

Impact of Market Prices on the Economic Feasibility of Transmission Expansion

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Presentation Outline

- Importance of Market Prices
- Methodologies
- Residual Supply Index (RSI) Approach
- Case Study

Market Prices - Why and When ?

- Why -- Economic viability of proposed expansion can be significantly influenced by market prices
 - $TB = ? PC = ? CS + ? GS + ? TS$, for both societal perspective
 - Total benefits = change in prod. costs = change in consumer, generator, and transmission surplus
 - Societal perspective - less efficient commitment and dispatch
 - Participant perspective - can be very sensitive to changes in LMP's due to impact on CS, GS, and TS
- When - Market prices need to be developed for economic transmission analyses when the cost-based simulation is not sufficient

Evolution of Modeling Market Prices

- Early 1990s - cost-based
- Mid 1990s - fixed bid adders
- Late 1990s - ancillary service price determination
- Early 2000s - game theoretic models (simple systems)
- Mid-2000s - dynamic bidding models

Game Theoretic Models

- Purpose is to try to mimic strategic bidding behavior of multiple parties in an open market
- Alternatives include
 - Cournot - quantity is strategic variable
 - Bertrand - price is strategic variables
 - Supply Function Equilibrium (SFE) - entire bid function is strategic variable
- Difficult to apply to complex, interconnected regional systems with many generators and transmission limits

Dynamic Bidding Models

- Bids change hourly as a function of system and market conditions
- Econometric model is developed based on actual, historical relationships
- Advantage - relationship is benchmarked to a variety of historical conditions
- Potential disadvantages - hourly market data may not be readily available or past may not represent the future

Residual Supply Index (RSI) Approach

- Econometric model with dynamic bidding
- Price Mark-Up (PMU) is derived from historical observation relating the market price to level and ownership of excess supply
- PMU is applied hourly to selected generator bids within a market zone

Price Mark-Up Definition

- $PMU = a + (b \cdot RSI) + (c \cdot PLU) + (d \cdot SP) + (e \cdot Peak)$
 - PMU - Price Mark-Up (applied to generator bids by hour and zone)
 - RSI - Residual Supply Index
 - PLU - Percent of Load Unhedged
 - SP - dummy variable for summer periods
 - Peak - dummy for peak periods

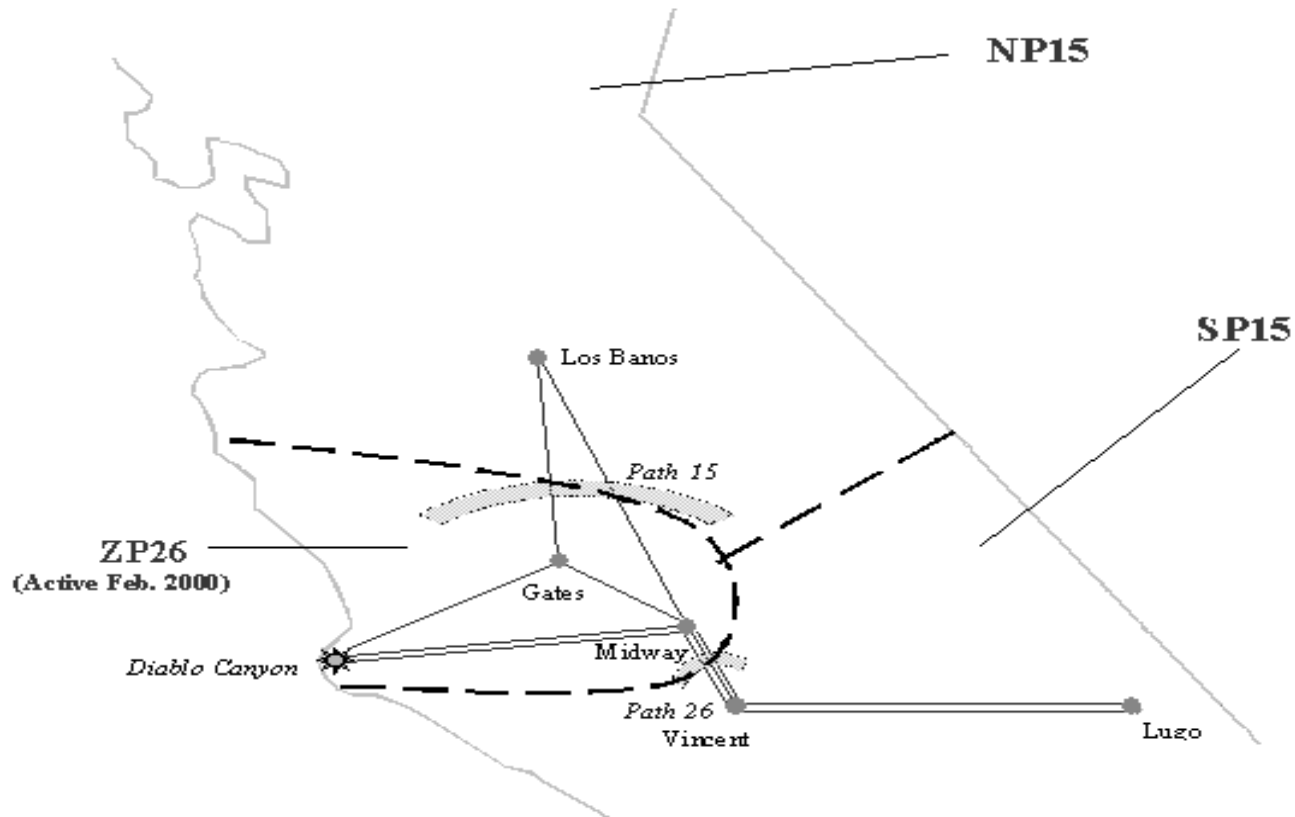
Residual Supply Index (RSI) Definition

- $RSI = (TS - \text{Max}(TUC)) / \text{Load}$
 - TS - Total Supply for a zone including import capability
 - TUC - Total Uncommitted Capacity of largest single independent generator
 - Load - hourly zonal demand including firm exports
 - In competitive markets, RSI represents hourly planning reserve margin (i.e. 1.15 or higher)
 - In uncompetitive markets, RSI becomes closer to zero

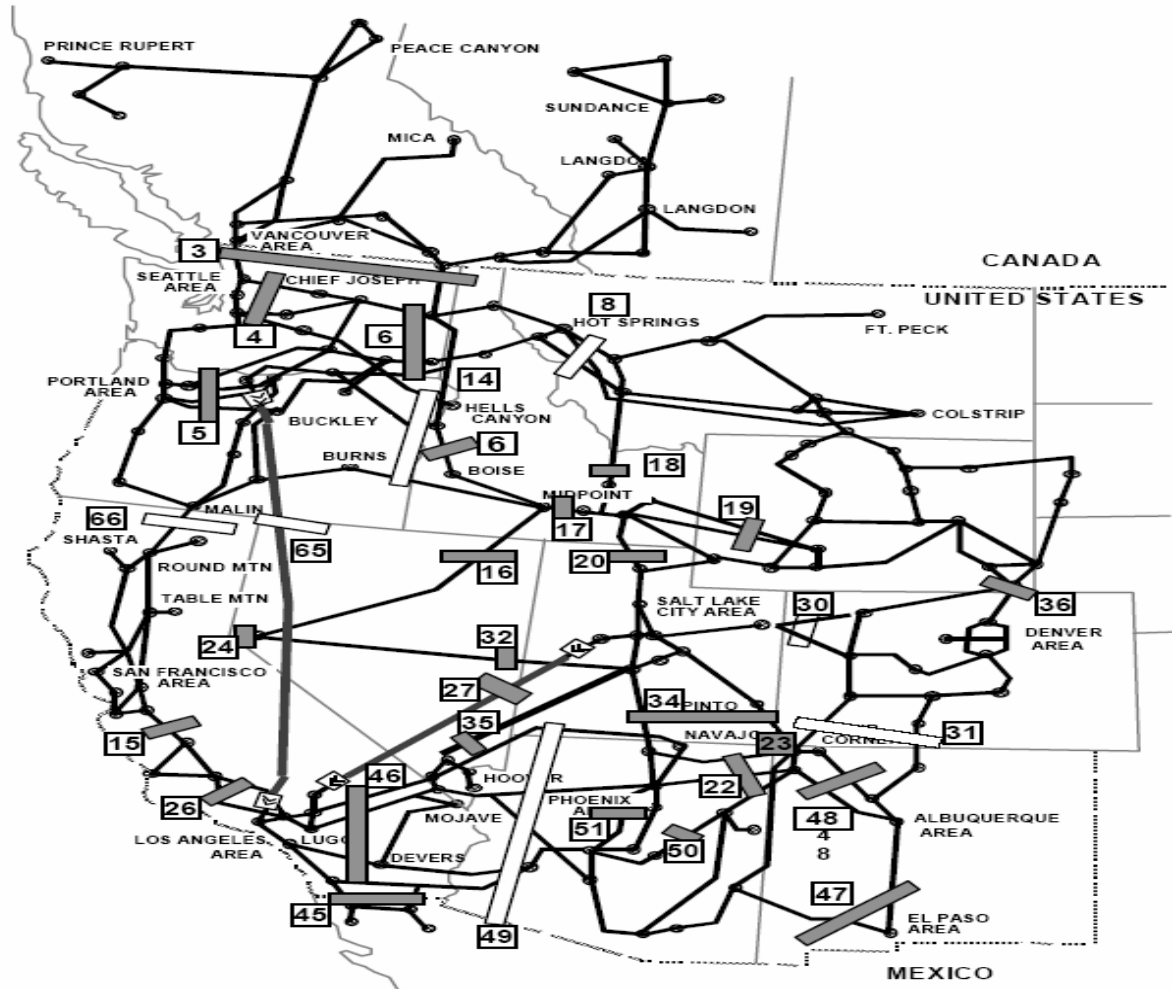
Percent of Load Unhedged (PLU) Definition

- $PLU = (Load - UG - UFC) / Load$
 - UG - Utility Generation
 - UFC - Utility Forward Contract
 - If completely hedged, PLU is zero (or negative)
 - If completely unhedged, PLU is one

Case Study - Path 26



Path 26 (cont.)



Price Mark-Up Derivation

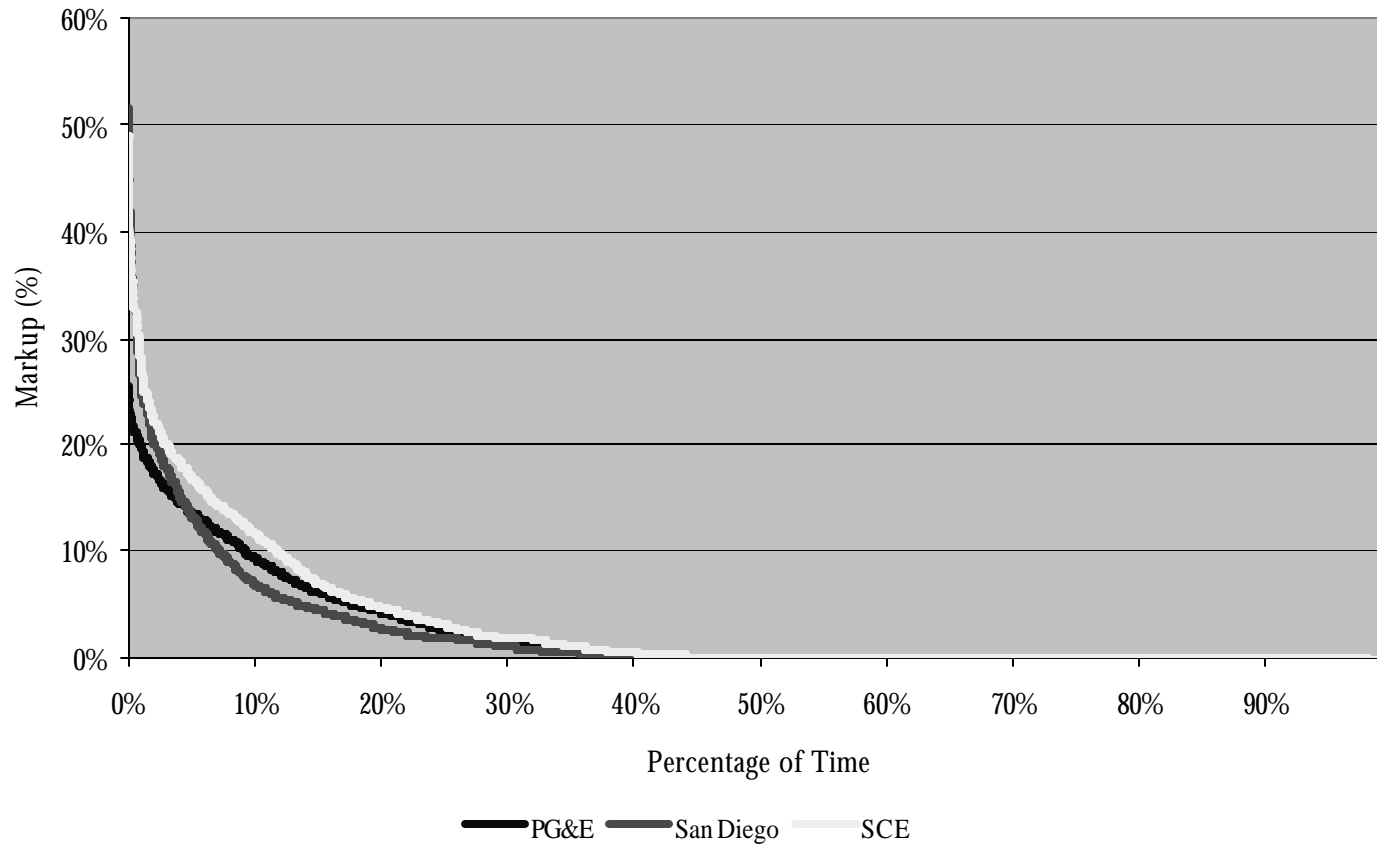
- Evaluated two years of hourly data for 3 zones in CA for regression equation (2000 and 2003)
- Regression results:
 - $PMU = 0.14 - (0.53 * RSI) + (0.65 * PLU) + (0.086 * SP) + (0.15 * Peak)$
 - Total number of observations - 31,333
 - R-squared - 0.46

PMU Illustration (typical summer peak hour)

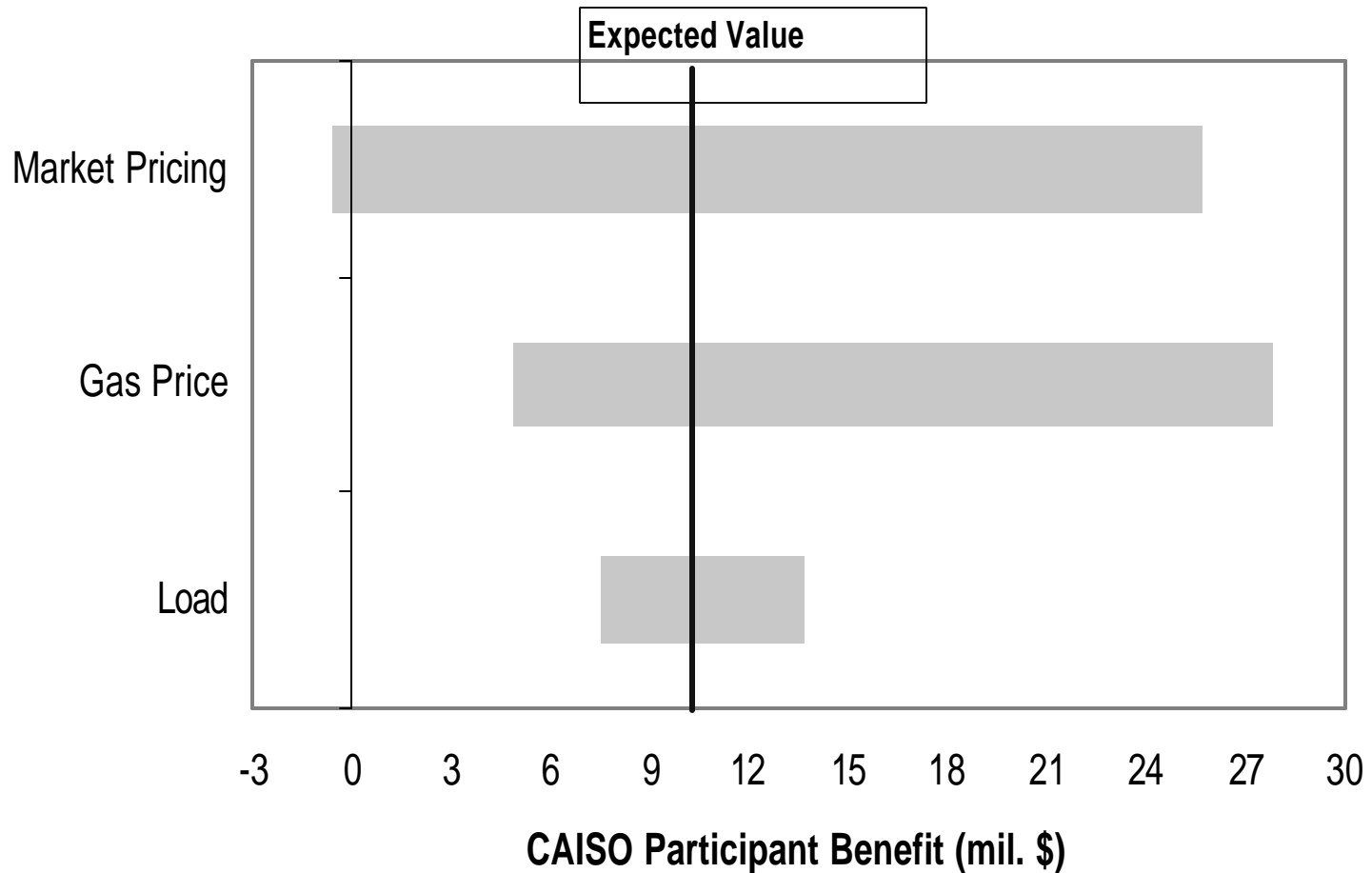
Competitive Conditions	Unhedged Load	Price Mark-Up (calc.)	Price Mark-Up (adj.)
very	0%	-26%	0%
	20%	-13%	0%
	40%	0%	0%
marginal	0%	-10%	0%
	20%	3%	3%
	40%	16%	16%
uncompetitive	0%	6%	6%
	20%	19%	19%
	40%	32%	32%

Predicted Price Mark-Ups in 2008

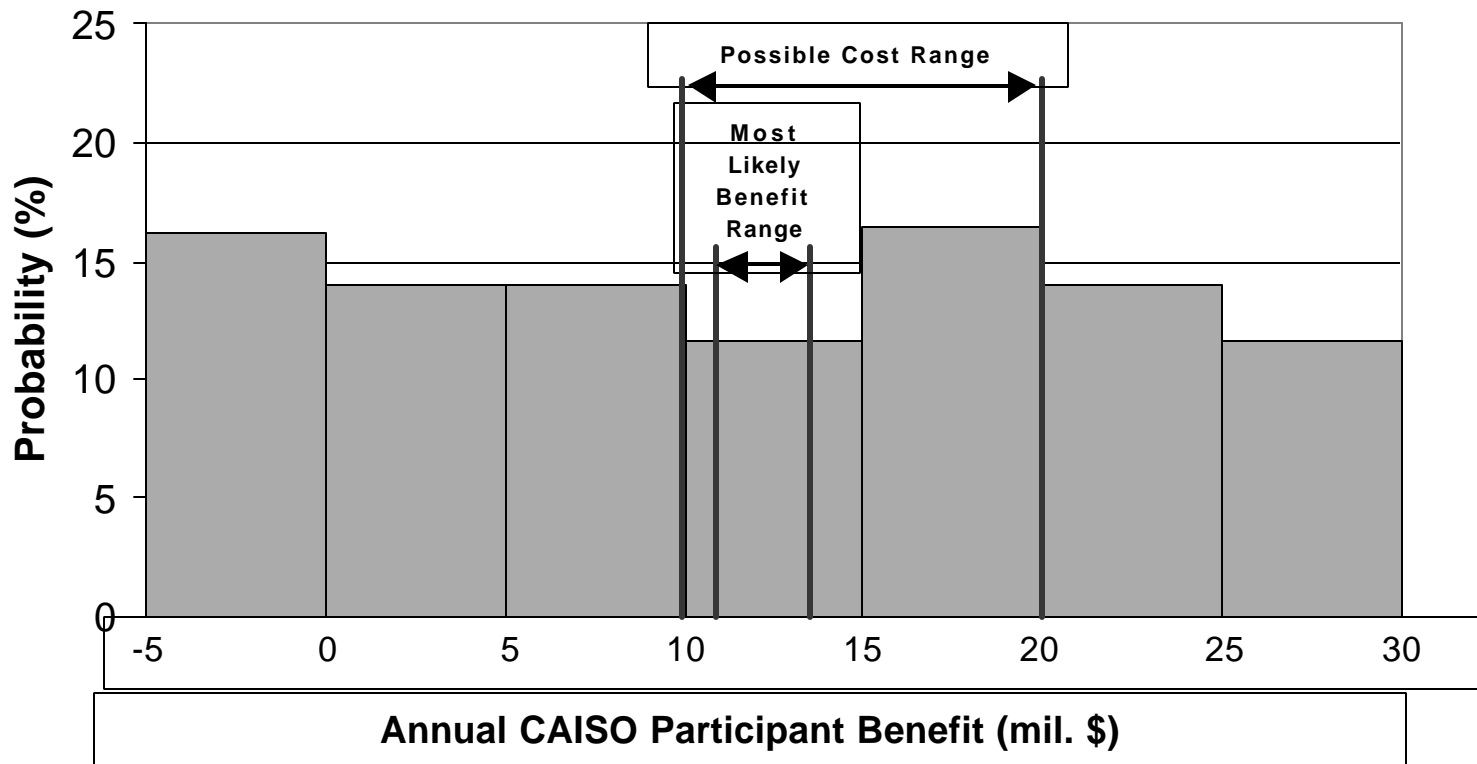
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Potential Impact of Single Uncertain Variables in 2013



Distribution of Potential Energy Benefits in 2013



For Further Info . . .

- “Transmission Economic Assessment Methodology Report”, CAISO, Chapter 4, “Market Price Derivation”, June 3, 2004.
<http://www.caiso.com/docs/2003/03/18/2003031815303519270.html>