# CVP Cost Allocation Study
## November 19, 2013

## Description of Analytical Tools

### Name
PLEXOS® Integrated Energy Model

### Author/Developer
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### Category
Power market simulation model used to evaluate CVP power accomplishments and benefits

### Main Features and Capabilities
- Weekly, hourly or sub-hourly time steps
- Spatial scale – California's power grid, but with the capability of simulating the power dispatch in the entire Western Interconnection
- Using the monthly water operations and constraints simulated in the CalSim2 model as input parameters to PLEXOS, simulates hourly dispatch of CVP power features to meet load and reserve requirements while respecting electrical transmission and generation constraints in order to depict on-peak and off-peak generation and the provision of ancillary services in such a way as to accurately reflect the current and future operations of the CVP power features
- Values CVP generation attributes by modeling the power markets operated by the California Independent System Operator (CAISO) under current and year 2020 conditions when California's mandate requiring 33% of electricity used to serve load be produced from renewable resources will be fully implemented

### Applications
PLEXOS is widely used for the following purposes:

- Price Forecasting
- Power Market Simulation and Analysis
- Detailed Operational Planning and Optimization of Power Plants and Grid
- Trading and Strategic Decision Support
- Generation and Transmission Capacity Expansion Planning (Investment Analysis)
- Renewable Integration Analysis

- Co-optimization of Ancillary Services and Energy Dispatch
- Transmission Analysis and Congestion Management
- Portfolio Optimization and Valuation
- Risk Management and Stochastic Optimization

PLEXOS' unique capability to model hydro generation in a dynamic manner considering the numerous regulatory and institutional constraints imposed on the hydro system makes it the ideal transmission-constrained power production model to evaluate hydropower operations and benefits. In addition to the work on the CVP Cost Allocation Study, Reclamation has contracted with Energy Exemplar to use the PLEXOS model to evaluate net power benefits of enlarging Shasta Dam, constructing Sites Off-stream Storage Reservoir with a daily pump-back operation and constructing Temperance Flat Reservoir upstream of Millerton Lake considering the impact to the Kerckhoff Power Project.

## Calibration/Validation/Sensitivity Analysis

PLEXOS results have been validated in a number of settings including the 2012 Long-Term Procurement Plan (LTPP) process, which is under the purview of the California Public Utility Commission (CPUC). Every two years, the CPUC holds an LTPP proceeding to review and adopt ten-year procurement plans for California's Investor-Owned Utilities (IOUs). The LTPP evaluates the utilities' need for new resources and establishes rules for rate recovery of procurement transactions[1]. For the 2012 LTPP, the CPUC requested that the California ISO conduct a system operational flexibility modeling study. The PLEXOS model was used to perform this study for the California ISO to study the status of CAISO's power system in the year 2022[2]. The results of the 2012 LTPP study have been used to inform PLEXOS modeling for Reclamation's storage studies and will be used in the CVP Cost Allocation Study's power benefits evaluation.

PLEXOS is a very flexible modeling tool, which is ideally suited to perform such sensitivity analyses such as looking at impacts on power benefits resulting from various forecasts of natural gas prices, different hydro conditions, variations in electric load forecasts, evolving cap and trade market assumptions, etc.

## Peer Review

The 2012 LTPP study reflects the inputs from multiple resources and has been reviewed by multiple stakeholders in the California power sector, as shown in Figure 1. WECC's Transmission Expansion Planning Policy Committee (TEPPC) oversees and maintains a public database for production cost and related analysis[3]. In the 2012 LTPP study, the latest TEPPC 2022 base case, along with the 2012 WECC Loads and Resources Subcommittee (LRS)'s report, were used for the

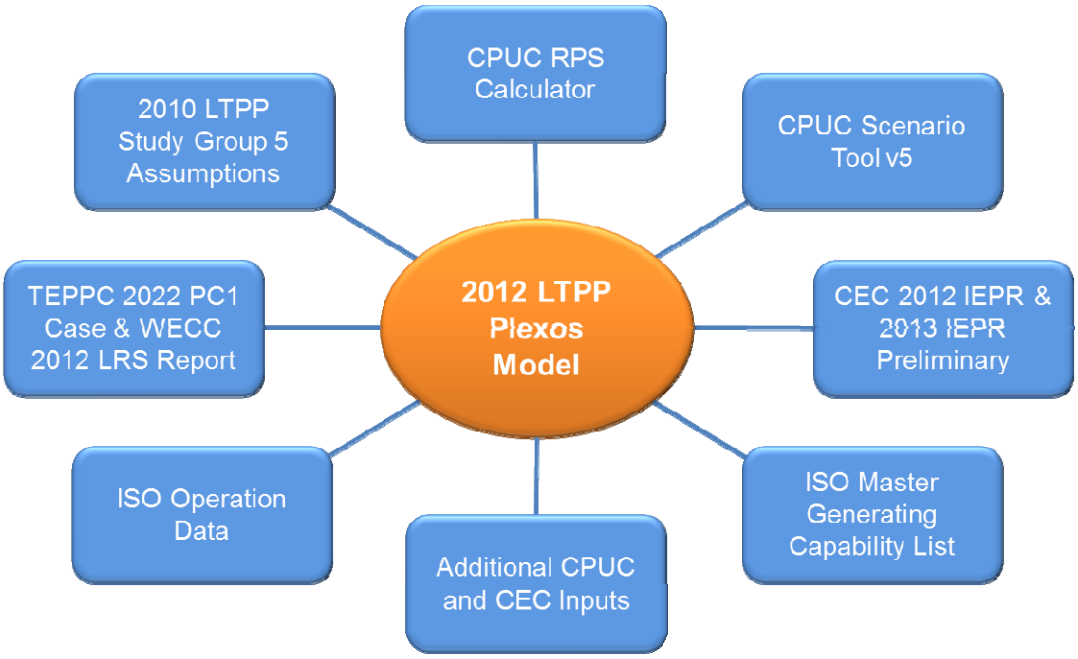
[1] See http://www.cpuc.ca.gov/PUC/energy/Procurement/LTPP/index_2012.htm
[2] See http://www.caiso.com/informed/Pages/StakeholderProcesses/RenewableIntegrationMarketProductReviewPhase2.aspx
[3] See https://www.wecc.biz/committees/BOD/TEPPC/Pages/TEPPC_Home.aspx

majority of the assumptions. The assumptions within California were further updated with CPUC's inputs from 2010 LTPP assumptions, Renewable Portfolio Standards (RPS), and scenario selection tool; with California Energy Commission (CEC)'s inputs on load forecast from Integrated Energy Policy Report (IEPR) and natural gas price forecast; with California ISO's inputs on generator data and operation data, etc.

## Description of PLEXOS Software

The energy and ancillary service co-optimization is the basis of the PLEXOS algorithm. The PLEXOS Mixed Integer Programming Algorithm (MIP) in SCUC/ED (Security Constrained Unit Commitment/Economic Dispatch) produces the optimal decision on the generation and reserve provisions from each generator to meet the system energy demand and reserve requirements.

**Figure 1. Source of LTPP Assumptions from Multiple Resources**




Source: R.12-03-014: LTPP Track II Workshop – Operating Flexibility Modeling Results