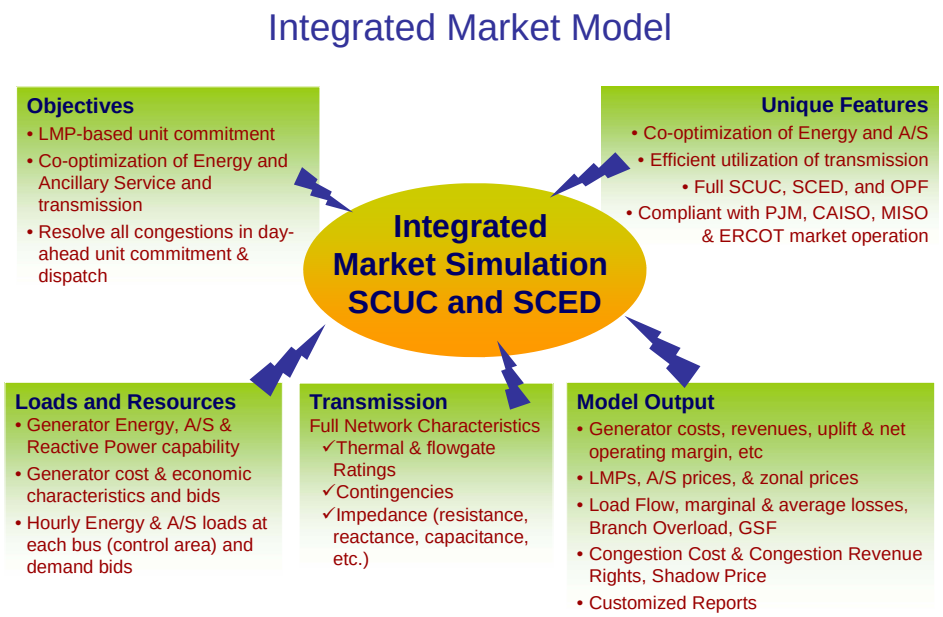
Appendix F. Overview of LCG Consulting's UPLAN model

A Complete System for Integrated Market Simulation, Price Forecasting, Optimal Power Flow, Asset Valuation, Options and Risk Management

Overview

The UPLAN Network Power Model (UPLAN-NPM) projects detailed physical and financial operations of electricity markets under conditions ranging from traditional regulation to today's post-restructuring competitive market structures.



UPLAN-NPM integrates electricity market simulation with a full (AC/DC) network transmission model, projects hourly Locational Marginal Prices (LMP), and is fully compliant with the market design specifications of Federal Energy Regulatory Commission (FERC) Order 2000 and Standard Market Design (SMD).

UPLAN-NPM has been used to accurately simulate and analyze such regional markets as PJM, New York, New England, MISO, ERCOT and California. The day-ahead market is simulated in UPLAN by optimizing the commitment of resources for energy and all ancillary services taking into account transmission and inter-regional constraints. The commitment and dispatch algorithms incorporate both optimal power flow and resource scheduling to faithfully simulate the security constraints of a complete transmission network.

UPLAN-NPM: Day-Ahead Market Model

UPLAN simulates overall day-ahead market using Security-Constrained Unit Commitment (SCUC) and Security-Constrained Economic Dispatch (SCED). In the first step, UPLAN schedules day-ahead resources in appropriate amounts and locations to meet forecast energy (loads) and ancillary services (reserves) requirements, while taking into account region-specific operating protocols as well as transmission constraints. Optimal Power Flow simulation is used to ensure that the final unit commitment can in fact obey all transmission constraints including line contingencies and generator outages.

In its determination of optimal unit commitment subject to security constraints, UPLAN realistically characterizes generators' market participation based on opportunity or marginal cost-based bidding, with arbitrage, which is simulated via a state-of-the-art multi-commodity Nash equilibrium algorithm.

For SCED, the OPF simulation may utilize either DC or AC power flow, and the system will be optimally re-dispatched to manage congestion while obeying transmission constraints such as line thermal limits, including use of post-contingency analysis for all specified contingencies under which the dispatch is required to remain secure. The two steps described above work interactively to realistically simulate day-ahead energy and ancillary service markets.

Integrated Market Simulation Features

- Day-Ahead Security Constrained Unit Commitment process and Security Constrained Economic Dispatch
  - Congestion management in day-ahead and during dispatch
  - Use of transmission constraints and resolve all congestion in the Day Ahead Markets
  - Distributed marginal (or average) losses for unit commitment and Dispatch
- Co-optimization of energy and ancillary services
- LMPs for energy at every node and A/S prices at every ISO controlled Zone
- Zonal as well as Nodal Model

Risk Management Analysis

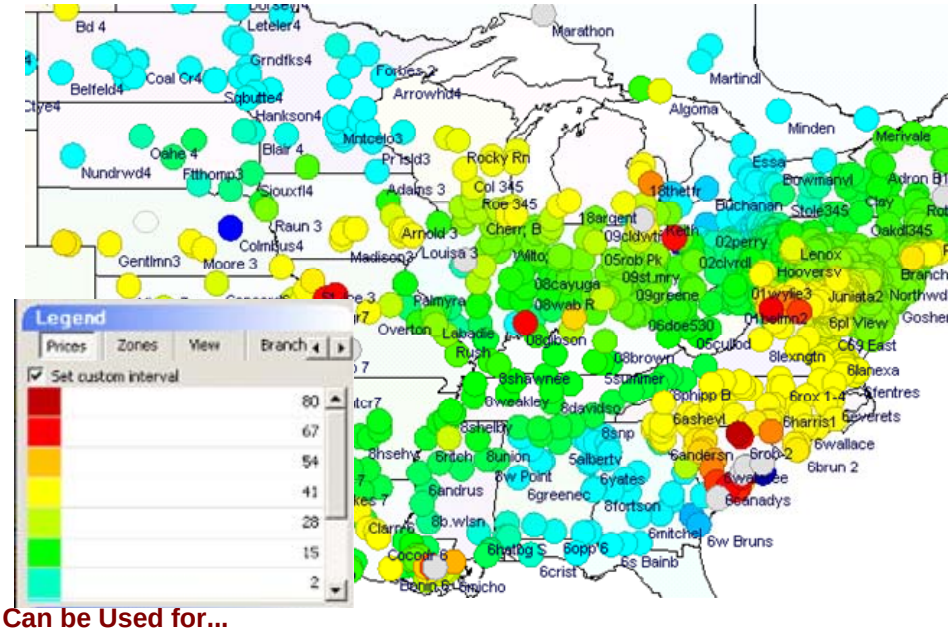
- Long term volatility for Asset Valuation, Capacity Expansion, and Transmission Valuation and Capacity Market Simulation
- Real time market using short-term volatility
- Volatility Model for Greeks and Structural Risk Management

Short and Long Term Generation Forecast

- Hourly Energy, Capacity and Ancillary Services Prices and Revenues
- Generator Performance, Operation, Starts, Emission, OOM, Hourly Operating Margins, Costs and Revenues
- Long-term Generation Valuation and Real Options

- Capacity Expansion & Retirements, Maintenance

Sample Output – Distribution of LMPs

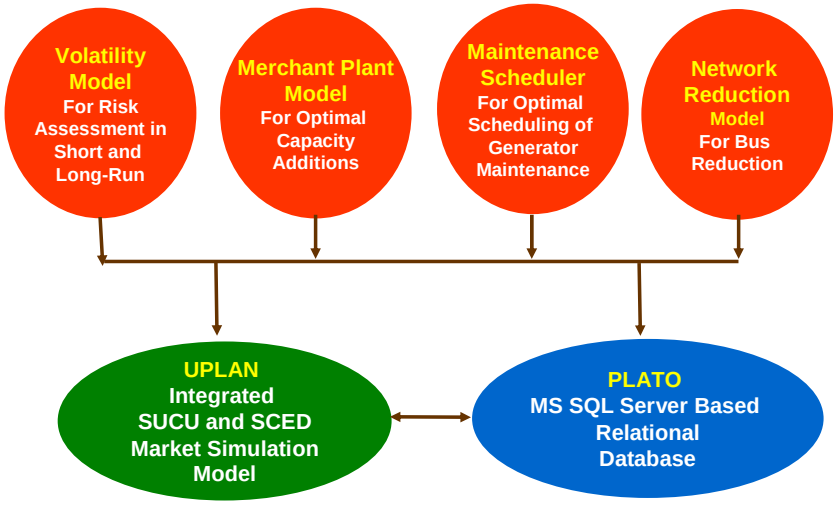


UPLAN Can be Used for...

- Energy (LMP), Capacity and Ancillary Service Prices
- Generator Costs, Uplift, Net Operating margin Income
- Fuel Consumption
- Congestion Cost & Congestion Revenue Rights, Shadow Price
- Load Flow, Branch Overload, GSF
- Reliability & System Adequacy Analysis
- ISO Operations and Tariff Design
- Market Power Analysis
- New market entry and Capacity Price Forecast
- Emission & Forecast Allowance Prices
- Volatility, Hedging & Risk Management
- Asset Valuations

Functional Components of UPLAN Integrated System

To address various business and regulatory issues in the evolving environment, the UPLAN system seamlessly integrated a number of models and databases.



LCG Consulting
4962 El Camino Real, Suite 112, Los Altos, CA 94022
Tel: (650) 962-9670 / Fax: (650) 962-9615
URL: http://www.energyonline.com
Email: Info@energyonline.com