



Gas Power Investments and Portfolios

Natural Gas Power Generation USA 2014

FC Gas Intelligence

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Chicago

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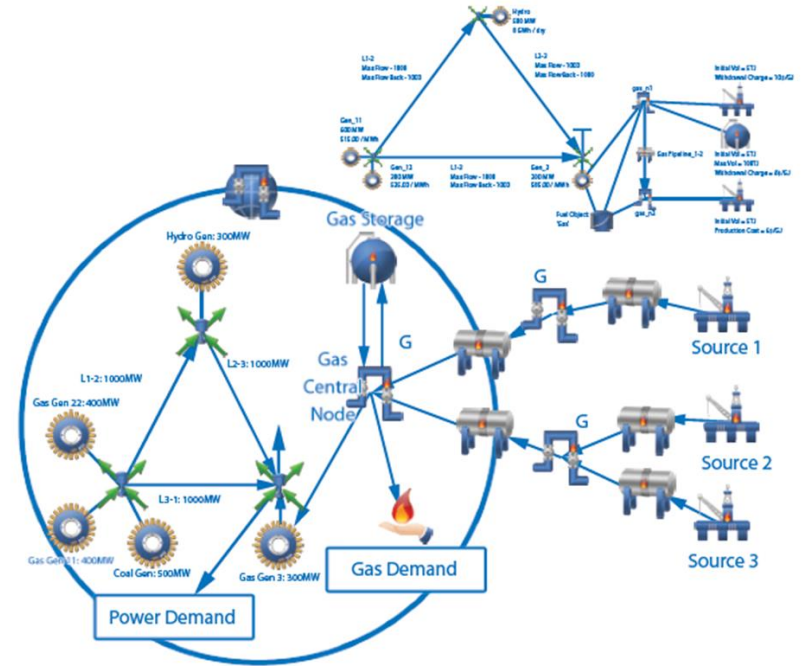
Energy Exemplar

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Trends

- Coal Retirements
- Renewables
- Ancillary Services
- Emission Policy and Regs
- Transmission Expansion
- Gas Pipeline Expansion
- Demand Response
- Distributed Generation
- Commodity Storage



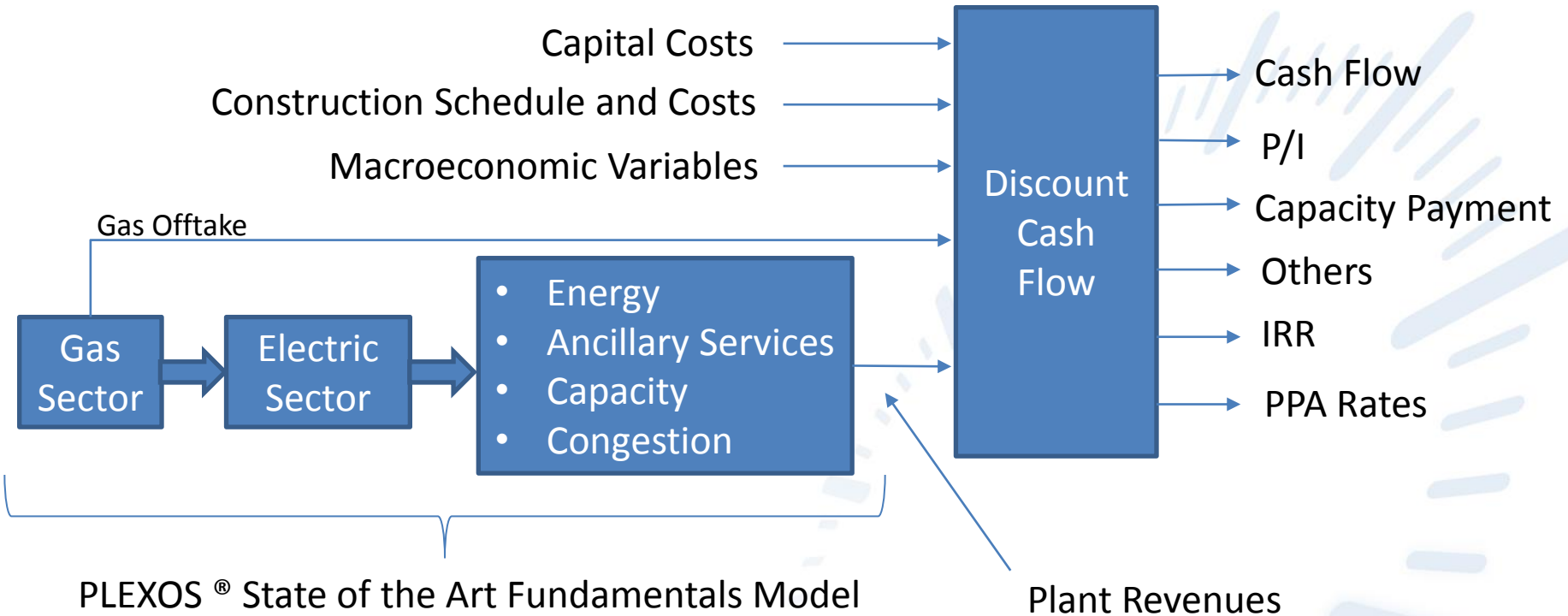


Valuation Factors

- Energy Prices
- Ancillary Service Prices
- Capacity Prices
- Congestion
- Basis Risk
- Spark Spread
- Portfolio Optimization



Illustrative Gas Power Plant Valuation Analysis

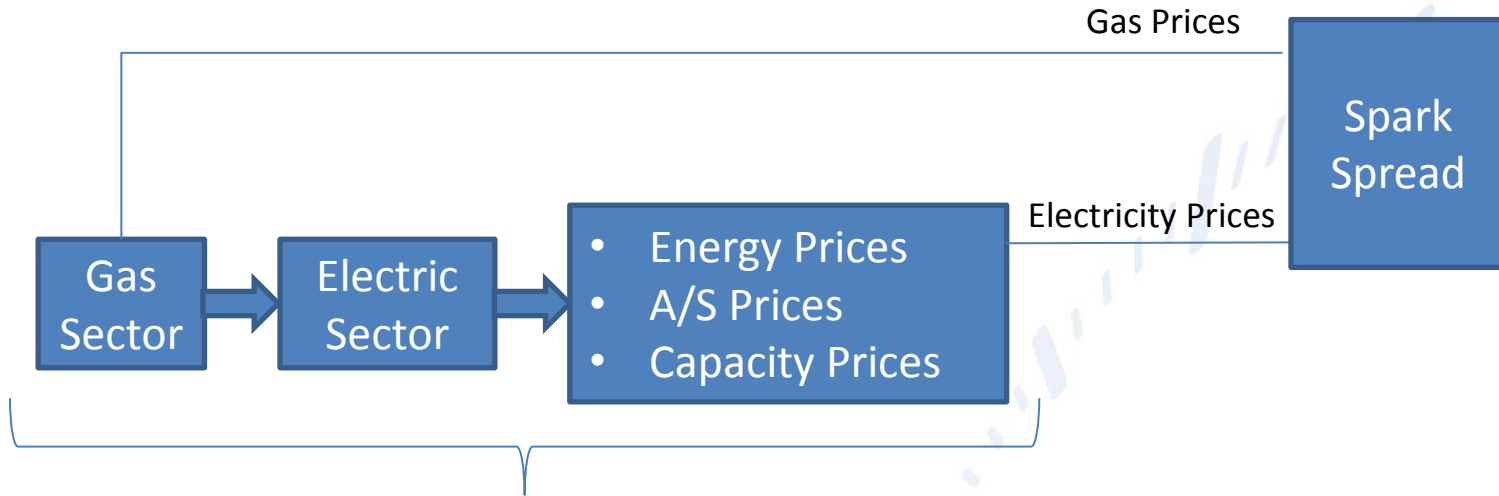


PLEXOS® State of the Art Fundamentals Model

Plant Revenues



Spark Spread – Fundamentals or Econometrics?



PLEXOS® State of the Art Multi Sector Fundamentals Model

Econometric Models
fall short of forecasting basis risk



Algorithms

- Mimic Least Cost Dispatch Systems
- Nodal/Zonal/Regional
- Sub Hourly and Hourly Production Cost
- Chronological or load duration curves
- Large-scale mixed integer programming solution
- Deterministic, Monte Carlo; or
- State-of-the-art Stochastic Optimization (optimal decisions under uncertainty)
- Simultaneous Gas Electric Production Cost

Stochastic Variables

- Load
- Fuel prices
- Electric prices
- Ancillary services prices
- Hydro inflows
- Wind infeed, *etc*
- Others



Market Dispatches

*Minimize Cost = generator fuel and VOM cost + generator start cost
+ contract purchase cost – contract sale saving
+ transmission wheeling
+ energy / AS / fuel / capacity market purchase cost
– energy / AS / fuel / capacity market sale revenue*

Subject to

- Energy balance constraints*
- Operation reserve constraints*
- Generator and contract chronological constraints: ramp, min up/down, min capacity, etc.*
- Generator and contract energy limits: hourly / daily / weekly / ...*
- Transmission limits*
- Fuel limits: pipeline, daily / weekly / ...*
- Emission limits: daily / weekly / ...*
- Others*



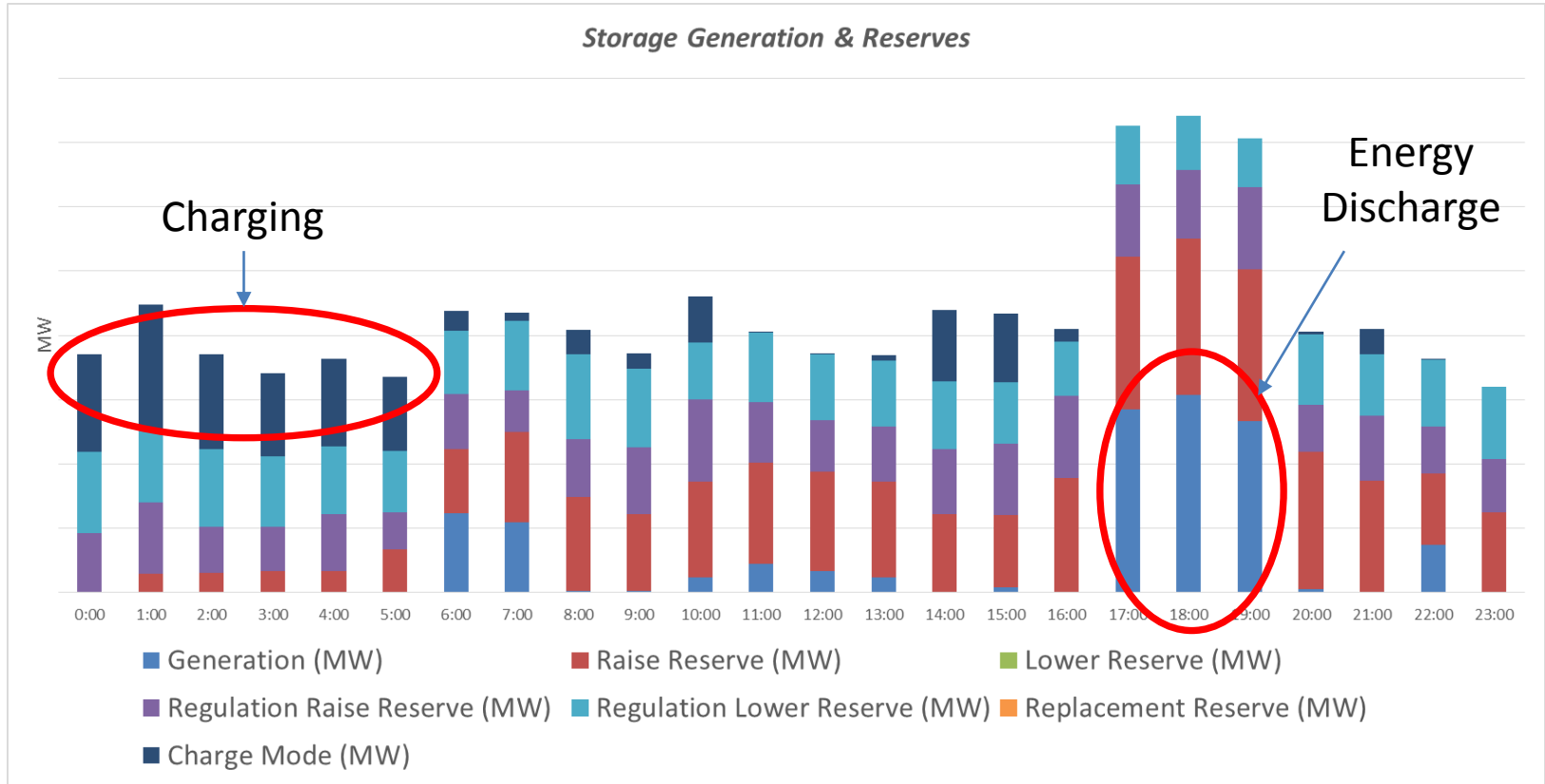
Ancillary Services

Reliable and Secure System Operation requires the following product and Services (not exhaustive):

1. Energy
2. Regulation & Load Following Services – AGC/Real time maintenance of system's phase angle and balancing of supply/demand variations.
3. Synchronised Reserve – 10 min Spinning up and down
4. Non-Synchronised Reserve – 10 min up and down
5. Operating Reserve – 30 min response time
6. Voltage Support – Location Specific
7. Black Start – (Service Contracts)



Energy Storage and Ancillary Services

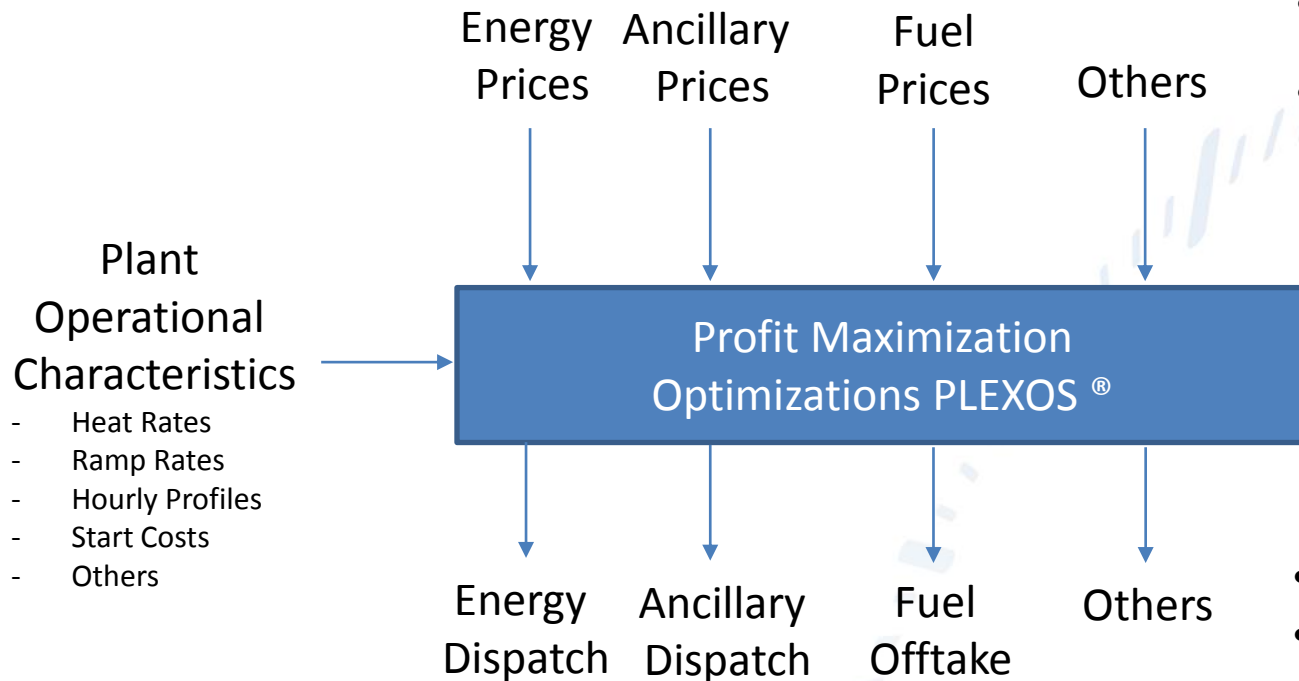




Portfolio Optimization



Portfolio Optimizations



- Plant Operational Characteristics
- Heat Rates
 - Ramp Rates
 - Hourly Profiles
 - Start Costs
 - Others

- 24 Hr Optimizations
- 1 Week Optimizations
- Longer Optimizations

- Multi Unit Portfolio
- Stochastic Replications



PLEXOS®
Integrated Energy Model

Gas Electric Operational and Planning Process



Planning Process

Power Sector

- 10 Year Plans
- Stakeholder Process
- Planning Coordinators
- Integrated Resource Plans
- Modeling Workgroups
- Regional Reliability Standards
- Planning Process Cost Recovery
- Regional Operations Planning

Gas Electric Studies and Taskforces

EISPC, EIPC, WIEB, Regional Taskforces

Natural Gas Sector

- No 10 year plans
- Stakeholder Process Pipeline to LDC
- No Planning Coordinators
- No Integrated Resource Plans
- No modeling workgroups
- No Regional Reliability Standards
- No shared cost allocation for planning pipelines
- Proposed project with open season



Strategic Planning Gas Electric

- Cost Recovery Mechanism
- Gas Electric Planning Coordinator Function
- Stakeholder Process
- 10 year plans
- Reliability Standards
- Least Cost Multi Sector Co-Optimized Planning
- National vs. Regional
- Operational Planning



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Integrated Energy Model

Energy and Ancillary Revenues including Gas Network



Energy and Ancillary Services Revenues including Pipeline Constraints

- Minimize:
 - Electric Production Cost + Gas Production Cost + Electric Demand Shortage Cost + Natural Gas Demand Shortage Cost + Ancillary Services Shortage Cost
- Subject to:
 - [Electric Production] + [Electric Shortage] = [Electric Demand] + [Electric Losses]
 - [Ancillary Service Provision] \geq [Ancillary Services Requirements]
 - [Transmission Constraints]
 - [Electric Production] and [Ancillary Services Provision] feasible
 - [Gas Production] + [Gas Demand Shortage] = [Gas Demand] + [Gas Generator Demand]
 - [Gas Production] feasible
 - [Pipeline Constraints]
 - others



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Integrated Energy Model

Investment and Portfolio Optimizations



Investment and Portfolio Optimizations

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- Gas / Electric Price Forecasting
- Gas / Electric Supply and Demand Balances
- Gas / Electric Asset Valuations
- Combined Gas / Electric Planning
- Gas / Electric System Adequacy
- Individual Sector Analysis (Gas or Electric)
- Fuel Diversity
- Congestion and Basis Risk Analysis
- Portfolio Optimizations

