

# Volatility and Structural Change: Lessons from the 2009 BP Statistical Review of World Energy<sup>1</sup>

By Christof Rühl and Neelesh Nerurkar\*

## Introduction

2008 was a very special year.

It was a year of high volatility, in which the worst global economic contraction since World War II started. And it was the year in which non-OECD energy consumption for the first time exceeded OECD energy consumption.

And, of course, these two big events are related. Non-OECD economies have had five years of the fastest growth ever, and they have dominated global energy demand growth since the turn of the millennium. This contributed to the rise in energy prices, which, in turn, are likely to have played a role in exacerbating the recession.

Both topics provoke doubts about our ability to sustain high economic growth and to secure sufficient energy resources. Can markets deliver enough investment to sustain energy security? Do governments have to do it? Or is more energy for more growth just becoming impossible? The following is a review of last year's world energy data, not an essay in predictions - but the numbers do give perspective. We first will review our two big themes, and then go through global energy markets by fuel.

## Volatility and Structural Change

The U.S. has been "officially" in recession since December 2007. But it was not until after the financial crisis that output actually fell. When it did, the decline was fast and contagious. By the fourth quarter, the global economy was shrinking. The recession spread around the globe with extraordinary speed, transmitted by a lack of credit and working capital, and then by the collapse of international trade. It is now a platitude, but the world did discover that it was more closely linked than many had expected.

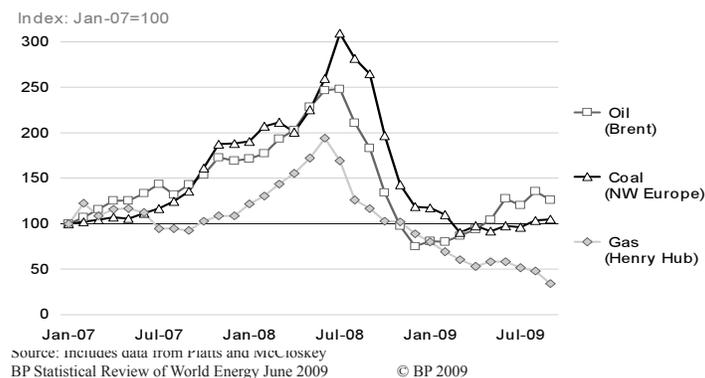
The impact on energy markets was sudden and severe. The contraction in the second half of 2008 caused a strong downward movement of prices and consumption. Prices for all fossil fuels peaked in the summer, and then fell. By January of this year, dated Brent had fallen by 75%, Henry Hub gas by 58%, and North-West European coal by 62%. Inventories rose, and spare capacity emerged, as annual production exceeded annual consumption in all fossil fuels. Power generation saw the lowest growth since 1992; in the OECD it fell. Primary energy growth slowed to 1.4%: global gas consumption was the slowest since 2001, coal the slowest since 2002, and oil consumption fell for the first time since 1993.

On the face of it, we saw a year of two halves: Prices and consumption moved up together in the first half of the year, and then down together in the second half, because of the impact of the economic crisis. But there was more to that year.

In 2008, non-OECD primary energy consumption exceeded OECD consumption for the first time and now accounts for 51.2% of global commercial energy consumption. This has been coming for a while: the non-OECD contribution to energy consumption growth has exceeded that of the OECD since the year 2000. For the first time, in 2008 non-OECD economies used more natural gas than the OECD; in addition, China's power generation overtook that of the EU; and carbon emissions from energy use in China exceeded those of the U.S.

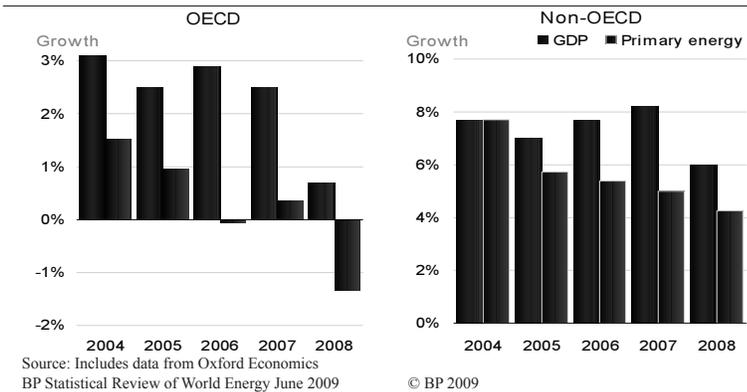
The structural shift we are observing is uneven across fuels. Coal demand has been dominated by the needs of industrializing economies since 1988; the non-OECD now accounts for 65% of consumption. Oil demand is converging, with non-OECD consumption growth having outpaced the OECD every year since

## Energy Prices



\*Christof Rühl is Chief Economist and Vice President at BP plc. Neelesh Nerurkar is an economist with the firm. See footnotes at end of text.

### GDP and Primary Energy Growth



1999. Currently, 45% of all oil is consumed outside the OECD.

How did energy markets cope with the volatility of 2008, and what links this volatility to the structural change just described?

The economy is the main driver of energy demand. For the world as a whole, primary energy demand growth slowed in line with GDP growth in 2008. In the non-OECD economies, the relationship remained broadly stable. But in the OECD, the relationship between GDP growth and primary energy growth shifted last year. Primary energy consumption fell by 1.3%, perhaps a sharper drop than the slowdown in economic growth would have suggested.

Strikingly, this decline can be accounted for by one fuel in one country – namely, the biggest decline in U.S. oil consumption since 1980.

However, the OECD decline comes on the back of two years of below-average energy consumption growth relative to GDP. OECD (and U.S.) oil consumption also had started to fall as early as 2006, well before the recession. It would therefore be wrong to attribute the decline in OECD primary energy and oil demand entirely to the economic slump. The data seems to confirm what many of us have long suspected, namely that energy demand in the OECD was relatively more sensitive to rising prices; and in the non-OECD, it was more sensitive to the years of high economic growth.

To appreciate and understand better these developments, we have to look at the data fuel by fuel.

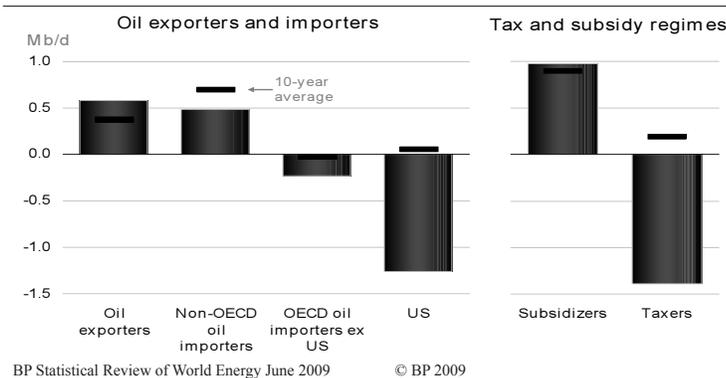
#### Fuel by Fuel

##### Oil

For the year as a whole, dated Brent averaged \$75/bbl, an increase of nearly \$25/bbl over 2007. This was the seventh consecutive increase in the annual oil price, something that has never happened before in the 150-year history of our industry. Of course, the annual average masks the unprecedented run-up and decline of which we are all aware: from \$96/bbl on January 1<sup>st</sup> 2008 to a peak of \$144/bbl in July – a

record even on an inflation-adjusted basis – and then back to \$34/bbl by Christmas. Prices have since bounced back to around \$70/bbl.

### Oil Consumption Growth in 2008



Global oil consumption fell by 0.6% or 420 Kb/d in 2008 – the most since 1982. OECD consumption fell for a third consecutive year, a decline for which the only explanation is the impact of high and rising prices. Non-OECD consumption growth, in contrast, remained robust until economic growth started to deteriorate.

One key event for oil demand was the magnitude of the decline in U.S. consumption: 1.3 Mb/d, as mentioned before, enough to account for almost the entire decline in

OECD primary energy consumption. A second was the slowdown of non-OECD importers, concentrated in Asia, where growth halved - from 750 Kb/d in 2007 to 340 Kb/d in 2008. More broadly, 2008 was no exception to a well established pattern. All of the cumulative oil demand growth since 1999 has come from the non-OECD; and all of the global demand growth over the past five years has come from countries where oil products are subsidized.

But to explain the price trajectory described above, we need to look at the supply side as well.

Having cut oil production the year before, OPEC members started to increase production in the face of rapid price increases in early 2008. Saudi Arabia accounted for the lion's share, with significant growth also seen in Iraq, Qatar, and Kuwait. With the usual lag between wellhead and storage facility,

these increases showed up as higher inventories by the summer of 2008 – just about the time that global demand collapsed. This quickly brought prices down.

In response, OPEC announced several production cuts, and by year-end it had pledged to cut more than 4 Mb/d. Relative to faltering demand this was too little, too late, to avoid a large price decline by year end. The full impact of OPEC's cuts has only been felt in 2009, with production down by around 3 Mb/d. These OPEC cuts helped to increase prices earlier this year, in the face of still falling demand, and they support prices now.

Meanwhile, non-OPEC production, falling by 610 Kb/d, suffered the largest decline since 1992. This decrease was driven by OECD countries, where decline accelerated to 750 Kb/d, with Mexican output falling by 310 Kb/d. In the face of an adverse tax system and a lack of drilling activity, Russia suffered its first annual decline in a decade (90 Kb/d). A combination of field maturity, high cost, and increasingly constrained access to investment meant that non-OPEC supply continues to struggle, despite those seven years of rising prices.

For the year as a whole, OPEC production rose by 990 Kb/d and so more than compensated for the large non-OPEC decline. Global oil production grew by 380 Kb/d, excluding biofuels. The excess of production over demand led inventories to rise substantially - OECD inventories rose by 134 Mbbls in 2008, the largest increase on record and continued to increase well into this year, leading to the deployment of floating storage to exploit the fall of spot below future prices. Needless to say, OPEC spare capacity has increased as well.

On a fundamental level, the oil market story is one of volatile price changes in a constrained market. Supply growth in regions open to investment has been anaemic, and openness to investment has itself deteriorated. This has left OPEC in the driver's seat controlling, together with other large resource holders, investment as much as production.

### Refining

The refining margin environment in 2008 suffered a double blow when falling product demand met a cyclical increase in capacity. BP's global average margin of \$6.52/bbl was the lowest since 2004, though still above the ten-year average. Early in the year, strong economic growth supported margins through middle distillate demand, which compensated for the price-related decline in U.S. gasoline demand. The need to produce distillate at the margin brought its price to between \$25/bbl and 35/bbl above crude oil, delivering record global distillate cracks and widening light heavy spreads globally. But refining margins weakened towards the end of the year when oil demand – including for distillate – collapsed because of the recession.

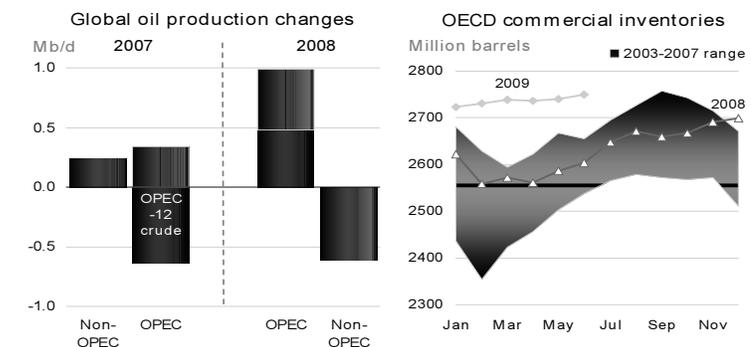
Spare refining capacity has increased as a result of new capacity, reflecting investment decisions during the “good years”, exacerbated by run cuts. Global unused refining capacity grew by 1.1 Mb/d in 2008: 800 Kb/d of this was because of new capacity, and 300 Kb/d because of lower crude runs. In 2009, new capacity growth is expected to add another 2 Mb/d. New capacity and run cuts are taking their toll: in April this year, utilisation fell to about 80%, the lowest monthly level in 7 years. Yet, OECD product inventories still reached their highest seasonal levels for 19 years – a stark illustration of the scale of over-supply this part of our industry faces.

### Natural Gas

Natural gas prices show a familiar pattern. All annual-average prices reached record nominal highs in 2008, with European contract gas the most expensive in the world. Prices in the liberalized U.S. Henry Hub and UK NBP markets rose sharply in the first half of 2008, but fell back as demand weakened while supply remained abundant. Oil-indexed Asian LNG and European contract prices rose for longer due to lags to oil prices, but then also fell off their peak. Prices remain depressed into 2009.

World gas production grew by 3.8%, the second strongest volumetric growth on our records. Gas consumption in the OECD grew faster than normal in the first half of 2008, but subsequently weakened

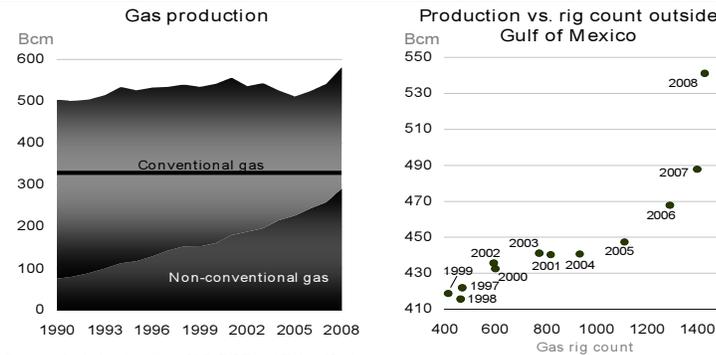
## Changes in Production and Inventories



Source: Includes data from IEA  
BP Statistical Review of World Energy June 2009

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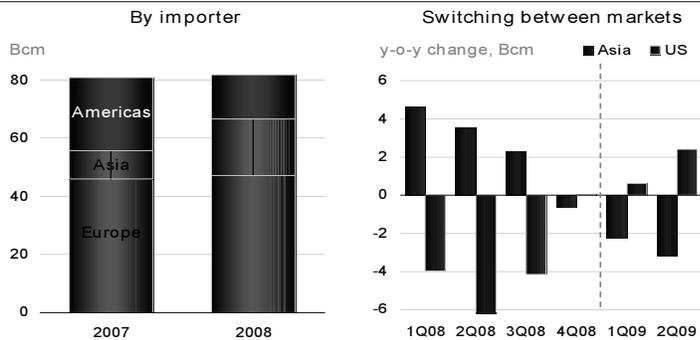
### US Gas Production



Sources: Includes data from U.S. DOE and Baker Hughes  
BP Statistical Review of World Energy June 2009 © BP 2009

caused drilling for these deposits to soar and technological advances allowed output per rig employed to rise exponentially. Investment in frontier technology has increased U.S. gas reserves by 45% and nearly doubled non-conventional gas production over the last decade. As a share of total U.S. gas output,

### Atlantic Basin LNG\*



\* LNG from Algeria, Belgium, Egypt, Nigeria, Norway, Trinidad and Equatorial Guinea

Sources: Includes annual data from Cedigaz and quarterly figures from Waterborne LNG  
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Belgium put LNG back onto a tanker and re-exported it to Asia – a first, as far as we are aware.

A good proxy for global gas market flexibility is the diversion of Atlantic Basin cargoes between regions. Atlantic Basin spot cargoes rose to 12% of total Asian imports in 2008, up from 7% in 2007, and zero in 2000. Meanwhile, abundant U.S. production caused U.S. LNG imports to fall by more than half in 2008. Asian LNG demand has turned negative this year, due to the recession, but output is growing. LNG is increasingly “looking for a home” and LNG plants are facing excess capacity. Nevertheless, the fungible share of LNG continues to rise, through good times and bad – first, before the demand and price peak in the summer of 2008, driven by consumers bidding for cargoes, and now, by producers discovering the advantages of flexible contracts when trying to place surplus LNG.

The story of gas markets into 2009 ends as one of too much supply chasing not enough demand. But behind it is the story of a supply response to high prices in the rise of non-conventional gas in the U.S.; and of accelerating global integration in response to market signals in LNG.

### Coal

Coal prices also exhibit the pattern familiar from other fuels – peaking in July and then tapering off. Prices in North West Europe, a good proxy for a globally traded coal price, reached \$219 per tonne in July and fell to \$58 by March this year. The volatility of this marker price for traded coal exceeded that for oil and gas.

Coal remained the world’s fastest-growing primary energy fuel. But at 3.1%, global consumption growth was so weak that, without the contribution from India and China, it would have fallen. Coal con-

and, at 2.5%, global consumption growth for the year as a whole was below the ten-year average. The non-OECD used more natural gas than the OECD for the first time ever last year and gas was the only fossil fuel for which non-OECD demand accelerated, driven by China, which recorded the world’s largest volumetric increase.

The impact of slowing demand in the second half of 2008 on prices has been exacerbated by two reactions to past high prices: investment in ‘non-conventional’ gas in the U.S. and a bunching of investments in LNG.

The development of non-conventional gas such as shale, tight gas, and coalbed methane allowed the U.S. to record the world’s largest production increment in 2008 (41.7 Bcm). Rising prices nonconventional gas went from 15% in 1990, to 28% in 1998, and to around 50% in 2008. It is, in fact, becoming conventional. Such growth caused U.S. Henry Hub gas prices to be among the lowest in the world.

Today, 19% of global gas production is traded by pipeline and 7% by LNG. LNG continues to link regions into one globally integrated market. This demands flexibility. A record number of LNG tankers were delivered last year, expanding fleet capacity by 19%. 2008 saw the longest journey ever travelled by an LNG tanker – from Norway to Tokyo. In early 2008 a record amount of flexible LNG headed to Asia, where Japan continued to suffer nuclear outages, and other countries bought more gas because oil prices had been high. In the autumn, with demand falling,

sumption in the OECD had the steepest decline since 1992, and in the non-OECD it grew at its slowest rate in six years.

Coal always is a China story. It meets 70% of China's energy needs; China accounted for 43% of global coal consumption and 85% of last year's growth. Yet growth in Chinese coal consumption has been slowing since 2003, and continued to slow in 2008. Power generation growth fell in the last quarter, as the economic crisis reached China and hit its export sector.

In the OECD, coal consumption fell by 1.9%, the steepest decline since 1992. Consumption in the EU fell 5.4%, as relatively low gas prices led to inter-fuel competition early in the year. The rising price of emissions within the European Emissions Trading Scheme made electricity production from coal more costly than from gas for most of 2008. As a result, UK coal-fired power generation fell by 8.3%, while gas generation rose by 8.9% in 2008. In Germany, coal generation fell by 6.5%, and gas generation rose by 9.1%. But because coal prices have been falling more rapidly than oil-indexed gas prices and because carbon prices have fallen too, fuel switching is now reversing in those parts of Europe where pipeline gas (tied to oil prices) dominates.

### *Renewables*

Renewables still account for only a small share of total energy consumption, and for the most part, still require government support. But from that small base they continued to grow fast, with global deployment reflecting government support as well as natural endowments. In contrast to all the other fuels, growth in renewables was led by OECD countries, where policy support is strongest. But like other fuels, 2008 saw rapid growth in the first half followed by a marked deceleration towards the end of the year, and into 2009.

Ethanol is now equivalent to 0.9% of global oil consumption. Production growth accelerated for a fourth consecutive year, rising by 31% in 2008. U.S. production rose to 600 Kb/d, as new capacity responded to tax incentives, blending mandates, and high gasoline prices. The credit crisis and falling product prices after mid-year slowed things down and left the U.S. ethanol industry with overbuilt capacity – by year-end about 15% of U.S. ethanol production capacity lay idle.

Wind power generating capacity growth accelerated to 30% in 2008, the fourth consecutive year of accelerating growth. Growth becomes a race between newly emerging big players: China recorded the fastest growth rate among the major markets and the second largest volume increment (6.2 GW, 106% growth), but the U.S. added the most new wind capacity, overtaking Germany, and with 21% has now the largest global share of global wind power capacity.

Solar power generating capacity grew even faster than wind. However, with capacity reaching 13.4 GW, solar is still a long way behind wind.

Together, wind, solar and geothermal power supply around 1.5% of global electricity.

### *Carbon Emissions*

Carbon emissions from energy use grew by 1.6% in 2008, which is slower than last year and below the ten-year average for the first time since 2002<sup>2</sup>.

China became the world's largest emitter of energy-related CO<sub>2</sub> in 2008; Asia Pacific accounted for nearly all of the world's net emissions growth. OECD emissions fell by 1.7%, mostly due to reduced oil and coal consumption, including switching from coal to gas for electricity generation in the EU.

Carbon markets grew strongly in 2008: trading volumes increased by 61%. But the recession took its toll here as well, with carbon prices behaving pro-cyclically: As energy demand and energy prices came down, carbon prices fell to €16/tonne CO<sub>2</sub>e at year-end, from almost twice as much in July 2008.

### **Conclusion**

Coming back to our two main themes, it is worth keep in mind one last set of numbers. Despite their rapid growth, non-OECD economies still account for only 25% of global GDP, produced by 82% of the global population. Per capita income therefore is \$2,300, compared with \$32,000 in the OECD. Combined with the energy data laid out at the beginning, this also means that it takes more energy to produce one unit of GDP in the poorer countries than it takes in the OECD. To be precise, to produce \$1000 worth of GDP takes 3.4 boe in the non-OECD versus 1.1 boe in the OECD - partially because of the growth of industry, but also because of inefficiencies. The scale of the challenge is easy to see.

So, what can the experience of a volatile year tell us about how to meet these longer-term challenges of adjustment?

In 2008, market reactions explain the developments we saw. In the short term, we registered huge

price volatility. Where these price changes were allowed to play themselves out – which was not always the case – they drove an efficient response.

- The brunt of the OECD decline in primary energy consumption was taken by U.S. oil because it is most exposed to crude price fluctuations.
- Globally, outside China and India, high coal prices and available gas supplies translated into falling coal and increasing gas consumption.
- In the EU, relative coal and gas prices prompted fuel switching in power generation, partially offsetting the decline in coal consumption growth.
- Intra-fuel price differentials also directed fuels to their highest valued use through trade – for example, when the EU replaced coal imports from Africa and Australia; or when low prices induced the re-contracting of LNG shipments.
- Where investment was allowed to react, high prices have translated into new supplies – witness the growth of non-conventional gas in the U.S. Where investment is constrained, this mechanism fails – witness the oil market.

But the commodity cycle has not disappeared. Refining, and to some extent also the North American gas market, bear witness to the threat of over-investment and feedback loops in capital intensive industries. Energy is a capital intensive business with long lead times; demand for its products depends on overall economic conditions. Cycles and price volatility are the norm reflecting our imperfect knowledge over long investment horizons.

The key to meeting the longer-term challenge is to manage through these ups and downs. In 2008 we saw a sharp turn in the economic cycle, and associated volatility in energy prices. Markets have served global energy security well - on the way up, and on the way down. In fact, it has been served best where markets were allowed to develop without interference.

#### **Footnotes**

<sup>1</sup> The Statistical Review data and a more detailed analysis of energy markets can be found at [www.bp.com/statisticalreview](http://www.bp.com/statisticalreview).

<sup>2</sup> We derive this by applying standard conversion rates to energy consumption, so our figures are therefore not comparable to official data.



Two great associations...one great session! All IAEE & AEA members are invited to attend the joint IAEE and AEA session to be held during the Allied Social Science Associations (ASSA) annual meeting in Atlanta, Georgia.

#### **IAEE/AEA Session**

#### **“Climate Policy for a Post-Kyoto World” 2<sup>nd</sup> Joint IAEE/AEA Session**

2:30pm, January 3, Hilton Atlanta, Room 201

**Presiding:** Carlo Andrea Bollino, Dept of Economics, Finance & Stats., University of Perugia

**John Weyant, Stanford University** – *Global Climate Policy Scenarios: An Update*

**Robert N. Stavins, John F. Kennedy School of Government, Harvard University** – *Getting Serious About Global Climate Change After Copenhagen: A U.S. and International Update*

**Scott Barrett, School of International & Public Affairs, Columbia University**

Also, please visit the IAEE/USAEE Cocktail Party which will take place during the ASSA meetings. We invite you to attend this event!