

Winter 2002/3: Gas Storage Forensics and Emerging Market Trends

Richard L. Levitan, President

Levitan & Associates, Inc.

INFOCAST

Boston, MA

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Overview

- Market Dynamics
- Storage trends
- Basis Blowout
- Negative Spark Spreads
- Gas / electric scheduling tensions
- Storage valuation principles
- Risk / reward allocation effects

Gas Market Developments

- Bleak E&P outlook short-to-intermediate term
- Continued Genco emphasis on optionality
- Winter v. Summer spark-spreads
- Volatility leads to negative spark spreads
- Value through opportunism

Emerging Storage Trends

- LDC Obligation to serve
- Increased market orientation
- High Deliverability Storage (HDS)
- Growth of synthetics, *i.e.*, financial products emulating physical storage performance
- Global LNG trade / renewed interest in LNG regasification terminals

Emerging Storage Trends, cont'd

- Variable hourly takes for gencos' load-following requirements
- Avoidance of costly imbalance penalties
- Multiple cycles: summer w/d, winter injection
- Price arbitrage
- Merchant storage services
 - Load-following
 - Parking and lending
 - Balancing

Changing Continental Supply Dynamics

- Maturation of existing producing basins
 - Running hard to maintain production levels
 - Gulf Coast
 - Onshore and shallow water production flat to declining
 - Deep water production growth
 - WCSB
 - Declining production from shallow wells in the east
 - Growth from deeper more expensive wells with longer lead-times, *e.g.*, Ladyfern (northeastern BC)

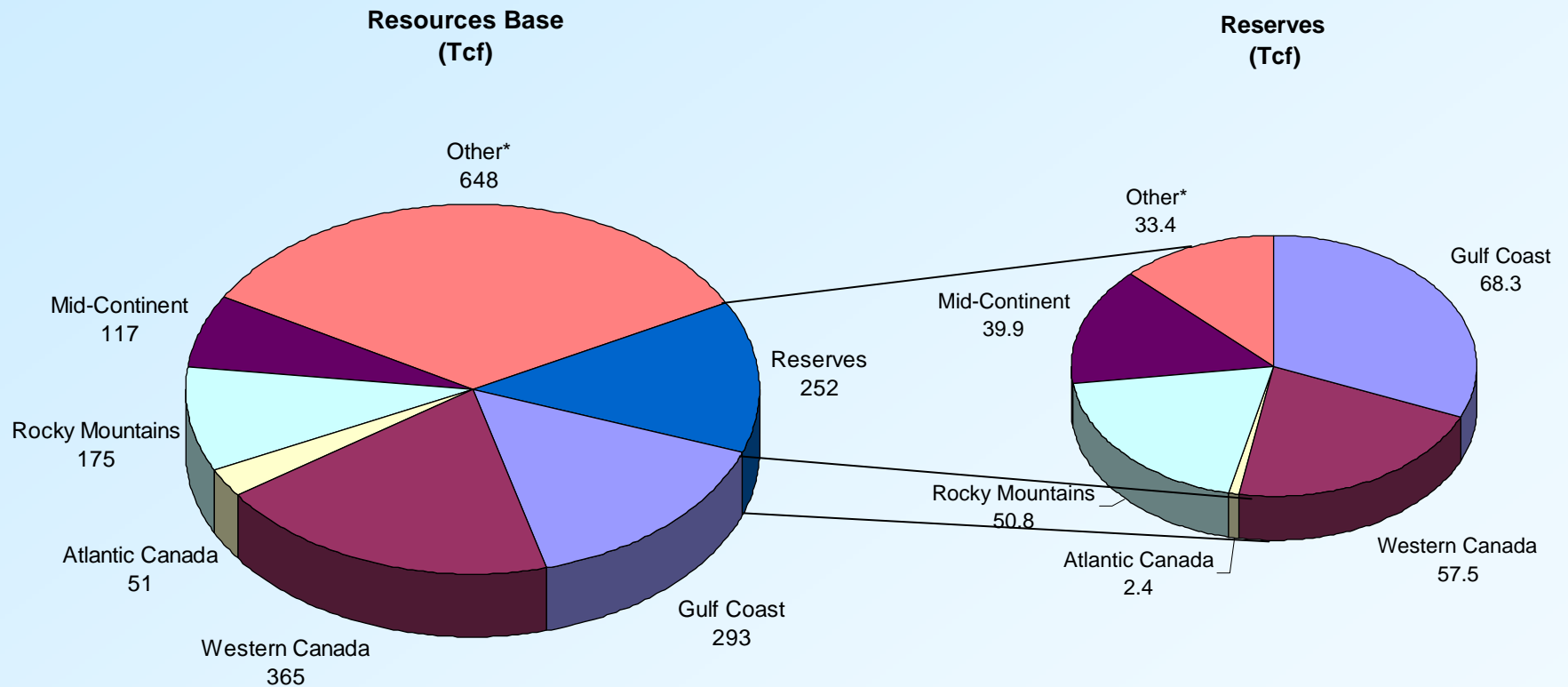
Changing Continental Supply Dynamics (cont'd)

- Growth from New Supply Basins and Sources
 - New basins less prolific and require new pipeline infrastructure
 - Atlantic Canada
 - Regional supply potential for Atlantic Canada and U.S. Northeast
 - Not another Gulf Coast
 - Rocky Mountain Producing Basin
 - Smaller fields
 - Coalbed CH₄
 - LNG growing supply source to fill production gaps

Continental Demand 2003-08 (update)

- DOE growth estimates top 7 Tcf by 2010 / 11.5 Tcf by 2020
- Generator demand growth about 2.6% per year to 80 Bcf/d by 2005
 - Fuel needs account for 45% of demand growth
 - Peak-demands by gas-fired generators increasing at 5% per year
 - Storage infrastructure requirements
- Bulk power reliability concerns

North American Natural Gas Supply

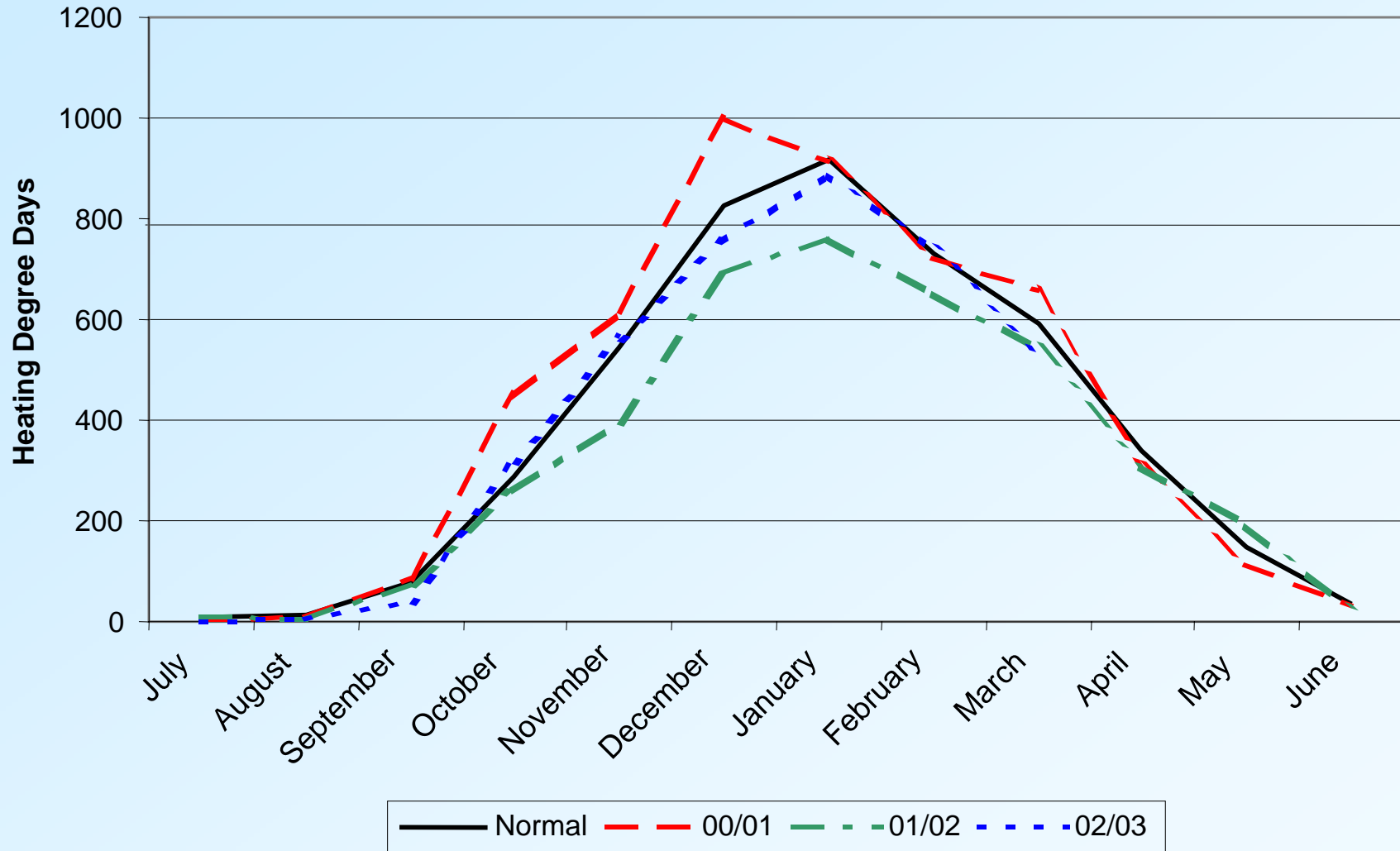


* "Other" includes Appalachia, Mid-Continent, Alaska, the Mackenzie Corridor, the Pacific Coast, other frontier regions of Canada and coalbed methane reserves and resources

Sources: EIA, CAPP, Canadian Potential Gas Committee

Recent Climate Trends

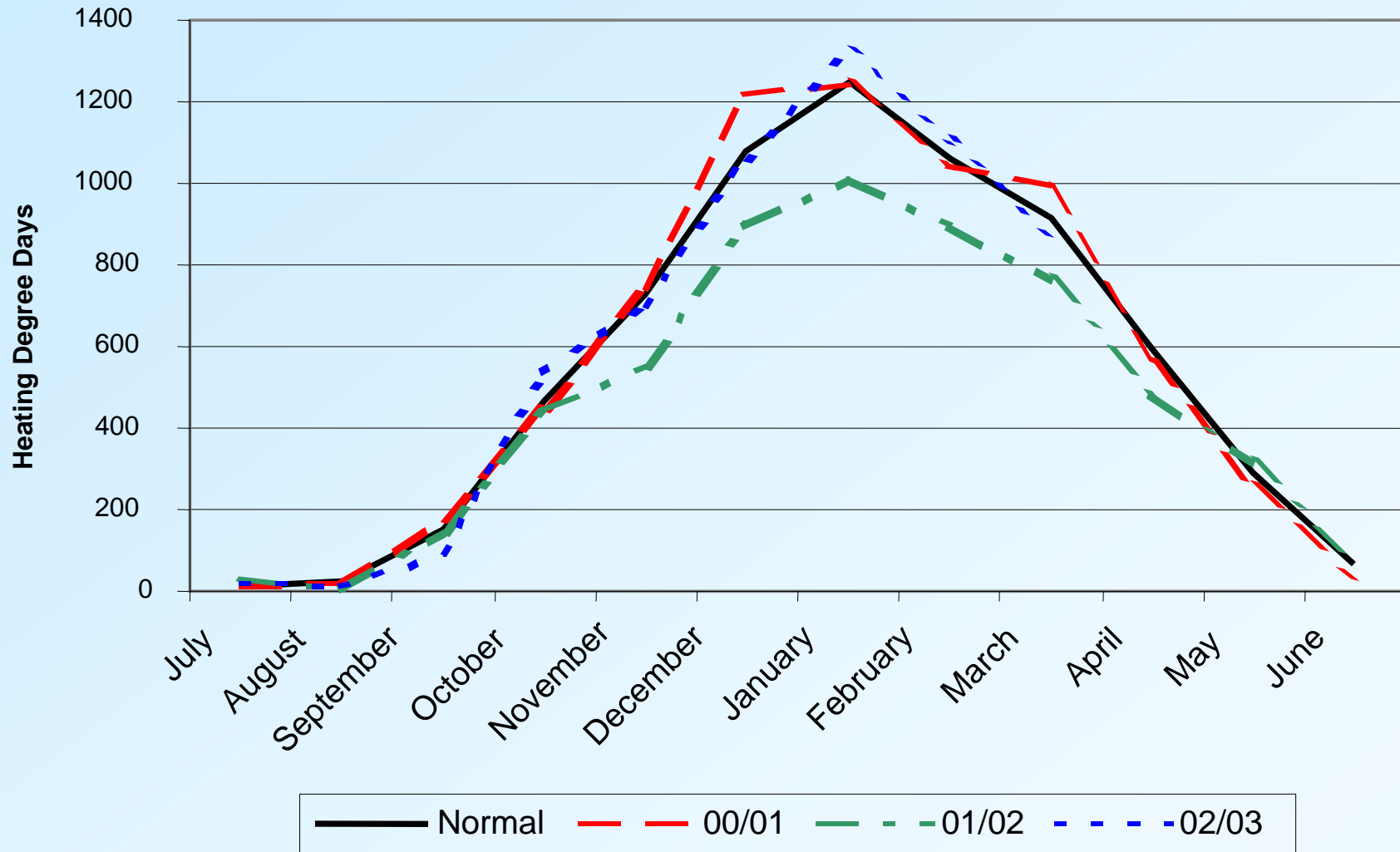
National



Source: National Oceanic and Atmospheric Administration

Recent Climate Trends

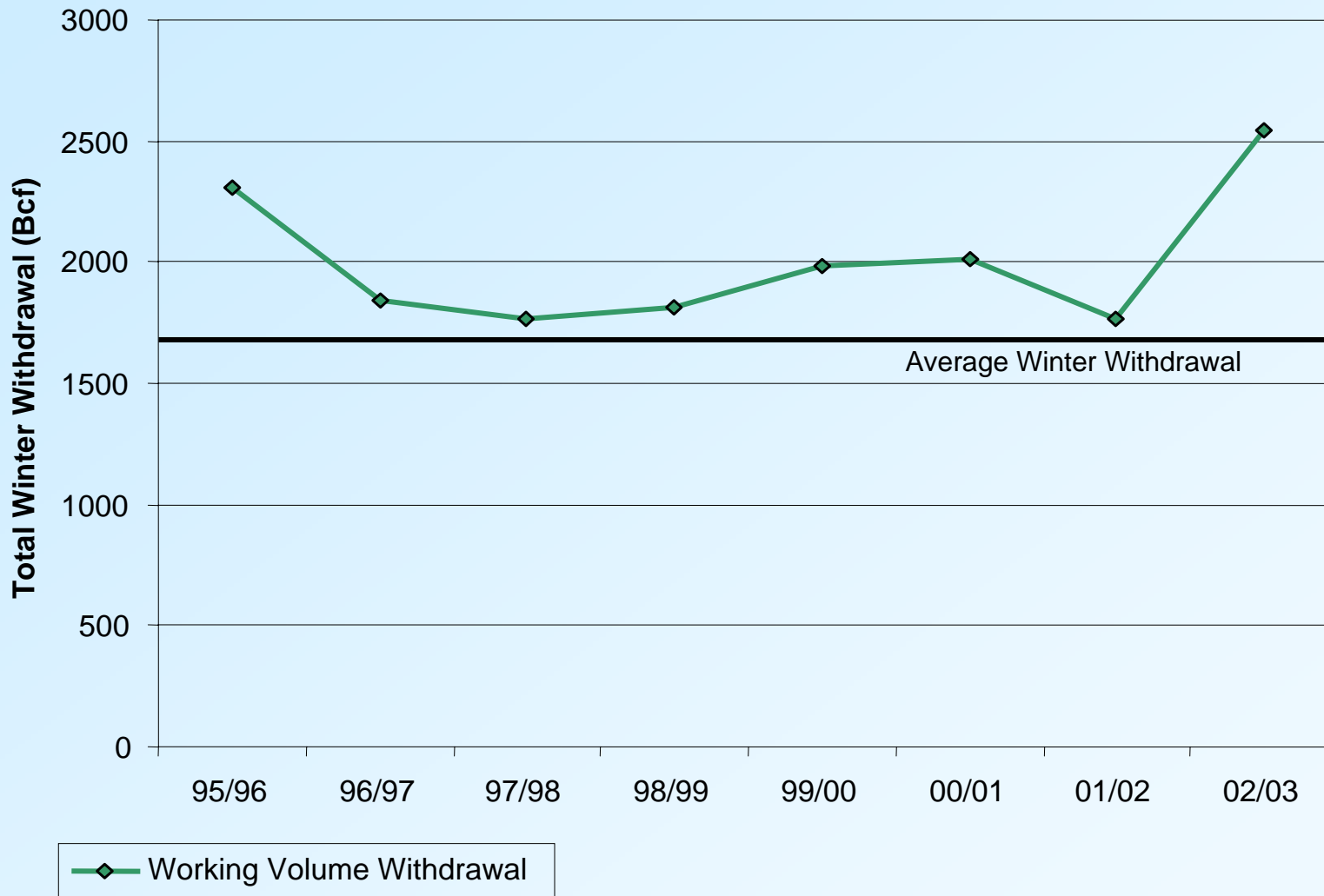
New England



Source: National Oceanic and Atmospheric Administration

Storage Withdrawal Trends

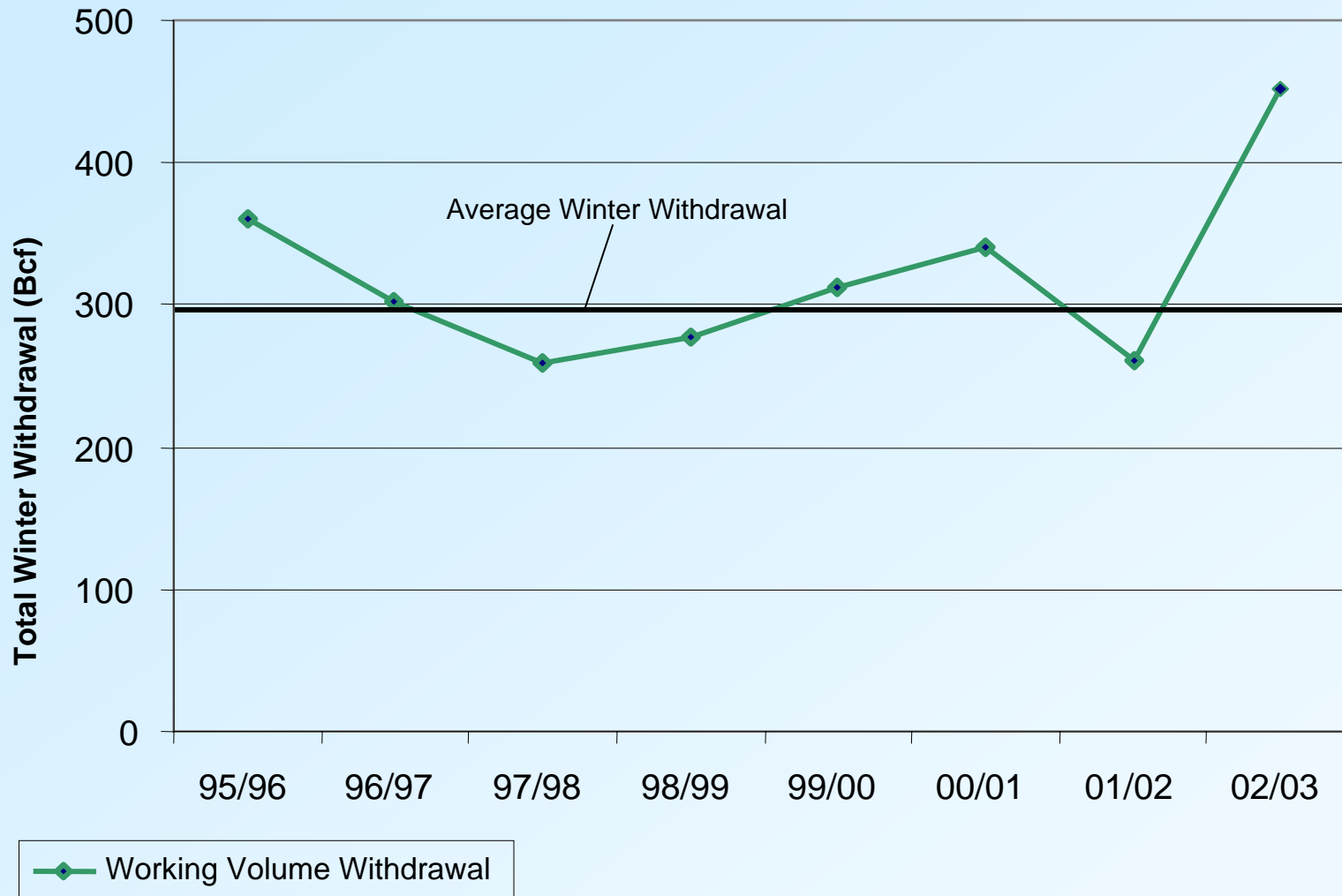
National



Sources: NOAA, EIA

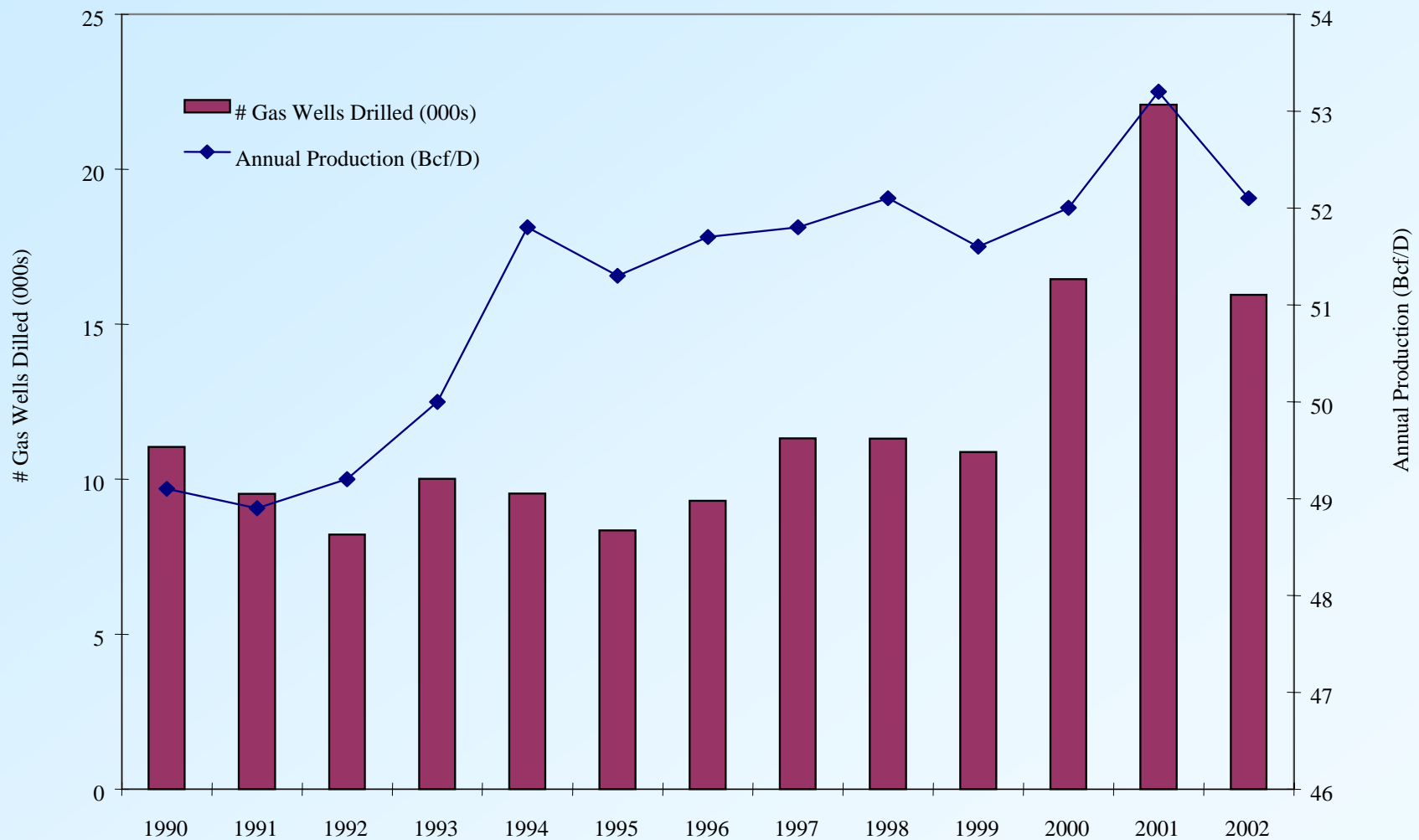
Storage Withdrawal Trends

Northeast

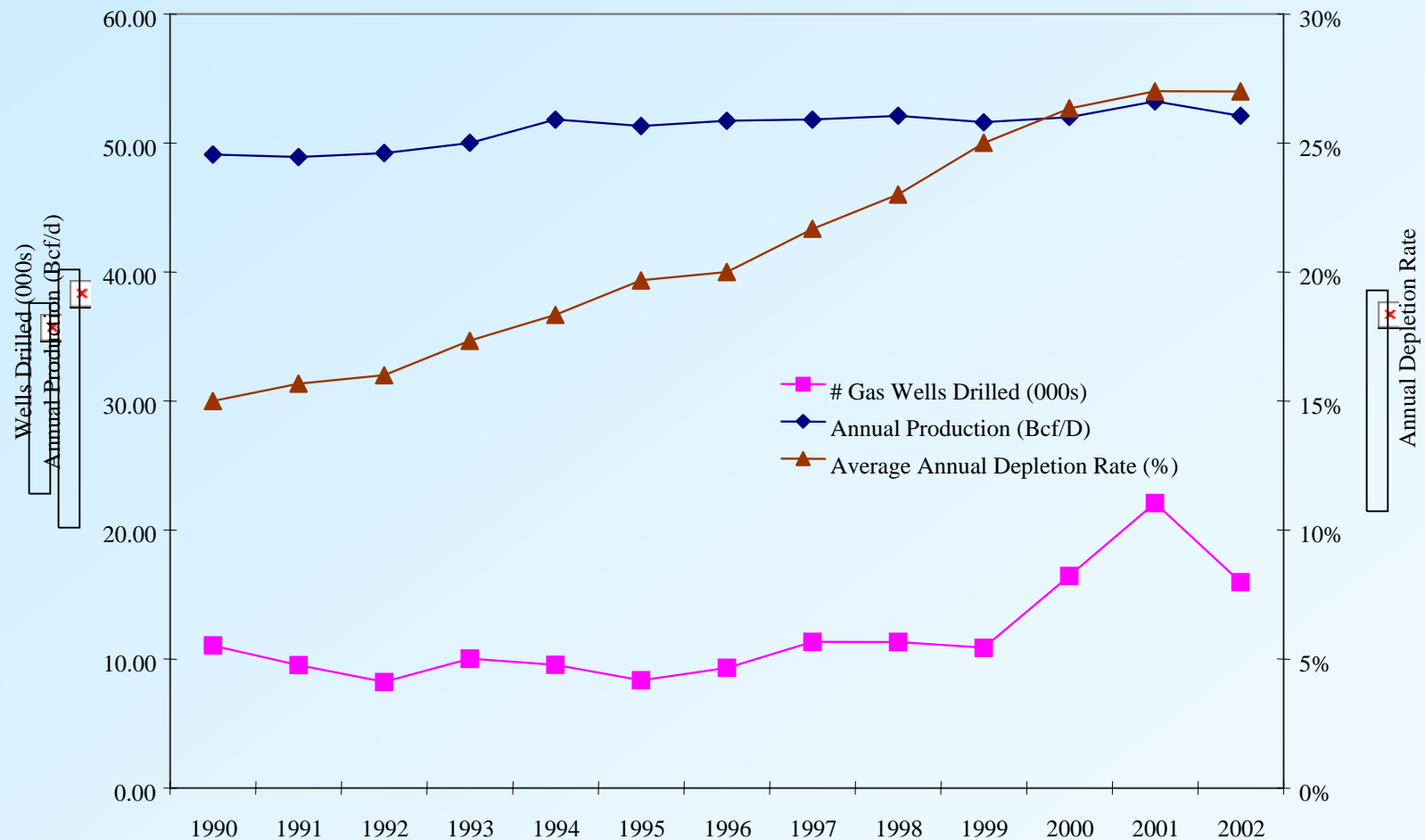


Sources: NOAA, EIA

U.S. Drilling and Production

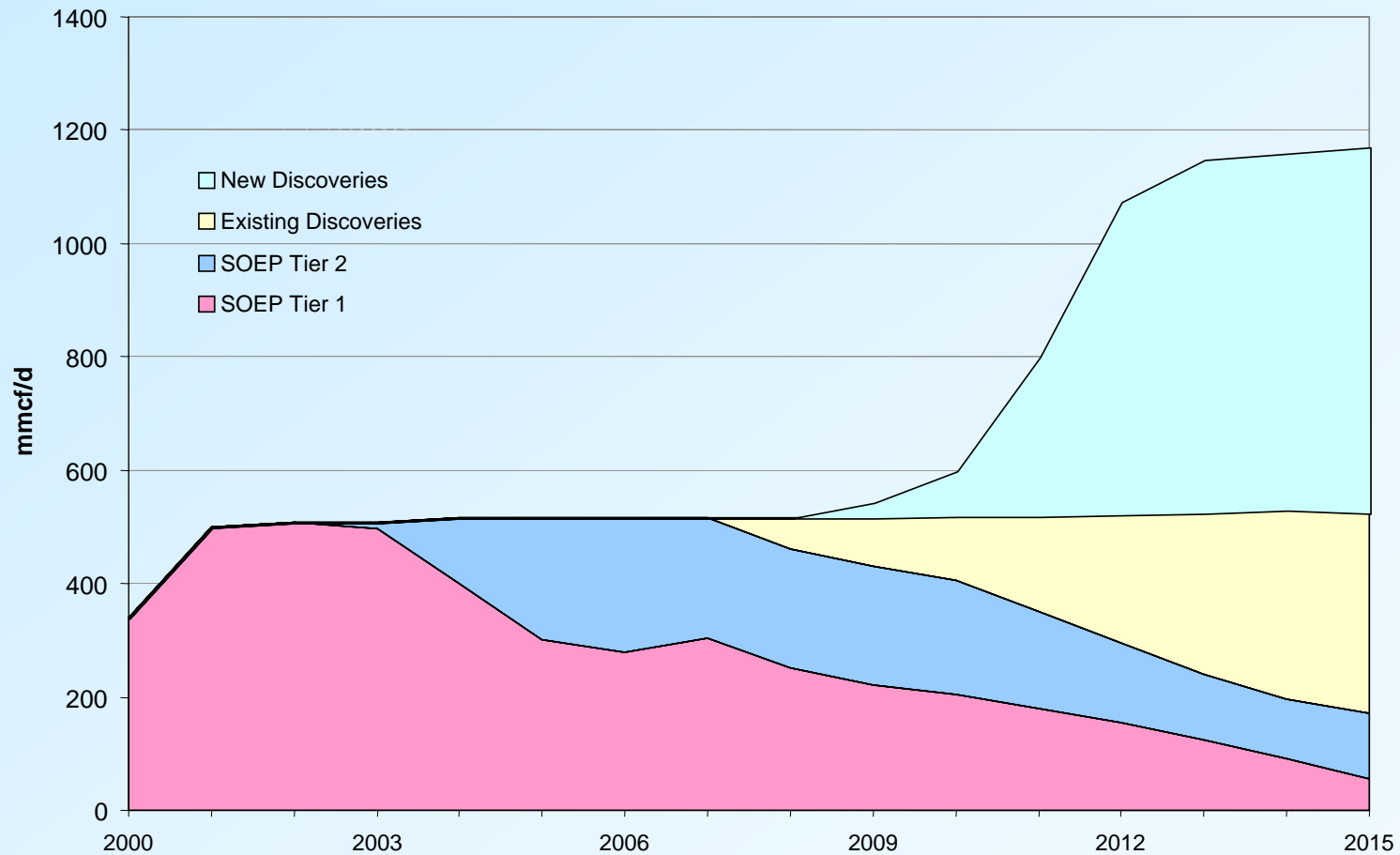


U.S. Drilling, Production and Depletion Trends



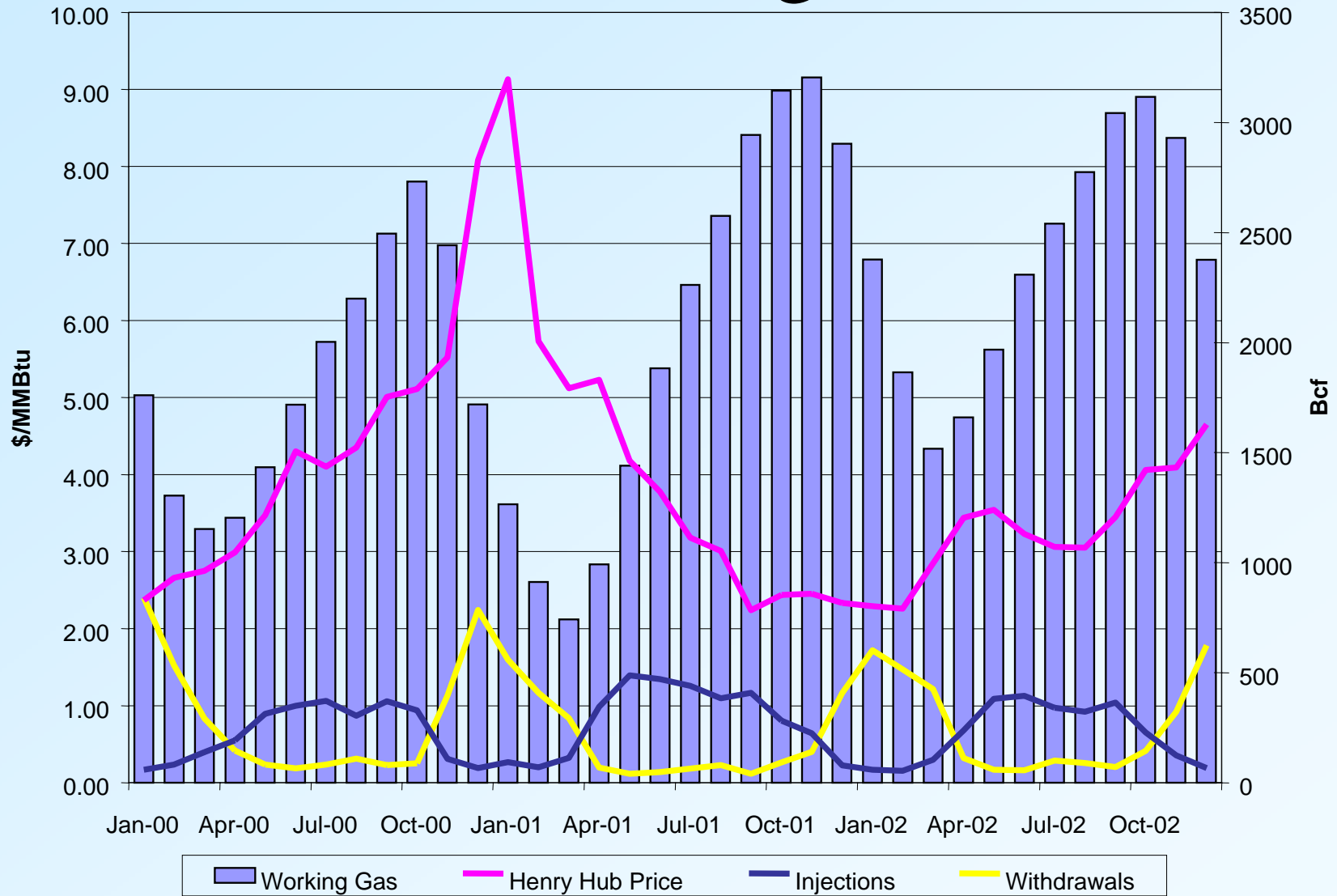
Sources: EIA, EOG Resources, Salomon Smith Barney Exploration & Production Group

LAI Outlook on Scotian Shelf Production



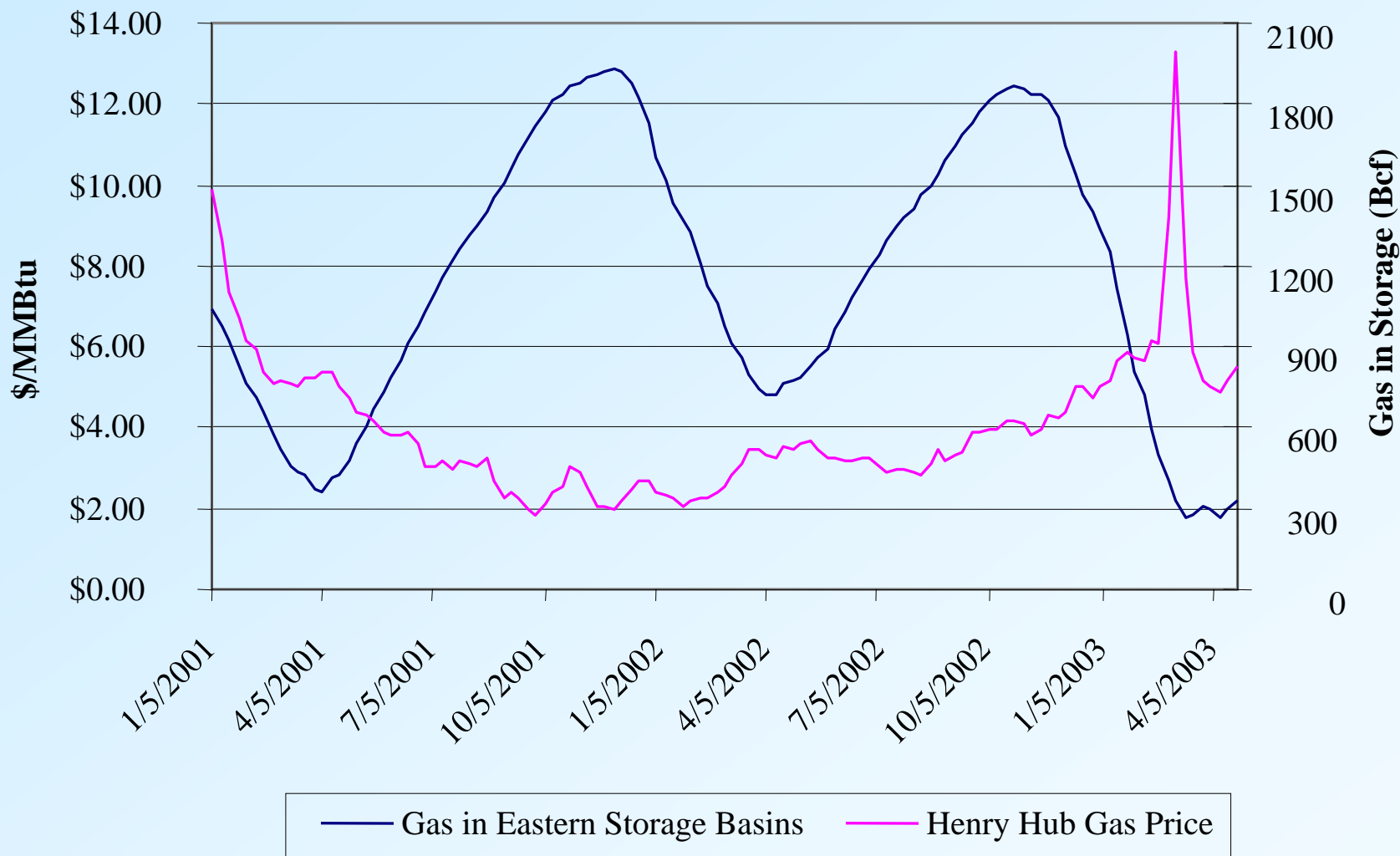
Sources: Shell Canada, Nova Scotia Department of Energy, Canadian Superior Energy, LAI Estimates

U.S. Gas Storage Levels

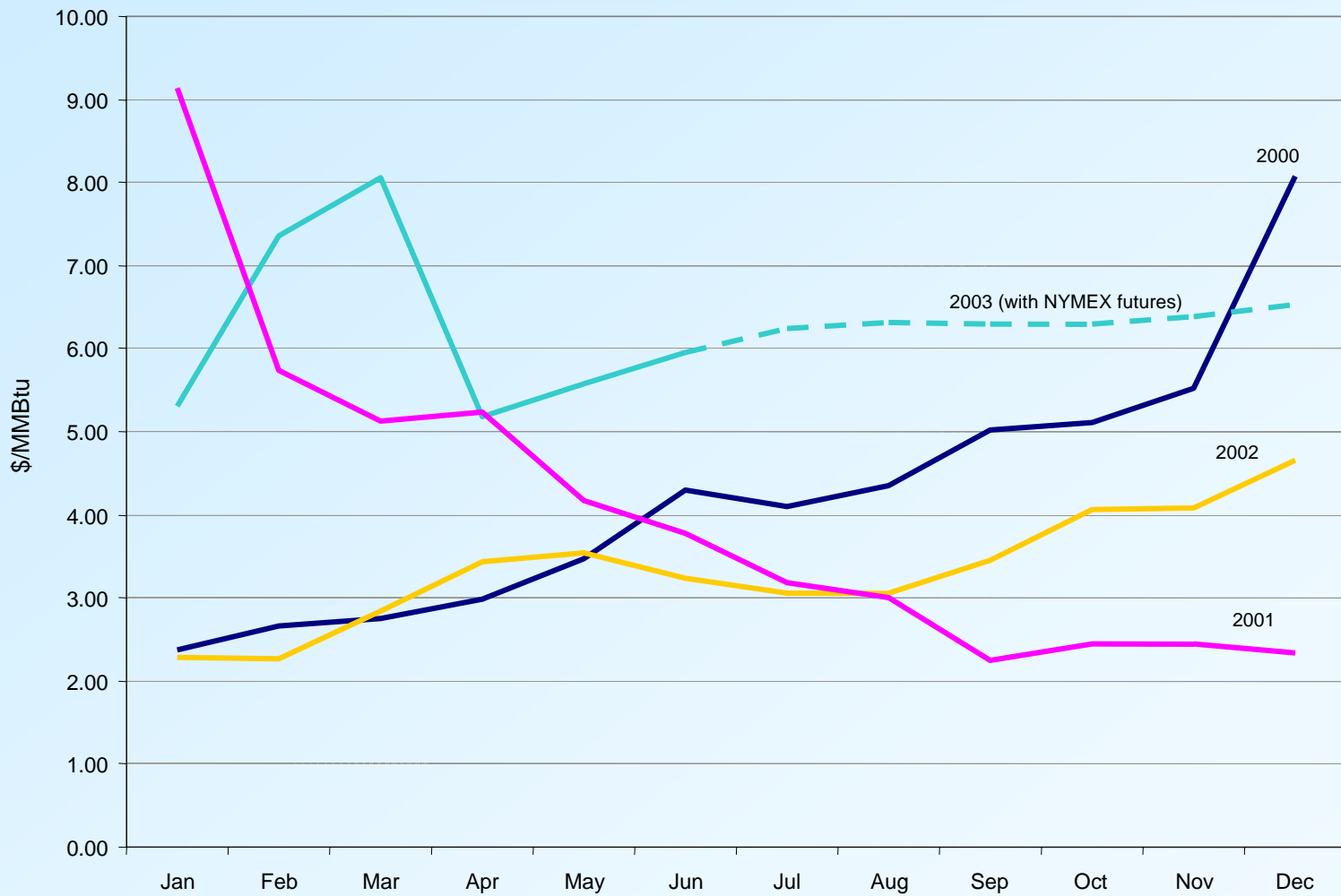


Storage Injection/Withdrawal Trends

Move Markets



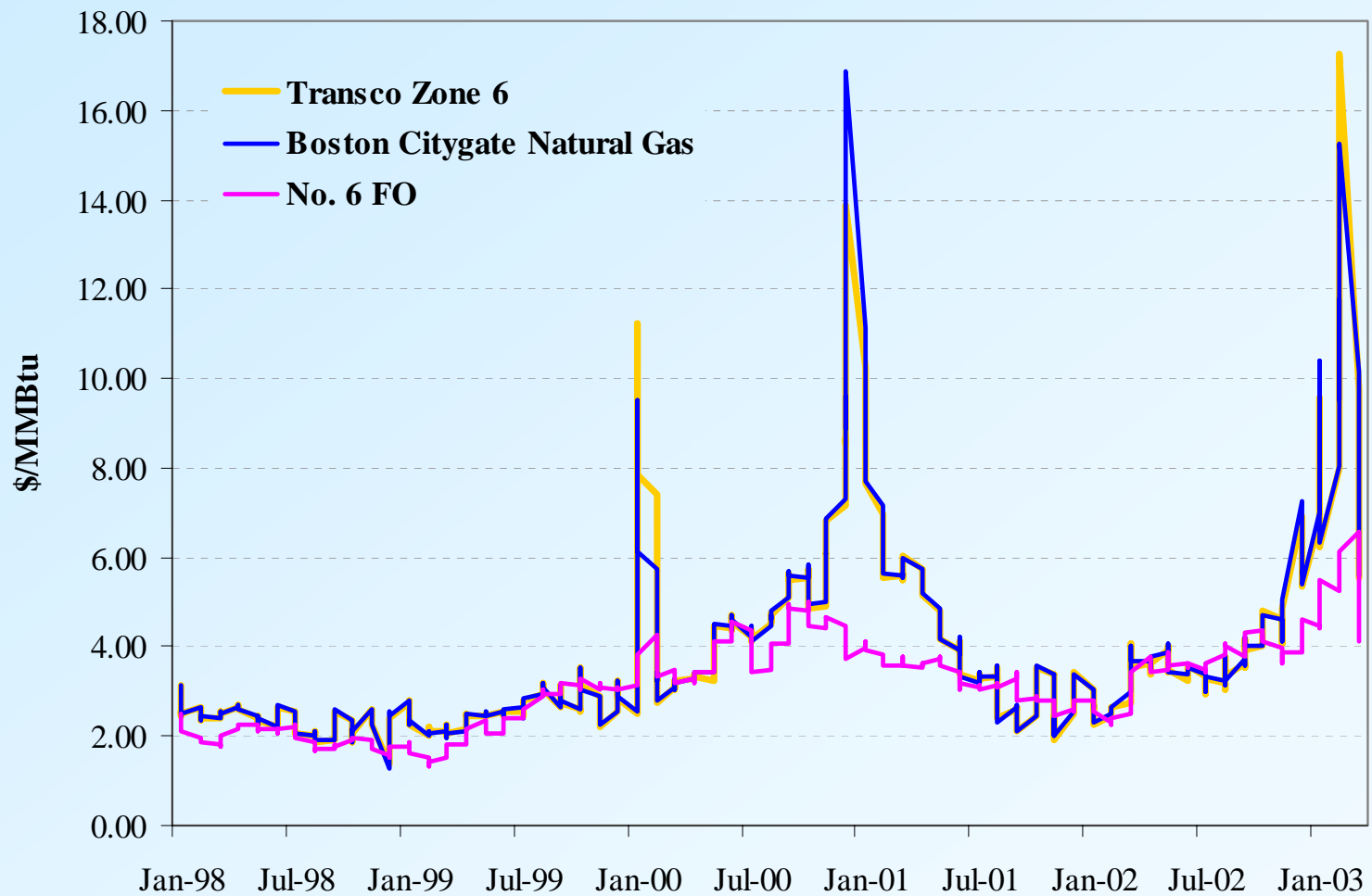
Henry Hub Historical Prices and Forwards



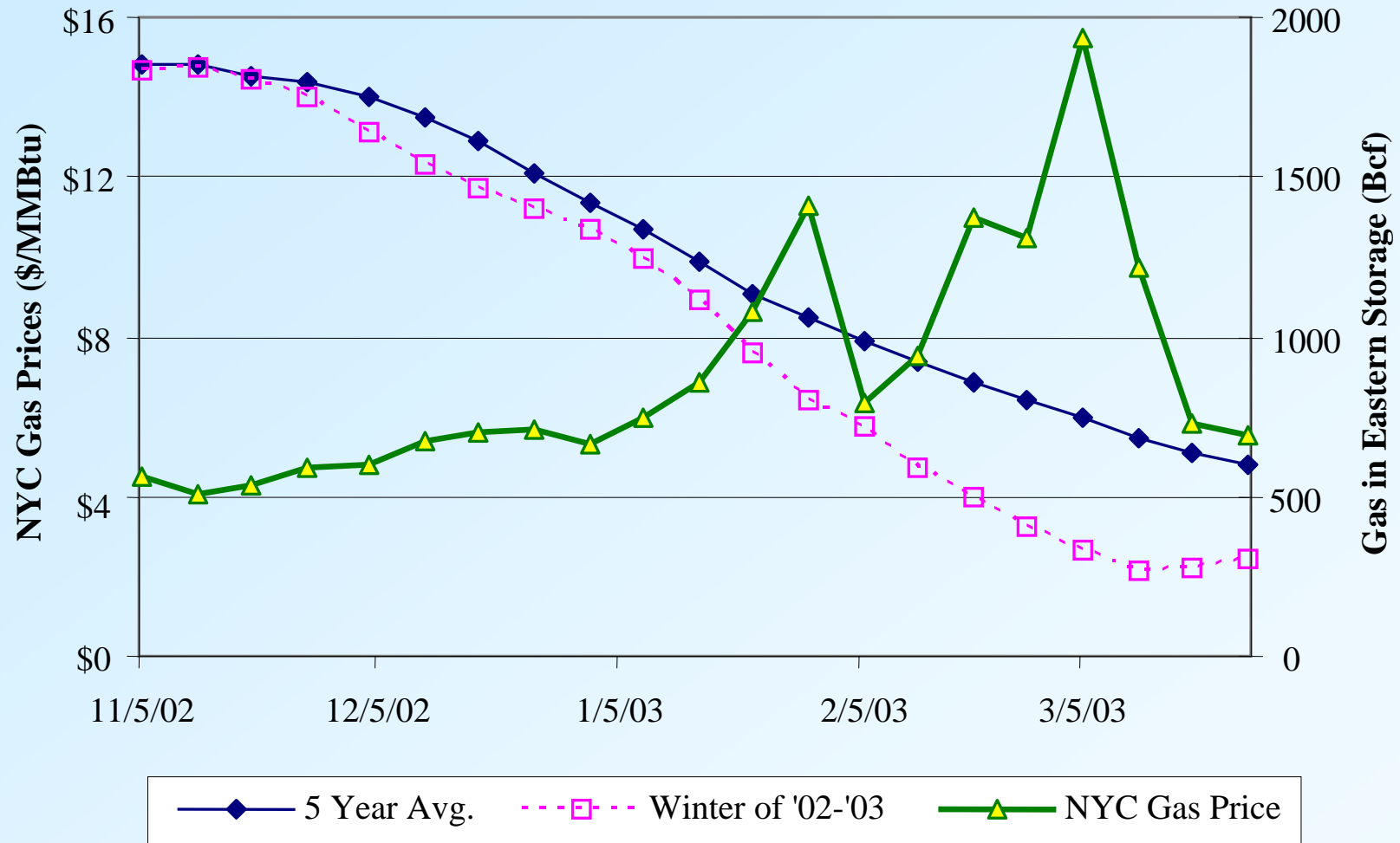
Transco Zone 6 Gas Prices



Boston Fuel Price Comparison

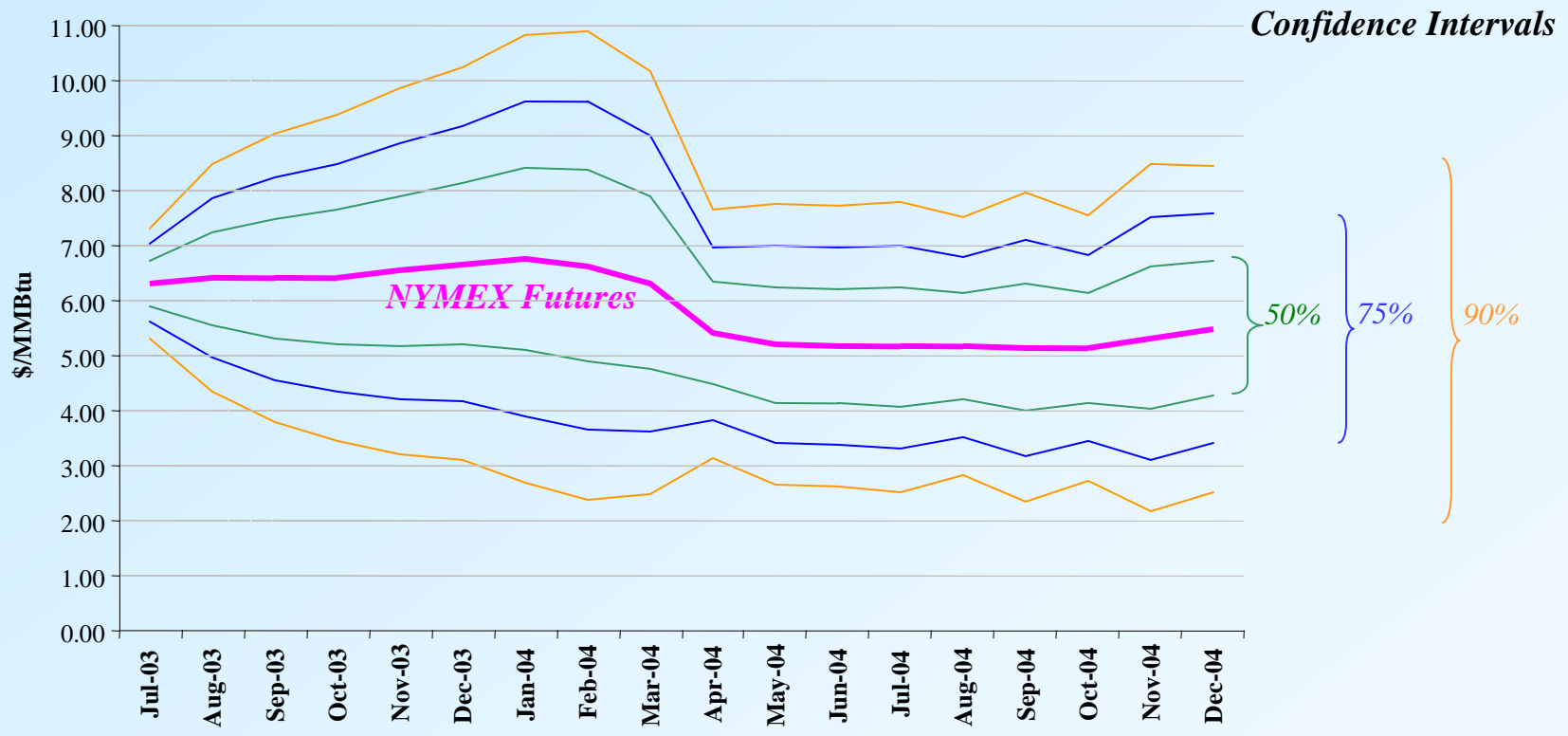


A Closer Look at Last Winter

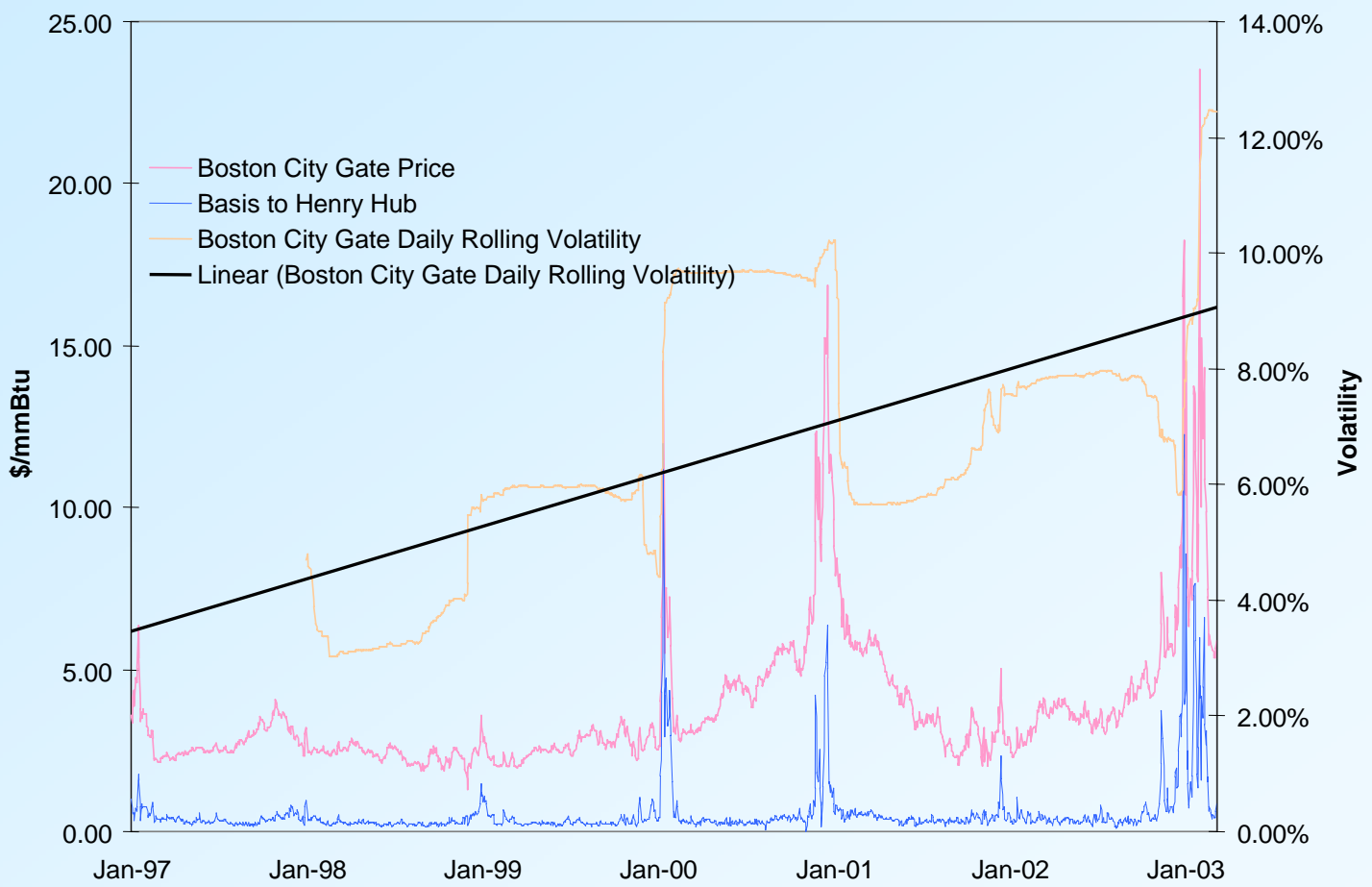


Henry Hub Volatility Outlook

Based on 6/10/03 NYMEX Futures & Options

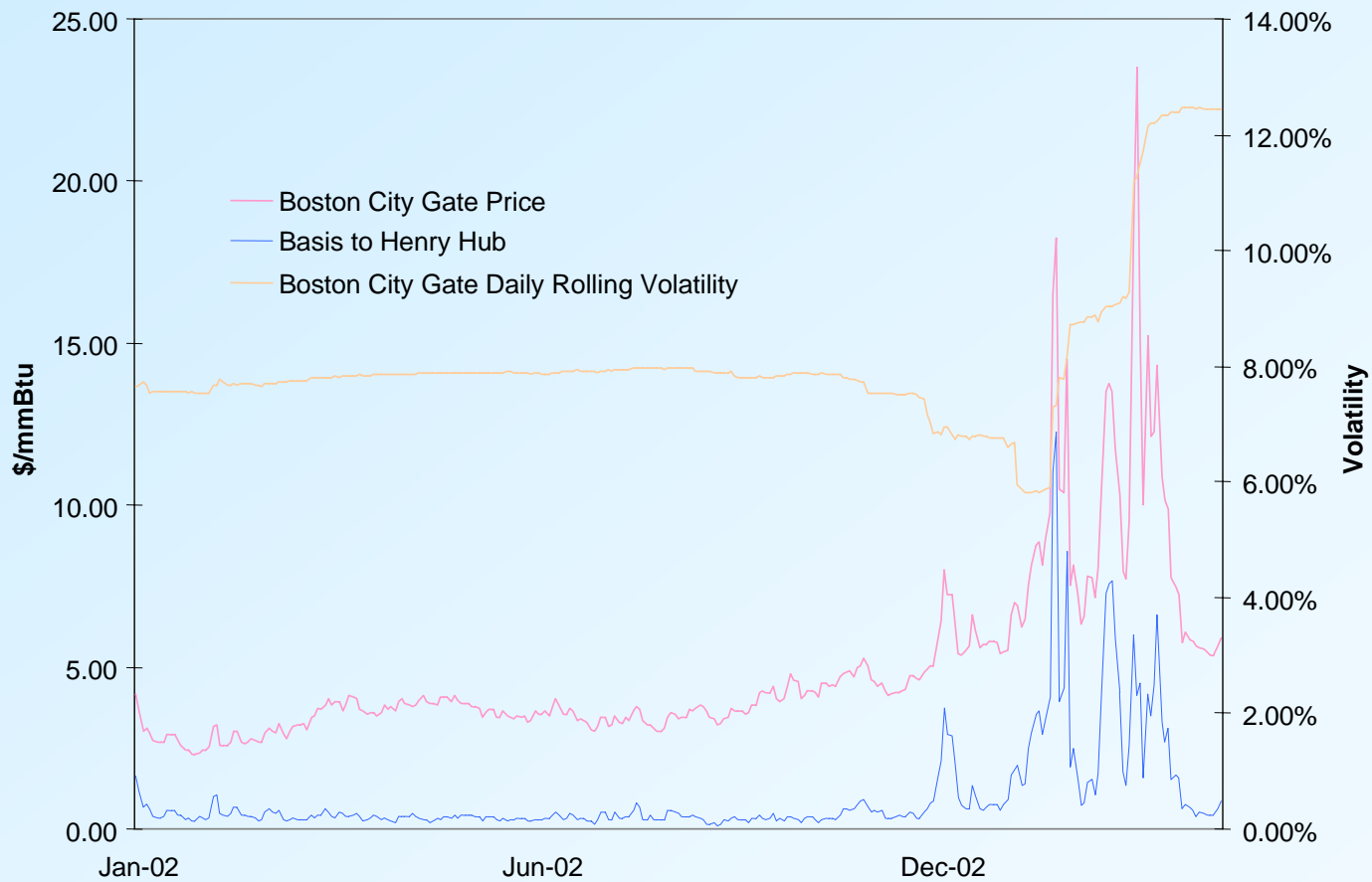


Increased Volatility in New England



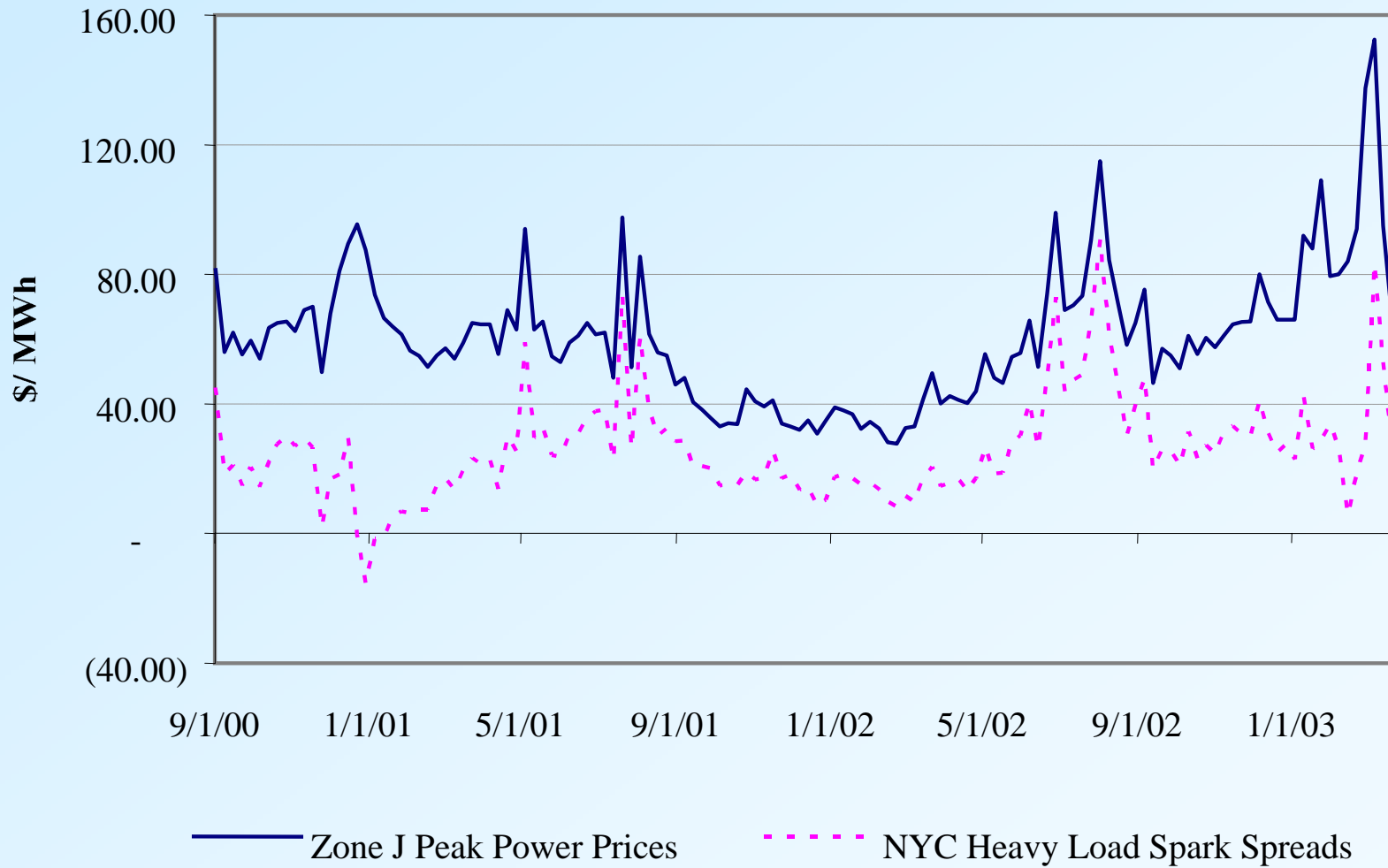
Source: Bloomberg Daily Gas Prices

2002 Boston Rolling Volatility and Basis

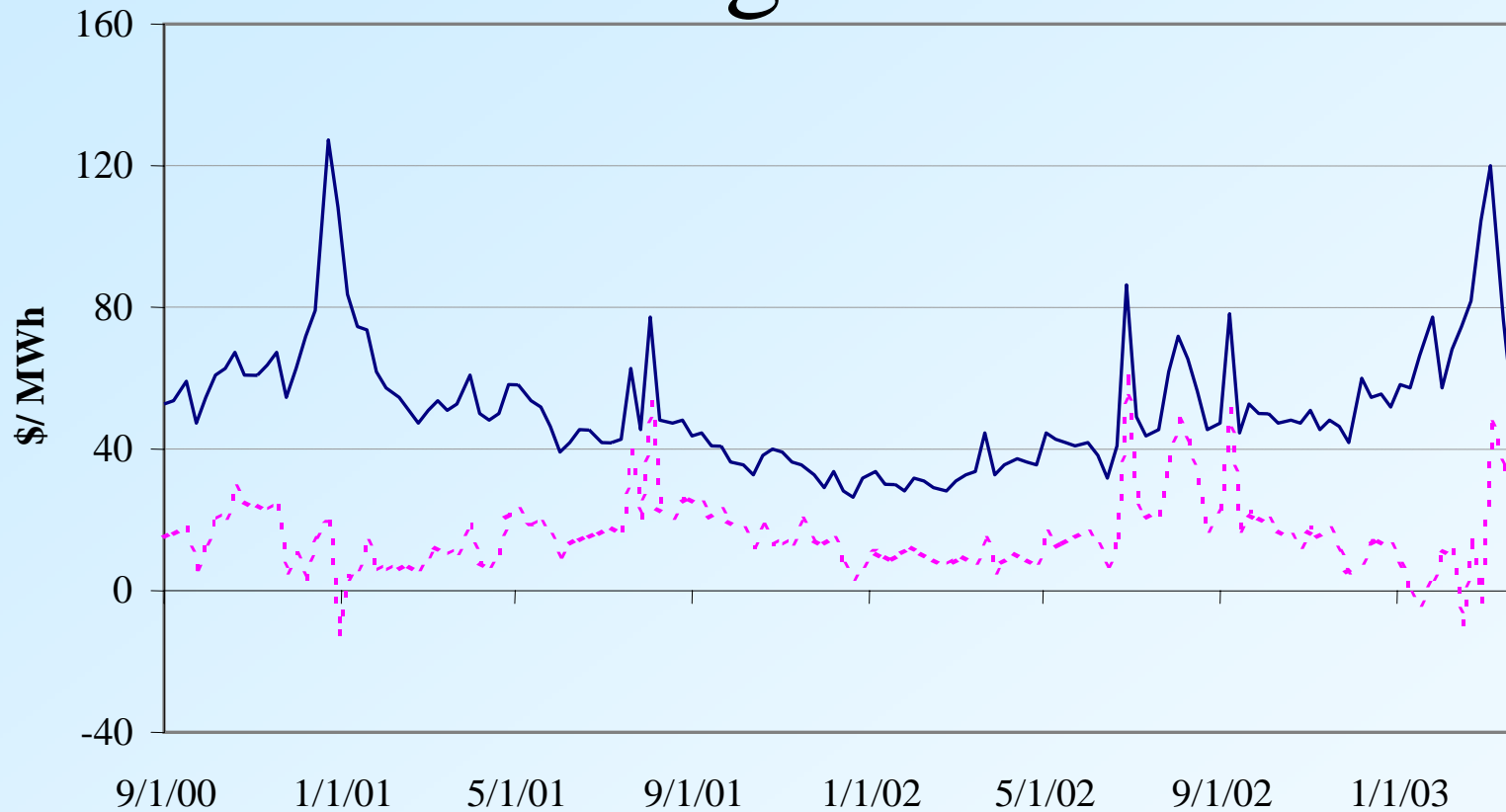


Source: Bloomberg Daily Gas Prices

NYC Heavy Load Spark Spreads



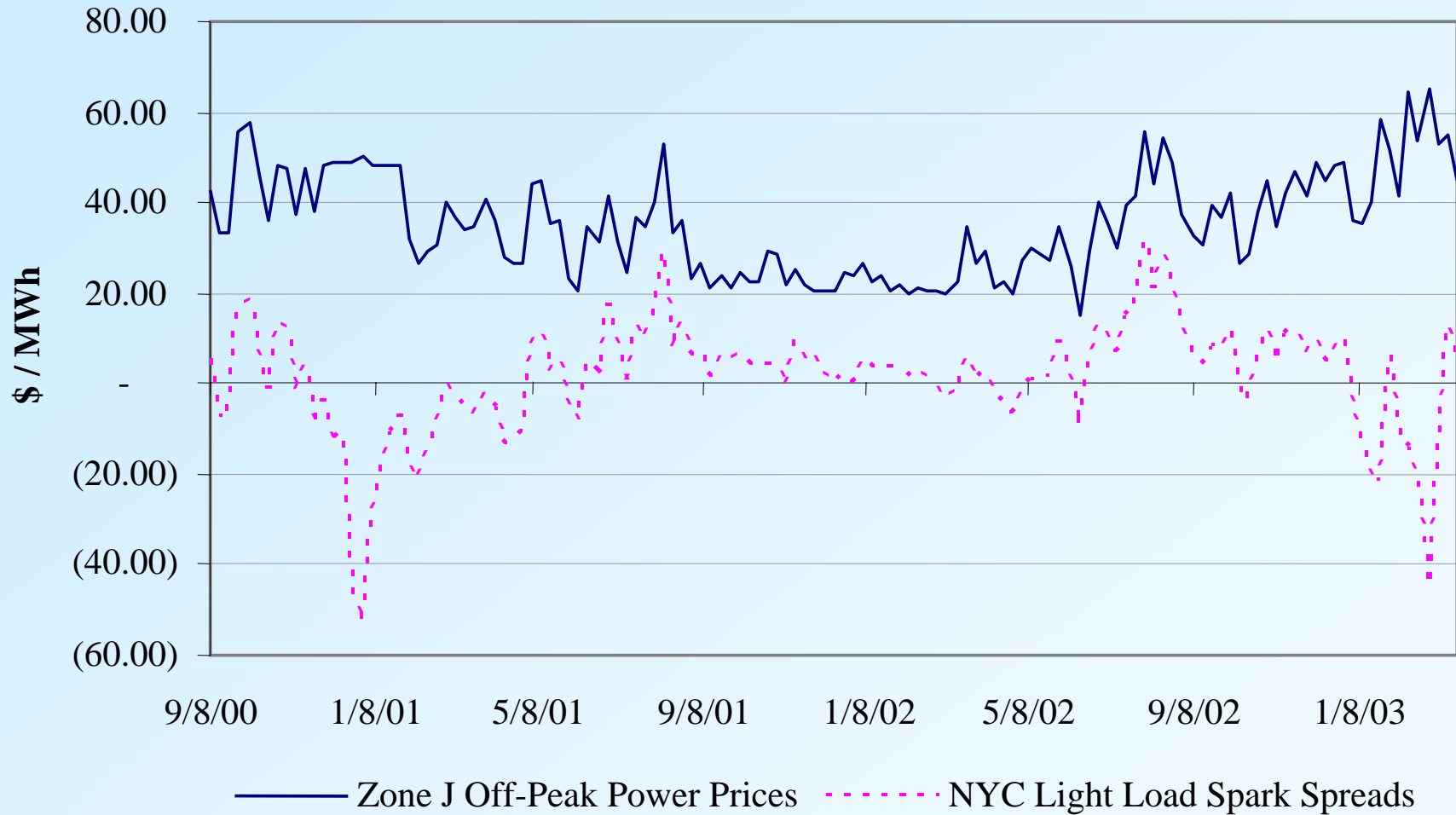
Heavy Load Spark Spreads in New England



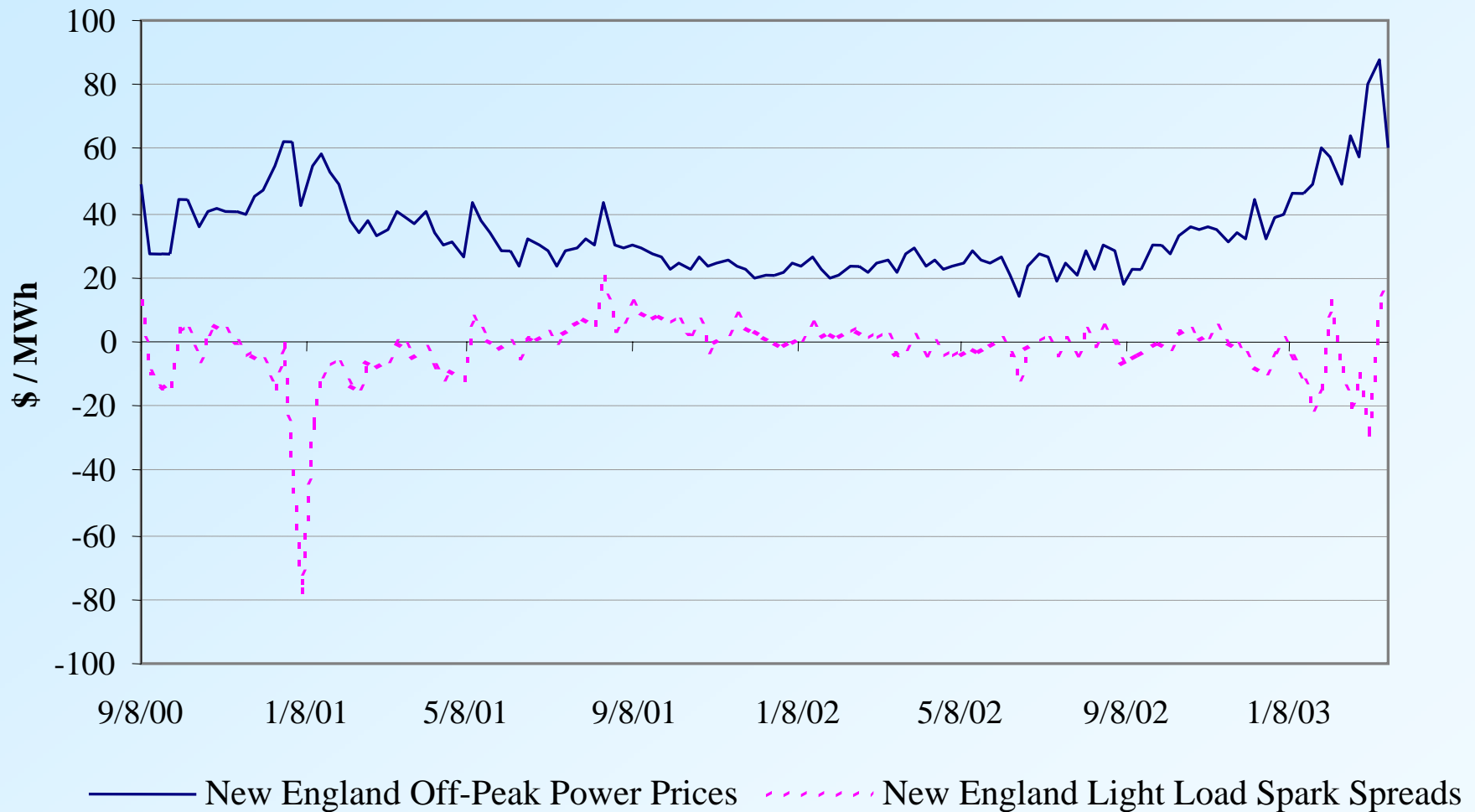
— New England Peak Power Prices

- - - New England Heavy Load Spark Spreads

NYC Off-Peak Spark Spreads



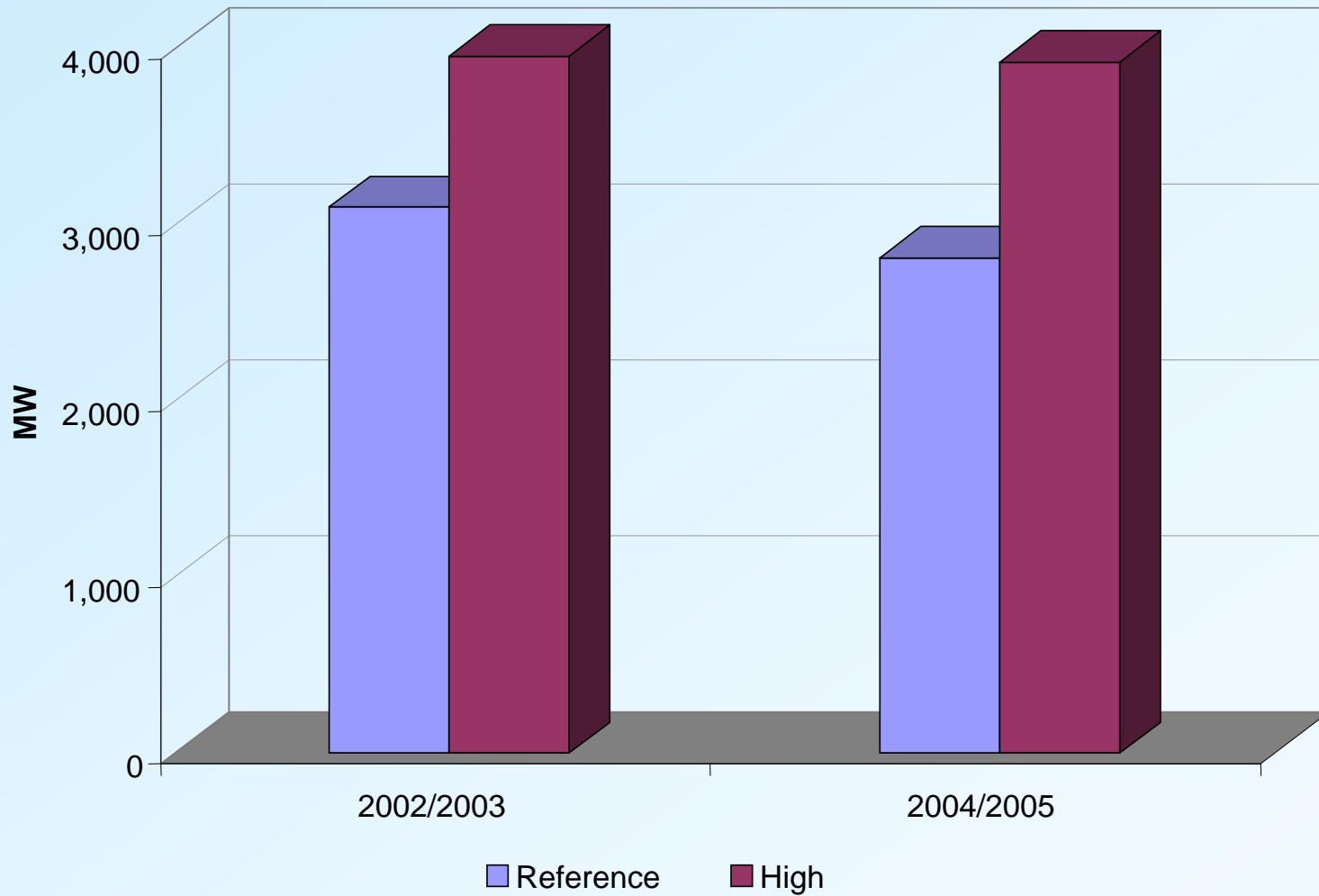
Light Load Spark Spreads in New England



Implications for Pipeline Infrastructure Developments

- Load factor dynamics resulting from new pathways
- Weakened financial condition of merchant sector post-Enron
- Risk tolerance considerations
 - Transporters
 - LDCs / Merchant Gencos
 - Marketers
 - FERC
- Contracting disincentives / credit enhancement options
- “Degradation” of non-firm services

Generation At-Risk in New England



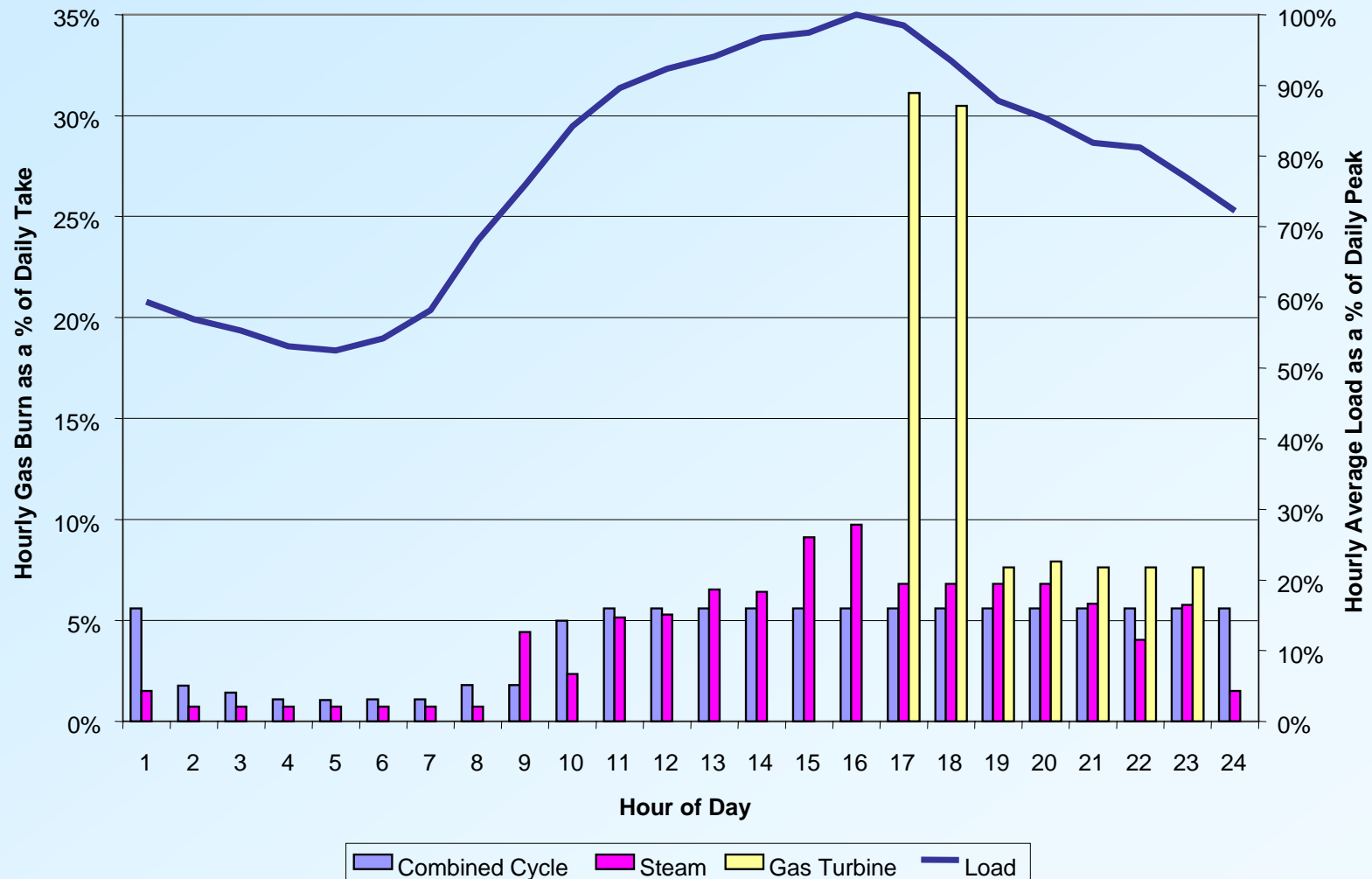
Merchant Generator Gas Needs

- **Flexibility** on services / scheduling
 - Variable hourly flows matching operating regime
 - Low-cost balancing options
 - Short or no notice start-up and shut-down
- **Pressure** and quality
 - New, dry low- NO_x gas turbine technology
 - 450+ psi
 - Ultra-low particulate and liquid contaminant levels
- **Price**, volumetric classification of cost

Pipeline Service Issues for Generators

- Mainline / storage infrastructure designed for core LDC requirements, not generators
- Spark-spread relationships impacting merit of FT
- Imbalance penalties for variable hourly takes
- Critical Notices / Operational Flow Orders
- Automatic Flow Control
- No notice or short notice re start-ups and shut-downs

Typical Generator Hourly Gas Burns and Daily Load Profile



Gas v. Electric Nomination “Disconnects”

- Gas is priced, scheduled and balanced on a daily basis
- Electricity is priced in the day ahead market and the real time market
- Scheduling and balancing in real time
- Scheduling compatibility issues
 - intra-day nominations to allow hourly and short start-ups
 - role of marketers

Storage Benefits for Power Generators

- Foster reliable deliveries
- Strengthen the connection between gas requirements and operating regime
- Arbitrage
 - Seasonal gas and transportation costs
 - Gas and electricity prices
- Help weather periodic liquidity squeezes
- Avoid costly imbalance and overrun penalties

Merchant Genco Perspective on Storage: Is the option worth the price?

- Location: Geologic constraints limit HDS sites
- High demand for market area storage, in particular, HDS
- Commoditization of regasification services
- Existing storage capacity designed for seasonal swings not merchant intra-day balancing
- Formidable financing challenges

Gas Storage Valuation

- Value of Storage
 - Defined by seasonal price spreads
 - Includes optionality (increases with increasing service flexibility)
 - Additional value through intra-seasonal spreads and daily arbitrage
- Intrinsic and extrinsic value considerations
 - Operating constraints
 - Forward price curves
 - Arbitrage
 - Volatility

Gas Storage Valuation (cont'd)

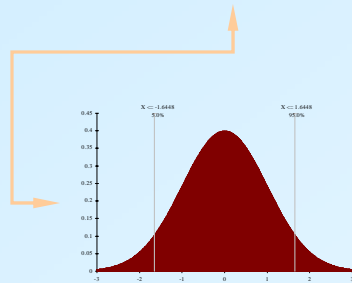
- Traditional “cash-and-carry” arbitrage of locational & seasonal price spreads undervalues gas storage
- Value enhancement through optimal injection/withdrawal strategies to capture volatilities in the liquid spot & forward markets
- Same concept applicable to valuing gas swing contract & interruptibility

Gas Storage Valuation

*Storage Value = Discount Factor * Expected Future Profit from Storage*

$$\frac{1}{(1+r)^t} \text{ (discrete) }, e^{-rt} \text{ (continuous)}$$

$$\sum \text{Probability} * [\text{Quantity} * \text{Non-Negative Net Profit}]$$



$$\text{Max} [0, \text{Revenues from Price Arbitrage} - \text{Costs}]$$

$$C^{\text{Trading}}(Q) - C^{\text{Injection}}(Q) - C^{\text{Withdrawal}}(Q)$$

$$V_{t_0, t_1} = e^{-r(t_1 - t_0)} * \sum_{i=1}^N \text{Prob}_i * \left[Q * \text{Max} \left(0, \Delta P_{t_0, t_1} - C^T(Q) - C^I(Q) - C^W(Q) \right) \right]_i$$

Who Will Pay for New Storage Infrastructure?

- 344 Bcf storage additions may be needed through 2015 \longrightarrow +\$400 MM / year
- Merchant generators seek volumetric pricing
- LDCs less able to anchor new storage projects
- Credit quality needed in form of long term storage entitlements
- Lender recourse to balance sheets / other credit enhancement vehicles

Q & A