

OPEC Secretariat Background Paper World Oil Outlook

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Key insights

Short-term oil market developments

- During 2014–2016 global oil supply outpaced world oil demand growth, leading to excess supply in the market and a strong deterioration in oil prices.
- The Declaration of Cooperation, adopted in 2016, was a necessary response to the growing market imbalance.
- Despite scepticism from many market observers, the Declaration of Cooperation has proven to be a resounding and historic success, with conformity levels far above 100%.
- As a result, OECD commercial onshore and offshore stock levels have seen sizeable draws during 2017, a clear sign that market rebalancing is under way.
- Preliminary data for January 2018 showed total OECD commercial oil stocks at 2,889 mb, around 74 mb above the latest five-year average. This represents a reduction of 266 mb since January 2017.
- Global economic growth improved notably in 2017 to an estimated rate of 3.8% y-o-y, up from 3.2% in 2016.
- In 2018, global GDP growth is forecast to remain strong at 3.8% y-o-y, similar to that of 2017. However, as some major economies are close to their short-term growth potential, further upside for global growth in the near-term is now limited.
- World oil demand in 2018 is projected to increase by 1.6 mb/d following almost a similar growth in 2017 reflecting the positive economic outlook.
- The 2018 OECD oil demand is foreseen to rise by around 0.3 mb/d. In the non-OECD region, growth is forecast at 1.3 mb/d, with China being the major contributing country to overall growth, followed by Other Asia, including India.
- Non-OPEC supply is projected to increase by 1.4 mb/d in 2018 following an estimated growth of 0.9 mb/d in 2017mb/d.
- US oil supply is forecast to grow by 1.30 b/d in 2018, with US tight crude production is projected to grow by 0.9 mb/d in 2018
- Expected sharp growth in non-OPEC supply is mainly due to the steady oil price recovery since summer 2017 and renewed interest in growth opportunities among the majors leading to a catch up in exploration activity this year, especially in the shale industry and deep water offshore.



Long-term oil outlook

- In the long-term, economic growth is driven mainly by technological development and demographic trends. In the Reference Case, global GDP between 2016 and 2040 is expected to increase at an average rate of 3.5% p.a.
- Within the OECD region, OECD America leads growth prospects with an average growth of 2.5% p.a. While in OECD Europe and OECD Asia Oceania increasing economic activity is limited by a declining working age population.
- Most of the global growth will be driven by Developing countries in the period to 2040. These countries are expected to grow, on average, by 4.5% p.a. during this period on the back of higher labour productivity growth and a more optimistic demographic outlook. Within Developing countries, India is expected to be the fastest growing at an average growth of 6.8% p.a. China follows with 4.7% p.a.
- In Eurasia the economic growth outlook is limited by an unfavourable demographic picture. Overall, GDP growth is forecast to average 2.5% p.a. in the long-term, with Russia at 2.3% p.a. and Other Eurasia at 2.7% p.a.
- Total primary energy demand is forecast to increase by 96 mboe/d between 2015 and 2040, rising from 276 mboe/d in 2015 to 372 mboe/d by 2040. In relative terms, this represents a 35% increase compared to the base year of 2015, with an average annual growth rate of 1.2 % during the forecast period.
- Long-term oil demand is expected to increase by 15.8 mb/d, rising from 95.4 mb/d in 2016 to 111.1 mb/d in 2040.
- Demand in the OECD region is anticipated to show a significant decline of 8.9 mb/d during the forecast period.
- The Reference Case envisages substantial oil demand growth in Developing countries. Driven by an expanding middle class, high population growth rates and stronger economic growth potential, the region's oil demand is expected to increase by almost 24 mb/d. It rises from 43.2 mb/d in 2016 to 67 mb/d in 2040.
- Within the Developing countries, China is expected to continue to be the largest consumer of oil during the forecast period, adding 6 mb/d to reach 17.8 mb/d by 2040. India will be the region with the second largest overall demand growth, adding 5.9 mb/d between 2016 and 2040.



- Global oil demand growth is forecast to decelerate steadily, slowing from over 1.3 mb/d every year during the period 2016–2020 to only 0.3 mb/d every year between 2035 and 2040.
- Non-OPEC liquids supply grows by a modest 3.4 mb/d from 2016–2040, all of which takes places in the first ten years, after which non-OPEC supply as a whole declines.
- US tight oil increases from 6.6 mb/d in 2016 to 11.1 mb/d by 2022. Thereafter, production grows at a slower pace until peaking in 2026/27, after which output is expected to decline again to 9.9 mb/d by 2040.
- In the Reference Case, demand for OPEC crude stays relatively flat at just over 33 mb/d until 2025, after which US tight oil is projected to peak, and with it overall non-OPEC supply. Thereafter, the demand for OPEC crude rises steadily, reaching 41.4 mb/d in 2040.
- Around 7.6 mb/d of new refining capacity is likely to come online between 2017 and 2022, while 19.6 mb/d of new refining capacity is expected between 2017 and 2040. The majority of the new capacity is anticipated to be located in developing regions supported by growing oil demand.
- The outlook also stresses the fact that medium-term refining expansion points to increasing competition and the need for refinery closures.
- In terms of trade, the outlook emphasizes that long term global oil trade is set to increase gradually with the Middle East playing a significant and expanded role in crude and products exports.
- Uncertainty emerging from the economic developments is in the range of 6 mb/d in 2040. Moreover, it is important to highlight that the uncertainty is skewed to the downside.
- Focusing on the increased penetration of EVs in the passenger car segment, oil demand in 2040 could be reduced by 2.5 mb/d compared to the Reference Case, to total 108.6 mb/d. Moreover, under this sensitivity case, global oil demand is estimated to plateau around this level in the second half of the 2030s.
- A sensitivity case focusing on energy efficiency shows that the net effect of an orchestrated push for even moderately improved efficiencies across all sectors of oil demand is comparable to the impact of alternative economic developments, as well as to the much discussed impact of a potential faster penetration of electric vehicles.
- Upside potential to non-OPEC supply could curb demand for OPEC crude by 4.6 mb/d in 2040. The effect of the downside sensitivity for non-OPEC



supply is less pronounced. In this case, demand for OPEC crude by 2040 would be some 3.6 mb/d higher than in the Reference Case.

Energy access and sustainable development

- Energy has a prominent place in the 2030 Agenda for Sustainable Development adopted at the UN Sustainable Development Summit on 25 September 2015, being fundamental to human development and a crosscutting issue in socio-economic prosperity and environmental sustainability.
- Energy is included explicitly as one of the SDGs, with goal number seven (SDG 7) calling to secure access to affordable, reliable, sustainable, and modern energy services.
- Based on the latest available data, around 1.1 billion people still function without electricity, and half of those people live in Sub-Saharan Africa. At the same time, approximately 3 billion people, the majority of them living in Sub-Saharan Africa and Asia, are still cooking without clean fuels and efficient technologies. This underscores the need for enhanced action with the objective to ensure energy access for all within the following years and up to 2030.
- It is evident that sufficient financial resources, technology development and effective policies designed to encourage investments in modern energy sources are needed to ensure energy access at a global level. International cooperation on these aspects could enhance actions of countries that aim to accelerate the transition to an affordable, reliable, sustainable and modern energy system.
- OPEC and its Member Countries have been strong advocates of sustainable development, recognising alleviation of energy poverty as a universal aspiration. The OPEC Fund for International Development (OFID) has recently inaugurated as a lead partner the *Oil and Gas Industry's Energy Access Platform*, together with other major oil and gas companies and other stakeholders including business developers. The objective of this platform is to contribute to the achievement of universal energy access, by leveraging industry capabilities to support access to energy, sharing best practices, fostering communication and contributing to better integrate energy access in policies and projects at country level.



1. Introduction

Traditionally, the OPEC Secretariat prepares a background paper for IEF Ministerial Meetings that analyses the outlook for energy and oil demand and supply, assesses critical uncertainties for future markets and addresses major challenges. It is also the objective of this paper to bring some of these challenges to the fore, in particular oil market developments since the last Ministerial Meeting, longer-term prospects for oil demand and supply as well as many other challenges related to sustainable developments and energy poverty.

When the last IEF Ministerial Meeting took place in Algiers, Algeria, in September 2016, the oil market was going through unprecedented turbulences. From 2014 to 2016, world oil supply growth outpaced that of oil demand, with world oil supply growing by 5.5 mb/d, while world oil demand increased by 4.1 mb/d. By July 2016, OECD commercial stock levels reached a record high of about 386 mb over the five-year average. The OPEC Reference Basket price fell by an extraordinary 80% between June 2014 and January 2016. Investments dropped substantially, with exploration and production spending falling annually by an enormous 27% in the years 2015 and 2016. Importantly, nearly one trillion dollars in investments were frozen or discontinued, and many thousands of high-quality jobs were lost.

In response to these market conditions, a breakthrough came in the form of the Declaration of Cooperation. This landmark decision was the culmination of the extensive consultations undertaken throughout 2016, which aimed to build consensus about the strategic urgency of rebalancing the global oil market in a collective manner.

As a result, at the first OPEC/non-OPEC Ministerial Meeting held on the 10th of December 2016 in Vienna, 24 oil producing nations agreed on a concerted effort to accelerate the stabilization of the global oil market through voluntary adjustments of around 1.8 mb/d to their total production. The 2nd OPEC/non-OPEC Ministerial Meeting, held on the 25th of May 2017, extended the voluntary production adjustments for another nine months commencing on the 1st of July 2017. Following the 3rd OPEC and non-OPEC Ministerial Meeting on the 30th of November 2017, the Declaration of Cooperation was amended to take effect for the whole year of 2018.



Despite scepticism from many market observers, the Declaration of Cooperation has proven to be a resounding and historic success. In fact, it has gone beyond what was originally envisaged. Starting with January 2017, with already high conformity levels by participating countries, the discipline and motivation to succeed advanced throughout the year. It ended with an astounding 133% conformity for the month of January 2018, and a remarkable average of 109% for the year 2017.

Efforts of participating countries resulted in an acceleration of the reduction of the stock overhang, driven by the high conformity levels. The five-year average for OECD commercial stock levels has fallen by more than 265 mb since the start of 2017, to 74 mb in January 2018. Moreover, there has been a significant quickening in this trend since May 2017.

Expectedly, prices responded to these trends and during the second half of 2017, all crude oil benchmarks have flipped into a clear backwardation for the first time since 2014. This has evidently been driven by the rebalancing process undertaken by participating countries. Moreover, increasingly there are signs that investments are growing again. There is no doubt that oil market fundamentals would have been very different today without the committed efforts of the 24 participating producers to the 'Declaration of Cooperation'.

2. Short-term oil market developments

2.1 Crude oil price movements

At the time of 15th IEF Ministerial Meeting, in September 2016, the price of the OPEC Reference Basket (ORB) was in the range of \$42-\$44/b. It ended 2016 significantly higher, at around \$53/b, up by around \$12/b compared to the average of 2016. This value was above the key \$50/b yearly average and the highest since 2014. Oil prices have received wide-ranging support from production adjustments led by OPEC and Russia, which started in January 2017 and are set to last through 2018, as well as from strong economic growth and financial markets, which have helped to tighten markets.



Oil futures improved markedly in 2017 to exceed \$50/b, spurred by strong demand and declining global inventories. International benchmark Brent crude futures ended the year 2017 with a rise of almost 21%, supported by a year of ongoing supply adjustments by OPEC and non-OPEC producing countries as well as strong demand, particularly from China. NYMEX WTI ended 2017 gaining near 17%, despite a significant increase in oil production in the US. These gains indicate that the global glut that has dogged the market since 2014 is shrinking.

By the end of the 1st half 2017, ICE Brent settled below the \$50/b mark for the first time in the year on concerns that rising global supply will counter output adjustments from OPEC and non-OPEC producers. US crude inventories remained more than 100 mb above the five-year seasonal average. Oil futures also crumbled due to concerns that persistent US production growth will translate into crude inventory builds, should seasonal refinery demand back off. Hedge funds also embarked on a new cycle of short-selling in Brent and WTI, which has added to downward pressure on prices.

But prices rallied nearly 50% since the middle of the year on robust demand and strong conformity with the production reduction. By the end of 2017, oil futures improved further to levels not seen since late 2014, with ICE Brent near \$67/b and NYMEX WTI around \$60/b. Both futures contracts continued to be supported by growing indications that the oil market is heading smoothly toward rebalancing, lower crude oil stocks and healthy demand. The positive outcome of the December 2017 decision between OPEC and non-OPEC producing countries to extend the Declaration to 2018 as well as supply turbulences in the North Sea buoyed the sustained gains in oil futures throughout the month. Crude futures were also boosted after the North Sea Forties pipeline was closed and US crude oil inventories continued to draw sharply.

2.2 Economic developments

Global economic growth improved notably in 2017 to an estimated rate of 3.8% yo-y, up from 3.2% in 2016. Strong growth in the US, along with rising growth levels in the Euro-zone and the UK and solid output numbers in Japan supported the OECD momentum. Also, emerging and developing economies' upside momentum was obvious especially in China, Brazil, and Russia. However, India's



GDP growth was negatively impacted by the double shock of demonetization together with goods and services tax reform.

The OECD's growth estimate points to 2.5% y-o-y in 2017, up from 1.8% in 2016. The US growth in 3Q17 was again better than expected, shifting the already strong growth momentum higher and leading to GDP growth of 2.3% in 2017, up from 1.5% in 2016. Underlying economic growth in the US remains strong.

Japan's economy enjoyed a broad-based momentum in 2017 and is expected to register growth of 1.8% y-o-y, up from 1.4% in 2016. Exports remain a vital part of the growth dynamic and government-led stimulus measures, in combination with structural reforms, are expected to continue supporting the trend. Euro-zone growth continued to show a solid momentum and a growth of 2.5% y-o-y is estimated for 2017, up from 1.8% in 2016.

The broad-based growth remains visible in all the Euro-zone economies. It also seems to be well supported across the various sectors. Supported by the global growth momentum in general and solid domestic consumption, the Euro-zone continues to enjoy a good dynamic, leading to a growth in 2017 of 2.5%, following GDP growth of 1.8% in 2016.

In 2017, the economy of China posted its first y-o-y rising rate of growth since 2010, growing by 6.9% vis-a-vis 6.7% in 2016. Strong growth in industry and exports and a resilient property market were the main drivers of the expansion. India's economic growth is estimated to have slowed down to 6.5% in the financial year 2017, down from 7.9% in the financial year 2016.

The Indian economy, affected by the double shock of the government's demonetisation measures and the introduction of the Goods and Services Tax (GST), lost momentum during the first half of the fiscal year, with growth slowing to 6.0% due to weaker private spending and sluggish investment activity.

Brazil and Russia emerged from recession in 2017, thanks to some improvements in household consumption, investment and trade. Brazil's growth is estimated at 1.0% y-o-y in 2017, up from a contraction of 3.6% in 2016, while Russia's economic growth estimate points to 1.9% y-o-y in 2017, from a contraction of 0.2% in 2016.



In 2018, as global economic growth has continued its improving momentum, global GDP growth is forecast to remain strong at 3.8% y-o-y, similar to that of 2017. However, as some major economies are close to their short-term growth potential, further upside for global growth in the near-term is now limited. Numerous challenges remain and are mainly related to the political sphere and the upcoming monetary policy decision in the US and the Euro-zone in combination with currently rising asset market's volatility.

2.3 Oil demand

For the third consecutive year world oil demand growth exceeded the 1.4 mb/d mark to register a growth of 1.6 mb/d, or 1.7% y-o-y, in 2017 (Figure 2.1). Cumulatively between 2015 and 2017, the world added around 5 mb/d of oil products demand on the back of healthy economic conditions globally and a relatively low oil price environment. In 2017, OECD Americas oil demand grew steadily, with the bulk of the growth coming from the industrial and transportation sectors, primarily for the light and middle part of the barrel.



In OECD Europe and Asia Pacific, following steady growth in the past two years, oil demand continued to be in positive territory for in 2017. Improvements in the economy, and consequently the petrochemical and transportation sectors, in



addition to colder-than-normal temperatures earlier in the year, lent strong support to oil demand growth during the first half of 2017.

In non-OECD, China oil demand growth was robust in 2017 as the petrochemical and the transportation sectors continued to expand at a healthy pace. Oil demand growth in Other Asia – primarily India and other countries in the region – increased despite slower-than-expected oil demand growth from India during the post-demonetization in the first half of 2017. In Latin America and Middle East, oil demand growth rebounded to positive territory in 2017, on the back of an uptick in economic conditions in Brazil, steady growth in Iraq, Kuwait and UAE.

In OECD countries, the bulk of gains in 2017 oil demand were seen in middle distillates, diesel oil, jet kerosene and naphtha. However, these gains are partly offset by shrinking demand for residual fuel oil. Middle distillates received strong support from industrial activities in OECD America and large part of Europe. Moreover, demand for light products improved in OECD Asia Pacific and Europe, supported by higher utilization rates for naphtha crackers.

In 2018, world oil demand is projected to grow by 1.59 mb/d to reach 98.6 mb/d. The OECD is foreseen to rise by around 0.32 mb/d, with OECD Americas and Europe being firmly in the positive, while OECD Asia Pacific is anticipated to decline. In the non-OECD region, growth is forecast at 1.26 mb/d, with China being the major contributing country to overall growth, followed by Other Asia, including India.

2.4 Oil supply

The world's liquids supply grew by 0.8 mb/d to average 96.5 mb/d in 2017, despite a decrease by 0.3 mb/d y-o-y in OPEC's crude oil production averaging 32.4 mb/d. Rising oil prices, compared to the previous year, led to output growth in non-OPEC countries, particularly from US tight oil as well as in Canada, Kazakhstan and Brazil. Meanwhile, OPEC NGLs and unconventional liquids output is estimated to have increased by 0.2 mb/d in 2017, to average 6.3 mb/d.

In 2017, non-OPEC countries produced 57.9 mb/d of liquids, indicating growth of 0.9 mb/d compared to 2016. OECD countries saw the greatest yearly growth among all regions. OECD supply increased by 0.7 mb/d in 2017, primarily from



OECD Americas. In 2016, world oil supply grew only by 0.3 mb/d driven by nearly 1.0 mb/d increase in OPEC crude oil production, while non-OPEC supply saw a contraction of 0.7 mb/d. During this year, global oil supply was 0.4 mb/d higher than demand for liquid products.



OPEC crude oil production averaged 32.4 mb/d in 2017, a decrease of 0.3 mb/d over the previous year. Following the Declaration of Cooperation between OPEC and 10 participating countries from non-OPEC's oil producers led by Russia, OPEC crude oil output stood at 32.2 mb/d in 1H17. It was 0.4 mb/d lower than the average of 2016. However, OPEC production increased by 0.4 mb/d to average 32.6 mb/d in 2H17 due to the production increase in Nigeria and Libya.

For 2018, non-OPEC supply is projected to increase by 1.4 mb/d, with total supply estimated at 59.3 mb/d. This expected sharp growth is due to the steady oil price recovery since summer 2017 and renewed interest in growth opportunities among the majors leading to a catch up in exploration activity this year, especially in the shale industry and deep water offshore. OECD supply is forecast to average 27.1 mb/d during 2018, representing annual growth of 1.5 mb/d, mainly from OECD Americas (US and Canada) at 1.4 mb/d.



At the end of 2017, OECD commercial stocks finished the year at 2,869 mb, around 200 mb less than the beginning of the year. At this level, OECD commercial stood at 89 mb above the five-year average. Within the OECD region, OECD America showed a surplus of 69 mb above the latest five-year average, followed by OECD Europe with a surplus of 14 mb, while OECD Asia Pacific indicated levels of 6 mb above the seasonal norm. It should be noted that the overhang to the five-year average was reduced by more than 250 mb since January 2017, a clear sign that the rebalancing of the oil market is underway.

Preliminary data for January 2018 has confirmed this downward trend with the difference to the latest five-year average now standing at 74 mb.



Figure 2.3

Long-term oil outlook¹ 3.

Overview of the Reference Case assumptions 3.1

Trends in future energy demand and supply presented in this background paper are based on a set of key assumptions. These are briefly discussed below.

The projections and scenarios are based on the 2017 edition of the World Oil Outlook.

The world is experiencing an era of demographic change. Global population is growing at an unprecedentedly low rate compared to the last century and the forecast is for a further deceleration. At the same time, the world continues to age as fertility rates decline and people live longer across the world. In addition, more people are moving from country to country, as well as increasingly to urban areas. The future of the global economy and the energy outlook will be heavily determined by these global demographic trends.

Based on the United Nations (UN) Population Division's 2015 Revision of World Population Prospects, the global population is estimated to increase from 7.3 billion in 2015 to 9.2 billion in 2040. The additional 1.8 billion people will mainly come from Developing countries, particularly from the Middle East & Africa and India. In the former, the population is anticipated to increase from 1 billion in 2015 to 1.7 billion in 2040. In the latter, it is expected to expand from 1.3 billion to 1.6 billion. The situation in China, however, is rather different. It is expected that the population will peak in 2028 at around 1.42 billion and then start a slow decline to 1.4 billion by 2040.

In the OECD, an additional 116 million people are forecast in the period to 2040, with most coming from OECD America. This region sees an additional 92 million partly as a result of immigration. OECD Europe is also expected to witness an increase, albeit smaller, with the addition of 24 million people. In OECD Asia Oceania, the population is estimated to plateau during the next decade and then start to decline. In Eurasia, the population is expected to peak in 2022 and then decline, particularly in Russia.

In parallel with the slowdown in population growth, the world continues to age. In fact, the share of the working age population (that is, individuals aged between 15 and 64 years old) in terms of the total global population peaked in 2012, following a steady increase since 1970. In 2012, two out of every three people in the world were of a working age. In 2040, it is estimated to be less than 64%. In the OECD, the picture is gloomier as this ratio is anticipated to fall below 60%.

Economic growth is one of the main drivers behind energy (and oil) demand. As such, robust assumptions made for the short-, medium- and long-term outlook are essential for a credible market analysis. In the long-term, economic growth is



driven mainly by technological development and demographic trends. In the Reference Case, global GDP between 2016 and 2040 is expected to increase at an average rate of 3.5% p.a. In the medium-term (2016–2022) economic activity is estimated to increase at an average rate of 3.5% p.a. In the rest of the 2020s, increasing labour productivity is anticipated to promote higher average growth of 3.6% p.a. In the 2030s, lower employment growth, coupled with lower labour productivity growth, is expected to reduce average global GDP growth to 3.3% p.a.

	2016-2022	2022-2030	2030-2040	2016-2040
OECD America	2.4	2.6	2.4	2.5
OECD Europe	1.9	1.8	1.7	1.7
OECD Asia Oceania	1.6	1.4	1.2	1.4
OECD	2.1	2.1	2.0	2.0
Latin America	2.6	3.2	2.6	2.8
Middle East & Africa	3.1	3.8	3.7	3.6
India	7.4	7.1	6.2	6.8
China	6.0	5.0	3.7	4.7
Other Asia	4.2	3.8	3.5	3.8
OPEC	2.6	3.2	3.2	3.1
Developing countries	4.9	4.8	4.1	4.5
Russia	1.9	2.7	2.4	2.3
Other Eurasia	2.7	3.0	2.6	2.7
Eurasia	2.2	2.8	2.5	2.5
World	3.5	3.6	3.3	3.5

Table 3.1Long-term annual real GDP growth rates in the Reference Case, % p.a.

Growth in the OECD region averages 2.0% p.a. over the period 2016–2040. Despite a marginally declining working age population, an increasing participation rate and improving labour productivity support growth prospects. In fact, the participation rate is highest in OECD countries, particularly in OECD Asia Oceania, mainly because of high female participation. Further female participation and



potentially the increasing participation of older individuals, as a result of increasing pressure on the social security systems and/or increasing retirement age, will likely see a marked increase in the participation rate and in turn support growth potential.

Within the OECD region, OECD America leads growth prospects with an average growth of 2.5% p.a. While in OECD Europe and OECD Asia Oceania increasing economic activity is limited by a declining working age population, the economic outlook in OECD America will be supported by expanding employment, particularly due to immigration. In fact, in OECD America net migration between 2016 and 2040 is expected to total around 35 million. Under a broad conservative assumption, GDP growth in the region – without immigration – would be reduced from 2.5% p.a. during the forecast period to at least 2.2% p.a. This would correspond to a loss in GDP of around \$2.8 trillion (2011 PPP).

Most of the global growth will be driven by Developing countries in the period to 2040 (Table 3.1). These countries are expected to grow, on average, by 4.5% p.a. during this period on the back of higher labour productivity growth and a more optimistic demographic outlook. Within Developing countries, India is expected to be the fastest growing at an average growth of 6.8% p.a. This is driven by a rapidly expanding working age population (additional 237 million between 2016 and 2040). China follows with 4.7% p.a. However, its growth decelerates steadily as working age population declines so that in the last decade of the forecast period it averages only 3.7% p.a. and even falls below 3.4% in the final couple of years.

In Eurasia the economic growth outlook is limited by an unfavourable demographic picture, particularly in Russia, where the working age population is expected to decline steadily. However, anticipated strong labour productivity gains will support growth. Overall, GDP growth is forecast to average 2.5% p.a. in the long-term, with Russia at 2.3% p.a. and Other Eurasia at 2.7% p.a.

The assumed GDP growth figures imply that the total size of the global economy in 2040 will be 226% that of 2016. In particular, world GDP is forecast to increase by \$136.6 trillion (2011 PPP), expanding from \$108.4 trillion (2011 PPP) to \$245 trillion (2011 PPP). Developing countries are estimated to account for three-quarters of the global GDP growth over the forecast period. Furthermore, one of



every two additional \$ (2011 PPP) of GDP are expected to come from China and India.

In 2016, OECD America accounted for 20% of global GDP, followed by OECD Europe and China, both with 18%, then Other Asia with a relative weight of 9% and India with 7% (Figure 3.1). The expected much higher growth of Developing countries in the long-term means that the weight of OECD America is estimated to drop to 16% and that of OECD Europe to 12% by 2040. On the other hand, China's contribution to the global economy is forecast to increase by over 5 percentage points to 23%. Even more remarkable is the case of India. Its weight in the global GDP is expected to increase by more than 8 percentage points to 16%.



The evolution of energy markets over time is significantly impacted by government policies, which are often used as mechanisms to stimulate change beyond purely market-driven forces. When forecasting the long-term energy outlook, there are many unknown variables, including when and which future policies may be enacted. Therefore, the Reference Case takes into account various energy policies that are already enacted, while accepting that the policy process is evolutionary in nature and susceptible to change over time.

Every year, the WOO projections are updated to reflect the impact of previously enforced policies and newly enacted ones, as well as taking into account the current debate on energy issues. As such, the following is an overview of policy developments and observable policy trends that have taken place since the publication of the WOO 2016; with the acknowledgment that policies are



constantly changing, and therefore, policy developments need to be proactively and continuously monitored.

The energy industry as a whole, and the oil industry in particular, are very much dependent on technology that has shaped the way in which energy is produced, as well as consumed around the world. Each step in the industry's evolution has been marked by scientific discoveries and their appropriate technical application. Technology has always been the key to multiply human dynamism and it is evident that it continues to undergo rapid advances in several areas across the energy spectrum, in particular, in the renewables arena.

In the oil industry, in less than a decade, two important technology developments have advanced on the supply and demand sides: the innovative combination of directional drilling and hydraulic fracturing ('fracking') – leading to the advent of tight oil, particularly in the US – and substantial improvements to battery technology creating a new mobility segment of electric vehicles (EVs).

It can be expected that these technical advancements will continue to evolve and change the future energy panorama. The current development of renewable energies and the introduction of EVs are strong signs of these trends, for example. Elsewhere, highly resistant fibres in conjunction with oil-based resins are already replacing traditional metal-based materials in the case of latest-generation airplanes, to highlight another state-of-the-art development. And in the field of oil discovery and exploration, technical development has always played a decisive role since early onshore drilling through the large-scale development of offshore and, today, tight oil reserves.

The present oil and energy outlook has, therefore, to consider technological developments in view of their impact on energy provision and energy efficiency.

3.2 Energy and oil demand

3.2.1 Energy demand in the Reference Case

The global energy system, the backbone of economic and socio-demographic developments around the world, is currently at a crossroads with several forces and drivers at play. One of these is the factor of energy production costs. In the



past year, since the last Outlook was published in November 2016, several signs of a continuing reduction in costs have been evident. This was especially the case for electricity generation by solar and wind energy. In the upstream oil sector, industry has seen a further decline in costs driven primarily by technology improvements and the application of best practices in tight oil production. This has had some spill-over effects in other areas. Elsewhere, natural gas prices in most markets have also remained at lower levels.

Another factor has been the shifting energy policies in consuming countries. Energy issues are evidently high on the agenda of the new US Administration, though more time is needed to evaluate the implications of its shift in policy direction, especially in terms of long-term trends. It remains to be seen to what extent the Administration's declared intentions to revive the US coal industry, open up federal lands for oil and gas production, provide support to the nuclear industry and expand the country's pipeline system will change the overall energy scene in North America.

In respect to the Paris Agreement, it remains unclear whether the US will remain committed to the cause. Moreover, it remains to be seen how will play out as opposition to this intention is taking shape both domestically and globally. Within the US, several states, cities, institutions and companies have said they will continue to pursue measures driven by climate change concerns. Similarly, in reaction to the intention of the US to withdraw from the Paris Agreement, several other regions and countries – led by the EU, China and India – have stated their intention to intensify efforts to reduce emissions.

Taking into account all these developments, as well as the assumed prospects for economic growth, socio-demographic trends and other factors described in Section 3.1, total primary energy demand is forecast to increase by 96 mboe/d between 2015 and 2040, rising from 276 mboe/d in 2015 to 372 mboe/d by 2040 (Table 3.2). In relative terms, this represents a 35% increase compared to the base year of 2015, with an average annual growth rate of 1.2 % during the forecast period.



		Lev mb	/els oe/d		Growth %p.a.	Share of global energy demand %				
	2015 2020 2030 2040		2015-2040	2015	2020	2030	2040			
OECD America	56.0	57.5	58.0	57.6	0.1	20.3	19.3	17.1	15.5	
OECD Europe	35.7	36.9	36.2	35.3	0.0	12.9	12.4	10.7	9.5	
OECD Asia Oceania	18.3	19.0	19.3	19.2	0.2	6.6	6.4	5.7	5.2	
OECD	110.0	113.5	113.6	112.0	0.1	39.9	38.0	33.5	30.1	
China	62.7	69.0	79.7	84.9	1.2	22.7	23.1	23.5	22.9	
India	16.8	20.6	30.4	39.7	3.5	6.1	6.9	9.0	10.7	
OPEC	19.8	21.5	26.9	31.3	1.9	7.2	7.2	7.9	8.4	
Other DCs	44.5	50.3	62.8	75.7	2.1	16.1	16.9	18.5	20.4	
DCs	143.8	161.5	199.9	231.7	1.9	52.1	54.2	58.9	62.4	
Russia	13.9	14.3	15.6	16.5	0.7	5.0	4.8	4.6	4.4	
Other Eurasia	8.3	9.0	10.3	11.4	1.3	3.0	3.0	3.0	3.1	
Eurasia	22.2	23.3	25.9	27.8	0.9	8.0	7.8	7.6	7.5	
Total world	276.0	298.2	339.4	371.6	1.2	100	100	100	100	

Table 3.2Total primary energy demand by region

This significant growth in global energy demand is, however, unequally distributed among major regions and country groupings. Energy demand in Developing countries is expected to grow at an average rate of 1.9% p.a. over the period 2015–2040. This is in sharp contrast with an average 0.1% p.a. growth rate projected for the OECD and 0.9% p.a. for Eurasia.

The key reasons for this variation are the different prospects that exist among the major country groups in terms of population growth, urbanization rates and growth in economic activity. On average, Developing countries are forecast to post a real GDP growth rate of 4.5% p.a. (on a 2011 PPP basis) over the 2015–2040 period compared with an average 2% p.a. growth in the OECD. Varying prospects in respect to population growth are even more pronounced with the majority of the additional population by the end of the forecast period living in Developing countries (1.7 billion people out of a 1.8 billion total increase).



Moreover, a large group of people in the Developing countries are expected to gain access to modern energy services for the first time during the forecast period. In contrast to this, OECD countries are at a more mature and saturated stage of development, and thus have a much lower rate of population growth and thus a lower potential for energy demand growth. Eurasia as a region stands somewhere in between. With prospects for average GDP growth at 2.5% p.a. and a marginally declining population, its energy demand is set to increase at rates slightly below the global average.

In terms of the actual quantity of energy demand in Developing countries, this is set to increase by 88 mboe/d from 2015–2040 compared to energy demand growth of close to 6 mboe/d in Eurasia and around 2 mboe/d in OECD regions. Within Developing countries, India and China have the largest additional energy demand during the forecast period, both in the range of 22–23 mboe/d.

Besides shifts in regional energy demand, significant changes in the global energy industry are also expected in terms of its mix. Trends from past years – such as the rapid growth of renewable energy, the expansion of gas, moderate growth in oil demand and slowing growth or even declining demand for coal in several regions – are set to continue, changing the future energy mix towards a less carbon-intensive one, as summarized in Table 3.3.

At the global level, the largest contribution to future energy demand increase is projected to come from natural gas. In absolute terms, demand for gas is estimated to increase by almost 34 mboe/d, reaching a level of 93 mboe/d by 2040. Accordingly, its share in the global energy mix is also anticipated to increase significantly by 3.6 percentage points. This represents the second largest increase in fuel shares, only behind other renewables.

This fuel category – consisting mainly of wind, photovoltaic, solar and geothermal energy – is projected to be by far the fastest-growing energy type with an average annual growth rate of 6.8% over the forecast period. It is estimated to gain a share of 4 percentage points during this period. However, its current base is rather low, contributing around only 1.4% to the global energy demand. Hence, the share of other renewables will still be below 5.5% by 2040, despite its impressive growth.



		Lev mb	/els oe/d		Growth % p.a.	Fuel shares %				
	2015	2015 2020 2030 2040 2		2015-2040	2015	2020	2030	2040		
Oil	86.5	92.3	97.9	100.7	0.6	31.3	30.9	28.8	27.1	
Coal	78.0	80.7	85.8	86.2	0.4	28.3	27.0	25.3	23.2	
Gas	59.2	65.2	79.9	93.2	1.8	21.5	21.9	23.5	25.1	
Nuclear	13.5	15.8	20.1	23.8	2.3	4.9	5.3	5.9	6.4	
Hydro	6.8	7.5	9.0	10.3	1.7	2.5	2.5	2.6	2.8	
Biomass	28.0	30.1	34.0	37.3	1.2	10.1	10.1	10.0	10.0	
Other renewables	3.8	6.6	12.9	20.0	6.8	1.4	2.2	3.8	5.4	
Total	276.0	298.2	339.4	371.6	1.2	100	100	100	100	

Table 3.3World primary energy demand by fuel type

The second-fastest growing energy source is projected to be nuclear energy, which is considered by many countries as a way to reduce CO2 emissions and address the issue of energy security. In the Reference Case, nuclear energy is estimated to meet more than 10 mboe/d of additional energy demand to 2040, contributing more than 6% to the global energy mix by the end of the forecast period.

The overall expected increase in nuclear energy (in terms of additional energy demand) will almost triple the incremental contribution of hydropower and also surpass those increases coming from biomass (including primary solid biofuels, industrial and municipal waste, liquid biofuels, biogases and charcoal) and coal.

It is to be noted that, at the global level, all major fuel types record positive growth in the Reference Case over the forecast period. Alongside the outstanding average growth rate of 6.8% projected for other renewables, gas, nuclear and hydropower grow at levels of around 2% p.a. on average while biomass is seen as growing at a rate of 1.2% p.a., close to the global average of all energy types.



Contrary to these energy sources, oil and coal are projected to grow at much lower rates of 0.6% and 0.4% p.a., respectively. Despite these relatively low rates, fossil fuels will retain a dominant role in the global energy mix, although with a declining overall share. Indeed, the share of fossil fuels in the global energy mix stood at 81% in 2015. This is estimated to decline below 80% by 2020 and then drop further to under 78% by 2030, to reach a share of 75.4% by 2040.

The trend of declining share of fossil fuels is led by coal, which is set to lose more than 5 percentage points, followed by oil whose share is expected to decline by more than 4 percentage points – both by 2040. This progressive shift away from coal and oil towards gas and renewables is a reflection of ongoing policies to address climate change concerns.

The declining share of oil in the energy mix is mainly the result of tightened fuel efficiency standards across most countries of the world. Examples of such measures include Corporate Average Fuel Economy (CAFE) and Corporate Average Fuel Consumption (CAFC) standards in the US and India, respectively, the Energy Efficiency Directive in the EU and the Federal Sustainable Development Strategy in Canada, among others.

Moreover, a gradual increase in the penetration of alternative vehicles also plays a role. In the case of coal, the loss in its share in the overall energy mix has mainly been driven by its substitution by natural gas and renewable electricity, which are more environmentally acceptable alternatives. Moreover, it is worth mentioning that this year's Reference Case sees coal demand peaking sometime around 2035. It is the only primary energy source expected to see peak demand at the global level.

3.2.2 Oil demand in the Reference Case

Long-term oil demand is expected to increase by 15.8 mb/d, rising from 95.4 mb/d in 2016 to 111.1 mb/d in 2040. As shown in Table 3.4, demand in the OECD region is anticipated to show a significant decline of 8.9 mb/d during the forecast period. This is in line with the historical declining trend that began in 2005, before it was broken in 2015 after the oil price decline. As already noted, this positive growth is scheduled to continue to 2019 only. The overall declining oil demand forecast in the OECD region is a result of a number of factors.



To start with, population growth in the OECD is expected to be rather low in the future, with a rise of only 0.3% p.a. on average for the period 2016–2040. Similarly, average economic growth in the region is estimated at only 2% p.a. for the same period. Furthermore, in the OECD a stronger tightening of policies targeting energy efficiency is anticipated. Finally, the Reference Case also sees a significant penetration of alternative fuel vehicles in this region.

							Growth
	2016	2020	2025	2030	2035	2040	2016-2040
OECD America	24.7	25.2	24.2	23.0	21.6	20.2	-4.4
OECD Europe	14.0	14.3	13.6	12.9	12.2	11.5	-2.6
OECD Asia Oceania	8.1	8.0	7.6	7.1	6.7	6.2	-1.9
OECD	46.8	47.5	45.5	43.0	40.5	37.9	-8.9
Latin America	5.7	6.0	6.4	6.8	7.0	7.3	1.6
Middle East & Africa	3.8	4.1	4.6	5.2	5.8	6.4	2.6
India	4.4	5.1	6.4	7.7	9.1	10.3	5.9
China	11.8	13.2	14.5	15.7	16.8	17.8	6.0
Other Asia	8.5	9.4	10.3	11.3	12.2	12.8	4.4
OPEC	9.1	9.8	10.7	11.5	12.0	12.4	3.3
Developing countries	43.2	47.5	52.8	58.2	63.0	67.0	23.8
Russia	3.4	3.6	3.7	3.8	3.8	3.7	0.3
Other Eurasia	1.9	2.1	2.3	2.5	2.5	2.5	0.7
Eurasia	5.3	5.7	6.0	6.2	6.3	6.2	0.9
World	95.4	100.7	104.3	107.4	109.7	111.1	15.8

Table 3.4Long-term oil demand in the Reference Case

The Reference Case envisages substantial oil demand growth in Developing countries. Driven by an expanding middle class, high population growth rates and stronger economic growth potential, the region's oil demand is expected to increase by almost 24 mb/d. It rises from 43.2 mb/d in 2016 to 67 mb/d in 2040. Within the Developing countries, China is expected to continue to be the largest consumer of oil during the forecast period, adding 6 mb/d to reach 17.8 mb/d by 2040.



India will be the region with the second largest overall demand growth, adding 5.9 mb/d between 2016 and 2040. Indian demand growth sees the fastest annual average growth rate of 3.6% p.a. Rapid growth is also expected in the Middle East & Africa (2.2% p.a.) while growth potential in Latin America is more limited (1% p.a.). In Eurasia, oil demand is forecast to increase by less than 1 mb/d to reach 6.2 mb/d in 2040. In fact, demand is anticipated to plateau around 2035 at 6.3 mb/d. Most of the growth is expected to come from Other Eurasia, which adds 0.7 mb/d during the forecast period.

Figure 3.2 clearly highlights the importance of Developing countries as a longterm oil demand growth driver. Over the forecast period, oil demand in the region is expected to increase, on average, by 1 mb/d p.a., with China and India combined accounting for half of that growth. However, the picture is rather different at the end of the forecast period, compared to the beginning, as oil demand growth decelerates and the regional demand growth gravity centre shifts from China to India.



Figure 3.2 Average annual oil demand growth in the Reference Case

Between 2016 and 2020, regional oil demand is expected to increase at an annual average of 1.1 mb/d, with China representing almost two out of every six additional regional barrels and India one out of every six. During the last five years



of the forecast period, however, oil demand growth decelerates significantly, to an annual average of just 0.8 mb/d as developing economies mature and see lower GDP growth figures. China will add one out of every four regional barrels, while India will add almost one out of three regional barrels by 2040.

In the OECD region, overall oil demand marginally increases between 2016 and 2020 driven by strong demand in OECD America and, to a lesser extent, OECD Europe. Thereafter, a continuous and accelerated decline is expected. In the last years of the forecast period, oil demand will decline, on average, by 0.5 mb/d p.a. Most of the decline will come from the road transportation sector as the regional car fleet becomes increasingly more efficient and the prevalence of EVs, which include PHEVs and BEVs, expands. In Eurasia, improving economic conditions and geopolitical stability will incentivize oil demand in the medium-term. However, in the long-term, oil demand growth is expected to be constrained by low economic growth and a declining population.

Figure 3.2 also shows another important demand trend. Global oil demand growth is forecast to decelerate steadily, slowing from over 1.3 mb/d every year during the period 2016–2020 to only 0.3 mb/d every year between 2035 and 2040. The relatively strong oil demand growth up to 2020 is a result of the lower oil price environment, accelerating economic growth and the impact of the IMO regulations on oil demand in 2020. Looking to the long-term, the outlook assumes that oil prices will gradually rise and that the global economy will decelerate as a result of lower employment growth coupled with lower labour productivity growth. These assumptions will certainty curtail demand growth. However, three further structural factors that can be expected to limit growth potential are of particular interest.

Firstly, the economy, particularly that of developing countries, is anticipated to increasingly shift away from heavy industry, which tends to be more oil intensive, to a more service-oriented structure. A good example of this is China, where the weight of the service sector in the national economy has increased steadily over the past decade. According to the World Bank, in 2006 it represented 42% of the economy, while in 2015 its share had increased to 50%. Over the same timeframe, the weight of the industry sector dropped from 48% to 41%.



Secondly, further efficiency improvements will likely curb future oil demand growth. Whether it comes from a tightening of energy efficiency policies, technological improvements, or both, the use of energy (and oil) is expected to become ever more efficient. For example, cars will consume less fuel per kilometre, airplanes will burn less fuel per passenger kilometre and less energy will be needed to heat the same house in the future.

Finally, oil demand will likely continue to be limited by fuel switching. This is particularly true in the road transportation sector, where increasingly more EVs are estimated to penetrate the market, thus, displacing barrels of oil. In the marine bunkers sector the use of LNG could also displace some barrels of oil in the long-term. Similarly, in the residential/commercial/agriculture sector a certain degree of substitution by gas can be expected to limit oil's sectoral demand growth.

							Growth
	2016	2020	2025	2030	2035	2040	2016-2040
Road	43.0	45.4	46.8	47.7	48.2	48.4	5.4
Aviation	6.0	6.6	7.2	7.8	8.4	8.9	2.9
Rail & dom. waterways	1.8	1.9	2.0	2.1	2.1	2.2	0.4
Marine Bunkers	3.8	4.2	4.7	5.0	5.2	5.4	1.5
Transportation	54.6	58.1	60.6	62.5	63.9	64.9	10.3
Petrochemicals	12.6	13.4	14.3	15.0	15.9	16.5	3.9
Other Industry	12.5	13.0	13.3	13.6	13.7	13.7	1.2
Industry	25.2	26.4	27.6	28.6	29.6	30.2	5.1
Resid./Comm./Agr.	10.5	10.9	11.4	11.7	12.0	12.1	1.7
Electricity generation	5.1	5.3	4.8	4.6	4.2	3.9	-1.2
Other uses	15.6	16.2	16.1	16.3	16.2	16.0	0.4
World	95.4	100.7	104.3	107.4	109.7	111.1	15.8

Table 3.5Sectoral oil demand in the Reference Case

From the sectoral point of view, as shown in Table 3.5 and Figure 3.3, most of the demand for oil in the Reference Case is used for transportation. This is the sector where oil faces less strong competition from alternative fuels. Between 2016 and



2040, the transportation sector is expected to account for two out of every three additional barrels consumed. Nevertheless, demand growth is foreseen to decelerate on the back of efficiency improvements driven by technological developments, the tightening of energy policies and the somewhat marginal (but increasing) penetration of natural gas and electricity fuelled means of transportation.

Oil use for industrial purposes is also expected to increase, though at a slower pace than in the transportation sector. Growth is driven mainly by the petrochemicals sector, while oil demand in the rest of the industry sector will continue to face strong competition from alternative fuels. Oil consumed for other uses is forecast to grow marginally, particularly because demand in electricity generation is projected to decline. However, measures to alleviate energy poverty, coupled with rising income and urbanization levels, will continue to foster a switch away from traditional fuels to oil.



The road transportation sector is currently the biggest contributor to oil demand. In 2016, this sector represented 45% of global demand with 43 mb/d. Significant demand growth is expected in the long-term, with an additional 5.4 mb/d up to



2040 to reach 48.4 mb/d. In fact, demand for one out of every three new barrels between 2016 and 2040 is estimated to come from the road transportation sector. Noteworthy growth is also expected for the petrochemicals sector where demand is anticipated to increase by 3.9 mb/d during the forecast period. Interestingly, sectoral demand is seen to grow at a much faster rate (1.1% p.a.) than overall demand (0.6% p.a.), so that the share of the petrochemicals sector is forecast to increase from 13% in 2016 to 15% in 2040.

The 'other industry' sector – comprising primarily iron and steel, glass and cement production, construction and mining – is the third biggest sector in terms of demand, with a total of 12.5 mb/d in 2016. At a global level, sectoral demand is anticipated to increase by 1.2 mb/d up to 2040. However, growth is expected to decelerate as global GDP moves from an industry-oriented structure towards a more service-oriented one. In fact, sectoral oil demand will exhibit almost negligible growth in the last few years of the forecast period. The use of oil in the residential/commercial/agriculture sector totalled 10.5 mb/d in 2016. Demand is expected to grow by 1.7 mb/d between 2016 and 2040, corresponding to an average growth rate of 0.6% p.a. Growth is partially curtailed because of the substitution away from oil to natural gas and renewables.

Aviation is the fastest growing sector driven by a rapidly growing middle class, particularly in developing countries and an increasing penetration of low-cost carriers (LCC). It is foreseen that oil demand will increase at an average rate of 1.4% p.a. between 2016 and 2040. In volumetric terms, demand is estimated to increase by 2.9 mb/d, rising from 6 mb/d in 2016 to 8.9 mb/d in 2040. Electricity generation is the only sector where declining demand is forecast at a global level. This is a result of increasing competition from coal and gas, as well as from renewables.

Oil use in the marine bunkers sector is anticipated to grow at a healthy rate (1.4% p.a. on average) up to 2040. The additional 1.5 mb/d of oil demand is a result of increasing global economic and trade activity. Finally, the rail and domestic waterways sector is the smallest in terms of oil demand. It accounts for only 2% of global demand. However, expanding infrastructure and trade activity, together with rising urbanization levels, is expected to foster demand growth in the long-term. Demand is expected to reach 2.2 mb/d in 2040.



3.3 Liquids supply

The Reference Case total non-OPEC liquids supply outlook envisages production declining marginally from 60.7 mb/d in 2020 to 60.4 million b/d in 2040, or by 0.3 mb/d in total. Thus, looking at the forecast period in its entirety, non-OPEC liquids supply grows by a modest 3.4 mb/d from 2016–2040, all of which takes places in the first ten years, after which non-OPEC supply as a whole declines.

The breakdown of the 2020-2040 liquids supply outlook in the Reference Case can be seen in Table 3.6. Regionally, Latin America and Eurasia show modest growth of 0.9 mb/d and 0.4 mb/d, respectively, in the period 2020–2040, while refinery processing gains add another 0.7 mb/d. OECD Europe, Asia Far East and China show meaningful declines. Overall growth of 0.3 mb/d in North America masks the fact that while US and Mexican supply shrinks by 0.8 mb/d and 0.4 mb/d, respectively, Canadian liquids production grows by 1.5 mb/d.

Breaking the long-term change into individual liquids components, of the modest aggregate non-OPEC liquids decline in the 2020–2040 period, the drop is most evident in non-OPEC crude production (-3.8 mb/d, including US tight oil), and non-OPEC NGLs (-0.5 mb/d). This is partially offset by growth from non-conventional (+2.1 mb/d, of which some 80% is Canadian oil sands), biofuels (+1.2 mb/d) and refinery processing gains (+0.7 mb/d).

In the Reference Case, demand for OPEC crude stays relatively flat at just over 33 mb/d until 2025, after which US tight oil is projected to peak, and with it overall non-OPEC supply. Thereafter, the call on OPEC crude production rises steadily, reaching 41.4 mb/d in 2040, or up 8.8 mb/d from 2016. This would imply OPEC's share of global oil production (including not only crude, but also all other liquids), would rise from 40% in 2016 to 46% in 2040.



	2016	2017	2020	2025	2030	2035	2040	Change 2020-2040
US & Canada	18.1	18.9	21.4	23.8	23.9	23.2	22.1	0.7
of which: tight crude	4.5	5.1	5.7	8.7	8.8	8.3	7.3	1.6
Mexico & Chile	2.5	2.3	2.1	1.9	1.8	1.7	1.7	-0.4
OECD Europe	3.8	3.8	3.8	3.7	3.5	3.3	2.9	-0.9
OECD Asia Oceania	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.1
OECD	24.8	25.5	27.7	30.0	29.7	28.7	27.2	-0.5
Latin America	5.1	5.2	5.6	6.3	6.4	6.5	6.5	0.9
Middle East & Africa	3.1	3.1	3.3	3.3	3.2	3.0	2.8	-0.5
Asia	3.7	3.6	3.5	3.5	3.4	3.1	2.9	-0.7
China	4.1	4.0	3.7	3.6	3.5	3.3	3.2	-0.5
DCs, excl. OPEC	16.0	16.0	16.1	16.7	16.4	15.9	15.3	-0.8
Russia	11.1	11.0	11.4	11.2	11.1	11.1	11.1	-0.3
Other Eurasia	2.9	3.0	3.1	3.2	3.5	3.7	3.8	0.7
Eurasia	14.0	14.1	14.5	14.4	14.6	14.8	14.9	0.4
Processing gains	2.2	2.2	2.3	2.4	2.6	2.8	3.0	0.7
Non-OPEC	57.0	57.7	60.7	63.6	63.5	62.3	60.4	-0.3
Crude	42.0	42.2	43.6	45.2	44.3	42.4	39.9	-3.8
NGLs	7.7	7.9	8.7	9.2	9.1	8.7	8.2	-0.5
of which: unconv. NGLs	2.2	2.2	2.5	3.2	3.3	3.1	2.9	0.4
Other liquids incl. biofuels	5.1	5.4	6.0	6.7	7.5	8.4	9.2	3.3
Total OPEC supply	38.8	38.7	40.4	41.0	44.1	47.6	50.9	10.5
OPEC NGLs	5.9	6.0	6.4	7.0	7.7	8.3	8.9	2.5
OPEC Other liquids*	0.2	0.3	0.3	0.5	0.5	0.5	0.6	0.2
OPEC crude	32.7	32.4	33.7	33.5	35.9	38.8	41.4	7.7
Stock change**	0.5	-0.3	0.4	0.2	0.2	0.2	0.2	
World supply	95.8	96.5	101.1	104.5	107.6	109.9	111.3	10.2

Table 3.6 Long-term liquids supply outlook in the Reference Case

* This item includes other non-crude streams, such as GTLs, methyl tetra-butyl ether (MTBE) and biofuels.

** Stock change assumptions reflect commercial stock inventories, development of Strategic Petroleum Reserves (SPR), and the rising need for stocks as refinery capacity expands.



The US tight oil sector, which has provided the bulk of non-OPEC supply growth since its emergence in the late 2000s, continues to display a strong degree of elasticity or responsiveness to price. When crude prices declined from mid-2014, it was US tight oil production that took the greatest hit, with an annual decline observed in 2016. However, a subsequent price recovery from the end of 2016 has turned sentiment around and overall US liquids supply has more or less returned to its previous peak reached in early 2015.

This Outlook forecasts a growth in US total tight oil from 6.6 mb/d in 2016 to 11.1 mb/d by 2022. Thereafter, production grows at a slower pace until peaking in 2026/27, after which output is expected to decline again to 9.9 mb/d by 2040. This compares with a significantly more conservative outlook for US tight oil presented in last year's WOO, in which US tight oil was only expected to grow to 7.2 mb/d by 2022 and peak at 8.7 mb/d in the late 2020s.



By contrast with the US, there have been comparatively small revisions to the tight oil outlook elsewhere. The Reference Case still assumes steady output growth in Canada, with total tight oil output rising from 0.5 mb/d in 2016 to 0.8



mb/d by 2022, and thereafter staying relatively flat. Russia and Argentina are both assumed to have much more modest increases in their respective tight oil sectors. In the Reference Case, no tight oil production in other countries is projected, despite a significant resource base, for example, in China, Colombia or Mexico.

3.4 Refining and oil movements

3.4.1 Refining outlook

Global incremental distillation capacity resulting from existing projects was assessed at 7.6 mb/d for the six-year period from 2017–2022. This represents a gradual recovery in the pace of additions relative to last year's projection of 7.3 mb/d for 2016–2021 and the 7 mb/d assessed two years ago for 2015–2020. Adding in an allowance for some limited additions to be achieved through 'capacity creep', the total medium-term increment to crude distillation units is projected to be around 8.4 mb/d for 2017–2022.

Figure 3.5 provides a summary assessment of the cumulative medium-term potential for additional crude runs based on assessed refinery projects – including an allowance for 'capacity creep' – compared to the required incremental product supply from refineries based on global product demand growth. On this basis, potential incremental crude runs average approximately 1.2 mb/d annually, leading to cumulative potential incremental runs of 7.4 mb/d in the period to 2022.

Compared to the refining potential, annual global demand growth in the six years from 2016–2022 is projected to average almost 1.2 mb/d p.a. However, close to 15% of the growth is covered by incremental supplies from biofuels, natural gas liquids (NGLs) and other non-crude streams. This leaves a little under 85%, or around 0.95 mb/d p.a. on average, to come from crude-based refined products.

The net result is an outlook where incremental refinery output potential and incremental refinery product demand are projected to be closely in balance through to 2018, but thereafter, a gap progressively opens up, starting with exceptionally high additions in 2019. Consequently, the cumulative 7.4 mb/d



refinery production potential is around 1.6 mb/d in excess of the 5.75 mb/d that refineries are projected to be required to produce by 2022.



Figure 3.5 Additional cumulative refinery crude runs, required and potential

On a regional basis, developed regions such as the US & Canada, Russia & Caspian and Europe show capacity surplus in 2022, mostly due to declining demand. In addition, the Middle East is also projected to see a considerable surplus by 2022, based on the intention to increase product exports.

This cumulative capacity overhang points to a period of rising international competition in the product markets and lower overall refinery utilization, which, as a consequence, could lead to capacity closures, especially in developed regions.

In the long-term, recent estimates indicate that the total of 19.6 mb/d of new refining capacity will be required between 2017 and 2040 (Figure 3.6). The majority of the new capacity is anticipated to be located in developing regions supported by growing oil demand.

Around half of the overall refining capacity (9.5 mb/d) is estimated to be added in the Asia-Pacific, while new capacities in the Middle East are expected to total around 3.7 mb/d, or some 20% of the total. Combined refining capacity additions



in Latin America and Africa are estimated to be around 4.5 mb/d, or almost 25% of the total. At the same time, in the long-term new builds in developed regions are estimated at below 2 mb/d, which equates to less than 10% of the global additions.





It is also important to recognize that the projected long-term additions are driven more by the shift in global demand from industrialized regions to developing regions (mostly the Asia-Pacific) than by outright global demand growth itself. In addition, these new refineries in developing regions will compete with existing facilities in the US & Canada, Europe and Russia & Caspian as demand in those regions flattens before starting to decline.

3.4.2 Oil movements

In terms of trade, the outlook emphasizes that long term global oil trade is set to increase gradually with the Middle East playing a significant and expanded role in crude and products.



The anticipated rather sharp changes in crude trade between 2016 and 2020 shown in Figure 3.7 stem mainly from developments in the US & Canada region. As oil production in the US & Canada increases, it is expected that crude exports rise significantly to world markets. Although a net-importing region, the US & Canada is estimated to export an appreciable share of its production, as a large portion of the crude produced is light-sweet (notably tight oil) and sold at a premium to high-sulphur and heavier grades, while US refineries process mainly medium and heavy grades. At the same time, imports to the US & Canada are also expected to increase in the period to 2020 as most refineries in the US are complex and capable of converting low-quality and highly-discounted crude into high-value products such as diesel and gasoline.



Figure 3.7 Inter-regional crude oil and products exports, 2016–2040

In the period post-2020, the international crude trade is estimated to drop slightly by 2025, as more regions are expected to use more crude locally in newly installed refining units, for example, in Latin America and Africa, as well as the Middle East. Thereafter, global trade increases gradually, in line with growing liquids demand, resulting predominantly in increasing exports from the Middle East and imports to the Asia-Pacific. The overall crude and condensate trade in



2040 is estimated to be just below 44 mb/d. On the product side, the trade volumes drop significantly between 2020 and 2025 as the refining system in product-importing regions expands, which reduces somewhat the need for refined product imports.

3.5 Critical uncertainties

The energy market, and in particular the oil market, is clouded with uncertainties that stem from a wide variety of sources. These include the economy, policy development, both from the demand and supply side, the pace of technology development, climate change, environmental regulations, speculative financial activities, fiscal conditions, the evolution of costs, to name just a few. This subsection attempts to address some of these: specifically those that are relevant to long-term oil market prospects.

Looking at the demand side, three sources of uncertainties were considered: alternative views on economic developments, on the level and speed of penetration of alternative vehicles and on the speed of adoption of energy efficiency measures across various oil demand sectors. For the supply side, upside and downside non-OPEC alternative supply sensitivities were considered.

Addressing the issue of economic developments, two alternative sensitivities were developed: higher GDP growth (HG) and lower GDP growth (LG). The HG sensitivity assumes that the average GDP growth for the forecast period is 3.6% p.a. This is the result of additional labour productivity gains and employment growth due to further efforts to improve human capital and promote labour market participation. In the LG sensitivity, the average GDP growth for the forecast period is assumed at 3.3% p.a. This is the result of an increasing move towards protectionism that limits trade and migration.

In the case of the HG, global oil demand reaches 113.8 mb/d in 2040. The LG sees demand at 107.5 mb/d in the same year. This implies that the overall uncertainty emerging from the economic developments is in the range of around 6 mb/d in 2040. Moreover, it is important to highlight that the uncertainty is skewed to the downside.



Figure 3.8 World oil demand in the economic growth sensitivities



Focusing on the penetration of EVs in the passenger car segment, an alternative sensitivity has been developed: the Sensitivity Case. In this sensitivity, a more optimistic view is taken on the penetration of EVs with the assumption that annual EV sales reach 80 million by 2040. This would mean that three out of every five cars sold in 2040 would be electric.



Figure 3.9 Oil demand in the Reference Case and the EV Sensitivity Case

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Under the assumption that the increasing EV penetration in the passenger car segment in the Sensitivity Case spreads, at least partially, to commercial vehicles, particularly in the medium-duty segment, oil demand in 2040 is reduced by 2.5 mb/d compared to the Reference Case, to total 108.6 mb/d. Moreover, global oil demand is estimated to plateau around this level in the second half of the 2030s.

Improvements in energy efficiency have long been recognized as a key element of policies focused on reducing emissions. Therefore, an alternative sensitivity – Accelerated Efficiency (AE) case – was developed assuming somewhat more aggressive efficiency improvements than those incorporated in the Reference Case. It is important to note, however, that the rates of efficiency improvements assumed in the AE case do not fully explore the potential for improvement that exists in the oil sector.

On the contrary, they in fact represent the moderate levels that are plausibly achievable if policymakers and technology work together in an orchestrated way in the decades to come. Compared to the Reference Case, the overall demand reduction in the AE case is 3.2 mb/d by 2040. The larger part of this reduction, around two thirds, is assumed to take place in Developing countries where a higher potential for efficiency improvements exists.





To reflect supply uncertainties, alternative non-OPEC supply sensitivities were also examined – both to the upside and the downside. These are explicitly constructed as a function of country-specific factors, including technology, regulation, taxation, innovation and others. The upside sensitivity shows greater potential, with 1.3 mb/d more non-OPEC oil production achieved by 2022, widening to around 4.6 mb/d in the long-term. By contrast, the downside sensitivity sees non-OPEC supply around 0.5 mb/d lower by 2022, widening to 3.6 mb/d by 2040.

Based upon the upside sensitivity for non-OPEC supply, the demand for OPEC crude is reduced to a low of around 31 mb/d in the latter half of the 2020s, before US tight oil peaks and demand for OPEC crude rises again. By 2040, demand for OPEC crude increases significantly to 36.8 mb/d, albeit still 4.6 mb/d lower than in the Reference Case. The effect of the downside sensitivity for non-OPEC supply is less pronounced. The demand for OPEC crude remains relatively flat at just over 33 mb/d in the medium-term horizon. Thereafter, it rises steadily, topping 40 mb/d in the early 2030s and reaching 45 mb/d by 2040. This is some 3.6 mb/d higher than in the Reference Case, and a full 8.1 mb/d higher than in the upside sensitivity estimate.



Figure 3.10



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4. Energy access and sustainable development

The 2030 Agenda for Sustainable Development (2030 Agenda), adopted at the UN Sustainable Development Summit on 25 September 2015, is in its early years of implementation. As a plan of action for people, planet and prosperity, it recognises that "eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development".

In this context, the multi-dimensional nature of poverty needs to be considered for the implementation of the 2030 Agenda. A holistic vision of society is required that aims to achieve economic well-being, social inclusion and environmental sustainability in an integrated manner. To this end, a set of 17 sustainable development goals (SGDs) are to be achieved by 2030 in order to stimulate action and put the world into a sustainable and resilient path.

The SDGs cover a wide range of issues for the world to develop sustainably. The goals call *inter alia* to end poverty and hunger, reduce inequalities, address climate change, promote peace and justice, and enhance partnerships. In addition, they also call to ensure access to basic quality services such as health care, education, water and sanitation, and sustainable energy. That is, the SDGs set a number of global priorities and objectives that are fundamentally interdependent and require a coherent approach and international cooperation to implementation.

Energy has a prominent place in the 2030 Agenda, being fundamental to human development and a cross-cutting issue in socio-economic prosperity and environmental sustainability. It is included explicitly as one of the SDGs, with goal number seven (SDG 7) calling to secure access to affordable, reliable, sustainable, and modern energy services. To achieve this goal, actions are needed to ensure universal energy access, to increase the share of renewable energy sources and to double the rate of energy efficiency improvement.

Besides these three targets, two enabling actions are also listed under SDG 7. The first focuses on international cooperation to facilitate access to clean energy research and technology, and promote investment in energy infrastructure and clean energy technology. The second is to expand infrastructure and upgrade



technology for supplying modern and sustainable energy services for all in developing countries, in accordance with their respective programmes of support.

To follow the implementation of the SDGs and their targets a number of indicators has been developed – those of goal number seven on energy are used in the below analysis. In addition, the High-Level Political Forum (HLPF), acting as the central UN body for the implementation of the 2030 Agenda, is tasked to conduct reviews on an annual and thematic basis. In 2018, SDG 7 will be reviewed and the theme of the HLPF session will be "Transformation towards sustainable and resilient societies".

To date, some progress has been made on the three targets of SGD 7. However, some countries appear to be far from achieving these by 2030. In regards to energy poverty, billions of people around the world still do not have access to electricity or clean fuels and technologies for cooking. On the other two targets, the share of renewable energy in total final energy consumption increased modestly over the period 2012-2014, while progress in doubling the global rate of improvement in energy efficiency is still not sufficient to meet the target.²



Figure 4.1 Access to electricity, % of population

Source: World Bank, 2017, Sustainable Development Goals (SDGs).

Based on the latest available data, about 85% of the world population had access to electricity in 2014 (Figure 4.1). An increase of 0.4 percentage points is observed

² Economic and Social Council, United Nations, (May 2017), Progress towards the Sustainable Development Goals: Report of the Secretary-General, High-level Segment, E/2017/66.



since 2012, implying that 86 million people gained access to electricity for the first time annually. However, around 1.1 billion people still function without electricity, and half of those people live in Sub-Saharan Africa.

In general, electrification has outpaced population growth in most regions, and countries in South Asia have increased their electrification by 22.8 percentage points in the course of the 2000–2014 period. Nevertheless, more than 20 African countries still have electricity access rates of 30% or less, accounting for the access deficit. Even within these countries, significant differences are observed between urban and rural areas.

At a global level, 27% of people living in rural areas do not have access to electricity in the year 2014. This rate increases to 28% in South Asian countries, and further to 82% in Sub-Saharan Africa. These figures therefore underscore the need for enhanced action with the objective to close the reported gap and ensure energy access for all within the following years and up to 2030.

At the same time, approximately 3 billion people, the majority of them living in Sub-Saharan Africa and Asia, are still cooking without clean fuels and efficient technologies. Figure 4.2 illustrates that as population and economies grow, electricity access has increased while access to clean cooking has lagged behind.

In 2000, the global average for electrification was 77.6% of world population and for clean cooking was 50.4%. In 2014, the share of population with access to electricity reached the level of 85.3% and the respective figure for clean cooking is only 57.4%.

As a result, the absolute number of people relying on solid fuels for cooking has increased. In urban areas, 78% of the world population has access to clean cooking, but only 22% of those living in rural areas. Overall, some countries – including those of Indonesia, Peru, Azerbaijan and South Africa – have made rapid progress in clean cooking, but for others there is more room for improvement (e.g. Madagascar, Rwanda, Tanzania, Uganda, Mali and Ethiopia).

It should be highlighted that even those regions and countries that report an (almost) universal electrification and access to clean cooking may also need to address energy access challenges. These relate mainly to remote, off-grid



locations, on-grid access with limited or intermittent supply due to poor infrastructure or fuel supply problems, and affordability issues.



Figure 4.2 Access to electricity and clean cooking

The indicators used above to measure energy access may be at (or close to) 100% in terms of physical access; however, the energy services considered may not be accessible to the energy poor, if they cannot afford their cost. In addition, ageing infrastructure, a lack of supply diversity, and interruptions or shortages in supply restrict access to energy in particular regions and populations – therefore, lead to energy poverty.

Moreover, lack of access to modern energy services could hinder the achievement of other SDGs. Considering the SDGs interact with one another, energy access enhances food security, economic development, human health and poverty reduction. A modern energy system could support all sectors of the economy – from businesses, medicine and education to agriculture, infrastructure, communications and high-technology.

For example, access to modern energy could reduce the share of population relying on wood, charcoal, dung and coal for cooking (and heating); resulting in fewer premature deaths due to indoor air pollution. Similarly, access to modern energy could empower women by creating income generation opportunities at home; girls could attend schools, children could do homework at night, hospitals



could store vaccines and medication, and people could engage in more productive job opportunities.

In light of the above, it becomes evident that sufficient financial resources, technology development and effective policies designed to encourage investments in modern energy sources are needed to ensure energy access at a global level. International cooperation on these aspects could enhance actions of countries that aim to accelerate the transition to an affordable, reliable, sustainable and modern energy system.

An uptake in renewables, the second target of SDG 7, would also ensue when moving away from traditional uses of biomass and towards modern energy sources. This progress is already taking off in the electricity sector, with wind and solar photovoltaic accounting for the majority of renewables' electricity capacity added each year. Given that emissions from the electricity sector constitute a significant share of total emissions from the combustion of fossil fuels, electricity generation from renewable sources and fuel substitution away from coal to lower carbon content fuels such as gas could lead to a significant reduction in emissions.

In the period 2012–2014, the share of renewable energy in the total final energy consumption increased by 0.4 percentage points, reaching the level of 18.3%. However, national circumstances should be highlighted. That is, the high shares reported for many developing countries reflect their reliance on traditional uses of biomass. For instance, in African countries, renewable energy accounted for 57% of total final energy consumption in 2014. The share of traditional use of biomass was though 49%, and modern renewable energy was only around 6% (Figure 4.3). As a result, the share of renewable energy in some developing countries is likely to decline while these economies accelerate their transition towards modern energy sources.

To achieve the goal in modern renewable energy, significant improvement in energy efficiency is also needed, as per the third target of SDG 7. A proxy used to measure energy efficiency is energy intensity – the ratio of energy used per unit of GDP. This implies that as energy efficiency increases, energy intensity declines; leading to higher economic value out of every unit of energy used³.

³ It should be reiterated that reducing energy intensity could also be the result of changing production and consumption patterns.





Source: Sustainable Energy for All: Global Tracking Framework - Progress toward sustainable energy, 2017.

This effect is evident in developed countries, where GDP grows with lower increasing rates in energy consumption. At a global level, energy intensity of the economy has improved by a 2.1% compound average annual growth rate in 2012–2014. Energy intensity at a global level has therefore reached the level of 5.4 MJ/2011 \$PPP⁴ in 2014, compared to 5.8 MJ/2011 \$PPP in 2012 (Figure 4.4). Policies designed to make countries more energy efficient have been a key driver for this development, but a way to go is still needed to reach the target by 2030 (that is approximately 3.4 MJ/2011 \$PPP).



Source: Sustainable Energy for All: Global Tracking Framework - Progress toward sustainable energy, 2017.

At a country level, Member States of the EU, such as Denmark, Italy and the UK, have already achieved the target, while other major energy consuming countries

⁴ Megajoules per 2011 purchasing power parity dollar.

(including the US, China and Russia) need to improve energy efficiency focusing on sectors with room for improvement (e.g. in the residential sector). At a regional level, convergence in energy intensity is observed across regions and toward the current global average. However, wide variation prevails between developed and developing countries in regards to transmission and distribution network losses in electricity.

OPEC and its Member Countries have been strong advocates of sustainable development, recognising alleviation of energy poverty as a universal aspiration. The OPEC Fund for International Development (OFID) has recently inaugurated as a lead partner the Oil and Gas Industry's Energy Access Platform, together with other major oil and gas companies and other stakeholders including business developers. The objective of this platform is to contribute to the achievement of universal energy access, by leveraging industry capabilities to support access to energy, sharing best practices, fostering communication and contributing to better integrate energy access in policies and projects at country level.

The focus areas of this initiative include the following: promote the use of cleaner cooking technologies and fuels that can reduce the incidence of household air pollution (e.g. biogas and liquefied petroleum gas); promote the integration of mini-grids that have as power source a diesel-powered generator, a renewable energy power plant or a hybrid power plant; and highlight the oil and gas sector technical knowhow to develop solutions that could have an important part to play in contributing to a sustainable energy future.

Finally, OFID is implementing an Energy for the Poor Initiative, which is funded through a revolving endowment of US\$1bn, a sum pledged by the institution's supreme body, the Ministerial Council, in its June 2012 Declaration on Energy Poverty. As of end-2016, energy operations accounted for almost \$4,280 million of OFID's cumulative commitments. These resources have been distributed among 90 countries for projects ranging from infrastructure and equipment provision to research and capacity building.



5. Concluding remarks

The global energy system, and oil markets as an integral part of it, are undergoing significant changes. Challenges and uncertainties our industry face are enormous, with ever increasing complexity and interdependence. Therefore, seeking adequate and sustainable solutions requires concerted efforts and, where appropriate, joint collaboration.

OPEC fully acknowledges the importance of dialogue and seeks close engagement with major stakeholders at various levels as an essential way to advance mutual understanding on common challenges — such as security of supply and demand, investments, cleaner fossil fuel technologies, environmental protection, the role of petroleum in promoting sustainable development and energy poverty.

For this reason, OPEC is continually engaged in a dialogue with both major oil consumers and producers, in international global cooperation via various fora, and high-level meetings, including cooperation with the International Energy Forum (IEF), the International Energy Agency (IEA) and G20 energy initiatives.

In this regard, it is particularly worth mentioning the joint collaborative efforts of the IEA-IEF-OPEC, such as the JODI programme for energy data transparency, the annual symposium on energy outlooks and workshops on financial markets and on coal.

OPEC's active participation in these efforts arises from the deep belief that dialogue builds confidence, can address the concerns of both producers and consumers and aids long-term market stability for the sake of our common future.

