Not Confidential

PG&E Hedging Tutorial

from an Electric Portfolio Gas Perspective

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PG&E Electric Gas Supply

Contents

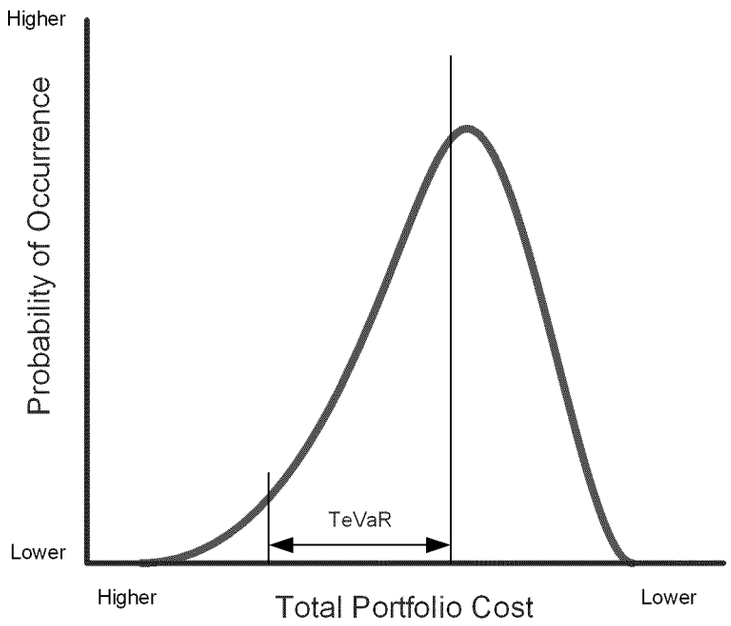
- Uncertainty and cost distribution
- Forwards
- Options
- Hedging strategy and risk preference
- Lessons learned from hedging experience
- Risk vs. Regret

PG&E Electric Portfolio

- Load Obligations
- Resources

If load were certain and resources exactly matched load, and the cost of those resources were certain, then PG&E's electric customers would have no cost uncertainty.

Cost distribution is caused by uncertainty

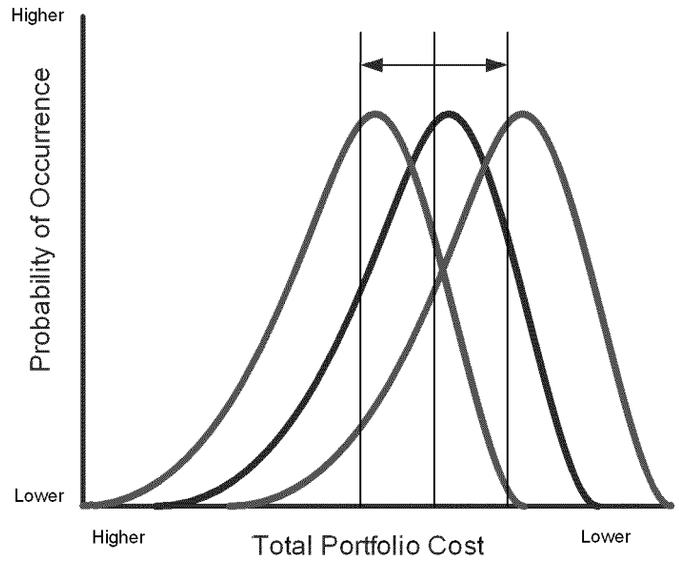


- Cost distribution includes:
  - Price uncertainty
  - Hydro generation uncertainty
  - Load uncertainty
- Least Cost Dispatch is embedded in the mean
- TeVaR is a measure of the width of the distribution

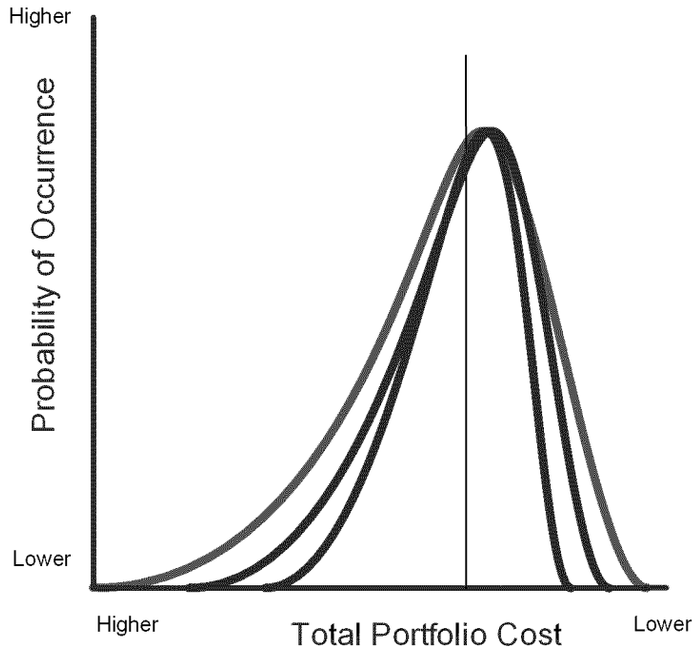
Mean of the distribution is moved by adding or removing cost from the portfolio

Activities that Move the Mean to the Left (higher cost)
- Adding load
- Adding above-market resources

Activities that Move the Mean to the Right (lower cost)
- Reducing load
- Adding below-market resources



Hedging narrows the distribution, but does not move the mean



Activities that Narrow the Distribution

- Adding fixed-price resources to portfolio
- Hedging with swaps and options

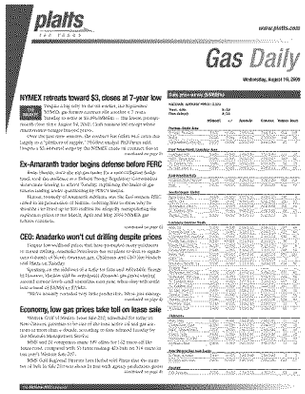
What is a Forward?

Forward: A contract between two parties, obligating one party to deliver a commodity at some future time (seller), the other party to pay – at delivery – some price set at the time the contract was entered into.

- Buyer will pay
- Seller will deliver
- No cash or commodity is exchanged at execution
- A seller can sell something they do not have yet
- Terms include commodity, price, quantity, delivery conditions, penalties for failure to perform, credit

What is an Index?

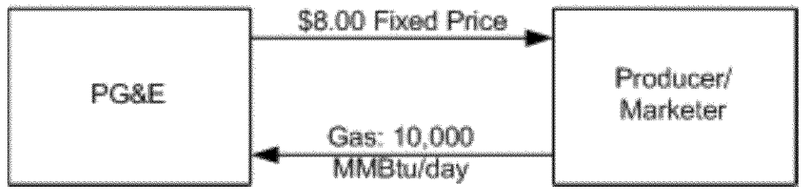
Index: An index price is a commodity price that is set by a publication or exchange for the commodity delivered at a specific location for a specific delivery period.


platts
www.platts.com
Gas Daily
Wednesday, August 19, 2009
NYMEX retreats toward $3, closes at 7-year low
Ex-Amaranth trader begins defense before FERC
CEO: Anadarko won't cut drilling despite prices
Economy, low gas prices take toll on lease sale

- A contract for a commodity priced at index has a floating price prior to index publication and a fixed price after publication
- The index publisher surveys the industry for trades at key market locations for various delivery periods. The published index is the weighted average of the surveyed trades
- The index is published on a pre-set schedule
- Indexes are normally for firm daily or monthly delivery (on-peak and off-peak for power)
- Monthly gas indexes in the U.S. are priced from bidweek trading (last 5 trading days prior to NYMEX futures contract expiration)

Example 1:
Fixed-Price Gas

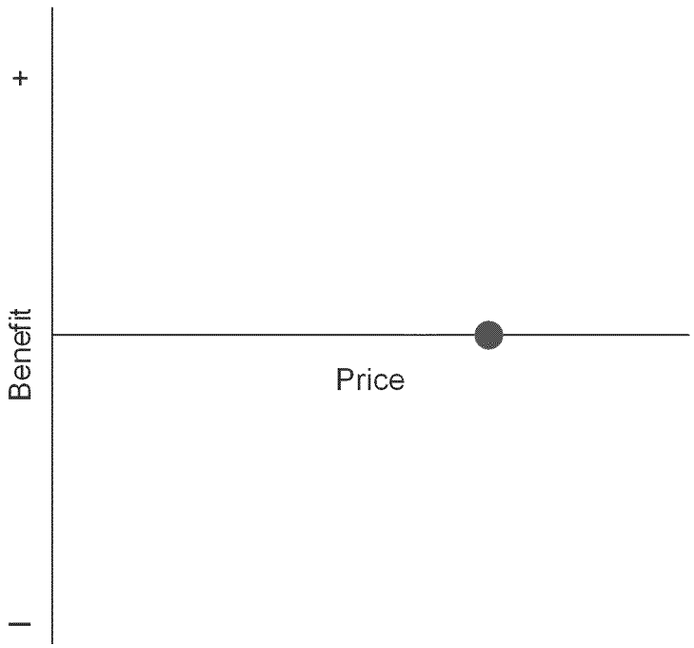
Purchase 10,000 MMBtu/day of gas at $8.00/MMBtu for delivery at PG&E Citygate in January 2011.



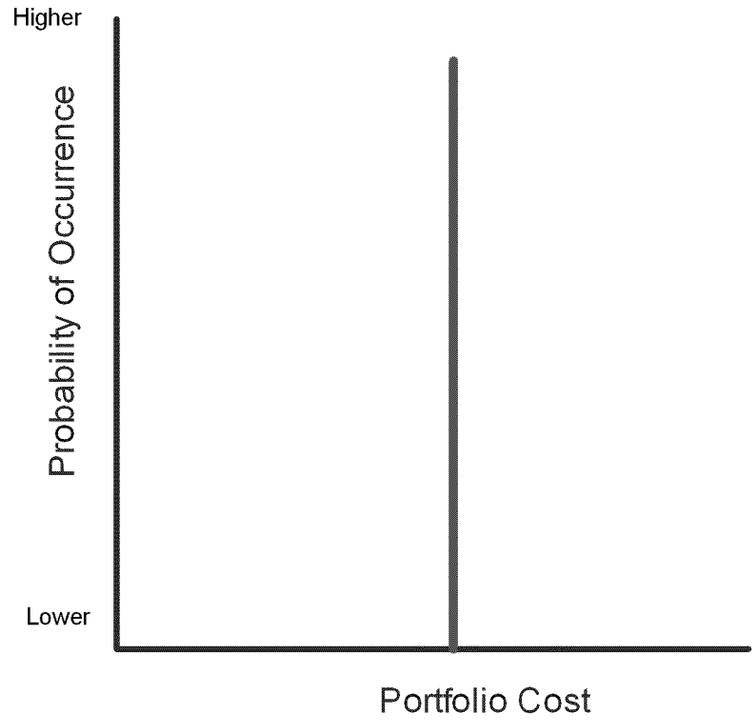
Product	Mark-to-Market (MtM) at Execution	MtM at Delivery
Fixed-price Gas	zero	?

Example 1:
Payout Diagram and Cost Distribution

Payout diagram



Cost Distribution



Example 1:
Mark-to-Market

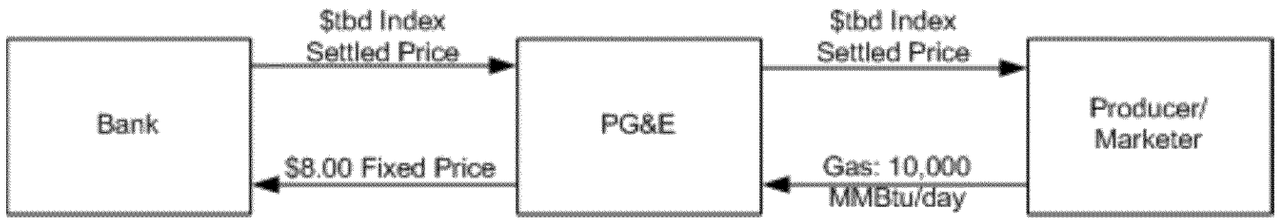
	Trade Day	Day 1	Day 2	Settle*
Trade Price	$8.00	$8.00	$8.00	$8.00
Closing Price	$8.00	$7.75	$8.10	$8.20
Unit MtM	$0.00	-$0.25	+$0.10	+$0.20
Total MtM	$0,000	-$2,500	+$1,000	+2,000
Settlement	n/a	n/a	n/a	**-$80,000**

Net cost at settlement = $80,000
($2,000 MtM "gain" implied)

*Physical gas trades settle on the 25th of the month following delivery.
Financial gas trades settle by the 5th of the delivery month.

Example 2:
Fixed-for-floating Swap Hedge

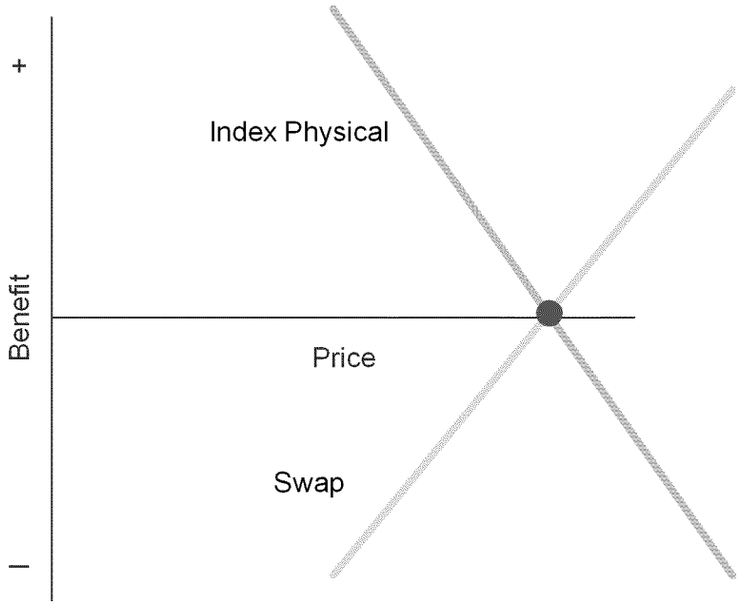
Purchase 10,000 MMBtu/day of gas at monthly index for delivery at PG&E Citygate in January 2011. Buy a fixed-for-floating swap at $8.00/MMBtu also for delivery in January 2011.



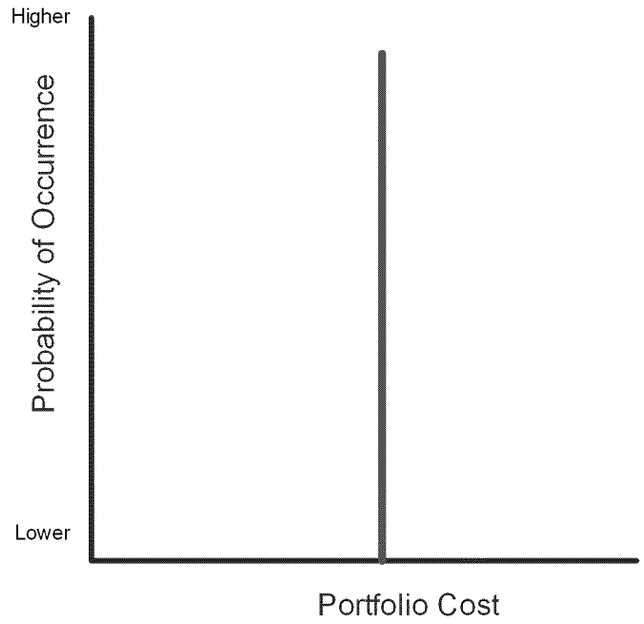
Product	MtM at Execution	MtM at Delivery
Index-priced Gas	zero	zero
FF Swap	zero	?

Example 2:
Payout Diagram and Cost Distribution

Payout diagram



Cost Distribution



Same as Example 1

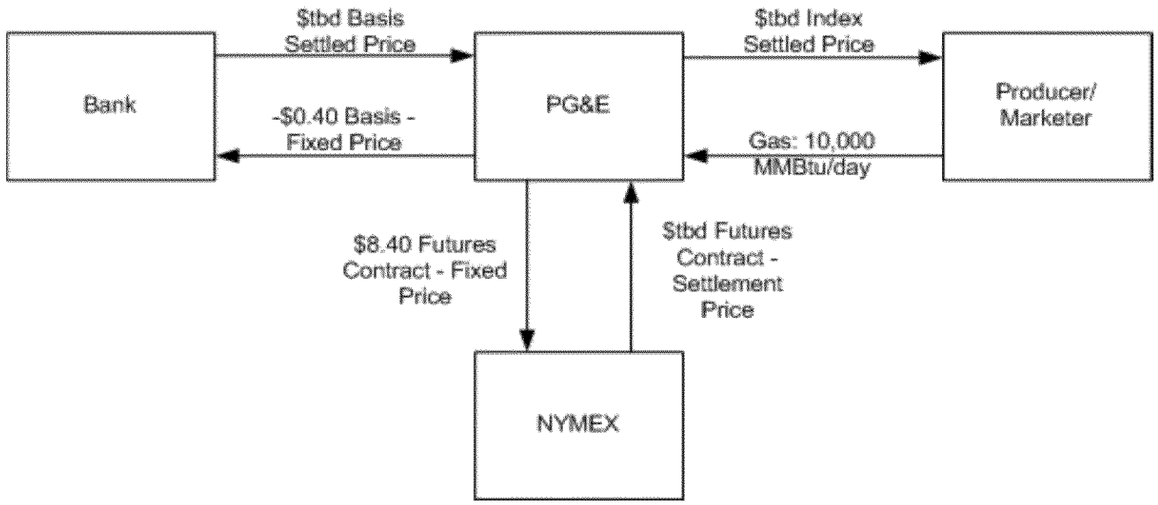
Example 2:
Mark-to-Market

	Trade Day		Day 1		Day 2		Settle	
Product	Index Gas	Swap	Index Gas	Swap	Index Gas	Swap	Index Gas	Swap
Trade Price	$0.00	$8.00	$0.00	$8.00	$0.00	$8.00	$8.20	$8.00
Closing Price	$0.00	$8.00	$0.00	$7.75	$0.00	$8.10	-$8.20	$8.20
Unit MtM	$0.00	$0.00	$0.00	-$0.25	$0.00	+$0.10	$0.00	+$0.20
Total MtM	$0,000	$0,000	$0,000	-$2,500	$0,000	+$1,000	$0,000	+$2,000
Settlement							**-$82,000**	**+$2,000**

Net cost at settlement = $80,000
(same as example 1)

Example 3:
Futures/Basis Swap Hedge

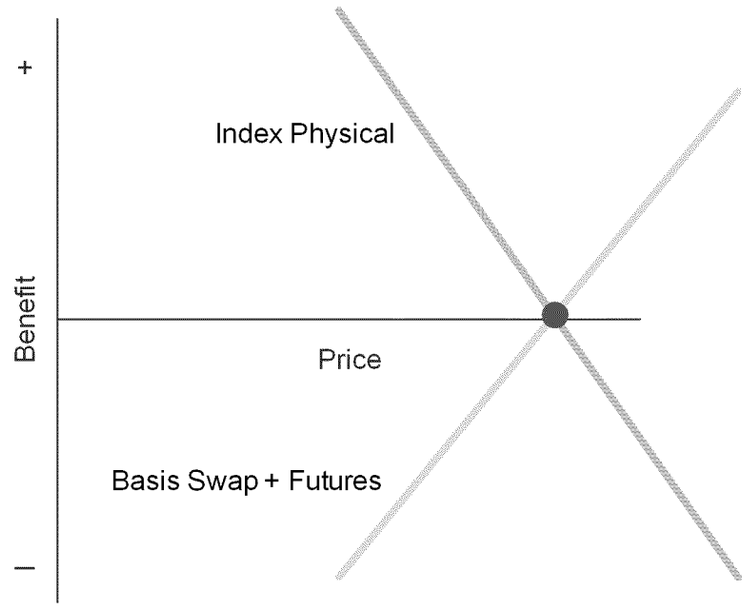
Purchase 10,000 MMBtu/day of gas at monthly index for delivery at PG&E Citygate in January 2011. Buy a futures contract at $8.40/MMBtu also for delivery in January 2011. Buy a basis swap at -$0.40/MMBtu also for delivery at PG&E Citygate in January 2009.



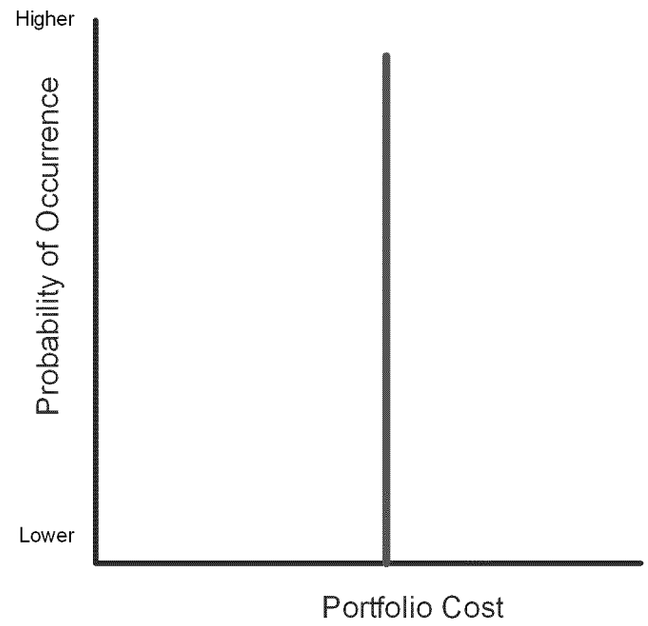
Product	MtM at Execution	MtM at Delivery
Index Gas	zero	zero
Futures	zero	?
Basis Swap	zero	?

Example 3:
Payout Diagram and Cost Distribution

Payout diagram



Cost Distribution



Same as Examples 1 & 2

Example 3:
Mark-to-Market

	Trade Day			Day 1		
Product	Index Gas	Futures	Basis Swap	Index Gas	Futures	Basis Swap
Trade Price	$0.00	$8.40	-$0.40	$0.00	$8.40	-$0.40
Closing Price	$0.00	$8.40	-$0.40	$0.00	$7.90	-$0.15
Unit MtM	$0.00	$0.00	$0.00	$0.00	-$0.50	+$0.25
Total MtM	$0,000	$0.00	$0.00	$0,000	-$5,000	+$2,500

Example 3:
Mark-to-Market

	Day 2			Settlement		
Product	Index Gas	Futures	Basis Swap	Index Gas	Futures	Basis Swap
Trade Price	$0.00	$8.40	-$0.40	$8.20	$8.40	-$0.40
Closing Price	$0.00	$8.35	-$0.25	$8.20	$8.50	-$0.30
Unit MtM	$0.00	-$0.05	+$0.15	$0.00	+$0.10	+$0.10
Total MtM	$0,000	-$500	$1,500	-$0,000	+$1,000	+$1,000
Settlement				**-$82,000**	**+$1,000**	**+$1,000**

Net cost at settlement = $80,000
(same as Examples 1 & 2)

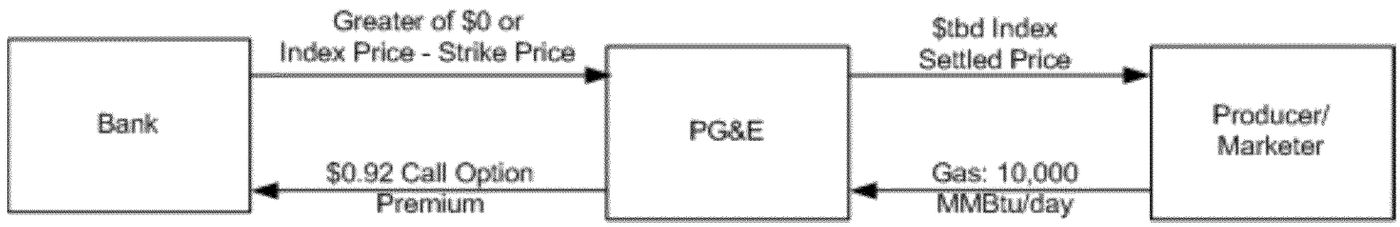
Options

Option: The right, but not the obligation, to execute a transaction (trade a forward) some time in the future.

Call Option: The right to buy a forward
Put Option: The right to sell a forward

Example 4:
At-the-Money* Call Option Hedge

Purchase 10,000 MMBtu/day of gas at monthly index for delivery at PG&E Citygate in January 2011. Buy a call option with a strike of $8.00/MMBtu (at-the-money) and a premium of $0.92/MMBtu also for delivery at PG&E Citygate in January 2011.

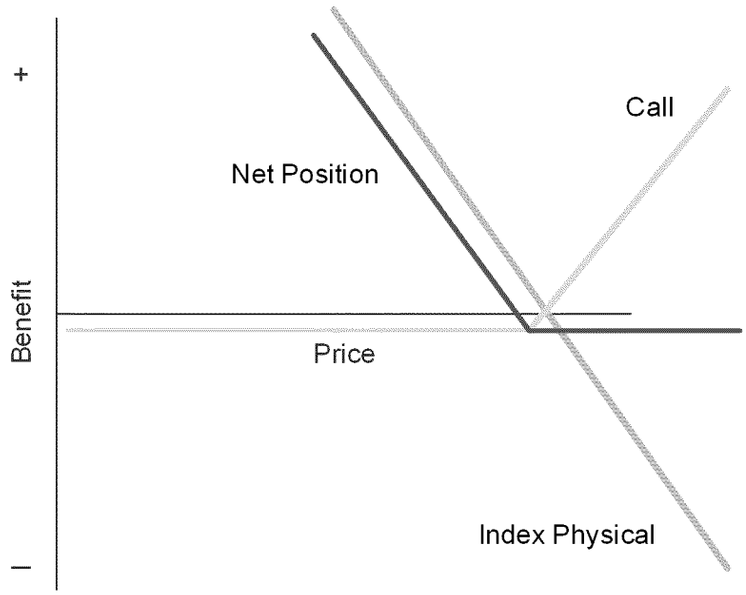


Product	MtM at Execution	MtM at Delivery
Index Gas	zero	zero
Call Option	zero	?

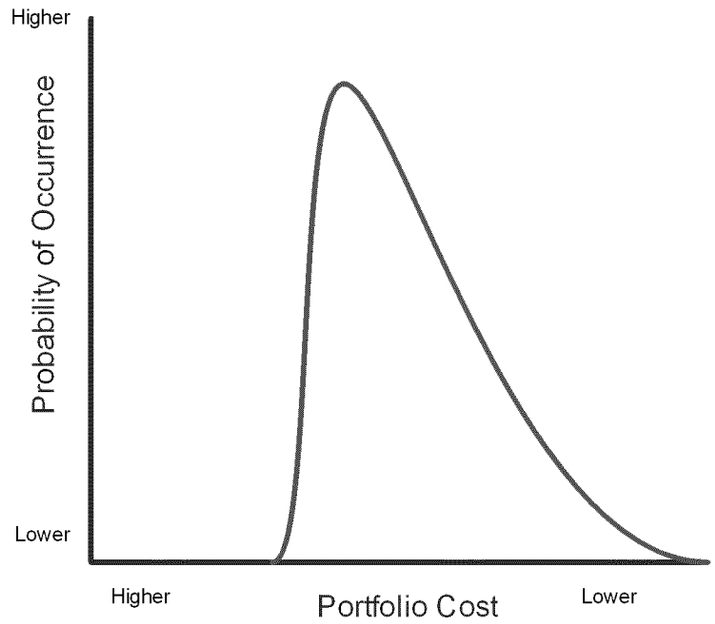
*At-the-money for an option means strike price equals current forward price

Example 4: Payout Diagram

Payout diagram



Cost Distribution



Example 4:
Mark-to-Market

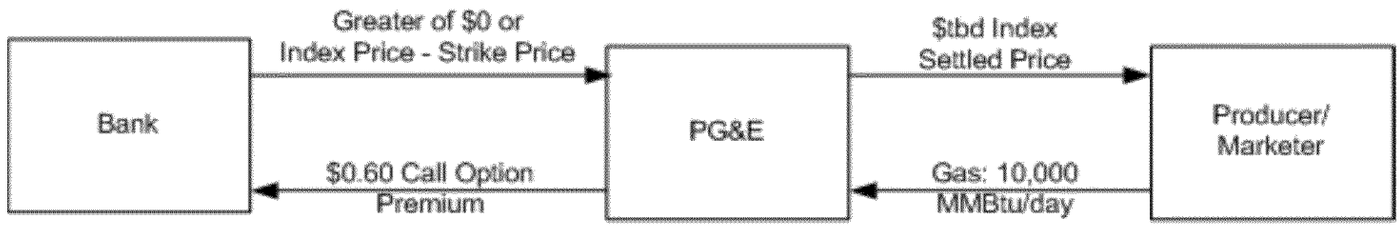
	Trade Day		Day 1		Day 2		Settle	
Product	Index Gas	Call Option	Index Gas	Call Option	Index Gas	Call Option	Index Gas	Call Option
Trade Price*	$0.00	$0.92	$0.00	$0.92	$0.00	$0.92	$8.20	$0.92
Underlying Closing Price		$8.00		$7.50		$8.10	$8.20	$8.20
Closing Price*	$0.00	$0.92	$0.00	$0.77	$0.00	$1.04	Strike Price = $8.00	
Unit MtM	$0.00	$0.00	$0.00	-$0.15	$0.00	+$0.12	$0.00	+$0.20
Total MtM	$0,000	$0,000	$0,000	-$1,500	$0,000	+$1,200	$0,000	+$2,000
Settlement	n/a	**-$9,200**					**-$82,000**	**+$2,000**

Net cost at final settlement = $89,200

*For an option, “trade price” and “closing price” are the option premium

Example 5:
Out-of-the-Money* Call Option Hedge

Purchase 10,000 MMBtu/day of gas at monthly index for delivery at PG&E Citygate in January 2011. Buy a call option with a strike of $9.00/MMBtu ($1 out-of-the-money) and a premium of $0.60/MMBtu also for delivery at PG&E Citygate in January 2011.

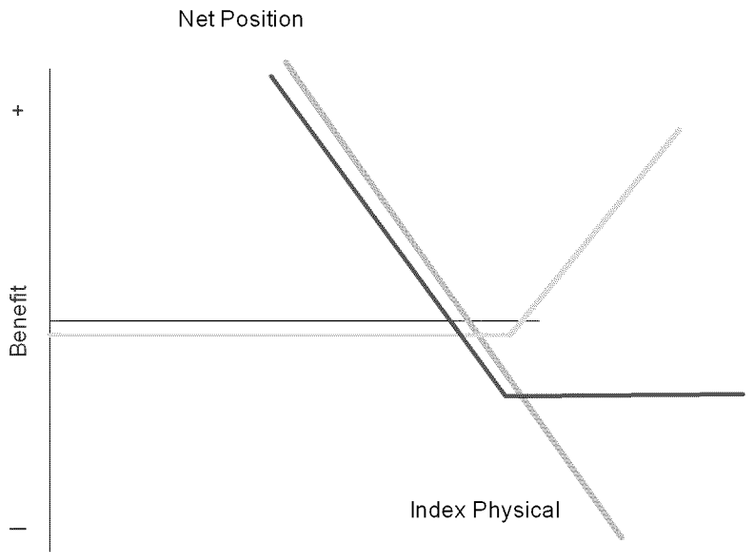


Product	MtM at Execution	MtM at Delivery
Index Gas	zero	zero
Call Option	zero	?

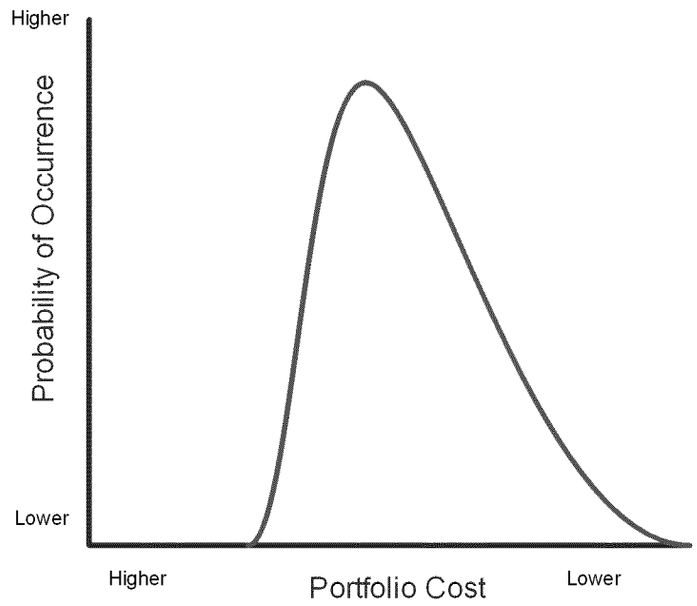
*Out-of-the-money for a call option means strike price is greater than current forward price

Example 5: Payout Diagram

Payout diagram



Cost Distribution



Example 5:
Mark-to-Market

	Trade Day		Day 1		Day 2		Settle	
Product	Index Gas	Call Option	Index Gas	Call Option	Index Gas	Call Option	Index Gas	Call Option
Trade Price*	$0.00	$0.60	$0.00	$0.60	$0.00	$0.60	$0.00	$0.60
Underlying Closing Price		$8.00		$7.50		$8.10	$8.20	$8.20
Closing Price*	$0.00	$0.60	$0.00	$0.52	$0.00	$0.65	Strike Price = $9.00	
Unit MtM	$0.00	$0.00	$0.00	-$0.08	$0.00	$0.05	$0.00	$0.00
Total MtM	$0,000	$0,000	$0,000	-$800	$0,000	+$500	$0,000	$0,000
Settlement	n/a	**-$6,000**					**-$82,000**	**$0,000**

Net cost at settlement = $88,000

For an option, "trade price" and "closing price" are the option premium

Option Delta

- Delta is the measure of how much the price of the option changes, for a small change in the price of the underlying commodity.

Gas Option Delta = (change in option premium)/(change in forward gas price)

Example: Delta = ($0.04/MMBtu)/($0.10/MMBtu) = 0.4

Delta Neutral

- The value of a delta-neutral position is insensitive to small changes in the underlying commodity price

Swap Hedge Example

Short Position	Long Position
-100,000 MMBtu	+100,000 MMBtu
Forecast gas burn for Moss Landing Power Plant in June 2011	Fixed for floating swap at PG&E Citygate for June 2011 delivery
Forward price for June 2011 increases $0.50/MMBtu	Forward price for June 2011 increases $0.50/MMBtu
Short position gets shorter	Long position gets longer
$0.50× -100,000 = -$50,000	$0.50 × 100,000 = +$50,000

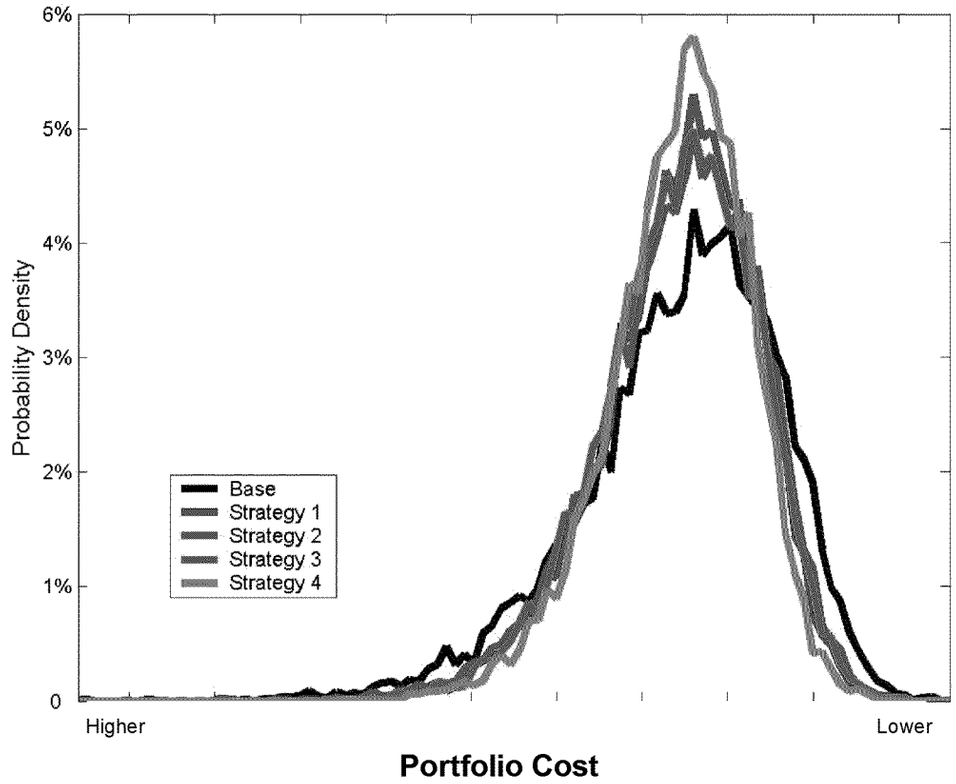
Option Hedge Example

Short Position	Long Position
-100,000 MMBtu	+100,000 MMBtu
Forecast gas burn for Moss Landing Power Plant in June 2011	200,000 MMBtu Call Option on PG&E Citygate for June 2011 delivery with delta = 0.5
Forward price for June 2011 increases $0.50/MMBtu	Forward price for June 2011 increases $0.50/MMBtu
Short position gets shorter	Option position gets longer
$0.50 × -100,000 = -$50,000	$0.50 × 200,000 × 0.5 = +$50,000

Hedging Strategy and Risk Preference

Hedging Strategies and Cost Distributions

- The question: Which hedging strategy is best?
  <should really be…>
  Which cost distribution do bundled electric customers prefer?
- Extensively discussed with PG&E's Procurement Review Group



Strategies differ by volume and product mix

Customer Risk Tolerance

How much of an increase in cost can customers tolerate?

< is operationalized as the question>

How wide should the probability distribution of portfolio cost be?

Customer Risk Tolerance (CRT)

- How wide should the probability distribution of portfolio cost be?
  - This is a risk preference
  - This is a policy issue
  - Current policy set by California PUC is 1 cent per kWh
    - For PG&E bundled electric portfolio, this corresponds to incremental portfolio cost on the order of $1 billion
  - Core Gas Supply performed a gas customer risk tolerance study in 2008.
  - The CPUC ordered Energy Division to conduct a similar study of bundled electric customers in D.02-10-062 and invited them to hold a workshop in D.07-12-052.

California PUC's Risk Management Policy For Electric Utilities

- Compare TeVaR measured at the 95th Percentile with CRT
  - In words: compare estimated width of probability distribution of portfolio cost with the stated 1 cent per kWh target for the width
- If TeVaR $>$ 1.25 $\times$ CRT, then meet and confer with Procurement Review Group
  - Stakeholder discussion of the situation is required
  - No particular portfolio action is required
  - 1.25 $\times$ CRT is referred to as the "notification level"
    - This is very different from a trading limit

Learning and insights from PG&E experience in hedging

- Learning and insights from PG&E experience in hedging
  - Hedging vs. speculating
  - Hedging: costs vs. cash flows
  - Risk vs. regret

Hedging vs. Speculating: Behaviors

- Market view
  - Hedging takes the market as is: the market (*i.e.*, what is currently transactable) is not right or wrong, it just plain exists
  - Speculating takes a view on where the market is headed and acts on that view
- Market timing
  - Hedging executes transactions relatively evenly over time, to diversify timing risk, similar to dollar cost averaging
  - Speculating uses event-driven trading to time the market, perhaps trading in and out of positions

Hedging vs. Speculating: Objectives

- Hedging objectives
  - Manage TeVaR
  - Protect against price blowout scenarios
  - Flatten positions that arise from physical assets and obligation to serve
- Speculating objective
  - Earn an outsized return on risk capital

Hedging: Costs vs. Cash Flows

Q: What is the cost of hedging?

A: Transaction costs.

- Broker fees
- Financing margin and collateral
- Bid-ask spreads

A: Option premiums are cash outflows, not costs.

Hedging has little impact on expected portfolio cost.

Cash Flows vs. Net Costs: Forwards

Q: At the time a forward (swap/forward/future) contract is executed, how much money trades hands?
A: Zero.

Q: At settlement, does money trade hands?
A: Yes.

Q: At time of execution, how much money is expected to trade hands at settlement?
A: Zero.

Q: Therefore, at execution, expected net cost of forward is zero?
A: Yes.

Q: But what about cost at settlement?
A: See “regret.”

Cash Flows vs. Costs: Options

Q: At the time an option contract is executed, how much money trades hands?
A: Buyer of option pays seller of option the option "premium."

Q: At settlement (option expiry), does money trade hands?
A: If option is in the money, seller of option pays buyer of option the difference between market price and option strike price.

Q: At time of execution, how much money is expected to trade hands at settlement?
A: The option premium plus the interest associated with the time value of money.

Q: Therefore, at execution, expected net cost of option is zero?
A: Yes.

Q: But what about cost at settlement?
A: See "regret."

Risk vs. Regret

- Risk is "potential negative impact that may arise from a future event"
- Regret is "distress of mind for what has been done or failed to be done"
  - Hedging example: quantity hedged is nearly always wrong in hindsight—too little or too much
  - Hedging example: buying options
    - Most of the time, these options won't pay back the option premium, and will regret buying them
    - When these options do pay out, will regret not having swaps instead
  - Hedging example: whether to hedge or not to hedge
    - Hedging seems to have more regret than not hedging
- Risk is prospective, regret is retrospective

Conclusion: Overcoming Regret

- Ask yourself: Is the hedging strategy designed to reduce risk or to avoid regret?
- Focus on the total portfolio—physical and financial—not just the hedge book
- Focus on the exposure ($) of a potential event separately from the probability of that event occurring
- Establish risk benchmarks and measure the portfolio against those benchmarks
- Include as a hedging objective: Manage option premium expenses

Bonus Material

Gas and Electric Indexes

- *Gas Daily* is the industry standard for day-ahead gas
- *InsideFERC* and *Natural Gas Intelligence* (NGI) are the U.S. industry standard indexes for monthly gas
- *Canadian Gas Price Reporter* (CGPR) is the industry standard index for gas delivered in Western Canada
- The *Intercontinental Exchange* (ICE) is the industry standard for electric indexes
- The California Independent System Operator (CAISO) EZ Gen Hub is the standard index for electricity in the CAISO territory