Valuation of storage assets

European Gas Transport, Storage and LNG

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Introduction

- Started Oct '04
- Provides high value energy market analysis to support
  - strategy formation
  - investment decisions
  - execution

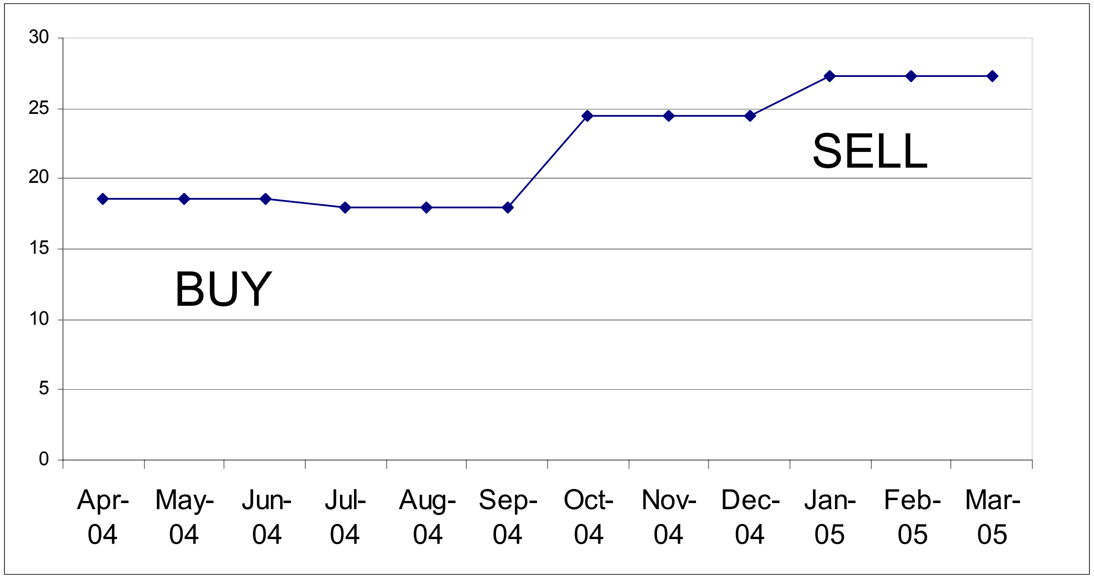
- Started 1997
- Founded by Les Clewlow and Chris Strickland
- Energy derivative pricing and risk management experts
- Software tools and libraries

Agenda

- Storage valuation approaches
- Applications
  - Strategic investment
  - Retail profile support
  - Flexible asset within portfolio

Valuing storage

- Ability to buy when prices low and sell when prices high…



- …subject to costs and constraints

→ a Real Option problem

Intrinsic value

- Value that could be obtained based on current forward curve
- Can lock-in through buying and selling respective forward contracts

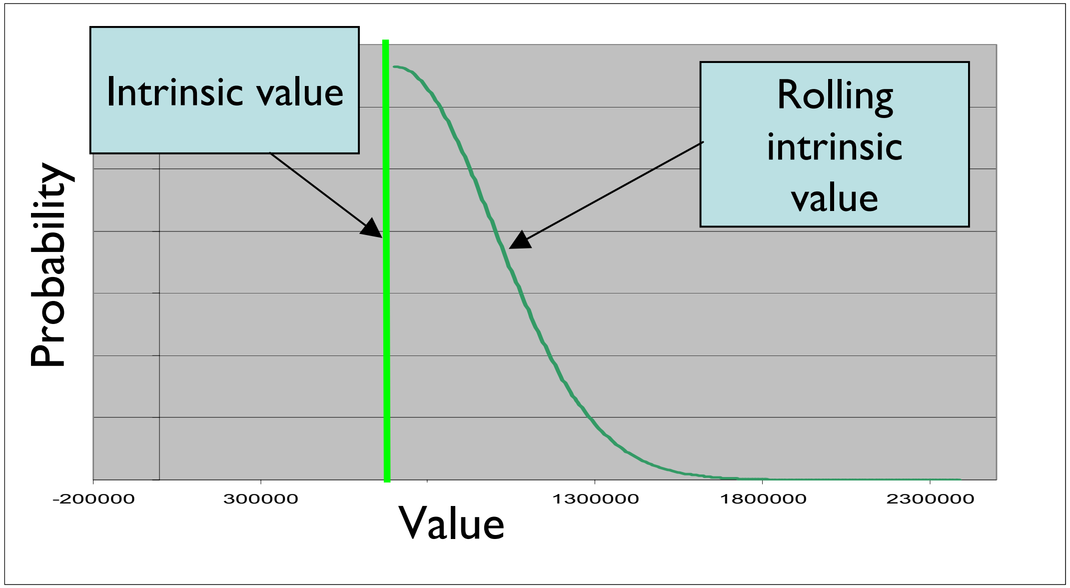
Storage Asset - Injections and Withdrawals (millions)

Injection / Withdrawal

	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Total In.	Max. In.
Apr-04		0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	43.143	17.783	17.064	78.000	78.000
May-04			0.000	0.000	0.000	0.000	0.000	0.051	0.000	44.500	18.385	17.665	80.600	80.600
Jun-04				0.000	0.000	0.000	0.001	1.856	0.000	39.120	18.871	18.152	78.000	78.000
Jul-04					0.000	0.000	16.632	3.223	1.365	20.566	19.767	19.048	80.600	80.600
Aug-04						0.000	16.574	3.210	1.383	20.584	19.784	19.065	80.600	80.600
Sep-04							21.106	2.602	0.000	18.870	18.070	17.351	78.000	78.000
Oct-04								0.000	0.000	22.010	13.177	12.458	47.646	80.600
Nov-04									0.000	14.712	13.913	13.194	41.819	78.000
Dec-04										0.000	0.000	0.000	0.000	80.600
Jan-05											0.000	0.000	0.000	80.600
Feb-05												0.000	0.000	72.800
Total Out	0.000	0.000	0.000	0.000	0.000	0.000	54.313	10.952	2.748	223.505	139.750	133.997		
Max. Out	225.000	232.500	225.000	232.500	232.500	225.000	232.500	225.000	232.500	232.500	210.000	232.500		
Storage Level	78.000	158.600	236.600	317.200	397.800	475.800	469.133	500.000	497.252	273.747	133.997	0.000		

Rolling intrinsic value

- Can re-evaluate profile as prices change
- Where possible, increase return by adjusting planned profile and re-balancing portfolio of forwards



- Value using Monte Carlo simulations
- Still not optimal – decisions do not take into account possible future price changes

Capturing time value

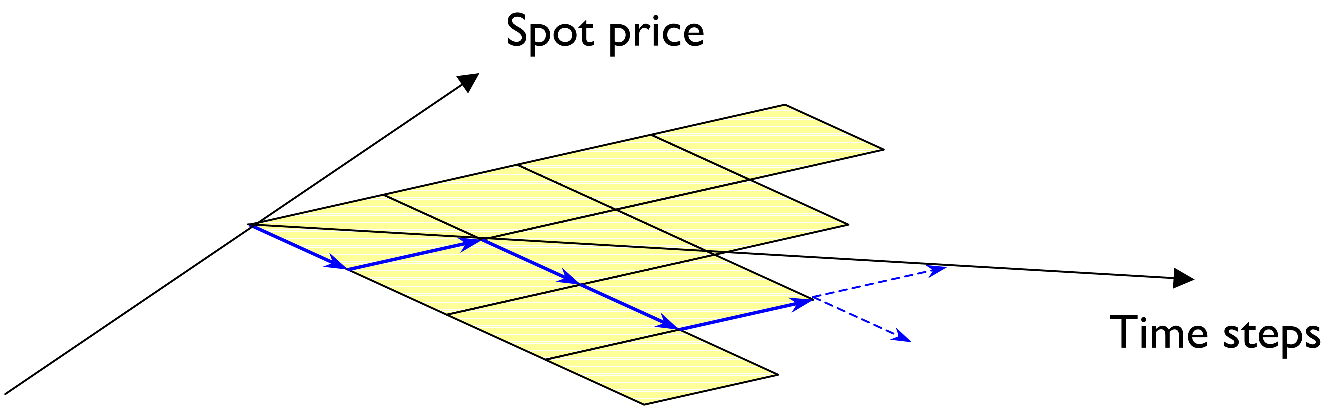
- Decision to withdraw or inject depends on current and potential future prices…
- …and current level of gas in storage

→ Example of a “path dependent” option

- Determine optimal injection/withdrawal decisions based on spot price
- Can be tackled through:
  – Least squares Monte Carlo
  – Tree methods

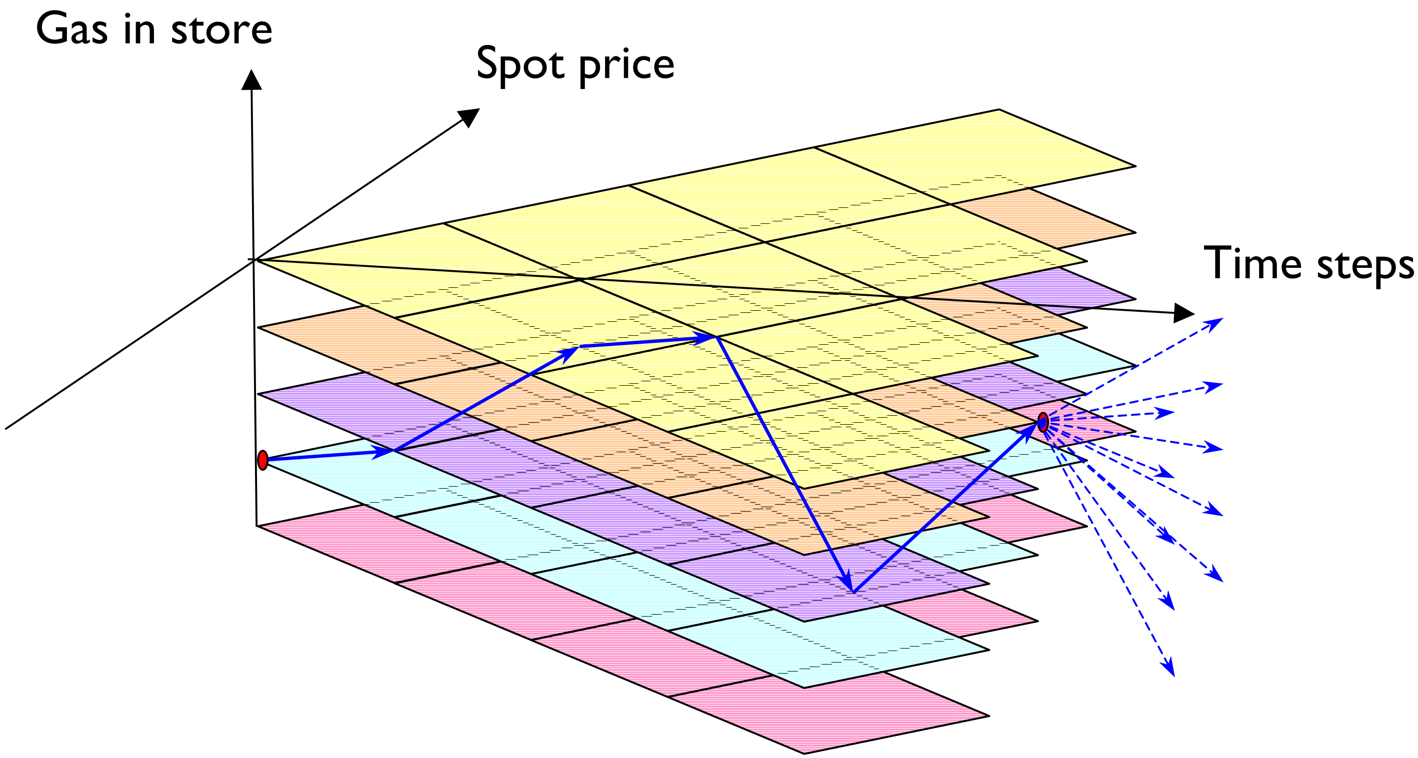
Trees…

- We can create a discretised view of all possible future price outcomes – a "tree"



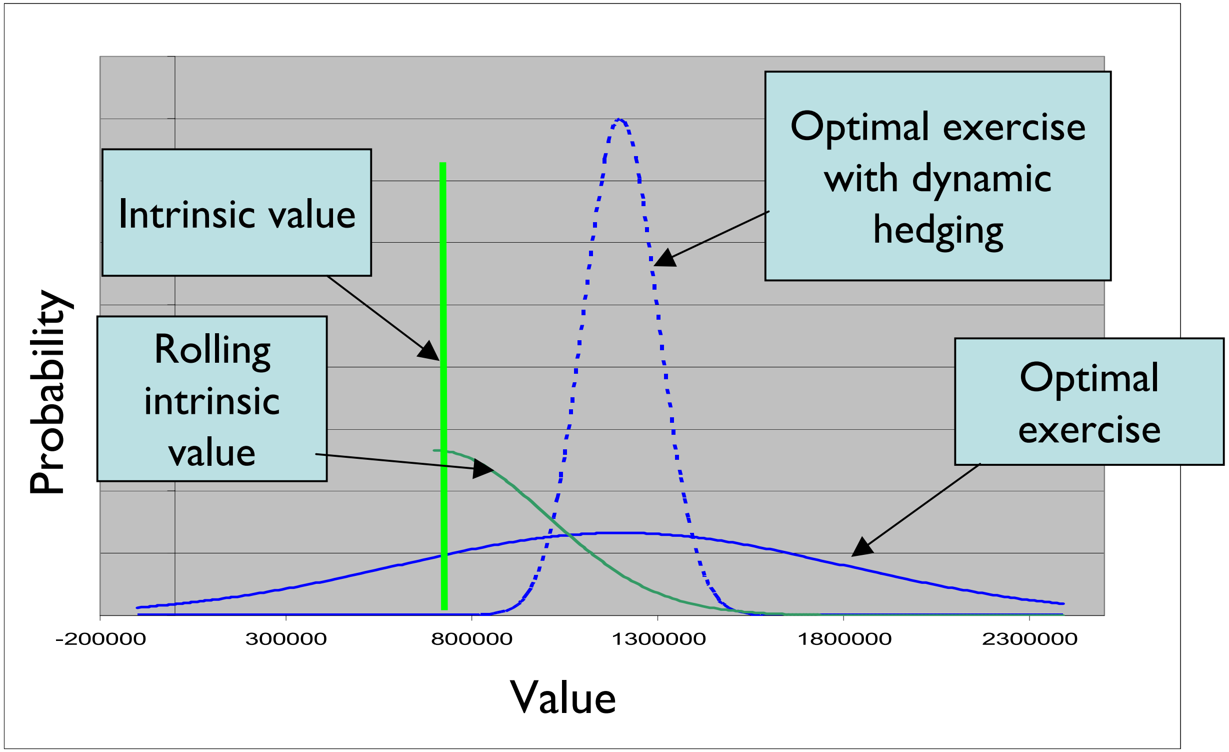
…and forests

- For each time step, we also track the possible withdrawals or injections, creating an additional dimension



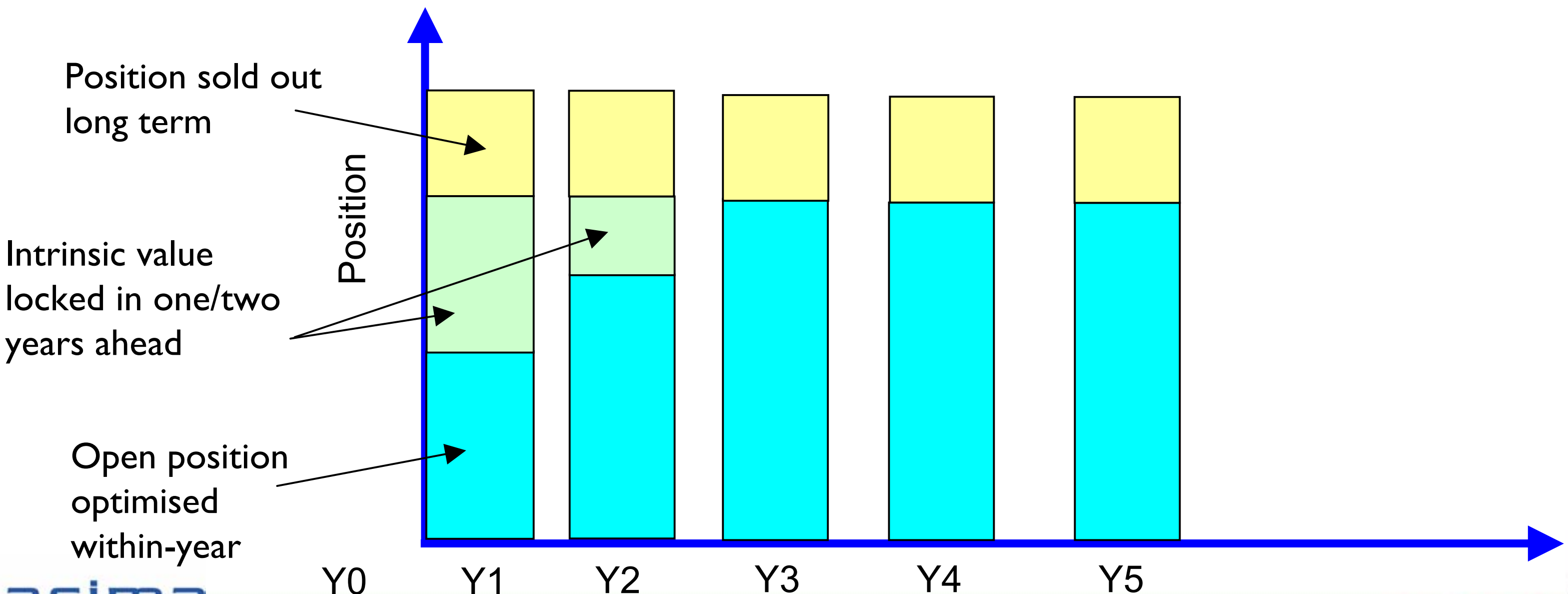
Value distribution

- Define optimal decision rules and determine a distribution of outcomes based on these rules
- Assess sensitivity to different contracts to calculate deltas to hedge against



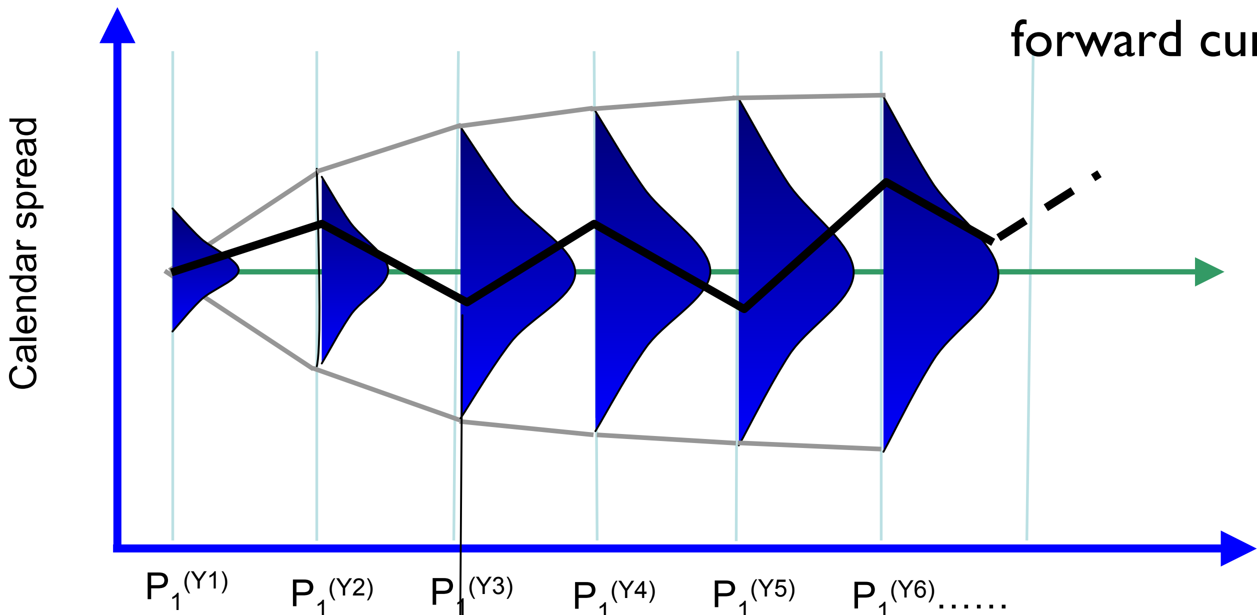
Strategic investment

- Storage gives long term position in calendar spreads
  - Fundamental drivers of seasonal shape
  - Play on security of supply
- Risk management through:
  - Sales of rights to third parties
  - Hedging through forwards contracts



Framework for valuing open position

Multi-factor evolution of forward curve

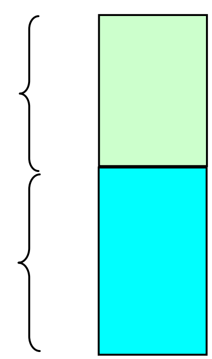


For each price point…

Storage model
-Valuation
-Risk measurement

One/two-year ahead intrinsic value

Optimised within year value



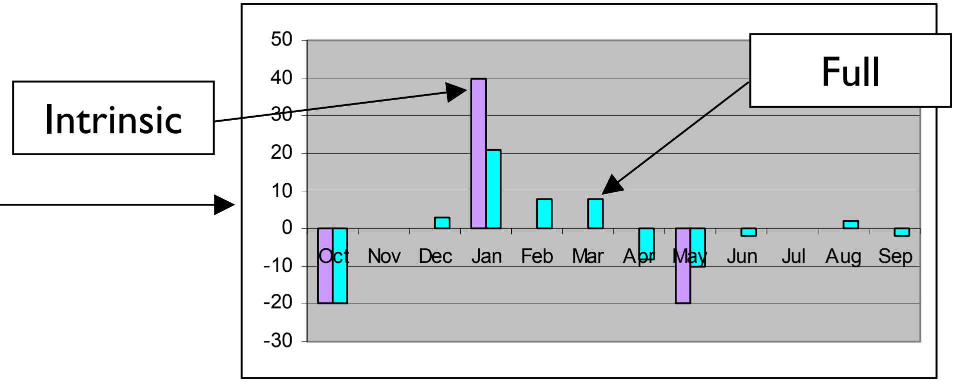
Retail profile support

- Storage provides hedge for retail profile
  - Difficult to hedge financially
  - Buying "shape" difficult/expensive
- Storage provides physical flexibility
  - Weekly/daily profiles
  - Managing within-day balance position
- Risk measurement through exposure calculation

Combined exposures

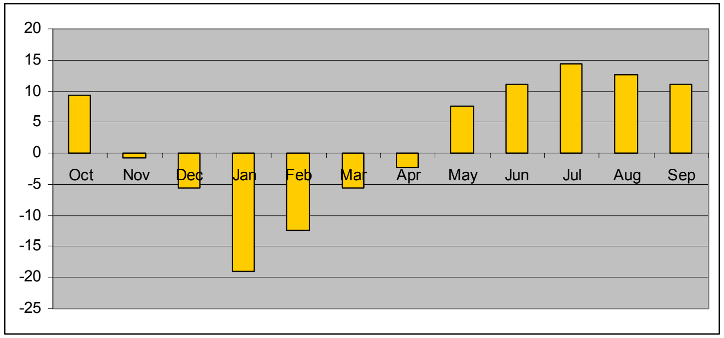
Storage model

Storage deltas

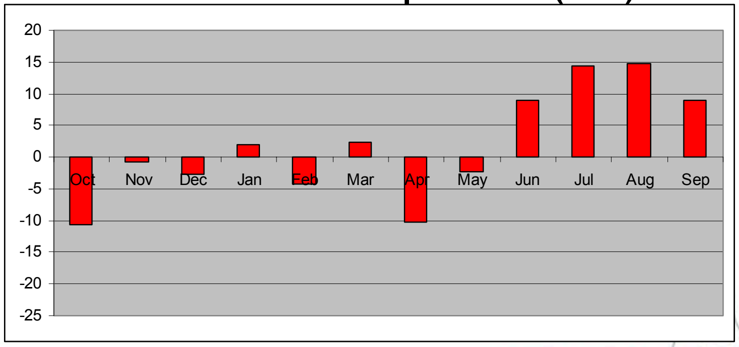


- Monthly retail demand volumes
- Fixed price retail contract
- Flat volume purchased for calendar year

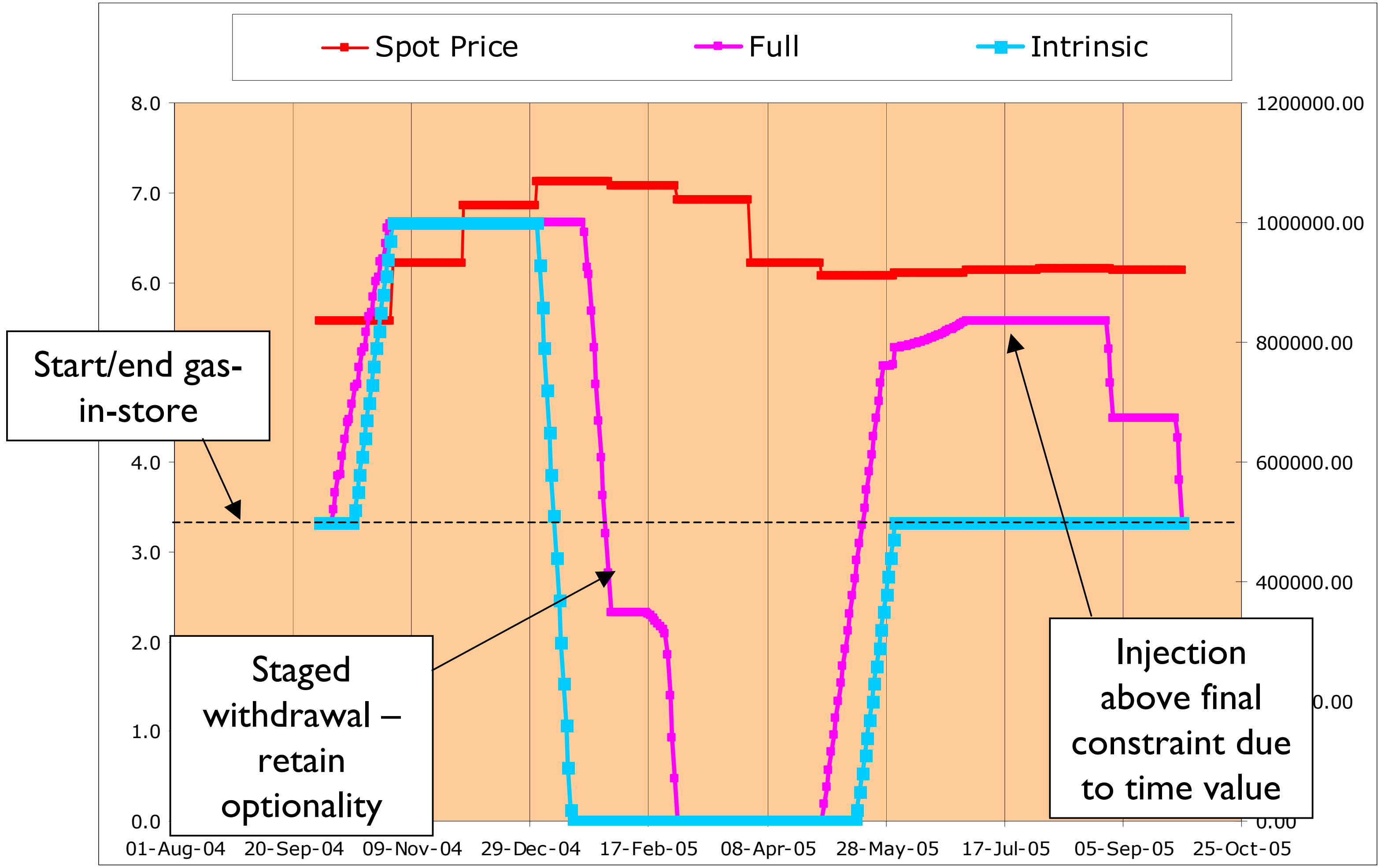
Retail exposure



Combined exposure (full)



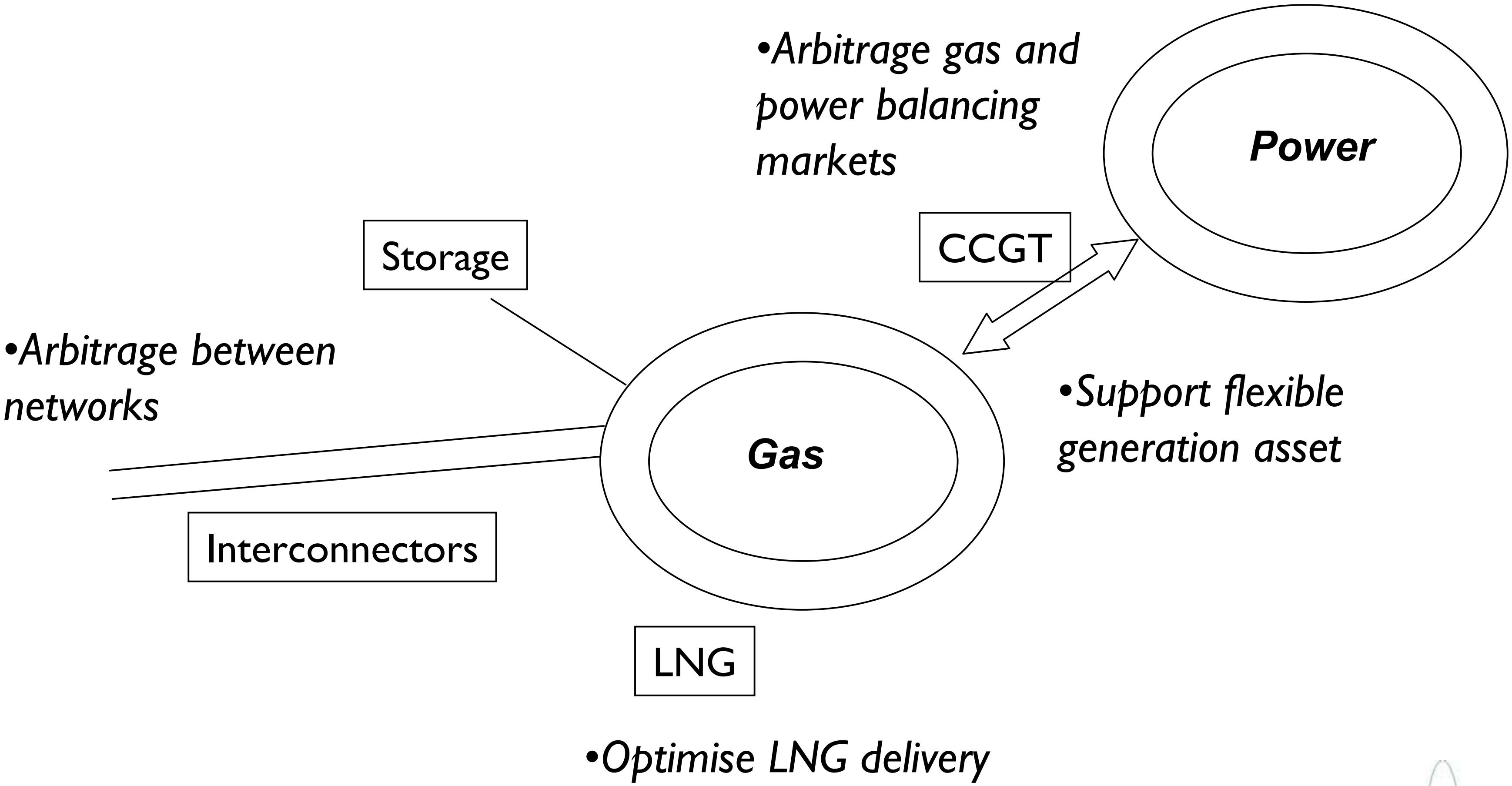
Profiles



Spot Price
Full
Intrinsic
8.0
7.0
6.0
4.0
3.0
2.0
1.0
0.0
1200000.00
1000000.00
800000.00
600000.00
400000.00
0.00
01-Aug-04
20-Sep-04
09-Nov-04
29-Dec-04
17-Feb-05
08-Apr-05
28-May-05
17-Jul-05
05-Sep-05
25-Oct-05
Start/end gas-in-store
Staged withdrawal – retain optionality
Injection above final constraint due to time value

Flexible asset within portfolio

- Within a broader portfolio, storage enhances ability to…

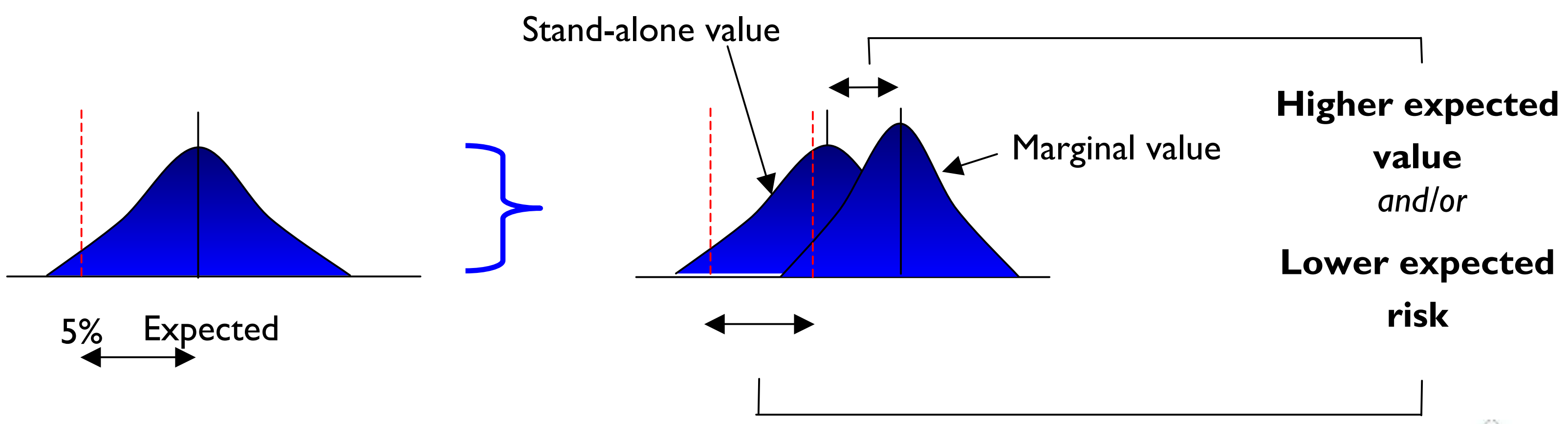


Marginal value

- Portfolio benefits may increase overall value and/or decrease risk
- Measure through determination of change in value of portfolio as a whole

Distribution of storage value

Stand-alone vs Marginal Value



Summary

- Storage represents a path-dependent real option problem
- Requires analysis of optimal exercise strategy
- Can be modelled using trinomial tree methodology
- Overall valuation framework depends on context
  - Time-frame
  - Optimisation and hedging strategies
  - Portfolio

Contacts

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