

# **Oil outlook to 2030**

OPEC Secretariat background paper

**Energy Dialogue to Respond to Global Challenges**  
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## Executive summary

This background paper offers insights into challenges facing the oil industry, focusing on the next two decades. These challenges are numerous, varied in nature, extend along the supply chain and include the short, medium and long terms. The ultimate objective is the continuing need for sustained market order and stability, with secure supply and demand, reasonable prices and fair returns to investors. Interdependence is essential in today's energy world, for parties to remain competitive internationally, handle continuously rising demand from an expanding global population and address broader energy-related issues, such as environmental protection, sustainable development and poverty eradication. The paper stresses that genuine, multilateral, well-targeted and constructive dialogue is essential in meeting these challenges, and notes the important role the International Energy Forum has played in expanding producer/consumer dialogue at the highest level over the past 15 years.

Looking at the near term, the continued volatility in the oil market is unsettling for normal day-to-day activities, as well as hampering sound investment planning for the future. The heightened levels of speculation have been a principal driving force behind the volatility, with oil becoming a financial asset. The falling value of the US dollar has encouraged inflows of new money into the crude oil futures market. Other contributors to the volatility include ongoing geopolitical developments and perceived market tightness and bottlenecks in the refinery sector. Crude oil prices have become detached from the dynamics of supply and demand fundamentals, since, in spite of the persistent price rises, the market remains well-supplied with crude. With the world now entering a cycle of economic slowdown, particularly in most OECD regions, the bleak global outlook is generating much uncertainty in energy circles, and many institutions have begun to revise down growth forecasts for oil demand.

On the oil outlook for the period up to 2030, OPEC's reference case reflects the widely held view that energy demand will continue growing for the foreseeable future and that oil will maintain its leading position in the world energy mix. Average annual growth of 1.4 per cent will see world oil demand reach 118 million barrels a day by 2030. Developing countries will account for most of the rise, with consumption doubling, and Asian DCs, in particular China, will be the focus of this. The transportation sector will be the main source of future oil demand increases, with the potential for growth far greater in the DCs. Downstream, virtually all the additional oil demand will be for light and medium products, with most of the increase being for transportation fuels. The change in the product mix, along with overall product demand growth, will necessitate an expansion of refinery downstream distillation, as well as conversion capacity to increase desired product yields.

The world's resources of crude oil and natural gas liquids are sufficient to meet the projected demand. Estimates of ultimately recoverable reserves have practically doubled since the early 1980s, while cumulative production has been less than a third of this increase. Improved technology, successful exploration and enhanced recovery from existing fields have been responsible for this reserve increase, and this remains an ongoing process. There is also a vast resource base of non-conventional oil to explore and develop, and the importance of this will grow with time. However, the potential growth for world biofuels must be balanced against the global impact of large-scale biomass use and trade for energy purposes. All in all, however, the issue of oil supply is one of deliverability, rather than availability.

The reference case shows non-OPEC oil and NGL supply rising by around 10 mb/d to reach nearly 59 mb/d by 2030. However, non-conventional oil supply from non-OPEC increases at strong rates over the entire projection period. Global biofuel production expands by 2.2 mb/d to 2.8 mb/d. Hence, the amount of crude oil, which OPEC would be relied upon to supply, increases after 2010, climbing to 38 mb/d by 2020 and 49 mb/d by 2030; this means that the share of OPEC crude in total world oil supply will not change very much in

the future. The global downstream sector will require more than 7.5 mb/d of combined upgrading capacity, more than 18 mb/d of desulphurisation capacity and around 2 mb/d of capacity for other supporting processes, in 2006–20, in addition to 13 mb/d of distillation capacity.

The global scale of upstream investment implied by the reference case outlook is not expected to be significantly greater than before; this is the result of the gradual shift from higher-cost non-OPEC to lower-cost OPEC supply. From 2006, total oil upstream investment requirements to 2030 amount to \$2.4 trillion (2006 US dollars). However, these estimates do not include investment in the necessary mid-stream infrastructure, such as pipelines, storage farms and ports. Downstream, the total required investment in refinery processing to 2020 is projected to be \$455 billion. Investment in replacement is highest in regions, such as the USA and Europe, with the largest installed base of primary and secondary processing units. The Asia-Pacific, particularly China, is projected to require the highest level of investment in new units. OPEC's Member Countries are investing heavily in expanding their production and refining capacity and delivery infrastructure.

There is much uncertainty, upstream and downstream, over future investment requirements. Important drivers of this uncertainty include future world economic growth, consuming countries' policies and technological developments, as well as future non-OPEC production levels. To avoid over- or under-investing, a key challenge is to anticipate the appropriate levels of demand. According to realistic lower-growth and higher-growth scenarios, such demand uncertainties result in a wide range of OPEC upstream investment requirements. For example, by 2020, an estimated uncertainty range of \$270 bn for required OPEC investment can be envisaged. For oil-producing developing countries, which are heavily dependant upon oil revenue for their economic and social advancement, there is the understandable desire to ensure that such revenue is put to good use and is not diverted to investing in unused oil production capacity. For both the upstream and the downstream, the importance of security of demand to sound investment strategies is thus emphatic. One major source of uncertainty concerns the fact that policy initiatives to support the development of biofuels may discourage refiners, as well as possibly crude oil producers, from investing in required capacity expansion; if biofuels fail to meet stated targets, the result could then be greater tightness and volatility in the oil market.

Another aspect of investment is the cost of infrastructure, with one research institute noting that upstream costs have nearly doubled since 2000. On top of this, the industry is experiencing a shortage of skilled labour for both construction and operations. Furthermore, with growing concern about local pollution and potential anthropogenic interferences with the climate system, the industry should adapt to the evolution towards a carbon-constrained world and play a more active role in research and development. Indeed, it can turn this challenge into an opportunity, by promoting cleaner fossil fuel technologies, and, in particular, the technology of carbon dioxide capture and storage. Developed countries, with the historical responsibility and the technological and financial capabilities, should take the lead in the development and deployment of this technology. And all of this must be undertaken in a manner consistent with the requirements of sustainable development, the Millennium Development Goals and the eradication of poverty.

OPEC welcomes any measures that enhance the global energy mix, and this includes developing renewables in an economic, socially and environmentally sound manner. But a sense of reality should be applied here, with regard to the extent to which capital resources are switched to developing renewables, since such resources could well get better returns by being focused on developing cleaner technologies for fossil fuels, which have the clear economic benefits of vast, accessible reserves and long-established markets and supporting infrastructure. Also, it cannot be stressed too much that, in an increasingly interdependent and integrated energy world, oil producers require access to the very latest technology at all times

to support their capacity-expansion programmes, their drive towards cleaner and more efficient fuels and their efforts to adopt other environment-enhancement measures.

Finally, the challenges outlined in the background paper require the full support of the international community, if the global energy sector is to meet all its goals successfully in the future. There is huge potential for strengthening cooperation among producers and consumers, involving both national and international oil companies, right along the supply chain. This highlights the importance of dialogue at the highest levels of government and industry, and the IEF provides a proven policy platform for this.

## **1. INTRODUCTION**

This background paper offers insights into future challenges facing the oil industry. The many diverse elements include the global economy, policy developments, resources, technology, efficiency, inter-fuel competition and investment.

Following these introductory comments, Section Two of this background paper will provide scenario-based perspectives on oil perspectives for the period 2005–30, focusing first on demand and then on supply, upstream and downstream. It will address the issue of the world's oil resources — conventional and non-conventional — and their ability to meet the expected rise in demand during this period and beyond.

Section Three will cover investment, highlighting the nature and extent of this along the supply chain, including the development and deployment of cleaner fuel technologies. It will focus, in particular, on uncertainties facing the oil market, and the impact these have on the drawing-up and implementation of effective plans and strategies for its healthy development in the future.

And the concluding section will bring all these elements together and outline some fundamental issues and challenges that will benefit from discussions at the 11th IEF.

### **1.1 Dialogue and challenges**

There have been major advances in energy dialogue over the past 15 years, and the International Energy Forum (IEF) has played a big part in this. It has demonstrated the value of a coordinated approach to handling key topical issues, among parties that otherwise might not have had the opportunity to gather together for joint deliberations on such a large scale and at such a high Government level. The biennial Ministerial-level meetings are representative of all sides and cover issues of growing depth and complexity, reinforcing interlinkages in an increasingly interdependent energy world. Their interaction with the biennial International Energy Business Forums gives an added dimension to their effectiveness. Furthermore, the Joint Oil Data Initiative (JODI) has already led to significant gains in transparency in the industry.

OPEC has been heavily involved in the establishment and development of the IEF, as well as JODI, because the Organization and its Member Countries recognise that genuine, multilateral, well-targeted and constructive dialogue is essential, if the many, diverse challenges facing energy are to be met efficiently and effectively in the future.

Interdependence is essential in today's energy world, for parties to remain competitive internationally, handle continuously rising demand from an expanding global population and, at the same time, address broader energy-related issues, such as environmental protection and sustainable development. Energy is central to poverty eradication, sustainable development and the achievement of the Millennium Development Goals.

The challenges facing the oil industry today are numerous, varied in nature, extend along the supply chain and include the short, medium and long terms. They are all linked, and shorter-term actions in the market must fit in with longer-term strategies. The ultimate link is the constant need for sustained market order and stability, with secure supply and demand, reasonable prices and fair returns to investors.

The challenges are summed up succinctly in the 'Riyadh Declaration', which concluded the Third OPEC Summit in November 2007. This states that the Organization's Heads of State and Government "have agreed on the ... principles to guide our Organization and Member Countries' economic, energy and environmental endeavours, within the following three themes: stability for global energy markets; energy for sustainable development; (and) energy and environment."

The issues that came to the fore at the 10th IEF in Doha in April 2006 — including uncertainties, data transparency, investment, energy security and human resources — remain

today; but the emphases and priorities may have shifted with the changing circumstances of the past two years. Indeed, the 10th Forum played a significant part in the broader understanding of the concept of energy security that emerged in the world at large in 2006.

OPEC maintains that energy security should be treated as a shared responsibility by all parties in an interdependent world, where security of demand goes hand-on-hand with security of supply. Such a broadbased approach is an essential prerequisite of a successful, flourishing oil market and contributes to its stability and sustainability. Hence OPEC awaits further constructive exchanges on this topic at the 11th Forum, where it is again a principal theme.

The Organization's commitment to an orderly, efficient and effective international oil market dates from its establishment in 1960 and has been reaffirmed repeatedly in its declarations, statements, decisions and actions. This makes sound commercial sense for its Member Countries. They rely heavily upon oil revenue for their economic and social development — in 2006, for example, an average of 75 per cent of Members' total export revenue came from oil sales; for many countries, the figure was higher than 90 per cent.

## **1.2 Market developments**

The continued volatility in the oil market is a matter of much concern. This has witnessed large fluctuations in prices and a general underlying sense of uncertainty, which is unsettling for normal day-to-day activities, as well as hampering sound investment planning for the future. However, the recent high oil prices do not appear to have harmed world economic growth, which has averaged a robust 4.9 per cent over the past five years.

A combination of factors has contributed to the present market situation. Most recently, these include the weakness of the US dollar, increased financial market speculation, ongoing geopolitical developments and perceived market tightness and bottlenecks in the refinery sector. A key concern is that crude oil prices have become detached from the dynamics of supply and demand fundamentals.

The heightened levels of speculation have been a principal driving force behind the volatility. Oil has become a financial asset, as other commodities. Large amounts of money have been flowing into the commodities markets from other asset classes to balance portfolio risks and seek higher returns. Notably, increased concern about the falling value of the US dollar has encouraged inflows of new money into the crude oil futures market.

While OPEC itself has no influence over speculation, it has taken action in other important areas where it can make a solid, meaningful contribution, in the interests of market order and stability. Its Member Countries have increased output substantially, when needed, to ensure that the market is well supplied and stocks at comfortable levels. They have accelerated plans to bring on-stream new production capacity, so as to establish a comfortable cushion of spare capacity in the market; this has seen them commit more than \$150 billion towards a crude oil capacity expansion of up to 5 mb/d by the end of 2012. And, where possible, they have increased their presence downstream, at home and abroad, to ease the severe bottlenecks that have emerged in the refining sectors of consumer countries in recent years. For example, major crude distillation refinery projects in OPEC Member Countries are expected to add over 3 mb/d of additional capacity by 2012, representing an investment of close to \$50 billion. These points will be elaborated upon in the paper.

At the present time, the oil market remains well-supplied with crude oil. Commercial oil stocks — crude and products — are in line with the seasonal trend and are expected to stay around their five-year average during the traditionally lower-demand season.

However, after an unprecedented six years of strong economic growth, accompanied by a surge in energy demand, the world now appears to be entering a cycle of economic slowdown. Turbulence in financial markets, the deepening sub-prime mortgage crisis in the United States of America (USA) and weakening economic data in the European Union (EU)

and Japan support expectations of a general economic slowdown in most OECD regions. However, initial estimates indicate that developing countries, including China and India, will continue to grow at healthy pace, albeit slower than in 2007. Nevertheless, overall, the bleak future global economic outlook is generating much uncertainty in energy circles, and many institutions have begun to revise down oil demand growth forecasts.

## **2. OIL PERSPECTIVES TO 2030<sup>1</sup>**

The reference case assumes an average global long-run economic growth rate of 3.5 per cent per annum (on a purchasing power parity basis) for the period up to 2030. There is an emerging perception that long-run oil prices will need to be higher than previously thought necessary, in order to finance the necessary investment, particularly given the growing awareness of the importance of rising costs, including the cost of the marginal supply of alternative fuels. Although the reference case assumes a long-term price path consistent with this perception, it is also assumed that the price has no significant impact on oil demand. The reference case also assumes no particular departure in trends for energy policies and technologies. It covers 12 OPEC Member Countries, and excludes Ecuador, which rejoined OPEC in the final quarter of 2007.

### **2.1 Oil demand**

The results of OPEC's outlook reflect the widely held view among analysts that energy demand is set to continue growing for the foreseeable future and that oil will maintain its leading position in meeting these expanding energy needs.

In the reference case, world energy demand grows at an average annual rate of 1.7 per cent (**table 1**). Fossil fuels will continue to provide more than 85 per cent of the world's total commercial energy needs. Gas is expected to grow at fast rates, and coal will retain its importance in the energy mix. Indeed, coal has recently seen robust growth, particularly in China. The total contribution of hydropower, nuclear and new renewables is set to remain modest, despite the extremely high growth rates for some renewables.

**Table 1**  
**World energy demand in the reference case**

	levels <i>mtoe</i>				growth % <i>p.a.</i> 2005-30	fuel shares %			
	2005	2010	2020	2030		2005	2010	2020	2030
Oil	4,002	4,319	4,996	5,689	1.4	39.2	38.4	37.5	36.5
Solids	2,822	3,144	3,703	4,181	1.6	27.6	28.0	27.8	26.8
Gas	2,346	2,655	3,352	4,276	2.4	23.0	23.6	25.1	27.4
Hydro/nuclear/ renewables	1,041	1,117	1,283	1,434	1.3	10.2	9.9	9.6	9.2
<b>Total</b>	<b>10,212</b>	<b>11,236</b>	<b>13,335</b>	<b>15,580</b>	<b>1.7</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

World oil demand is set to rise by 34 mb/d between 2005 and 2030, when it will reach 118 mb/d (**table 2**). This constitutes an average annual growth rate of 1.4 per cent.

OECD countries, currently accounting for close to 60 per cent of world oil demand, see further growth of 4 mb/d by 2030, reaching 53 mb/d. Developing countries account for most of the rise in the reference case, with consumption doubling to 58 mb/d. Asian developing countries will experience an increase of 20 mb/d, which represents more than

<sup>1</sup> World Oil Outlook 2007 is available in <http://www.opec.org>

**Table 2**  
**World oil demand outlook in the reference case**  
*m b/d*

	2005	2010	2015	2020	2025	2030
North America	25.5	26.1	26.9	27.7	28.4	29.0
Western Europe	15.5	15.6	15.8	15.9	15.9	15.8
OECD Pacific	8.6	8.6	8.6	8.6	8.6	8.5
<b>OECD</b>	<b>49.6</b>	<b>50.3</b>	<b>51.3</b>	<b>52.2</b>	<b>52.9</b>	<b>53.4</b>
Latin America	4.6	5.0	5.5	5.9	6.4	6.8
Middle East & Africa	3.0	3.4	4.0	4.6	5.2	5.9
South Asia	3.1	3.9	5.0	6.1	7.3	8.6
Southeast Asia	4.4	5.2	6.1	7.1	8.0	9.0
China	6.5	8.7	10.4	12.3	14.3	16.4
OPEC	7.4	8.2	9.1	9.9	10.8	11.7
<b>DCs</b>	<b>29.0</b>	<b>34.5</b>	<b>40.0</b>	<b>45.9</b>	<b>52.0</b>	<b>58.5</b>
FSU	3.8	4.0	4.2	4.3	4.5	4.6
Other Europe	0.9	0.9	1.0	1.0	1.0	1.1
<b>Transition economies</b>	<b>4.7</b>	<b>4.9</b>	<b>5.2</b>	<b>5.4</b>	<b>5.5</b>	<b>5.7</b>
<b>World</b>	<b>83.3</b>	<b>89.7</b>	<b>96.5</b>	<b>103.5</b>	<b>110.4</b>	<b>117.6</b>

two-thirds of the growth in all the developing world. China alone will see demand growth of just over 8 mb/d during this period.

Nevertheless, energy poverty will remain an important issue over this transitional period. By 2030, developing countries will consume, on average, approximately five times less oil per person, compared with OECD countries. While North America will consume close to 20 barrels per person annually and Western Europe more than ten barrels, the figure for China will be just four — in other words, one-fifth that of North America.

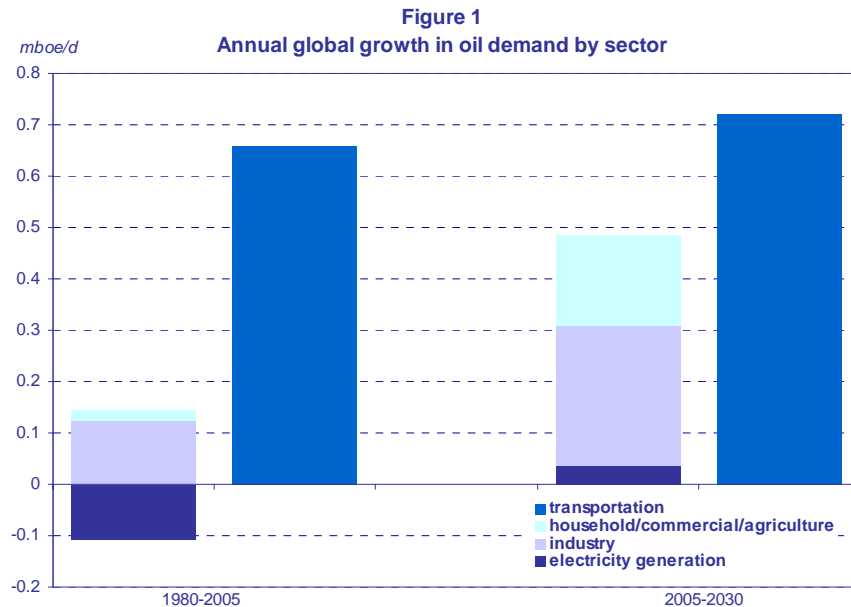
The transportation sector will be the main source of future oil demand increases, with oil remaining the fuel of choice in this sector (**figure 1**). Growth in the OECD is expected to continue rising, although saturation effects should, increasingly, have an impact upon the expansion of passenger car ownership. OECD countries will still account for more than half global transportation demand in 2030.

The potential for growth in the stock of cars, buses and lorries, however, is far greater in developing countries. For example, two-thirds of the world's population currently live in countries with less than one car per 20 people. The total stock of cars is expected to rise from 700 million in 2005 to 1.2 billion by 2030, and the global volume of commercial vehicles is anticipated to more than double.

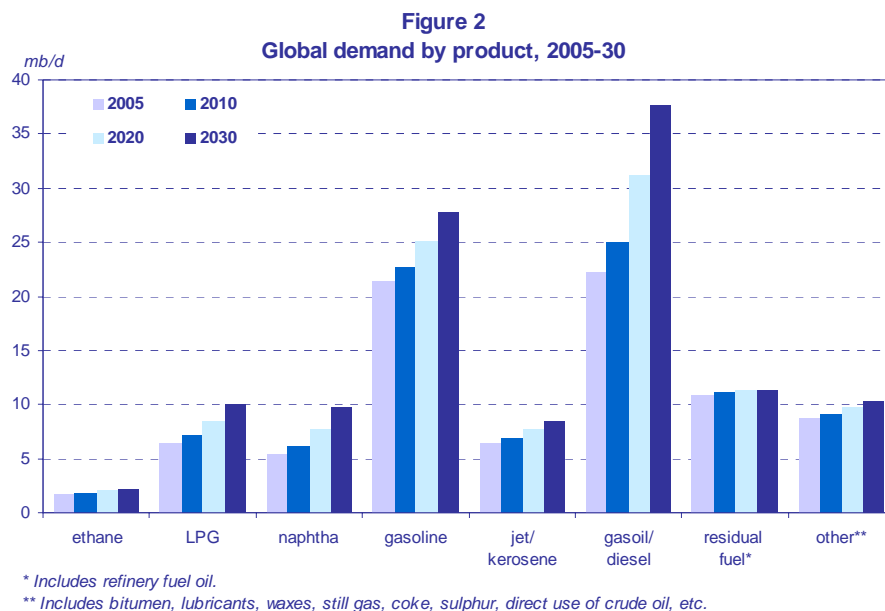
Technology will play a big part in determining future oil demand for the transportation sector. The average use of oil per vehicle is affected by conventional engine efficiencies, gasoline/diesel mixes, and the rate of development and diffusion of new technologies. The highest efficiency improvements are assumed to take place in China, South Asia and OPEC Member Countries, reflecting, in part, the scope for these changes.

Of the non-transportation oil use, the main expected source of increase will be in the industrial and residential sectors of developing countries, which see a combined growth to 2030 of over 11 mboe/d in the reference case. Oil use in households is closely associated with the gradual switch away from traditional fuels. This trend is expected to continue, especially in the poorer developing countries of Asia and Africa, with the urbanisation movement throughout the developing world central to the shift towards commercial energy. Despite the

expected continued growth in electricity production and consumption, oil demand in this sector will experience no significant growth.



With regard to the evolution of oil product demand, this has important implications for downstream investment needs (**figure 2**). Many of the recent trends in the refined product mix are expected to continue over the projection period. Of the 34 mb/d of additional oil demand by 2030, more than 32 mb/d will be for light and medium products, while only 2 mb/d is expected to be for the heavy end of the refined barrel. This will pose one of the biggest challenges for refiners in the coming years. Furthermore, as demonstrated earlier, the bulk of the increase is for transportation fuels, mainly diesel oil, gasoline and jet kerosene. It must also accommodate stringent new product specifications. The change in the product mix, along with overall product demand growth, will necessitate an expansion of refinery downstream distillation, as well as conversion capacity to increase desired product yields.

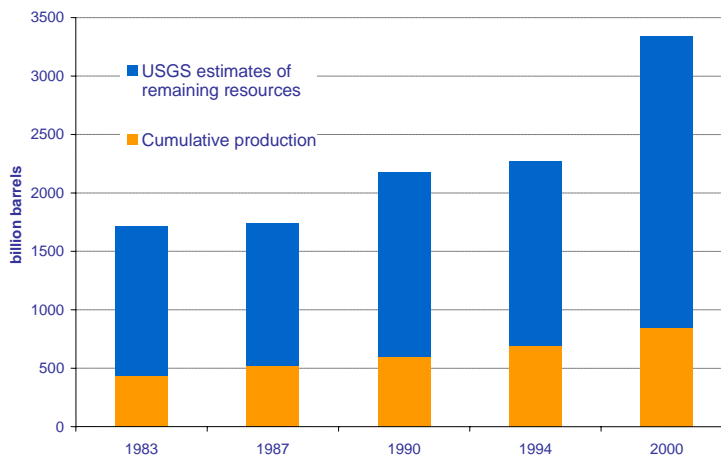


## 2.2 Oil resources

The world's resources of crude oil and natural gas liquids (NGLs) are sufficient to meet the projected demand. Estimates from the US Geological Survey of ultimately recoverable reserves have practically doubled since the early 1980s, from just under 1.7 trillion barrels (tr b) to over 3.3 tr b, while cumulative production during this period has been less than one-third of this increase (**figure 3**).

Improved technology, successful exploration and enhanced recovery from existing fields have enabled the world to increase its resource base to levels well above the expectations of the past, and this remains an ongoing process. New technologies, such as horizontal drilling, extended reach drilling, and 3-D and 4-D seismic, have helped identify new accumulations, increase recovery, extend the reach to frontier regions or resources and make development of sub-commercial resources commercially attractive. This has seen, for example, Saudi Aramco beginning to raise recovery rates in some fields to 70 per cent of the original oil-in-place,<sup>2</sup> and, half-way across the world, a more-than-tripling of the limit to development in the deep water of the Gulf of Mexico in just a decade, from 3,000 feet to around 10,000 ft.

**Figure 3**  
World's conventional oil resources



Source: US Geological Survey.

If we look at, specifically, the world's proven crude oil reserves, these rose every year between 1986 and 2006, climbing from 0.862 tr b to 1.195 tr b. OPEC's share of these reserves fluctuated within a range of 75–78 per cent, increasing — again, every year — from 0.644 tr b to 0.922 tr b during the same period.<sup>3</sup>

In addition to conventional oil, there is also a vast resource base of non-conventional oil to explore and develop. This includes heavy oil, tar sands, oil shale, gas-to-liquids (GTLs), coal-to-liquids (CTLs) and biofuels. Their importance will grow over time, and the challenges lie more on the technological, environmental and economic hurdles regarding their production and processing.

Turning to biofuels, many governments in the developed world have set ambitious target requirements. The potential growth for world biofuels must be balanced against the global impact of large-scale biomass use and trade for energy purposes, in terms of land-use changes, competition with food supply and other biomass uses, biodiversity and competition

<sup>2</sup> Abd Allah Al-Jumah, *The Future of Global Energy*, Ceraweek 2008,

<sup>3</sup> OPEC Statistical Oil Bulletin, 2007

for water resources. In addition, the impact of the widespread use of biofuels on air quality in urban areas has not yet been fully assessed.

In a nutshell, taking into account the vast resources of both conventional and non-conventional liquid fuels, the world has enough oil to meet its growing energy needs for decades to come. Indeed, with so much oil around, the issue of oil supply is not one of availability. Instead, it is one of deliverability. This, in turn, is dependant upon substantial investment in the industry, at the right time and in the right place.

## 2.3 Oil supply

### 2.3.1 Upstream

In the outlook assessment for crude and NGL supply, many factors influence the future growth potential. One key consideration is the investment in new fields and field expansions. There are numerous development projects in non-OPEC countries underway, or announced and expected to begin producing during the next five-to-six years. The figures for non-OPEC crude oil plus NGL supply in the initial years of the reference case are based upon a bottom-up approach, using a country-specific database of investment projects. Non-OPEC production growth is underpinned by over 300 ‘greenfield’ and ‘brownfield’ development projects, most of which are in the construction phase. As in the past two decades, offshore (shallow and deepwater) oil production will account for most of the cumulative increase.

**Table 3**  
**World oil supply outlook in the reference case**  
*m b/d*

	2005	2010	2015	2020	2025	2030
US & Canada	10.4	11.3	11.7	12.3	12.8	13.0
Mexico	3.8	3.8	3.8	3.5	3.2	2.9
Western Europe	5.8	5.0	4.3	3.9	3.5	3.2
OECD Pacific	0.6	0.7	0.7	0.8	0.8	0.8
<b>OECD</b>	<b>20.5</b>	<b>20.9</b>	<b>20.6</b>	<b>20.5</b>	<b>20.3</b>	<b>19.9</b>
Latin America	4.3	5.0	5.6	6.2	6.6	6.6
Middle East & Africa	4.4	5.0	5.1	5.3	5.1	5.0
Asia	2.6	2.9	2.8	2.5	2.3	2.1
China	3.6	4.2	4.5	4.8	5.0	5.3
<b>DCs, excl. OPEC</b>	<b>14.9</b>	<b>17.0</b>	<b>17.9</b>	<b>18.7</b>	<b>19.0</b>	<b>19.1</b>
Russia	9.4	10.3	11.0	11.2	11.2	11.2
Caspian and other FSU	2.1	3.5	4.1	4.5	4.9	5.2
Other Europe	0.2	0.2	0.2	0.1	0.1	0.1
<b>Transition economies</b>	<b>11.7</b>	<b>14.0</b>	<b>15.3</b>	<b>15.9</b>	<b>16.2</b>	<b>16.6</b>
Processing gains	1.9	2.2	2.4	2.8	3.0	3.2
<b>Non-OPEC</b>	<b>49.0</b>	<b>54.1</b>	<b>56.3</b>	<b>57.8</b>	<b>58.5</b>	<b>58.8</b>
of which: non-conventional	2.2	4.1	5.8	7.4	8.9	10.2
<b>OPEC NGLs/non-conventional</b>	<b>4.1</b>	<b>5.7</b>	<b>6.8</b>	<b>7.8</b>	<b>8.8</b>	<b>9.8</b>
<b>OPEC crude</b>	<b>31.1</b>	<b>30.2</b>	<b>33.8</b>	<b>38.2</b>	<b>43.5</b>	<b>49.3</b>
<b>World</b>	<b>83.3</b>	<b>89.7</b>	<b>96.5</b>	<b>103.5</b>	<b>110.4</b>	<b>117.6</b>

Looking at the reference case supply projections, non-OPEC oil and NGL supply rises continuously to reach a level of 58.8 mb/d by 2030, an increase of around 10 mb/d, compared with 2005 (**table 3**). Non-OPEC crude increases from Latin America, Russia and the Caspian compensate initially for decreases elsewhere, mainly in the North Sea. The Middle East and Africa region experiences a slight rise in volumes over the medium term to 2010, and reaches thereafter a plateau of around 5 mb/d.

Non-conventional oil supply from non-OPEC increases at strong rates over the entire projection period (**table 4**). Canadian oil sands supply is projected to grow from about 1.1mb/d in 2005 to almost 3.0 mb/d by 2015 and 3.8 mb/d in 2020. Production is seen as having the potential to reach 4.6 mb/d by 2025 and 5.0 mb/d by 2030.

**Table 4**  
**Non-OPEC non-conventional oil supply outlook (excl. biofuels) in the reference case**  
*m b/d*

	2005	2010	2015	2020	2025	2030
USA and Canada	1.2	2.1	2.9	4.0	5.0	5.7
W. Europe	0.1	0.2	0.2	0.2	0.2	0.2
OECD Pacific	0.0	0.0	0.1	0.1	0.1	0.1
<b>OECD</b>	<b>1.3</b>	<b>2.3</b>	<b>3.2</b>	<b>4.4</b>	<b>5.3</b>	<b>6.1</b>
Middle East and Africa	0.2	0.2	0.2	0.2	0.2	0.2
Asia	0.0	0.0	0.1	0.2	0.3	0.3
China	0.0	0.1	0.3	0.4	0.6	0.8
<b>DCs, excl. OPEC</b>	<b>0.2</b>	<b>0.2</b>	<b>0.5</b>	<b>0.8</b>	<b>1.0</b>	<b>1.3</b>
<b>Non-OPEC</b>	<b>1.5</b>	<b>2.5</b>	<b>3.7</b>	<b>5.1</b>	<b>6.3</b>	<b>7.3</b>

Of the other forms of non-OPEC non-conventional oil, CTLs and GTLs are also expected to grow, from about 150,000 b/d and less than 50,000 b/d, to 1.5 mb/d and 500,000 b/d respectively from 2005 to 2030. These increases will come predominantly from the USA, China, South Africa and Australia.

Furthermore, total global biofuel production increases in the reference case by 2.2 mb/d to reach 2.8 mb/d by 2030 (**table 5**). In absolute terms, the biggest increase in biofuel production occurs in the USA.

**Table 5**  
**Non-OPEC biofuel outlook in the reference case**  
*m b/d*

	2005	2010	2015	2020	2025	2030
USA and Canada	0.3	0.6	0.7	0.8	0.8	0.9
Western Europe	0.1	0.4	0.5	0.5	0.5	0.5
<b>OECD</b>	<b>0.4</b>	<b>1.0</b>	<b>1.2</b>	<b>1.3</b>	<b>1.3</b>	<b>1.4</b>
Latin America	0.3	0.4	0.5	0.6	0.7	0.8
Middle East and Africa	0.0	0.0	0.0	0.1	0.1	0.1
Asia	0.0	0.0	0.1	0.1	0.1	0.2
China	0.0	0.1	0.2	0.3	0.3	0.4
<b>DCs, excl. OPEC</b>	<b>0.3</b>	<b>0.6</b>	<b>0.8</b>	<b>1.0</b>	<b>1.2</b>	<b>1.4</b>
<b>Non-OPEC biofuel</b>	<b>0.7</b>	<b>1.6</b>	<b>2.1</b>	<b>2.3</b>	<b>2.6</b>	<b>2.8</b>

Thus, the reference case sees more than 10 mb/d of non-conventional oil supply coming from non-OPEC by 2030; this is 8 mb/d higher than in 2005.

In the reference case, the amount of crude oil, which OPEC would be relied upon to supply, increases after 2010, climbing to 38 mb/d by 2020 and 49 mb/d by 2030. This means

that the share of OPEC crude in total world oil supply will not change very much in the future.

### 2.3.2 Downstream

The downstream oil sector is an important part of the supply chain and in recent years has been characterised by tightness across all the basic refining functions, including key upgrading and quality improvement processes. Constraints in converting heavy and/or high sulphur streams into light and clean products are a primary factor contributing to the price differentials that exist today. The extent to which refining tightness remains or eases will depend on the evolution of what is currently a neck-and-neck race between refining capacity growth and product demand growth.

Several factors will shape developments in the downstream sector in the years to come. Growing demand for oil products clearly means there will be a rising volume of crude oil that needs to be refined. Moreover, the oil product demand structure will change, with the expected continued move towards lighter products. At the same time, and driven by environmental concerns, product specifications are moving towards significantly cleaner products that will necessitate substantial reductions in sulphur content, as well as improvements in other quality parameters. To meet these challenges, the downstream sector will require significant investment to ensure that sufficient distillation capacity is in place, supported by adequate conversion and desulphurisation, as well as other secondary processes and facilities.

In the reference case, additional refinery crude runs, resulting from global demand increases, should reach 4.7 mb/d by 2010 and more than 10.5 mb/d by 2015, compared with 2006. Considering the current high refinery utilisation rates in key regions, such as China, the USA, Japan and Western Europe, and constraints on increasing it in other regions, there are mixed signals as to the ability of distillation capacity expansion to keep pace with growing demand. The reference case scenario for distillation capacity expansion in the medium term shows that a total of 8.5 mb/d of new capacity (including capacity creep), out of more than 14 mb/d of announced projects, will be added to the global refining system through to 2012, and 9.2 mb/d by 2015. Almost 70 per cent of new capacity will be located in the Middle East and the Asia-Pacific.

By 2020, a total of 13.1 mb/d of additional distillation capacity, combined de-bottlenecking and major new units will be required, compared with the refining base in 2006. Clearly, future capacity expansion should be predominantly placed in the Asia-Pacific, driven by the region's expected demand increase.

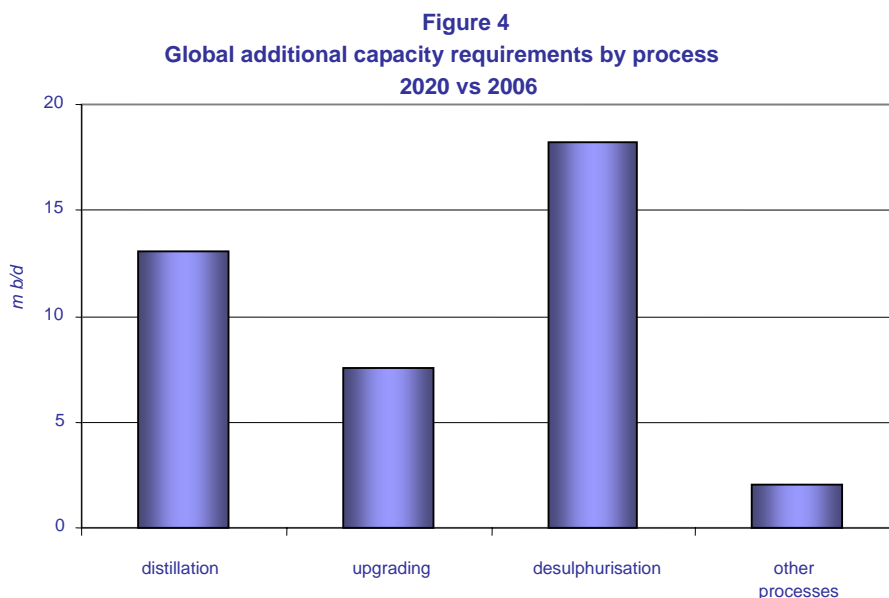
Additional downstream conversion units and the associated support facilities will also be required to meet future product demand, as well as changing product specifications. Needless to say, this is to be seen in the context of the changing crude slate too.

On the crude supply side, it is expected that the weighted average production slate will decline in its quality only moderately with respect to both average API gravity and sulphur content. The changing crude slate will not, therefore, create an additional problem for the refining sector. The real challenge, in this respect, will come from the demand side. The expected shift in the structure of demand towards lighter products and much tighter fuel quality specifications will be a greatly superior challenge to the one resulting from the change in quality of the global crude slate. Indeed, the global move towards lighter products will require additional upgrading capacity to produce a higher proportion of these, and tighter fuel specifications, especially with respect to sulphur content, will necessitate increases in desulphurisation capacity.

Taking into account the most likely changes in the future supply and demand structure and the corresponding quality specifications, the global downstream sector will require more than 7.5 mb/d of combined upgrading capacity, more than 18 mb/d of desulphurisation

capacity and around 2 mb/d of capacity for other supporting processes, such as alkylation, isomerisation and reforming, over the period 2006–20, in addition to the 13.1 mb/d of distillation capacity (**figure 4**).

The impact of stricter product quality specifications is reflected in the projection that, by 2020, the global refining system will need more than 18 mb/d of additional desulphurisation capacity over the 2006 base. This is dominated by requirements to produce additional ultra-low sulphur gasoline and diesel. Desulphurisation requirements will be significant across all regions, but the bulk of these units is projected in OECD regions, as these move towards ultra-low sulphur fuels by 2010–12 and essentially all gasoline and diesel streams have to be desulphurised. In other regions, due to the limited existing capacity, even modest sulphur reduction implies considerable capacity additions. This is particularly significant for countries like China and India, which are on the path to following the high European standards.



### **3. INVESTMENT CHALLENGES**

#### **3.1 Reference case requirements**

This analysis has underlined the need for substantial investment along the entire supply chain. Expansion of non-OPEC capacity is two-to-three times as expensive as that of OPEC, with this gap widening over time. The highest-cost region is the OECD, which also experiences the largest decline rates.

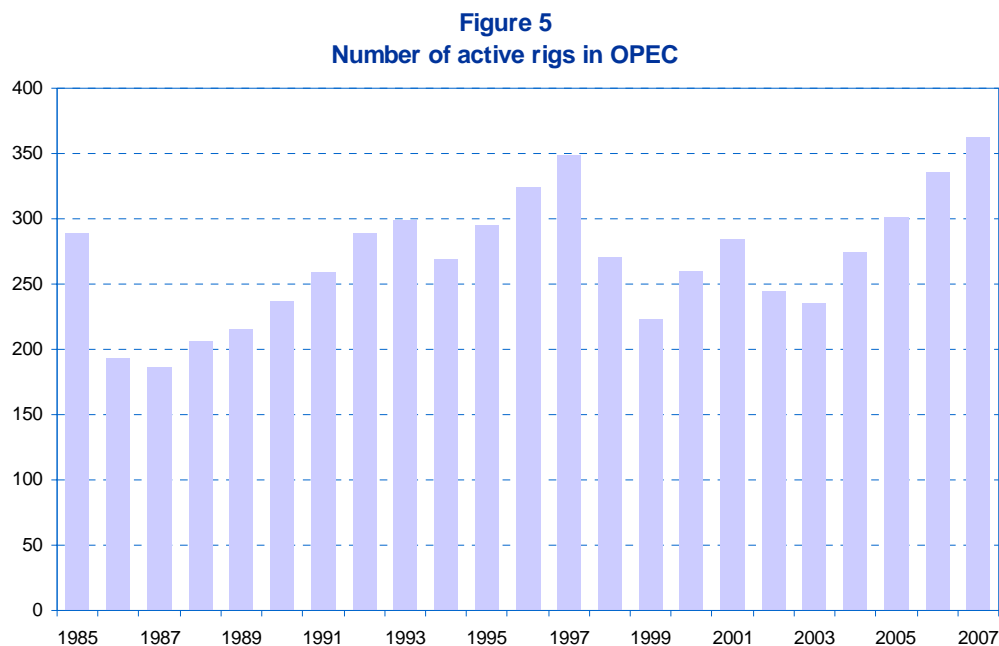
From 2006, total oil upstream investment requirements to 2030 amount to \$2.4 trillion (in 2006 US dollars). The OECD accounts for 38 per cent of this figure, due mainly to the high costs of enhancing output from mature fields and the offshore sector and of developing and deploying non-conventional oil. Non-OECD groups require around \$300 billion of investment by 2010, and close to another \$300 billion in the following five years. These estimates, it should be stressed, do not include investment in the necessary mid-stream infrastructure, such as pipelines, storage farms and ports.

Nevertheless, the global scale of upstream investment implied by the reference case outlook is not expected to be significantly greater in magnitude than that witnessed previously. This is the result of the gradual shift from higher-cost non-OPEC to lower-cost OPEC supply.

Downstream, the total required investment in refinery processing to 2020 is projected to be \$455 billion in the reference case. Of this, \$108 billion comprises the cost of known projects, \$112 billion encompasses further required process unit additions, such as revamps and de-bottlenecking/creep, as well as major new units, and \$235 billion covers ongoing replacement. Investment in replacement is highest in those regions, such as the USA and Europe, that have the largest installed base of primary and secondary processing units. The Asia-Pacific is projected to require the highest level of investment in new units to 2020, and China accounts for around 75 per cent of that region's total. As with the upstream, it is important to emphasise, when considering downstream investment, that these estimates are based upon refinery process requirements and do not include the infrastructure required beyond the refinery gate.

OPEC's Member Countries are investing heavily in expanding their production and refining capacity. Upstream, in the medium term, OPEC capacity growth is underpinned by more than 120 projects. As noted earlier in the paper, total cumulative capital expenditure to 2012 is estimated today to be likely to exceed \$150 billion. These investments are expected to result in an increase in capacity, by 2012, of more than 5 mb/d from current levels. Moreover, the quality of crude from these new projects is overwhelmingly medium-to-light, compatible with a growth in demand expected to be driven mostly by transportation fuels. Similarly, production capacity of OPEC NGLs and GTLs will be expanded significantly, by almost 2.3 mb/d to reach 6.6 mb/d by 2012.

Another illustration of the acceleration of upstream activity is given by the number of active rigs in Member Countries (**figure 5**). In 2007, these reached the highest level of the past two decades.



Member Countries are also investing heavily in refining and delivery infrastructure, such as pipelines, storage facilities and terminals. Very large and complex refineries are being planned or under construction, both domestically and abroad. This will help alleviate the current tightness and re-establish balance in the downstream sector, although it is recognised that this is the primary responsibility of consuming countries. However, the long certification and approval processes in consuming countries is a major hindrance to investment in the refining sector. As mentioned earlier, major crude distillation refinery

projects in Member Countries are expected to add more than 3 mb/d of additional capacity by 2012, representing an investment of close to \$50 billion.

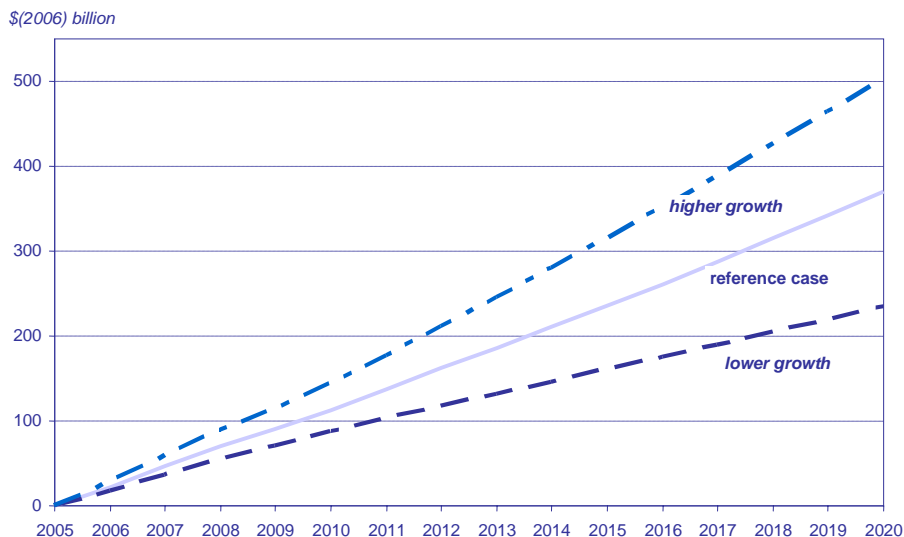
### 3.2 Uncertainties

It is important to recognise the existence of a large amount of uncertainty, upstream and downstream, over the future investment requirements. Important drivers of this uncertainty include future world economic growth, consuming countries' policies and technological developments, as well as future non-OPEC production levels.

Upstream, these affect future demand and non-OPEC supply and, hence, the required additional OPEC oil. Given such uncertainties, a key challenge will be to anticipate the appropriate level of demand to make the necessary investments to maintain and expand oil capacity, as well as the corresponding downstream infrastructure, without over- or under-investing.

Lower-growth and higher-growth scenarios result in a wide range of demand for OPEC oil and imply a corresponding wide range of upstream investment in Member Countries over the coming years (**figure 6**).

**Figure 6**  
**Cumulative OPEC upstream investment requirements**



The lower-growth scenario depicts a possible future where the drivers of change give rise to relatively low growth in oil demand. In this scenario, the world economy is assumed to expand at a more modest rate, 0.5 per cent lower per annum than in the reference case. This results in world oil demand being almost 5 mb/d lower than in the reference case by 2015 and 8 mb/d lower by 2020. Accordingly, demand for OPEC oil falls by more than 3 mb/d and 6 mb/d respectively. Conversely, the higher-growth scenario see world oil demand rise by more than 2 mb/d and almost 4 mb/d by 2015 and 2020, and OPEC supply rise by an additional 1 mb/d and 2 mb/d by these two years, compared with the reference case.

Such demand uncertainties result in a wide range of OPEC upstream investment requirements. For example, by 2020, an estimated range of \$270 billion for required OPEC investment can be envisaged, with the lower growth scenario suggesting a cumulative requirement of just under \$230 billion, instead of the \$500 billion in the higher growth case. Of course, the timeframe to 2020 could be considered as sufficiently long to adjust expansion plans in accordance with evolving demand patterns. In reality, the types of investment that are required vary substantially, and lead-times and pay-back periods can be long, particularly

if the necessary infrastructure is not in place. Even over the period to 2010, there is an estimated range of investment uncertainty of \$50 billion, increasing to \$160 billion by 2015. These ranges are even more dramatic, should estimates include corresponding investments in infrastructure, such as pipelines, storage, terminals and ports.

These figures clearly demonstrate the scale and reality of the main investment challenge faced by the oil industry in general and OPEC in particular.

For oil-producing developing countries, which, as noted earlier, are so dependant upon oil revenue for their economic and social advancement, there is the understandable desire to ensure that such revenue is put to good use and is not diverted to investing in oil production capacity that may not be needed. Without the confidence that additional demand for oil will emerge and without the market signals that long-run prices are supportive, the incentive to invest can be reduced, leading to under-investment.

Similar arguments prevail for the downstream, with regard to the impact of uncertainties.

For both the upstream and the downstream, the importance of security of demand to sound investment strategies is thus emphatic.

One major source of uncertainty at the present time concerns the fact that policy initiatives to support the development of biofuels may discourage refiners, as well as possibly crude oil producers, from investing in required capacity expansion. Should such a situation be followed by biofuels failing to meet stated targets, the result could be greater tightness in the downstream, and possibly the upstream, and, in turn, this could have a significant impact on prices, margins and volatility.

There is also the issue of the future structure of a complex downstream sector that includes both oil and biofuels. How should the sector be structured to withstand major disruptions? With the increasing number of biofuel producers, the chances of losing this capacity for a longer period and over a larger area — for example, due to drought — could easily lead to a shortage of required fuels.

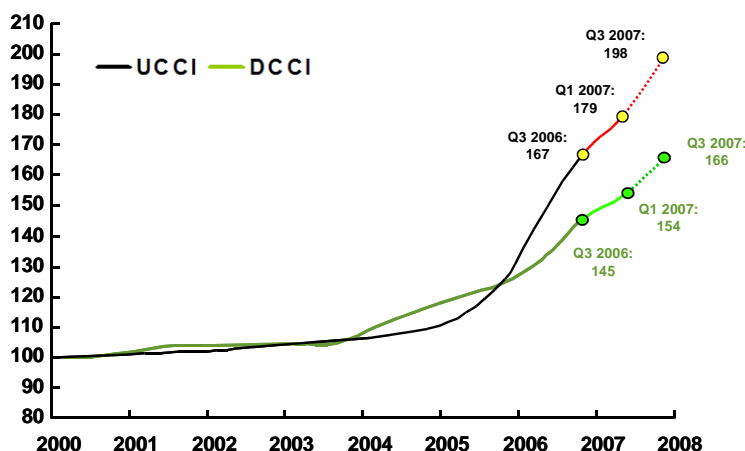
Overall, uncertainty over the magnitude of the rise in non-OPEC non-conventional supply is growing, with, for example, both the EU and the USA recently adopting ambitious targets for biofuel use in the medium-to-long term.

### **3.3 Infrastructure and human resources**

Another aspect of investment is the cost of infrastructure, such as rigs and tankers, as well as the cost and availability of human resources. According to an IHS/CERA cost index, upstream costs have risen by 98 per cent since 2000, with 75 per cent of the increase coming in the last two and a half years (**figure 7**). This can be viewed in the context of rig rates and the costs of steel and other raw materials shifting upwards significantly.

In the area of human resources, the industry is experiencing a shortage of skilled labour for both construction and operations, and, as a result, wages have increased. The number of students enrolling in petroleum and chemical engineering courses has also shown a significant decline since the mid-1980s. This is particularly significant with a large section of the existing workforce approaching retirement. To alleviate the skilled manpower shortage, efforts should be made to help facilitate education and training in energy disciplines. The industry should be made more attractive to prospective graduates — this includes making it easier for students to enrol in universities across national borders — and employees the world over.

Figure 7  
Capital cost index in upstream (UCCI) and downstream (DCCI)



Source: Cambridge Energy Research Associates

### 3.4 Environment and sustainable development

Improving energy efficiency is, as ever, a key objective, and, across the world, the long-trend for declining energy intensity continues, with 1.3 boe per US \$1,000 of GDP (purchasing power parity, 2000 base) required in 2006, compared with 2.2 boe in 1976. The corresponding figures for oil are 0.5 barrels and 1 barrels. There are also benefits to be had from the diversity in the energy mix, but this needs to recognise the real contribution of each type of energy.

With increasing international attention being devoted to the protection of the environment, reflecting growing concern about local pollution and potential anthropogenic interferences with the climate system, the petroleum industry must adapt to the evolution towards a carbon-constrained world. This must be done in a proactive manner and at a time when there are still many uncertainties about the scope of long-term limitations in greenhouse gas emissions and about the relative contributions of technology, mandatory/voluntary targets and timetables, and flexible mechanisms, such as emissions trading or the clean development mechanism.

The oil industry is in a position to turn this challenge into an opportunity, by promoting cleaner fossil fuel technologies, and, in particular, the technology of carbon dioxide capture and storage into deep geological formations. This technology has the potential to contribute to significant net reductions in CO<sub>2</sub> emissions. The industry needs to play a more active role in research, development and demonstration, in defining industry standards for site selection, monitoring and verification, and contributing to improved public acceptance. Having said this, developed countries, bearing the historical responsibility and having the technological and financial capabilities, should take the lead in the development and deployment of this technology.

Moreover, this must be handled in a manner consistent with the requirements of sustainable development, with due attention paid to the three intertwined and mutually supportive pillars of economic growth, social development and protection of the environment — with the eradication of poverty being the overriding global priority, facilitated by improved access to modern energy services.

#### **4. CONCLUDING REMARKS**

In presenting projections on the oil outlook to 2030, this background paper has identified challenges facing the industry, as it seeks to meet the continuing rises in demand that have been forecast for this period.

The reference case sees world energy demand continuing to grow throughout the projection period, with the share of fossil fuels exceeding 85 per cent. Although oil's share of the total energy mix will fall by nearly three percentage points to 36 per cent, it will comfortably maintain its role as the leading commercial energy source. Developing countries will account for most of the rise in oil demand, with consumption doubling to 58 mb/d, while, at the sector level, transportation will experience the biggest increase.

World oil supply will rise steadily, in line with projected demand growth, and this will accommodate increasing amounts of non-conventional oil. The world's oil resources, conventional and non-conventional, can comfortably support the steadily growing supply for decades to come.

Furthermore, attention must be paid to the downstream sector, since this is also a key element of the supply chain and, ultimately, of market stability. In addition to rising demand, there is a continued move towards lighter and cleaner products, and to accommodate this will require timely investment in refinery upgrading.

In order to meet these challenges, oil producers must have as clear an idea as possible of the quantity of oil that will be needed in the future. Oil-producing developing countries, in particular, cannot afford to invest their limited financial resources in building-up production capacity that will eventually lie idle, when there are other equally important competing uses for these funds at a domestic economic development level.

This, therefore, places a premium on consumers providing predictability of demand for the future and ensuring that their energy or energy-related policies are consistent with this over extended periods, due to the long investment lead-times and the heavy upfront capital outlays in the oil industry. Such consumer-country policies include those aimed specifically at encouraging other forms of supply, notably, at the present time, biofuels, whose large use is the subject of much debate across the world, in terms of sustainability, including competition with food, impacts on forests and biodiversity, and negative energy and environmental balances.

OPEC welcomes any measures that enhance the global energy mix, particularly in the interests of promoting sustainable development and the eradication of poverty; this includes developing renewables in an economic, socially and environmentally sound manner. But, at the same time, the Organization believes that a sense of reality should be applied here, with regard to the extent to which capital resources are switched to developing renewables, since such resources could well get better returns by being focused on developing cleaner technologies for fossil fuels, which have the clear economic benefits of vast, accessible reserves and long-established markets and supporting infrastructure.

The industry, recognising that fossil fuels will continue to satisfy the lion's share of energy needs for decades to come, has already made much progress in developing clean fuel technology, and this ongoing process promises to yield even greater benefits in the future. It has been accompanied by significant advances in developing greenhouse gas-mitigation measures, notably carbon capture and storage. OPEC is highly committed to this promising technology, and a major demonstration project is already in place in one of its Member Countries, Algeria. Most recently, at the Third OPEC Summit in Riyadh in November 2007, four other OPEC Members — Kuwait, Qatar, Saudi Arabia and the United Arab Emirates — pledged a total of US \$750 million to research into energy and the environment.

Overall, it cannot be stressed too much that, in an increasingly interdependent and integrated energy world, oil producers require access to the very latest technology at all times

to support their capacity-expansion programmes, their drive towards cleaner and more efficient fuels and their efforts to adopt other environment-enhancement measures.

However, in seeking to improve the industry's ability to meet the future challenges, there are other serious obstacles to overcome, such as shortages of skilled personnel and rising costs. To alleviate the manpower shortages, efforts should be made to facilitate education and training in energy disciplines, as well as, more generally, to make the industry more attractive to potential entrants, as a means of pursuing a sound life-time career. With respect to the rising costs, there is no escaping the basic laws of economics, and the recent oil price increases have gone some way towards redressing the balance here.

OPEC maintains that prices should be at levels that are acceptable to producers and consumers alike, allowing fair returns to investors and enabling sufficient revenue to be ploughed-back into the future healthy development of the sector. Sustained efforts should be made at an international level to reduce the present high level of speculation in the oil market, since this has been a significant driver of recent developments there, including the volatility.

Challenges such as these need the full support of the international community, if the global energy sector is to meet all its goals successfully in the future. There is huge potential for strengthening cooperation among producers and consumers, involving both national and international oil companies, right along the supply chain. This highlights the importance of dialogue at the highest levels of government and industry, and the IEF provides a proven policy platform for this.

Finally, OPEC hopes that this background paper has underlined its longstanding commitment to market order and stability — and that, at the same time, it has articulated issues which will lead to productive exchanges at the 11th International Energy Forum.