

Executive summary

The year that has passed between the publication of the 2008 edition of the World Oil Outlook (WOO) and the finalization of this year's has been one of unprecedented turbulence. Oil prices have roller-coastered: starting 2008 at US\$92/b, the OPEC Reference Basket rose to a record \$141/b in early July before falling to \$33/b by the end of the year, the lowest level since summer 2004. The central element linked to this collapse in oil prices, of course, was the global financial crisis that originated in the US, and the ensuing deep recession in Organisation for Economic Co-operation and Development (OECD) countries and sharp slowdown of economic activity in developing countries. This, in turn, has choked demand for oil. Against this backdrop, a host of new challenges have arisen in preparing this outlook.

One of these challenges relates to assumptions for future price developments. For the Reference Case, the oil price assumption is the perception of the behaviour of upstream costs in general, and in particular, the cost of the marginal liquids barrel. Already in last year's reference case, the long-term real price assumption reflected the expectation that high costs would eventually peak and then decline as cyclical elements separate from structural ones. This has already started to occur. Over the projection period, nominal prices are assumed to stay in the range \$70–100/b. However, it is important to note that this is an assumption, and does not reflect or imply any projection of whether such a price path is likely or desirable.

The assumptions made for economic growth for the medium- and long-term consider the potential depth and length of the global economic contraction. This includes the lessons learned from past recessions in OECD countries, and the possible implications of the responses by governments and monetary institutions around the world, in particular in terms of expansionary policies and monetary easing. There is a growing perception that the economic slowdown will be 'U-shaped', that is the recovery will gather momentum only gradually. Although the timing and strength of the recovery remain uncertain, for the Reference Case, it is assumed that the end of 2009 represents the bottom of the cycle, with the global economy actually contracting. In 2010, recovery is underway, but far from complete, and gains momentum in 2011. By 2012, the Reference Case assumes that economic growth is back to trend values.

Long-term world economic growth assumptions in the Reference Case are based upon demographic trends and productivity growth assessments. The strongest growth is expected in developing countries and regions, in particular China and South Asia, which expand at an average rate of 6.3% per annum (p.a.) and 4.7% p.a. respectively over the period 2009–2030. The average rate for global growth is 3% p.a. over the same timeframe. This is lower than the figure appearing in the previous WOO. This is partly due to the considerable downward revisions to economic growth prospects as the global financial crisis has evolved. Another reason is that the average growth for

the world is calculated using updated purchasing power parity factors, which means that the weight is reduced for some of the fast growing developing countries, such as India and China.

Another major issue to address in developing the Reference Case is the extent to which energy policies are introduced into the outlook. In this year's Reference Case, two sets of policies have been incorporated: the United States (US) Energy Independence and Security Act (EISA), which has been passed into law, and the European Union's (EU) climate and energy legislative package, for which related directives have now been adopted by both the EU Council and the European Parliament.

Under all scenarios, energy use is set to rise. In the Reference Case, it increases by 42% from 2007–2030. Developing countries will account for most of these increases, by virtue of higher population and economic growth. However, energy use in developing countries will remain much lower on a per capita basis. Globally, renewable energy will continue to grow fast, but from a low base. Nuclear grows faster than in the previous outlook, while hydropower is also set to expand. Realistically, however, fossil fuels will continue to satisfy most of the world's energy needs, contributing more than 80% to the global energy mix over this period. And oil will continue to play the leading role to 2030.

The medium-term prospects for oil demand are adversely impacted by the lower economic growth assumptions. OECD oil demand falls from 47.5 mb/d in 2008 to 45.5 mb/d by 2010, and remains at that level to 2013. The main source of incremental oil demand will be developing countries. However, given the anticipated slow recovery, the annual increments in demand for 2010 and 2011 are below that of 2012, once economic growth is assumed to return to its trend potential. This, in total, represents a major reassessment from the previous reference case. By 2013, oil demand is 5.7 mb/d lower than in last year's outlook, with a difference of more than 4 mb/d already witnessed in 2009.

As we look further into the future, oil demand patterns become increasingly influenced by the implementation of policies. Efficiency improvements are stronger than previously assumed, and this, compounded with the downward revision to medium-term expectations due to the global recession, has led to a significant downward adjustment to oil demand in the longer term. Oil demand in the Reference Case is less than 106 mb/d in 2030, down from 113 mb/d last year.

Developing countries are set to account for most of the long-term demand increase, with consumption rising 23 mb/d over the period 2008–2030 to reach

56 mb/d. Almost 80% of the net growth in oil demand from 2008–2030 is in developing Asia. Nevertheless, per capita oil use in developing countries will remain far below that of the developed world. For example, oil use per person in North America will still be more than ten times that of South Asia. OECD oil demand falls over the entire projection period, having ‘peaked’ in 2005.

The transportation sector is the main source of future oil demand growth, accounting for over 60% of the total increase to 2030, although it is also lower than the previous year’s assessment, due again to the current global economic slowdown, as well as the assumed greater efficiency improvements. The total stock of cars rises from just over 800 million in 2007 to well over 1.3 billion by 2030, with three quarters of this increase coming from developing countries. Car ownership per capita in developing countries rises rapidly from a low base of just 31 cars per 1,000 people in 2007 to 87 per 1,000 by 2030. This remains well below OECD levels, however, which average 530 per 1,000 by 2030. The expansion in commercial vehicles in developing countries is also stronger than elsewhere, accounting for over 80% of the increase.

Oil use is at the heart of much industrial activity. In addition to the petrochemicals industry, diesel and heavy fuel oil, in particular, are needed in construction and other major industries such as energy, iron and steel, machinery and paper. The strongest increase in the industry sector comes from developing Asia and OPEC Member Countries, particularly due to the fast growing oil demand for petrochemicals.

On the products side, the continuing shift to middle distillates over the entire period remains a dominant feature of the future demand slate. This is clearly reflected in the fact that out of 20 mb/d of additional demand by 2030, compared to 2008, almost 60% is for middle distillates.

Turning to supply, total non-OPEC oil supply is expected to continue to rise slightly over the medium-term, increasing by just over 1 mb/d for the years 2008–2013. This increase comes mainly from non-conventional oil. Non-OPEC crude oil plus natural gas liquids (NGLs) are expected to stay flat over this period, reaching a level in 2013 that is more than 3 mb/d below last year’s reference case. This downward revision is largely the result of lower oil prices leading to cancellations and delays, debt financing becoming more difficult and lower earnings limiting equity finance. Non-conventional oil, mainly Canadian oil sands, continues to grow in the medium-term, but again the low oil price environment has dampened growth prospects compared to the previous outlook.

The Reference Case thereby points to demand for OPEC crude oil, having fallen in 2009 in the face of the global economic contraction, thereafter

rising slowly over the medium-term, returning back to 2008 levels by around 2013. Large investments are currently underway in OPEC Member Countries to expand upstream capacity. Although a low price environment may lead to the delaying or even postponing of some projects beyond 2013, spare OPEC crude oil capacity is nevertheless set to remain at comfortable levels. In the Reference Case, OPEC upstream development investment requirements to 2013 amount to around \$110–120 billion.

In the long-term, total non-OPEC oil supply continues to rise as the increase in non-crude sources is stronger than the slight decline in total non-OPEC crude supply. Up to 2020, crude production increases in Russia, the Caspian and Brazil largely compensate for declines in the OECD. Non-conventional oil supply (excluding biofuels), mainly from Canadian oil sands, rises in the Reference Case by 4 mb/d from 2008–2030. The Reference Case also sees strong biofuels growth. On top of this, OPEC and non-OPEC NGLs are expected to grow. As a result of these developments, the amount of OPEC crude that will be needed continues to rise, reaching just over 41 mb/d by 2030, albeit some 2.5 mb/d lower than last year's reference case.

The expansion in Reference Case demand is largely met with non-crude supply from both OPEC and non-OPEC sources, leaving the contribution of crude only modest. Indeed, while global crude oil supply in 2015 is 71 mb/d, the same as 2008, by 2030 there is only a need for 77 mb/d. The resource base of conventional crude, together with non-conventional oil, is more than sufficient to meet future demand. Therefore, the key issue is not related to availability, but to deliverability and sustainability, as well as the uncertainties surrounding the extent to which increases in the demand for crude will actually materialize.

This points to the issue of investments along the entire supply chain, something that is crucial to both producers and consumers. Up to 2030, cumulative upstream investment requirements are estimated to amount to \$2.3 trillion (2008 dollars) in the Reference Case. Costs have been sharply inflated since 2003, but a reversal, albeit still slow, has recently been observed, which might indicate a shift towards a new cost cycle. This has been factored into estimates for upstream investment requirements.

The possible implications of a recession that is deeper and longer than assumed in the Reference Case are explored in the Protracted Recession scenario. Risks for the global economy remain skewed toward the downside, despite recent economic data indicating a slowdown in the rate of contraction, and an improvement in business and consumer confidence. Interest spreads in the inter-bank lending markets have come down, but are still much higher than in 'normal' times. Risks stem in particular from possible delays in implementing policies to stabilize financial markets, the

further deterioration of the health of banks that could lead to more tightness in credit availability, country rating downgrades, deflation dangers, and the insufficient access of emerging economies to foreign financing. In addition to the more pessimistic view of the rate of the global economic recovery, the Protracted Recession scenario also assumes that crude oil prices are significantly softer than in the Reference Case. In this scenario, world demand in 2013 is 2.4 mb/d lower than the Reference Case, with demand at 85.5 mb/d.

Low prices have significant impacts upon oil supply prospects, reducing both profitability and cash flows. Indeed, the first signs of a reaction to the recent oil price fall are appearing: the rig count has already fallen swiftly in the US, and a similar picture is emerging elsewhere. The link between price movements and upstream activity is nothing new. This has also been observed in the past. The economics of non-conventional oil supply would also be adversely affected by a prolonged soft price environment.

This scenario also has important implications on OPEC Member Country investment activity. Indeed, history has clearly shown the dilemma of having to make investment decisions in a climate of demand pessimism and low oil prices. OPEC Member Countries have concerns over the problem of security of demand, and the risk that large investments will be made in capacity that is not needed. The Protracted Recession scenario combines the mix of low oil prices, demand uncertainty, and significant initial levels of spare capacity, as a result of a tide of investments undertaken in the face of high oil prices. In this scenario, the additional element of the increased difficulty in securing credit compounds the investment hindrances.

In the Protracted Recession scenario, OPEC is assumed to respond to the increased demand for its oil as non-OPEC supply is reduced due to the low oil price, while upstream capacity investment is primarily focused on compensating for natural declines. Nevertheless, if non-OPEC supply continues to be affected through a lack of investment, then spare capacity in OPEC Member Countries would dwindle. The scenario suggests that spare capacity could be reduced to less than 3 mb/d by 2012 and below 2 mb/d by 2013. Should this tightness occur, prices must react. The lack of capacity that emerges is a result of the low prices that are assumed over the medium-term. This is similar to the period of low prices in 1998/1999 which was a driver for the capacity shortages that presaged the 2004–2008 price rise. In this scenario, history, to an extent, repeats itself, as low prices sow the seeds of unstable markets and price spikes.

The recent price turbulence, the ongoing global financial crisis, and many of the uncertainties that complicate upstream investment decisions are also relevant to the

downstream. Rising oil prices from 2003–2008, together with refining tightness and high margins, have in recent years brought forward an increasing number of projects. However, several factors are now acting to delay, postpone or even cancel some projects. These include, among other things, the prospect of sharply reduced oil demand across almost all world regions, difficulties in arranging debt and equity financing and expectations of further falls in construction costs.

It is estimated that around 6 mb/d of new crude distillation capacity will be added to the global refining system from existing projects by 2015. Almost 50% of this new capacity is located in Asia, mainly China and India. In addition to distillation capacity, 5 mb/d of associated new conversion capacity and over 6 mb/d of desulphurization capacity is expected to be constructed worldwide from 2009–2015.

The implication of these capacity additions, in combination with demand projections and increases in non-crude supply, is for a sustained period of low refinery utilizations and hence, poor refining economics. In the Reference Case, the continuing increases in refineries' potential to run crude, and the slow return to positive additional required crude runs, result in the distillation capacity surplus widening to over 4 mb/d by 2010, and around 5 mb/d by 2012, where it remains for some years. If the current recession extends further than the Reference Case assumes, this surplus will evidently be even greater.

Indeed, in the Protracted Recession scenario the surplus crude run capability expands to well over 7 mb/d by 2014. The clear result is stronger downward pressures on refining margins. While last year's WOO foresaw that "an easing in the refining sector could begin as early as 2009 and intensify through 2010–2013", the results of this year's outlook go far beyond the effects previously envisaged, mainly due to the deep recession and the inclusion of policy impacts.

In the Reference Case, global crude runs will not have recovered to 2007 levels until sometime around 2015. And even when they do, it is expected that they will continue to rise slowly, so that by 2030 crude runs are only 9 mb/d above 2007 levels. On the basis that the Reference Case reflects the future, it is clear that the refining industry will face some major challenges and restructuring in order to maintain its viability.

The impacts are not, however, regionally uniform. As already identified in last year's WOO, the refining sector in the US & Canada is projected to be most impacted, by a combination of an ethanol supply surge, a decline in gasoline demand, as well as the continuing effects of dieselization in Europe that generates low-cost

gasoline for US export. Based on the outlook, not only do crude throughputs in the US & Canada never recover to 2007 levels, they also steadily decline throughout the period to 2030.

Thus, it is expected that the OECD regions will suffer a seriously depressed period for refineries, especially those focused on gasoline rather than distillates. This indicates a need for widespread consolidation and closure to bring back operating rates and refinery viability. To examine this in more detail, a series of model cases to indicate the possible scale of the restructuring and consolidation needed were run as variants of the 2015 Reference Case. The results suggest that no less than 10 mb/d of closures, predominantly in the US & Canada, Europe and the OECD Pacific, are needed to restore utilization rates and refining margins to profitable levels.

The outlook in these three regions stands in stark contrast to that for developing regions, especially the Asia-Pacific. The vast majority of the refining capacity expansions to 2030 are projected to be in the Asia-Pacific and the Middle East, at around 10 mb/d and 3 mb/d respectively, out of a global total of 18 mb/d. Expansions in the Asia-Pacific are dominated by China with more than 5 mb/d.

In respect to conversion capacity, projections highlight a sustained need for incremental hydro-cracking as some 4.3 mb/d of the 5.4 mb/d of global conversion capacity requirements to 2030 — above existing projects — are for this process type. Conversely, recent substantial coking capacity additions together with expected declines in the supply of heavy sour crudes in the medium-term, is leading to a coking surplus. It means that coking additions only appear to be required after 2020. The requirements for catalytic cracking units are adversely impacted by declining gasoline demand growth and rising ethanol supply, especially in the Atlantic basin.

Substantial desulphurization capacity additions will be necessary to meet sulphur content specifications, with some 14.5 mb/d required to 2030, which is over and above existing projects of 6.4 mb/d. Taking these figures together, of the 21 mb/d of global desulphurization capacity additions from 2008–2030, more than 70%, or 15 mb/d, are for distillate desulphurization. The bulk of the remainder, 5 mb/d, is for gasoline sulphur reduction.

To have this capacity in place, the global refining system will require around \$780 billion (2008 dollars) of investment to 2030. The Asia-Pacific region should attract the highest portion of these investments.

Global oil trade, including crude oil, refined products, intermediates and non-crude based products, will see a moderate change in the period to 2015, recording less

than a 2 mb/d increase from 2007–2015, rising from 52.5 mb/d to 54.6 mb/d. The same period, however, will experience a shift in the structure of this trade as crude oil exports are anticipated to decline by almost 1 mb/d, with the trade in oil products increasing by 3 mb/d. In the period beyond 2015, oil trade will resume its growth. By 2030, inter-regional trade increases by almost 12 mb/d, from 54.6 mb/d in 2015 to more than 66 mb/d by 2030. Both crude and products exports will increase from 2015–2030, but crude exports will gain bigger volumes than products. By the end of the forecast period, both crude and products exports will be approximately 7 mb/d higher than in 2007.

The tanker market is also exposed to a combination of the fallout from the current economic turmoil, stagnant medium-term demand for oil movements, even declining in the short-term, and a relatively large increase in tanker capacity over the next few years as a result of record order books. Longer term, growth in the inter-regional crude oil trade and refined products will necessitate increases in global tanker capacity. However, this is limited, with the global tanker fleet expected to expand by around 100 million deadweight tonnes, or 25%, by 2030, compared to its capacity at the end of 2008.

The estimations of price differentials points to a number of implications. A first and obvious consequence is that the excess refining capacity and excess gasoline output capability will lead to closures, especially of those refineries that are gasoline-oriented. Secondly, the projected differentials raise the question of how product demand will react. In this regard, several options exist that could alter the future demand pattern, such as higher naphtha demand in the petrochemical sector, increased demand for naphtha as a fuel, and shifting diesel demand back to gasoline, although the effects would likely be limited. A third and central question relates to refinery process technology as sustained wide differentials between naphtha/gasoline and diesel present incentives for adaptations and new developments in refinery processes and catalysts. These are aimed at converting surplus naphtha/gasoline to diesel either through the revision of fluid catalytic cracker operations or by converting naphtha more directly to diesel.

A principal theme that emerges from the outlook, in both upstream and downstream assessments, is cyclical, with its ensuing challenges of making the appropriate investments in an environment of uncertainty and in an industry characterized by massive upfront capital requirements and long-lead times. This has been underscored as the current global financial and economic crisis has unfolded. The need for counter-cyclical measures to support stability in markets is now recognized more than ever.

It is evident from both the Reference Case and the Protracted Recession scenario that the overarching challenge facing the energy industry in general, and

OPEC in particular, stems from the large uncertainties about future demand levels for energy and oil. The uncertainties that lie ahead, and the corresponding difficulties associated with making appropriate and timely investment decisions, underline the importance of exploring other oil supply and demand paths outside of those depicted in the Reference Case. With this in mind, lower growth and higher growth scenarios have been developed.

In the *lower growth* scenario, downside demand risks from lower economic growth than in the Reference Case are coupled with a strong policy drive, over-and-above Reference Case assumptions, to further increase oil use efficiency in the longer term. In a *higher growth* scenario, the possibility of a swifter recovery from the global recession than assumed in the Reference Case is considered, combined with a more positive outlook for longer term growth prospects. The results show a wide range in OPEC upstream investment requirements. By 2020, investments under the *higher growth* scenario are \$430 billion in real terms, whereas under the *lower growth* scenario they are just \$180 billion. Even to 2013, which represents a timeframe over which investments are effectively locked in, requirements could be as low as \$70 billion or as high as \$170 billion.

In addition, there are various other challenges facing the oil industry. Clearly, for most individuals, businesses and governments, the dramatic changes to the economic landscape over the past year as the global financial crisis has unfolded are the current overriding concern. While the recession-driven demand destruction has demonstrated worries over security of demand, the current environment also clearly reveals the benefit of OPEC's counter-cyclical measures. For example, OPEC's substantial supply increase between 2002 and 2006 had a strong mitigating effect on pro-cyclical movements, when world demand sharply increased and non-OPEC supply declined. Reciprocally, OPEC's recent supply adjustment has had a similar effect in the face of the current deep global economic crisis and the ensuing steep oil demand decline.

The economic stimulus packages put in place are another example of the necessity of counter-cyclical policy measures. They demonstrate broad agreement on the requirement for sound regulation in financial markets. For oil, there is a need to improve the functioning of futures and over-the-counter (OTC) markets, by *inter alia*, upgrading the availability of, and access to information on paper oil market participants and transactions, better monitoring, imposing a cap on speculative activity, and strengthening regulations to close various loop-holes.

Further uncertainties and challenges include those related to upstream and downstream costs and the future availability of skilled human resources. On the cost issue, for the past few years, the oil industry has seen costs that have been significantly

inflated, in part as a result of the low oil price environment and low margins ten years or so ago that led to the implementation of downsizing and cost-cutting strategies. While costs have fallen a little, the question is whether this cost behaviour is structural or cyclical. Regarding human resources, the past has shown that it is critical to maintain and enhance the adequacy of the industry's skills base, even during an economic downturn. There is a need to advance the numbers of students taking energy-related courses, and to make sure these are open to all students from across the world. More work needs to be done to help make the industry more attractive to employees, as well as to future graduates, including easing university enrolment across national borders. To this end, further coordinated efforts should be undertaken by international oil companies, national oil companies, service companies, governments, regulators and academia.

The outlook points to rising environmental challenges. The oil industry has a good track record in reducing its environmental footprint. And with the world expected to rely essentially on fossil fuels for many decades to come, it is vital to ensure the early and swift development, deployment, diffusion and transfer of cleaner fossil-fuels technologies. This is true for both local and global environmental protection. The need to adapt to a carbon-constrained environment will make the use of these cleaner technologies all the more pressing. Of particular note is carbon capture and storage, a proven technology that has a high economic potential for mitigation. Developed countries, having the financial and technological capabilities, and bearing the historical responsibility for the state of the Earth's atmosphere, should take the lead in mitigation and adaptation efforts, as well as in providing technology and financial resources, as enshrined in the United Nations Framework Convention on Climate Change, its Kyoto Protocol and the Bali Action Plan.

Moreover, the outlook points to a broader set of challenges, such as the issue of sustainable development and its corollary, fighting energy poverty. It is important to remember that poverty eradication is the very first UN Millennium Goal. And a major part, as well as a catalyst in helping alleviate poverty, is making sure that every person has access to modern energy services. It is critical that the world community makes sure access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services is available to all.

Addressing all of these challenges should involve the strengthening and broadening of the dialogue between energy producers and consumers, in particular through the International Energy Forum. Cooperation among national, international and service companies should be enhanced, and should encompass, *inter alia*, the development, deployment and transfer of more advanced upstream and downstream technologies.