

Locational Marginal Pricing Study

Recent & Upcoming Reports: LMP Studies 3A, 3B, & 3C

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CALIFORNIA ISO



Presentation Overview

- Recently released Locational Marginal Pricing (LMP) Studies:
 - **Study 3B:** Projected 2006 conditions, to support CRR Study 2, released 8/24/05 (<http://www.caiso.com/docs/2005/07/01/200507011120032841.html>)
 - **Study 3A, Report 2:** Nov. 2003 to April 2004 conditions, released 10/20/05 (<http://www.caiso.com/docs/2004/01/29/2004012910361428106.html>)
- LMP Study 3C releases are starting
 - Initial release: May 2004 conditions
- LMP Study 3C methodology





Purpose of LMP Studies

- Analyze proposed market structure
- Identify needed details of market structure
- Information for planning LMP implementation
- Identify requirements for load aggregation
- Phases of Studies:
 - Study 3A: Historical conditions, with initial model
 - Study 3B: Historical bids with future conditions
 - Study 3C: Historical conditions with improved model





LMP Study 3A & 3B Model

- Hourly integrated energy and congestion management market (single-settlement) with no market separation rule or balanced schedule requirement;
- Market conditions for a full year Nov. 2002 to Oct. 2003;
- Actual hourly load data, aggregated similarly to zones identified in May '02 proposal;
- Market-based bid curves, which incorporate generation outages;
- Modification of bid curves to reflect RMR dispatch;
- Hour-ahead path ratings, without adjustment for ETC capacity, plus internal interfaces (San Francisco, Bay Area, San Diego, Fresno, North Bay, etc.);
- Recognition of scheduling limits
- Transmission line outages for 500 kV lines and 500-to-220 kV transformers;
- Ancillary service constraint for operating reserve;
- Unit commitment dependent on the market bids (not optimized);
- \$250 bid cap; and
- AC OPF algorithm including contingency analysis (impact of potentially significant outages).





Differences: Studies 3A vs. 3B

- LMP Study 3A
 - Fall 2003 ISO Operations network model
 - “Closed loop” network model to show ultimate impact of LMP
- LMP Study 3B
 - 2006 Planning network model
 - New generation added, generation retirements placed off-line
 - Loads scaled up by 8.64% to projected 2006 level
 - “Open loop” network model to match CRR Study 2 and initial MRTU implementation
 - Updated interface constraints
 - Losses estimated and removed from area loads, to avoid double-counting





Study 3B: Key Findings

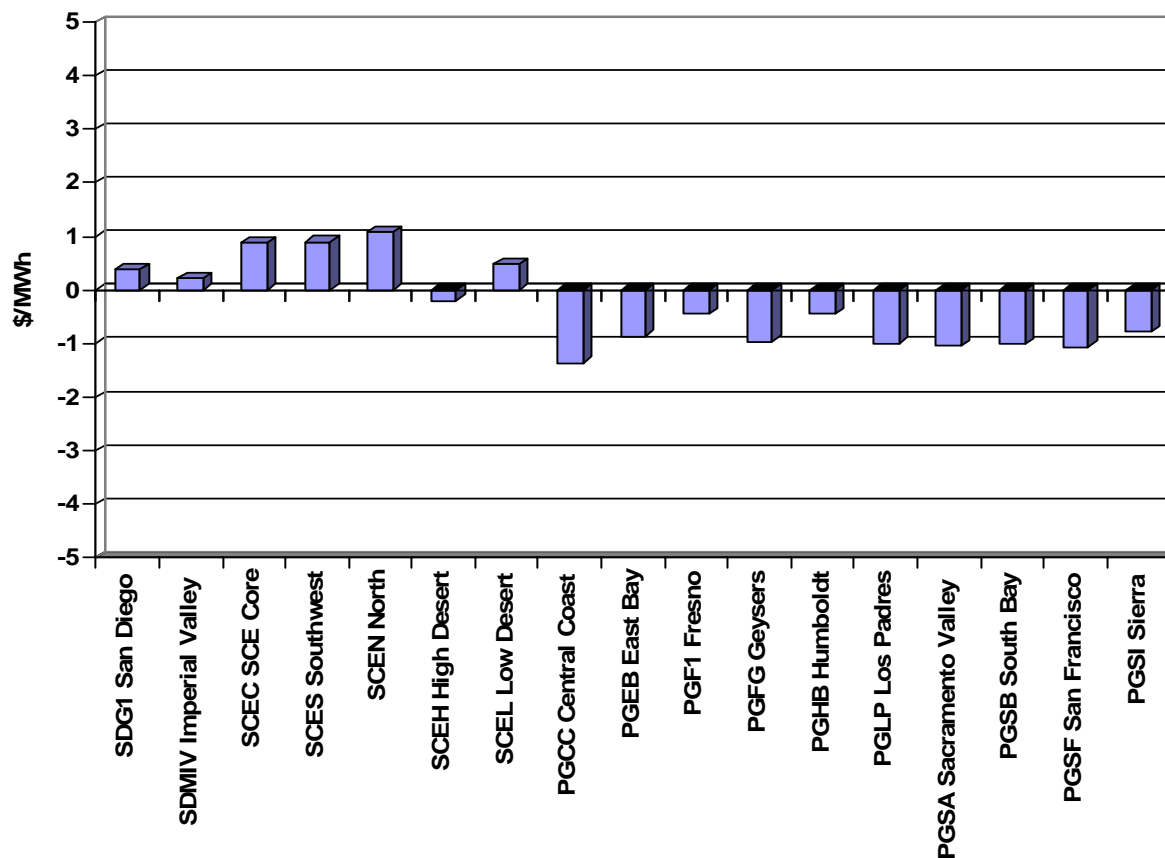
LMP prices within major zones were generally very similar.
(More variation in Summer than Winter)

North of Path 15		South of Path 15	
Local Load Zone	Avg. Annual LMP	Local Load Zone	Avg. Annual LMP
Humboldt	\$44.03 / MWh	Los Padres (ZP26)	\$40.10 / MWh
San Francisco	41.96	SCE Core	42.91
East Bay	40.41	SCE Southwest	42.78
South Bay	40.72	SCE North	42.28
Fresno	41.62	SCE High Desert	38.71
Geysers	40.87	SCE Low Desert	42.42
Sierra	40.53	San Diego	42.44
Sacramento Valley	41.10	Imperial Valley	38.72
Central Coast	40.50		



Study 3B Results: Average Congestion

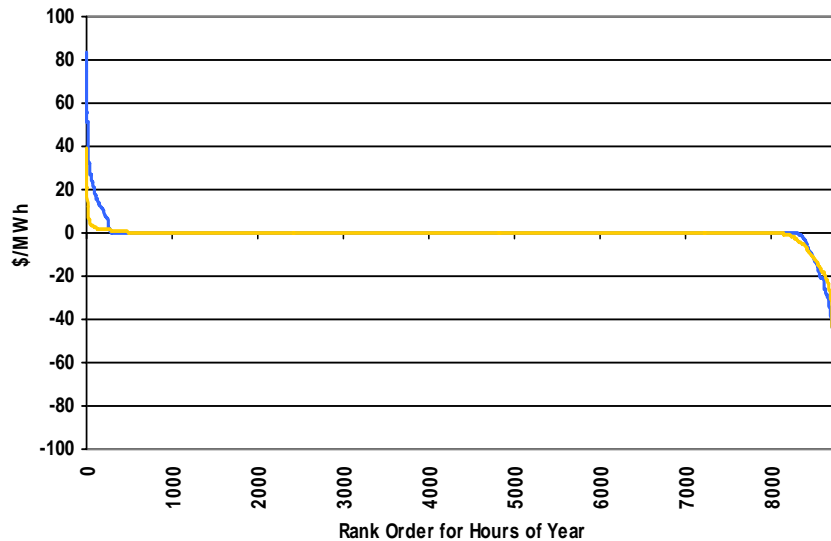
Annual Average LMP Congestion Price by Area



Study 3B Results: Time Variation

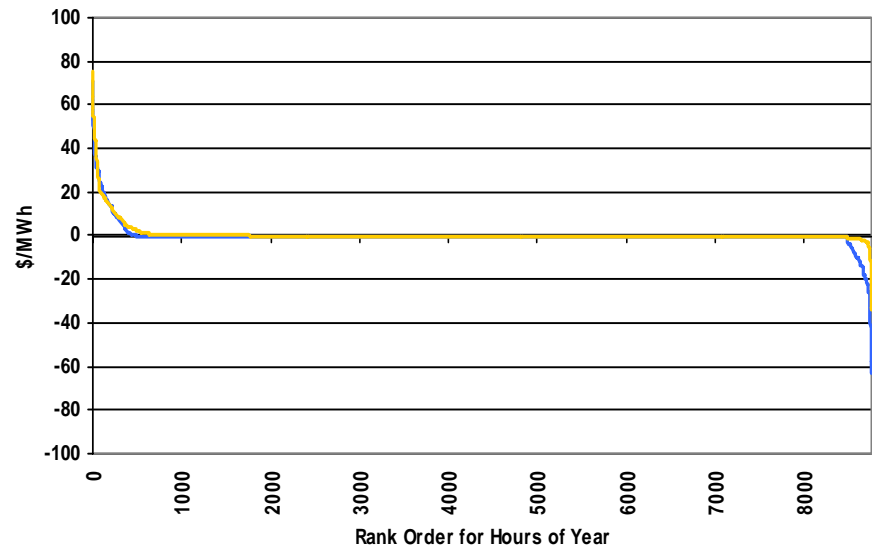
- Less than 1% of nodal prices exceeded \$100/MWh, and 91% were below \$65.
- 89% of nodal prices were within \$3/MWh of average load aggregation price.
- The frequency and magnitude of "congestion costs" are similar to what is found in the ISO's current market.

Actual Real-Time Congestion Price Duration Curve,
NP15 Congestion Zone, vs. Modeled PG&E Load Aggregation



— NP15 Congestion Zone (Existing) — PG&E Load Aggregation Zone (MRTU)

Actual Real-Time Congestion Price Duration Curve,
SP15 Congestion Zone, vs. Modeled SCE Load Aggregation

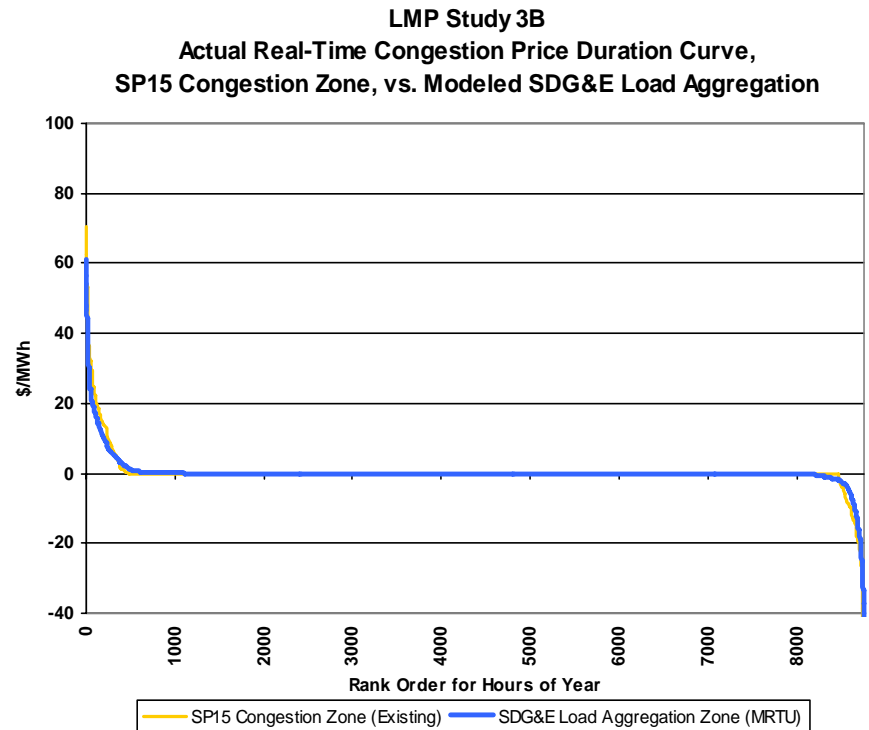
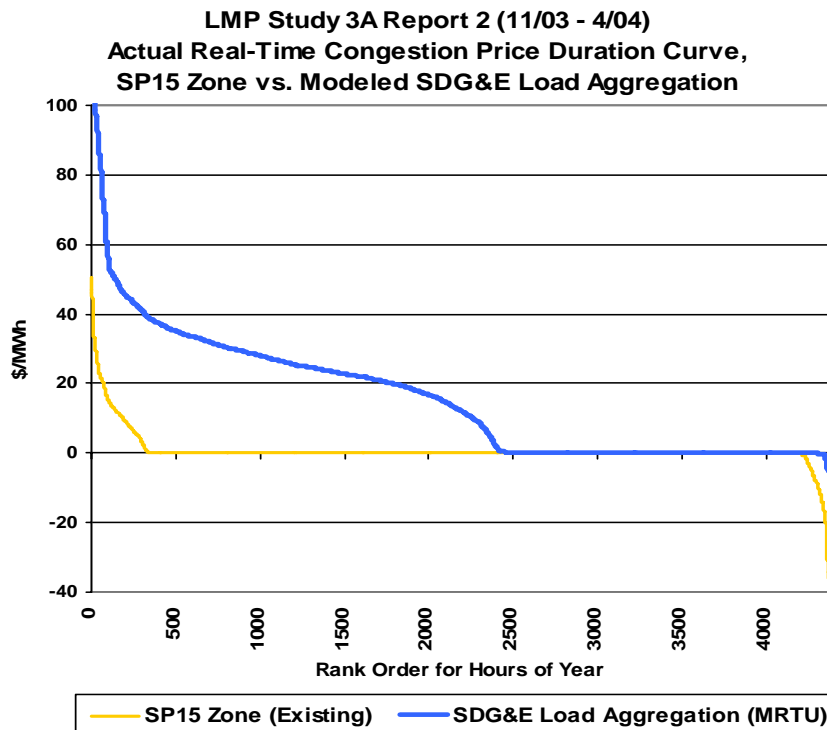


— SP15 Congestion Zone (Existing) — SCE Load Aggregation Zone (MRTU)



Study 3A & 3B Results: Miguel

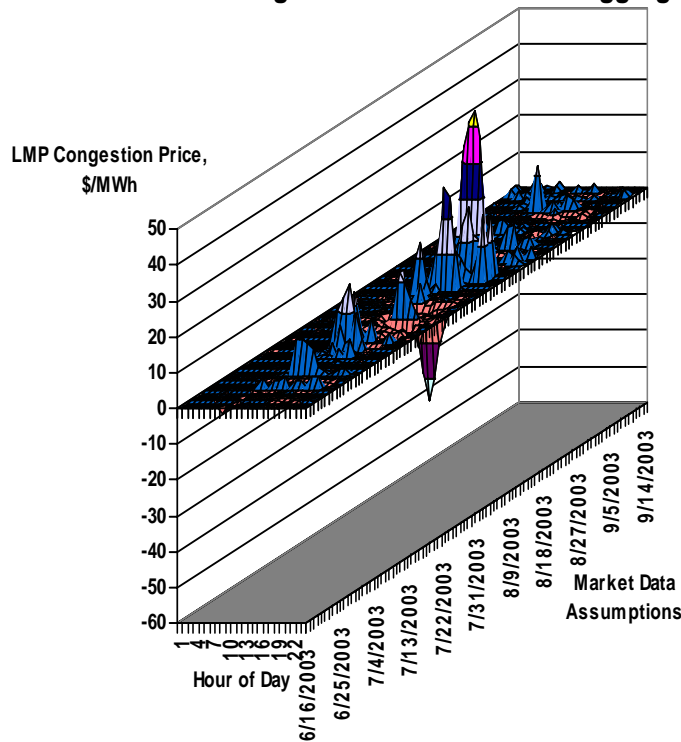
For the San Diego Gas and Electric (SDG&E) area, costs of congestion at Miguel substation caused significant LMP price differentials in LMP Study 3A. By 2006, upgrades will be in service that nearly eliminate the Miguel limit as a binding constraint, and few high prices occur in San Diego relative to other areas.



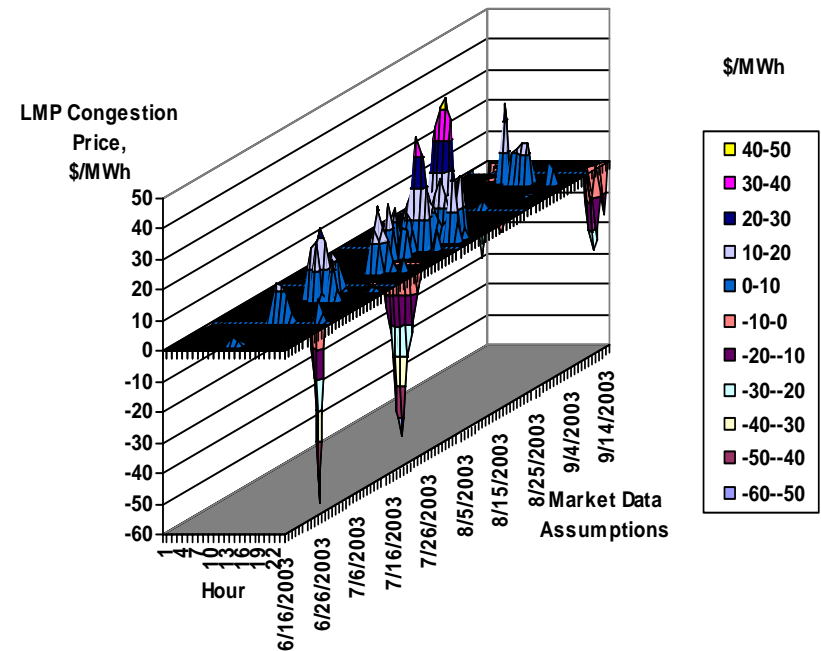
Study 3B Results: Time Variation

Within local load zones, price variations can occur in specific hours, but typically last only a few hours or less. This pattern is similar to the actual price variations that have resulted from the ISO's current market.

Simulated LMP Congestion Price: SCE Load Aggregation

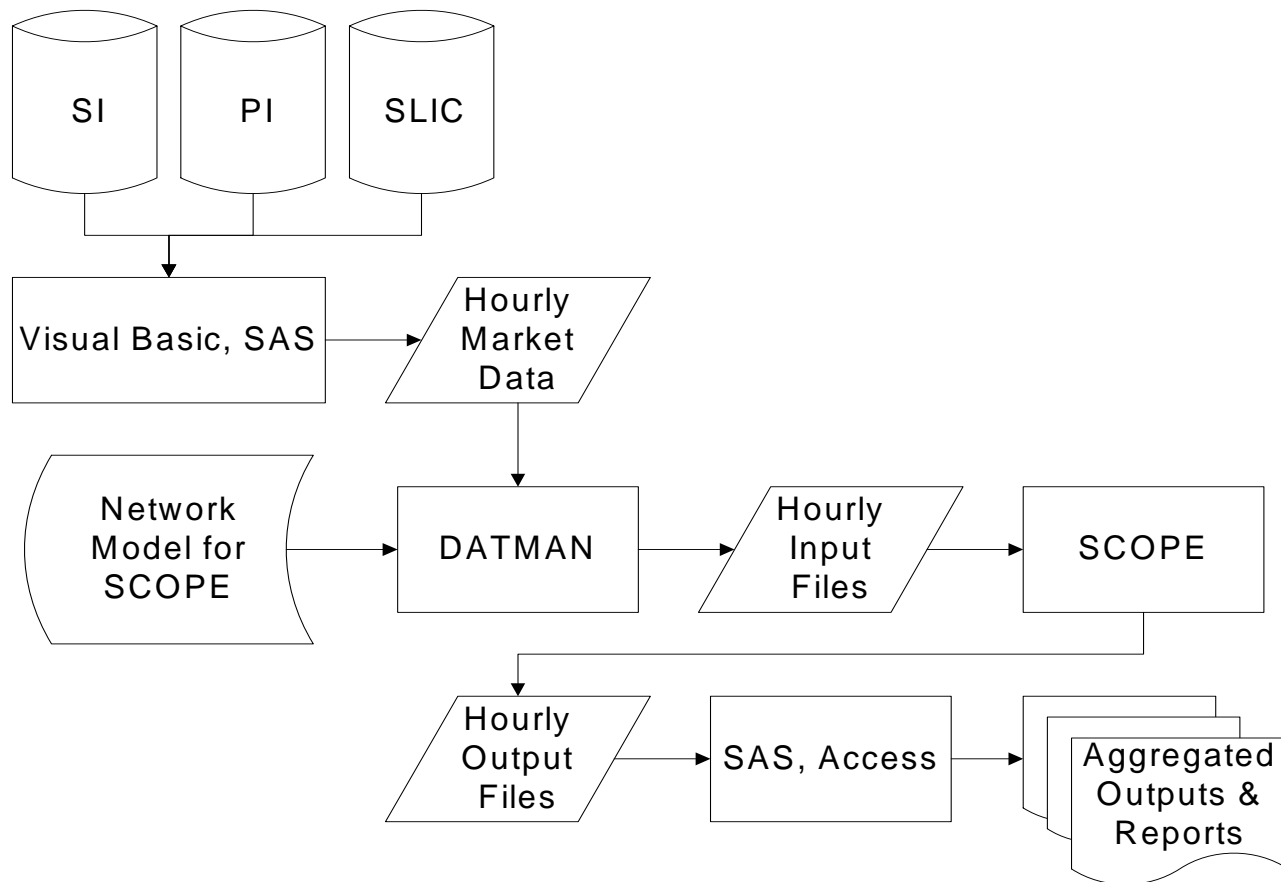


Actual Ex-Post Zonal Congestion Price: SP15



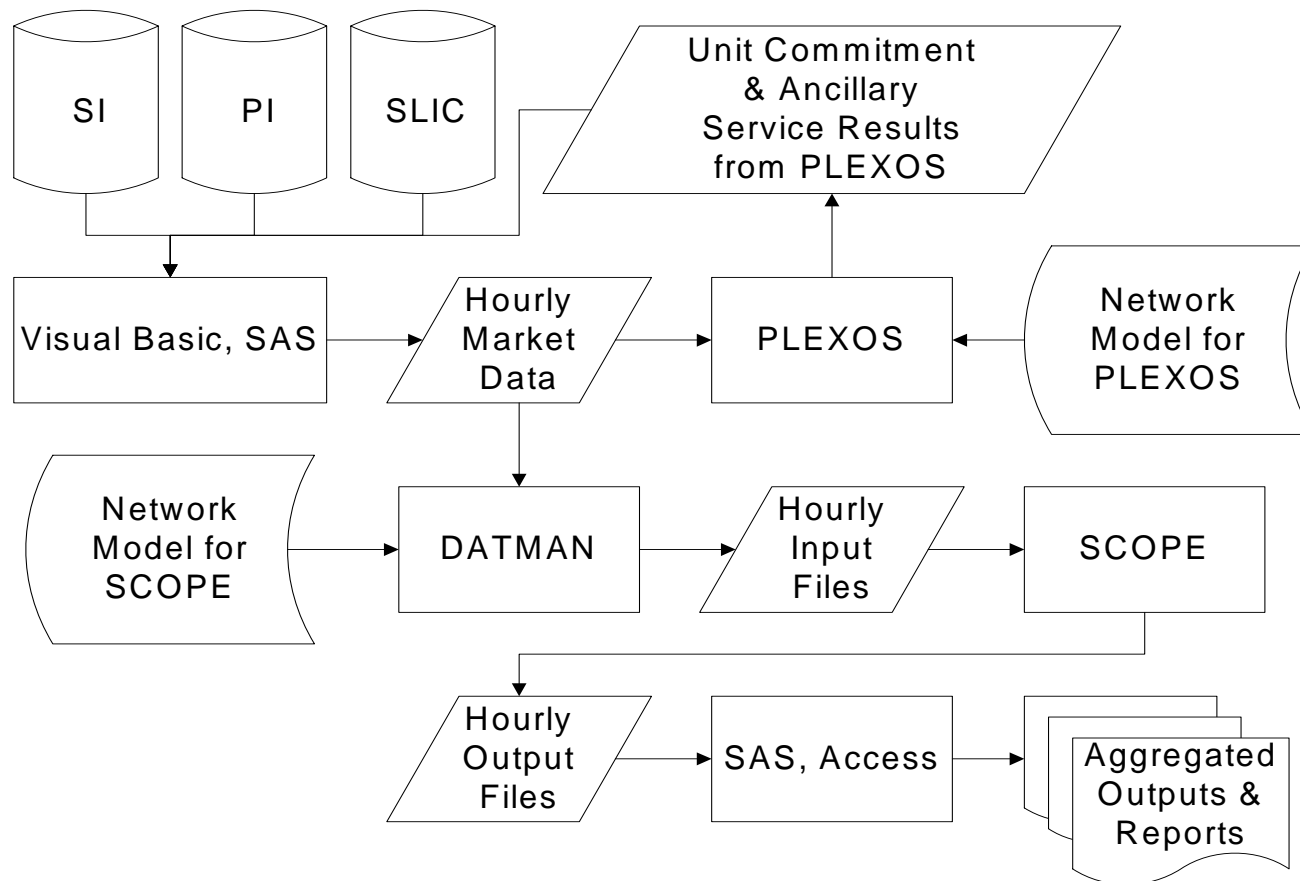
Study 3A & 3B: Process Flow

Studies 3A & 3B have used AC OPF, treating dispatch intervals as independent snapshots in time.



Study 3C: Process Flow

Study 3C adds optimization of unit commitment and ancillary service reservations, followed by AC OPF for final prices.



Study 3C Results: May 2004

Highlights:

1. May 3 Transmission Emergency due to South of Lugo congestion
2. Limited Miguel congestion due to SWPL maintenance

Simulated Load Zone LMP Congestion Price: SDG&E Load Aggregation

