SEVENTH IEA IEF OPEC SYMPOSIUM ON ENERGY OUTLOOKS

INTERNATIONAL ENERGY FORUM

AN INTERNATIONAL ENERGY FORUM PUBLICATION 15 FEBRUARY 2017

INTRODUCTORY PAPER:

A COMPARISON OF RECENT IEA AND OPEC OUTLOOKS

International Energy Forum in partnership with **Resources for the Future**

RESOURCES FOR THE FUTURE

This introductory paper was prepared by the IEF and Resources for the Future, in consultation with the IEA and OPEC

SEVENTH IEA IEF OPEC SYMPOSIUM ON ENERGY OUTLOOKS

Acknowledgements

This report was prepared by the **IEF** and Resources for the Future, in consultation with the International Energy Agency and the Organization of the Petroleum Exporting Countries.

Richard G. Newell, President and CEO of Resources for the Future, served as Principal Researcher on the project. Daniel Raimi, Senior Research Associate, led the drafting of this paper. Michael Greenberg, Research Assistant, provided key research. Alan Krupnick, Senior Fellow and Co-Director of the Center for Energy and Climate Economics, provided additional support.

The **IEF** and Resources for the Future would like to thank the **IEA** and **OPEC** for their constructive comments and insights into this document and the on-going dialogue that underpins the trilateral programme of work.

Table of Contents

Acronyms and Abbreviations

bbl	Barrel
CPS	Current Policies Scenario (IEA)
EOR	Enhanced Oil Recovery
FSU	Former Soviet Union
GDP	Gross Domestic Product
GHG	Greenhouse gas
HEG	Higher Economic Growth Scenario (OPEC)
IEA	International Energy Agency
IEF	International Energy Forum
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
kb/d	Thousand Barrels per Day
LEG	Lower Economic Growth Scenario (OPEC)
LTO	Light Tight Oil
mb/d	Million Barrels per Day
mboe	Million Barrels of Oil Equivalent
mboe/d	Million Barrels of Oil Equivalent per Day
MOMR	Monthly Oil Market Report (OPEC)
mtoe	Million Tonnes of Oil Equivalent
MTBE	Methyl Tertiary Butyl Ether
MTOMR	Medium-term Oil Market Report (IEA)
NGLs	Natural Gas Liquids
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
OMR	Oil Market Report (IEA)
OPEC	Organization of the Petroleum Exporting Countries
ORB	OPEC Reference Basket
ppm	Parts per Million
R/P	Resources-to-Production
SPR	Strategic Petroleum Reserve
UN	United Nations
UPS	Upside Supply Scenario (OPEC)
URR	Ultimately Recoverable Resources
USGS	U.S. Geological Survey
WEO	World Energy Outlook (IEA)
WOO	World Oil Outlook (OPEC)

1. Key Observations

1.1 Overview

- This Introductory Paper provides a **comparative analysis of the short-, medium-, and long-term energy outlooks** published by the IEA and OPEC in 2016, and serves **to inform discussions of the Seventh IEA-IEF-OPEC Symposium on Energy Outlooks** taking place in Riyadh, Saudi Arabia on 15 February 2017.

- The Paper **compares** the **most recent estimates for energy demand and supply** through the three projection timeframes of the IEA and OPEC energy outlooks, **along with the methodologies and conventions the IEA and OPEC use**.

- Comparisons **include short-, and medium-term liquid supply and demand projections, up to mid-2018 and 2021** respectively, and **a comparative analysis of primary energy demand projections by energy source in the long-term energy outlooks to 2040** for the three main scenarios. These are t**he Current and New Policies Scenarios** of the IEA and **the Reference Case** of OPEC.

- Finally, the comparative analysis of these three scenarios is placed in the context of the additional scenarios that both the IEA and OPEC present in their 2016 energy outlooks.

1.2 Recent Progress on Data Harmonisation and Comparability of Outlooks

- Substantial progress was made over the course of the six IEA-IEF-OPEC Symposia on Energy Outlooks to enhance the comparability of the IEA and OPEC energy outlooks. **IEF facilitated collaboration between IEA and OPEC experts** in a series of ongoing technical meetings that **enabled the alignment of methodologies and conventions**, and brought about a better **understanding of differences in IEA and OPEC historical baseline data** with a view to reduce differences. Thus, **the IEA and OPEC now use mutually consistent base year oil demand data**.

Key achievements include:

- **similar publication** dates of the short-term and long-term energy outlooks,

- **similar baselines** for total primary energy demand (2014), as well as oil demand and supply (2015),

- **projection period time frames** of monthly short-term outlooks, and for medium-, and long-term outlooks with the same end years - 2021 and 2040; and

- **the disaggregation by region** of oil demand of OPEC member country demand in long term outlooks, light tight oil, and of biofuels in both monthly and medium term oil market outlooks and **fuel classifications** that treat natural gas liquids separate from crude.

1.3 Opportunities to Advance the Comparability of Outlooks

Nevertheless, there are additional opportunities to make the outlooks more comparable.

- **The remaining differences in world liquids demand and supply baselines at 1.7 mb/d and 1.4 mb/d** respectively, could be reduced and ideally eliminated. These differences relate almost entirely to the non-OECD region and propagate over assessment periods.

- **The publication date of the medium-term oil market outlook** by the IEA and OPEC could be better aligned. Currently they are separated by a 10-month interval.

- **A more consistent classification of liquid fuels at regional and global levels** could be sought. There are issues with maritime and aviation fuels, as well as biofuels classifications and units.

- **Ongoing dialogue at the expert level on assumptions and methodologies remains valuable** to deepen understanding of the impact that different price assumptions and different views on the evolution of policy, technology and economic growth have on longer term oil supply and demand balances, particularly as this relates to the role of unconventional production and other energy sources.

- Finally, with the inclusion of Gabon and Indonesia as OPEC member countries in 2016, **regional classification by OPEC of its member country liquid fuel demand data and projections has become more important** to facilitate an effective comparison with IEA data.

1.4 IEA and OPEC Short-Term Oil Outlooks

- **Differences in world liquids demand and supply baseline data at 1.7 mb/d and 1.4 mb/d** respectively, **are slightly smaller than those reported on last year**. However, the difference in **stock build in 2015 that the IEA estimates at 1.7 mb/d and OPEC at 2 mb/d is significantly higher** than for 2014, when both organisations estimated a stock build of 1 mb/d.

- **Both the IEA and OPEC December 2016 short-term oil market reports account for the decision taken on 30 November 2016 by OPEC to adjust production in 2017**. However only the IEA has also incorporated the decision of 10 December 2016 by a selection of non-OPEC member countries to follow suit.

- Finally, a **large difference in short-term supply from OPEC Member Countries of 0.9 mb/d remains, due primarily to different definitions used by IEA and OPEC** for 'Natural Gas Liquids and unconventionals' for which there is a divergence of 0.6 mb/d.

Liquids Demand

- **OPEC and the IEA respectively estimate 2015 world liquids demand baselines at 93.2 mb/d and 94.9 mb/d, respectively**; a difference of 1.7 mb/d. This difference is slightly larger than last year's difference of 1.5 mb/d, and largely due to non-OECD data diverging on China,

other non-OECD Asia, and the Middle East by between 0.4 mb/d to 0.6 mb/d for each region.

- **Both the IEA and OPEC have only modestly revised their world liquids demand growth estimates for 2016** over the past year. The **IEA increased its projected world liquids demand growth estimate by 0.2 mb/d from 1.2 mb/d in January to 1.4 mb/d in December 2016**, because of demand growth in the OECD, while **OPEC assessments have been largely constant at 1.2 mb/d throughout the year** as OECD liquids demand growth was offset by reduced demand growth in non-OECD countries.

- **The IEA and OPEC project 2016 world liquids demand to reach 96.3 mb/d and 94.4 mb/d**; widening the difference in their estimates to 1.9 mb/d.

- **Both the IEA and OPEC have similar world liquids demand growth estimates for 2017**, projecting growth of 1.3 mb/d and 1.2 mb/d over the next year. **This similarity at the global level masks distinct differences in regional liquids demand growth assessments**. While the IEA is more bullish about demand growth in non-OECD Asia and the FSU region than OPEC, OPEC estimates stronger demand growth in the OECD Americas than the IEA, which forecasts zero growth.

- **The IEA and OPEC estimate 2017 world liquids demand to reach 97.6 mb/d and 95.6 mb/d, respectively**. This leads to a growing gap between assessments from 1.5 mb/d in 2015 to 1.9 mb/d and 2 mb/d for 2016 and 2017 respectively, suggesting a need for further collaboration on historical baseline data and methodological issues.

Liquids Supply

- **The IEA and OPEC estimate 2015 world liquids supply baseline data at 96.6 mb/d and 95.2 mb/d** respectively; a difference of 1.4 mb/d, slightly lower than last year's report, with differences again primarily due to non-OECD data divergences on OPEC supplies (0.9 mb/d), the FSU (0.3 mb/d), and other non-OECD Asia (0.2 mb/d).

- **OPEC and the IEA estimate 2016 world liquids supply at 94.4 mb/d and 96.3 mb/d** respectively, amounting to a difference between estimates of 1.9 mb/d.

- **OPEC and the IEA estimate 2017 world liquids supply at 95.6 mb/d and 97.6 mb/d** respectively; differing in their assessment by 2 mb/d.

- **The IEA projects net annual liquids supply growth of 1.4 mb/d and 1.3 mb/d for 2016 and 2017** respectively. This compares to the slightly **more modest net annual supply growth projection by OPEC of 1.2 mb/d for both years**.

- **IEA and OPEC non-OPEC supply growth projections have been remarkably consistent in recent years**. However, unlike most monthly short-term assessments made during previous years, **non-OPEC liquid supply growth forecasts were generally revised downwards in 2016**. Both the IEA and OPEC note a 0.8 mb/d decline in 2016 for this category relative to 2015 and a recovery of 0.2 mb/d and 0.3 mb/d in 2017. These trends are largely attributable to changes in supply growth of "unconventionals" in the OECD Americas region.

- **Non-OPEC non-OECD declines in supply growth over 2016 were more modest** with the IEA and OPEC projecting a decline of 0.3 mb/d and 0.2 mb/d respectively due to reductions in supply from China, other non-OECD Asia, Africa and Latin America. These were partly offset by production increases in Russia in 2016.

- Regional assessments of **IEA and OPEC estimates on short-term world liquids supply growth reveal a large and growing difference in constructed estimates for OPEC supply**. This increased from 0.9 mb/d in 2015 to 1.3 mb/d in 2016, and 1.5 mb/d in 2017. This growing gap may well point at differences in historical baselines and methodological issues, meriting further discussion.

- Though somewhat lower than the 0.5 mb/d recorded in 2015, **the largest difference in IEA and OPEC estimates of non-OPEC liquids supply is for the FSU region**, amounting to 0.4 mb/d in projections for 2016 and 0.3 mb/d for 2017.

1.5 IEA and OPEC Medium-Term Oil Outlooks

Liquids Demand

- **The IEA and OPEC expect 2021 world liquids demand to reach 101.7 mb/d and 99.2 mb/d** respectively.

- Both the IEA and OPEC forecast robust liquids demand growth but **OPEC projects a slightly lower annual growth rate of world liquids demand** of 1.1 mb/d, compared to the annual growth rate of 1.2 mb/d forecast by the IEA through to 2021.

- **The IEA and OPEC medium term world liquids demand projections reveal a growing differential of 2.5 mb/d by 2021**. This compares to 2015 projections gap of 1.7 mb/d for world liquids demand in 2020.

- **The IEA projects non-OECD liquids demand to be 3.0 mb/d higher than OPEC in 2021, partly due to a higher baseline demand estimate (1.7 mb/d).**

- **Differences in regional liquids demand projections are more substantial than last year** in part due to the return of Indonesia and Gabon to OPEC Member Country status. OPEC excludes its member countries from regional groupings and publishes OPEC liquids demand separately in medium-term outlooks.

- **OPEC and IEA assessments of OECD liquids demand growth both show modest declines**. OPEC projects a slower decline in consumption ending at 45.7 mb/d in 2021, 0.5 mb/d higher than the IEA's projection of 45.2 mb/d for the same year.

- **Both the IEA and OPEC note that the overall driver for liquids demand growth remains transportation, followed by petrochemicals and industrial demand**. However, growth projections are dampened by the impact of fuel efficiency standards, notably in the OECD, and slowing demand growth in China due to structural shifts towards a services and consumption oriented economy.

Liquids Supply

- **OPEC and the IEA project world liquids supply to reach 99.4 mb/d and 101.7 mb/d by 2021** respectively, differing in their medium-term liquid supply assessment by 2.3 mb/d.

- **In a marked change from last year's medium-term projections, both the IEA and OPEC project non-OPEC supply to decline in 2016**. The IEA projects a decline of 0.6 mb/d, while OPEC projects non-OPEC supplies to decline more sharply by 1.1 mb/d in 2016.

- **OPEC and IEA non-OPEC supply projections are roughly similar through 2019** remaining close to net-zero growth in 2017 and marking an annual growth of 0.6 mb/d and 0.7 mb/d in 2018 and 2019 respectively, driven by a rebound in production in the OECD Americas and Latin America regions.

- **IEA and OPEC projections diverge in 2020 and 2021**. In 2020, OPEC forecast supply growth of around 0.8 mb/d driven by the OECD Americas and Latin America, while the IEA projects growth of 0.6 mb/d with a smaller contribution from OECD Americas. For 2021, OPEC projects more modest growth of 0.7 mb/d while the IEA projects growth of 0.8 mb/d.

- **The IEA's medium-term projection shows substantially stronger supply growth than OPEC for the OECD region**, led by OECD Americas. The IEA estimates 2021 OECD supplies of 27.2 mb/d, with 22.9 mb/d from OECD Americas, compared with OPEC's 2021 OECD forecast of 25.6 mb/d, with 21.6 mb/d from OECD Americas.

- **In sum, the IEA and OPEC forecast total non-OPEC supplies to reach 59.7 mb/d and 58.6 mb/d in 2021 respectively**; a 1.1 mb/d difference.

- T**he IEA and OPEC project supplies from OPEC member countries to reach 42 mb/d and 40.7 in 2021 respectively** - a difference of 1.1 mb/d. This difference arises from IEA's 2021 world liquids supply projections being 2.3 mb/d higher than OPEC's projection, that in part also reflects Indonesia and Gabon becoming OPEC Member Countries in 2016.

- **This year's IEA and OPEC medium-term oil supply estimates from the United States and Canada differ substantially, unlike 2014 and 2015 estimates**. While both made downward revisions this year, OPEC and the IEA respectively project oil production from the United States and Canada of 18.2 and 19.4 mb/d in 2021, a difference of 1.2 mb/d.

1.6 IEA and OPEC Long-Term Energy Outlooks

- The IEA and OPEC prepared **projections through 2040** for total primary energy demand, along with liquid fuel demand and supply. Both organisations use 2014 historical data as the baseline for primary energy demand and 2015 for oil in their projections.

- The central scenarios of each organisation that **are subject to this comparative analysis are the Reference Case of OPEC and the New Policies Scenario of the IEA**.

- **The comparison is placed in the broader context of OPEC's High and Low Supply Scenarios** that present alternative projections than the Reference Case as a function of liquids supply, **and newly elaborated Scenarios A and B** that assume policies reducing

emission at a faster pace, and full implementation of country pledges agreed under the Paris Agreement respectively. This report also includes discussion of the **IEA's Current Policies Scenario**, which provides a business-as-usual scenario, and the **IEA's 450 Scenario**, which assumes policies are implemented to limit greenhouse gas emissions to a level consistent with an expected mean global temperature increase of 2° Celsius.

Primary Energy Demand

- Total primary energy demand in **OPEC's Reference Case reaches 382 mboe/d in 2040** compared with the **IEA's Current Policies Scenario estimate of 396 mboe/d**. These assessments are lower than those given in 2015 of 400 mboe/d and 397 mboe/d, respectively. The **IEA's New Policies Scenario reaches 361 mb/d in 2040**.

- **This year's IEA and OPEC forecasts show global primary energy demand growing more slowly than in previous years' projections**. OPEC's Reference Case has shifted the most, projecting that primary energy demand will grow by 40% from 2014 to 2040, compared with 49% growth from 2013 to 2040 in last year's assessment. The IEA's Current Policies Scenario forecasts 43% growth over the projection period, a smaller departure from last year's estimate of 45% growth, and the IEA's New Policies Scenario sees 31% cumulative growth, compared with 32% in 2015's outlook.

- **OPEC's Reference Case and IEA's Current Policies Scenario project significantly higher primary energy demand then the IEA's New Policies and 450 Scenarios, along with OPEC's new Scenarios A and B**. IEA's Current Policy and 450 Scenario show the largest difference of 96 mboe/d in 2040, while OPEC projections for primary energy demand in 2040 diverge by 27 mboe/d at most.

- **OPEC and the IEA both project that fossil fuels will continue to dominate the primary energy mix** with oil, gas and coal maintaining a 74% to 79% share of total primary energy demand in 2040 with the exception of OPEC's new Scenario B, where fossil fuels account for 71% of the primary energy mix, and the IEA's 450-Scenario, where fossil fuels supply 58% of primary energy demand in 2040.

- **However, the IEA and OPEC differ on the shares of coal, oil, and natural gas in total primary energy demand in 2040**. The IEA's Current Policies Scenario projects coal and oil consumption to be 16 mboe/d and 9 mboe/d higher, respectively, than OPEC's Reference Case. The IEA's New Policies Scenario projects lower consumption of all fossil fuels than OPEC's Reference Case with the most substantial difference seen in natural gas (-15 mboe/d), coal (-8 mboe/d), and oil (-3 mboe/d).

Energy Supply Mix

- **The IEA's New Policies and Current Policies Scenarios project that oil will maintain its position as the leading fuel in 2040**, though its share shrinks, and it is nearly overtaken by coal in the Current Policies Scenario.

- **Like last year, OPEC's Reference Case for 2040 projects that natural gas emerges as the leading primary energy source, at the expense of oil and coal**. Natural gas is set to grow the fastest among fossil fuels (in percentage and absolute terms), with an increasing

share in the fuel mix in every scenario examined here, including the IEA 450 Scenario and OPEC's Scenarios A and B.

- **Both the IEA and OPEC project that the share of renewables, led by biomass, will increase in all scenarios** from 14% in 2014 to 16% under the IEA's Current Policies Scenario, 17% in OPEC's Reference Case, and to 19% under the IEA's New Policies Scenario by 2040.

Liquids Demand

- **The share of oil in the world primary energy portfolio is expected to decrease, but the level of oil demand still enjoys robust growth over the projection period**. In both IEA's New Policies Scenario and OPEC's Reference Case, world liquids demand reaches around 110 mb/d by 2040. In the IEA's Current Policies Scenario, 2040 world liquids demand grows to 122 mb/d.

- **The difference between the highest (IEA Current Policies Scenario) and lowest (IEA 450 Scenario) projections for 2040 world liquids demand is 36 mb/d**. Further reductions in liquids demand would be necessary to reach a global temperature target of 1.5°C, an additional target discussed in the 2015 Paris Agreement.

- **The IEA's Current Policies Scenario provides the highest forecasts for liquids demand growth of 1 mb/d per year up to 2040**, while OPEC's Reference Case projects annual growth for liquids demand of 0.7 mb/d, slightly more than the IEA's New Policies Scenario projection of 0.6 mb/d.

- **The IEA's New Policies and Current Policies Scenarios show India overtaking China as the leading centre of demand growth**, while OPEC forecasts that absolute growth in liquids consumption in China and India will be roughly equal.

Liquids Supply

- **Both the IEA's New Policies Scenario and OPEC's Reference Case forecast global supply in 2040 of roughly 110 mb/d**, while the IEA's Current Policies Scenario projects 122 mb/d of supply in 2040.

- **OPEC is substantially more bullish on production from non-OECD Europe and Eurasia**, projecting 2040 production to be 2.6 mb/d and 1.6 mb/d higher than the IEA New Policies and Current Policies Scenarios, respectively.

- **OPEC projects that OPEC member nations will provide 46% of global supply in 2040, 1% higher than its 2015 estimate**, compared to OPEC shares of 44% and 45% under this year's IEA's New Policies and Current Policies Scenarios, 2% and 1% respectively lower than IEA's 2015 outlook.

- **IEA's Current-, and New Policies Scenarios are more bullish on supplies from the OECD**, as the OECD Americas region supplies 1.2 mb/d and 3.7 mb/d more than OPEC's Reference Case under the IEA's New Policies and Current Policies Scenarios, respectively.

- **IEA's Current-, and New Policies Scenarios project a substantially larger biofuels supply than OPEC in 2040 and see non-OPEC tight crude peaking at higher levels and in later years** than OPEC's Reference Case. In the New Policies Scenario, non-OPEC tight oil grows through 2035, reaching a peak of 7.5 mb/d before falling to 6.8 mb/d in 2040.

1.7 Recent Trends

- **The IEA's New Policies Scenario, Current Policies Scenario, and OPEC's Reference Case project increasing OPEC liquids supply** and roughly stable non-OPEC liquids supply.

- **For non-OPEC liquids, all three scenarios project conventional supplies to decline**, while other non-OPEC liquids including tight crude/oil and biofuels grow.

- **Oil in 2040 – along with other fossil fuels – maintain a central position in the global fuel mix under the central scenarios examined here**. However, global oil demand growth rates will likely be tempered by technological advancement and more stringent environmental policies such as those pursued under the 2015 Paris Agreement.

- **Global oil supply has declined more slowly than expected**. It remains unclear to what extent decreased investment in higher cost projects such as deep water and arctic development will reduce supply in the coming five to ten years, and how this will impact market stability.

- **OPEC Member Countries will likely continue to play a central if not increasing role** in global oil supply to meet long-term demand.

2. Background and Introduction

The International Energy Agency (IEA) and the Organization of the Petroleum Exporting Countries (OPEC) track global energy market trends to produce short-, medium- and long-term energy outlooks. Their insights shape perceptions on how energy markets might evolve and influence important policy and investment decisions around the world.

In light of their influence, the Joint Statement of the Jeddah Energy Meeting (2008) called for shared analyses of the oil market trends and outlooks produced by the IEA and OPEC. The Cancun Ministerial Declaration (2010) recognised the IEF's role as a platform for sharing insights and exchanging views about energy market trends, and called for the IEA, IEF, and OPEC to organise an annual Symposium on Energy Outlooks at the IEF Secretariat[1]. The three organisations held their First Symposium in 2011 and have collaborated since then to advance understanding of the factors that drive energy supply and demand.

An introductory paper comparing the most recent outlooks prepared by the IEA and OPEC has accompanied each Symposium. This paper is for the Seventh Symposium and takes as reference the outlooks published by both organisations in 2016. As in previous editions, the objectives of this analysis are:

- To identify similarities and differences in estimates for short-, medium-, and long-term oil demand and supply;
- To contrast the long-term outlooks for primary energy demand and the global energy mix; and
- To better understand the methodologies, definitions, and assumptions behind these projections and outlooks.

An on-going challenge in the comparison of energy outlooks concerns the different use each organisation makes of historical data, definitions, and geographical classifications. The introductory paper of the Sixth Symposium identified opportunities to harmonise a number of variables:

- Ongoing analysis of differences in historical data, particularly in non-OECD demand, as well as the Former Soviet Union (FSU) and OPEC natural gas liquids (NGLs) and unconventionals supply;
- Understanding factors that underscore differences in medium- and long-term oil price assumptions;
- Advancing efforts to standardise liquids fuel supply categories;
- Adopting consistent approaches in classifying fuels at regional versus global levels (e.g. biofuels, bunkers);
- Understanding policy assumptions made in each long-term energy outlook;
- Sharing viewpoints on oil supply forecast models, and analysing potential enhancement of long-term oil supply projection models, particularly with respect to unconventional resources; and
- Standardising unit conversion processes across the following units: mb/d, mboe/d, and mtoe.

1 Attachment II of the Cancun Declaration identifies specific areas of collaboration through a trilateral Programme of Work.

The IEA and OPEC continue to make progress on some of these areas. Similar to last year, they used the same baseline years for long-term energy projections in the outlooks published this year: 2014 for primary energy demand and 2015 for oil. In addition, they agreed to share and review historical baseline supply and demand data for the years 2008 to 2014 for those non-OECD countries where apparent differences are largest. These efforts reflect the successful cooperation of the IEA and OPEC and the established practice of discussing and reviewing their methods and approaches on a regular basis, for instance by verifying the sensitivity of their models to variations in historical baseline data.

Table 1 lists the publications used for comparison in this introductory paper. Note that the IEA Medium-Term Oil Market Report (MTOMR) was published in February 2016, ten months earlier than the release of OPEC's Medium-Term projections in its 2016 World Oil Outlook (WOO2016).

Table 1. IEA and OPEC Outlooks Analysed in this Introductory Paper

	IEA		OPEC	
Report type	**Report name**	**Publication date**	**Report name**	**Publication date**
Short-term	Oil Market Report (OMR)	Jan. – Dec. 2016	Monthly Oil Market Report (MOMR)	Jan. – Dec. 2016
Medium-term	Medium-Term Oil Market Report (MTOMR)	Feb. 2016	World Oil Outlook (WOO2016)	Nov. 2016
Long-term	World Energy Outlook (WEO)	Nov. 2016	World Oil Outlook (WOO2016)	Nov. 2016

3. Baseline 2015 Liquids Data

The harmonisation of the baseline historical data between the IEA and OPEC is a necessary step to enhance the comparability of their outlooks. **Table 2**, **Table 3**, and **Table 4** compare IEA and OPEC base year (2015) demand, supply, and stock change data, respectively, using the IEA's December OMR and OPEC's December MOMR, both short-term outlooks. Note that as an outcome of the collaborative work on historical baseline data the IEA and OPEC have mutually consistent base year oil demand data in their reports.

As shown in **Table 2** and **Table 3**, differences in world liquids demand and supply baselines remain high, diverging by 1.7 mb/d for demand and 1.4 mb/d for supply, slightly smaller than the differences identified last year. Specifically, IEA estimates 94.9 mb/d whereas OPEC estimates a lower 93.2 mb/d for 2015 world liquids demand, and IEA estimates 96.6 mb/d whereas OPEC estimates 95.2 mb/d for 2015 world liquids supply. These data indicate a large stock build during 2015, with estimates of 2.0 mb/d for OPEC and 1.7 mb/d for the IEA, significantly higher than in last year's report when both organisations estimated a net stock build of about 1 mb/d during 2014.

Table 2 provides details on the IEA's and OPEC's estimates for regional baseline demand data. Similar to last year's assessment, the historical difference is almost completely attributable to non-OECD nations, particularly from China, other non-OECD Asia, and the Middle East. Smaller differences in demand estimates emerge for Latin America and Africa.

Table 2. Liquids Demand in 2015 (mb/d)

	IEA	OPEC	Difference (IEA-OPEC)
Total OECD	**46.4**	**46.4**	**0.0**
OECD Americas	24.6	24.6	0.0
OECD Europe	13.7	13.7	0.0
Asia Oceania	8.0	8.0	0.0
Total Non-OECD	**48.5**	**46.8**	**1.7**
Asia	24.0	23.0	1.0
China	11.5	11.0	0.6
Other non-OECD Asia	12.5	12.0	0.5
Middle East	8.4	8.0	0.4
Latin America	6.8	6.6	0.2
FSU	4.6	4.6	0.0
Non-OECD Europe	0.7	0.7	0.0
Africa	4.1	4.0	0.1
World	**94.9**	**93.2**	**1.7**

Table 2 data sources: *IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Table 4.1, 4.2.*

Table 2 note: *Sums may not total due to rounding.*

As for world liquids supply, **Table 3** shows that the IEA-OPEC difference in 2015 data lies primarily in OPEC supply (0.9 mb/d) and non-OECD producers (0.6 mb/d), particularly FSU nations and non-OECD Asia (excluding China and Indonesia).

Different treatment of biofuels means that comparing regional non-OPEC supply forecasts between the IEA and OPEC requires adjustments. While OPEC includes biofuels in each region's total liquids supply, the IEA does not. The IEA's Medium-Term Oil Market Report (MTOMR) and the monthly Oil Market Report (OMR) publishes biofuels production by region separately (in table 5 and 5a of the MTOMR, and table 17 of the OMR). This paper adds those regional biofuels data – both historical and forecast data – to each region's oil supply data. To ensure consistency, we verified that MTOMR regional biofuels supply data were roughly equal to the OMR biofuels data.

Regarding supply from OPEC Member Countries, there is a notable gap between the IEA's and OPEC's estimates of OPEC NGLs and unconventionals supply (0.6 mb/d) (the difference being in the same direction and magnitude as non-OECD supply estimates). This large divergence may result from different definitions for this category. IEA reports in its OMR that NGLs and unconventionals supply includes OPEC condensates, oil from non-conventional sources (e.g., Venezuelan Orimulsion) and non-oil inputs to Saudi Arabian methyl tertiary butyl ether (MTBE), while OPEC provides less detail about the specific components of this category. Compared to NGLs and unconventionals, the difference in OPEC crude oil supply estimates between the IEA and OPEC is more modest (0.3 mb/d).

Table 4 presents stock changes and other items that account for the difference between supply and demand data in the IEA and OPEC reports. Both the IEA and OPEC report data on commercial oil stock changes and strategic petroleum reserve (SPR) changes from reporting OECD countries. "Oil-on-water" is oil used in floating storage and water transit. The remainder of the gap between total supply and total demand is allocated to a "miscellaneous to balance" item, which covers both stock changes in non-OECD countries and other items. As **Table 4** shows, both organisations estimate a large stock increase in 2015, with OPEC estimating stock growth of 2.0 mb/d and the IEA estimating 1.7 mb/d. Since the IEA and OPEC have similar estimates about OECD stock and "Oil-on-water" items, the difference in total stock change is thus reflected in the constructed "miscellaneous to balance" item.

Table 3. Liquids Supply in 2015 (mb/d)

	IEA[a]	OPEC	DIFFERENCE (IEA - OPEC)
Total OECD	**25.3**	**25.3**	**0.0**
OECD Americas	21.1	21.1	0.0
OECD Europe	3.8	3.8	0.1
Asia Oceania	0.5	0.5	0.1
Total Non-OECD	**30.1**	**29.5**	**0.6**
Non-OECD Asia	7.3	7.1	0.2
China	4.4	4.4	0.0
Other non-OECD Asia	3.0	2.7	0.2
Middle East	1.3	1.3	0.0
Latin America	5.3	5.2	0.1
FSU	14.0	13.7	0.3
Non-OECD Europe	0.1	0.1	0.0
Africa	2.1	2.1	0.0
Processing gains	2.2	2.2	0.0
Total Non-OPEC	**57.6**	**57.0**	**0.6**
Total OPEC	**39.0**	**38.2**	**0.9**
OPEC crude	32.4	32.1	0.3
OPEC NGLs + unconventionals	6.7	6.1	0.6
World	**96.6**	**95.2**	**1.4**

Table 3 data sources: *IEA OMR Dec 2016, Table 1; IEA MTOMR 2016, Table 5, 5a; OPEC Dec 2016, Table 5.1, 10.3.*

Table 3 notes: *Sums may not total due to rounding. IEA liquids supply calculated by summing IEA oil and IEA biofuel estimates.*

IEA[a] "OPEC NGLs" includes condensates, oil from non-conventional sources (e.g. Venezuelan Orimulsion) and non-oil inputs to Saudi Arabian MTBE.

Table 4. Stock Change and Miscellaneous Items (2015-2014) (mb/d)

	IEA	OPEC	DIFFERENCE (IEA - OPEC)
Reported OECD	**0.8**	**0.8**	**0.0**
Industry/commercial	0.8	0.8	0.0
Government/SPR	0.0	0.0	0.0
Oil-on-water	**0.3**	**0.3**	**0.0**
Miscellaneous to balance [(a)]	**0.6**	**1.0**	**-0.4**
Total stock change & misc.	**1.7**	**2.0**	**-0.3**

Table 4 data sources: IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Table 10.3.

Table 4 notes: Sums may not total due to rounding.

OPEC[(a)] miscellaneous to balance is computed as the difference between total OPEC stock change/misc. and other reported stock changes.

4. Short-term Oil Outlooks

Short-term oil market reports from the IEA and OPEC forecast oil demand and supply up to 18 months in the future based on regular monitoring of macroeconomic and energy market conditions, technology, and policy developments. Monthly oil market reports also include statistics and analyses of other topics that we do not focus on in this paper, such as fluctuations in benchmark oil prices, oil stocks, movements in product markets, and trade flows. Both the IEA and OPEC capture market-moving events and offer in-depth analyses in their respective reports. Notably, both December reports incorporate OPEC's late 2016 agreement to adjust production in 2017. However, the reports differ in that the IEA included in its December MOMR the announcement by non-OPEC nations (led by Russia) to adjust production in 2017, while OPEC's December OMR report does not. In this section, we summarise and compare their perspectives on short-term macroeconomics, as well as oil demand and supply outlooks[2].

4.1 Economic Growth Assumptions

The IEA and OPEC take different approaches for short-term GDP forecasts. The IEA primarily refers to the IMF's projections published in the World Economic Outlook and the World Economic Outlook Updates; occasionally, the IEA makes minor adjustments to the IMF forecasts in its OMRs. Unlike the IEA, OPEC has established its own GDP projections based on a modelling approach.

As in recent years, 2016 economic performance in both developed and developing countries, with the primary exception of India, was generally lower than originally forecast. Both the IEA's and OPEC's 2016 economic growth estimates in their December 2016 monthly reports are lower than the forecasts made a year ago. The IMF has made downward adjustments to world GDP growth forecasts for six consecutive years, due to lingering problems stemming from the global financial crisis in developed countries and slower growth in several large

2 Though this introductory paper compares data from the December 2016 oil market reports, reports from January to December in 2016 from both organisations were reviewed to assess how their views evolved throughout the year.

developing economies, notably Brazil, China, and Russia. Similar to last year, India emerged as an exception to this trend in 2016 with higher than forecasted GDP growth. Nonetheless, both the IMF (used by IEA) and OPEC forecasts exhibit confidence that global economic growth will increase in 2017. As **Table 5** shows, the IMF and OPEC expect 2017 GDP growth to exceed 2016 growth by 30 and 20 basis points, respectively. The IMF's 3.4% world GDP growth rate forecast for 2017 is slightly higher than OPEC's estimate of 3.1%. These discrepancies result from different perspectives on future growth along with differing methods for calculating GDP.

Table 5. Short-term Global GDP Growth Assumptions

	IEA (IMF)	OPEC
2016	3.1%	2.9%
2017	3.4%	3.1%

Table 5 data sources: *IMF World Economic Outlook Oct 2016, Table 1.1; OPEC MOMR Dec 2016, Table 3.1.*

Some variations in major economies are worth noting. For example, OPEC's 2017 GDP growth forecasts for India, the United States and the Euro Area (7.2%, 2.1% and 1.3%, respectively) are slightly lower than the IMF's estimates (7.6%, 2.2% and 1.5%, respectively). Conversely, OPEC's 2017 growth forecasts for Japan (0.9%) is substantially higher than the IMF's (0.6%). Both organisations expect economic growth in China to be 6.2% in 2017.

4.2 Short-term Liquids Demand

Both the IEA and OPEC revise their short-term liquids demand forecasts monthly, based on market and policy movements, as well as comparison between actual data and changes in macroeconomic conditions. In addition, they occasionally revise methodologies for calculating demand for specific regions, which may also result in changes to demand forecasts.

As **Figure 1** illustrates, the IEA and OPEC both saw modest revisions to their global liquids demand growth estimates over the course of the year. Overall, the IEA increased projected 2016 demand growth by 0.2 mb/d over the course of the year, with projections for OECD demand growth seeing a wider range of estimates than non-OECD nations. For OPEC, global demand growth projections declined by 0.1 mb/d, as moderate growth in the OECD was offset by declines in non-OECD nations. The dotted-, and dash lines in **Figure 1**, reflecting Non-OECD and OECD country assessments respectively, show that the increases for both the IEA and OPEC came primarily from OECD countries. The IEA's upward revisions were further supported by an increase in the non-OECD region from November to December, while OPEC's overall increase was slightly offset by a decrease in the non-OECD.

Figure 1. Monthly Revisions of Annual Estimates for 2016 World, OECD, and Non-OECD Liquids Demand Growth (mb/d)

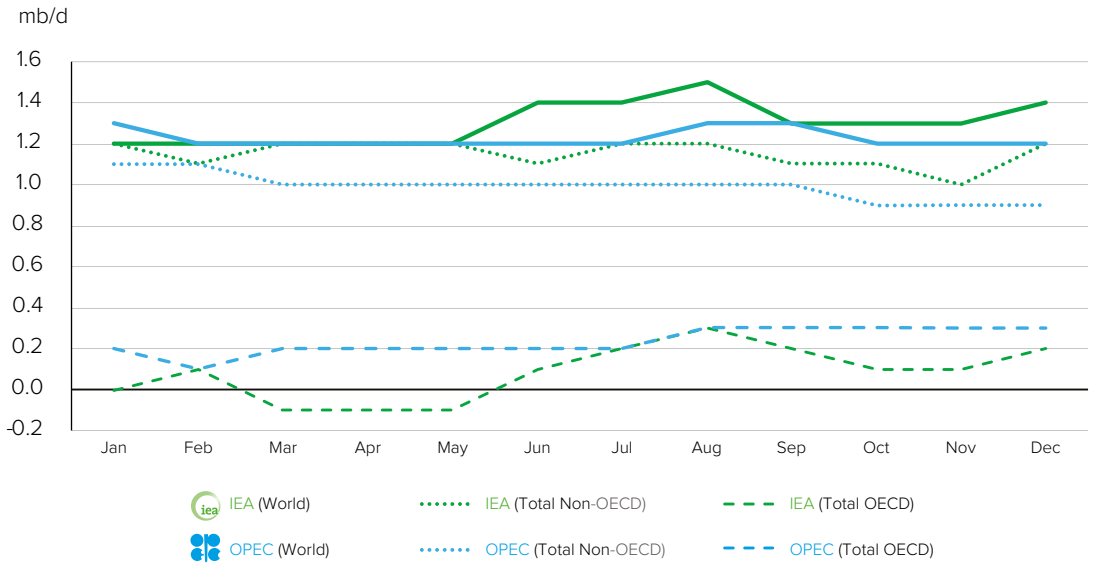


Figure 1 data sources: *IEA OMR Jan–Dec 2016, Table 1; OPEC MOMR Jan–Dec 2016, Table 10.3. 2016 revisions are relative to 2015 data.*

Looking forward in **Figure 2**, both IEA and OPEC demand growth forecasts for 2017 are similar in magnitude to those seen last year. The IEA projects global demand growth of 1.3 mb/d, slightly higher than the 2016 level, while OPEC's projection of 1.2 mb/d is equal to its 2016 estimate.

Divergent perspectives on liquids demand growth in 2016, coupled with historical data differences, explain the gaps between the IEA's and OPEC's liquids demand projections for 2016 and 2017. As **Figure 2** shows, this gap has expanded from 1.8 mb/d in 2015 to 1.9 mb/d in 2016, and is 2.0 mb/d in the 2017 forecast. For reference, the gap in 2014 was 1.5 mb/d.

Figure 2. Short-term World Liquids Demand: 2015-2017 (mb/d)

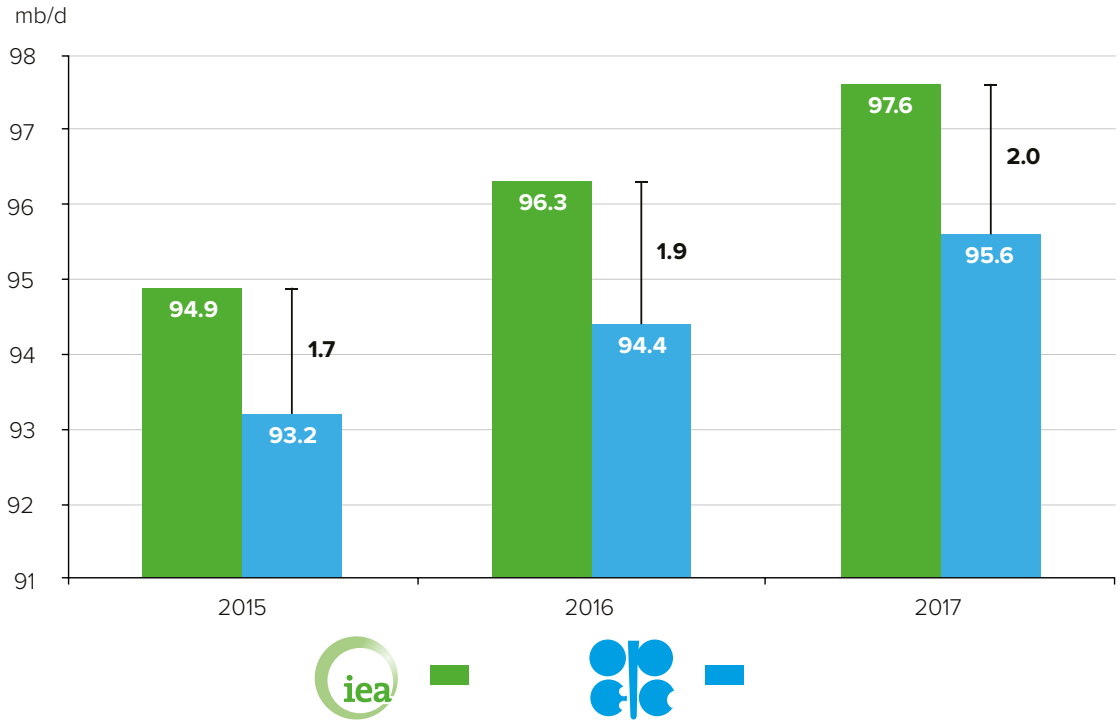


Figure 2 data sources: *IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Table 10.3.*

Figure 2 note: *2015 are historical data and 2016/2017 are projections.*

The IEA's and OPEC's regional liquids demand outlooks for 2016 and 2017, as well as the projection differences between them, are summarised in **Table 6**. These short-term demand outlooks vary greatly in regions that have large differences in historical data – particularly in the non-OECD region, including China, other non-OECD Asian nations, and the Middle East (see **Table 2**). Of particular interest is the difference in historical data for China. In last year's Introductory Paper, the historical (2014) difference in Chinese oil demand between the IEA and OPEC was 0.1 mb/d, compared to a difference of 0.6 mb/d this year (2015). This divergence in baseline data contributes to the substantial difference in forecasted Chinese demand of 0.7 mb/d in 2016 and 2017. This reinforces our view on the impact of differences in historical baseline data and the importance of ongoing collaboration between the organisations on this topic.

Both the IEA and OPEC believe non-OECD regions will continue to lead global demand growth, particularly non-OECD Asia, followed by Africa, the Middle East, and FSU nations. Although not reflected explicitly in **Figure 3**, India is a major contributor to demand growth in other non-OECD Asia, while South Korea shows robust growth in the OECD. Growth in India and South Korea in 2016 was 7% and 6% respectively, and in 2017, Indian demand is projected to grow by an additional 6% according to the IEA, and 4% according to OPEC. South Korea is projected to grow more slowly in 2017, at 3% according to the IEA[3].

Despite these similarities, a number of regional discrepancies also appear in **Table 6** and are

3 For India, see IEA December OMR Table 2 and OPEC December MOMR pages 36-37. For South Korea, see IEA December OMR Tables 2 and OPEC December MOMR page 40.

highlighted in **Figure 3**. In particular, the IEA has substantially more bullish estimates about demand growth in non-OECD Asia than OPEC. The IEA also projects moderately stronger growth than OPEC in FSU nations in 2016. In contrast, OPEC is more bullish on growth in the OECD Americas (where IEA projects zero growth), and relatively minor differences emerge in forecasts for OECD Asia Oceania.

Table 6. Short-term Liquids Demand Forecasts (mb/d)

	2016			2017		
	IEA	OPEC	Difference (IEA-OPEC)	IEA	OPEC	Difference (IEA-OPEC)
Total OECD	**46.6**	**46.7**	**-0.1**	**46.6**	**46.9**	**-0.3**
OECD Americas	24.6	24.8	-0.2	24.6	25.0	-0.4
OECD Europe	13.9	13.9	0.0	13.9	13.9	0.0
Asia Oceania	8.1	8.0	0.1	8.0	7.9	0.1
Total Non-OECD	**49.7**	**47.7**	**2.0**	**51.0**	**48.7**	**2.3**
Asia	25.0	23.8	1.2	25.9	24.4	1.5
China	11.9	11.2	0.7	12.2	11.5	0.7
Other non-OECD Asia	13.1	12.5	0.6	13.7	12.9	0.8
Middle East	8.4	8.0	0.4	8.6	8.1	0.5
Latin America	6.7	6.5	0.2	6.7	6.5	0.2
FSU	4.8	4.7	0.1	4.9	4.7	0.2
Non-OECD Europe	0.7	0.7	0.0	0.7	0.7	0.0
Africa	4.2	4.1	0.1	4.3	4.2	0.1
World	**96.3**	**94.4**	**1.9**	**97.6**	**95.6**	**2.0**

Table 6 data sources: *IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Table 4.1, 4.2.*

Table 6 note: *Columns may not sum to total due to rounding.*

Figure 3. Short-term Liquids Demand Annual Growth (mb/d)

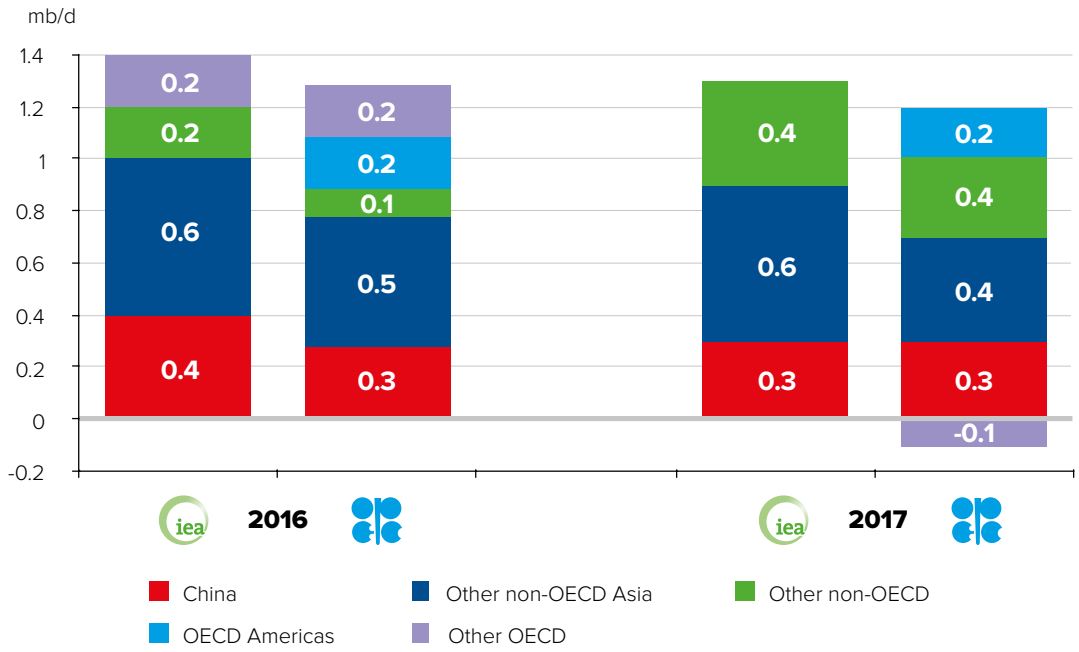


Figure 3 data sources: *IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Tables 4.1, 4.2.*

4.3 Short-term Liquids Supply

Unlike most months during the previous several years, non-OPEC liquids supply forecasts were generally revised downwards in 2016 relative to 2015. **Figure 4** reveals that forecast revisions were substantial for both the IEA and OPEC, with both ending 2016 with projections of a -0.8 mb/d decline in 2016 relative to 2015. Estimates for declines from non-OPEC OECD nations ranged between -0.4 mb/d and -0.7 mb/d, ending the year at -0.6 mb/d. This decrease reflects weakened production in the United States and Canada, where unconventional supplies such as tight oil and oil sands both declined. Non-OPEC non-OECD declines were more modest, with both the IEA and OPEC projecting a decline of just -0.1 mb/d at the beginning of 2016. By the close of the year, both projections had been revised downwards, to -0.2 mb/d for OPEC and -0.4 mb/d for the IEA. These more modest declines in the non-OECD were primarily attributable to reductions in China, other non-OECD Asia, Africa, and Latin America, and were in part offset by increasing Russian production during 2016.

Figure 4. Monthly Revisions of Annual Estimates for 2016 Non-OPEC Liquids Supply Growth (mb/d)

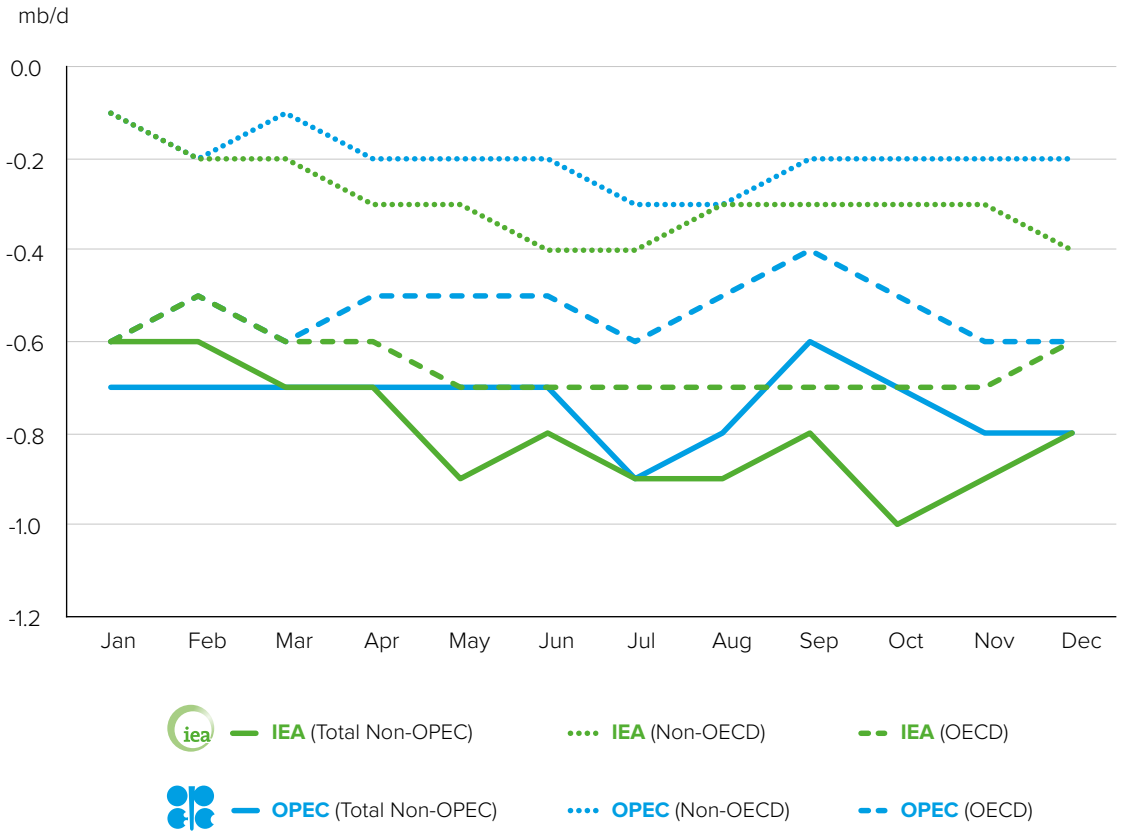


***Figure 4 data sources**: IEA OMR Jan-Dec 2016, Table 1; OPEC MOMR Jan-Dec 2016, Table 10.3. 2016 revisions are relative to 2015 data. Indonesia is included as an OPEC member in all months. Gabon is added as an OPEC member in July for OPEC and IEA data, and therefore is removed from this figure's data in that month.*

After growing rapidly in 2014, non-OPEC liquids supply growth slowed in 2015 and production began to decline in 2016. As noted above, these trends are largely attributable to changes in supply from OECD Americas "unconventionals." As **Figure 5** indicates, non-OPEC supplies are projected to increase modestly in 2017. **Figure 5** also indicates that the IEA's and OPEC's views about overall non-OPEC supply trends remain similar for the short-term outlooks. The 2017 estimates also reflect that the IEA includes in its December OMR Russia's announced 2017 production cuts, while OPEC's December MOMR does not.

Figure 5. Short-term Non-OPEC Liquids Supply Annual Growth (mb/d)

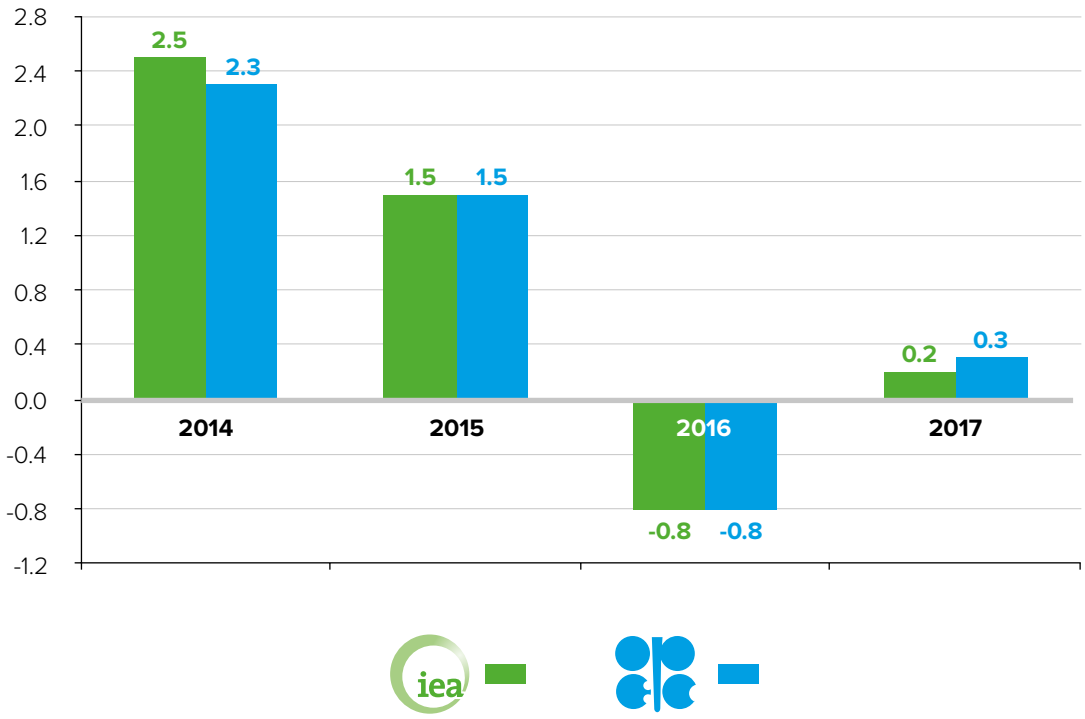


Figure 5 data sources: *IEA OMR Dec 2016, Table 1; OPEC MOMR Dec 2016, Table 10.3.*
Note: Indonesia and Gabon were included as OPEC members in the December 2016 outlooks, and are not included here in prospective or retrospective data.

Table 7 displays a detailed comparison of short-term liquids supply outlooks by region. The IEA-OPEC difference in overall non-OPEC supply outlooks is substantially larger than the difference in historical supply data of 1.4 mb/d (see **Table 3**). This difference in global supply estimates grows from 1.9 mb/d in 2016 to 2.0 mb/d in 2017.

Though neither IEA nor OPEC make projections for OPEC supply, the difference between the IEA's and OPEC's constructed estimates for OPEC supply has grown from 0.9 mb/d in 2015 to 1.3 mb/d in 2016 and 1.5 mb/d in 2017. This merits continued discussion. "OPEC crude" in Table 3 is an estimate based on reported supply data from OPEC Member Countries, whereas the Table 7 item "Call on OPEC crude + stock ch. & misc" is a constructed item. This item is calculated by subtracting total non-OPEC supply as well as OPEC NGLs and unconventionals supply from world liquids demand projections, since neither the IEA nor OPEC projects OPEC crude supply in their oil market reports. Therefore, differences between the IEA and OPEC in the "Call on OPEC crude + stock ch. & misc" item and "Total OPEC" item do not directly reflect different views regarding OPEC crude supply; rather the differences could reveal their distinct projections of global liquids demand and non-OPEC crude supply.

For non-OPEC liquids supply, the largest differential (0.4 mb/d in 2016 and 2017) comes from FSU nations, stemming in part from differences in historical data. As noted above, the IEA's December OMR incorporates Russia's agreement announced in late 2016 to reduce production growth in 2017, while OPEC's MOMR does not incorporate this development. Substantial variation also emerges between the two estimates for OPEC unconventionals +

NGLs, which grows from 0.5 mb/d in 2016 to 0.6 mb/d in 2017. Another difference (0.1 mb/d in 2016 and 0.2 mb/d in 2017) appears in projections from OECD Americas, highlighting different estimates about North American unconventional supplies. While the IEA projects modest growth in 2017, OPEC forecasts a small decline in the region.

Figure 6 illustrates how the IEA's and OPEC's regional supply growth estimates differ in 2016 and 2017.

Table 7. Short-term Liquids Supply Forecasts by Region (mb/d)

	2016			2017		
	IEA [a]	OPEC	Difference (IEA-OPEC)	IEA [a]	OPEC	Difference (IEA-OPEC)
Total OECD	**24.7**	**24.7**	**0.0**	**24.7**	**24.6**	**0.2**
OECD Americas	20.5	20.5	-0.1	20.6	20.4	0.2
OECD Europe	3.8	3.8	0.1	3.7	3.7	0.0
Asia Oceania	0.4	0.4	0.0	0.5	0.4	0.1
Total Non-OECD	**29.7**	**29.3**	**0.4**	**29.9**	**29.7**	**0.2**
Asia	6.9	6.8	0.1	6.7	6.7	0.0
China	4.1	4.1	0.0	3.9	4.0	-0.1
Other non-OECD Asia	2.8	2.7	0.1	2.8	2.7	0.1
Middle East	1.3	1.3	0.0	1.2	1.3	-0.1
Latin America	5.2	5.1	0.1	5.4	5.3	0.1
FSU	14.2	13.9	0.4	14.4	14.0	0.4
Non-OECD Europe	0.1	0.1	0.0	0.1	0.2	0.0
Africa	2.0	2.1	-0.1	2.1	2.2	-0.1
Processing gains	**2.3**	**2.2**	**0.1**	**2.3**	**2.2**	**0.1**
Total Non-OPEC	**56.8**	**56.2**	**0.6**	**57.0**	**56.5**	**0.5**
Total OPEC	**39.5**	**38.2**	**1.3**	**40.6**	**39.1**	**1.5**
Call on OPEC crude + stock ch. & misc.[(b)]	32.7	31.9	0.8	33.6	32.7	0.9
OPEC NGLs + unconventionals	6.8	6.3	0.5	7.0	6.4	0.6
World Supply[(a)]	**96.3**	**94.4**	**1.9**	**97.6**	**95.6**	**2.0**

Table 7 data sources: *IEA OMR Dec 2016, Table 1; IEA MTOMR 2016, Table 5, 5a; OPEC MOMR Dec 2016, Table 5.1, 5.2, 10.3.*

Table 7 notes: *Sums may not total due to rounding.*

IEA[(a)]: Biofuels from IEA MTOMR 2016 are added to IEA regional oil supply data for comparability with OPEC estimates.

Call on OPEC crude + stock ch. & misc[(b)]: Equals total liquids demand minus non-OPEC supply minus OPEC NGLs/unconventionals.

Total OPEC and World Supply[(c)]: Estimates for total OPEC supply and world supply are constructed from other components because IEA and OPEC do not directly provide these forecasts in their reports. Gabon and Indonesia are included as OPEC members.

Figure 6. Short-term Liquids Supply Net Annual Growth Forecasts (mb/d)

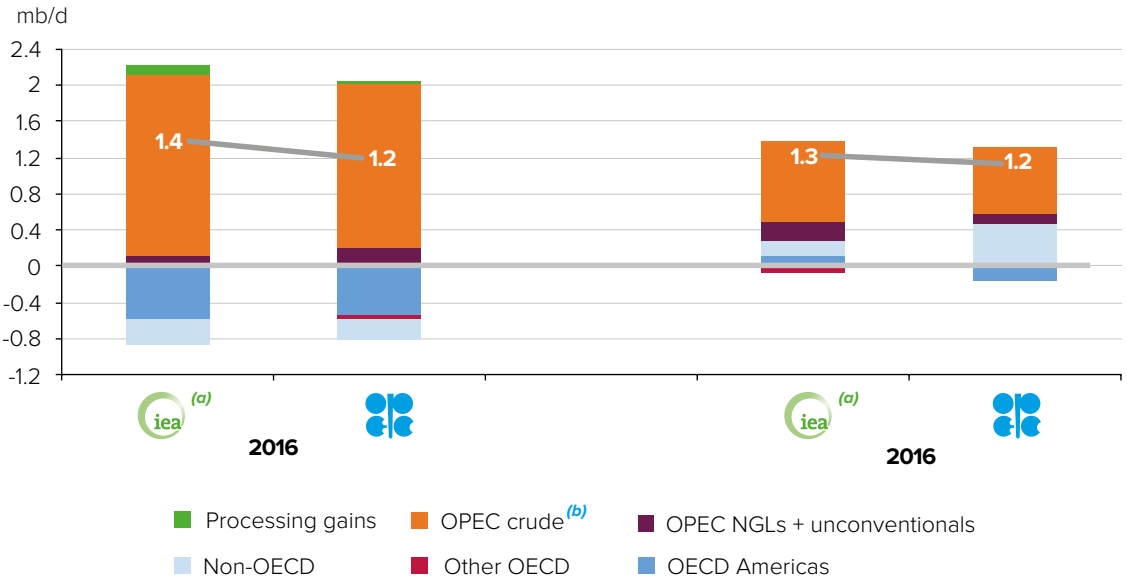


Figure 6 data sources: *IEA OMR Dec 2016, Table 1; IEA MTRMR 2016, Table 5, 5a; OPEC MOMR Dec 2016, Table 5.1, 5.2, 10.3.*

Figure 6 note*: IEA[(a)]: Biofuels from IEA MTRMR 2016 are added to IEA regional oil supply data for comparability with OPEC estimates.*

OPEC crude[(b)]: IEA and OPEC do not forecast OPEC crude; this estimate is constructed as the "call on OPEC crude" including "stock change and miscellaneous". Gabon and Indonesia are included as OPEC members.

5. Medium-term Oil Outlooks

Our comparison of medium-term outlooks analyses the IEA's Medium-Term Oil Market Report (MTOMR) published in February 2016, and OPEC's World Oil Outlook (WOO) published in November 2016 (**Table 1**). Both organisations make their medium-term projections through 2021, using 2015 as a base year. However, there is a nine-month gap between publication dates of the two reports, and given the dynamic nature of market conditions, this gap still complicates the comparison of the projections.

5.1 Oil Price and Economic Growth Assumptions

5.1.1 Oil Price

The price of oil is one of the primary factors influencing the projections of oil demand. The basis for IEA and OPEC oil price assumptions differs in two fundamental ways.

First, the IEA and OPEC use different price proxies. In the WOO series, OPEC makes assumptions for an OPEC Reference Basket (ORB) price, which is a production-weighted average price of a number of representative OPEC crudes driven by the cost estimates of marginal supply. This year, crudes from Indonesia and Gabon, which both re-joined OPEC in 2016, were added to the basket.[4] In contrast, the IEA uses an "IEA Average Import Price", which reflects the IEA's perspective on its member countries' future crude import prices.

4 Although Indonesia suspended its membership in December 2016, all outlooks included in this paper classify Indonesia as an OPEC member.

Second, oil price assumptions are derived through distinct approaches. OPEC's medium-term price assumptions mainly reflect its assumptions on the ORB price detailed above, while its longer-term price assumptions also take into account its estimates of the cost of supplying the marginal barrel. In contrast, the IEA utilises market information – the Brent futures price curve – to derive its medium-term price assumptions. From the IEA's perspective, Brent futures prices reflect what market players will accept to pay in the future, which in turn shapes the medium-term demand and supply outlook. Of course, neither approach is perfect, and oil prices are volatile in nature. For example, the Brent crude oil futures price declined from more than US$107/bbl in mid-2014 to about US$60/bbl by the end of 2014, reaching a low near US$30/bbl in early 2016, then rebounding to roughly US$55/bbl by the end of 2016.

The different methods for developing oil price assumptions have led to distinct medium-term price outlooks, although the slope of the price paths after 2016 is very similar. As **Figure 7** illustrates, the IEA's MTOMR shows the nominal "IEA Average Import Price" growing slowly from US$52/bbl in 2015 to US$54/bbl in 2016, then reaching to US$80/bbl in 2020 and 2021. The nominal ORB price in OPEC's WOO2016 declines from US$49.50/bbl in 2015 to US$45/bbl in 2016, slowly recovering to US$65 by 2021—significantly lower than last year's OPEC price assumption of $80/bbl in 2020, which was in turn well below the 2014 assumption of $110/bbl in 2019.

Figure 7. Medium-term Oil Price Assumptions (nominal US$)

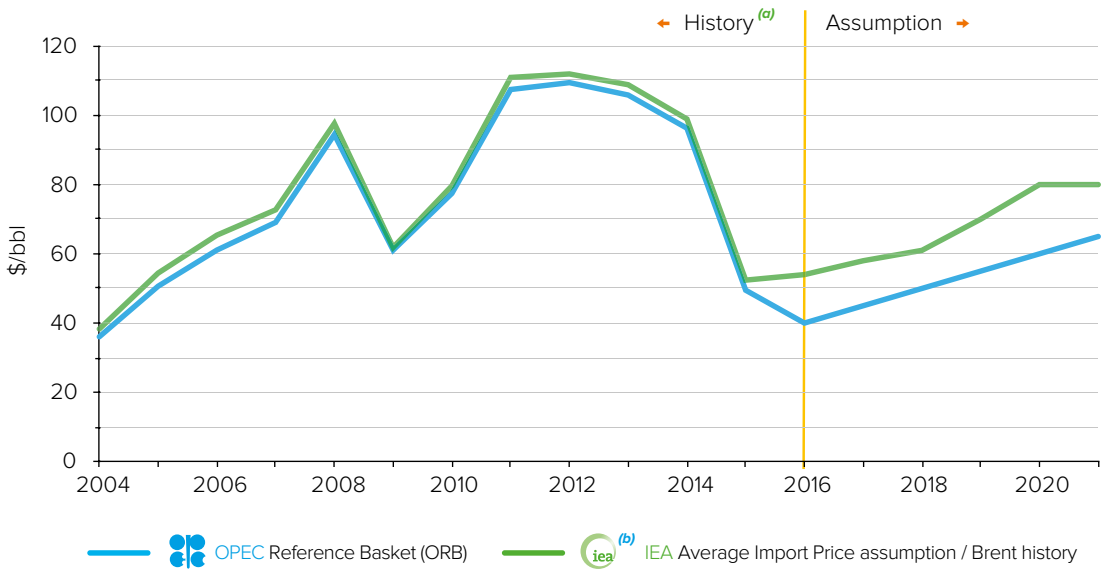


Figure 7 data sources: *Annual average ORB price from OPEC WOO2016 and history from http://www.opec.org/opec_web/en/data_graphs/40.htm?selectedTab=annually;*

Annual average IEA import price from IEA MTOMR 2016, provided via internal communication, and Brent history from https://www.quandl.com/data/ODA/POILBRE_USD-Brent-Crude-Oil-Price

Figure 7 notes: *(a) Only historical prices up to the time IEA and OPEC wrote their reports were included*

(b) IEA Average Import Price assumption is based on the Brent futures strip, gradually increasing from 2016 to 2021.

5.1.2 Economic Growth

Both the IEA and OPEC have adjusted their expectations for medium-term global economic growth compared to last year. The IEA (based on IMF forecasts) lowered its growth estimate for 2016 but increased its projected growth rate in later years to reach 4.0% by 2020, up from 3.8% in the previous years' projection. OPEC lowered its expectations for growth across all years, resulting in substantially lower projections than those included in the IEA's MTOMR2016, which was released nine months earlier than the WOO2016 (**Table 8**). Note that in its subsequent October 2016 update, the IMF lowered its growth forecasts to 3.1% and 3.8% in 2016 and 2021, respectively.

Table 8. Medium-term Annual GDP Growth Assumptions (%)

	2016	2017	2018	2019	2020	2021
OPEC	3.0%	3.1%	3.4%	3.5%	3.6%	3.7%
IEA	3.4%	3.6%	3.7%	3.9%	4.0%	4.0%

Table 8 data sources: *IEA MTOMR 2016, Table 1.2; OPEC WOO2016, Table 1.3. IEA's forecast relies on IMF's January 2016 World Economic Outlook Update.*

Under both projections, most OECD and non-OECD economies expand over the medium-term, though non-OECD nations continue to grow at a faster rate. However, downside risks exist in both OECD and non-OECD nations. For the OECD, legacy issues stemming from the global financial crisis continue to subdue the Eurozone's growth potential, and Japan's economic outlook still remains uncertain. The OECD Americas region, led by the United States, enjoys a stronger recovery than other OECD regions. For most non-OECD nations, economic growth in recent years has repeatedly been weaker than expected, as major emerging economies such as Brazil and Russia contract due to lower commodity prices and China's economy continues its transition away from manufacturing and exports. Finally, geopolitical risks will continue to affect economic growth in Europe, the Middle East, parts of south America, and other regions with impacts potentially spilling over to energy and other commodities markets.

5.2 Medium-term Liquids Demand

5.2.1 Global and Regional Demand Growth

Similar to last year's assessment, both the IEA and OPEC expect robust medium-term growth in global liquids demand. As **Table 9** shows, the IEA projects annual average growth of 1.2 mb/d in global liquids demand, reaching 101.7 mb/d by the end of 2021. OPEC projects slightly lower demand growth rate but modestly higher than its 2015 demand growth assessment at around 1.0 Mb/d compared to the 2016 demand growth assessment at around 1.1 mb/d per year reaching 99.2 mb/d by 2021. As illustrated by **Figure 8**[(a)], the IEA's steeper demand growth trajectory, coupled with a substantially higher baseline (1.7 mb/d), leads to a 2.5 mb/d differential in world liquids demand projection by 2021 compared to OPEC's estimate, well above last year's differential of 1.7 mb/d in 2020. **Figure 8**[(b)] shows that these differences arise largely from non-OECD nations, due to varying historical demand data and the IEA's more bullish view on non-OECD liquids demand growth.

Regarding OECD liquids demand, both the IEA and OPEC project modest declines. Starting from the same 2015 baseline (46.2 mb/d), OPEC projects a slower decline in consumption, ending roughly 0.5 mb/d higher than the IEA's projection for 2021. The divergence in oil demand growth between OECD and non-OECD nations reinforces how global oil markets are transforming. OPEC's WOO2016 shows that oil demand from non-OECD countries surpassed that of OECD nations in 2015, while the IEA's MTOMR2015 estimates this crossing point occurred about one year earlier.

Figure 8. Medium-term Liquids Demand (mb/d)

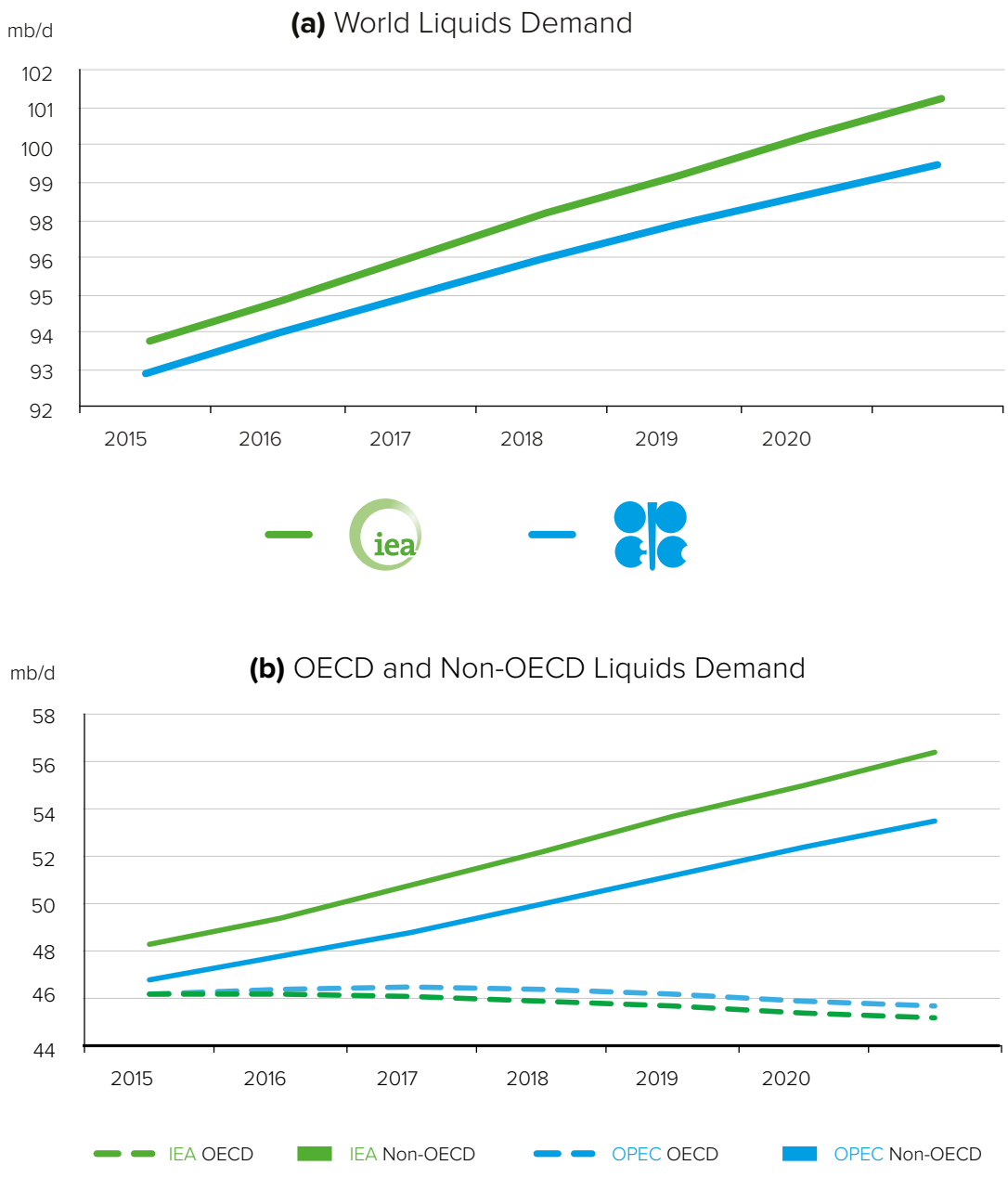


Figure 8 data sources: *IEA MTOMR 2016, Table 2; OPEC WOO2016, Table 3.1.*

Table 9 presents a detailed comparison of the IEA and OPEC medium-term liquids demand outlooks for comparable regions. Modest differences between the projections appear in OECD Americas, OECD Europe, and non-OECD Asia. However, direct comparison of non-OECD Asia is challenging for medium-term forecasts because the IEA and OPEC have different regional definitions. In the WOO's medium-term projections, OPEC excludes its member countries from regional groupings and publishes OPEC liquids demand separately. The IEA does not make a similar distinction. The difference is more substantial this year than last because of Indonesia's and Gabon's return to OPEC member status, reducing OPEC's estimates for other non-OECD Asian demand. For reference, Indonesia consumed an estimated 1.6 mb/d in 2015. To allow for comparison across other regions where OPEC members are located, we group together the Middle East, Africa and Latin America for regional demand projections.

Table 9. Medium-term Liquids Demand Forecasts (mb/d)

	2021		Avg. annual growth (2015-2021)		
	IEA	OPEC	IEA	OPEC	Difference (IEA-OPEC)
Total OECD	**45.2**	**45.7**	**-0.2**	**-0.1**	**-0.1**
OECD Americas	24.2	24.7	0.0	0.1	-0.1
OECD Europe	13.1	13.4	-0.1	0.0	-0.1
Asia Oceania	7.8	7.6	-0.1	-0.1	0.0
Total Non-OECD	**56.5**	**53.5**	**1.4**	**1.1**	**0.2**
Asia	28.9	25.2	0.9	0.7	0.2
China	13.6	12.5	0.4	0.3	0.1
India	5.1	5.4	0.2	0.2	0.0
Other non-OECD Asia	10.2	7.3	0.3	0.2	0.1
[a]Middle East, Africa & Latin America	21.6	22.8	0.4	0.4	0.0
Europe & Eurasia	6.0	5.5	0.1	0.1	0.0
World	**101.7**	**99.2**	**1.2**	**1.1**	**0.1**

Table 9 data sources: *IEA MTOMR 2016, Table 2; OPEC WOO2016, Table 3.1.*

Table 9 notes: *Sums may not total due to rounding.*

[a] *OPEC calculates demand from OPEC member countries as a whole by excluding them from corresponding geographical region, which makes demand figures for Asia, the Middle East, Africa, and Latin America not comparable with IEA estimates. In this report, Middle East, Africa and Latin America are grouped together for regional demand comparisons. In addition, Indonesia, which consumed roughly 1.6 mb/d in 2015, was an OPEC member for most of 2016, and is not included in OPEC's estimate for Asia, which contributes to differences in the "Total non-OECD," "Asia," and "Other non-OECD Asia" regions.*

5.2.2 Sectoral Demand

The WOO2016 provides sectoral oil demand projections for the year 2015 and for five-year intervals through 2040. In WOO2016, road transport accounts for the largest share of oil demand at roughly 45 percent through 2021. Petrochemicals and other industrial uses each account for roughly 13 percent of demand over the medium term in OPEC's projection. The IEA's MTOMR2016 does not include detailed global sectoral data. However, the report does discuss some key shifts in oil market dynamics. Key points include more modest projections of consumption growth in transportation fuels due to increasing vehicle efficiency standards particularly in the OECD, as well as the slowing of demand growth in China due to structural economic shifts from exports and heavy industrial consumption towards services and domestic consumption. Nonetheless, the overarching driver of demand growth continues to be transportation, followed by petrochemicals and industrial demand.

5.3 Medium-term Liquids Supply

5.3.1 Liquid Fuels Classification and Projection Methodology

For their medium-term liquids supply outlooks, both the IEA and OPEC take a "bottom-up" approach of assessing field-level supply capabilities for each country. However, they may take different upstream oil production projects into account and estimate different levels of productivity for each field. Differing supply projections between the IEA and OPEC could also result from their distinct oil price assumptions.

In addition, an understanding of the differences in the IEA's and OPEC's categorisation of liquid fuels is necessary for fair comparison of their projections. **Figure 9(a)** and **(b)**, respectively, illustrate the IEA's and OPEC's distinct liquids classification systems.

First, the two institutions differ in their categorisation of certain types of unconventional oil supplies. In WOO2014, OPEC began using the term "unconventional NGLs," defined as NGLs extracted from low-permeability formations with hydraulic fracturing technology, which is included in the "NGLs" category. **Figure 9(a)** shows that the IEA groups together conventional crude oil, NGLs (including conventional and unconventional supplies) and condensate into one category, and "unconventional oil" into another. For OPEC, the equivalent of the IEA's "unconventional oil" group is "other liquids," though the reports separately account for U.S. and Canadian "tight crude," along with the aforementioned "unconventional NGLs." Additionally, OPEC and the IEA use different technical terms in their reports, such as "kerogen oil" in WEO2016 vs. "oil shale" in WOO2016. Finally, OPEC categorises biofuels together with its "other liquids" supply sources, whereas the IEA treats biofuels distinctly from all other oil supply sources.

Figure 9. Liquid Fuels Categorisation by the IEA and OPEC

(a) IEA Liquid Fuel Schematic

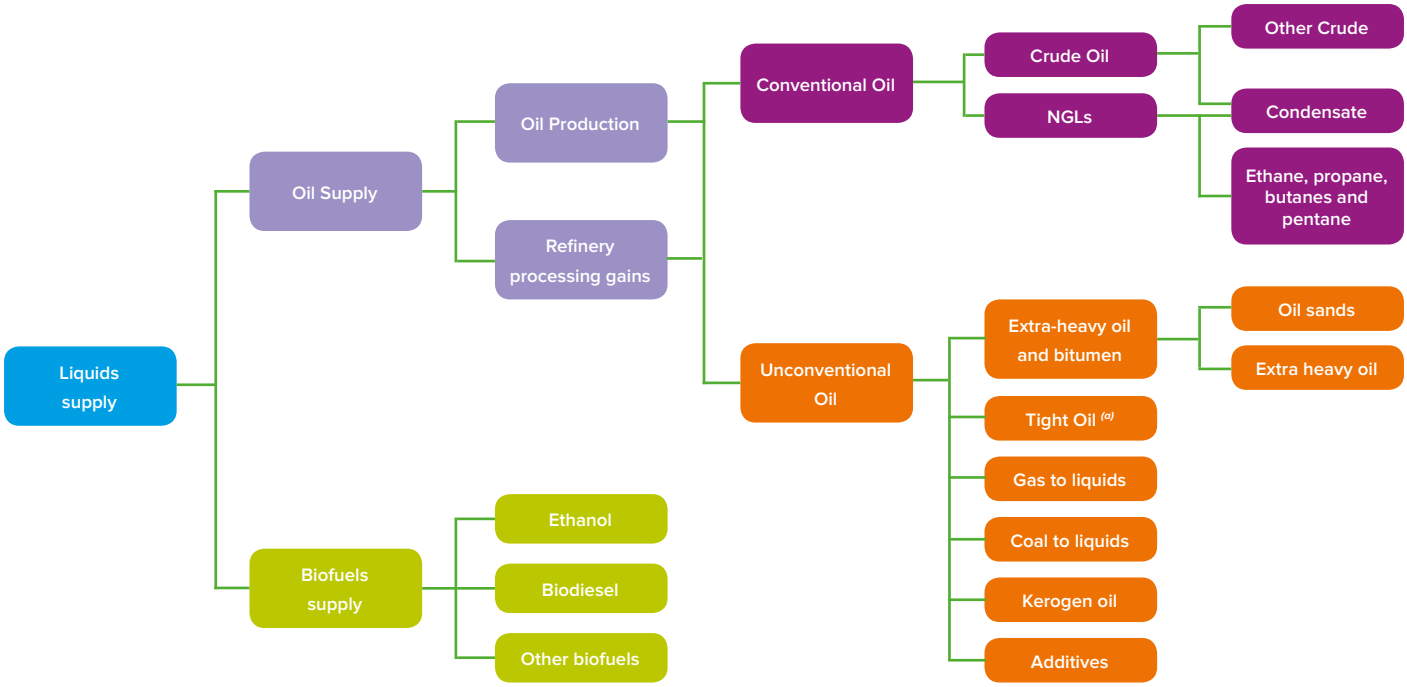


Figure 9(a) *source: IEA WEO 2015, Figure C.1. We include the 2015 figure in this report to more closely align with the colour scheme developed for Figure 9(b) below. An examination of the equivalent WEO 2016 figure (page 644) reveals that there have been no substantive changes in liquids classification methodologies.*

[a] ***IEA*** *previously referred to "tight oil" as "light tight oil".*

(b) OPEC Liquid Fuels Schematic

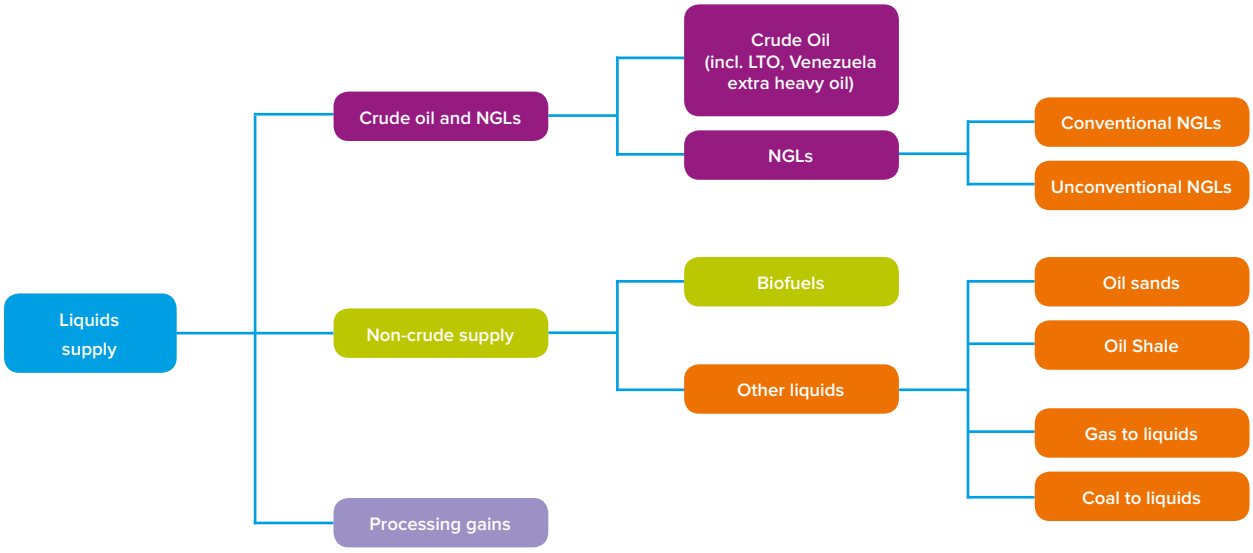


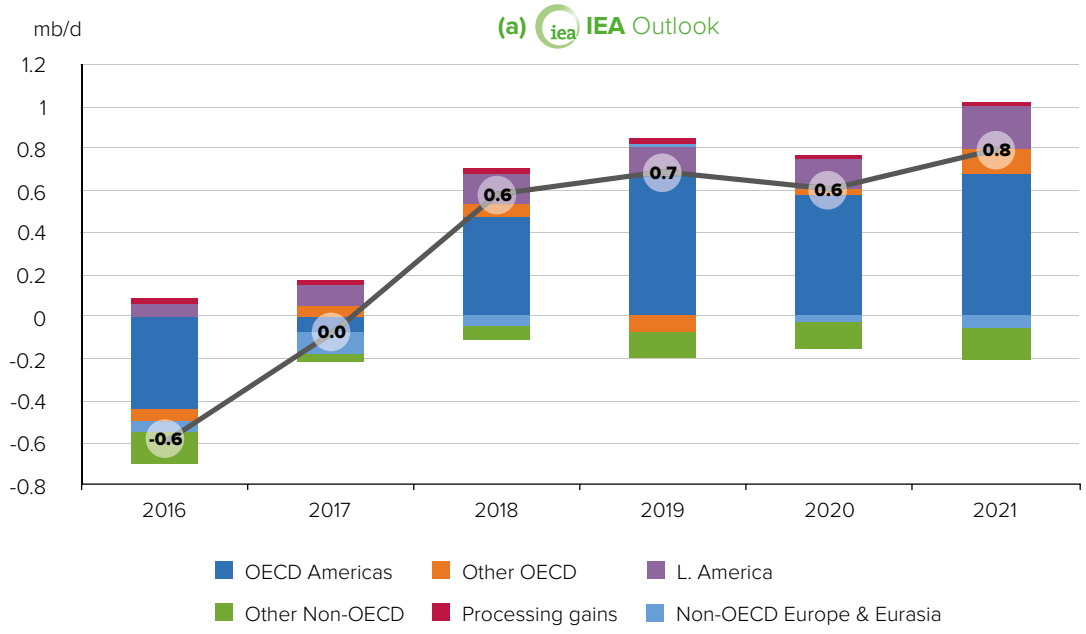
Figure 9(b) source: *Duke University Energy Initiative and IEF based on WOO2015. Through internal communication in 2016, OPEC reports that this liquids classification system has not changed for WOO2016.*

5.3.2 Global and Regional Liquids Supply

In a marked change from last year's medium term projections, both the IEA and OPEC project non-OPEC supply to decline in 2016, driven by reduced production in OECD Americas (**Figure 10(a)** and **Figure 10(b)**). OPEC's projects a decrease in 2016 supplies of 1.1 mb/d, substantially more than the IEA's projection of a 0.6 mb/d decrease. However, over the next several years, overall non-OPEC supply growth projections are similar across the two outlooks, with supply remaining roughly flat in 2017, as growth from Latin America is largely offset by declines in North America and Europe/Eurasia. In 2018 and 2019, projections agree that non-OPEC supply will grow annually by 0.6 to 0.7 mb/d, primarily driven by OECD Americas and Latin America.

In 2020, the two projections again diverge. OPEC forecasts growth of roughly 0.8 mb/d with most growth coming from OECD Americas and Latin America, while the IEA projects an increase of 0.6 mb/d with a smaller contribution from OECD Americas. In 2021, the overall trend reverses, with OPEC forecasting slower growth of 0.7 mb/d and the IEA projecting additional supply of 0.8 mb/d. Over the course of the projection period, the United States and Canada lead supply growth after declining more than any other region in 2016. Latin America, led by Brazil, contributes the second largest share.

Figure 10. Medium-term Non-OPEC Liquids Supply Annual Growth (mb/d)



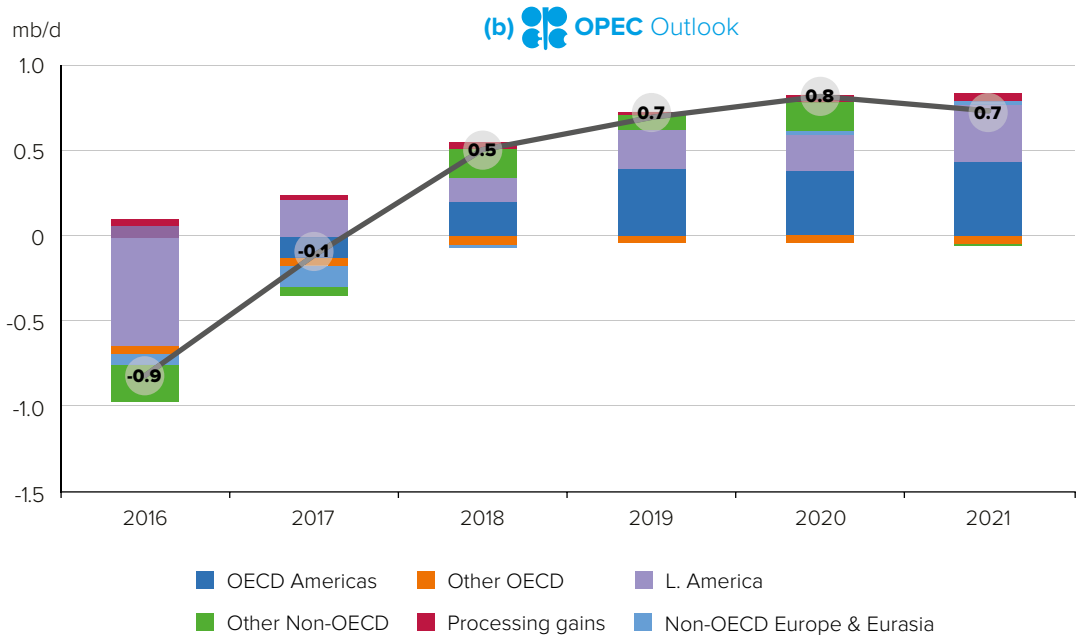


Figure 10 data sources: *IEA MTOMR 2016, Table 3, Table 5, Table 5a; IEA MTRMR 2016, Table 3.1 for biofuels; regional data from OPEC WOO 2016, Table 4.1. Some totals may differ due rounding.*

Figure 10 notes: *Other OECD is the sum of data from OECD Europe and Asia Oceania; Other Non-OECD is the sum of data from Middle East & Africa and Non-OECD Asia. Because Gabon joined OPEC in July 2016, it is included as an OPEC member for OPEC's WOO, but not in the IEA's MTOMR. Indonesia is included as an OPEC member in both. Biofuels are added to IEA regional oil supply data for comparability with OPEC estimates.*

Table 10 provides a detailed regional comparison of medium-term liquids supply between the two outlooks. Compared to last year, the IEA's medium term projection shows substantially stronger supply growth than OPEC for the OECD Americas and OECD Europe regions, resulting in a 1.5 mb/d difference by 2021; an increase of 1 mb/d compared to last year's differential. In a contrast that is similar to last year's assessment, OPEC is more bullish on supplies from non-OPEC Middle East & Africa, as well as from Latin America, projecting total non-OECD supplies to be 0.5 mb/d higher in 2021 than the IEA.

In total, the IEA forecasts 59.7 mb/d in supplies from non-OPEC nations in 2021, while OPEC estimates 58.6 mb/d, a 1.1 mb/d difference. The IEA projects supplies from OPEC member nations of 42.0 mb/d, 1.2 mb/d higher than the OPEC's forecast. This difference arises primarily from the fact that in the IEA's forecast, global supplies in 2021 are 2.3 mb/d higher than the OPEC's, with OPEC nations providing a roughly 41% share of supplies under both forecasts. Notably, the IEA's forecast does not include Gabon as a member of OPEC because the MTOMR was published before that nation re-joined in July 2016. Gabon produced roughly 0.22 mb/d of crude oil in 2014.

Average annual growth figures as shown in **Table 10** are somewhat complicated due to the divergent baseline (2015) data for certain regions. For example, total OPEC supplies differ by 0.5 mb/d, and total non-OPEC supplies differ by 0.8 mb/d in the baseline.

Notably, neither medium term projection incorporates the November 2016 agreement between OPEC members that set a production target of 32.5 mb/d in 2017, and the

subsequent announcement that a select group of non-OPEC members, notably Russia, would also adjust production growth[5]. However, OPEC's WOO does incorporate the September, 2016 Algiers Accord (170th (Extraordinary) Meeting of the OPEC Conference) which opted for an OPEC-14 production target ranging between 32.5 and 33.0 mb/d.

Table 10. Medium-term Liquids Supply Forecasts (mb/d)

	2021		Avg. annual growth (2015-2021)		
	IEA[(c)]	OPEC	IEA	OPEC	DIFFERENCE (IEA-OPEC)
Total OECD	**27.2**	**25.7**	**0.3**	**0.1**	**0.3**
OECD Americas	22.9	21.6	0.3	0.1	0.2
OECD Europe	3.7	3.4	0.0	-0.1	0.1
Asia Oceania	0.7	0.6	0.0	0.0	0.0
Total Non-OECD (Non-OPEC)	**30.1**	**30.6**	**0.0**	**0.2**	**-0.2**
Asia	7.0	6.9	0.0	0.0	0.0
China	4.2	4.1	0.0	-0.1	0.0
Other non-OECD Asia	2.8	2.8	0.0	0.0	0.0
Middle East & Africa [(a)]	3.2	3.6	-0.1	0.0	-0.1
Latin America	6.0	6.3	0.1	0.2	-0.1
Europe & Eurasia	13.9	13.8	0.0	0.0	0.0
Processing Gains	2.4	2.3	0.0	0.0	0.0
Total Non-OPEC	**59.7**	**58.6**	**0.3**	**0.3**	**0.1**
Total OPEC	**42.0[(d)]**	**40.8**	**0.5**	**0.4**	**0.1**
OPEC crude[(b)]	34.9	33.8	0.5	0.3	0.2
OPEC NGLs + unconventionals	7.2	7.0	0.1	0.2	-0.1
World	**101.7[(d)]**	**99.4**	**0.9**	**0.7**	**0.2**

Table 10 data sources: *IEA MTOMR 2016, Tables 3, 5, and 5a; OPEC WOO2016, Table 4.1.*

Table 10 notes: *Sums may not total due to rounding.*

[(a)] The IEA includes Gabon, which re-joined OPEC in July 2016, in its MTOMR estimates for the "Africa" region, while OPEC groups Gabon in the "OPEC" category in WOO2016.

[(b)] For IEA includes stock change and miscellaneous. OPEC also includes stock change in medium-term and long-term projections.

[(c)] IEA regional supply estimates include biofuels, based on IEA MTOMR 2016 Tables 5 and 5a.

[(d)] Estimates for total OPEC supply and world supply are constructed from other components because IEA does not directly provide these forecasts in their reports.

5 The oil exporting Non-OPEC countries that participated in the meeting held at OPEC in Vienna on 10 December 2016 are Azerbaijan, Oman, Mexico, Sudan, South Sudan, Bahrain, Malaysia, Equatorial Guinea, Bolivia, Kazakhstan and Russia.

Unlike recent years, IEA and OPEC projections for medium-term oil supply from the United States and Canada have declined substantially due to lower prices and less drilling activity. Also unlike 2014 and 2015, when projections were similar, this year's projections diverge substantially. Both organisations made similar downward revisions to their 2016 and 2017 forecasts for the two countries, but the IEA projects more rapid growth beginning in 2018, reaching 19.4 mb/d by 2021 compared with OPEC's forecast of 18.2 mb/d in 2021 resulting in a difference of 1.2 mb/d between IEA and OPEC assessments of United Sates and Canadian oil supply projections in 2021. (**Figure 11**).

Figure 11. Medium-term US and Canadian Oil Supply (mb/d, excluding biofuels)

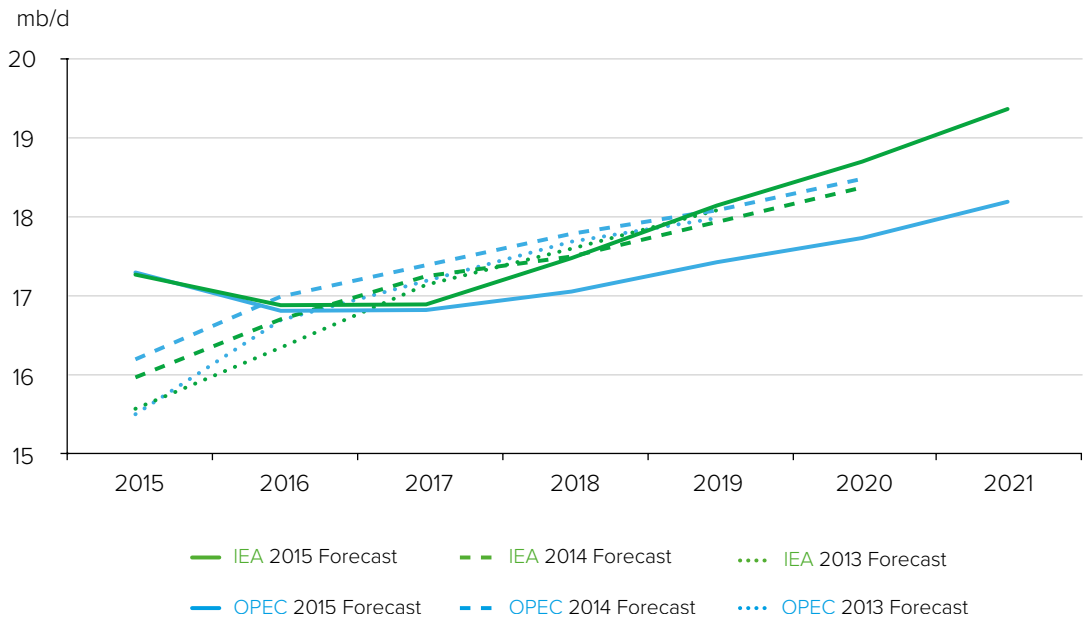


Figure 11 data sources: *IEA MTOMR 2016 Table 3; OPEC WOO2016, Table 4.1; IEA MTOMR 2015, Table 3; OPEC WOO2015, Table 1.9 & Table 3.5; IEA MTOMR 2014, Table 3; OPEC WOO2014, Table 1.12 & Table 3.5.*

6. Long-term Energy Outlooks

The following comparison of long-term outlooks evaluates the IEA's World Energy Outlook 2016 (WEO2016) and OPEC's World Oil Outlook 2016 (WOO2016). In these reports, the IEA and OPEC make projections extending through 2040, with both organisations using baseline years of 2014 for primary energy demand and 2015 for oil. However, differences between the two organisations in their choice of units for primary energy demand create challenges in making comparisons. OPEC uses million barrels of oil equivalent per day (mboe/d), while the IEA uses million tons of oil equivalent (mtoe) per year. To address this issue, we convert the IEA's units of primary energy from mtoe per year to mboe/d by multiplying by 7.37[6] mboe/mtoe and dividing that total by 365 days per year, yielding a conversion factor of 0.0202 mboed/mtoe.

6 IEA, Oil Information 2015, IV.93.

6.1 Key Assumptions

6.1.1 Scenarios

Both the IEA and OPEC conduct scenario analysis to address uncertainties through 2040. **Table 11** lists key assumptions for each scenario included in the WEO2016 and WOO2016. A more detailed comparison is provided in **Annex 1**, and a comparison of outlook results for each scenario is featured in **Annex 2**.

Table 11. Long-term Scenario Key Assumptions

IEA WEO Scenarios	OPEC WOO Scenarios
Current Policies Scenario: Only considers policies that have been enacted as of mid-2016	**Reference Case:** Considers enacted policies and also accepts that the policy process evolves overtime
New Policies Scenario: Considers both policies in place and commitments announced	**Scenarios A and B** Demand grows more slowly due to climate policy. Scenario B assumes full adoption of INDCs, and faster development and deployment of technology. Scenario A assumes more limited policy
450 Scenario: Assumes policies are taken to limit the concentration of GHGs in the atmosphere to 450 ppm of CO2 equivalent	**Supply Scenarios (Highside/Lowside):** Looks at possibility of higher or lower non-OPEC supply than the Reference Case

The IEA has maintained its analysis of three core scenarios – the New Policies Scenario, the Current Policies Scenario and the 450-ppm Scenario. The New Policies Scenario, the central scenario in the WEO series, considers both policies in place as well as policies that have been announced. The Current Policies Scenario is provided as a baseline scenario to show how the global energy market might evolve without further policies. Finally, the 450 Scenario creates an energy path consistent with the trajectory towards a 450-ppm climate target, a level estimated to have a 50% chance of limiting global temperature increase to 2°C by 2100. All three IEA scenarios share the same GDP and population assumptions, while variations in policy affect technological development and energy markets.

OPEC also employs scenario analysis in the WOO series, and the WOO2016 continues to build on OPEC's World Energy Model (OWEM) for upstream liquids demand and supply projections. In the WOO series, the Reference Case is the central scenario. As in WOO2015, this year OPEC not only considers enacted policies, but also accepts that the policy process evolves over time. In WOO2016, OPEC highlights several new energy policies in the Policy Assumptions section of chapter 1 and examines their potential impacts over time. Because OPEC's Reference Case in WOO2016 is not strictly based on energy policies already in place, it becomes more challenging to find a single counterpart in IEA's WEO2016 for comparison.

OPEC examines two pairs of alternative scenarios in WOO2016. For its supply scenarios, the Upside Supply Scenario focuses on more optimistic projections for tight crude and unconventional NGLs supply and the Downside Supply Scenario considers factors that may reduce both conventional and unconventional production. In its second set of scenarios, OPEC focuses on different approaches to reducing GHG emissions following the 2015 Paris Agreement. In Scenario A, new energy efficiency and fuel substitution efforts are added to the Reference Case, leading to a modest reduction in emissions. In Scenario B, all Parties to the Paris Agreement adopt their Intended Nationally Determined Contribution (INDC) in a timely manner and new technologies are deployed faster, further reducing emissions.

Because OPEC's Reference Case considers both enacted policies and proposals or commitments that are not legally enacted, we compare it with both the IEA's Current Policies Scenario and the IEA's New Policies Scenario.

6.1.2 Demography

As in previous outlooks, both the IEA and OPEC base their demographic assumptions primarily upon projections made by the United Nations Department of Economic and Social Affairs Population Division. Direct comparison is complicated slightly by different base years of 2014 for the IEA and 2015 for OPEC. However, both project annual average population growth of 0.9% per annum through 2040. Moderate differences exist on overall population levels, with 2040 global estimates of 9.15 billion from the IEA and 9.08 billion from OPEC.

For both outlooks, the large bulk of new population comes from non-OECD nations. Both projections assume a 1.0% annual population growth rate for non-OECD nations, and a 0.4% growth rate for OECD nations. According to the IEA's assumptions, population growth rates from 2014 to 2040 are highest in Africa (2.3% p.a.), the Middle East (1.4% p.a.), and India (0.9% p.a.). India is likely to overtake China as the world's most populous country in the early 2020s, growing to a population of more than 1.6 billion by 2040.

In addition to population growth assumptions, urbanisation is projected to accelerate under both projections, with the share of people living in cities growing from 53% in 2014 to 63% in 2040. The trends occurs most rapidly in Africa and non-OECD Asia, with China in particular rapidly urbanising from a rate of 55% in 2014 to 73% by 2040. Other crucial demographic factors that may impact energy consumption include age structure and global migration patterns. For example, energy demand projections will be higher if demographic assumptions include a larger percentage of working-age population and more immigrants from non-OECD nations to OECD nations.

6.1.3 Economic growth

The IEA and OPEC take similar approaches in deriving GDP assumptions. For medium-term projections, both use internal expertise in combination with economic forecasts published by the IMF, World Bank and other organisations. Their long-term projections, however, are based on assumptions about working population and productivity levels, key factors in determining economic growth rates. The IEA and OPEC use slightly different assumptions, and their forecasts for annual average global economic growth through 2040 vary modestly, with OPEC assuming 3.5%, and the IEA assuming 3.4%.

The IEA and OPEC both make GDP assumptions in Purchasing Power Parity (PPP) terms[7]. However, the two organisations use different benchmark projection years in their outlooks to calculate compound average annual growth. OPEC publishes growth assumptions from 2015-2040, with increments of 2015-2021, 2021-2030, 2030-2040. The IEA uses 2014 as a baseline year, and publishes assumptions from 2014-2040, with increments of 2014-2020, 2020-2030, and 2030-2040.

Through communications with both modelling teams, standardised data were gathered and are presented in **Figure 12**. From 2015 to 2020, growth assumptions are fairly similar between the two organisations, but begin to diverge in the longer term. For example, OPEC's 2030-2040 annual average economic growth assumptions for India (6.4%), China (4.1%), the OECD (2.0%), and the World (3.4%) are notably higher than the IEA's assumptions of 5.3%, 3.2%, 1.7%, and 3.1%, respectively. However, the IEA's growth assumptions for Russia are substantially higher than OPEC's in both the 2020-2030 and 2030-2040 periods. Comparisons between regional groupings such as the Middle East, Africa, or Latin America is complicated by the fact that OPEC separates its member countries from these regions in WOO2016, reporting them in a distinct "OPEC" category.

Figure 12. Long-term GDP Growth Assumptions for Selected Regions

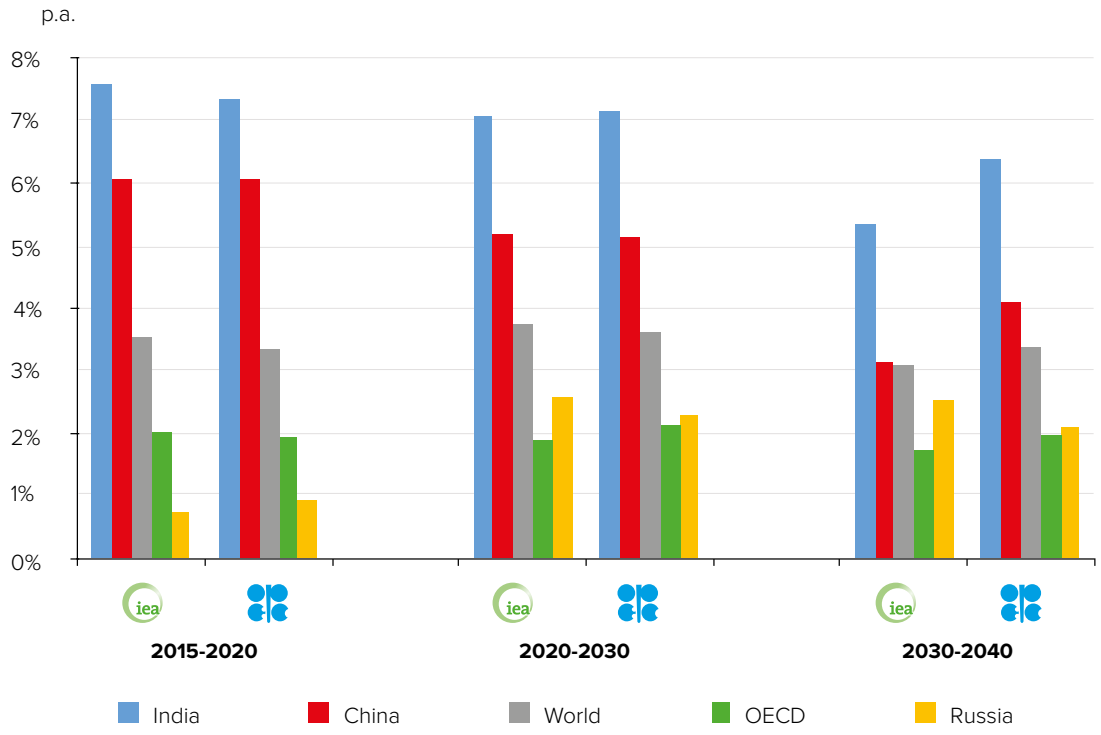


Figure 12 data sources: *IEA internal communication; OPEC internal communication.*

7 The World Bank's International Comparison Program (ICP) released revised data for Purchasing Power Parity (PPP) in 2014. In this revision, emerging economies see large upward GDP adjustments, and China becomes the world's largest economy. Both organisations have incorporated this change into their reports.

6.1.4 Oil Prices

OPEC's long-term oil price assumptions are derived based on its estimation of the cost of supplying the marginal barrel. The IEA WEO series takes a different approach from its MTOMR series to derive long-term oil prices. Instead of referring to the Brent futures curve (which does not extend to 2040), the IEA's long-term price assumptions are based on the equilibrium prices reached in a supply-demand model. The IEA's equilibrium price factors in marginal cost assumptions, investment return requirements (12%)[8] and policy factors.

Even accounting for the differences described above, the gaps between the IEA's and OPEC's long-term oil price assumptions remain large. As shown in Figure 13, OPEC's oil price assumptions (in real 2015 US$) in the Reference Case are substantially lower than most WEO2016 Scenarios. Among the IEA's three scenarios, the Current Policies Scenario has the highest oil price assumptions due to higher oil demand, leading to gaps of US$25/bbl and US$54/bbl relative to OPEC's Reference Case in 2020 and 2040, respectively. These gaps are substantially larger than those described in last year's Sixth Symposium Introductory Paper, which were US$12/bbl and US$46/bbl in 2020 and 2040, respectively. Only in the IEA's 450 Scenario are 2040 oil prices lower than OPEC's Reference Case outlook (OPEC does not publish price assumptions for its alternative scenarios).

Figure 13. Long-Term Oil Price Assumptions in 2020 and 2040 (real 2015 US$/bbl)

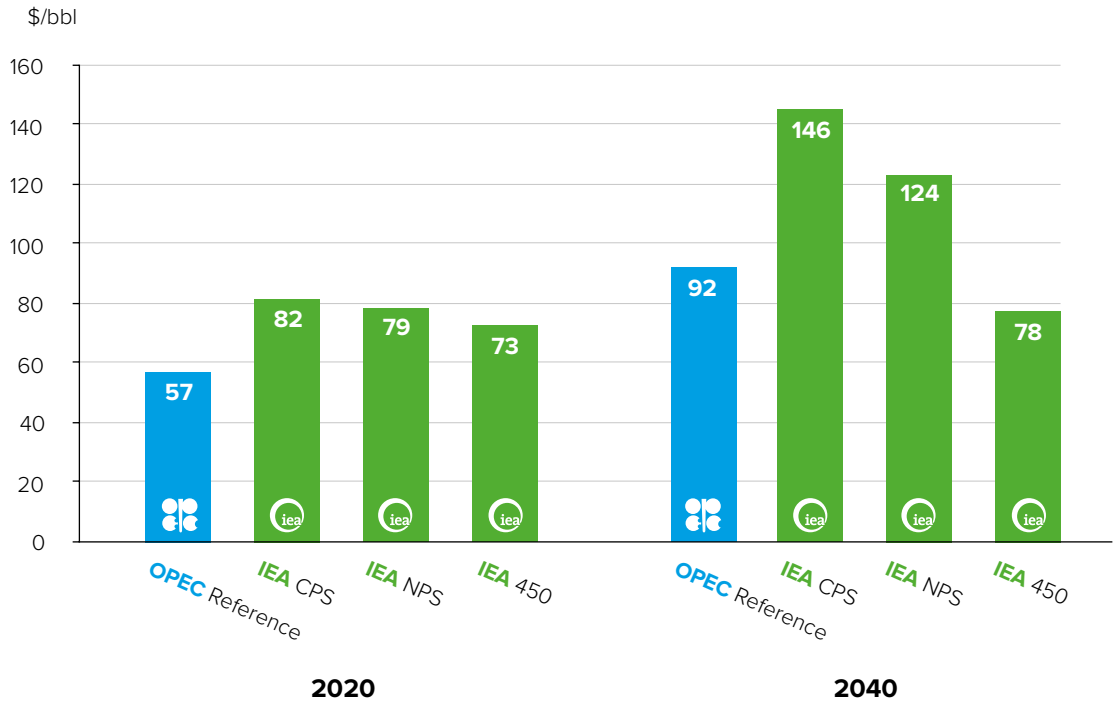


Figure 13 Data Sources: *IEA WEO2016 Table 1.4; OPEC WOO2016 Figure 1.9.*

8 IEA, World Energy Outlook 2013 (Paris: OECD/IEA, 2013), p.459.

6.1.5 Energy and Environmental Policies

Each year, projections incorporate new policies enacted or proposed. This year, with the late 2015 announcement of the Paris Agreement, policies related to climate change have received additional attention. A brief comparison of policy updates between WEO2016 and WOO2016 is provided below. In WEO2016, the IEA highlights proposals or commitments included in its New Policies Scenario, which includes the INDCs submitted at Paris. The IEA also includes a detailed discussion of additional policies or technological developments that may be necessary to reach a 450ppm target, as well as considerations for a 1.5°C target. The 2016 Current Policies Scenario receives less detailed discussion, and does not incorporate the INDCs.

In their policy highlights, OPEC highlights several proposals that are common with the IEA's New Policies Scenario, including an update to the U.S. Renewable Fuels Standard, revisions to the European Union's Emissions Trading System, policies adopted under China's 13th Five Year Plan which limits growth in energy consumption and reduces energy intensity, India's new fuel efficiency standards, and a number of other policies. While OPEC incorporates INDCs and additional climate policies into its Scenarios A and B, the Reference Case does not include these specific pledges for most countries.

	IEA WEO2015: Highlighted Policies	OPEC WOO2015: Highlighted Policies
	New Policies Scenario only	Reference Case only
		**Argentina:** Reduction in energy subsidies
	**Brazil:** INDC of 37% GHG emissions reductions below 2005 levels by 2025	
	**China:** INDC of emissions peak by around 2030; reduced carbon intensity; increased share of non-fossil sources to 20% by 2030 Efforts for a structural economic shift from investment and exports towards services and consumption Emissions trading system from 2017	Reduce energy intensity 15% and carbon intensity 18% from 2015 levels by 2020
	**EU:** INDC of 40% GHG emissions reductions below 1990 levels by 2030; 27% renewables by 2030; energy efficiency improvements Revisions to Emissions Trading System	INDC of 40% GHG emissions reductions below 1990 levels by 2030 EU: Revisions to Emissions Trading System
	**INDIA:** INDC of 33-35% reduction in carbon intensity below 2005 levels by 2030; goal of 40% electricity from non-fossil sources	Vehicle standards leading to 15% greater energy efficiency from 2010 levels by 2022
	**INTERNATIONAL:** Fossil fuel subsidies phased out in all net-importers within 10 years	
	**JAPAN:** INDC of 26% GHG emissions reductions from 2013 levels by 2030	"Energy Mix Plan" 2030, including 20-22% of power from nuclear by 2030
	**MEXICO**	Continued growth of competition in the oil and gas sector
	**RUSSIA:** INDC of limiting GHG emissions to 70-75% of 1990 levels by 2030	
	**US:** INDC of 26-28% GHG emissions reductions from 2005 levels by 2025.	Finalised rules for biofuels
		Reduction in fossil fuel subsidies

6.2 Long-term Energy Demand

6.2.1 Primary Energy Consumption

Despite substantial developments in energy markets during 2016, the overarching trends in global energy consumption are similar to those described in last year's Sixth IEF Symposium report. Global energy demand continues to grow through 2040, and while the percentage rate of growth is slower, absolute levels of growth are similar to previous decades. Consumption growth is driven primarily by population and economic growth, with the majority of new demand coming from developing countries, particularly in Asia. Fossil fuels continue to dominate the primary energy mix, with oil, gas and coal maintaining between 74% and 79% of the total share in all the scenarios excluding the IEA 450 Scenario. As always, significant uncertainties remain regarding policy and technological development, which will play important roles in shaping the pace of demand growth as well as the composition of the fuel mix.

However, there are some important differences between 2016 and 2015 projections. Total primary energy demand forecasts for all major scenarios are substantially lower this year than in 2015. In OPEC's WOO2016 Reference Case, demand grows by 40% from 2014-2040, compared with 49% growth from 2013-2040 in WOO2015. Both IEA Scenarios show more modest changes, with the Current Policies Scenario growing by 43% from 2014-2040, compared with last year's projection of 45% growth from 2013-2040. The IEA's 2016 New Policies Scenario projects growth of 31%, compared with 2015's projection of 32% growth.

Figure 14 provides a comparison of projections for total primary energy supply by energy source, highlighting a number of differences. Of the three major Scenarios, the IEA's Current Policies Scenario projects the most robust growth in energy demand, followed by OPEC's Reference Case and the IEA's New Policies Scenario. The IEA's Current Policies Scenario projection for coal and oil consumption is 16 mboe/d and 9 mboe/d higher, respectively, than OPEC's Reference Case. However, OPEC's Reference outlook for gas is 6 mboe/d higher than the IEA's Current Policies Scenario. Under the IEA's New Policies Scenario, consumption for all fossil fuels is lower than OPEC's Reference Case, with the largest difference again seen in natural gas (-15 mboe/d), followed by coal (-8 mboe/d), and oil (-3 mboe/d). In terms of total primary energy demand and the composition of the fuel mix, the IEA's New Policies Scenario falls closest to OPEC's Scenario B, which, like the New Policies Scenario, envisions timely adoption of INDCs under the Paris Agreement. The IEA's 450 Scenario includes much slower growth in overall primary energy demand and a notable decrease in the share of fossil fuels in the primary energy mix. As the scenarios tighten to meet GHG goals, coal is the biggest loser of relative market share.

Figure 14. World Primary Energy in 2014 and Outlook for 2040 (mboe/d)

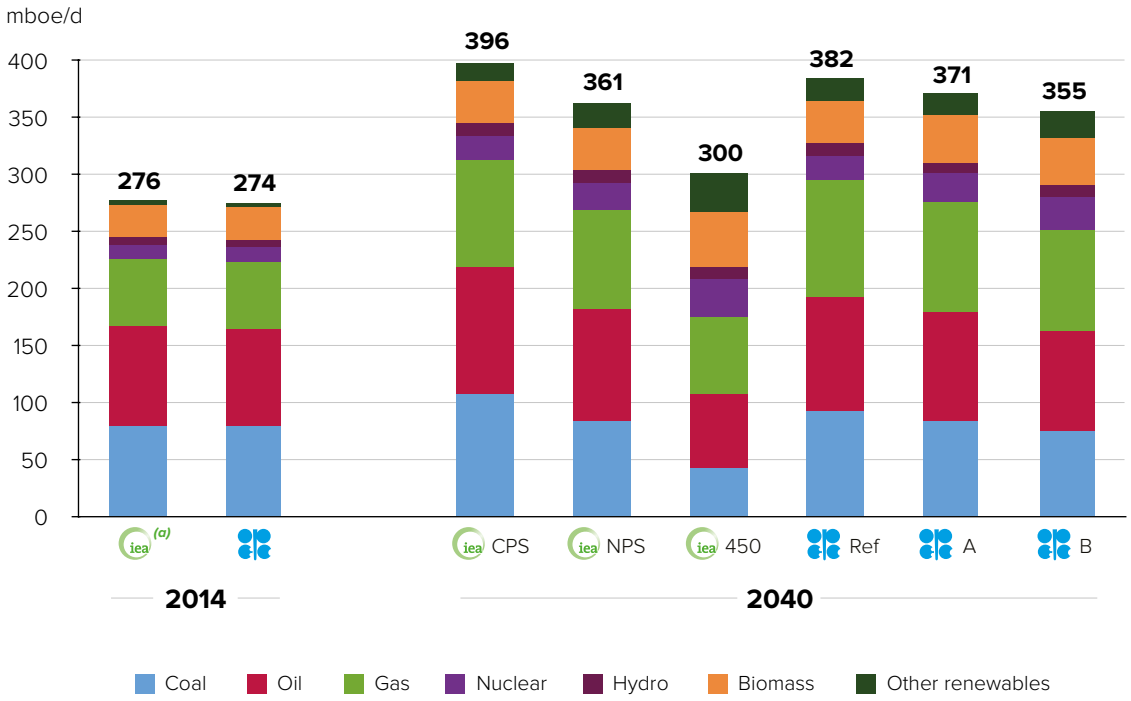


Figure 14 data sources: *IEA WEO 2016, Annex Tables; OPEC WOO2016, Tables 2.2, 8.3 and 8.4.*

Figure 14 notes: *[a]IEA primary energy is converted from mtoe per year to mboe/d by multiplying by 0.0202 mboed/mtoe.*

Figure 15 presents the share of each fuel in the global energy mix in 2014, along with projections for 2040. In the IEA's New Policies and Current Policies Scenarios, oil is expected to maintain its position as the leading fuel in 2040, though its share shrinks, and it is nearly overtaken by coal in the Current Policies Scenario. In OPEC's Reference Case for 2040, natural gas again emerges as the leading primary energy source, at the expense of oil and coal. The IEA projects the share of oil will decline from 31% in 2014 to 27% and 28% in 2040 in the New Policies Scenario and the Current Policies Scenario, respectively, while OPEC sees a drop from 31% to 26% in the Reference Case. In the IEA's Current Policies Scenario, the share of coal declines modestly during the projection period from 29% to 27%, while it drops more rapidly from 28% to 24% in the OPEC Reference Case. Natural gas is set to grow the fastest among fossil fuels with an increasing share in the fuel mix in every projection examined here (including the IEA 450 Scenario and OPEC's Scenarios A and B). The share of renewables, led by biomass, is projected to increase in all scenarios from 14% in 2014 to 16% under the IEA's Current Policies Scenario, 17% in OPEC's Reference Case, and to 19% under the IEA's New Policies Scenario. Most of this growth comes from renewable electricity such as wind, solar, and hydro, and electricity is expected to grow faster than any other final form of delivered energy worldwide.

Figure 15. World Primary Energy Fuel Shares in 2014 and Outlook for 2040

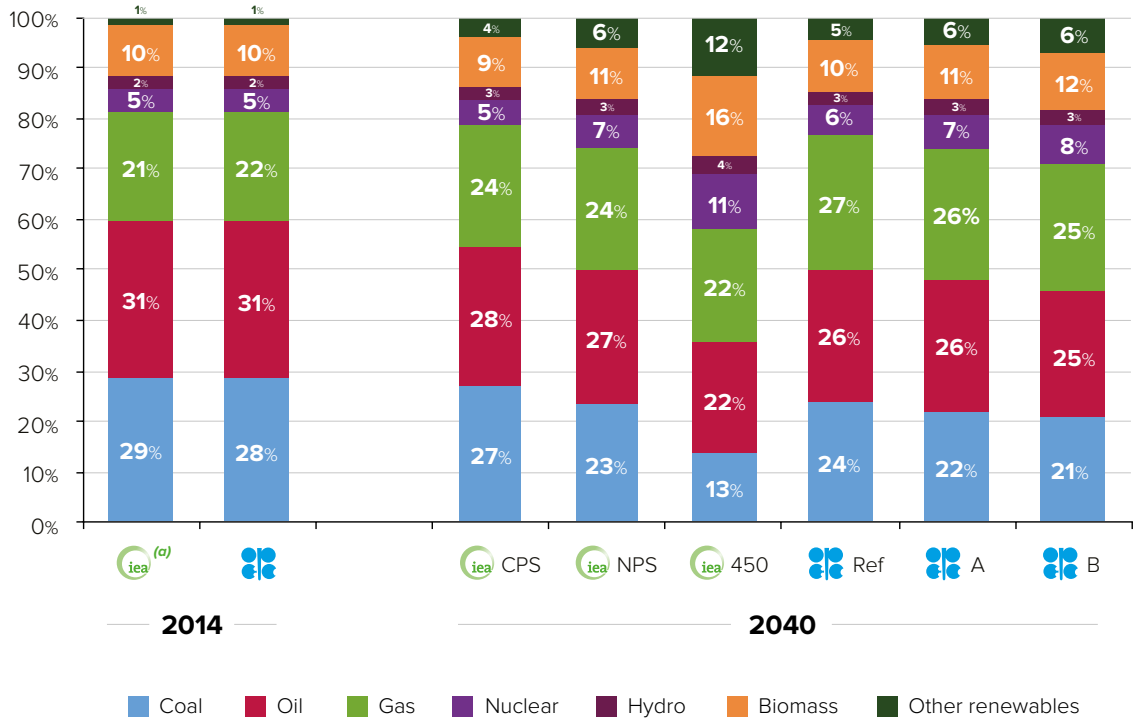


Figure 15 data sources: *IEA WEO 2016, Annex Tables; OPEC WOO2016, Tables 8.2, 8.3 and 8.4.*

Figure 14 notes: *[a]IEA primary energy is converted from mtoe per year to mboe/d by multiplying by 0.0202 mboed/mtoe.*

6.2.2 Liquids Demand

Similar to previous year's assessments, it remains a challenge to directly compare liquids demand between the WEO and WOO reports. First, the IEA and OPEC diverge on their classification of biofuels. The IEA groups biofuels into the renewables category, and projects demand for biofuels and oil separately. OPEC includes biofuels in the liquids category, as the IEA does in its OMR and MTOMR (but not the WEO). To adjust for this difference, we aggregate the IEA's oil and biofuels demand for each region, making the numbers comparable with OPEC's.[9] We also must convert IEA biofuels data in energy equivalent units to volumetric units for comparison with OPEC.[10]

Second, the IEA and OPEC define bunker fuels differently. While the IEA reports international marine bunker and aviation fuel as a distinct "bunker" group – not attributable to any country or region – OPEC includes bunker and aviation fuel in each region's oil demand, just as it does with biofuels. In addition, OPEC does not differentiate between international and domestic aviation fuels. Aggregating total marine bunker and aviation fuel demand from the OPEC WOO2016 report leads to a substantially larger number than that reported under the "bunkers" category in the WEO2016. For this reason, we do not compare bunker and aviation fuels between the IEA and OPEC, although we do show "bunkers" as a category for the IEA's world oil demand projections.

Third, although OPEC disaggregated its member countries demand data to improve direct comparison with IEA's outlook, an inconsistency still exists within the Middle East & Africa regions as reported in the two outlooks. While IEA reported Middle East and Africa regions separately, OPEC groups them together as a single category. This paper aggregates the Middle East and Africa in WEO2016 to more directly compare oil demand projections between the two organisations.

Incorporating the adjustments described above, **Table 12** presents a comparison of long-term world liquids demand projections using the IEA's New Policies Scenario, Current Policies Scenario and OPEC's Reference Case. Although the share of oil in the world primary energy portfolio is expected to decrease, the level of oil demand still enjoys robust growth over the projection period. In both IEA's New Policies Scenario and OPEC's Reference Case, world liquids demand reaches around 110 mb/d by 2040. In the IEA's Current Policies Scenario, 2040 world liquids demand grows to 122 mb/d (**Figure 16**).

The difference between the highest (IEA Current Policies Scenario) and lowest (IEA 450 Scenario) projections for 2040 world liquids demand is over 43 mb/d. Further reductions in liquids demand would be necessary to reach a global temperature target of 1.5°C, a temperature goal outlined in the 2015 Paris Agreement. Considering the historical gap in the base year of the projections, OPEC's Reference Case projects annual growth for

9 For the IEA's New Policies Scenario and Current Policies Scenario, biofuels projections are aggregated from Annex A Tables, pp. 548-625.

10 We use a conversion factor of 0.032 mbd/mtoe for biofuels. This overall conversion factor is computed by first deriving a factor of 1.463 mbd/mboed for converting ethanol in energy-equivalent barrels to volumetric barrels (we divide IEA's world biofuels demand in volumetric mbd terms (from IEA's MTOMR) by the demand in mboed). We then multiply 1.463 mbd/mboed by 0.022 mboed/mtoe (we divide IEA's world biofuels demand in oil-equivalent mb/d terms (presented in WEO2015 Table 3.1) by corresponding biofuels demand in mtoe (presented in WEO2015 Annex A tables) to arrive at an overall conversion factor of 0.032 mbd/mtoe. This conversion factor differs slightly from the one we use from primary energy demand, as described in Section 5.

liquids demand of 0.7 mb/d, slightly more than the IEA's New Policies Scenario projection of 0.6 mb/d, but well below the IEA's Current Policies Scenario forecast of 1.1 mb/d per year. **Figure 16** also suggests that demand growth will slow in the coming decades. Both the IEA and OPEC estimate slower annual demand growth after 2020 relative to 2015-2020 under all scenarios. While OPEC projects a further decline in growth beyond 2030, both IEA scenarios forecast slower growth from 2020 to 2040 than over the earlier period.

Table 12. Long-term Liquids Demand Forecasts (mb/d)

	2040			Avg. annual growth (2015-2040)			Difference (IEA-OPEC)	
	IEA NPS [a]	IEA CPS	OPEC Reference Case	IEA NPS	IEA CPS	OPEC Reference Case	NPS	CPS
Total OECD	**33.2**	**37.7**	**37.3**	**-0.4**	**-0.2**	**-0.4**	**-0.0**	**0.1**
OECD Americas	19.8	22.9	20.1	-0.2	0.0	-0.2	0.0	0.1
OECD Europe	8.7	9.8	11.1	-0.1	-0.1	-0.1	0.0	0.0
Asia Oceania	4.8	5.0	6.1	-0.1	-0.1	-0.1	0.0	0.0
Total Non-OECD	**65.6**	**71.4**	**72.1**	**0.8**	**1.1**	**1.0**	**-0.2**	**0.1**
Asia	35.6	38.8	37.3	0.6	0.7	0.6	-0.1	0.0
China	16.0	17.8	17.1	0.2	0.3	0.3	-0.1	0.0
India	10.2	10.8	10.4	0.3	0.3	0.3	0.0	0.0
Other non-OECD Asia	9.5	10.2	9.8	0.1	0.1	0.1	0.0	0.0
Latin America	7.9	8.4	7.3	0.1	0.1	0.1	0.0	0.0
Middle East & Africa	17.1	19.0	6.0	0.2	0.3	0.1	0.1	0.2
Europe & Eurasia	5.1	5.2	6.0	0.0	0.0	0.0	0.0	0.0
Bunkers [b]	11.2	12.5	n/a	0.2	0.2	n/a	n/a	n/a
World	**110.0**	**121.6**	**109.4**	**0.6**	**1.1**	**0.7**	**-0.1**	**0.4**

Table 12 data sources: *IEA WEO 2016, Annex A Tables; OPEC WOO2016, Table 3.2.*

Table 12 notes: *Sums may not total due to rounding.*

[a] Biofuels from IEA WEO 2016 Annex A are added to IEA regional oil demand data for comparability with OPEC estimates, after converting from mtoe to mb/d. 2015 regional biofuels data from IEA provided via internal communication.

[b] Bunkers in the IEA WEO include international marine bunkers and aviation fuels. In the OPEC WOO, all bunkers are within regional demand.

Figure 16. World Liquids Demand Projections in Various Scenarios (mb/d)

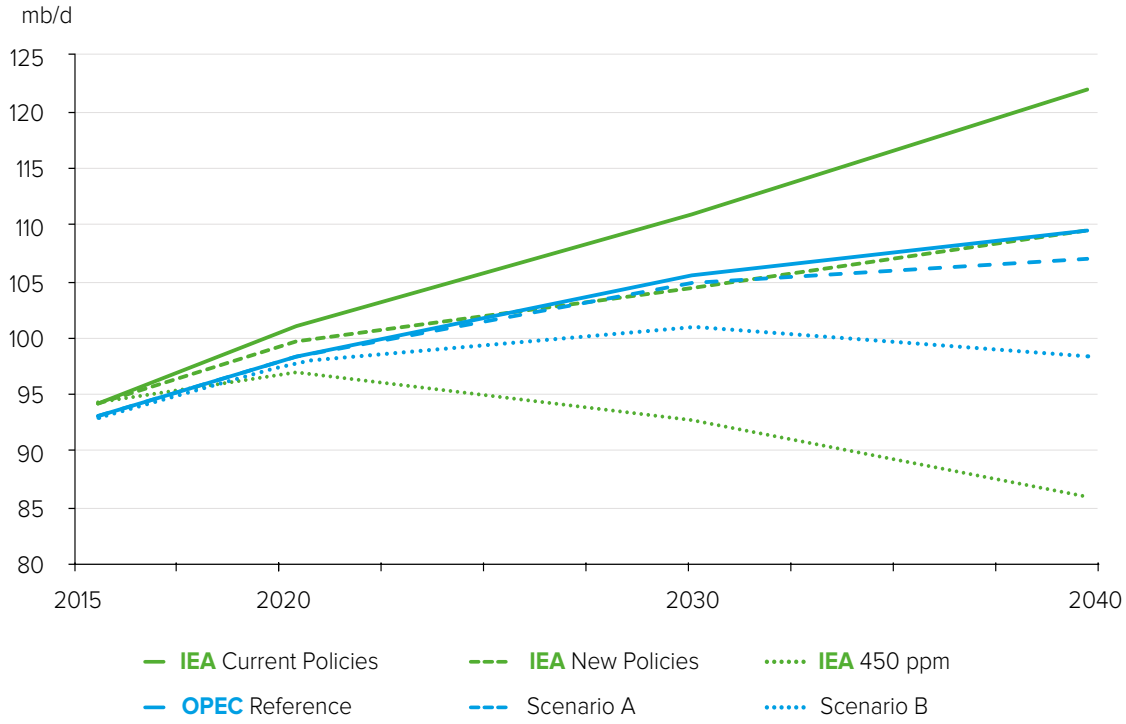


Figure 16 data sources: *IEA WEO 2016, Annex A Tables for Scenario Projections and Table 3.1; OPEC WOO2016, Table 3.2 and Figure 8.5. Figure 16 notes: Biofuels from IEA WEO 2016 Annex A are added to IEA regional oil demand data for comparability with OPEC estimates, after converting from mtoe to mb/d.*

Regarding consumption trends for OECD and non-OECD groupings, the IEA's New Policies Scenario, Current Policies Scenario and OPEC's Reference Case make remarkably similar projections. All three project that OECD nations will experience a decline in long-term oil demand, yet this decrease is expected to be more than offset by robust demand growth in non-OECD nations. The centre of demand growth continues to shift to developing countries, with non-OECD nations' share of total oil demand increasing from half to nearly two-thirds over the course of all outlooks, including alternative scenarios (**Figure 17**).

For specific regions and nations, the IEA and OPEC share similar views on overarching trends of oil demand, with some moderate differences. For instance, both project (not shown) that non-OECD Asia will lead consumption growth over the forecast period. However, the IEA's New Policies and Current Policies Scenarios show India overtaking China as the leading centre of demand growth, while OPEC forecasts that consumption in China and India grow a pace by 6.3 mb/d up to 2021 in absolute terms. Other regional differences are modest, with strong growth projected in the Middle East and Africa (0.2 mb/d to 0.3 mb/d p.a.), moderate growth in Latin America (0.1 mb/d p.a.), and minimal growth in non-OECD Europe and Eurasia (0.01 mb/d to 0.02 mb/d p.a.).

Figure 17. OECD and Non-OECD Shares of Liquids Demand in 2015 and Outlook for 2040

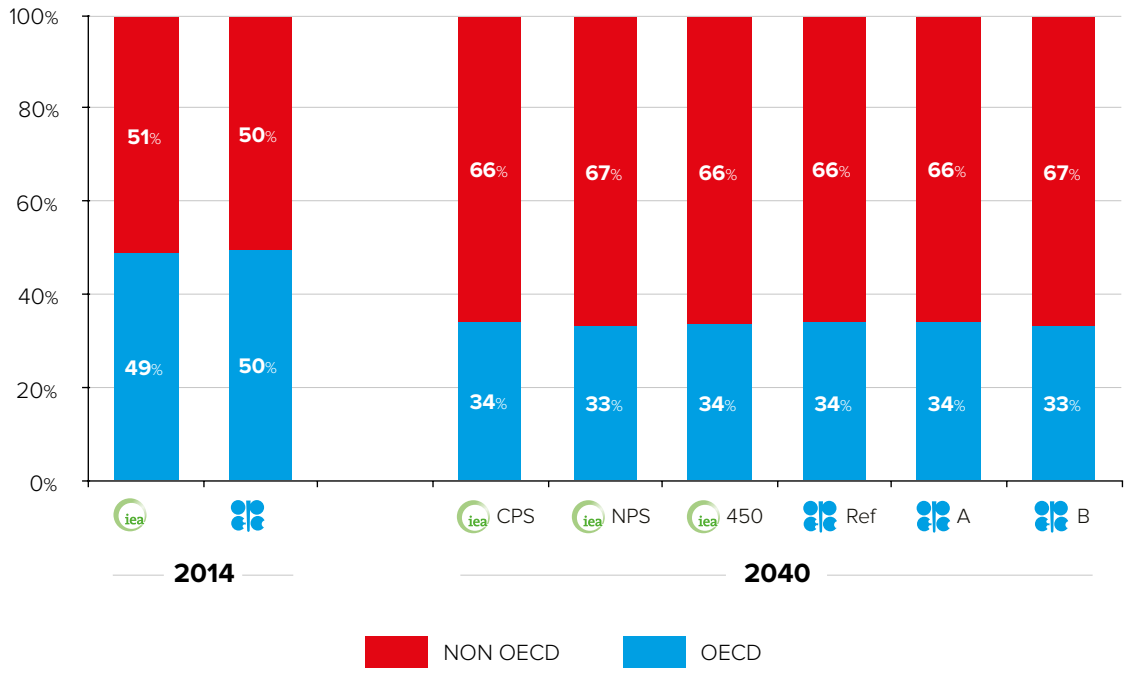


Figure 17 data sources: *IEA WEO 2016, Annex A Tables for Scenario Projections and Table 3.1; OPEC WOO2016, Tables 3.2, Figures 8.5 and 8.6.*

Figure 17 note:

[a] The "bunkers" group in the IEA's WEO report is excluded from calculation for OECD and non-OECD oil demand shares.

[b] Biofuels from IEA WEO 2015 Annex A are added to IEA regional oil demand data for comparability with OPEC estimates, after converting from mtoe to mb/d by multiplying by a factor of 0.032.

Figure 17a. Non-OECD Asia Liquids Demand Outlook for 2040

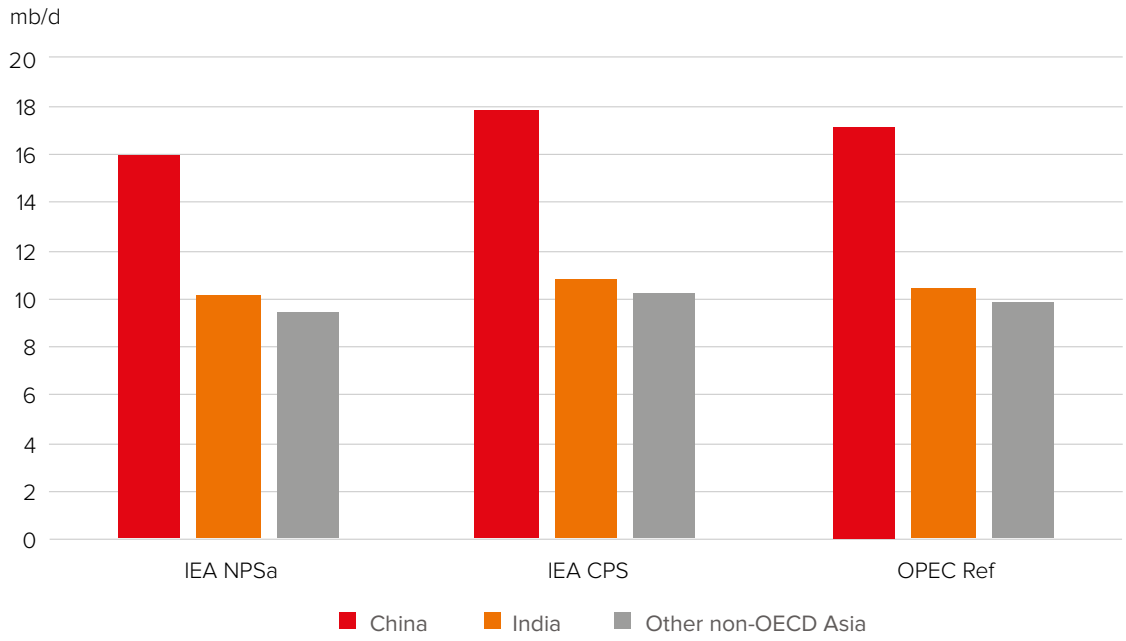


Figure 17a data sources: *IEA WEO 2016, Annex A Tables; OPEC WOO2016, Table 3.2.*

Figure 17a note:

[a]Biofuels from IEA WEO 2016 Annex A are added to IEA regional oil demand data for comparability with OPEC estimates, after converting from mtoe to mb/d. 2015 regional biofuels data from IEA provided via internal communication.

[b]Bunkers are included within regional demand for the OPEC WOO2016, but not for IEA estimates.

Perspectives on sectoral trends are consistent between the IEA and OPEC. Transportation and the petrochemicals industry are expected to remain the largest oil consumers and contribute the majority of demand growth. Oil consumption for power generation is projected to decrease in all regions. As a result, shares of oil consumption in transport and petrochemical sectors become larger.

6.3 Long-term Oil Supply

6.3.1 Mathematical Models

In Section 3, we noted that both the IEA and OPEC base their medium-term supply projections on bottom-up approaches. However, their long-term supply projection methodologies are more distinct.

In its WOO series, OPEC uses a resources-to-production (R/P) model to verify estimates of annual future oil production based on variables including discovery rates, development cost, profitability and drilling footage. In this model, the focus is on estimating the economic accessibility of oil resources in each country. OPEC primarily relies on U.S. Geological Survey (USGS) data (updated most recently in 2012) for country-level estimates of Ultimately Recoverable Resources (URR), supplemented by regional updates and other sources. The advantage of using R/P to verify estimates is its simplicity and ease of understanding. However, URR estimates are subject to substantial uncertainty, and past research has identified cases where URR estimates may be low due to the possible exclusion of new discoveries and underestimates of reserve growth[11] . In addition, unanticipated technological advancements may substantially affect the economic viability of known resources.

Indeed, OPEC notes that the largest concern in using an R/P model is the challenge of incorporating unconventional resources. OPEC finds its model inappropriate in developing supply forecasts for tight crude and unconventional NGLs, and therefore separates its supply forecasts for tight crude and unconventional NGLs from conventional liquids resources.

Like last year, the WOO2016 includes a detailed assessment of active unconventional plays in North America. For unconventional resources outside North America, OPEC continues to take a relatively cautious approach. Section **5.3** describes the regional results of these projections.

The IEA employs a bottom-up modelling approach for its long-term oil supply projection. Unlike in the MTOMR, however, the IEA takes a country-by-country approach instead of the field-by-field approach (though the first five years of the long-term projection employs field-by-field analysis). For the long-term projections, production in each country is derived by simulating the investment process, considering existing and potential resources, global oil demand, and a net present value (NPV) ranking of possible projects in that country.

Another important difference between the IEA's long-term supply forecast and its medium-term forecast lies in the methodology for calculating OPEC supply. As shown in **Table 10**, OPEC crude is constructed by subtracting non-OPEC supplies and OPEC NGLs/unconventionals supply from total world oil demand in the MTOMR. In the long-term WEO model, however, supplies from OPEC Member Countries are projected using the same methodology used for non-OPEC nations.

11 Adam R. Brandt, Review of mathematical models of future oil supply: Historical overview and synthesising critique, Energy, Volume 35, Issue 9, September 2010, Pages 3958-3974, ISSN 0360-5442, http://dx.doi.org/10.1016/j.energy.2010.04.045.

6.3.2 Liquids Supply

Table 13 summarises long-term liquids supply outlooks for the IEA's New Policies and Current Policies Scenarios and OPEC's Reference Case. Both the IEA's New Policies Scenario and OPEC's Reference Case forecast global supply in 2040 of roughly 110 mb/d, while the IEA's Current Policies Scenario projects 122.5 mb/d of supply in 2040. Other differences emerge regarding regional supplies. First, OPEC is substantially more bullish on production from non-OECD Europe and Eurasia, projecting 2040 production to be 2.6 mb/d and 1.6 mb/d higher than the IEA New Policies and Current Policies Scenarios, respectively. OPEC also projects that OPEC member nations will provide 45% of global supply in 2040, similar to the respective shares of 44% and 45% under the IEA's New Policies and Current Policies Scenarios. In contrast, both IEA projections are more bullish on supplies from the OECD, as the OECD Americas region supplies 1.2 mb/d and 3.7 mb/d more than OPEC's Reference Case under the IEA's New Policies and Current Policies Scenarios, respectively. In addition, both of these IEA Scenarios project a substantially larger biofuels supply than OPEC in 2040.

Table 13. Long-term Liquids Supply (mb/d)

	2040			Avg. annual growth (2015 - 2040)			Difference (IEA-OPEC)	
	IEA NPS	IEA CPS	OPEC Reference Case[a]	IEA NPS	IEA CPS	OPEC Reference Case	IEA NPS - OPEC	IEA CPS - OPEC
Total OECD	**25.4**	**28.3**	**24.0**	**0.1**	**0.2**	**0.0**	**0.1**	**0.2**
OECD Americas	22.3	24.8	21.1	0.1	0.2	0.0	0.1	0.2
OECD Europe	2.2	2.5	2.3	-0.1	0.0	0.0	0.0	0.0
Asia Oceania	0.9	1.0	0.5	0.0	0.0	0.0	0.0	0.0
Total Non-OECD	**27.0**	**30.5**	**28.3**	**-0.1**	**0.0**	**0.0**	**-0.1**	**0.1**
Non-OECD Asia	5.6	7.2	5.2	-0.1	0.0	-0.1	0.0	0.1
Middle East, Africa & Latin America	9.2	10.2	8.4	0.0	0.1	0.0	0.0	0.1
Europe & Eurasia	12.1	13.1	14.7	-0.1	0.0	0.0	-0.1	-0.1
Processing Gains	3.0	3.4	3.0	0.0	0.0	0.0	0.0	0.0
World Biofuels supply	6.4	5.5	3.6	0.2	0.1	0.1	0.1	0.1
Total Non-OPEC	**61.8**	**67.7**	**58.9**	**0.2**	**0.4**	**0.1**	**0.1**	**0.3**
Total OPEC	**48.1**	**54.8**	**50.7**	**0.4**	**0.6**	**0.5**	**-0.1**	**0.1**
OPEC crude	35.6	41.2	40.9	0.1	0.4	0.4	-0.2	0.0
OPEC NGLs+ unconventionals	12.5	13.6	9.8	0.2	0.3	0.1	0.1	0.1
World Supply	**109.9**	**122.5**	**109.6**	**0.5**	**1.0**	**0.6**	**-0.1**	**0.5**

Table 13 data sources: *IEA WEO 2016, Annex A Tables, Table 3.6, and internal communication; OPEC WOO2016, Tables 4.2 and 4.10.*

Table 13 notes: *Sums may not total due to rounding.*

[a] The IEA WEO does not include regional biofuels supply. Regional biofuels supply (OPEC WOO2016 Table 4.10) is therefore subtracted from each of OPEC's regional total liquids supply (OPEC WOO2016, Table 4.2) and only world biofuels supply is provided.

OPEC and the IEA differ somewhat in their projections for global unconventional supplies. In its Reference Case, OPEC shows a short-term decline in unconventional crude, including tight crude, followed by an upturn beginning in 2018 and continuing through the late 2020s to a peak of 6.3 mb/d. Unconventional NGLs in North America grow slowly through the early 2030s to a peak of 3.2 mb/d in the Reference Case. In the Reference Case, modest non-OPEC unconventional supplies come from Russia and Argentina. In the Upside Supply Scenario, Russian unconventionals reach 0.5 mb/d by 2035, with Argentina, China, and Mexico together contributing 0.5 mb/d by the late 2030s under the Upside Supply Scenario.

The IEA forecasts non-OPEC tight crude peaking at higher levels and in later years than OPEC's Reference Case. In the New Policies Scenario, non-OPEC tight oil grows through 2035, reaching a peak of 7.5 mb/d before falling to 6.8 mb/d in 2040. The IEA also discusses the range of possible production paths for US tight oil, which varies widely depending on assumptions regarding price and resource availability. While the US is the dominant producer of tight oil in the New Policies Scenario, Canada contributes roughly 0.5 mb/d in 2040, with an additional 1.1 mb/d of tight oil supplies coming from other nations led by Argentina, Mexico, and Russia.

Recall from Figure 9 (Section 3) that the IEA and OPEC use different classification systems for liquids fuels, presenting challenges when comparing long-term supply forecasts. Analysis of the IEA's and OPEC's views about the composition of world supply by fuel type, as shown in **Figure 18** and **Figure 19**, also yields notable points. **Figure 18** shows that all three scenarios project increasing OPEC liquids supply, and roughly stable non-OPEC liquids supply. Consequently, **Figure 19** shows how OPEC's share of global supply rising under all forecasts, from the current level of around 40% to roughly 46% in all three scenarios. For non-OPEC liquids, all three scenarios project conventional supplies to decline, while other non-OPEC liquids including tight crude/oil and biofuels grow.

Figure 18. Liquids Supply Sources in 2015 and Outlook for 2040 (mb/d)

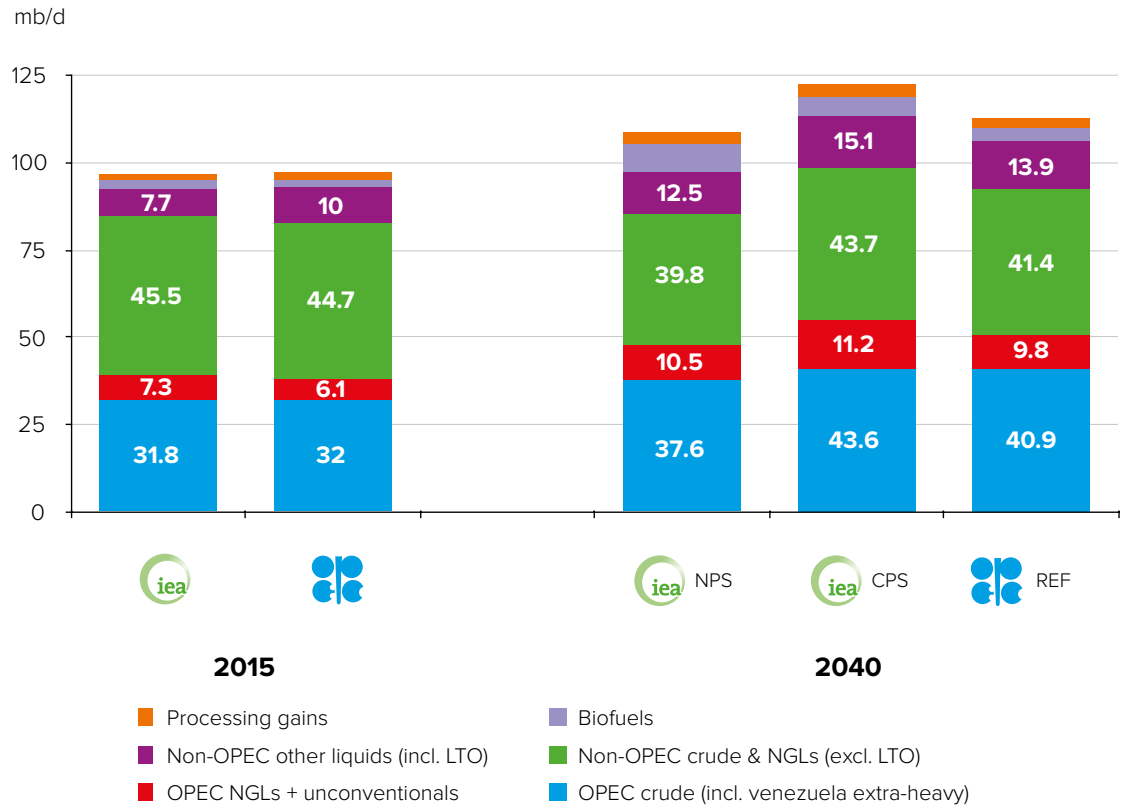


Figure 18 data sources: *Internal communication with IEA; IEA WEO2016 Table 3.7; OPEC WOO2016, Tables 4.2 and 4.10.*

Figure 18 note: *IEA biofuels converted from energy-equivalent basis to volumetric mb/d by multiplying a factor of 1.463.*

Figure 19. Shares of Liquids Supply by Types in 2015 and Outlook for 2040

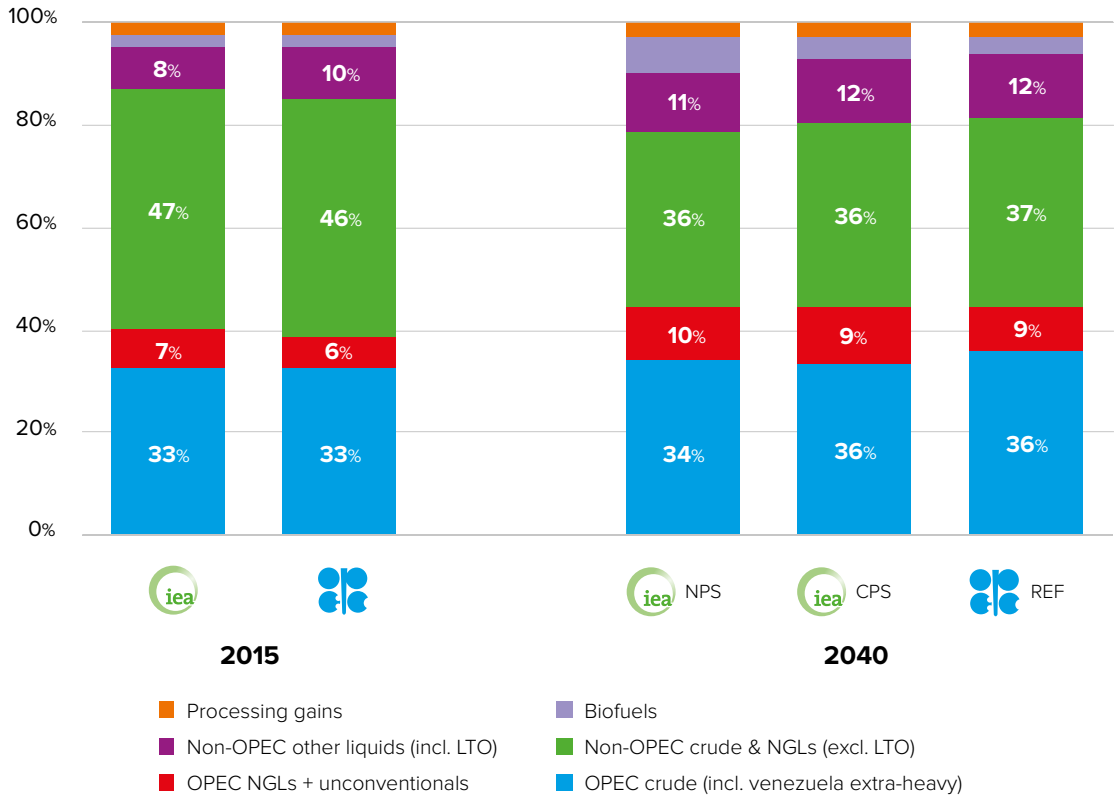


Figure 19 data sources: *Internal communication with IEA; IEA WEO2016 Table 3.7; OPEC WOO2016, Tables 4.2 and 4.10.*

Figure 19 note: *IEA biofuels converted from energy-equivalent basis to volumetric mb/d by multiplying a factor of 1.463.*

Finally, **Figure 20** presents a comparison of world liquids supply forecasts from six WEO2016 and WOO2016 scenarios. This figure highlights how dramatically world supply outlooks can be affected by different policy assumptions. The IEA primarily varies its assumptions by adjusting key energy and environmental policies, affecting all types of liquids supply. In the WOO2016, policy changes lead to lower levels of liquids demand in Scenarios A and B. However, OPEC does not publish regional supply estimates for these scenarios.

Figure 20. 2040 Liquids Supply Outlook in Different Scenarios (mb/d)

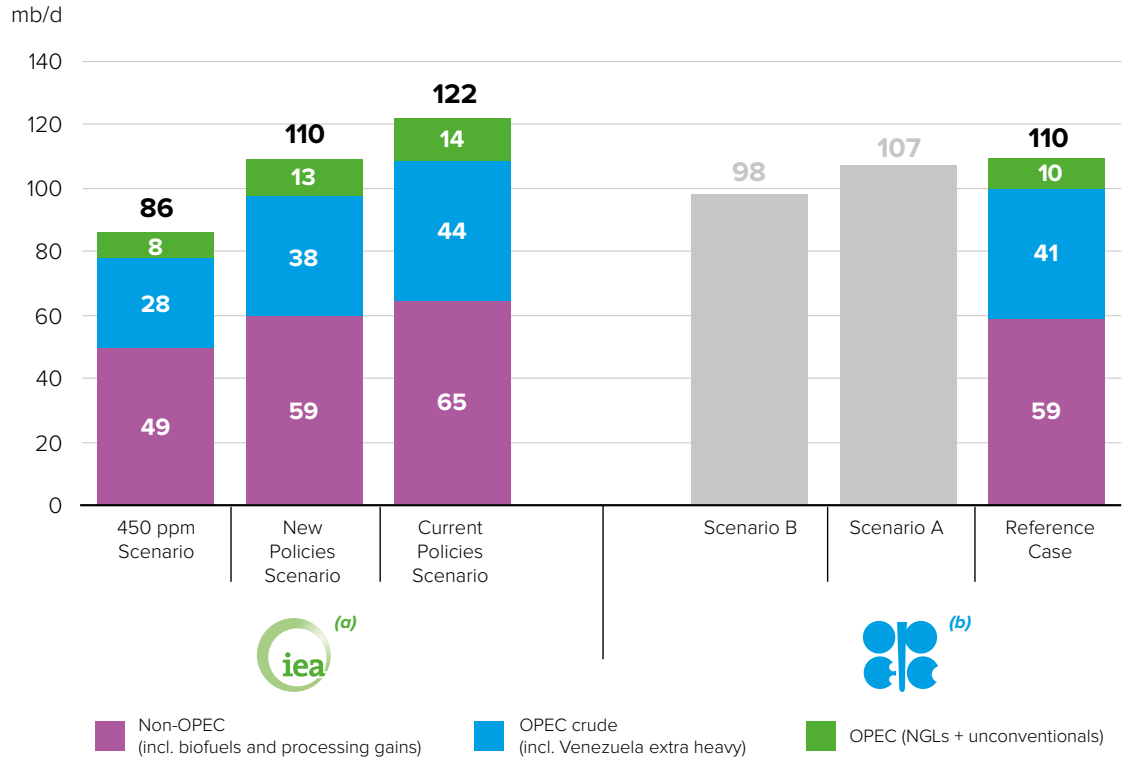


Figure 20 data sources: *Communication from IEA; IEA WEO2016 Table 3.7; OPEC WOO2016, Table 4.2, Figure 8.5.*

Figure 20 notes:

IEA[(a)]: biofuels are converted from energy-equivalent basis by multiplying a factor of 1.463.

OPEC[(b)]: WOO does not report regional supply estimates for Scenarios A and B. This figure shows liquids demand estimates in 2040 for Scenarios A and B.

7. Final Remarks

2016 witnessed a slow but steady increase in global oil prices from the lows of late 2015 and early 2016. After falling steeply near the end of 2014 from $110/bbl to $60/bbl, prices generally declined more slowly through 2015, reaching a low of roughly $30/bbl by early 2016. Since that time, prices have steadily recovered, hovering near the $55/bbl mark near the end of 2016. This slow increase in prices is attributable to a range of factors, including declining North American production, the late 2016 announcement by OPEC and non-OPEC members to coordinate cuts in production, and continued geopolitical uncertainty in key producing regions. At the same time, robust supplies from OPEC and non-OPEC nations coupled with relatively slow global economic growth has kept prices from rising rapidly.

While for some countries low oil prices support economic growth, the precipitous drop in crude prices has triggered concerns elsewhere, including negative spill-over effects on financial markets, decreased investment in unconventional oil production, and weakened economic growth prospects and heightened risk of fiscal and political stresses in some major oil-producing countries. Rising prices are likely to ease some of these pressures on major oil producers, though many uncertainties remain.

Notwithstanding these short-term uncertainties, some long-term fundamentals are clear. Economic expansion and population growth will continue to boost global oil demand, with the majority of growth contributed by non-OECD nations, particularly non-OECD Asia, the Middle East and Africa. Unless policies or technologies change significantly more than currently expected, and despite international efforts to slow global climate change, oil in 2040 – along with other fossil fuels – appears likely to maintain a central position in the global fuel mix. However, as major emerging economies mature, more efficient technologies are deployed, and environmental efforts pledged under the Paris Agreement come into effect, global oil demand growth rates will likely be tempered.

Despite continued low prices, global supply has declined more slowly than some had expected. OPEC nations have continued to increase production, and policy developments such as the lifting of Iranian sanctions have contributed to global supply growth. Production in Russia has also continued to grow. North American supply, previously a major driver of global production growth, has moderated and begun to fall, as a decline in investment in U.S. unconventionals coupled with a major fire in western Canada led to lower 2016 production rates.

Looking to 2017, recent announcements by OPEC and non-OPEC nations to coordinate production cuts may have a notable effect on global markets. A surge in oil prices during late 2016 has been attributed to these announcements, which may in turn result in additional investments and production in other regions.

The key questions for long-term oil supply are which nations and what types of oil production are likely to supplant production declines from existing projects and support demand growth. Despite declining in 2016, non-OPEC supply from unconventional plays has increased sharply in recent years. The industry has made efficiency gains to cope with lower oil prices, though it is unclear how sustained low prices will affect capacity and what price levels would be sufficient to support a rebound. In addition, it is unclear to what extent declining investment in higher cost projects such as deepwater and arctic development will reduce supply in the coming five to ten years. Nonetheless, to meet long-term demand, OPEC member countries will likely continue to play a central if not increasing role in global oil supply as high cost non-OPEC supplies remain under pressure from volatility and moderate growth in prices.

This introductory paper seeks to enhance understanding of views and methodologies from two widely acknowledged information providers, the IEA and OPEC, by comparing their outlooks over corresponding time horizons. Various similarities and differences between their historical data, assumptions and projections are described in this paper. Our objective is not to harmonise all assumptions or to eliminate differences in perspectives. Instead, the goal is to pursue higher-quality data and insight and control for differences in convention in order to better inform stakeholders worldwide.

As a continuous effort, the Seventh IEA-IEF-OPEC Symposium on Energy Outlooks aims to provide an open platform to facilitate consumer-producer dialogue on global energy security. After a careful comparison of the IEA's and OPEC's multi-horizon outlooks, this paper proposes the following issues for further discussion at the symposium:

- Ongoing analysis of differences in historical data, particularly in non-OECD demand, as well as FSU and OPEC crude and OPEC NGLs/unconventionals supply;
- Understanding factors that underscore differences in medium- and long-term oil price assumptions;
- Advancing efforts to standardise liquids fuel supply categories;
- Adopting consistent approaches in classifying fuels at regional versus global levels (e.g. biofuels, bunkers);
- Understanding policy assumptions made in each long-term energy outlook;
- Sharing viewpoints on oil supply forecast models, and analysing potential enhancement of long-term oil supply projection models, particularly with respect to unconventional resources; and
- Standardising unit conversion processes across mb/d, mboe/d, and mtoe.

Annex 1: Long-term Outlook Assumptions

	OPEC			IEA		
Variables	**Reference Case**	**LEG**	**HEG**	**New Policies**	**Current Policies**	**450-ppm**
Global Economic Growth Rate (2015-2040)	3.50%	same as Reference Case	same as Reference Case	3.40%	same as New Policies	same as New Policies
Population, Billion (2015-2050)	From 7.3 to 9.7	same as Reference Case	same as Reference Case	From 7.3 to 9.7	same as New Policies	same as New Policies
Oil Price Assumptions (in 2015$)	$57/bbl by 2020; $92.3/bbl by 2040	Not specified	Not specified	$79/bbl by 2020; $124/bbl by 2040	$82/bbl by 2020; $146/bbl by 2040	$73/bbl by 2020; $78/bbl by 2040
Oil investment (2016-2040 in 2015$)	Upstream: $7.4 trillion; Midstream and downstream: $2.6 trillion	Not specified	Not specified	Upstream: $11 trillion; Midstream and downstream: $2.3 trillion.	Upstream: $14 trillion; Midstream and downstream: $3.0 trillion.	Upstream: $6.8 trillion; Midstream and downstream: $1.4 trillion.
Energy and Environmental Policies	Primarily considers policies that have been enacted, but also acknowledges potential impacts from policy proposals	Climate mitigation occurs at faster than Reference Case, led by energy efficiency.	Climate mitigation occurs faster than Scenario A, all nations will meet and extend INDCs supplemented by faster technology deployment	Considers both policies in place and commitments announced	Only considers policies that have been enacted as of mid-2014	Assumes policies to be taken to limit the concentration of GHGs in the atmosphere to 450-ppm of CO2 equivalent
Carbon Prices (in 2015$)	Not specified	Not specified	Not specified	By 2040: $50/tonne in EU and Korea; $35/tonne in China; $24/tonne in South Africa; $20/tonne in Chile	By 2040: $40/tonne in EU and Korea	By 2040: $140/tonne in US, Canada, EU, Japan, Korea, Australia and New Zealand; $125/tonne in China, Russia, Brazil and South Africa

Annex 2: Long-term Outlook Results

	OPEC				IEA			
	Base Year	2040 Scenario			Base Year	2040 Scenario		
		Reference Case	LEG	HEG		New Policies	Current Policies	450-ppm
Global energy demand (mboe/d) [a] (2014-2040)	273.9	382.1	370.7	354.9	276.3	360.7	396.5	300.4
Global Oil Demand (mb/d) (2015-2040)	93	109.4	106.9	98.3	94.1	109	122	86
Non-OPEC Supply (mb/d) [b] (2014-2040)	59	61.9	Not specified	Not specified	57.7	61.5	67.3	50.9
OPEC Crude (mb/d) [c] (2014-2040)	32	40.9	Not specified	Not specified	31.8	35.6	41.2	26.7
OPEC NGLs and Other Liquids (mb/d) (2015-2040)	6.1	9.8	Not specified	Not specified	7.3	12.5	13.6	8.4

***Annex 2 notes**:*

[a] *IEA primary energy is converted from mtoe per year to mboe/d by multiplying by a factor of 0.0202 mboed/mtoe.*

[b] *Include biofuels and processing gains.*

[c] *OPEC crude includes Venezuela extra-heavy oil.*

SEVENTH IEA IEF OPEC SYMPOSIUM ON ENERGY OUTLOOKS

International Energy Forum in partnership with **Resources for the Future**

RESOURCES FOR THE FUTURE