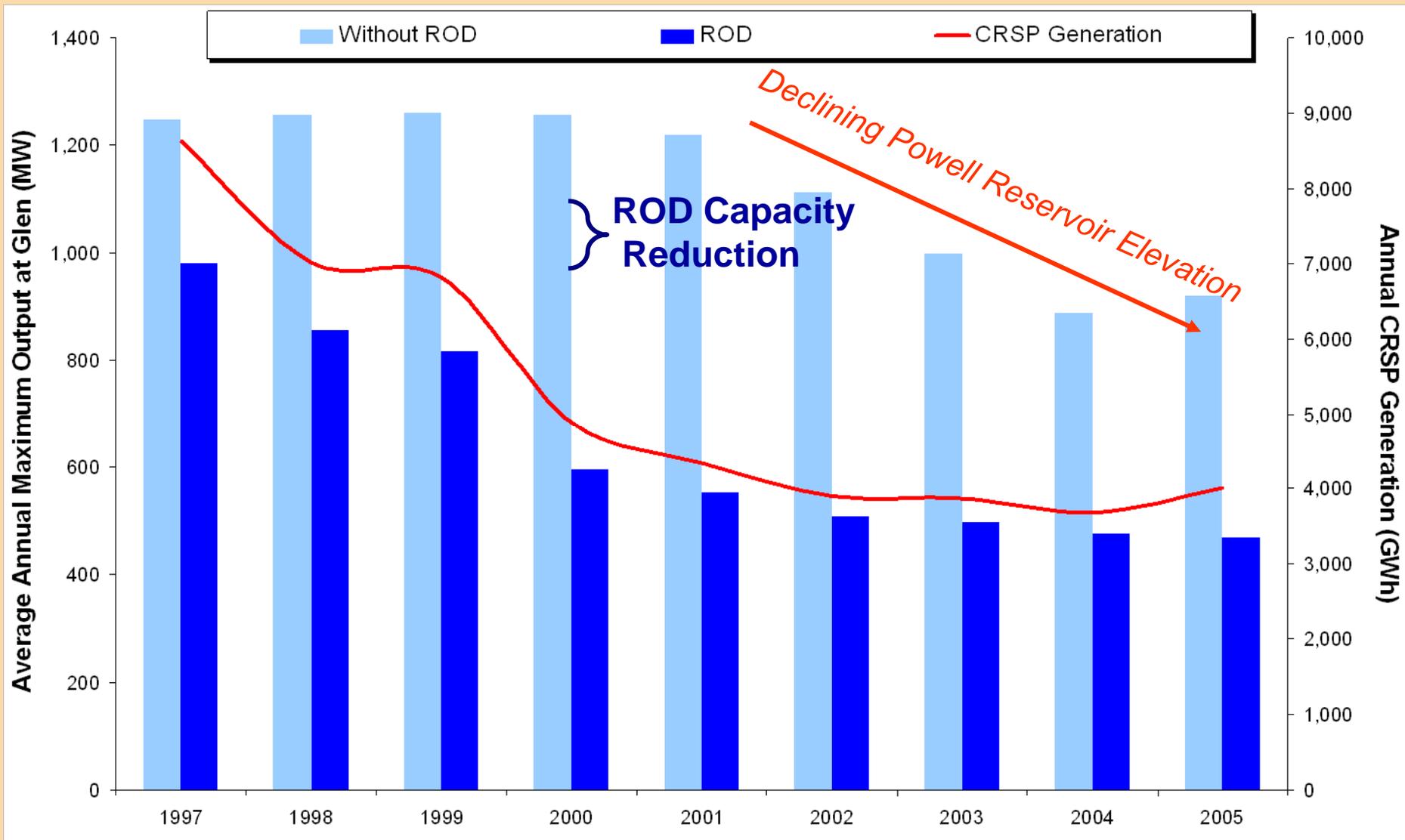
- Duplicated the general approach used for the GCD EIS
- Completed as an economic analysis
- Used economic dispatch to simulated GCD operations
- Used market prices (rather than purchase prices)
- GT Max model used (similar to model used to simulate dispatch for the GCD EIS)

GCD Operations and Market Conditions

- Reality differed from assumptions made for the GCD EIS analysis
 - Hydrological conditions became drier
 - Several GCD experimental releases were implemented
 - California Energy Crisis occurred

Capacity Reductions:

↓ Turbine Water Releases and ↓ Lake Powell Water Storage



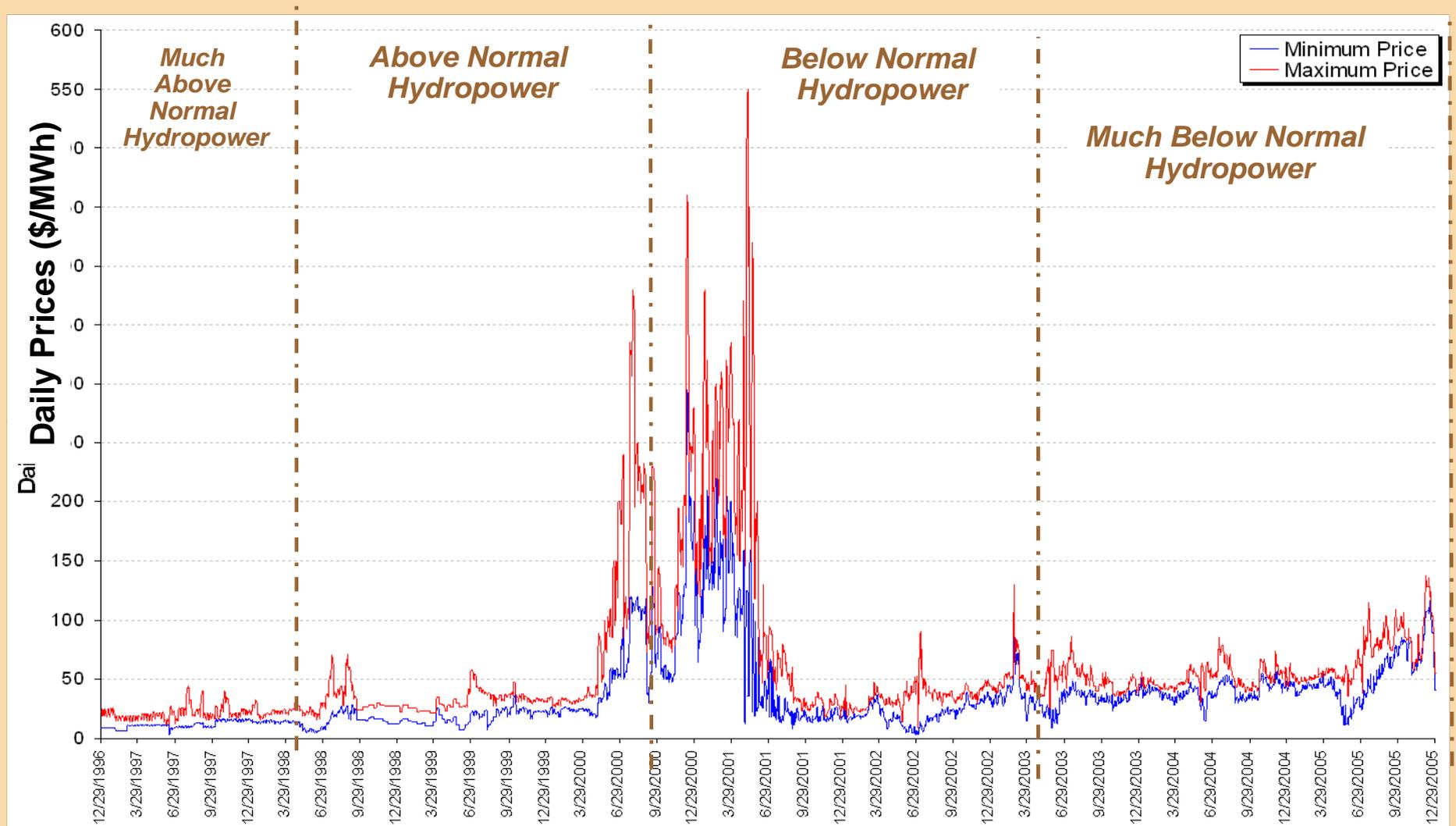
Experimental Releases

- Low Summer Steady flows
- Trout suppression flows
- BHBF 2004 and 2008
- HMF in 1997 and 2000
- 'Photo Flows' in some years



Source: BOR

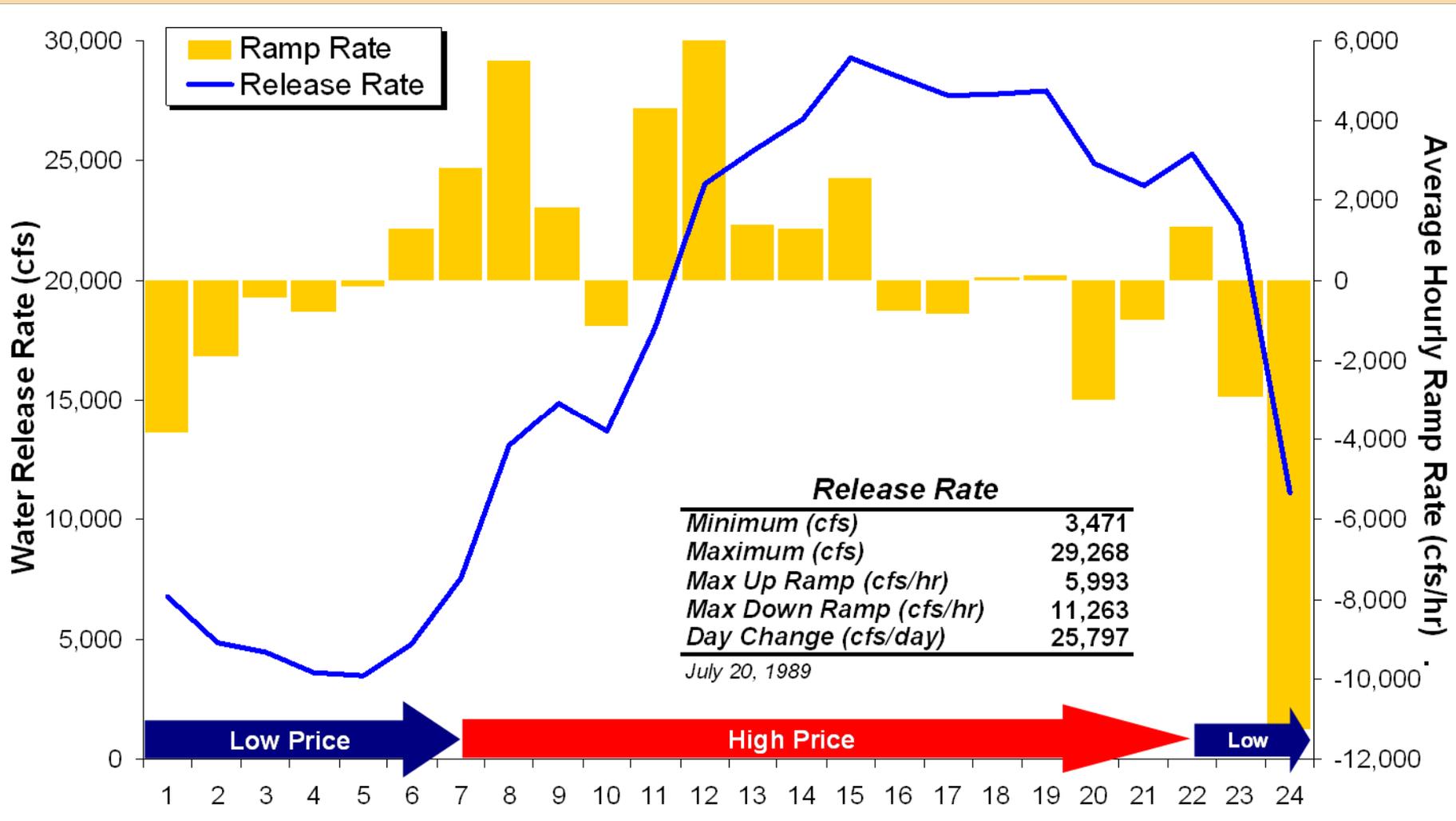
Volatile Market Prices: *Not Predicted in GCD EIS*



Ex Post Study Methods

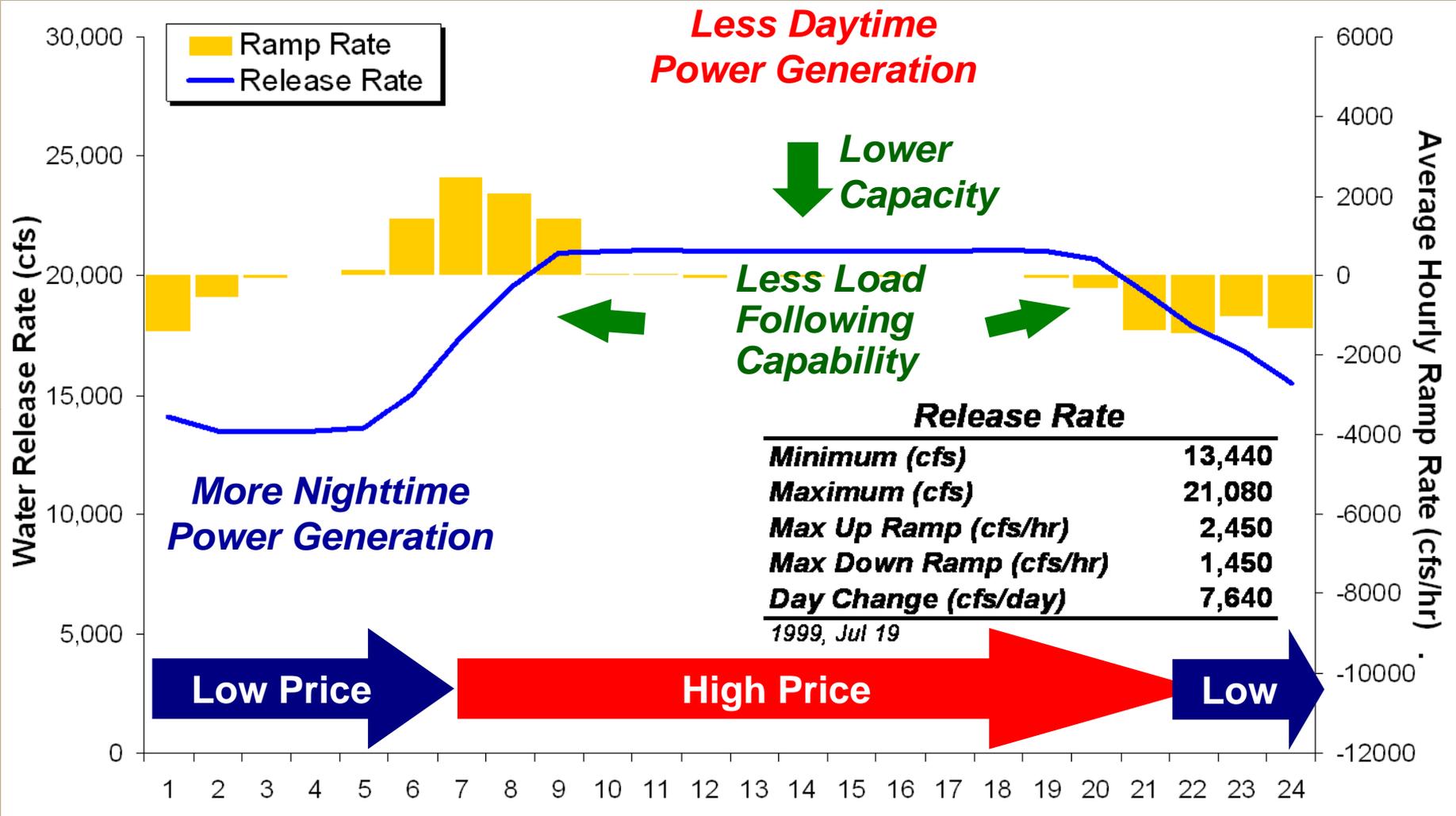
- Used GT Max model
- Simulated operation of the entire CRSP power system
- Incorporated other models to capture complex interactions among market and hydrological conditions, changes in electrical demand, and contract terms
- Simulated the electrical demands of the largest CRSP customers

Operations *Before* ROD

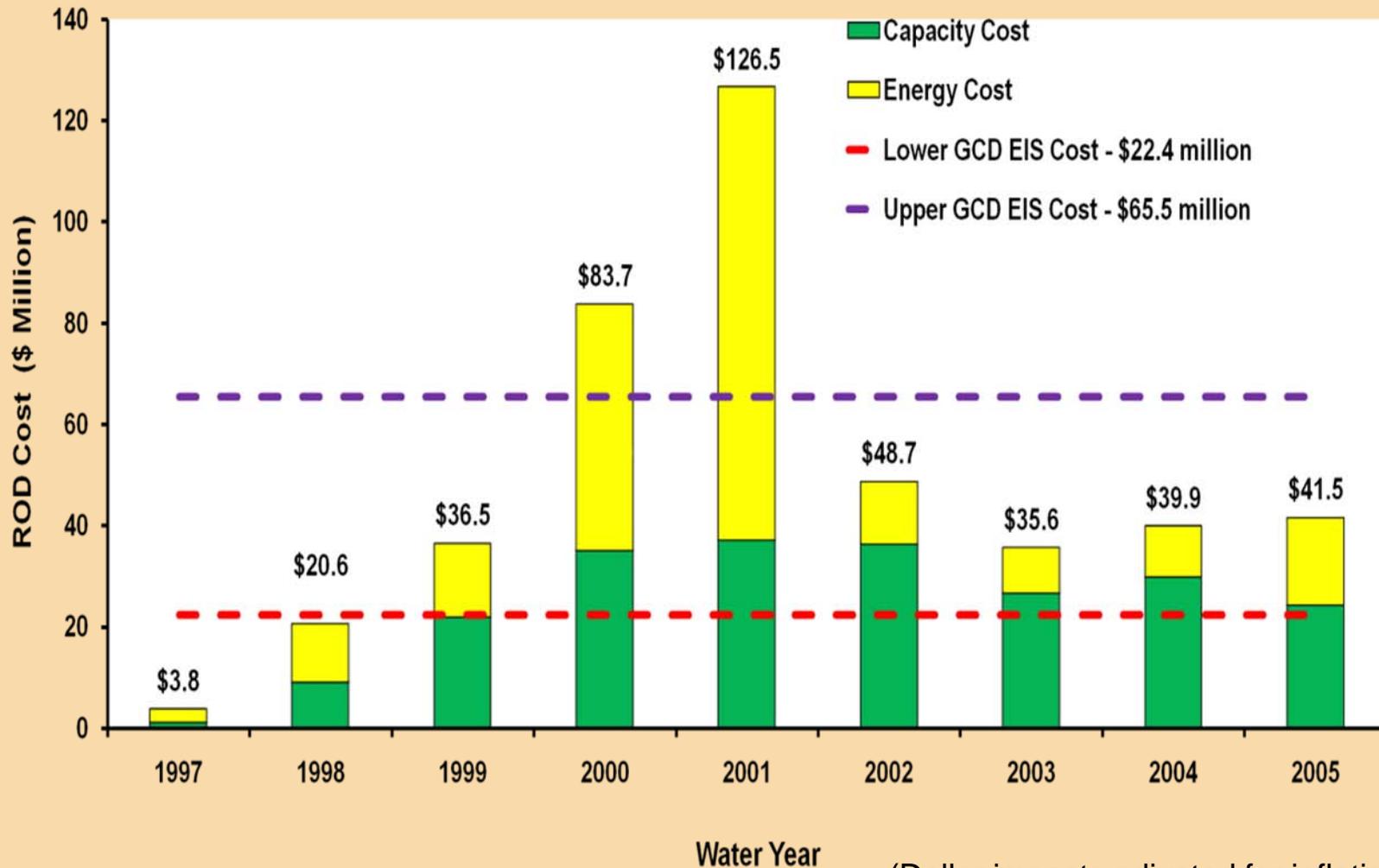


Operations After ROD:

Economic Value of the Hydropower Resource Reduced



Ex post Economic Analysis Impact Comparison with GCD EIS



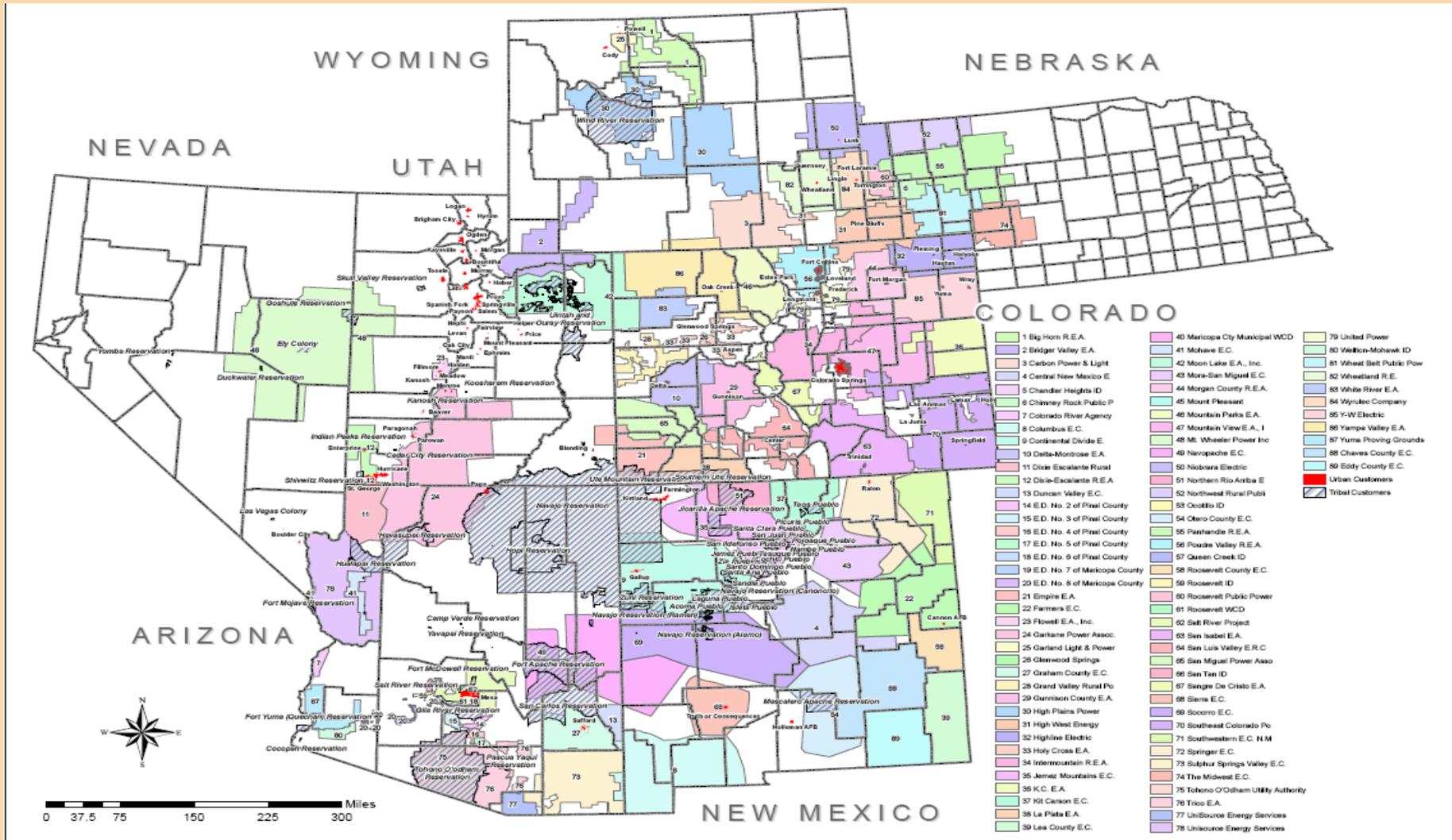
(Dollar impacts adjusted for inflation)

Study Results

- Annual average economic impact of the GCD ROD on the electrical power system:
 - \$50 million (in today's \$)
- Compared to the range of possible impacts described in the GCD EIS :
 - \$22.4 million * (Hydro method)
 - \$65.5 million * (CROD method)

*(Adjusted to today's dollars for direct comparison)

CRSP Wholesale Customers' Service Areas



WAPA Service Territory

DISCLAIMER:
 The data represented on this map has been developed from the best available sources. Although efforts have been made to ensure that the data are accurate and reliable, errors and variable conditions originating from physical sources used to develop the data may be reflected in the data supplied. Users must be aware of these conditions and bear responsibility for the appropriate use of the information with respect to possible errors, scale, positional accuracy, development methodology, and other circumstances specific to this data. The user is responsible for understanding the accuracy limitations of the data provided herein. The burden for determining fitness for use lies entirely with the user. The data on this map is for reference use only.

United States Department of Energy
 Western Area Power Administration
 Colorado River Storage Project

Post ROD report

- Available on the Western website:
www.wapa.gov/crsp

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Questions?