KUALA LUMPUR 2012 WORLD GAS CONFERENCE

25th world gas conference

"Gas: Sustaining Future Global Growth"

Wholesale Gas Price Formation

How the world prices gas

PGCB – Study Group 2 Report

By: Mike Fulwood and Floris Merison

Date: 5 June 2012

Venue: Kuala Lumpur

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Wholesale Gas Price Formation – How the world prices gas

- Wholesale Gas Price Formation Survey
  - Results of 2010 survey
  - Comparisons with previous surveys
- Globalisation or Regionalisation of Gas Prices
  - Gas price convergence
  - Is Gas different from other commodities?
  - Future of oil price indexation
  - Can parallel pricing mechanisms continue to co-exist?
- Gas Price Drivers
  - Competing fuels analysis
  - Hub trading and pricing patterns in North America
  - Price Volatility
  - Long run marginal cost as a price driver
- Impact of Carbon Tax or Cap and Trade Policies
- Conclusions

Survey of Wholesale Gas Price Formation

- Objective to establish baseline survey on wholesale price formation mechanisms around the world
- IGU members provided the data for almost 100 countries, and Nexant have collated and analysed them
- First undertaken for the year 2005 and was repeated for 2007 – reported at WGC in 2009 in Buenos Aires
- Surveys for 2009 and 2010 undertaken for this triennium,
- Focus on wholesale prices (broadly defined) – hub, border, wellhead, city-gate

Different types of price formation mechanisms

Oil Price Escalation	OPE	The price is linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. In some cases coal prices can be used as can electricity prices.
Gas-on-Gas Competition	GOG	The price is determined by the interplay of supply and demand – gas-on-gas competition – and is traded over a variety of different periods (daily, monthly, annually or other periods).
Bilateral Monopoly	BIM	The price is determined by bilateral discussions and agreements between a large seller and a large buyer, with the price being fixed for a period of time – typically this would be one year.
Netback from Final Product	NET	The price received by the gas supplier is a function of the price received by the buyer for the final product the buyer produces. This may occur where the gas is used as a feedstock in chemical plants.
Regulation Cost of Service	RCS	The price is determined, or approved, by a regulatory authority, or possibly a Ministry, but the level is set to cover the "cost of service", including the recovery of investment and a reasonable rate of return.
Regulation Social and Political	RSP	The price is set, on an irregular basis, probably by a Ministry, on a political/social basis, in response to the need to cover increasing costs, or possibly as a revenue raising exercise.
Regulation Below Cost	RBC	The price is knowingly set below the average cost of producing and transporting the gas often as a form of state subsidy to its population.
No Price	NP	The gas produced is either flared, or provided free to the population and industry, possibly as a feedstock for chemical and fertilizer plants.
Not Known	NK	No data or evidence.

Collecting the data and analysis

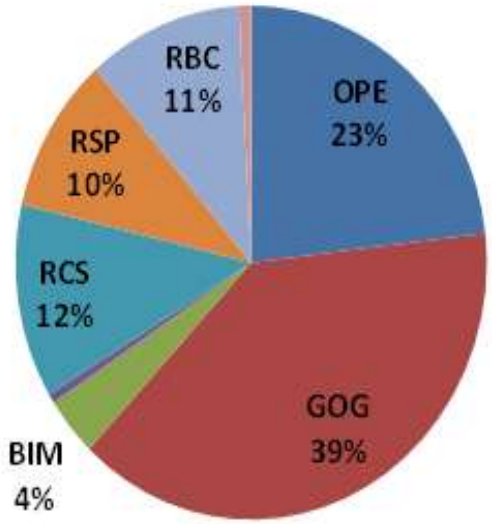
Country	United Kingdom					
Region	Europe					
Volumes 2010: BCM	Consumption	Production	Imports		Exports	
			Pipeline	LNG	Pipeline	LNG
	98.0	59.7	34.4	18.7	13.4	0.0
Wholesale Price Formation	Domestic Production		Imports			
			Pipeline		LNG	
Oil Price Escalation	18.0%					
Gas-on-Gas Competition	82.0%		100.0%		100.0%	
Bilateral Monopoly						
Netback from Final Product						
Regulation: Cost of Service						
Regulation: Social and Political						
Regulation: Below Cost						
No Price						
Not Known						
Total	100.0%		100.0%		100.0%	
Estimated 2010 Wholesale Price Range ($/MMBTU)	Average		High		Low	
	$5.99		$7.51		$4.50	

- Data collected on standard excel sheets by country
  - Domestic production – indigenous production consumed in country
  - Pipeline imports
  - LNG imports
  - Wholesale prices
- Aggregated and analysed at Regional and World Level
  - Domestic production
  - Pipeline imports
  - LNG imports
  - Total imports
  - Total consumption
  - Average wholesale prices

Analysed by the IGU regions

2010 results at the world level

World Price Formation Mechanisms 2010



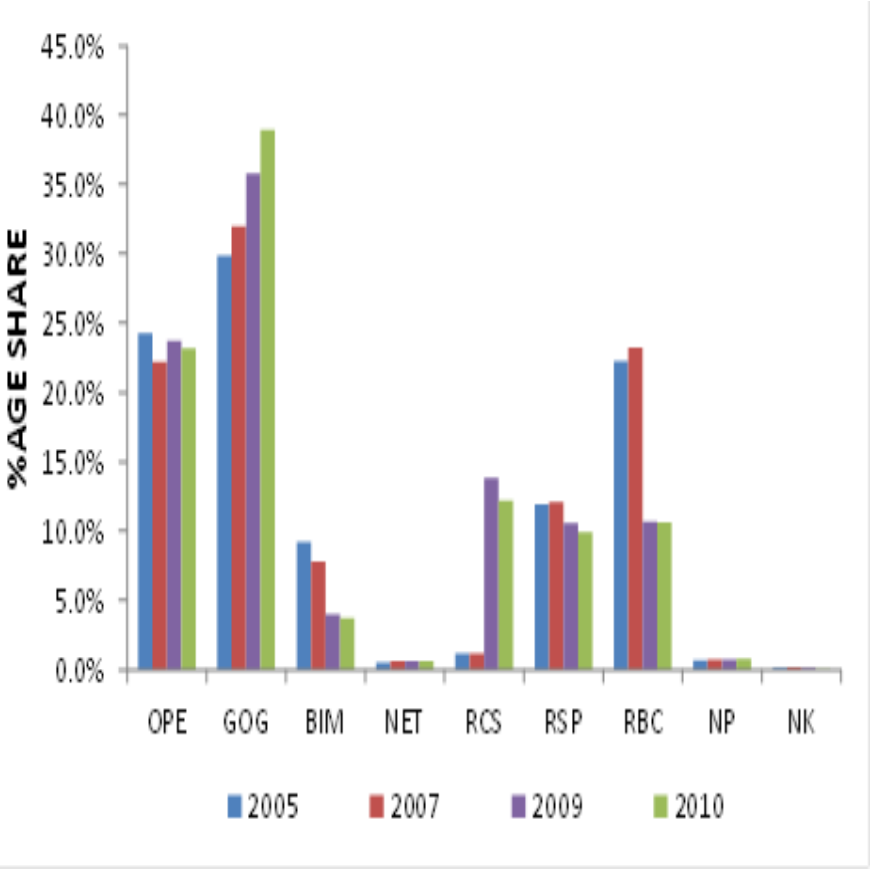
- The Bilateral Monopoly category is important in some of the intra-FSU trade and indigenous production in Qatar, Australia and New Zealand.
- The three regulated categories – cost of service, social and political and below cost – are found predominantly in indigenous production in the FSU and Middle East, plus China, Malaysia and Indonesia.
- The gas-on-gas competition category is obviously dominated by North America, but in Europe with the UK market and the continental trading hubs it is also important.
- The survey also records a significant amount of gas-on-gas competition in the FSU region, specifically Russia. This reflects the changes in the domestic Russian market which has seen the larger consumers, in a number of Russian regions, being allowed to trade directly with independent producers.
- The oil price escalation category is dominated by imported gas under long term contracts, linked to oil product prices, into Europe, as well as the LNG contracts into Asia Pacific, linked to crude oil prices.
- In addition, there is now a significant element of oil price escalation in the FSU region, principally the exports from Russia to Ukraine and Moldova, plus purchases by Russia from Central Asia countries, linked to a basket of oil product prices similar to the contracts to Western Europe but at a discounted level.

Regional breakdown summary for 2010

2010	Total Consumption - BSCM									
	OPE	GOG	BIM	NET	RCS	RSP	RBC	NP	NK	TOT
North America	0.0	827.2	0.0	0.0	0.0	0.0	0.0	12.0	0.0	839.2
Latin America	24.7	24.3	6.9	16.1	9.0	59.3	0.0	0.0	0.0	140.3
Europe	349.4	217.2	2.4	1.0	12.4	5.8	0.5	4.7	0.9	594.2
Former Soviet Union	81.5	180.9	29.5	0.0	258.7	20.4	88.3	2.8	0.0	662.0
Middle East	23.4	2.9	30.0	2.3	0.0	139.0	171.0	2.7	0.0	371.2
Africa	7.4	0.0	4.2	0.8	0.8	1.9	86.7	0.7	0.0	102.6
Asia	90.3	3.7	3.2	0.0	112.0	26.9	3.3	0.0	0.0	239.4
Asia Pacific	187.1	25.8	47.3	0.0	9.5	73.6	0.0	3.2	0.0	346.5
Total World	763.7	1 282.1	123.4	20.2	402.4	326.9	349.8	26.1	0.9	3 295.4
	23.2%	38.9%	3.7%	0.6%	12.2%	9.9%	10.6%	0.8%	0.0%	100.0%

Changes in World price formation mechanisms

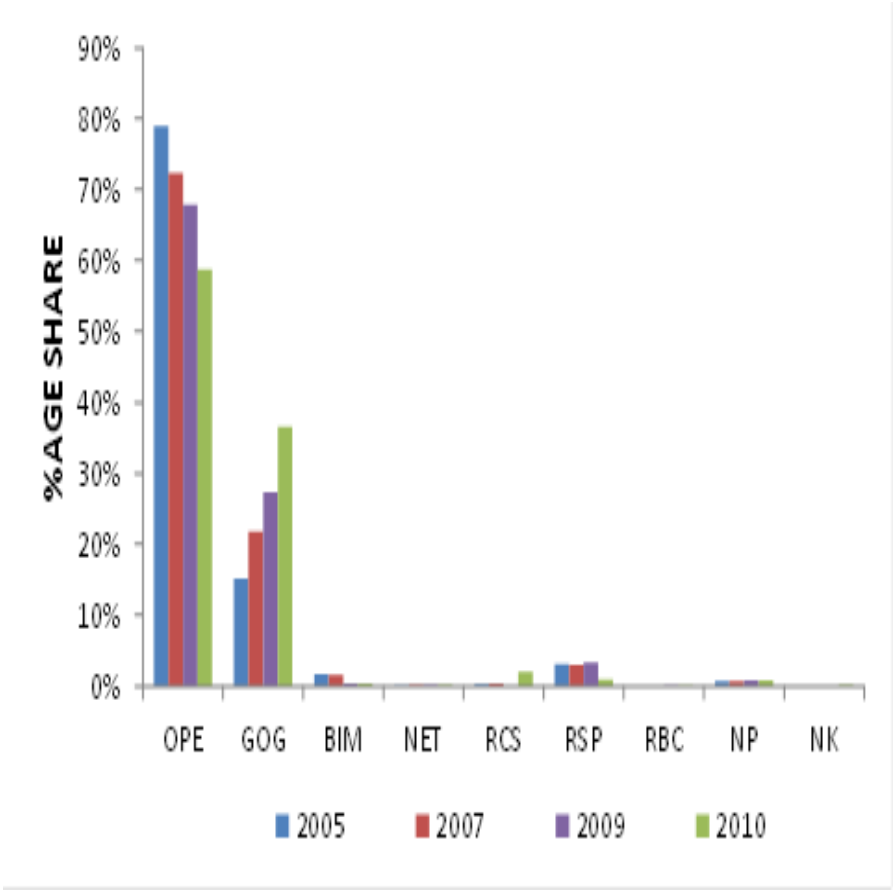
World Price Formation Mechanisms Shares 2005 to 2010



- The main increase has been in the gas-on-gas competition category rising from 30% in 2005 to 32% in 2007, to 36% in 2009 and 39% in 2010.
- The key change from 2007 to 2009 and 2010 was in the Former Soviet Union following the changes in the domestic Russian market, which has added some 5.5% to the share since 2007. Excluding the change in the Russian domestic market, the increase in the GOG category would have been 1.5% since 2007. This is principally due to the change in Europe – next slide.
- The oil price escalation share declined between 2005 and 2007, but then the structural change in the intra-FSU market as pricing switched from bilateral monopoly, led to an increase in its share, followed by a further small decline in 2010.
- The overall share of the three regulated categories has declined marginally from 2005 through to 2010, to around 32%,. The key change has been within the regulated categories with a switch in Russia from below cost to cost of service of a share of 7% of total world consumption.

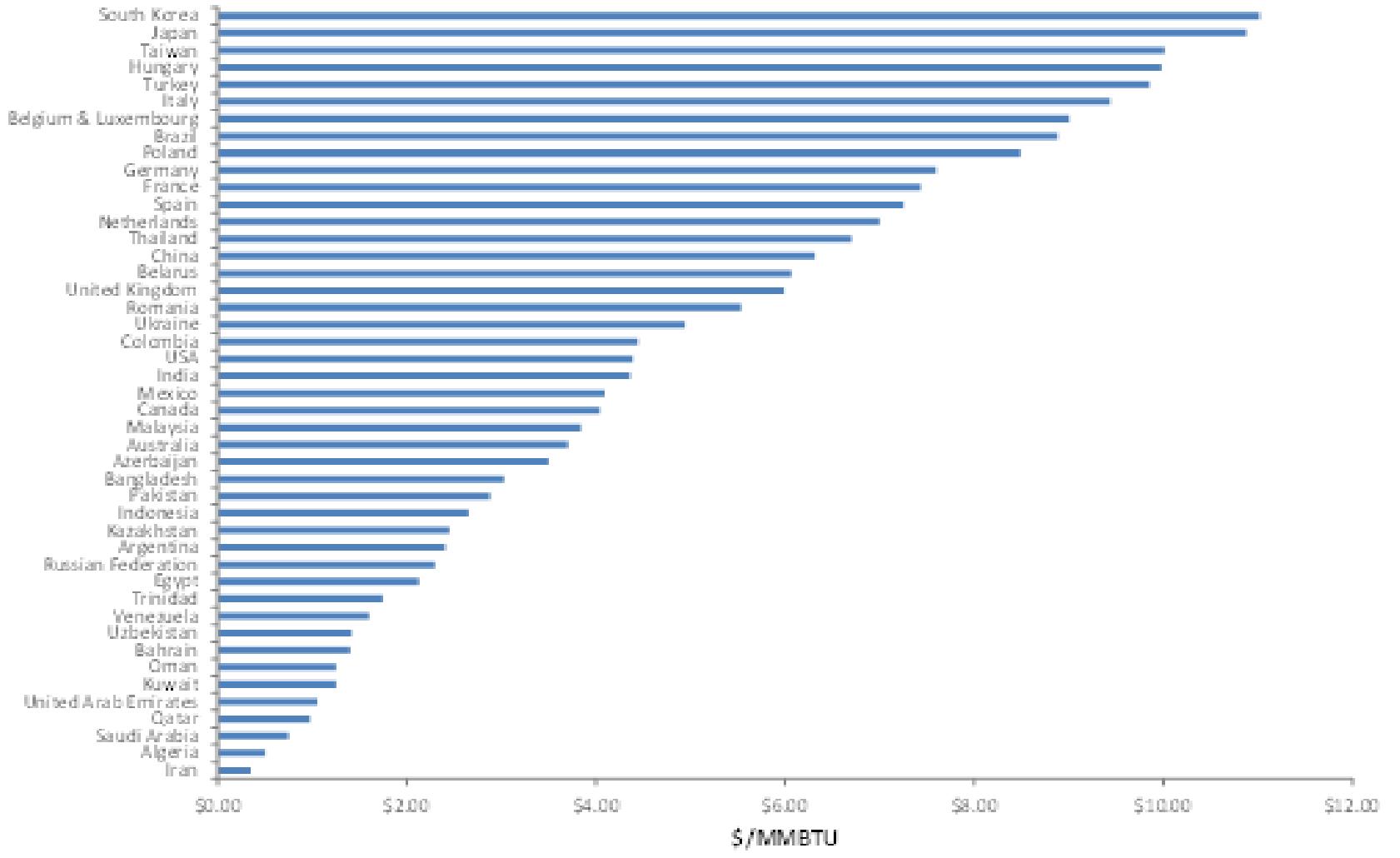
Changes in Europe price formation mechanisms

Europe Price Formation Mechanisms Shares 2005 to 2010



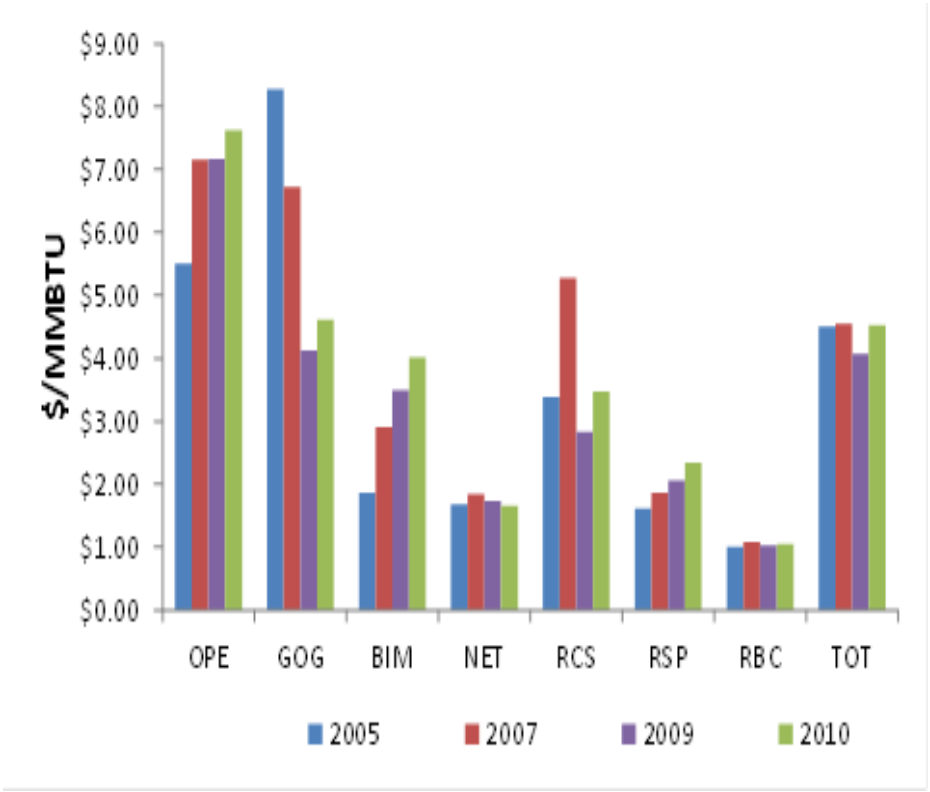
- The trend in Europe is very clear with the switch away from oil price escalation to gas-on-gas competition.
- This reflects the increase in the volumes of gas physically delivered from trading hubs to customers and, in 2010, the incorporation of an element of spot price indexation in a number of long term contracts
- Gas-on-gas competition is predominantly a North-West Europe phenomenon – clearly in the UK but also the Netherlands, Belgium, France and Germany
- Progress in Southern and Eastern Europe has been much slower and, apart from Italy, is largely confined to spot LNG cargoes.
- In countries such as Germany, the Netherlands and France in particular, large end users, including power plants, are demanding that the prices they pay reflect hub and spot prices,
- This has led to major wholesale buyers such as EON and RWE, suffering continued large losses on their gas sales

Average wholesale prices by country 2010



Changing wholesale prices

Changes in Wholesale Price Levels 2005 to 2010

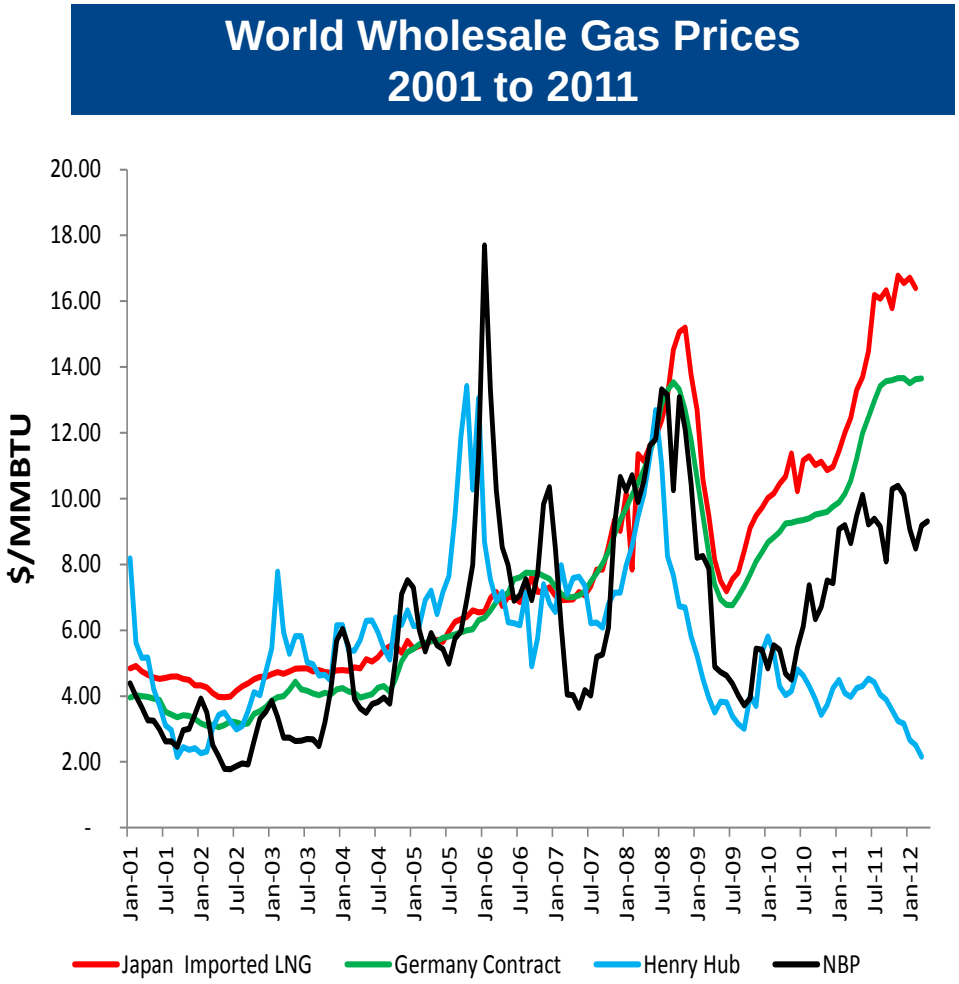


- Average prices around the world have changed little from 2005 through 2007 and 2009 to 2010.
- Average wholesale prices were just over $4.50 in 2010, up slightly from the $4.00 level in 2009 but similar to the levels in both 2007 and 2005.
- Gas-on-gas competition prices have been on a generally declining trend from being the highest prices in 2005 at over $8.50 to just under $4.60 in 2010.
- Oil price escalation prices have risen consistently reflecting increasing oil prices over the period.
- Bilateral monopoly prices have also been consistently rising but this reflects the transition, especially in intra-FSU trade, towards more market related pricing.

Globalisation or Regionalisation of Gas Prices

- Gas price convergence
- Is gas different from other commodities?
- Future of oil price indexation
- Can parallel pricing mechanisms continue to co-exist?

Converging and diverging world gas prices



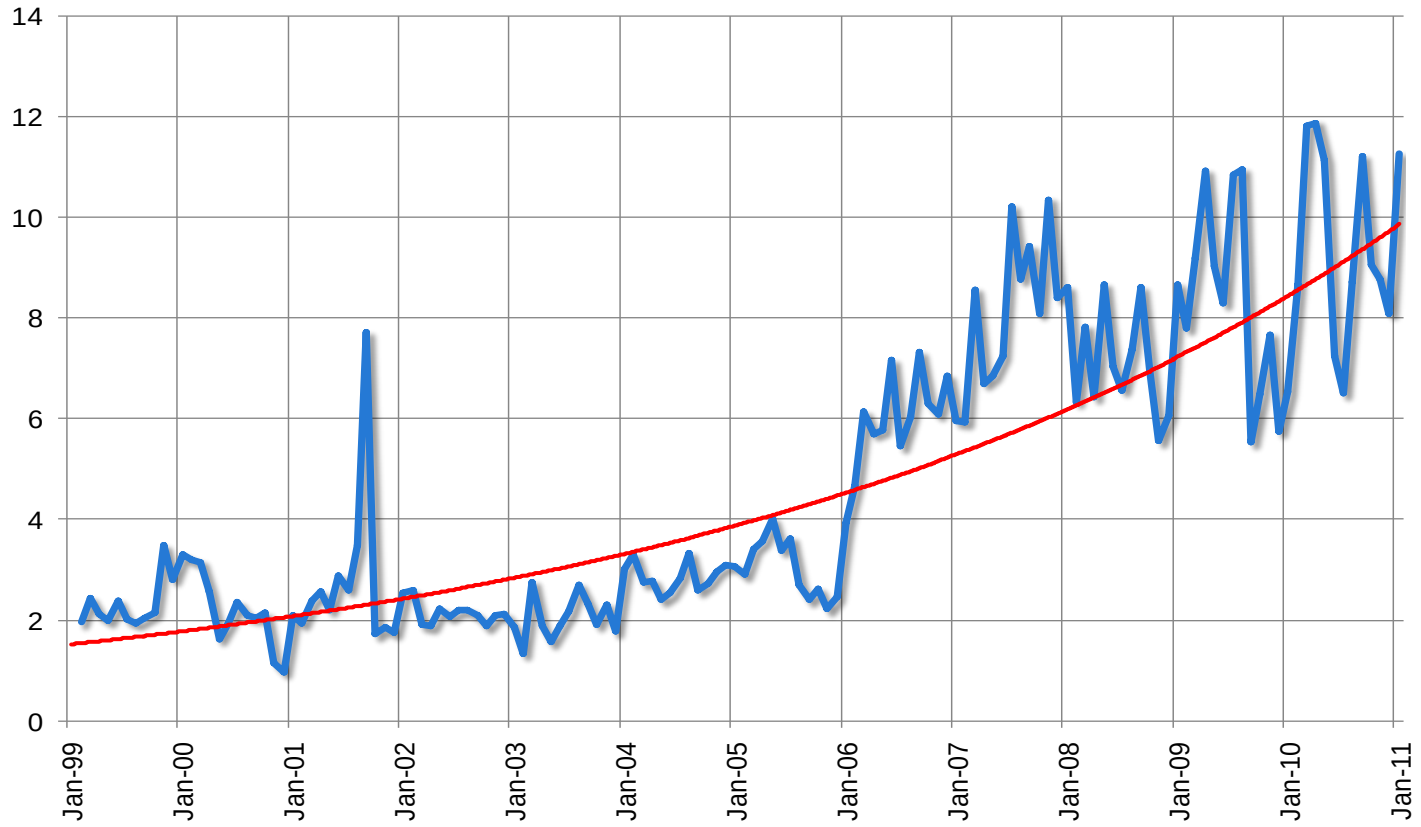
- The Japan Imported LNG price and the German Contract price are largely driven by oil price linkage under long term contracts, while the Henry Hub and NBP spot prices are subject more to the market fundamentals.
- Spot prices show greater volatility but average contract and spot appear to be reasonably close through to 2008. From mid-2008 spot prices decoupled in a significant manner from contract prices, falling sharply as the demand for gas started to decline and more supply was becoming available.
- From mid to late 2009, another phase was entered with the German Contract Price diverging from the Japan price, possibly reflecting some changes to long term contracts into Germany.
- In the second quarter of 2010, NBP started to diverge from Henry Hub as the UK was affected by supply issues and later by the very cold weather. Henry Hub prices, however, remained at low levels as the supply of shale gas increased rapidly.

Is gas different from other commodities?

- Transport costs
- Storage costs
- Constant volume equilibrium
- Volatility
- Liquidity

Liquidity

Ratio of Oil and Gas Traded Futures Volumes



(Nymex, ICE, TOCOM)

The future of oil price indexation

Arguments For

- Competition between oil and gas on the supply side
- Competition between oil and gas on the demand side
- Resource value of hydrocarbons
- Pricing via a third commodity
- Oil prices have lower volatility
- Higher confidence in the tradability of oil than gas
- Shareholders prefer oil price related risk
- High level of acceptance of oil price indexation

Arguments Against

- Separate markets
- Other alternatives are available
- Political support for change
- Political support for short term contracts
- Better interconnection between regional gas markets
- Reduced fear of market power

Can parallel pricing mechanisms continue to co-exist?

- Parallel pricing mechanisms do co-exist as evidenced in the wholesale gas price formation survey
- Gas Price Divergence /Convergence
- Market integration/ Global Trade
- Political preferences
- Merging different pricing mechanisms?

Gas Price Drivers

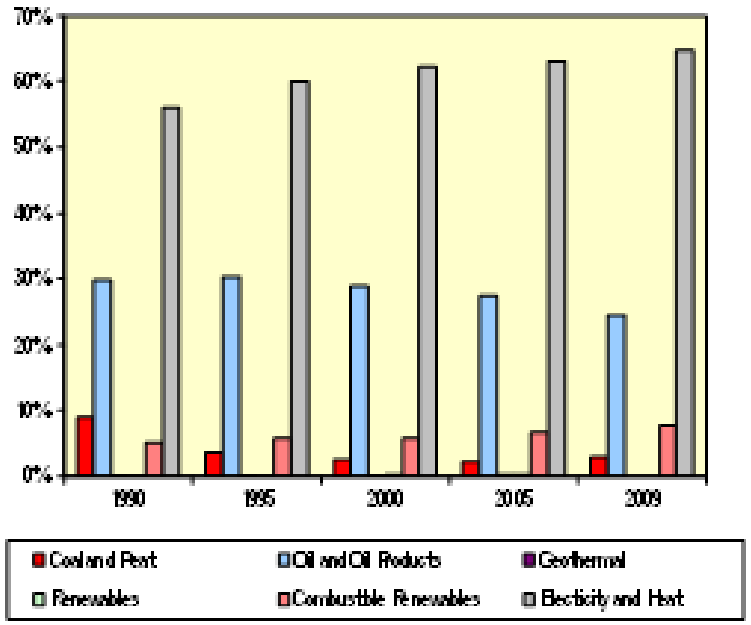
- Competing fuels to gas
- Hub trading and pricing in North America
- Price volatility
- Long run marginal cost as a price driver

Competing fuels to gas - methodology

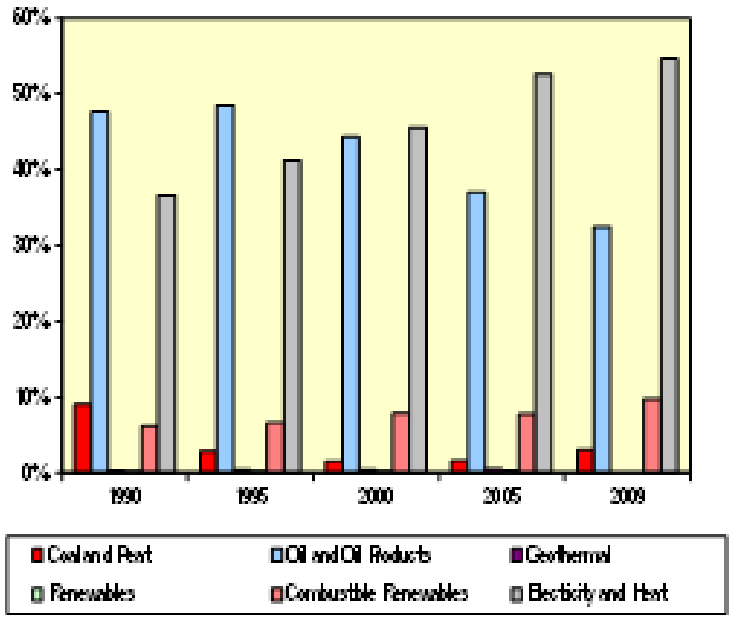
- Competing fuels to gas can be an important price driver – part of the original rationale for oil price indexation
- Market share analysis can provide useful insights but looking at simple market shares can be misleading
  - The more diverse the number of fuels and market shares the greater the scope for competition e.g. if a fuel has a dominant share in a market sector in a country then there is less competition than if market shares are more evenly spread.
  - The extent of diversity / competition can be measured by the Herfindahl-Hirschman Index (HHI).
- Our methodology calculates the HHI for each market sector in each country and then uses the resulting HHIs to weight the market shares of competing fuels to gas when aggregating such that sectors in countries with lower HHIs get more "weight" in any aggregation – ***giving more weight to markets where there is greater competition as opposed to market where there is less competition***.
- Analysis considered the stationary markets – residential and other, industrial and electricity generation

Competing fuels to gas

Residential & Other: World



Residential & Other: Main Importers

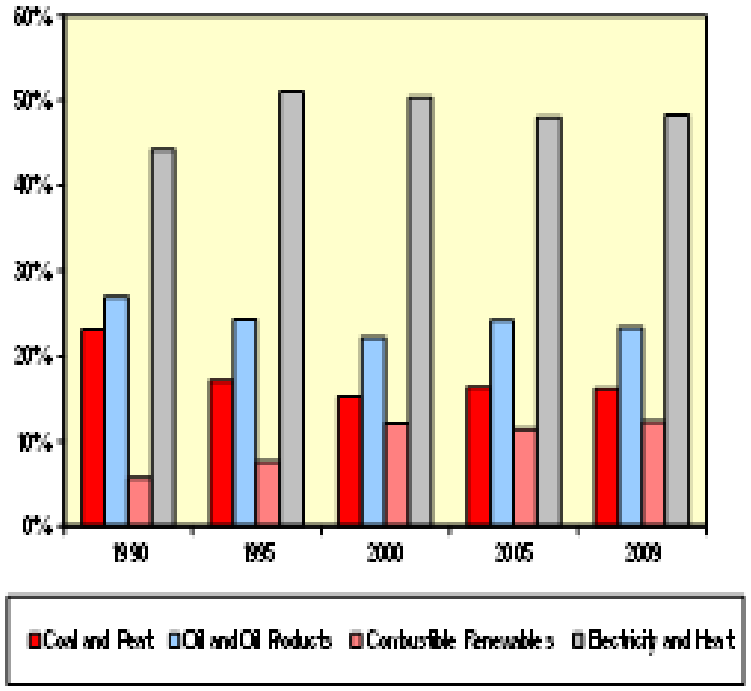


- At the World level, Electricity is the main alternative fuel to gas in the residential and other sectors and its importance has been increasing over time, mainly at the expense of Oil.
- This has been particularly true in the Main Importing Countries such as Germany and Japan as the use of Oil as a heating fuel has been displaced by Gas and Electricity

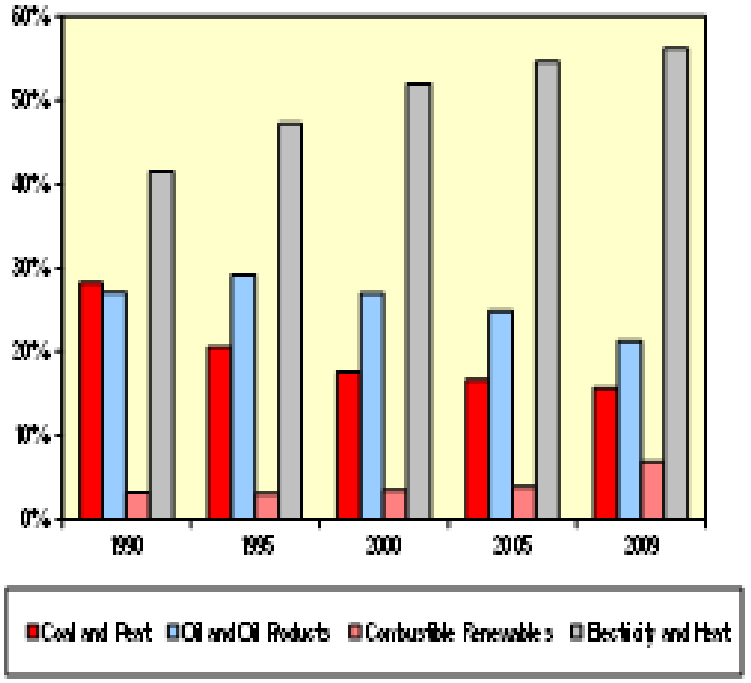
Main importing countries – Germany, Italy, France, Spain, Turkey, Japan, Korea, Taiwan

Competing fuels to gas

Industrial: World



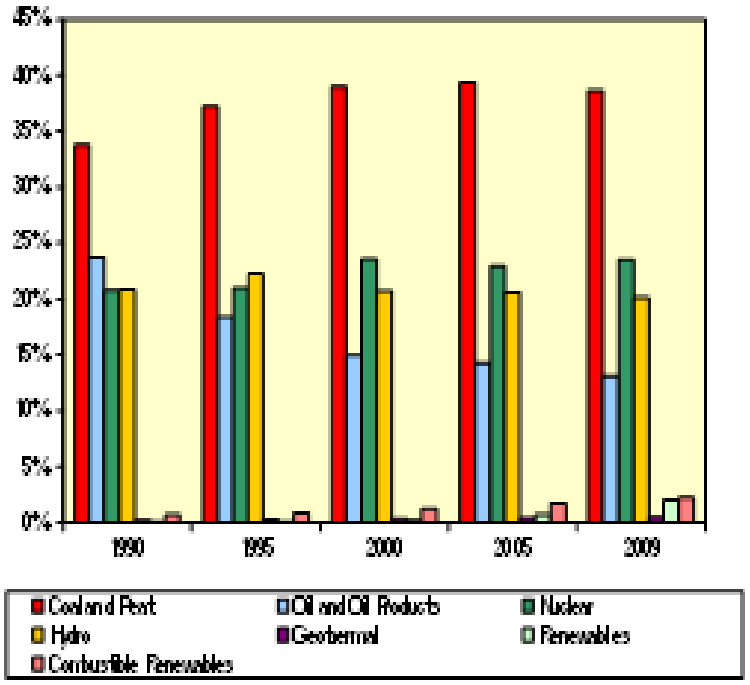
Industrial: Main Importers



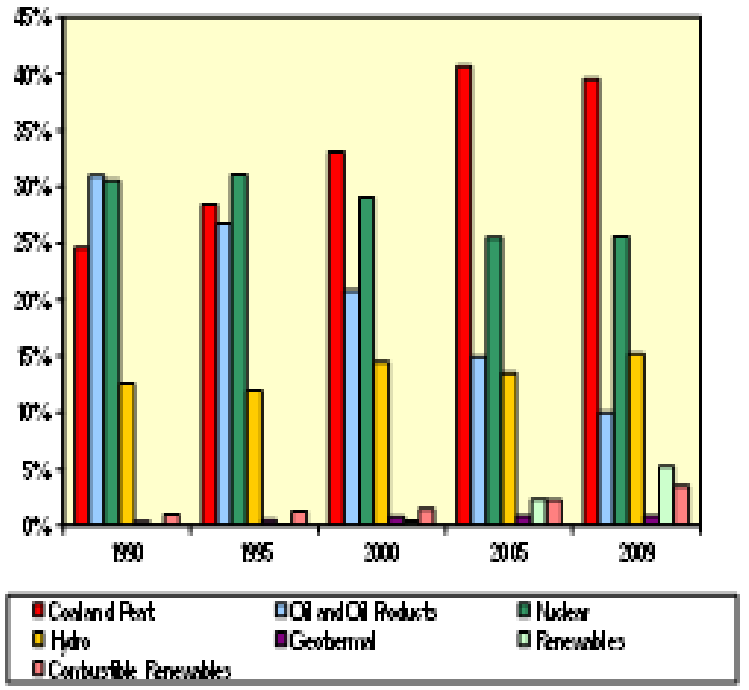
- Electricity is the main competing fuel in the USA, Germany and the UK while Oil is more important in Japan.
- Coal has been declining as a competing fuel in Germany and the UK. The share of Oil as a competing fuel to gas has broadly been maintained in the 4 main countries.

Competing fuels to gas

Electricity Generation: World



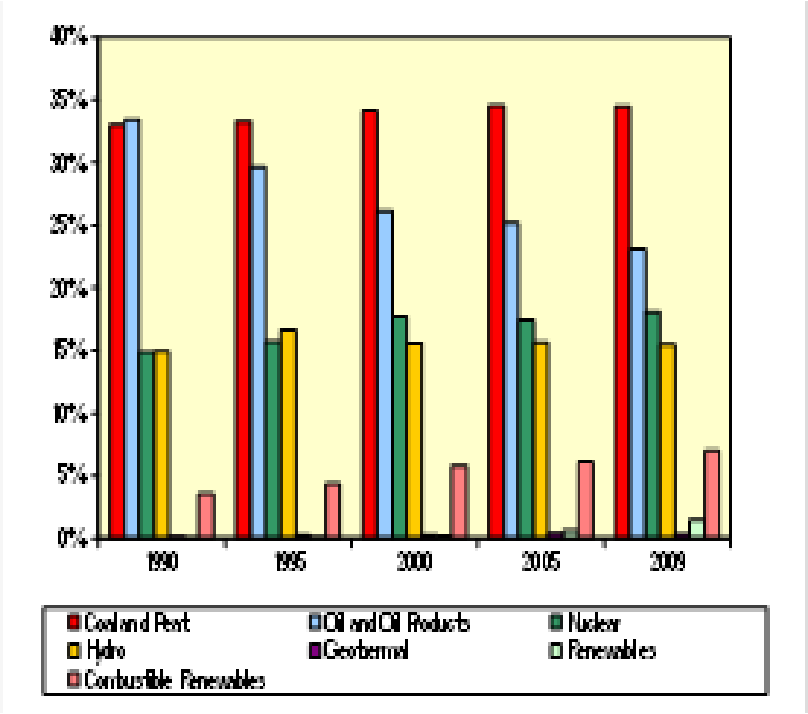
Electricity Generation: Main Importers



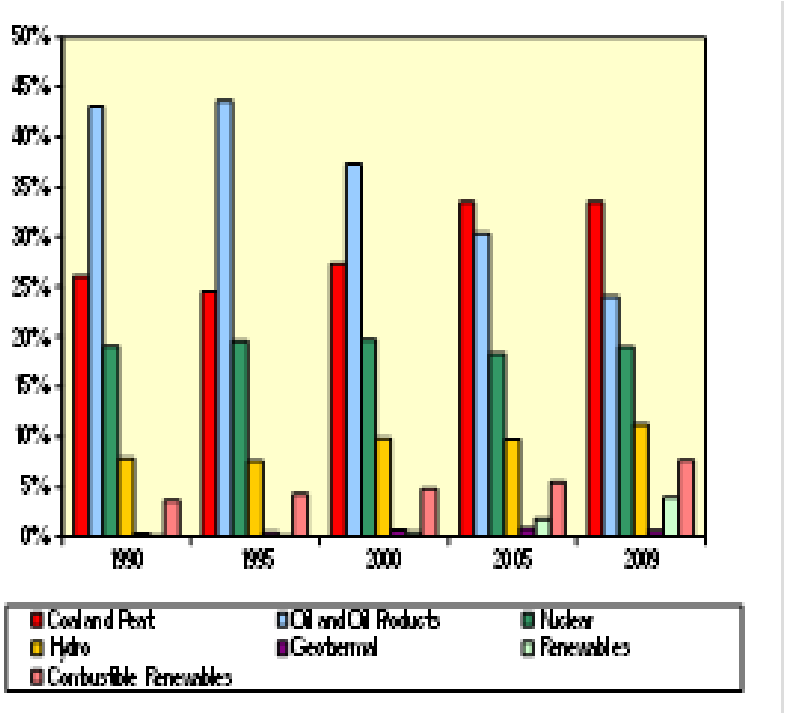
- At the World level, Coal is the main competing fuel to gas and its share has been increasing over time. Nuclear and Hydro are the next most important competing fuels, while the share of Oil has been declining.
- In the Main Importing Countries, Oil, with Nuclear, was the main competing fuel, but its importance has declined significantly, with Coal being much more important.

Competing fuels to gas

Total Primary Energy: World



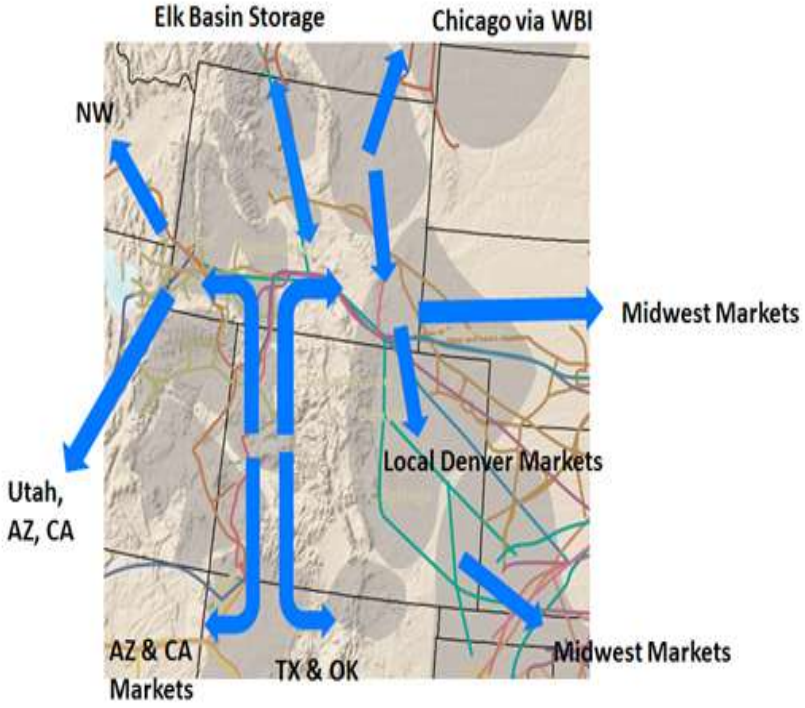
Total Primary Energy: Main Importers



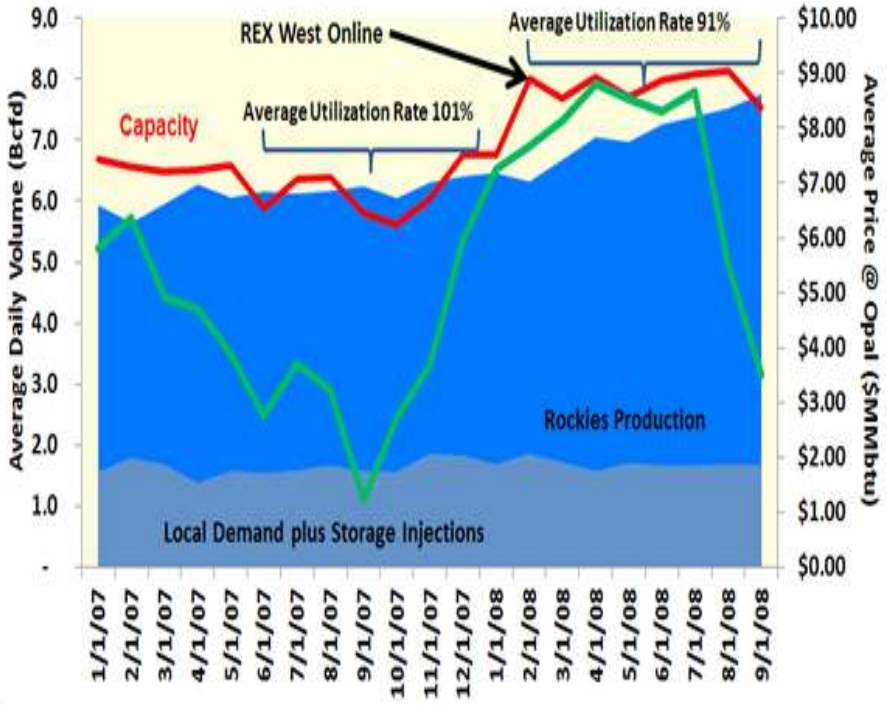
- At the World level, Coal is increasingly the main competing fuel to gas, with Oil in decline and Nuclear and Hydro marginally increasing. Renewables – Combustible as well as Wind and Solar - are increasing their share.
- For the Main Importers, Oil was the key competing fuel until 2005, when it was displaced by Coal, and is now losing market share to Nuclear, Hydro and Renewables. This trend is well illustrated by the changes over time in Germany and Japan.

Hub trading and pricing in North America

Natural Gas Flows from Rockies



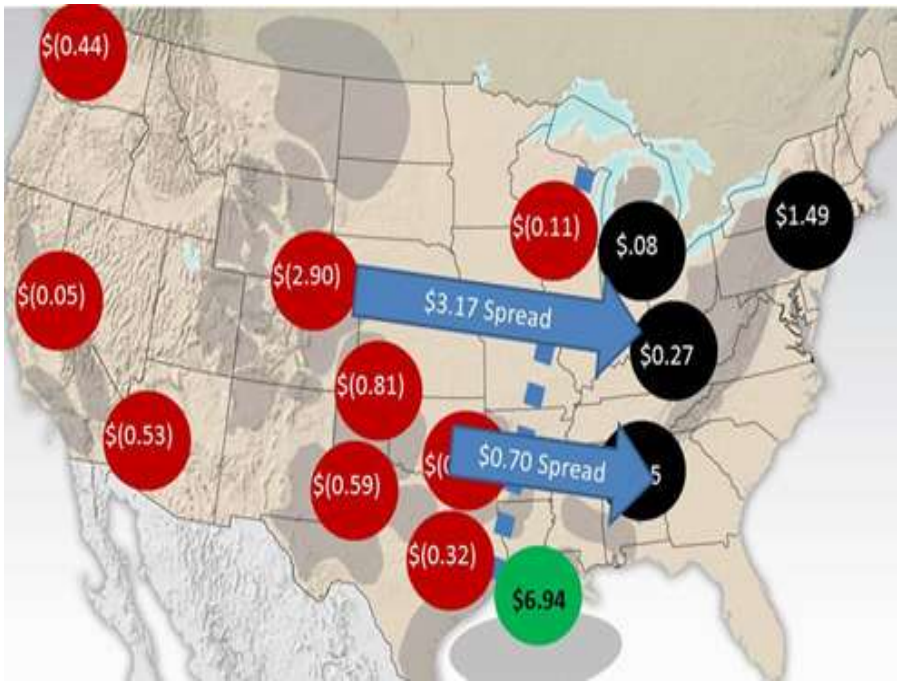
Export Constraints Drive Pricing



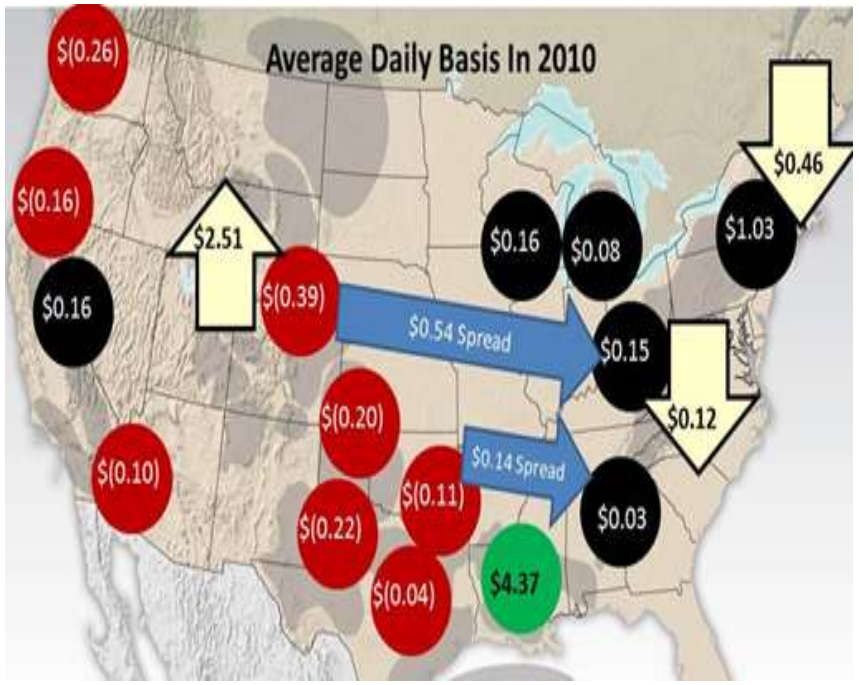
- North American market is the best example of a relatively free gas market and provides a vivid depiction of how regional price disparities arise and how markets then allocate investment capital to resolve these price disparities
- Gas production in Rockies was increasing in 2007 but lack of export pipeline capacity drove prices down – green line in the chart

Hub trading and pricing in North America

Average Basis in 2007



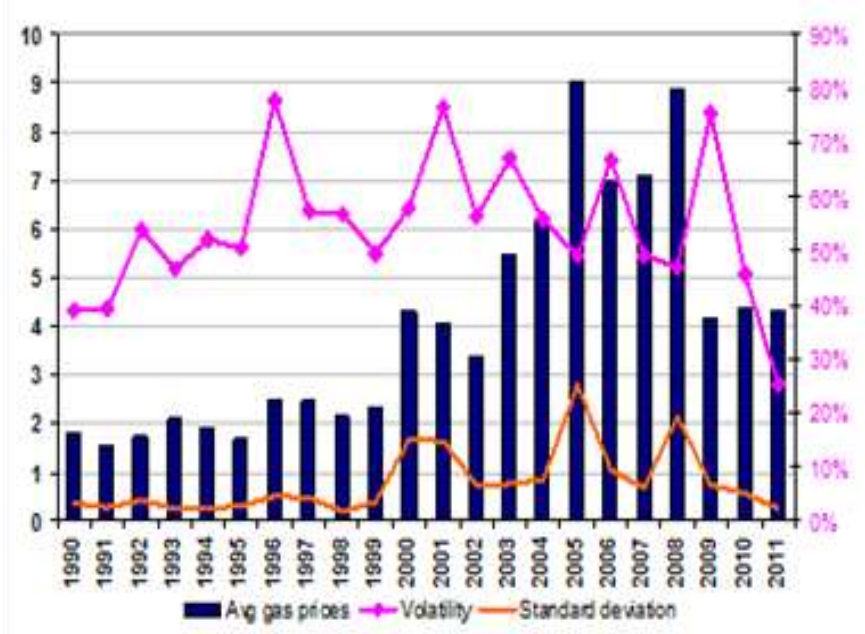
Average Basis in 2010



- Rockies prices at a big discount to Henry Hub and the east coast prices because of constraints
- Big push to build more capacity and by 2010 basis differentials had narrowed significantly
- **The price signals drove the infrastructure investment**

Managing price volatility

Price and Volatility in the USA 1990 to 2011

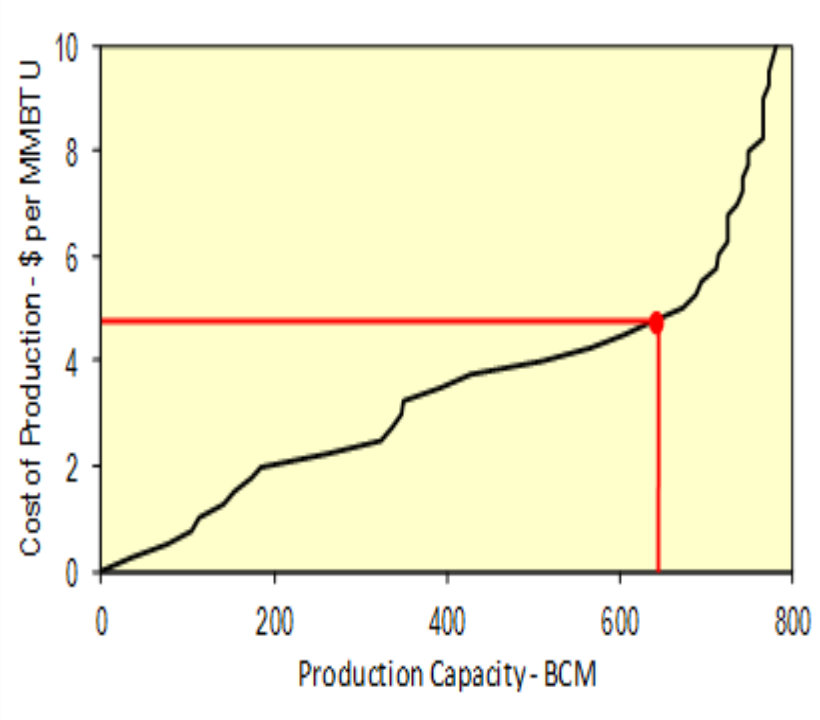


Price volatility results in financial exposure for producers and consumers alike. A high degree of price volatility is generally unfavourable to market players since dramatic price fluctuations increase financial uncertainties and escalate risks.

- The US natural gas market has for some period been characterized by relatively high price volatility, particularly during the years following deregulation and the introduction of open access in the late 1980's and early 1990's.
- As prices collapsed, volatility has dropped as the global financial crisis suppressed industrial demand and significant volumes of unconventional gas started coming into the market.
- Difficult to predict with certainty where volatility levels will go in the future, the impact of volatility will likely be moderated in the low gas price environment .
- Lower deviations in absolute dollar amounts are in store even in the unlikely scenario where volatility levels remain the same. Relatively low percentage volatility in an environment of high prices can result in greater economic exposure than a higher degree of volatility in a moderately priced market.

Long run marginal cost as a price driver

Example US Supply Curve



- How important is long run marginal cost as a price driver
- In a competitive market, the equilibrium market clearing price would be equal to the LRMC, which, in the example chart from the US, is rising as move volume is brought to the market.
- While this could be a reasonable depiction of the US market, in other markets the price is well above the LRMC
- Other factors are important, in particular competing prices – possibly oil indexed long term contract prices .
- LRMC may provide a long term price floor but tight markets would tend to push the price towards competing price levels

Source: Nexant World Gas Model. The cost of production represents the wellhead cost and there would be additional costs to deliver the gas to market hubs

Impact of Carbon Tax or Cap and Trade Policies

- The analysis of the impact of a carbon tax or cap and trade policies on gas prices is still at a relatively early stage, since there is little or no experience or data to take into account.
- Preliminary conclusions from modelling in the US suggests that, at least at low levels of a carbon tax, short term demand for gas would rise at the expense of coal, thereby putting upward pressure on gas prices.
- The longer term impacts at possibly higher levels of carbon tax remain more difficult to quantify but economic theory would suggest that at some point gas begins to lose market share in the power generation sector to renewables.

Conclusions

- The Wholesale Gas Price Formation Survey for 2010 confirms the continuing trend towards gas-on-gas competition, particularly in Europe, and away from oil price indexation.
- Little evidence, as yet, of any move towards a global gas price, even to the extent that prices might move together, reflecting only basis differentials.
- The US market shows that diverging prices can provide signals for investment in more infrastructure and are not necessarily a sign that markets aren't working.
- Price volatility can also provide signals but it has been declining in the US as a result of abundant shale gas supplies
- Long run marginal cost of gas may provide a price floor but competing prices are also important in determining the market price for gas
- Oil has been in continuous decline as a competing fuel to gas in most markets and has almost disappeared as a power generation fuel in some countries
- The debate on the future of oil price indexation in long term contracts continues, especially in European markets. In some end-user European markets prices move through the year in line with oil prices, but with the base price level determined on gas hub (forward) prices.
- The fundamental argument on the future of oil price indexation in Europe may come down to the extent to which the hub and spot trading markets are sufficiently liquid such that the participants can have full confidence in the price transparency, ability to trade and the lack of any market manipulation

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