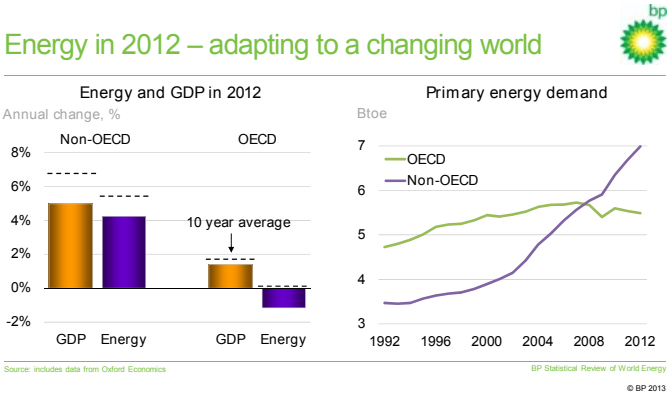
Energy in 2012 – Adapting to a Changing World

By Christof Rühl and Joseph Giljum*

2012 produced a fair number of headline figures. The U.S. led the world in both oil and gas production increases - and for oil, achieved the biggest increase in the country's history, ever. China's annual increase in hydropower outpaced that of any other country on record, while nuclear energy recorded the biggest decline ever. Three of the world's four largest economies (Germany, Japan, China), together representing a quarter of global GDP, ran their economies with a higher share of renewables than of nuclear. Meanwhile, LNG trade declined for the first time, while record amounts of coal, exiled from the U.S. by the shale gas revolution, found their way to Europe.

While individual fuels each have a unique tale to tell, the main theme that emerges from this review is how energy markets continue to adapt to a changing world. The energy system moves slowly, but it does move, and it is quite good at adjusting not only to structural changes but also to transitory disruptions. The following is a summary of those developments, adapted from the *2013 Statistical Review of World Energy*, a rigorous and objective review of last year's energy data.

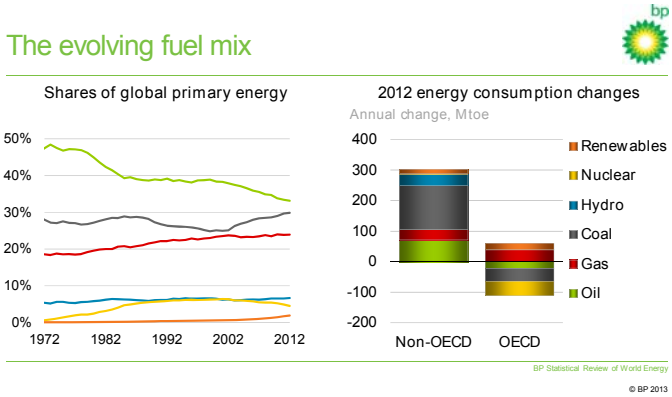


On the face of it, energy developments in 2012 look unsurprising. Consumption growth slowed to 1.8%, below its ten year average, and that holds true for all fuels bar renewables and hydropower, and in all regions except Africa - quite in line with a lacklustre economic performance overall. However, to capture the many moving parts beneath the calm aggregate surface it is best to start by looking at 2012 in the context of long-term trends.

2012 in Long-term Context

First among these trends is the relentless shift of the world's economic center of gravity toward the emerging markets of the non-OECD. Over the last twenty years, global energy consumption increased by 52%. Over the last ten years alone, demand rose by 30%, almost all of which (99%) outside of the OECD. Then, over the last five years, OECD consumption fell four times; and in three of those years despite positive GDP growth.

2012 fits right in: OECD energy consumption declined by 1.2%, despite positive GDP growth and hard on the heels of a similar result for 2011. In primary energy consumption, the OECD is back to where it was in 2002 - despite cumulative GDP growth of 26%. We have long held that OECD oil consumption is in structural decline. While it is surely too early to make a similar call for primary energy; these numbers suggest that it is a development worth watching.



There is a rarely noted corollary to this shift in the center of gravity. As the non-OECD economies industrialize, they also unlock more energy resources. Many may have heard utterances about emerging market growth leading to energy shortages, but the data clearly illustrates that the industrializing world not only outpaces the OECD in terms of demand growth, it also contributes its fair share to production. Over the last ten years, the non-OECD accounted for 98% of the increase in global production. In 2012, this share was 92%, despite surging unconventional U.S. output and decelerating Chinese coal production.

A third significant trend over the last decade has been the unprecedented rise in energy prices. In inflation adjusted terms, average annual oil prices for the last five years were 230% higher than for the same period ten years ago; for coal, the increase was 140%; and for natural gas, 90%. Over the last five years, the spread across fossil fuel prices has widened as well. 2012 saw a moderation of sorts: oil remained relatively stable, but at record levels, gas prices bifurcated across regions, dropping massively in the U.S. but rising

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in all other regions of the world; and coal declined everywhere.

These higher prices are taking their toll. They impact demand, in particular in countries where economic growth is less energy intensive and consumers are not sheltered by subsidies. Changing price differentials also shape the global fuel mix and high prices eventually trigger supply responses. 2012 provides examples for all these effects. Oil, which (in energy terms) commands the highest value, continued the slide in its global market share that started with the first oil price shock in 1973. Last year oil was the only fossil fuel that lost market share in the OECD and the non-OECD alike. Meanwhile, price spreads between gas and coal triggered competition between them, often across borders; and in the U.S., record high oil prices triggered a migration from shale gas to tight oil activity.

To trace these developments in more detail, it's best to look at them fuel by fuel.

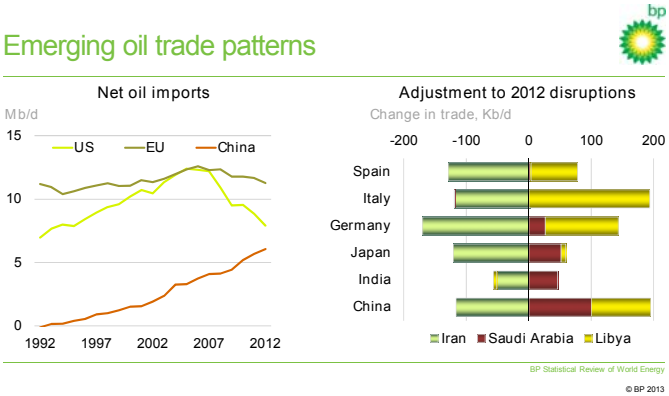
Fuel by Fuel

Crude oil

While oil remains the world's dominant fuel, it has lost market share for a remarkable 13 years in a row, and its share of global primary energy is the lowest in our records. Last year oil prices remained essentially flat, with Dated Brent averaging nearly $112 per barrel. This stability of prices, however, masks an apparent disconnect between supply and demand: global consumption rose by a below-average 890 Kb/d, but production rose twice as fast, by an above-average 1.9 Mb/d.

To explain this disconnect one must pay attention to the detail. Starting with supply, last year saw - after Libya in 2011 - another OPEC producer experiencing a significant decline in output. Iranian production fell by 680 Kb/d, due to international sanctions; adding in outages in several other MENA countries resulted in aggregate losses of well over 1 Mb/d. Yet global output rose strongly, with OPEC accounting for nearly three-quarters of the growth due to the recovery in Libya and large increases in Saudi Arabia, Iraq and Kuwait. Production outside of OPEC also increased (by 490 Kb/d) with the U.S. recording the largest increase in the world thanks to continued growth in tight oil supplies with output in North Dakota and Texas - the states with the most productive tight oil formations - increasing by nearly 800 Kb/d.

As for consumption, OECD demand fell again - by 530 Kb/d, the sixth decline in the past seven years. Europe and the U.S. drove the decline as, in addition to the economic slowdown in Europe, both regions saw strong consumer reactions to the sustained level of high prices, especially in the transport sector. The U.S., for example, saw the largest improvement in fuel economy for new light vehicles sales since 1980. However, this decline was more than offset by the non-OECD, where demand grew by a below-average 1.4 Mb/d. Even though growth was weaker than average in China, the country still registered the largest increment to oil consumption in the world for the 12th time in the last 13 years, with demand now surpassing 10 Mb/d.



These developments are also altering trading patterns. The strong growth in U.S. output, combined with weaker consumption, has dramatically reduced oil import requirements. Since peaking in 2005, U.S. net imports have fallen by 4.5 Mb/d, or 36% - a reduction nearly as large as the entire 2012 consumption of the world's third-largest consumer, Japan. Over that same period, Chinese net oil imports rose by 2.8 Mb/d or 84%. In 2005, the U.S. and EU imported similar amounts; in 2012, U.S. net imports were nearly one-third below those of the European Union.

Other events in 2012, including sanctions affecting Iranian exports and the return of Libyan production, also influenced trading patterns. As Iranian deliveries to Europe fell sharply, the region expanded its imports from North Africa. Asia also curtailed Iranian purchases, with higher Saudi production largely offsetting these lost volumes.

The question remains: given the large mismatch between aggregate production and consumption, how could prices remain flat? The answer lies in inventories. While the increase in OECD stocks was not enough to explain the gap, if the experience of the past decade tells us anything, it is that the OECD is no longer the main driver of oil markets. And indeed, estimates of inventory movements outside the OECD, while incomplete, nonetheless help to explain the disconnect: increases in non-OECD inventories account for nearly two-thirds of the global changes last year, thus helping to explain the oil market in 2012.

Refining

Global average refining margins improved markedly in 2012, although there was hardly any improvement in global capacity utilization. Large regional differences reflect the underlying strain of markets adjusting to new refining capacity in some regions, while there were closures elsewhere. Net global refining capacity additions last year totalled 360 Kb/d, but this masks significant changes - with China and India expanding the most and their additions closely matched by reductions in Europe and the Caribbean. In this way, the migration of refining capacity away from established markets continued in 2012.

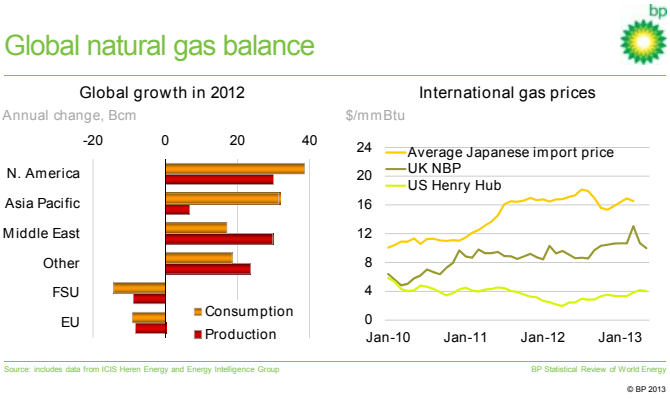
China accounted for almost two thirds of last year's 480 Kb/d growth in global crude runs and nearly all of the net growth in the non-OECD. In the OECD, crude runs grew by 160 Kb/d with reductions in Europe and Japan more than offset by growth in North America. Interestingly, since 2005 liquids demand has fallen by around 2 Mb/d in each the U.S. and Europe - but U.S. crude runs are down by 210 Kb/d over that period while European crude runs dropped by more than 2 Mb/d. The reason is that U.S. refiners benefit from more complex configurations, lower natural gas prices and in some cases, access to discounted North American crudes, all of which have helped to turn the U.S. into a major product exporter - a position it is unlikely to lose, at least as long as U.S. crude exports remain legally constrained.

Natural Gas

Two trends dominated the evolution of natural gas markets over the past few years: the rapid growth of shale gas in the U.S., and the expansion of global LNG. U.S. production continued to grow in 2012, if at a slower pace, but LNG trade declined for the first time on record. These developments, together with the continuing impact of Japan's post-Fukushima adjustment, shaped gas markets and in the event created an important example of inter-fuel competition between gas and coal.

But first the basics: consumption rose by 82 Bcm last year, faster than 2011 but below the ten year average. The U.S. saw the world's largest gain in consumption - an increase by itself bigger than that of any global region - followed by Asia on the back of strong LNG demand. Global production grew by 72 Bcm, also below average, with the European Union and the FSU registering the largest declines. Regional gas prices moved in lockstep with this pattern: Spreads widened, with U.S. prices recording their lowest annual average since 1999, Japanese import prices reaching a new average annual record, and UK spot prices edging up as the global competition for LNG tightened the market in Europe.

In the U.S., output continued to rise by 33 Bcm, but growth was below the record expansion of 2011. Lower prices and a reorientation of drilling away from gas and toward higher-priced oil drove the slowdown. The impact on gas output would have been much sharper without the rapid growth of associated and liquids-rich gas supply triggered by rising oil output. Meanwhile, a warm winter on top of record production growth in 2011 curtailed heating demand and pushed inventories to unusually high levels in early 2012. The only sector flexible enough to absorb this surplus was power - which required gas prices to fall far enough to be able to compete with coal. All told, an additional 44 Bcm of gas went into the power sector - the largest annual jump of any fuel used in U.S. power generation for at least 40 years.



Meanwhile, fortunes changed in the remarkable history of LNG. For at least two decades, international gas trade had grown on average 2.5 times as fast as consumption every year, and LNG trade more than 3 times as fast. Until last year, that is, when LNG trade declined. How did this happen?

The prime suspects would be the lumpy nature of capacity growth in LNG and under-utilization of existing capacity. Indeed, in contrast to the large additions that characterized past decades, only one new project was actually operating by the end of 2012. Utilization rates also fell, because either rising domestic demand or falling production crowded out feedstock for exports, or in the wake of unplanned outages and outright infrastructure damage.

The net effect was a decline in supply. With Asian demand for LNG remaining strong, and Japan facing a growing need to replace nuclear power post-Fukushima, the LNG market tightened. Japan increased imports to a record high of 119 Bcm and paid a record premium over European spot prices to attract supplies. China and other Asian countries increased LNG imports amidst solid economic growth, while a severe drought in Latin America also helped to push up demand. With no need to compete for

LNG at the Asian price level, European LNG imports declined by nearly 25%.

The lack of LNG should have been good news for traditional suppliers to the European gas market, such as Russia and Norway. Instead, they faced competition from an unexpected quarter - cheap coal. Much of it came from the U.S., exiled from power generation by the shale gas revolution. While coal prices were falling, European gas prices continued to rise as Russia maintained its oil-indexed pricing. This opened up a large gap between the costs of generating power from gas and coal, with coal on average 45% cheaper. Meanwhile, carbon prices were far too low to redress the balance in favor of gas. The result was a large switch from gas to coal in power generation - a mirror image of the U.S. experience, although on a smaller scale. The largest five European power markets used nearly 20% less gas in power. In volume terms gas lost around 17 Bcm of demand, compared to a 44 Bcm gain in the U.S..

Standing back from the detail, 2012 demonstrated once again the interconnections among regional gas markets. The market is not yet globally integrated like oil, but developments in one region increasingly impact others, either through the pricing of LNG or indirectly through the global coal market.

Coal

Global coal growth moderated last year, with consumption as well as production growth below average. Consumption growth decelerated to 2.5%, almost half the rate of 2011; and production growth slowed from 6% to 2%. Putting cross-Atlantic coal trade aside, in global terms coal remains a China story. The engine of China's industrialization, domestic coal production, rose by 135% over the last ten years. For this period, one fuel in one country accounted for more than one third of global energy consumption growth. Last year China consumed more than half the coal in the world for the first time.

Such volume comparisons will remain important. But the Chinese data also hint at a more intricate question. The Chinese authorities aim to rebalance the economy, from extensive growth toward a higher share of services and domestic consumption. If successful, this would lower China's coal intensity. The 2012 data appears to indicate that coal consumption may have re-entered a path of slowing growth which had started in 2003, when coal growth reached a staggering 20%. In 2009-10, this path was interrupted by energy intensive stimulus programs, administered to combat the global economic crisis. It is too early to tell, but this is yet another development worth watching.

Outside of China, the slow-down of consumption growth was widespread. By region, there was notably faster growth only in Africa and the EU. By country, the main exceptions were Japan, where coal helped to mitigate the consequences of nuclear outages; and India where coal demand rose substantially to replace gas in power generation. Production growth outside China was dominated by the coal exporters of Indonesia, Russia, and Australia. Meanwhile, coal continues to internationalize, with trade outpacing consumption for the 10th consecutive year.

Non-fossil Fuels

Despite near average precipitation, hydroelectric output grew by an above-average 4.3% in 2012, with all the net increase in one country. On the back of a massive program of capacity expansion, China accounts for more than half the global increment over the last ten years; in 2012, it booked the largest annual increment on record. Nuclear generation suffered a second year of record decline of nearly 7% driven by the near-complete shutdown in Japan and as a result its share in primary energy fell to the lowest since 1984.

Renewable power generation grew by 15% in 2012, just above the ten year trend, but also experiencing its first serious slowdown. However, with relatively slow growth in total power generation, renewables continued to gain market share, rising to nearly 5% last year. Growth was led by three countries: China, the U.S., and Italy which together accounted for almost half of global generation growth. Meanwhile, China overtook Germany as the second largest renewable power producer, behind the U.S.

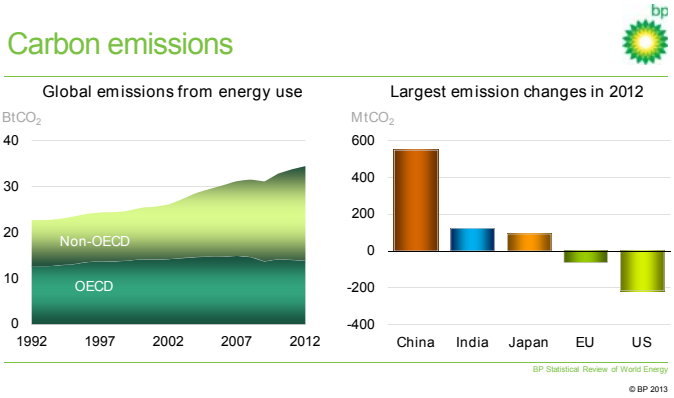
While renewable power growth slowed, biofuel production fell by 0.4%, led by the first fall in U.S. ethanol production since 1996. With the worst drought since the 1950s and falling gasoline consumption, U.S. ethanol was squeezed between high corn prices and the "blend wall", forcing several ethanol plants to close. However, renewables in aggregate continued to increase their share of primary energy consumption despite declining biofuels and slackening growth in renewable power, from 2.2% in 2011 to 2.4% in 2012.

Carbon Emissions

Global carbon emissions from energy consumption rose by 1.9% in 2012, slightly faster than primary energy consumption. Unsurprisingly, the largest growth came from China and India, but Japan also

recorded a significant increase as it adjusted to the loss of nuclear energy. The U.S. recorded the largest reduction, dropping much faster than the EU. This surprising development is largely due to fuel switching in power generation - from gas to coal in the EU, and from coal to gas in the U.S.

Given that a coal plant emits roughly twice as much CO_2 per kilowatt hour as a modern gas plant, the net effect of higher gas and lower coal consumption in the U.S. was an emission reduction of 164 Mt; the opposite effect in the EU was an increase of 21 Mt. The EU is known for being heavily invested in climate policy, not so the U.S. So what went wrong? Ultimately, it is a price effect: weak gas prices crowded out coal in the U.S., and weak coal prices together with high gas prices subsequently favored coal in Europe.



In theory, the EU ETS carbon price was designed to offset just such a cost advantage. However, it would have taken a carbon price in the range of €40-45/tonne to keep gas competitive in power, whereas the actual carbon price averaged just €8/tonne last year, due to the build-up of a large surplus of allowances. To some extent this surplus reflects the impact of the recession in Europe (the ETS has no built-in adjustment to changes in economic fortune and hence energy demand). But it also reflects the unintended consequences of related but poorly integrated energy policy interventions, specifically the mandated renewable and energy efficiency targets that were not anticipated when the ETS was designed. The support of these targets by various subsidy mechanisms outside the EU ETS contributed directly to reducing the demand for and hence the price of carbon permits. In this way, it is fair to say that one part of climate policy (the carbon price) has fallen victim to the success of another (the renewable and efficiency targets).

Conclusion

There were many examples of adjustment in this year's *Statistical Review of World Energy*. Some of them reflect long established trends, such as demand patterns between OECD and non-OECD. Others reflect adaptation to disruptions for a variety of reasons, such as the Iranian sanctions or record low gas prices in the U.S. Correspondingly, some of these adjustments may turn out to be temporary while others should have a more lasting impact. Importantly, it matters for policy design to recognize the nature of these changes in a system so complex and internationally integrated as the global energy system, as the example of the European climate policy demonstrates. Markets are quick to adapt and may do so in unexpected ways.

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