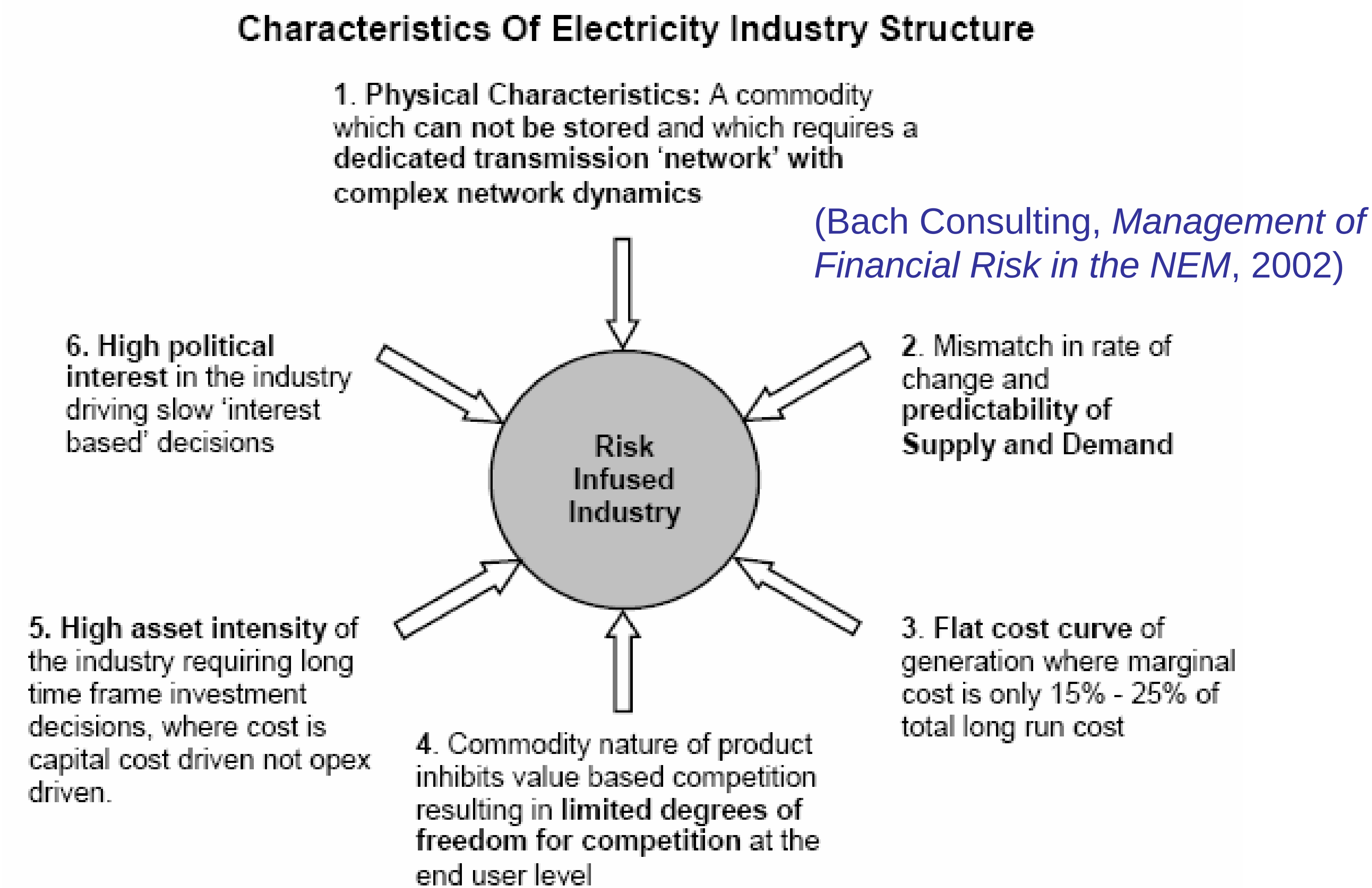
CEEM Specialised Training Program

EI Restructuring in Australia

Derivative Markets and the NEM

Iain MacGill and Hugh Outhred
Centre for Energy and Environmental Markets
School of Electrical Engineering and Telecommunications
The University of New South Wales
i.macgill@unsw.edu.au
www.ceem.unsw.edu.au

Electricity market participants face significant risks



(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

2 – mismatch in supply + demand

Electricity Demand & Supply Characteristics And Their Overall Implications

Characteristics*

Demand:

- Base load 65%
- Peak load 35%
- Demand growing at 2.5% p.a.
- Highly weather dependent
- Demand is becoming more 'peaky'

Supply:

- Units of production tend to be large in comparison to demand variations
- Large units take time to come on line
- Interconnector limits can restrict access to unused capacity
- Base capacity is 73% and intermediate/Peak is 27% (Exhibit 6)

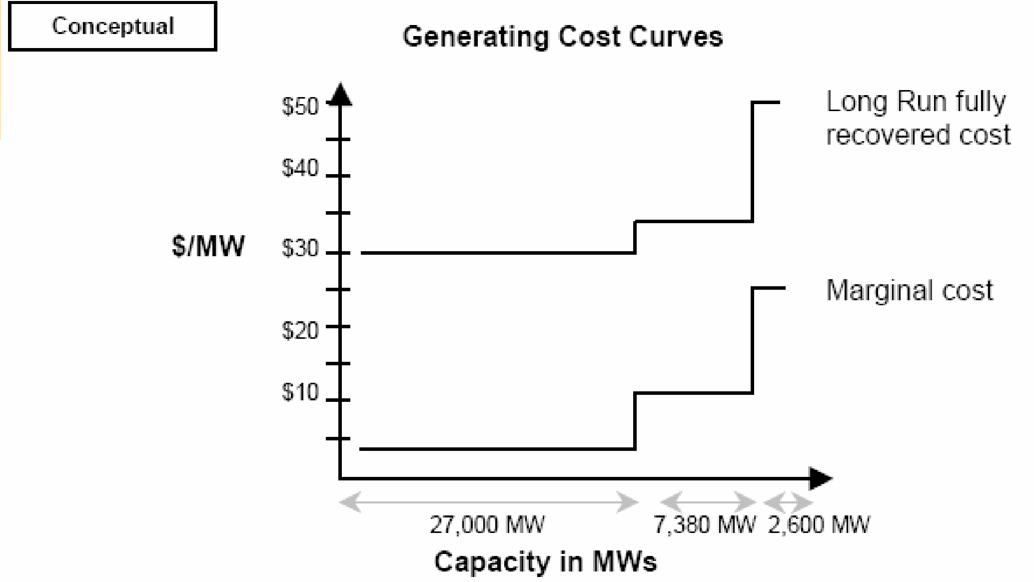
Insights

- Additional capacity will be required
- Base load and peak load capacity is out of synch with demand load variability
- Base loaders have capacity to attack peak loads (Exhibit 5)

* Source: NEMMCO SOO 2001, and the NECA Interim Report, 2001

(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

3 – Gen cost curves



(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

Electricity Generation Characteristics And Their Overall Implications

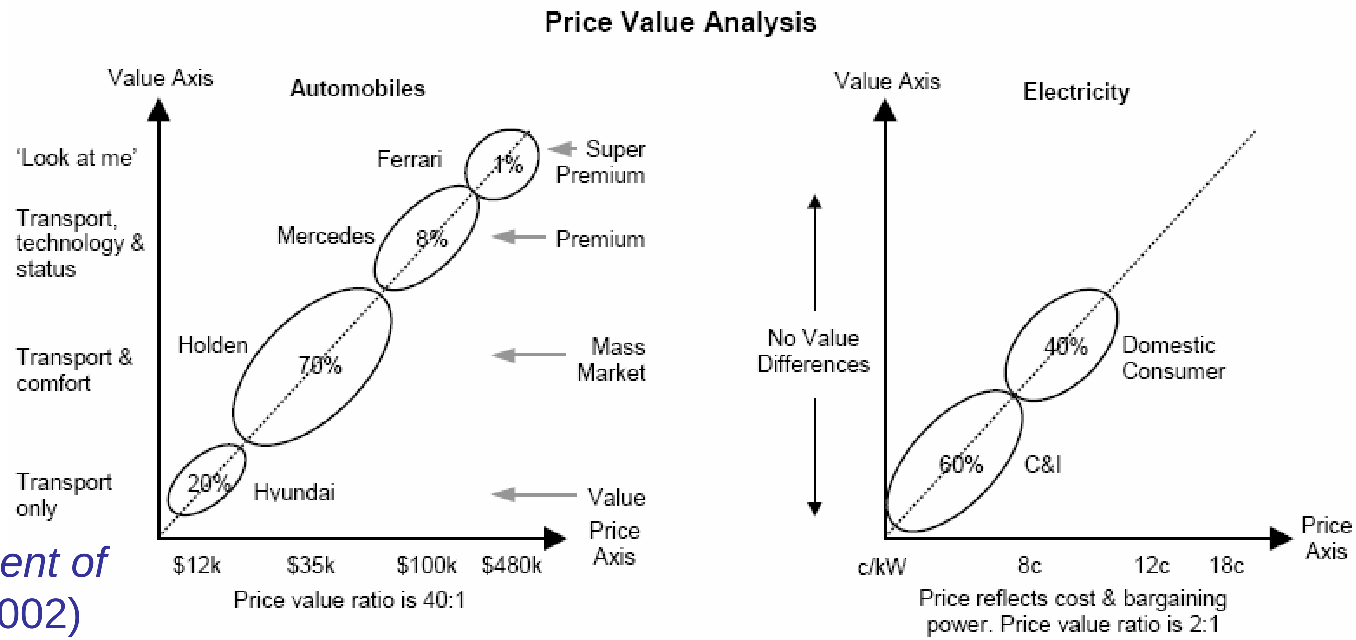
Characteristics

- Long run cost curve for industry is relatively flat up to base and intermediate peak volumes
- Marginal cost curve is less flat but marginal cost is very low in relation to long run costs
- Marginal cost of highest base producer ($12) or peak ($25) is lower than the long run cost of the most efficient producer approx. $30 (Exhibit 7) (excludes super peakers who may have marginal costs around $200/MWhr)
- With deep transmission the cost curve is 'whole of industry' but without deep transmission it becomes
- nodal or at best regional
- Nodal markets waste production capacity

Insights

- Investment decisions require price certainty or steep industry cost curve - neither exist so high risk
- Investment decisions to meet growth will be uncertain. This is an industry where you are only allowed to be as smart as your most financially stressed competitor
- Generating investment decisions are inextricably linked to transmission investment decisions
- Investment could lag demand ahead of long periods of low returns

3 – limited value-based competition



(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

The Commodity Nature Of Electricity Inhibits Value Based Competition At The End User Level

Characteristics	Insights
• Approx 65% of the value of the end-user market is open to competition • Electricity has tight price/value characteristics (see Exhibit 9) • Value of DSM is largely captured by the user of electricity i.e. it has a negative impact on prices • Retail competition is costly in terms of cost to acquire, cost of churn and cost to serve • Cost to acquire new customers drops significantly as additional customers are acquired	• One off user gains will occur as price competition takes place while industry costs actually increase • Retail competition currently opening up very few degrees of freedom for capturing of share other than price* • Retail competition is likely to diminish once 'high cost little benefit' outcomes of competing on price only are recognised

* this may change over time with a maturing end user market

5 – high asset intensity

Approximations

Exhibit 11

Electricity Industry Value Chain 2000

	Fuel Providers	Generators	Transmission	Distribution	Retail	Totals
Value Added	$2b	$3b	$2b	$5b	$1b	$13b
Assets (Depreciated Value)	$2b	$10b*	$6b	$26b	$3b	$47b
Rev:Asset	1:1	1:3	1:3	1:5	1:3	1:3.6
c/kW	1.2c	1.8c	1.2c	3.1c	0.6c	8c

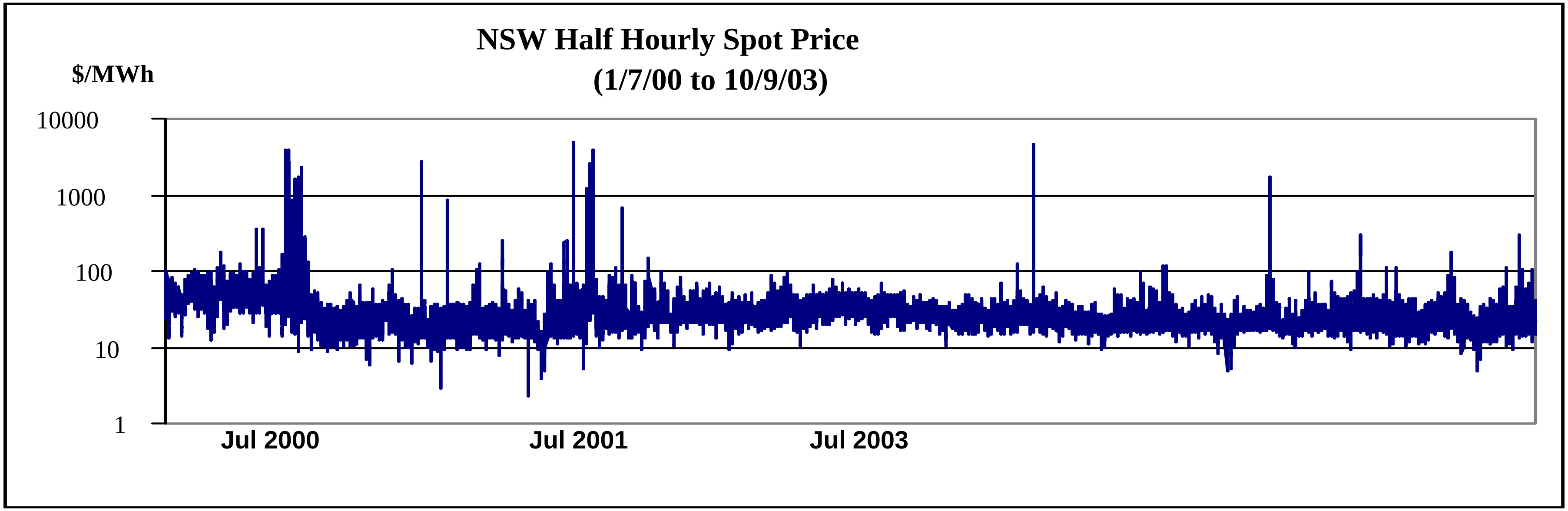
Source: Derivation of figures from annual reports of participants and the NEMMCO SOO
* Written down asset value; replacement value is approx. $40b

(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

Implications Of Asset Intensity

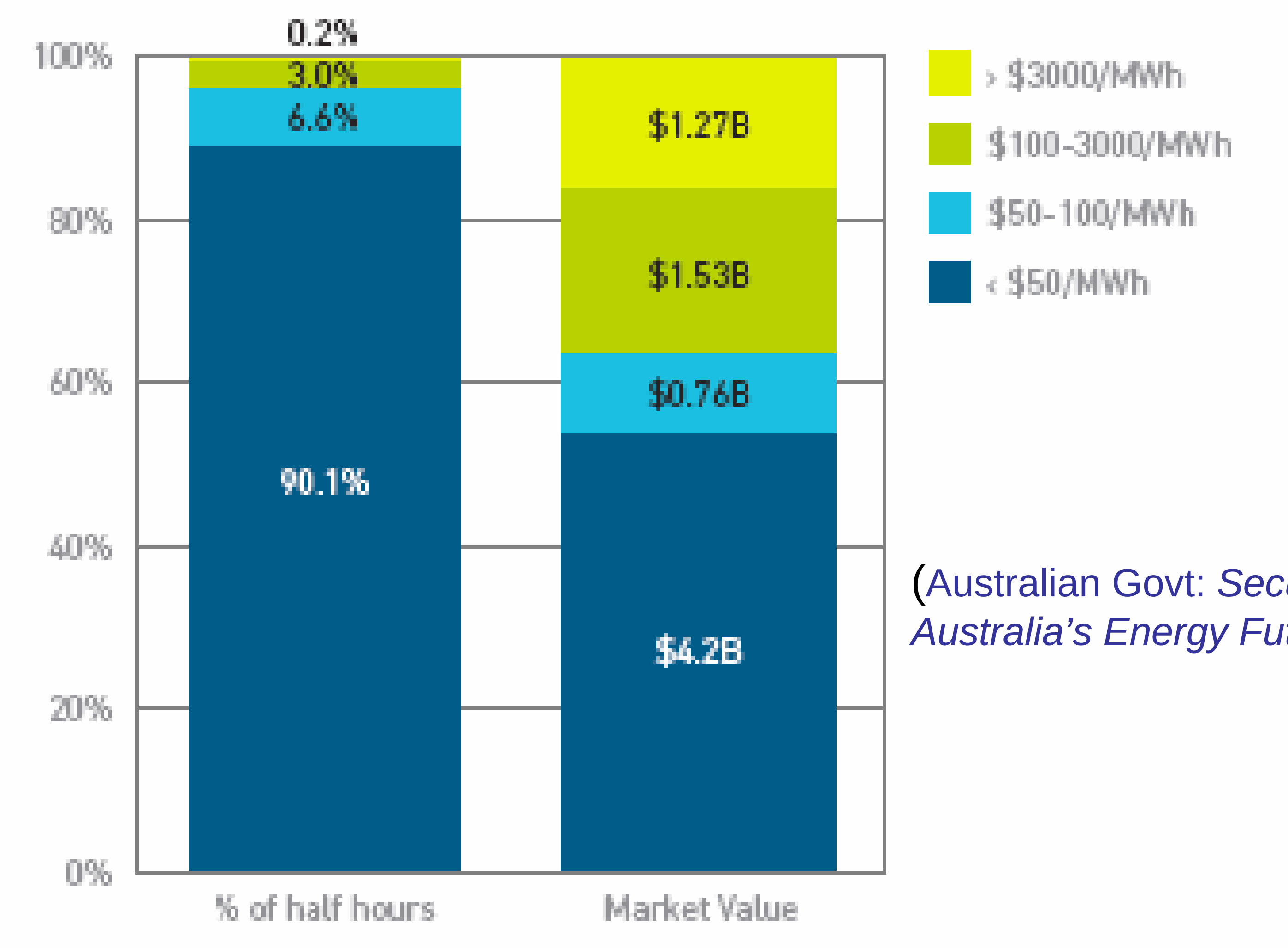
Insights
• Profitability will probably be low and investment risk therefore high • Investment decisions are the critical decisions not operating costs as investment drives cost • Industry operates with small margins on sunk assets. • New assets will be difficult to justify on current industry economics • Generation investment is irrevocably linked to transmission investment but controlled by different parties and processes

Outcomes include high spot price volatility + uncertainty



(CIRGRE, Risk Transformation for Generators in the NEM, 2004)

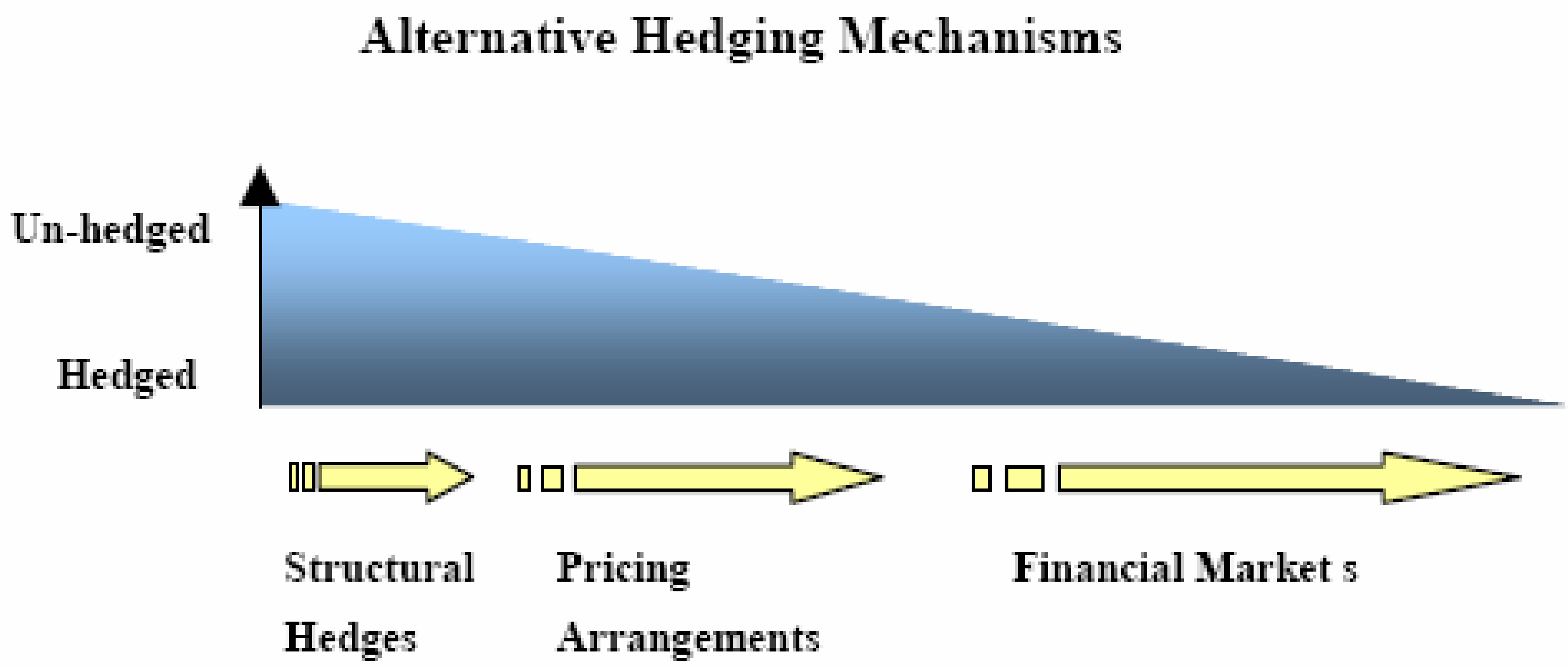
And therefore spot mkt revenue uncertainty



(Australian Govt: *Securing Australia's Energy Future,* 2004)

A range of hedging approaches for participants

(KPMG, *Development of Energy Related Financial Markets* Report to the CoAG, September 2002)



Participant motivation for trading in electricity derivatives - risk management

- Generators that have fixed costs but face variable spot price
- Retailers that buy at variable spot price & sell on pre-determined retail price
- Large end-users that buy at variable spot price & sell in competitive product market
- Opposing (complementary) risk profiles:
  - Generator natural seller of derivatives
  - Large end-user natural buyer of derivatives
  - Retailer potentially both seller & buyer

Risks in derivative trading

- *Market risk:* price or volume changes in spot or derivative markets
- *Credit risk:* counterparty fails to meet contractual obligations
- *Regulatory risk:* impact on derivative value due to regulatory decisions
- *Operational risk:* internal decision making, equipment performance, liquidity management, exogenous phenomena

Risk positions and strategies for mkt participants

(CIRGRE, Risk Transformation for Generators in the NEM, 2004)

	Generator	Retailer	Financial Intermediary
Natural NEM Position	Long physical capacity; Uncertain Spot Revenue	Short physical capacity; Uncertain Spot Costs	No physical capacity No market positions
Commercial Objectives	Close Long Spot; Exposure; Fix revenue; Lock in Contribution	Close Short Spot Exposure; Fix portion of costs; Lock in Margin	Trade/arbitrage to achieve profits
Hedging Strategy	Sell Spot; Hedge long Spot position	Buy Spot Hedge short Spot position DSM Contracts	None
Trading Strategy	Trade around hedges	Trade to adjust hedges; Trade around hedges	Arbitrage; Stop/Loss on open positions
Implications High Spot Prices	Plant must run and cover contracts	Hedges must accurately cover demand	-

Market power issues in spot & derivative mkts

Spot markets	Derivative markets
Buyers have little discretion between market intervals	Buyers have much discretion between market intervals
Buyers cannot be sellers	Buyers can also be sellers
Significant barriers to entry	Few barriers to entry
Derivative market positions limit gains from price setting	Risk assessment depends on limited spot market power
Auction: market maker must manage counter-party risks	Opportunities for bilateral trade as well as auctions

Derivatives:- definitions

- A derivative (contract) is a ‘paper’ product:
  – Derivatives are also called “financial instruments”
- Its only relationship to the physical product is through the spot price:
  – It creates a financial obligation related to a future spot market price outcome
- Key derivatives for electricity:
  – Two-sided contract for differences (CFD) or swap
  – Call option or cap (a form of one-sided CFD)
  – Put option or floor (a form of one-sided CFD)

Derivatives:- key parameters

- Quantity of spot market units to which derivative applies (e.g. MWh)
- Spot market period(s) to which derivative applies
- Strike price:
  - Interpretation depends on the type of derivative

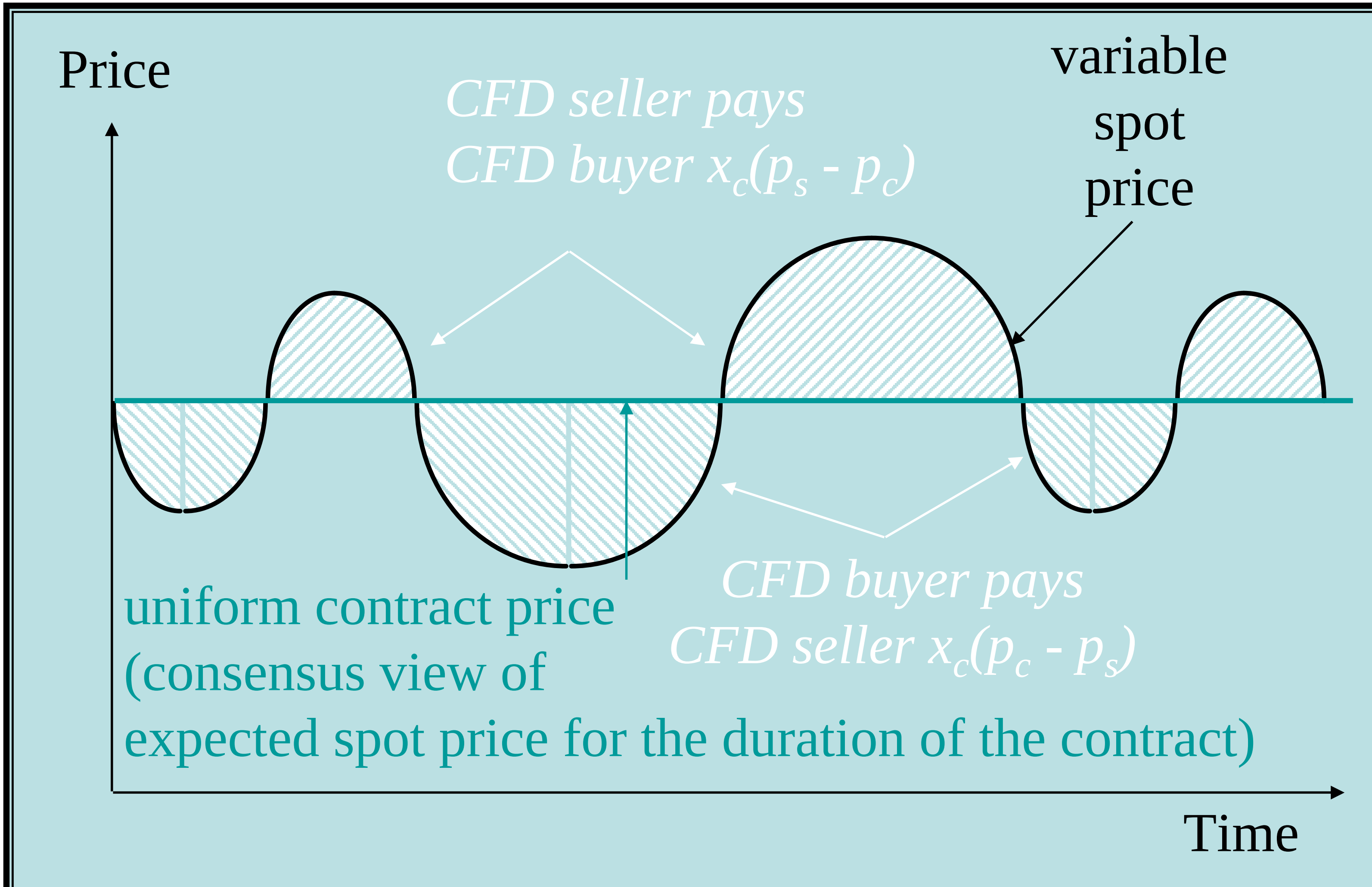
Two-sided CFD or swap:- definitions

- A CFD or swap is a piece of paper stating:
  1. Contract price (strike price) = p_c
  2. Contract quantity = x_c
  3. A future spot time at which contract will be reverse traded (or ‘closed out’) at spot price p_s
- Trade in CFDs is only related to trade in the physical commodity by the spot price at which the reverse trade is carried out

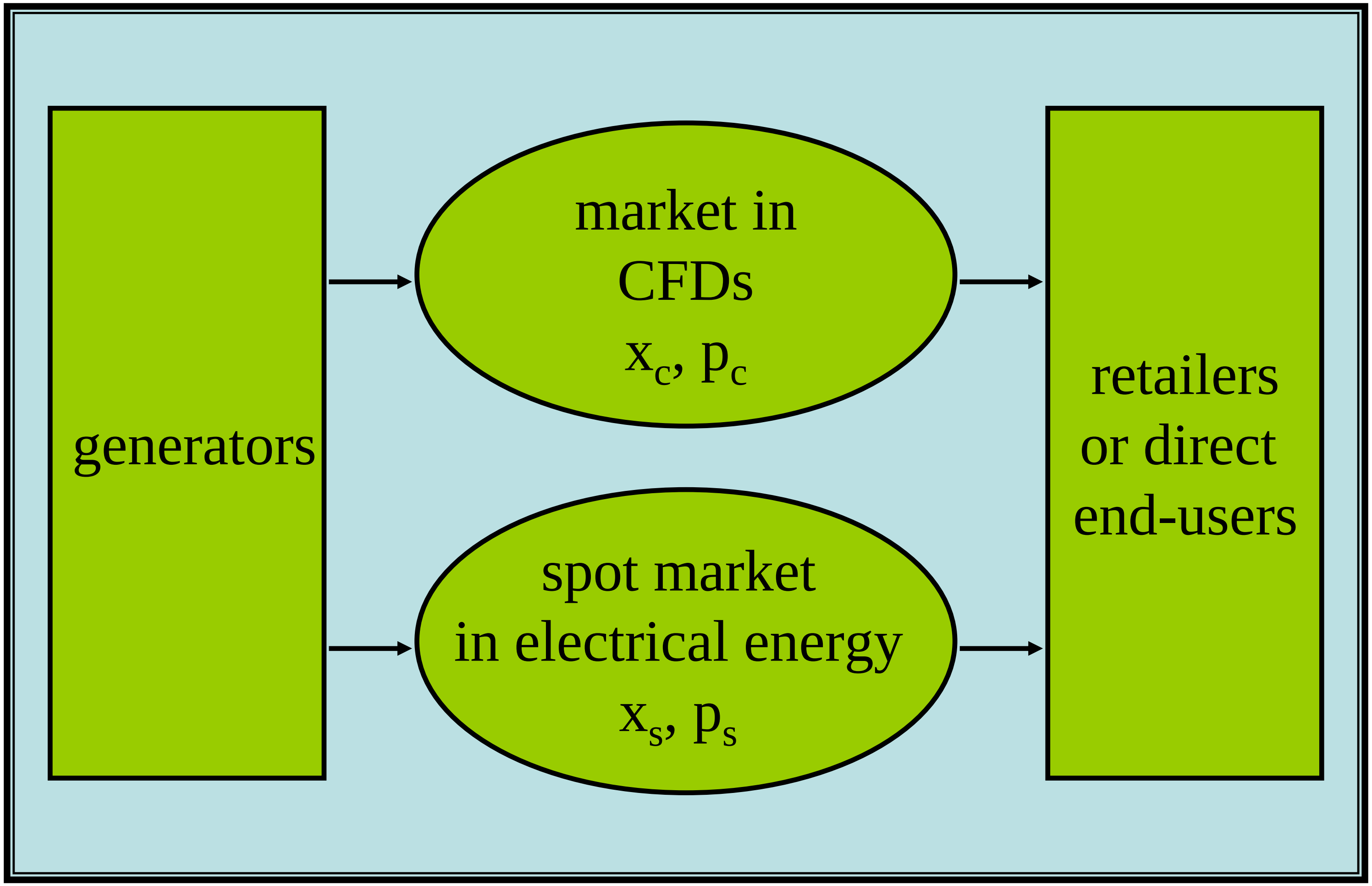
Trader’s view of CFD trading

- CFD buyer:
  - Buys CFD at contract time; cost $= p_c x_c$
  - Sells CFD at spot time; income $= p_s x_c$
  - *Net cost of CFD to buyer* $= x_c(p_c - p_s)$
- CFD seller:
  - Sells CFD at contract time; income $= p_c x_c$
  - Buys CFD at spot time; cost $= p_s x_c$
  - *Net value of CFD to seller* $= x_c(p_c - p_s)$
- Market in CFDs to allow adjustment of x_c

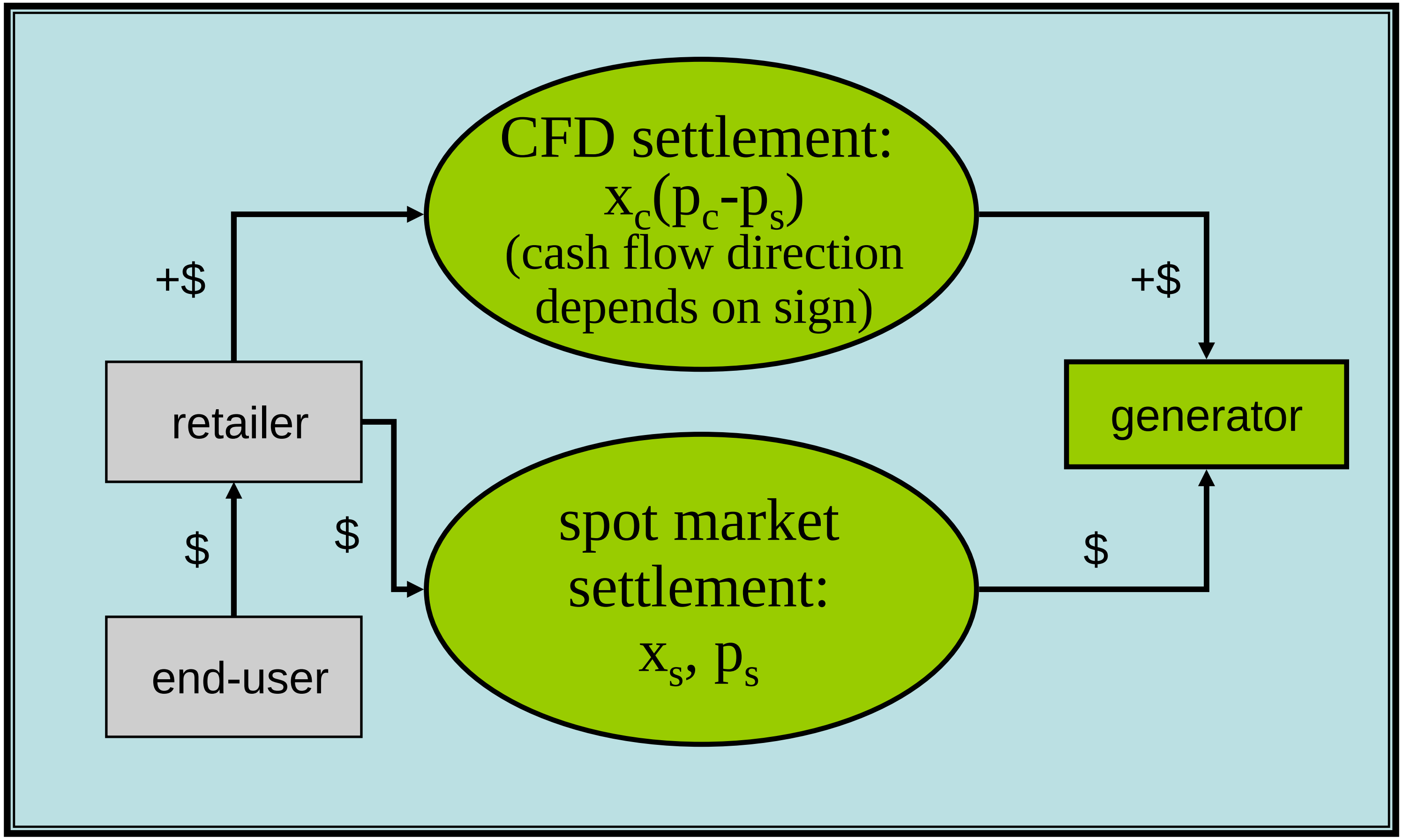
Effect of CFD 'close-out'



CFD & electricity trading



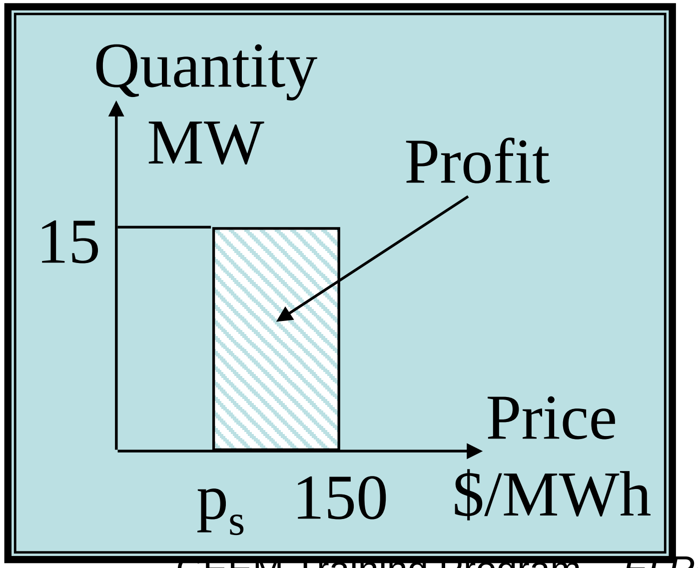
CFD & electricity trading cashflow



Retailer recovers cash flow from end-user via a retail tariff

Direct end-user using CFD as a 'hedge'

- End-user with 15 MW factory buying directly from spot market:
  - Assume that product value = (150-p_s) \$/MWh
- At contract time, end-user buys:
  15 MW CFD @ 50 \$/MWh = 750 \$/h
- 'Locked in' profit = 15(150-50) = 1500 \$/h



Direct end-user using CFD as a 'hedge'

At spot time, consider two cases:

1. Spot price = 100 $/MWh

   With consumption of 15 MW, spot + CFD trading

   cost = $p_c x_c + p_s(x_s - x_c)$ =50x15+100(15-15) = **750 $/h**
   (same as cost of CFD, regardless of spot price)

2. Spot price = 200 $/MWh

   Either consume 15 MW with same result as case 1

   Or **shut down factory** & earn a profit from the CFD transaction alone:

   profit from CFD = $x_c(p_s - p_c)$ = 15(200-50) = **2,250 $/h**

Summary of CFD properties

- CFD protects against future price risk:
  - Incentive to fully hedge expected spot position
- *Thus CFD market predicts future spot market in both price & volume (hedge volume only)*
- Even when fully hedged, there is still an incentive to respond to spot price:
  - Rewards voluntary price response
  - Generator not protected against outage risk

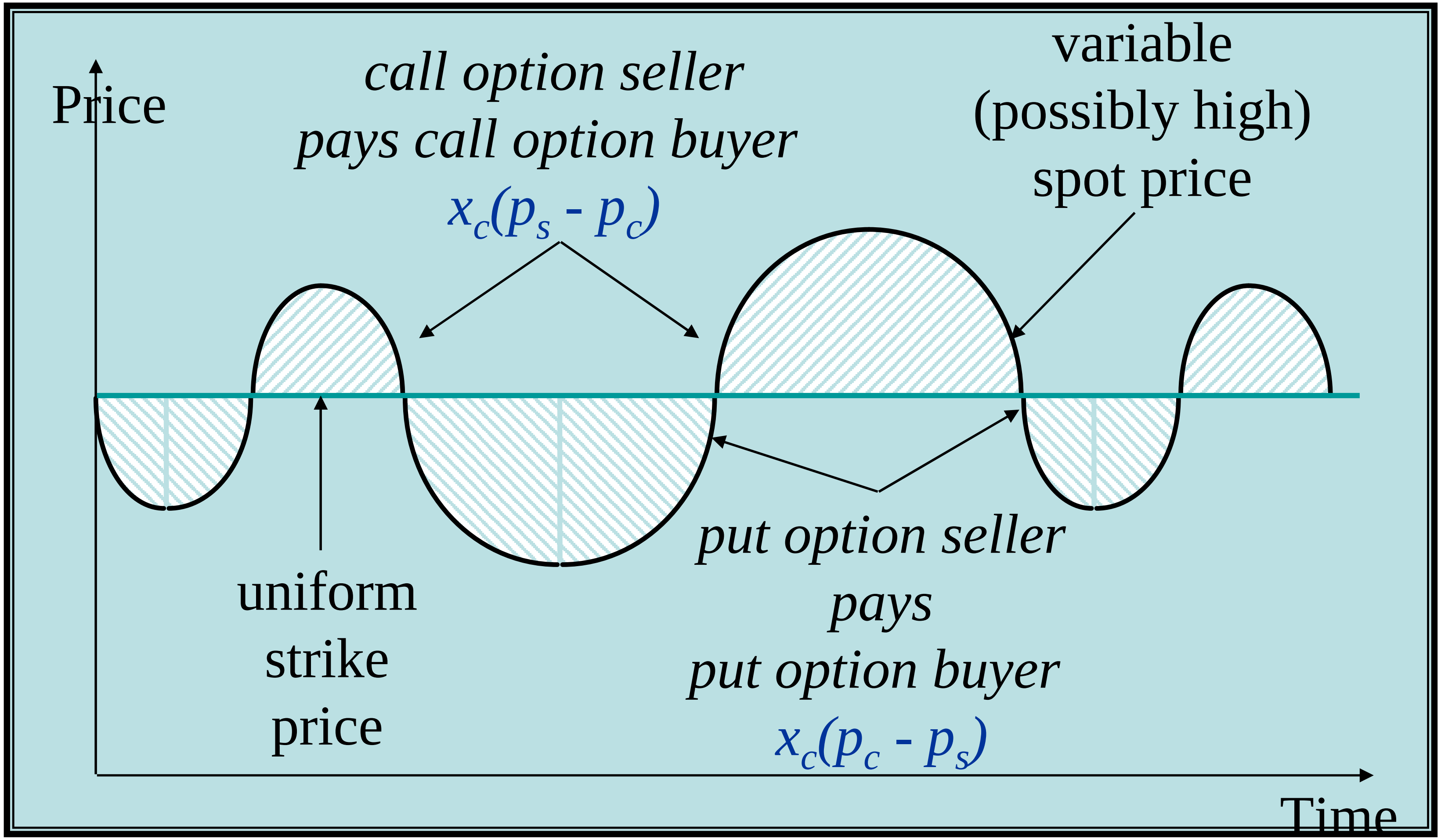
Call option or cap:- definition & role

- The seller must compensate the buyer if the spot price is **above** the strike price
- Potential call option buyer:
  - consumer with inflexible demand
  - unreliable base load generator
- Potential call option seller:
  - reliable, high operating cost thermal generator
  - low capacity factor hydro generator

Put option or floor:- definition & role

- The seller must compensate the buyer if the spot price is **below** the strike price
- Potential put option buyer:
  - inflexible base load generator
- Potential put option seller:
  - large electricity consumer

Call & put options: illustration

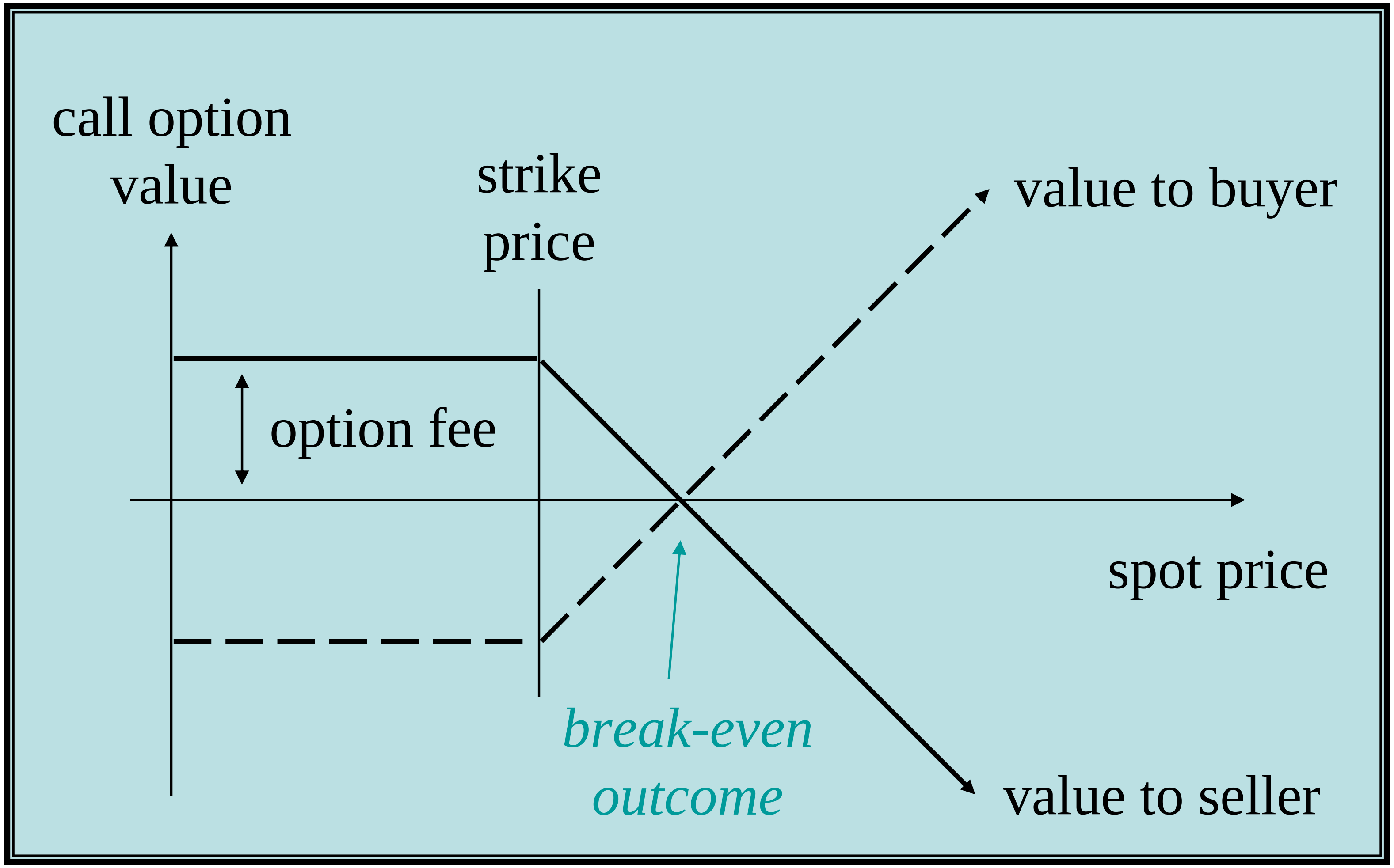


(buy a CFD = buy a Call & sell a Put at the same strike price & with the same option fee)

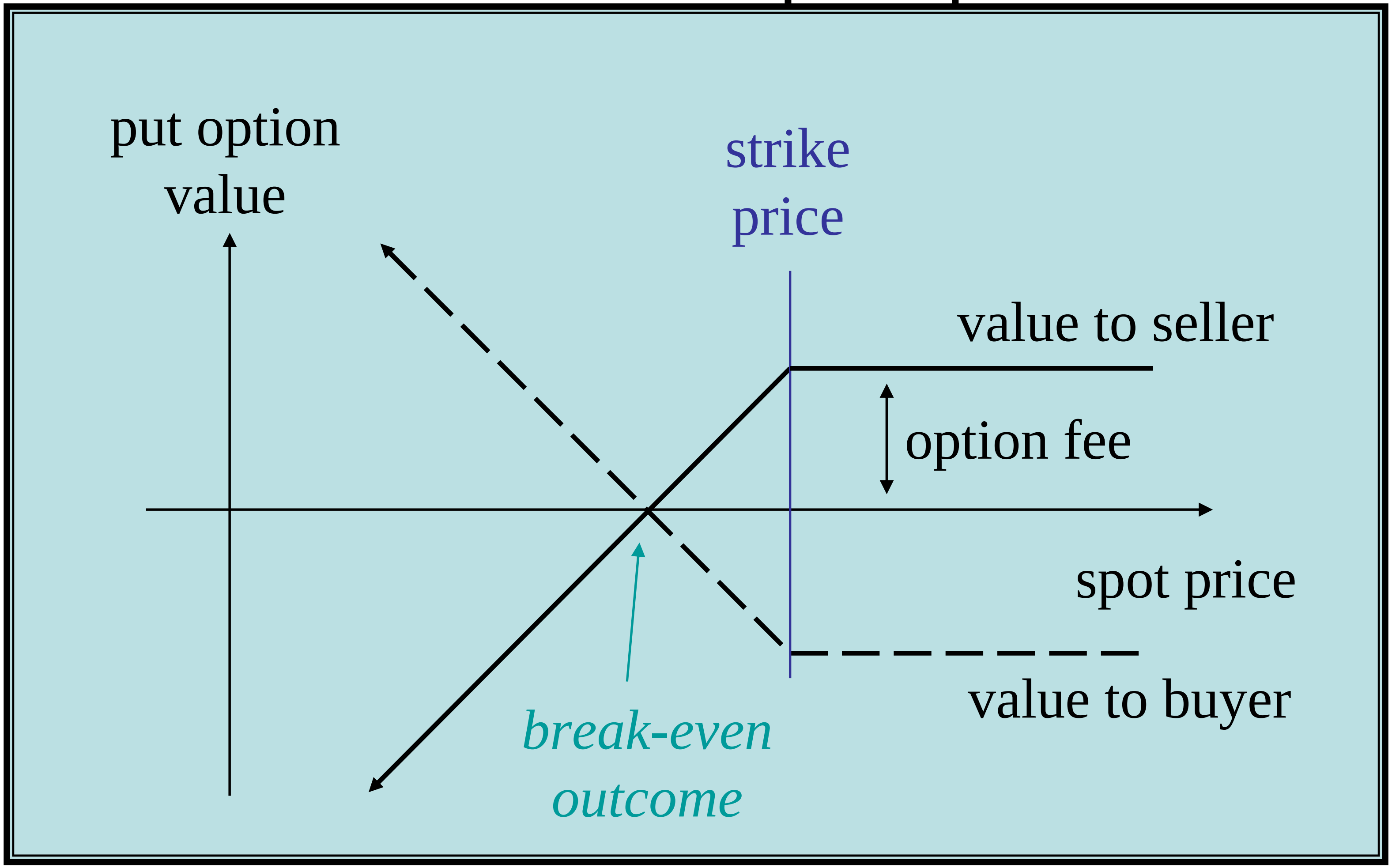
Call & put options: features

- Options are single-sided versions of CFDs
- Unlike CFDs, the option buyer must pay a fee to purchase the option:
  - The option fee is based on an estimate of the 'close-out' value of the option at spot time:
    - a call option will have non-zero 'close-out' value if the spot price exceeds the option strike price
    - a put option will have non-zero 'close-out' value if the spot price is lower than the option strike price
- Can create composite derivatives, eg:
  - A collar combines a call option at a higher strike price with a put option at a lower strike price

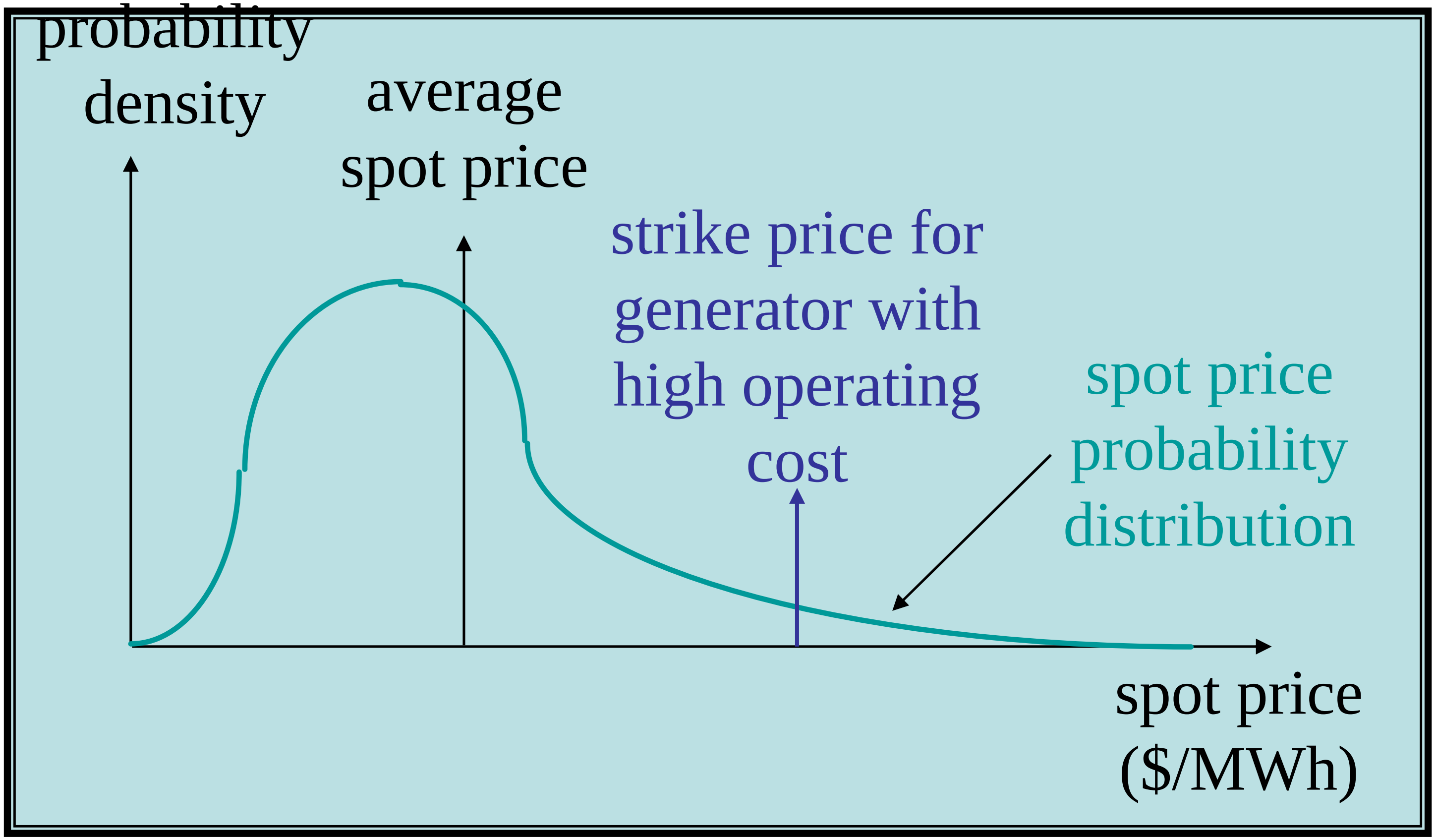
Final value of a call option



Final value of a put option



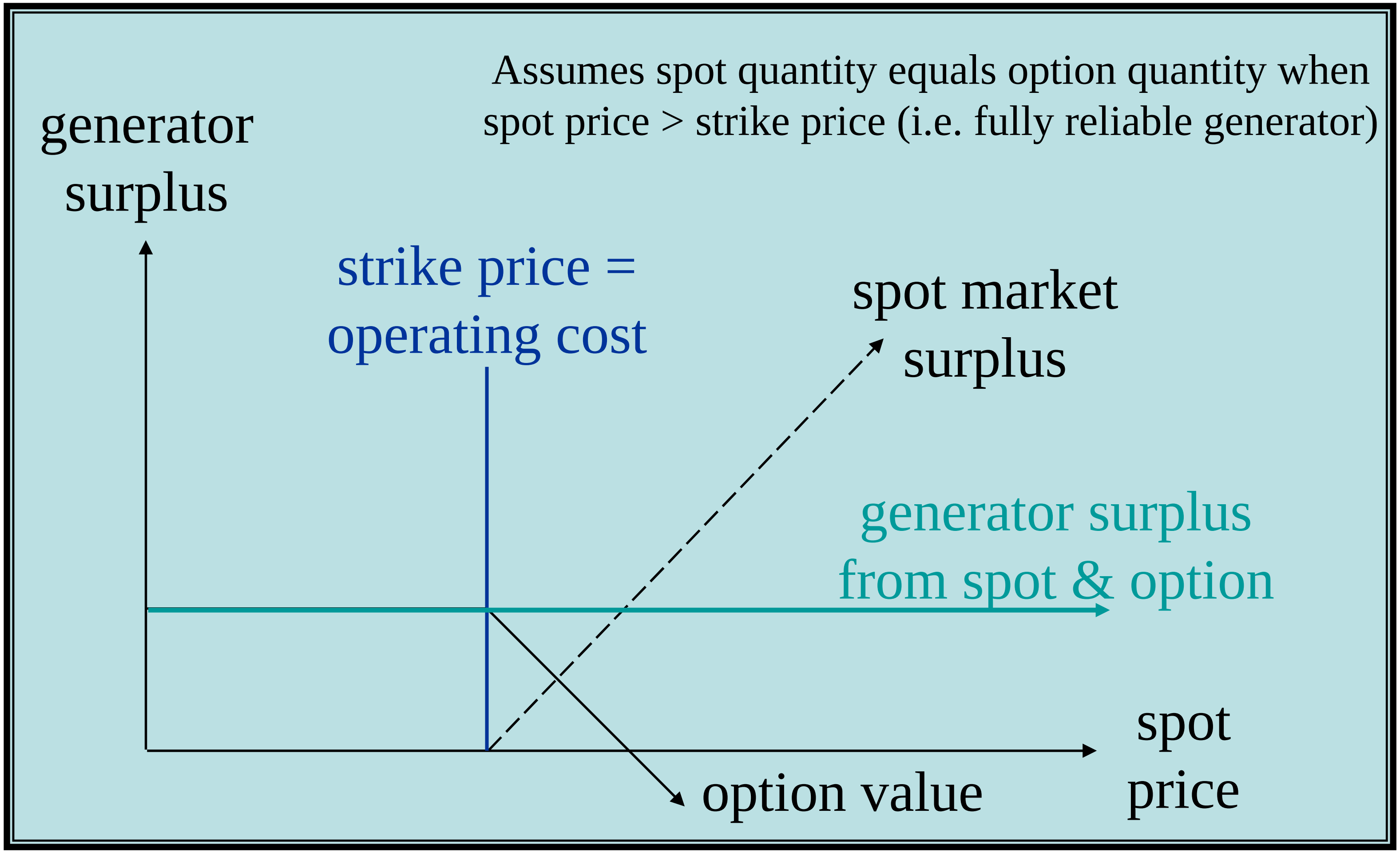
Call option & generator with high operating cost #1



Call option & generator with high operating cost #2

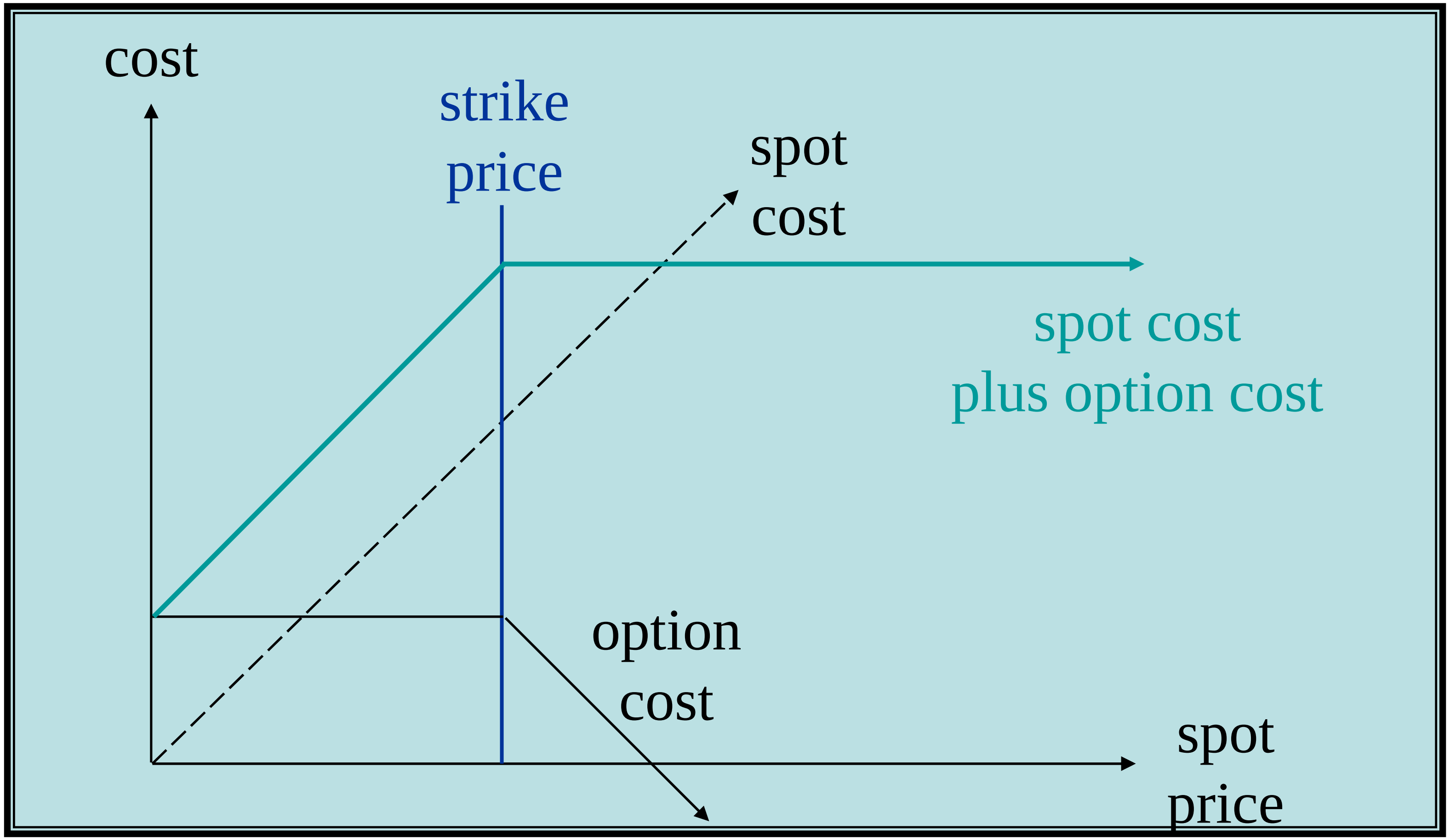
- Generator would like assured operating surplus to earn return on investment
- But operating cost > expected spot price:
  - Cannot benefit from a CFD contract
- If generator reliable (both start & operate):
  - Sell call option @ strike price = operating cost
  - Then option fee provides return on investment:
    - Size of fee depends on likelihood of: *spot price > strike price*

Call & spot: generator surplus



Call & spot: cost to retailer or end-user

Assumes spot quantity equals option quantity when spot price > strike price (i.e. fully reliable generator)



Call option as end-user hedge #1

- End-user with 100 MW inflexible load
- Generator with 60 $/MWh operating cost
- End-user buys call option from generator:
  - 100 MW, 60 $/MWh, period T, option fee = F
- Period T scenario 1:- spot price = 20 $/MWh
  - Call option inactive, generator does not operate:
    - Earns fee F
  - End-user buys at spot price:
    - Total cost = spot cost + F

Call option as end-user hedge #2

- Period T scenario 2: spot price = 200 $/MWh
  - Generator pays end-user the option ‘close out’ value: 100x(200-60) = 14,000 $/h
  - Generator sells electricity, incurs operating cost:
    - Surplus from spot market = 100x(200-60) = 14,000 $/h
  - Generator surplus from spot + call option = F
  - End-user buys 100 MW electricity at spot price, receives *option* ‘close out’ value from generator:
    - End-user cost = 100x200 -14,000 + F = 6,000 $/h + F
      - Shielded from spot price > strike price (60 $/MWh)

Call option as end-user hedge #3

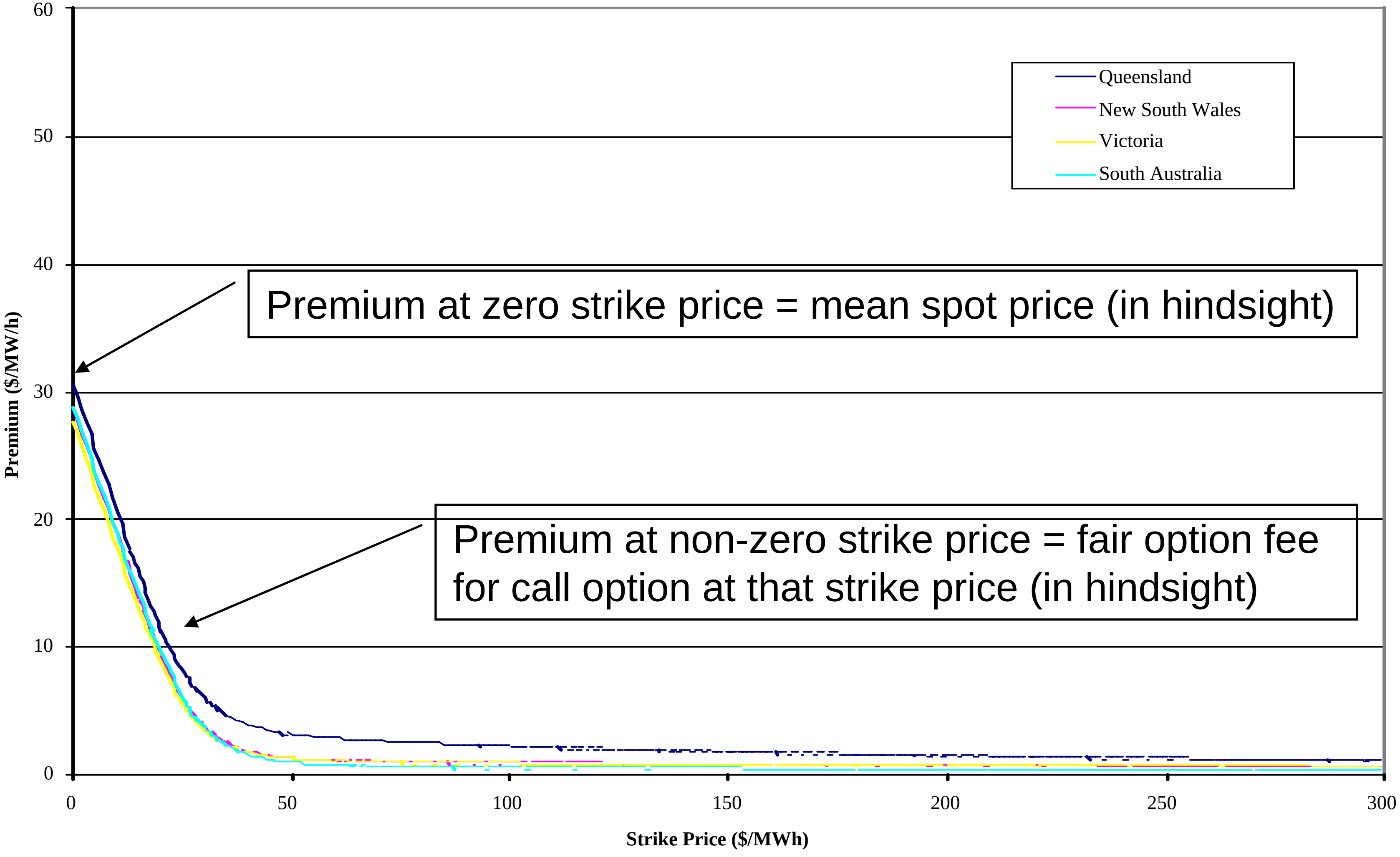
- Setting the option fee F at contract time:
  - Assume:
    - Reliable generator
    - Expected spot consumption = 100MW
    - Spot price probability distribution given in table below
  - Then:
    - Ave. spot price = .35x20+.5x30+.15x200 = 52 $/MWh

price ($/Mwh)	20	30	200
probability	0.35	0.5	0.15

Call option as end-user hedge #4

- Expected outcomes for end-user:
  - Cost without option = 52x100 = 5,200 \$/h
  - Cost with option = (.35x20+.5x30+.15x60)x100 = 3,100 \$/h
  - **Benefit from option = 2,100 \$/h**
- Expected end-user benefit from option equals expected generator spot income
  - Basis for negotiating F if both are risk averse
- Both generator & end-user still see an incentive to respond to spot price

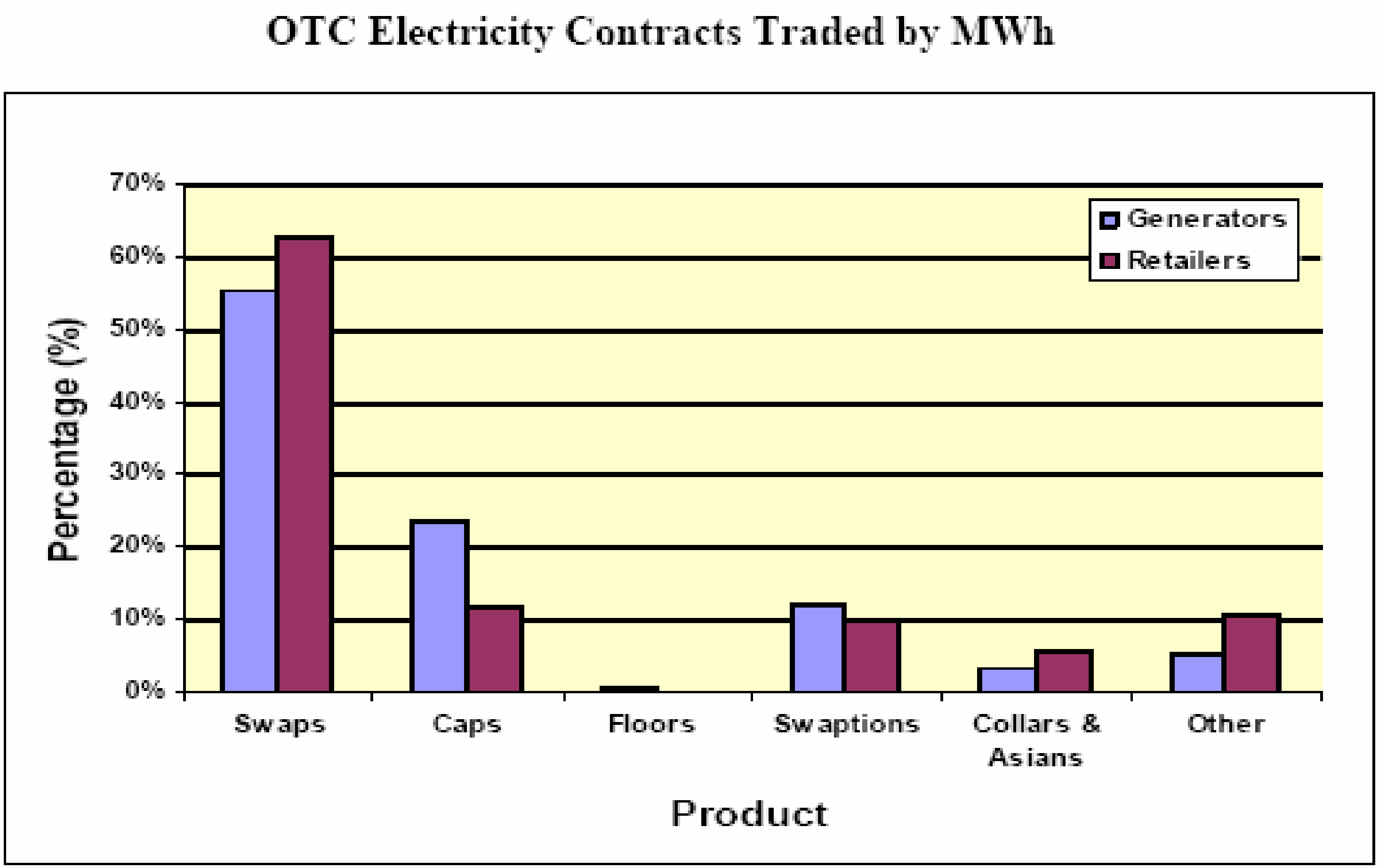
Example: Premium ($/MWH) for all NEM spot prices above strike price for year to 4/02 (Reliability Panel, 2002)



Available financial markets for participants

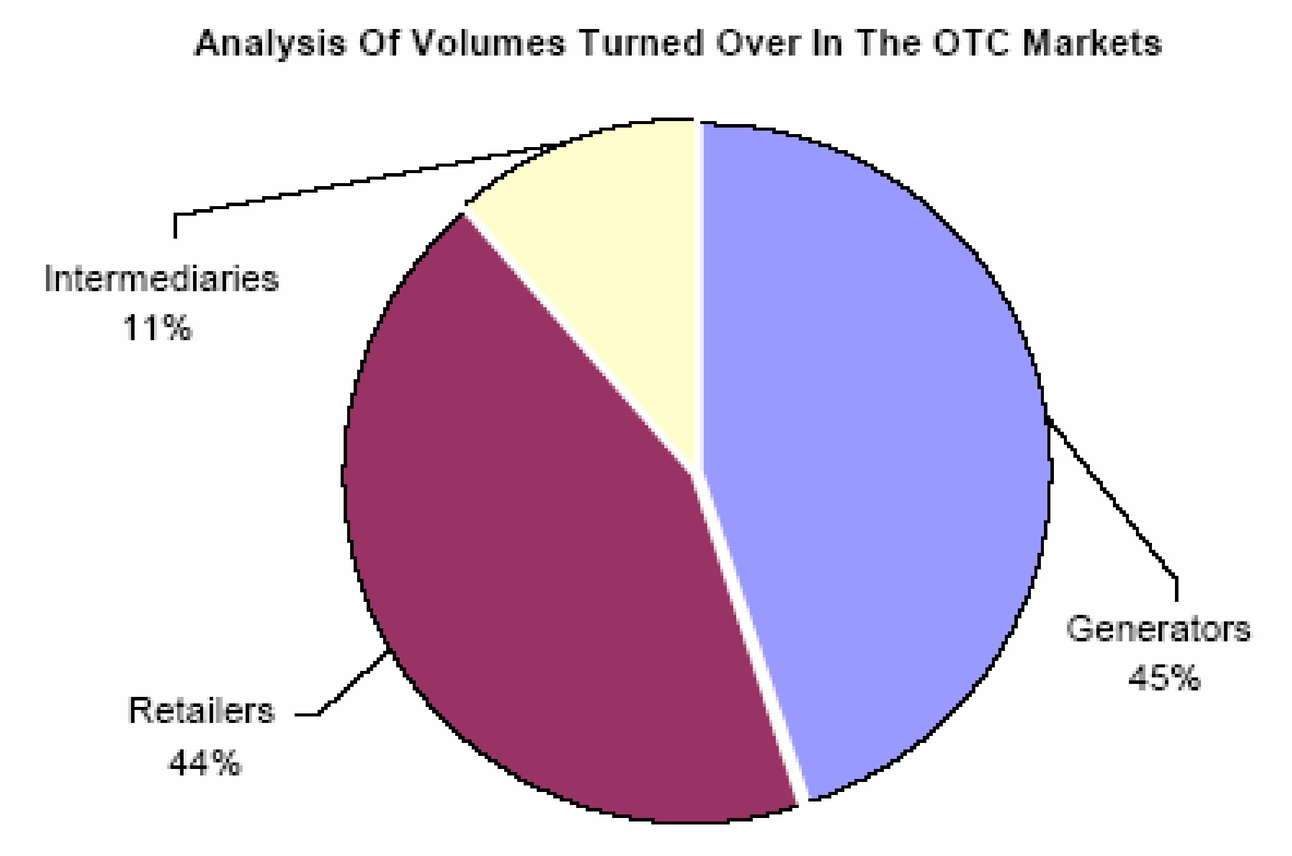
Financial Market Item	**Comment** *(CIRGRE, Risk Transformation for Generators in the NEM, 2004)*
OTC Direct Larger and/or customised hedges negotiated confidentially between NEM participants	Confidential, direct negotiations between counterparties; Larger, and/or complex, customised quantity derivatives; ISDA based contracts; physical conditions (carbon tax, force majeure…); Major source of market hedging; unsuitable for trading.
OTC Standard Smaller, standard hedges and trades between participants via a broker facilitated screen	Broker facilitated negotiations between counterparties; Smaller, standardised quantity derivatives; ISDA based contracts; 'Clean' (Few physical conditions); Main source of market trading.
Exchanged Traded Futures Exchanged traded contracts currently being established by two futures exchanges	Broker facilitated futures contracts through Exchanges; Smaller, standard derivative contracts; Futures contracts; 'Clean' (No physical conditions); Currently developing as channel for trading and hedging.

OTC contract volumes for the NEM



(KPMG, *Development of Energy Related Financial Markets,* Report to the CoAG, 2002)

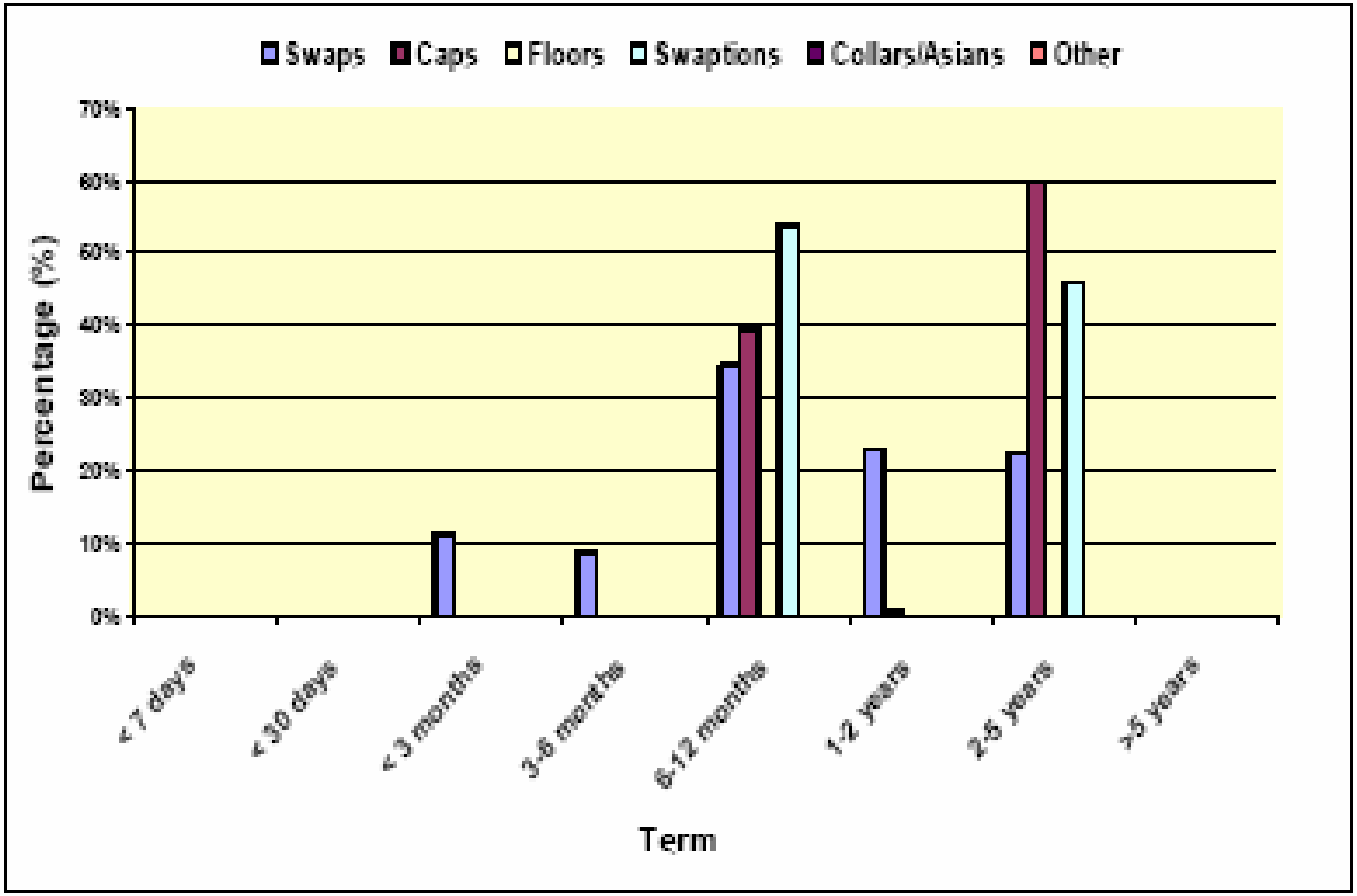
Participant volumes in OTC



Retailer positions in the NEM

Figure 4: Retailer Position

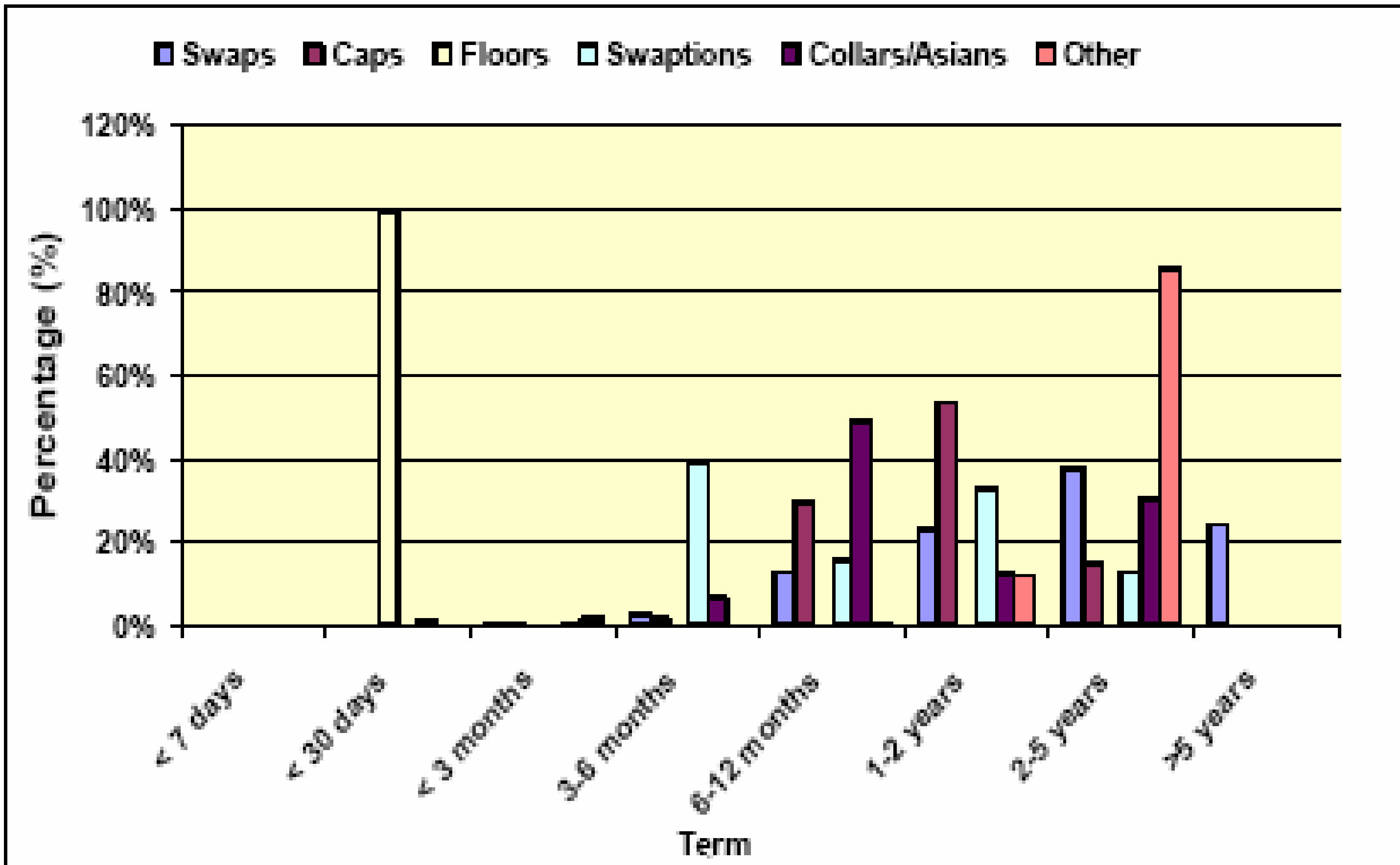
(KPMG, *Development of Energy Related Financial Markets,* Report to the CoAG, 2002)



Generator positions in the NEM

Figure 5: Generator Position

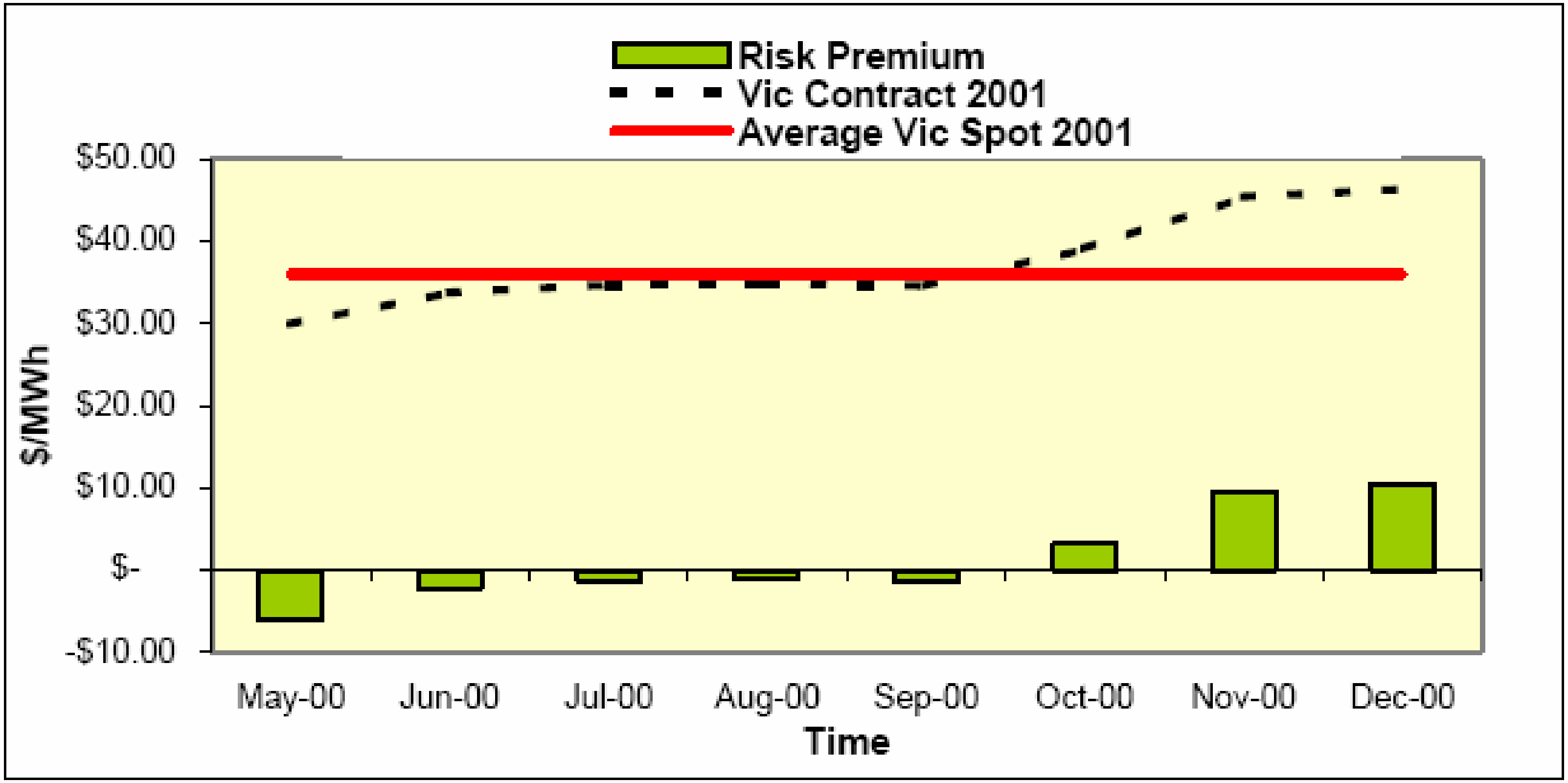
(KPMG, *Development of Energy Related Financial Markets,* Report to the CoAG, 2002)



NEM risk premiums

Figure 8: Comparison of Financial Contract and Spot Price – May to December 2000

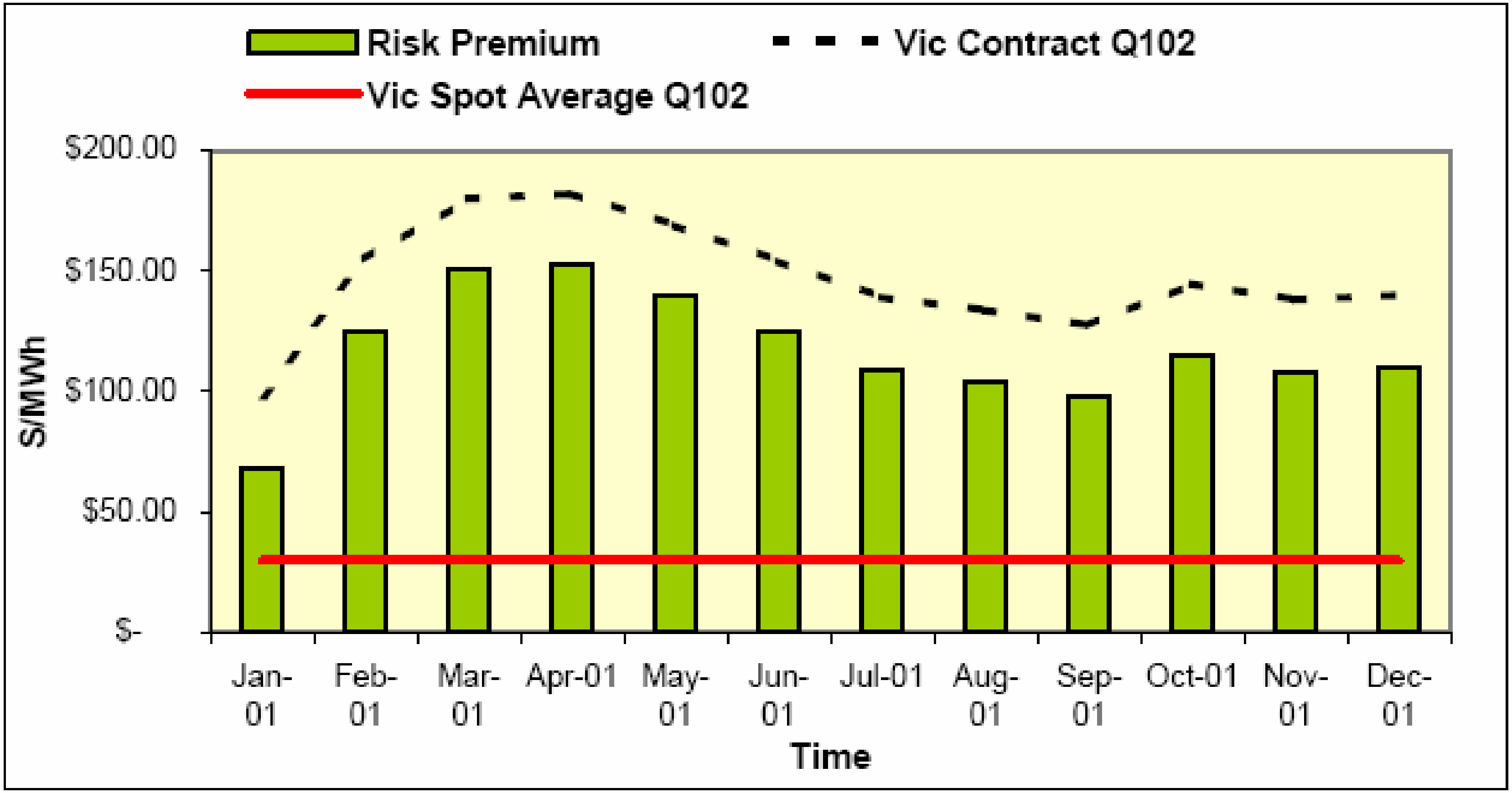
(KPMG, *Development of Energy Related Financial Markets,* Report to the CoAG, 2002)



NEM risk premiums (cont.)

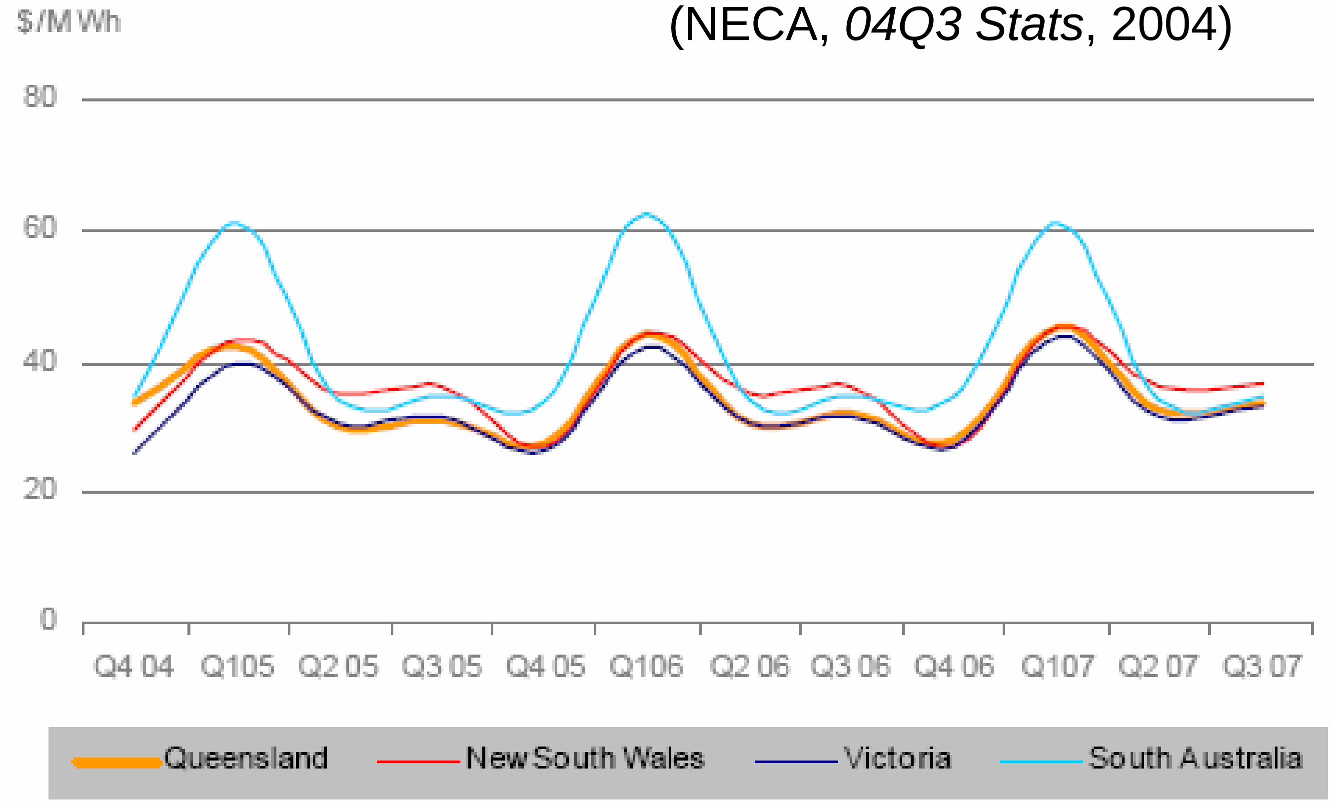
Figure 9: Comparison of Financial Contract and Spot Price – January to December 2001

(KPMG, *Development of Energy Related Financial Markets,* Report to the CoAG, 2002)

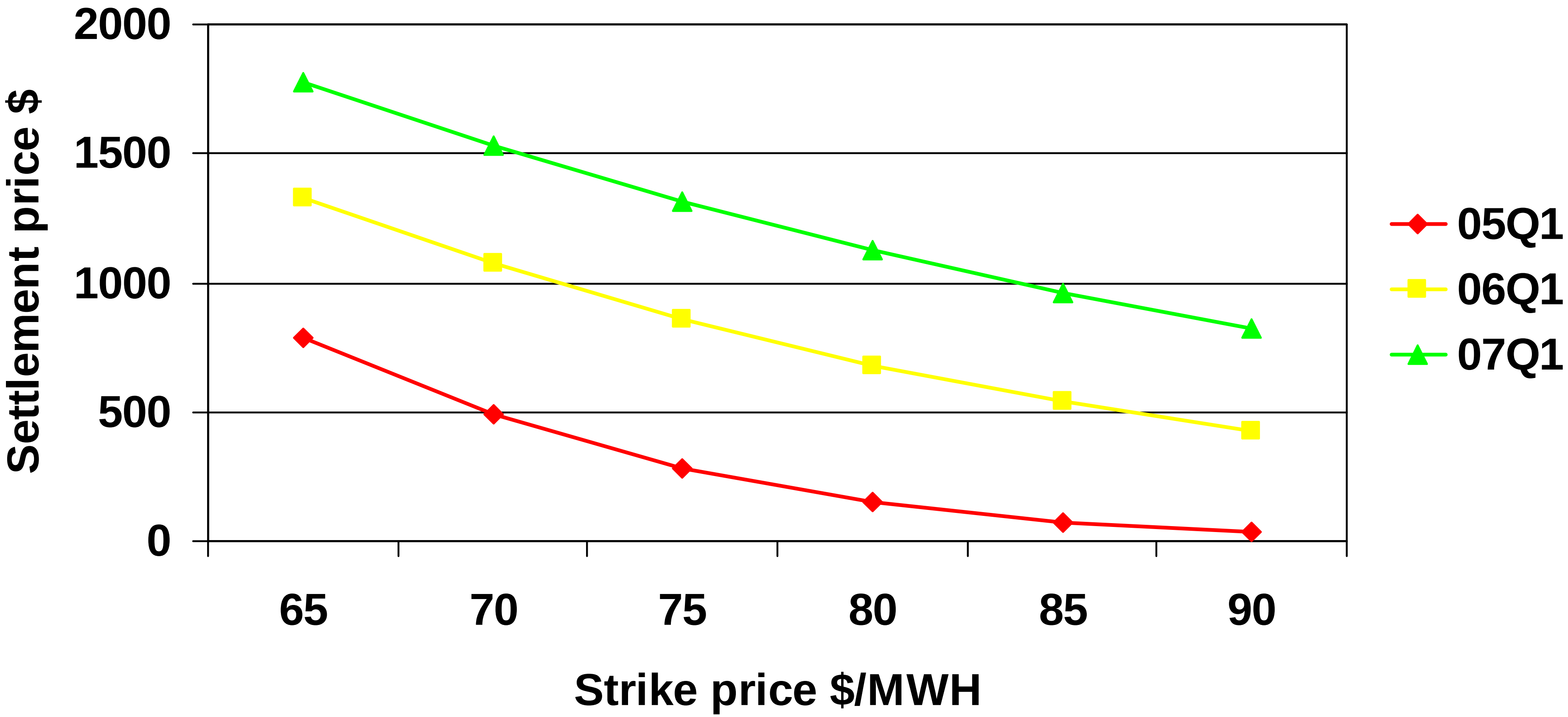


NEM flat contract prices Q3/2004

(NECA, *04Q3 Stats*, 2004)



Example: d-cyhpaTrade exchange-traded call options for NSW peak period (www.d-cyphatrade.com.au)



Other interventions: NSW 3rd Tranche vesting contracts

(July 1998 to December 2000)

- Two types of contract:
  1. CfDs covering around 80% of franchise load:
     - NSW govt preferred a strike price of 44.5 $/MWh
     - ACCC proposed to reduce this to 37 $/MWh
  2. Cap (buy call) & ‘binary option’ floor (sell adder rather than put)
     - ACCC proposed cap of 37 $/MWh (NSW 65 $/MWh)
     - Floor price of 14 $/MWh representative of fuel costs
- This structure was designed to:
  - – Allow 95-98% of franchise load to be ‘vested’
  - – Expose generators to pool prices at the margin

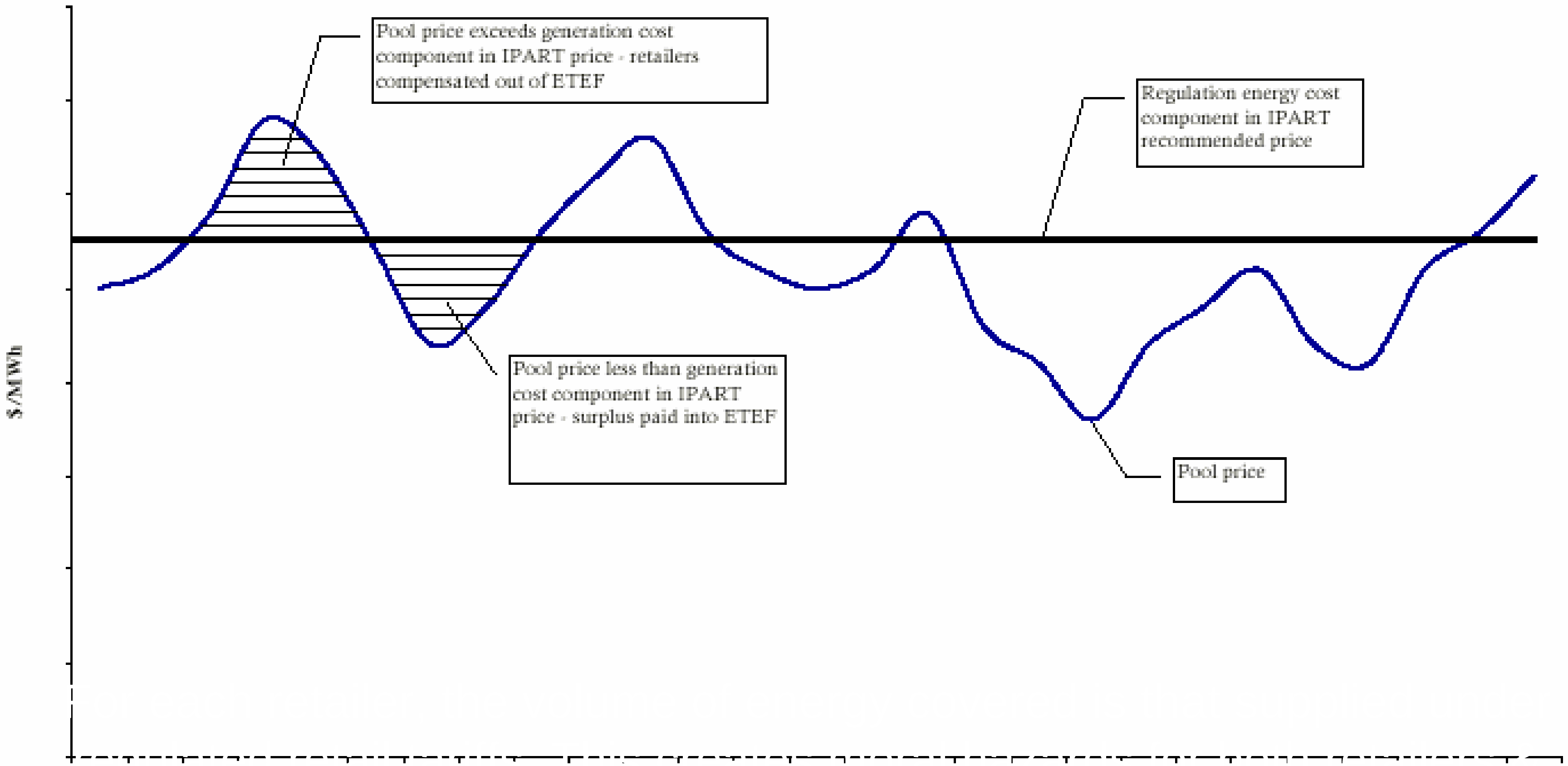
Other interventions: NSW Electricity Tariff Equalisation Fund

(NSW Electricity Supply Amendment Act, 2000, applying from 2001)

- A form of CFD to cover default tariff load:
  - Between state-owned retailers & Ministerial Corp'n, underwritten by state-owned generators:
    - Strike price based on IPART estimate of LRMC
    - Volume set *ex-post* at NEM settlement:
      - Uncertain volume deters gens from other contracts
    - Return of ETEF surplus to gen's is discretionary:
      - Reduces their incentive to offer lower than LRMC
      - Encourages them to bid up spot price if ETEF high
- Poor social, economic & environmental policy
  - Winners: residential air-cond, interstate gen's
  - Losers: low income & contestable consumers

NSW Electricity Tariff Equalisation Fund

(NSW Treasury, December 2000)



Issues raised by ETEF

- Regulated tariff will subsidise consumers with “expensive habits” (e.g air-conditioning)
- Retailers can pass on these risks via ETEF
  - Underwrites A/C marketing drives (eg EnergyAust)
- Retailers may try to bias ETEF volumes:
  - Up when spot price high, down when low
- Discourages NSW generators from selling other forward contracts (as in South Aust):
  - Increases risk to other customers & retailers
- Generators are effectively uncontracted when the ETEF fund is in surplus & no calls expected

Alternatives to ETEF

- Careful use of CFDs, caps & collars
- Swaptions: options over CFDs, caps & collars
- Flex products:
  - Flexible volume CFDs, caps & collars
- Weather derivatives:
  - Call option on weather event, such as temperature or rainfall
  - Broker tries to match counter-party interests
- Physical actions such as improved house design (derivative market assists valuation)

Summary, derivative contracts

- When used well, derivative contracts:
  - Reduce spot market price risk
  - Do not interfere with spot market incentives
  - Can be used as a vesting contract to impose transitional financial obligations
- Given well designed spot & derivative markets, trade in derivatives can:
  - Predict future spot market conditions
  - Provide flexible risk management facilities
  - Improve control of market power

Current use of derivatives in the NEM

- Risk management framework incomplete:
  - Aggregate volume information not available to support network planning
  - Little end-user participation in derivative trading, so risk chain incomplete
- Possible remedies:
  - Develop measures of hedge volume by region
  - Restructure retail tariffs to spot & forward form:
    - Consider using profile forward volumes for small end-users

An international comparison - futures

(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

Exchange-Traded Market Criteria	Nordpool	NEM	PJM
Volumes	359 TWh (2000)*	42 GWh (2000)**	2.8 TWh (1999 annualised)***
Allows short- to medium-term price discovery in anonymous transparent manner	• Extensively traded contracts ranging from day ahead to four years out provides deeply traded forward curve • Stimulated by incentives for market-markers (50% rebate on clearing fees and no fees on trading depending on market-making category)	• Foregone due to thinly traded SFE Exchange contract	• No price discovery due to delisting
Allows readjustment of long-term hedges as they become short-term	• Annual and season contracts extend out to 4 years • Monthly futures contract cascade into weekly and daily contracts as short- to medium-term becomes current	• Thinly traded SFE exchange contract does not enable readjustment of position	• No readjustment possible due to delisting. Lack of use potentially caused by significant basis risk between the PJM Nymex futures contract (being settled against Western hub price) and spot nodal pricing at possibly 2000+ different nodes in the PJM system
Prices credit through margin calls and novation	• Extensive as spot, exchange-traded and majority of bilateral contracts are cleared through exchange	• Does not occur due to lack of trading. Margining calls considered to be problematic (along with contract design)	• No novation benefits due to delisting

An international comparison - OTC

(Bach Consulting, *Management of Financial Risk in the NEM*, 2002)

OTC Market Criteria	Nordpool	NEM	PJM
Provides basis for longer-term customised contracts	• Capacity for both medium- to long-term contracts • Approximately 80-85% (volumes) of bilateral contracts are standardised	• 20% of volumes done on broker screens in short-to-medium term, remainder long-term bilaterally negotiated	• High degree of customised contracts
Allows for separation of physical and financial risk	• Liquidity enables the trading out of positions in the short-term	• Inability to trade out of positions and dominance of hedging motivations creates a 'buy and hold' mentality to cover physical risk	• Moderate ability to trade in short-term
Allows for many hybrid products like swaps, swaptions, Asian options and caps	• High degree of hybrid products	• High degree of hybrid products	• High degree of hybrid products
Allow for credit risk to be priced and swapped	• Majority of bilateral credit risk is novated through exchange clearing (80-85% of volume)	• Credit finessed through counterparty trading limits and matching	• Counterparty credit limits used
Provides the basis for a legitimate forward price curve that reciprocally reflects spot and derivative prices over shorter-time periods.	• Deeply traded futures products provides a transparent and firm forward curve ranging from day-ahead to 4 years	• OTC forward curve provided on voluntary basis is regarded as questionable	• Forward price information obtained through low-volume trading
Volumes	891 TWh 2000*	203 TWh 2000-01**	Data not available
Liquidity Ratio (Financial/Physical)	2.3 times (including exchange-traded yields liquidity ratio of 3.2)	1.1 times	Data not available Anecodatal evidence indicates limited liquidity

* Source www: nordpool.no Note the reported amount refers to bilateral contract volume cleared through Nordpool

** Source: AFMA Australian Financial Markets Report 2001