

# NINTH IEA IEF OPEC SYMPOSIUM ON ENERGY OUTLOOKS



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## INTRODUCTORY PAPER: A COMPARISON OF RECENT IEA AND OPEC OUTLOOKS

International Energy Forum in partnership with Resources for the Future



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



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## Acknowledgments

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.

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## Acronyms and Abbreviations

bbl	Barrel
CPS	Current Policies Scenario (IEA)
EIA	U.S. Energy Information Administration
EOR	Enhanced Oil Recovery
FSU	Former Soviet Union
GDP	Gross Domestic Product
GHG	Greenhouse gas
IEA	International Energy Agency
IEF	International Energy Forum
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
kb/d	Thousand Barrels per Day
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
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
SDS	Sustainable Development Scenario (IEA)
SPR	Strategic Petroleum Reserve
UN	United Nations
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 2018** and serves to inform discussions at the Ninth IEA-IEF-OPEC Symposium on Energy Outlooks taking place in Riyadh, Saudi Arabia on 27 February 2019.

**Comparisons focus on the Current and New Policies Scenarios of the IEA and the Reference Case of OPEC**, and include short-, and medium-term liquid supply and demand projections, from 2017 through to 2023, and a comparative analysis of long-term oil projections from 2017 to 2040.

**These are placed in the context of the Sustainable Development Scenario of the IEA and the Sensitivity Cases of OPEC** that factor in the fulfilment of the UN's 2030 Agenda for Sustainable Development, and other variables.

### 1.2 Recent Progress on Data Harmonisation and Comparability of Outlooks

**Policy and investment decisions are better informed and become more effective over time through in-depth dialogue on energy market outlooks** based on robust and readily comparable data, compatible methodologies, and transparent assumptions. The IEA, IEF and OPEC remain committed to achieving greater data consistency and improving the comparability of energy outlooks.

**Therefore, two senior expert meetings in which the U.S. EIA also took part were hosted by the IEF**; in Riyadh on 13 February 2018 in advance of the Eighth IEA-IEF-OPEC Symposium on Energy Outlooks, and in Vienna on 15 March 2018 in advance of the 6<sup>th</sup> IEA-IEF-OPEC Workshop on the Interactions between Physical and Financial Energy Markets that concluded to focus attention on options to bridge differences in the:

- Classifications of countries and regions across both OECD, non-OECD and OPEC Member Countries, rendering them easier to compare.
- Fuel types categorisations in regional and global balances.
- Historical baseline data sets and revisions thereto.

**The IEF set up a series of teleconference calls** to further review the historical data, fuel and country classification exchanged between organisations and discuss options with the following outcomes so far:

- **Historical baseline data for the OECD region aligns, and differences in world liquids demand and supply baselines are smaller than those identified in previous years**, though they remain fairly high, diverging by 0.6 mb/d for demand and 1.1 mb/d for supply between the IEA and OPEC. Yet estimates for OPEC crude supplies are equal this year.
- **Organisations continue to exchange non-OECD Historical Baseline Data up to 2016** (Asia, FSU, Africa, and Middle East) and beyond when available, to better understand differences on an ongoing basis.
- **Work is ongoing on classifications** of natural gas liquids, condensates and biofuels and of countries and regions.
- **The U.S. EIA has continued its participation in the joint IEA-IEF-OPEC technical meetings** and volunteered further details on its data collection, fuel streams, geographical classification, and projection methodologies.
- **Participants agreed to strengthen their cooperation on the IEF platform and**

The IEA, IEF and OPEC are committed to improve data consistency and the comparability of energy outlooks.

**improve on enhancing the comparability of energy outlooks** including by keeping track of how outlooks differ and evolve across scenarios on a yearly basis in collaboration with Resources for the Future, and more regularly through the IEF's comparative analysis of the short-term outlooks issued monthly.

### 1.3 Opportunities to Advance the Comparability of Outlooks

**A challenge in comparing long-term outlooks arises from differences in regional groupings between the IEA and OPEC.** While OPEC reports its main regional results in terms of OECD status (i.e., OECD Americas, OECD Europe, non-OECD Asia, etc.), the IEA does not group countries according to OECD status in its main results and Annex tables. However, the IEA, an OECD body, has graciously provided additional data with these regional groupings for this report to enhance comparability.

**Though OPEC disaggregated its member countries' demand data to improve direct comparison with IEA's outlook, an inconsistency still exists within the Middle East and Africa regions.** While the IEA reports Middle East and Africa regions separately, OPEC groups them together as a single category.

**Unlike last year the IEA and OPEC use different baseline years for their projections.** The IEA uses 2016 as a baseline year and provides an estimate for 2017 demand for both primary energy and oil, while OPEC uses 2015 as its baseline year for primary energy and 2017 for oil.

**Similar to previous year's assessment, the historical difference in 2017 liquids demand assessments is completely attributable to non-OECD nations,** particularly from Asia, where the IEA and OPEC diverge by 0.4 mb/d, 0.3 mb/d of which is attributable to China. Other notable differences emerge from demand estimates for the Middle East (0.3 mb/d), FSU nations (0.2 mb/d), and Africa (0.1 mb/d).

**For the non-OECD region, liquids supply estimates diverge by 0.3 mb/d,** driven by a discrepancy of 0.3 mb/d for FSU nations.

**The IEA-OPEC difference in 2017 liquids supply baseline data lies primarily in OPEC supply (0.7 mb/d),** which is smaller than the 2016 difference of 0.9 mb/d. The difference resides in the notable gap between estimates of OPEC NGLs and unconventional supply (0.7 mb/d).

**Though the IEA has begun publishing additional biofuels data, different treatment of biofuels persists and comparing regional non-OPEC supply forecasts between the IEA and OPEC still requires adjustments.** While OPEC includes biofuels in each region's total liquids supply, the IEA only includes global biofuels supply in its monthly reports. However, the IEA's Medium-Term Oil 2018 report publishes 2017 biofuels production by region.

**The IEA and OPEC continue to 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.

**As markets rebalance, both the IEA and OPEC show stock declines reversing several years of global stock builds. The 0.5 mb/d difference in IEA-OPEC stock changes is due to the "oil-on-water" category;** here the IEA estimates a 0.4 mb/d build while OPEC estimates a decline of 0.2 mb/d in their short-term oil market reports.

**Differences between the IEA and OPEC in their choice of units for primary energy demand also create challenges in making comparisons.** OPEC uses million barrels of oil equivalent per day (mboe/d), while the IEA most frequently uses million tons of oil

equivalent (mtoe) per year.

#### 1.4 IEA and OPEC Short-Term Oil Outlooks

**The IEA and OPEC revised their forecasts for global economic growth during 2018.** For 2019, the IEA projects steady growth at 3.5%, while OPEC projects a decrease in the rate of global economic growth to 3.5%.

##### *Liquids Demand*

Both the IEA and OPEC project world liquids demand to reach the 100 mb/d threshold in 2019.

**The IEA and OPEC project world liquids demand to reach 99.2 and 98.8 mb/d in 2018 and reach the 100 m/d threshold in 2019 when their estimates reach 100.6 and 100.1 mb/d respectively.** Assessments diverge by 0.4 mb/d in 2018 and by 0.5 mb/d in 2019 largely on account of different estimates for Asia, the Middle East and the FSU.

**The IEA and OPEC revised their global liquids demand growth estimates over the course of the year,** with OPEC showing higher demand growth throughout most of 2018. The projected rate of global demand growth from both organisations at the beginning of the year was equal to the growth rate projected at the end of the year: 1.3 mb/d for the IEA and 1.5 mb/d for OPEC for 2018.

**The IEA and OPEC revised demand growth from OECD nations upwards by 0.40 mb/d and 0.24 mb/d respectively,** while more modestly revising downwards their estimates for non-OECD demand growth in their monthly assessments over 2018.

Global oil demand continues to grow strongly though at slightly lower levels than in recent years.

**The IEA projects slightly faster growth of 1.4 mb/d, while OPEC sees lower growth of 1.3 mb/d in 2019.** Global oil demand continues to grow strongly at more than 1 mb/d, though at levels slightly below those forecast in previous years.

**Both the IEA and OPEC note that non-OECD regions will continue to lead global demand growth,** particularly China and other non-OECD Asia. However, both organisations also project strong growth from the OECD Americas region in 2018 and 2019 but differ in their assessments for liquids demand growth in Latin America on account of Brazil.

##### *Liquids Supply*

**OPEC and the IEA project world liquids supply to reach 98.8 and 99.2 mb/d in 2018 and reach the 100 m/d threshold in 2019 when their estimates reach 100.1 and 100.6 mb/d respectively.** Assessments diverge by 0.4 mb/d in 2018 and 0.5 mb/d in 2019 largely on account of different estimates for OECD Americas and the FSU in the non-OECD region.

U.S. tight oil growth has surprised to the upside over the past two years.

**OPEC and the IEA substantially revised upwards non-OPEC liquids supply growth forecasts in 2018 with respective upward revisions of 2.5 mb/d and 2.4 mb/d in December 2018 relative to 2017,** with U.S. tight oil consistently growing at faster-than-expected rates over the past two years.

**OPEC and the IEA project non-OPEC liquids supply to increase by 2.2 mb/d and 1.5 mb/d in 2019 respectively, driven again by OECD Americas.**

**While total OPEC supplies in 2018 are 38.8 mb/d in both projections, this convergence masks substantial differences in estimates for OPEC NGLs and unconvensionals** where the IEA projects 0.7 mb/d more than OPEC. In 2019 OPEC and the IEA estimate OPEC supplies at 37.9 and 38.7 respectively with variation stemming from a 0.6 mb/d difference in OPEC NGLs and unconvensionals supplies.

## 1.5 IEA and OPEC Medium-Term Oil Outlooks

### *Liquids Demand*

**The IEA and OPEC expect 2023 world liquids demand to reach 104.7 mb/d and 104.5 mb/d respectively.**

Both the IEA and OPEC expect robust global liquids demand growth over the medium term.

**Like last year's assessment, both organisations expect robust medium-term growth in global liquids demand.** Liquids demand in the baseline year is 97.2 mb/d for OPEC and 97.8 mb/d for the IEA, a difference of 0.6 mb/d, roughly half of the baseline difference observed in last year's report.

**The IEA and OPEC project average annual demand growth of 1.2 mb/d from non-OECD nations, while OPEC is more bullish about the OECD,** projecting annual average growth of 0.03 mb/d compared with the IEA's projected annual average decline of 0.1 mb/d. By 2023, non-OECD consumption exceeds the OECD by 9.4 mb/d and 11.1 mb/d under OPEC's and the IEA's respective projections.

**OPEC's demand projections for 2023 are generally higher for OECD regions, and the IEA's projections generally higher for the non-OECD.**

**The IEA and OPEC note the uncertainties and challenges that hang over the medium-term outlook as a consequence of the International Marine Organization mandates for 2020 on fuel specifications.** This will reduce demand for high sulphur fuel oil, which currently accounts for roughly 75% of bunker fuel demand, with a variety of other effects that will depend on investment and compliance cost.

The IEA's and OPEC's demand growth assessments vary for the OECD and non-OECD region, while the impact of new fuel quality standards is uncertain.

### *Liquids Supply*

**Both OPEC and the IEA project world liquids supply to reach 104.7 mb/d by 2023.** Both organisations project production growth to decline over the medium-term, though the cumulative level of growth varies substantially due to differences in baseline data.

OPEC projects a net increase of 8.6 mb/d in non-OPEC production by 2023, while the IEA forecasts 5.5 mb/d, well-above levels seen in last year's reports.

**OPEC's projections show substantially stronger non-OPEC supply growth than the IEA,** particularly for the OECD Americas. OPEC and the IEA respectively project 27.8 mb/d and 25.6 mb/d from OECD Americas in 2023, well above previous medium-term projections.

**OPEC projects OECD Americas liquids supply to grow by 6.3 mb/d while the IEA estimates growth of 4.2 mb/d over the projection period.** Projections show steady growth in non-OPEC Latin America, with net gains of 1.5 mb/d estimated by OPEC and 1.0 mb/d by the IEA.

**Forecasts diverge on production from non-OECD Europe and Eurasia: OPEC projects cumulative growth of 0.3 mb/d compared with the IEA's projection of 0.6 mb/d in growth.** OPEC's projections for supplies from non-OECD Asia at 7.5 mb/d in 2023 are also well above IEA estimates of 6.9 mb/d.

**In total the IEA forecasts 62.7 mb/d in liquids supply from non-OPEC nations in 2023, while OPEC estimates 66.1 mb/d, a 3.4 mb/d difference.**

**The IEA and OPEC estimate 2023 supply from OPEC members at 42.0 mb/d and 38.6 mb/d respectively.** This difference of 3.4 mb/d is inferred by subtracting total non-OPEC production and OPEC NGLs/unconventionals supply from world demand projections for 2023.

OPEC projects non-OPEC production to increase by 8.6 mb/d while the IEA forecasts a rise of 5.5 mb/d by 2023.



## 1.6 IEA and OPEC Long-Term Energy Outlooks

### Primary Energy Demand

Alternative IEA and OPEC scenarios show hydrocarbon demand's resilience on the long-term.

**Fossil fuels continue to dominate the primary energy mix, with oil, gas and coal maintaining between 74% and 78% of the total share in all main scenarios in 2040.** In the IEA's Sustainable Development Scenario and OPEC's Sensitivity B Analysis, fossil fuels satisfy 60% and 63% of respective global demand.

**While demand growth rates slow in percentage terms, absolute levels of growth are similar to previous decades.** Total primary energy demand grows by 1.4%, 1.1%, and 0.002% per annum in the IEA's Current Policies, New Policies, and Sustainable Development Scenarios, respectively. In OPEC's projections, demand grows annually by 1.2%, 0.7%, and 0.5% respectively in the Reference Case, Sensitivity A, and Sensitivity B Analysis. By 2040, global demand is 358 mboe/d in the IEA's New Policies Scenario, slightly higher than the WEO 2017 projection of 355 mboe/d in 2040. Under OPEC's Reference Case, global demand in 2040 is 365 mboe/d, slightly below the WOO2017 projection for 2040 of 372 mboe/d.

### Energy Supply Mix

While oil maintains its position as the leading fuel, natural gas grows at the fastest pace in all long-term scenarios.

**In the IEA's Current Policies Scenario and New Policies Scenario, along with all of OPEC's scenarios, oil maintains its position as the leading fuel in 2040,** though its share shrinks from 32% in the base year to 28 - 29%.

**Natural gas is set to grow the fastest among fossil fuels in absolute and percentage terms under all scenarios, including the IEA Sustainable Development Scenario.** Although it does not attain the status of leading fuel source (as it did in some 2016 scenarios), it overtakes coal and reaches 25% of global primary energy demand in all scenarios other than OPEC's Sensitivity B, where it reaches 26%.

Renewables' shares lie far apart, ranging from 17% to 31% across scenarios to 2040.

**The share of renewables (i.e. hydro, biomass, solar, wind and other renewables) is projected to increase in all scenarios** from 14% in the base year to 17% under the IEA's Current Policies Scenario, 19% in OPEC's Reference Case, 20% under the IEA's New Policies Scenario, and 31% under the IEA's Sustainable Development Scenario. Virtually all of this growth comes from renewable electricity.

### Liquids Demand

Security of demand weakens over the longer-term.

**Liquids demand figures are higher than those projected last year.** In IEA's New Policies Scenario and OPEC's Reference Case, world liquids demand reaches 112.7 mb/d and 111.7 mb/d, respectively, by 2040. In the IEA's Current Policies Scenario, 2040 world liquids demand grows to 125.3 mb/d.

**Long term certainty of demand weakens as the difference between the highest and lowest scenario projections for world liquids demand grows to 45.5 mb/d in 2040,** well above the range of 42 mb/d found in last year's comparative analysis.

**Liquids demand growth slows under all three main scenarios after 2025 to varying degrees.** Under the IEA's Sustainable Development Case, there is little growth through 2025, followed by substantial declines in absolute levels through to 2040.

**At regional and national levels, the IEA and OPEC share similar views on overarching trends of liquids demand.** While OPEC's projections appear substantially more bullish than the IEA's, these differences are in part attributable to different methodologies.

Transport and the petrochemicals industry contribute the most to oil demand growth towards 2040.

**For sectoral trends the IEA and OPEC also share similar viewpoints.** Transportation and the petrochemicals industry are expected to remain the largest oil consumers and contribute the majority of demand growth as consumption for power generation

decreases in all scenarios.

### **Liquids Supply**

**The IEA's New Policies Scenario and OPEC's Reference Case forecast similar global supply in 2040** of 112.6 mb/d and 111.9 mb/d, respectively, while the IEA's Current Policies Scenario projects 125.3 mb/d. On an annualised basis, the IEA's Current Policies Scenario grows at 1.2 mb/d while the New Policies Scenario and OPEC's Reference Case each grow by 0.6 mb/d.

The IEA projects substantially higher OECD Americas supplies than OPEC over the longer term.

**The IEA's projections for supplies from the OECD Americas under the New Policies and Current Policies Scenarios are respectively 1.3 mb/d and 3.6 mb/d higher than OPEC's Reference Case in 2040.** This forecast differs from OPEC's stronger medium-term projections for OECD Americas supplies.

**OPEC is more bearish on production from non-OECD Europe and Eurasia**, projecting 2040 production to be 1.9 mb/d and 3.0 mb/d below the IEA New Policies and Current Policies Scenarios, respectively.

**The IEA and OPEC differ in their inferred estimates for OPEC supplies by 6.7 mb/d** between the highest and lowest estimates across central scenarios. This is also due to substantial differences in assessments for both OPEC crude and OPEC NGLs/unconventionals.

### **1.7 Recent Trends**

Both the IEA and OPEC see tight oil supplies peak higher and later when compared to projections last year.

**Both organisations project substantially higher growth in tight oil supplies.** OPEC estimates global tight crude supplies reaching a peak of 10.2 mb/d around 2030 (up from a peak of 9.2 mb/d in 2030 in the WOO 2017) before declining to 8.5 mb/d in 2040. The IEA shows tight crude peaking at 11 mb/d in the New Policies Scenario and 12.1 mb/d in the Current Policies Scenario in 2040 (up from a peak of 9.5 mb/d in 2035 in the WEO 2017).

Oil market volatility increases due to a confluence of variables that are difficult to predict slowing down investment in conventional supply.

**Oil market volatility has increased due to a wide range of factors**, including uncertain prospects for global economic growth in the context of international trade disputes, the extension of coordinated adjustments to production from OPEC members in collaboration with several non-OPEC countries, unexpectedly rapid growth in U.S. tight oil production, the effects of U.S. sanctions on Iranian oil exports, and more.

**A wider range of policy and technology options show greater uncertainty in liquids demand outlooks.** While long-term market fundamentals remain unchanged 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 conventional projects and support demand growth over medium-, and longer-term horizons.

## 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.<sup>1</sup> 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 Ninth Symposium and takes as reference the outlooks published by both organisations in 2018. 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 Eighth Symposium identified opportunities to harmonise a number of variables:

- **Reduce and, ideally, eliminate the differences in world liquids demand and supply baselines.** These differences relate almost entirely to the non-OECD region and propagate over assessment periods.
- **Better align the publication dates of the medium-term oil market outlooks** by the IEA and OPEC. Currently they are separated by a 6-month interval.
- **Enhance consistency in the classification of liquid fuels at regional and global levels.** There are issues with maritime and aviation fuels, as well as biofuels classifications and units.
- **Continue dialogue at the expert level on assumptions and methodologies** 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.
- **Align baseline years for long-term outlooks.** This year, the two organisations use different baseline years for their long-term projections, with OPEC using 2015 for primary energy and 2017 for oil, and the IEA using 2016 for both, with estimated data provided for 2017.
- Finally, the addition and subtraction of certain OPEC member countries in 2016

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

highlighted the importance of the **regional classifications by OPEC of its member country's liquid fuel demand data and projections** to facilitate an effective comparison with IEA data.

The IEA, IEF and OPEC work together to mitigate discrepancies and ensure consistency in their different outlooks.

The IEA and OPEC have made progress on some of these areas. In addition, they agreed to share and review historical baseline supply and demand data for the years 2006 to 2015 and 2016 where available for those non-OECD regions where apparent differences are largest; the FSU, Asia, the Middle East, and Africa. 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.

Following the successful conclusion of the Eighth Symposium, the US Energy Information Administration has participated in these ongoing consultations on historical baseline data and methodologies used in outlook projections.

**Table 1** lists the publications used for comparison in this introductory paper. Note that the IEA Medium-Term Oil 2018 report was published in March 2018, six months earlier than the release of OPEC's Medium-Term projections in its 2018 World Oil Outlook (WOO2018).

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

Report Type	IEA		OPEC	
	Report Name	Publication Date	Report Name	Publication Date
<b>Short-term</b>	Oil Market Report (OMR)	Dec. 2018	Monthly Oil Market Report (MOMR)	Dec. 2018
<b>Medium-term</b>	Oil 2018	Mar. 2018	World Oil Outlook (WOO 2018)	Sept. 2018
<b>Long-term</b>	World Energy Outlook (WEO 2018)	Nov. 2018	World Oil Outlook (WOO 2018)	Sept. 2018

### 3. Baseline 2017 Liquids Data

The harmonisation of 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 (2017) 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 fairly high, diverging by 0.6 mb/d for demand and 1.1 mb/d for supply. These differences are smaller than those identified in previous years, by several hundred thousand barrels per day. For 2017 world liquids demand, the IEA estimates 97.9 mb/d whereas OPEC estimates 97.3 mb/d. For supply, the IEA estimates 97.5 mb/d and OPEC estimates 96.4 mb/d. These data indicate a decrease in global stocks during 2017, with declines of 0.9 mb/d for OPEC and 0.5 mb/d for the IEA.

**Table 2** provides details on the IEA's and OPEC's estimates for baseline liquids demand data by region. Similar to previous year's assessment, the historical difference is completely attributable to non-OECD nations, particularly from Asia, where the IEA and OPEC diverge by 0.44 mb/d, 0.28 mb/d of which is attributable to China. Other notable differences emerge from demand estimates for the Middle East (0.3 mb/d), FSU nations (0.2 mb/d), and Africa (0.1 mb/d).

**Table 2. Liquids Demand in 2017 (mb/d)**

	IEA	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>47.4</b>	<b>47.4</b>	<b>0.0</b>
OECD Americas	25.1	25.1	0.0
OECD Europe	14.3	14.3	0.0
Asia Oceania	8.1	8.1	0.0
<b>Total Non-OECD</b>	<b>50.50</b>	<b>49.86</b>	<b>0.64</b>
Asia	26.00	25.56	0.44
China	12.60	12.32	0.28
Other non-OECD Asia	13.4	13.2	0.2
Middle East	8.5	8.2	0.3
Latin America	6.5	6.5	0.0
FSU	4.5	4.7	-0.2
Non-OECD Europe	0.7	0.7	0.0
Africa	4.3	4.2	0.1
<b>World</b>	<b>97.9</b>	<b>97.3</b>	<b>0.6</b>

**Table 2 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Table 4 - 1, 4 - 2.

**Table 2 notes:** Numbers rounded to nearest significant digit.

As for world liquids supply, **Table 3** shows that the IEA-OPEC difference in 2017 data lies primarily in OPEC supply (0.7 mb/d). Outside of the OECD, where historical data aligns, estimates diverge by 0.3 mb/d, driven by a discrepancy of 0.26 mb/d for FSU nations. These differences are smaller than those observed in last year's report, where total OPEC supplies in 2016 (the baseline year) differed by 0.9 mb/d, though supplies from FSU nations again differed by roughly 0.3 mb/d.

Different treatment of biofuels means that comparing regional non-OPEC supply

forecasts between the IEA and OPEC still requires adjustments. While OPEC includes biofuels in each region's total liquids supply, the IEA only includes global biofuels supply in its monthly reports. However, the IEA's medium-term Oil 2018 report publishes 2017 biofuels production by region, which we include here. This paper adds these regional biofuels data – both historical and forecast data – to each region's oil supply data. To ensure consistency, we verified that global biofuels supply data of the IEA's Medium-Term Oil 2018 report were roughly equal to the OMR estimates.

Different treatment for biofuels and alternate definitions for NGL's and unconvensionals make it difficult to compare OPEC and non-OPEC supply.

Regarding supply from OPEC Member Countries, there remains a notable gap between the IEA's and OPEC's estimates of OPEC NGLs and unconvensionals supply (0.7 mb/d), roughly equal to the discrepancy observed in last year's report, while estimates of OPEC crude supplies are equal. Note that IEA and OPEC have different definitions for NGLs and unconvensionals. IEA reports in its OMR glossary that NGLs and unconvensionals supply includes OPEC condensates, oil from non-conventional sources (e.g., Venezuelan Orimulsion, oil shales, CTLs, GTLs) and other sources of supply (e.g., blending components such as MTBE), while OPEC provides less detail about the specific components of this category that may well be more restrictive.

**Table 3. Liquids Supply in 2017 (mb/d)**

	IEA <sup>(a)</sup>	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>25.7</b>	<b>25.7</b>	<b>0.0</b>
OECD Americas	21.5	21.5	0.0
OECD Europe	3.8	3.8	0.0
Asia Oceania	0.4	0.4	0.0
<b>Total Non-OECD</b>	<b>29.9</b>	<b>29.6</b>	<b>0.3</b>
Non-OECD Asia	7.62	7.56	0.06
China	4.0	4.0	0.0
Other non-OECD Asia	3.7	3.6	0.1
Middle East	1.2	1.2	0.0
Latin America	5.2	5.2	0.0
FSU	14.31	14.05	0.26
Non-OECD Europe	0.1	0.1	0.0
Africa	1.4	1.5	-0.1
Processing gains	2.3	2.2	0.1
<b>Total Non-OPEC</b>	<b>58.0</b>	<b>57.5</b>	<b>0.5</b>
<b>Total OPEC <sup>(b)</sup></b>	<b>39.50</b>	<b>38.85</b>	<b>0.65</b>
OPEC crude	32.6	32.6	0.0
OPEC NGLs + unconvensionals	6.9	6.2	0.7
<b>World</b>	<b>97.5</b>	<b>96.4</b>	<b>1.1</b>

**Table 3 data sources:** IEA OMR Dec 2018, Table 1; IEA Oil 2018, Tables 5, 5a; OPEC MOMR Dec 2018, Table 5 – 2 and 5 – 3.

**Table 3 notes:** Numbers rounded to nearest significant digit. IEA liquids supply calculated by summing IEA oil and IEA biofuel estimates.

<sup>(a)</sup> IEA's "OPEC NGLs" includes condensates, oil from non-conventional sources (e.g. Venezuelan Orimulsion) and non-oil inputs to Saudi Arabian MTBE.

<sup>(b)</sup> Total OPEC equals OPEC crude plus OPEC NGLs/unconvensionals.

Both the IEA and OPEC report continued stock declines highlighting the extent of market rebalancing but views on "oil on water" differ.

**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 modest stock decrease in 2017, with OPEC estimating stock reductions of 0.9 mb/d and the IEA estimating 0.4 mb/d. Highlighting the extent of market rebalancing, these stock declines reverse several years of global stock builds. The largest contributor to the 0.5 mb/d difference in stock declines comes from the 0.6 mb/d difference in the "oil-on-water" category, where the IEA estimates a 0.4 mb/d build and OPEC estimates a decline of 0.2 mb/d.

**Table 4. Stock Change and Miscellaneous Items (2017-2016) (mb/d)**

	IEA	OPEC	Difference (IEA-OPEC)
<b>Reported OECD</b>	-0.5	-0.5	0.0
Industry/commercial	-0.4	-0.4	0.0
Government/SPR	-0.1	-0.1	0.0
<b>Oil-on-water</b>	0.4	-0.2	0.6
<b>Miscellaneous to balance <sup>(a)</sup></b>	-0.3	-0.2	-0.1
<b>Total stock change &amp; misc.</b>	<b>-0.4</b>	<b>-0.9</b>	<b>0.5</b>

**Table 4 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Table 11 - 1.

**Table 4 notes:** Numbers rounded to nearest significant digit.

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



Short-term monthly oil market reports capture the effect of market moving variables on demand and supply over an 18 months projection period.

## 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 the agreement reached between OPEC and several non-OPEC nations on December 7<sup>th</sup>, 2018, in which agreement was reached to adjust production by roughly 1.2 million barrels per day beginning in January 2019.

In this section, we summarise and compare the IEA's and OPEC's perspectives on short-term macroeconomics, as well as oil demand and supply outlooks.<sup>2</sup>

### 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.

Both the IEA's and OPEC's 2018 economic growth estimates in their December 2018 monthly reports are equal to those made a year ago. In both 2017 and 2018, both organisations projected global GDP growth in 2018 of 3.7%. Notably, both organisations have revised down their forecasts for global economic growth during 2018. For 2019, the IEA projects steady growth at 3.7%, while OPEC projects a decrease in the rate of global economic growth to 3.5%. As **Table 5** shows, regional variation is modest across most major economies. Projections vary most substantially for Brazil, where the IEA projects 2018 and 2019 growth of 1.4% and 2.4% respectively, 0.3% and 0.6% above the growth rates projected by OPEC. These differences likely stem in part from the 2-month lag between the time the forecasts were made: October 2018 for the IMF (referenced by IEA) and December 2018 for OPEC.

**Table 5. Short-term GDP Growth Assumptions**

	2018			2019		
	IEA (IMF)	OPEC	Difference (IEA - OPEC)	IEA (IMF)	OPEC	Difference (IEA - OPEC)
<b>World</b>	3.7%	3.7%	0.0%	3.7%	3.5%	0.2%
<b>US</b>	2.9%	2.9%	0.0%	2.5%	2.6%	-0.1%
<b>China</b>	6.6%	6.5%	0.1%	6.2%	6.1%	0.1%
<b>EU</b>	2.0%	1.9%	0.1%	1.9%	1.7%	0.2%
<b>Japan</b>	1.1%	1.0%	0.1%	0.9%	1.1%	-0.2%
<b>India</b>	7.3%	7.5%	-0.2%	7.4%	7.2%	0.2%
<b>Brazil</b>	1.4%	1.1%	0.3%	2.4%	1.8%	0.6%

**Table 5 data sources:** IMF World Economic Outlook Oct 2018, Table 1.1; OPEC MOMR Dec 2018, Table 3 - 1.

### 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

<sup>2</sup> Though this introductory paper compares data from the December 2018 oil market reports, reports from January to December in 2018 from both organisations were reviewed to assess how their views evolved throughout the year.

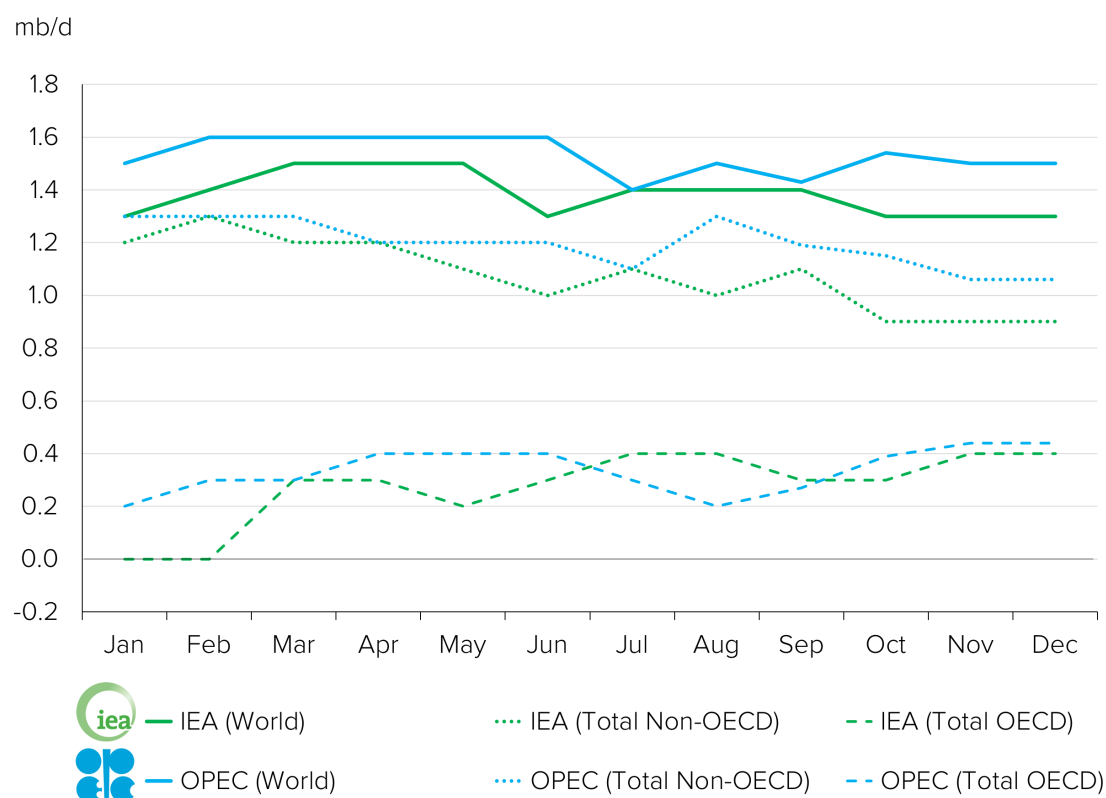


calculating demand for specific regions, which may also result in changes to demand forecasts.

Both organisations revised their estimates for non-OECD demand growth downwards, while upgrading demand growth for the OECD.

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, with OPEC showing higher demand growth throughout most of 2018. Interestingly, the projected rate of global demand growth from both organisations at the beginning of the year was equal to the growth rate projected at the end of the year: 1.3 mb/d for the IEA and 1.5 mb/d for OPEC. The dotted- and dash lines in **Figure 1**, reflecting non-OECD and OECD country assessments respectively, show that both organisations revised their estimates for non-OECD demand growth downwards while revising growth from OECD nations upwards over the course of the year.

**Figure 1. Monthly Revisions of Annual Estimates for 2018 World, OECD, and Non-OECD Liquids Demand Growth**

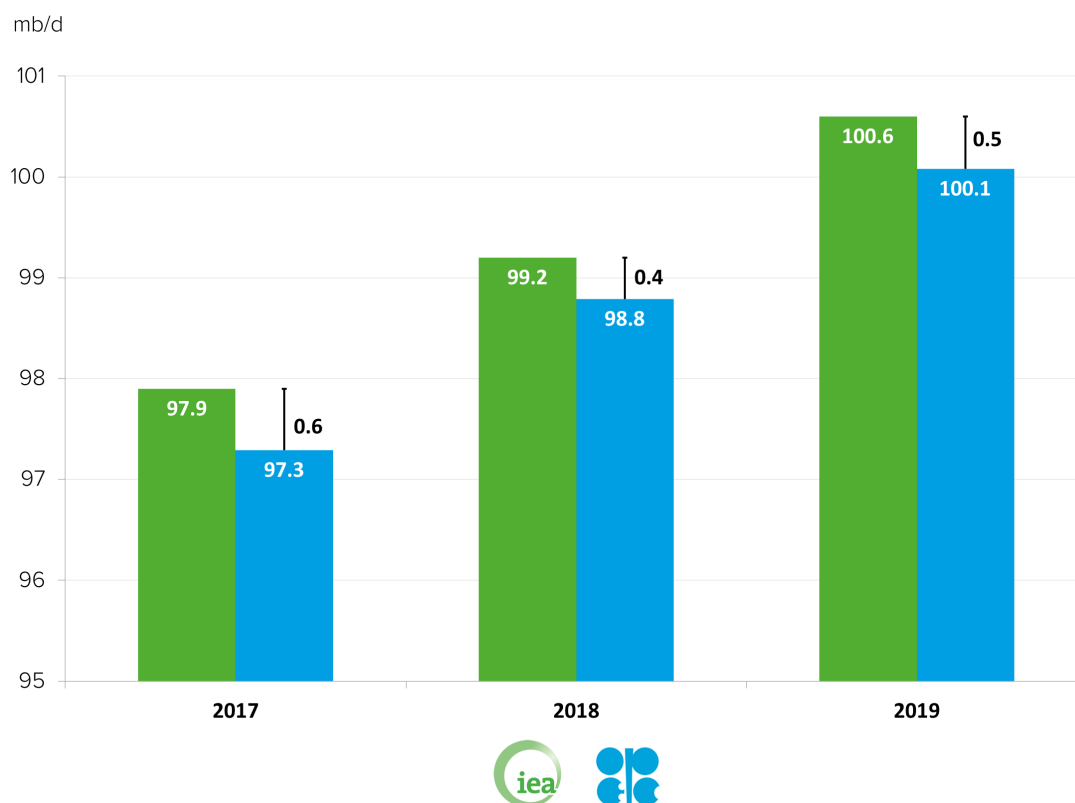


**Figure 1 data sources:** IEA OMR Jan–Dec 2018, Table 1; OPEC MOMR Jan–Dec 2018, Table 11 - 1.

Global oil demand continues to grow strongly though at slightly lower levels than in recent years.

Looking forward in **Figure 2**, the IEA projects global demand growth of 1.3 mb/d in 2018, slightly lower than OPEC's projection of 1.5 mb/d. These 2018 demand growth projections are equal to the estimates made by both organisations in December, 2017 for that year. In 2019, the IEA projects slightly faster growth of 1.4 mb/d, while OPEC sees lower growth of 1.3 mb/d. These growth rates are lower than those observed during the historical period of 2017, when the IEA saw demand growth of 1.5 mb/d and OPEC saw growth of 1.7 mb/d. In summary, global oil demand continues to grow strongly at more than 1 mb/d, though at levels slightly below those forecast in previous years.

**Figure 2. Short-term World Liquids Demand: 2017-2019**



**Figure 2 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Table 11 - 1.

**Figure 2 notes:** 2017 are historical data and 2018/2019 are projections. Sums in data callouts may not total due to rounding.

Differences in historical baseline data of non-OECD regions have been reviewed and reduced.

Differences in the IEA and OPEC regional demand growth assessments vary overtime and centre on non-OECD Asia and Latin America.

The IEA's and OPEC's regional liquids demand outlooks for 2018 and 2019, as well as the differences between them, are summarised in **Table 6**. These short-term demand outlooks have historically varied most widely in regions that have large differences in historical data – particularly in non-OECD regions including China, other non-OECD Asian nations, and the Middle East (see **Table 2**). In previous years such as 2015, differences between baseline liquids demand varied by as much as 1.7 mb/d.<sup>3</sup> This year, differences are more modest in magnitude.

Both the IEA and OPEC believe non-OECD regions will continue to lead global demand growth, particularly China and other non-OECD Asia. However, both organisations also project strong growth from the OECD Americas region in 2018 and 2019. Despite these similarities, some modest regional discrepancies also appear in **Table 6** and are highlighted in **Figure 3**. In particular, the IEA is more bullish on demand growth in China for both 2018 and 2019, and overall demand is substantially higher in the IEA's forecast due to differences in historical baselines. Baseline differences are smaller for other non-OECD Asia, and while OPEC projects stronger growth for this region in 2018, this dynamic flips in 2019, when the IEA forecasts slightly stronger growth than OPEC. One additional notable difference appears in Latin America in 2019, where OPEC forecasts demand levels which are 0.3 mb/d higher than the IEA's. This is somewhat surprising given that OPEC's economic forecast for Brazil, the largest economy of the region, is well below the IEA's forecast (see **Table 5**).

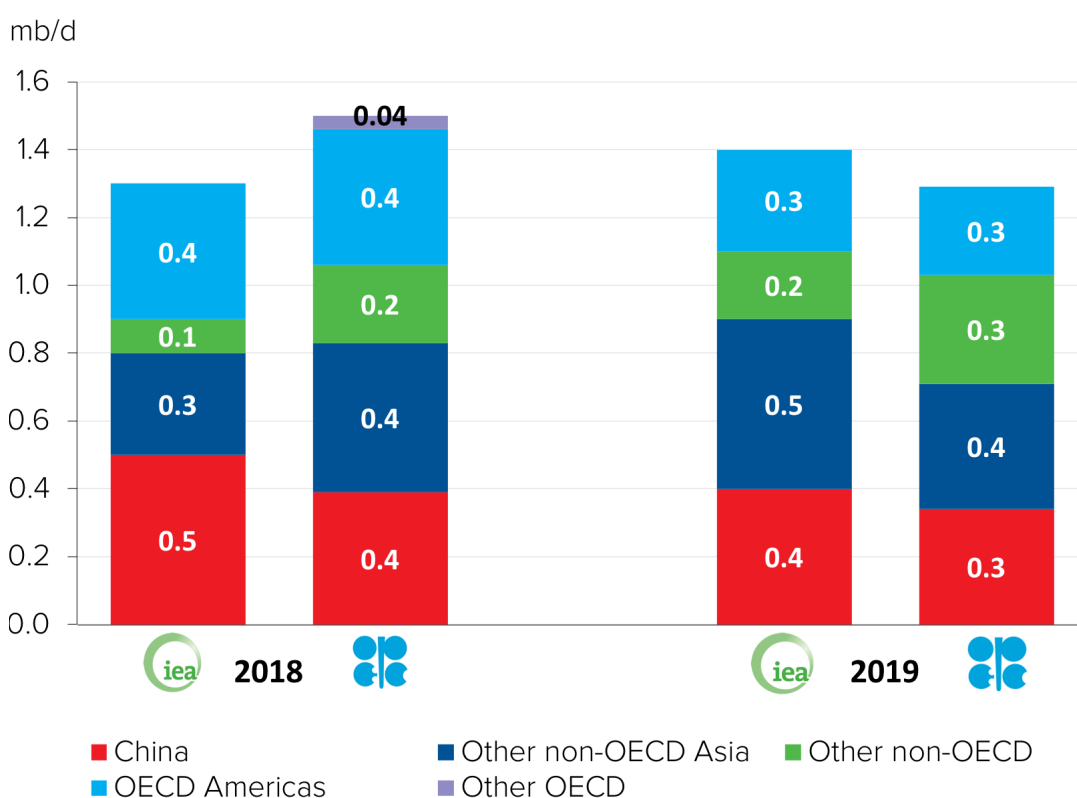
<sup>3</sup> See Table 2 from the Introductory Paper to the Seventh IEA-IEF-OPEC Symposium on Energy Outlooks, published in February 2017.

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

	2018			2019		
	IEA	OPEC	Difference (IEA-OPEC)	IEA	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>47.8</b>	<b>47.9</b>	<b>-0.1</b>	<b>48.1</b>	<b>48.1</b>	<b>0.0</b>
OECD Americas	25.5	25.5	0.0	25.8	25.7	0.1
OECD Europe	14.30	14.35	-0.05	14.4	14.4	0.0
Asia Oceania	8.0	8.1	-0.1	7.9	8.0	-0.1
<b>Total Non-OECD</b>	<b>51.4</b>	<b>50.9</b>	<b>0.5</b>	<b>52.5</b>	<b>52.0</b>	<b>0.5</b>
Non-OECD Asia	26.8	26.4	0.4	27.7	27.1	0.6
China	13.1	12.7	0.4	13.5	13.1	0.4
Other non-OECD Asia	13.7	13.7	0.0	14.2	14.1	0.1
Middle East	8.4	8.1	0.3	8.4	8.2	0.2
Latin America	6.4	6.5	-0.1	6.3	6.6	-0.3
FSU	4.7	4.8	-0.1	4.8	4.9	-0.1
Non-OECD Europe	0.8	0.7	0.1	0.8	0.8	0.0
Africa	4.3	4.3	0.0	4.4	4.4	0.0
<b>World</b>	<b>99.2</b>	<b>98.8</b>	<b>0.4</b>	<b>100.6</b>	<b>100.1</b>	<b>0.5</b>

**Table 6 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Table 4 - 1, 4 - 2.

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

**Figure 3. Short-term Liquids Demand Annual Growth**

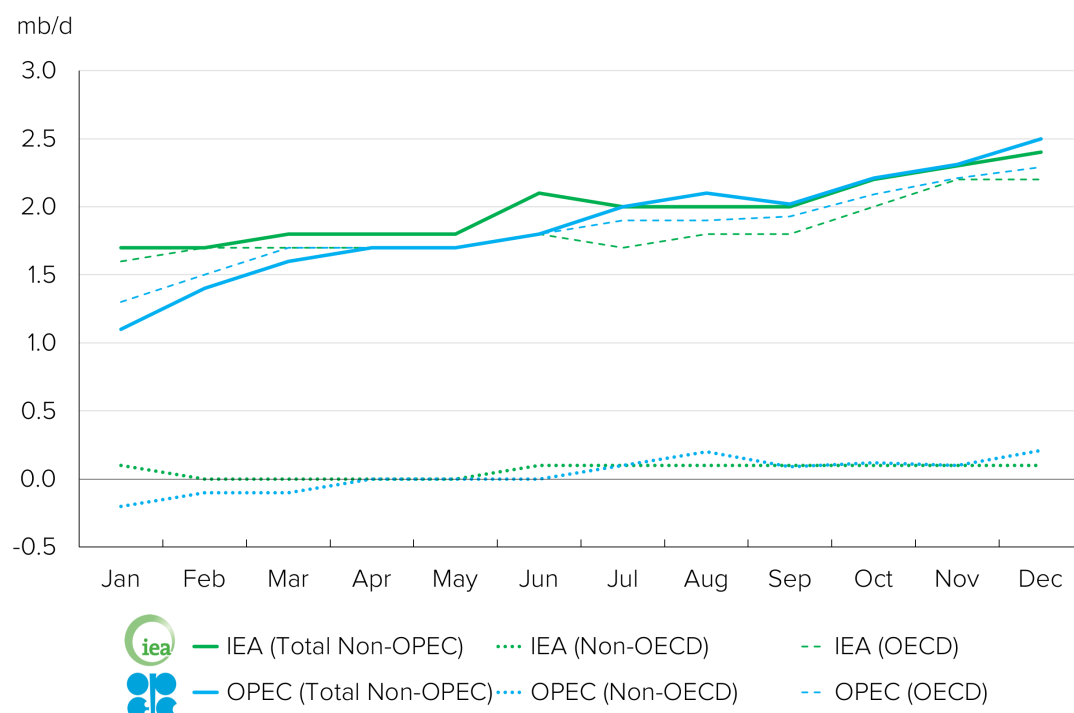
**Figure 3 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Tables 4 - 1, 4 - 2.

### 4.3 Short-Term Liquids Supply

U.S. tight oil growth has surprised to the upside over the past two years.

Like last year, non-OPEC liquids supply forecasts were revised upwards in 2018. **Figure 4** reveals that forecast revisions were very large for both OPEC and the IEA, with respective upward revisions to reach 2.5 mb/d and 2.4 mb/d in December 2018 relative to 2017. These upward revisions were driven almost entirely by the OECD, with U.S. tight oil in particular growing at faster-than-expected rates in response to higher prices during the middle part of 2018 and continued technological advancements. Revisions for non-OECD production were modest throughout the year.

**Figure 4. Monthly Revisions of Annual Estimates for 2018 Non-OPEC Liquids Supply Growth**



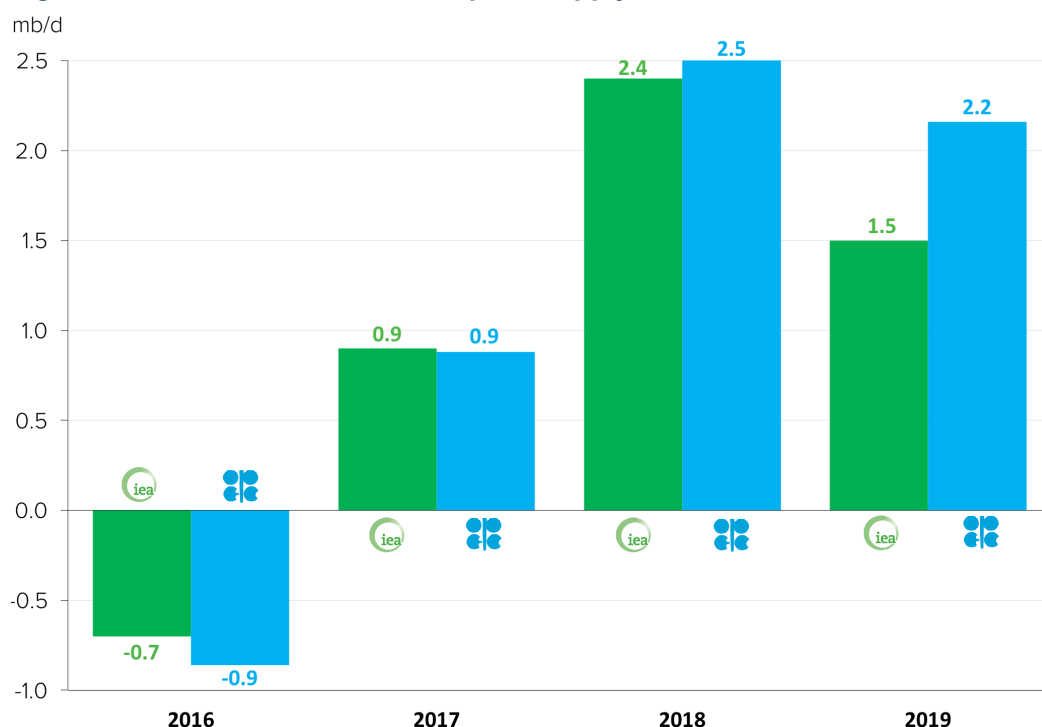
**Figure 4 data sources:** IEA OMR Jan-Dec 2018, Table 1; OPEC MOMR Jan-Dec 2018, Table 11 - 1.

**Figure 4 notes:** Congo joined OPEC in June 2018. Congo produced 320,000 b/d in November 2018 according to secondary sources cited in OPEC's December 2018 MOMR.

Non-OPEC liquids supply is projected to increase at a slower rate in 2019 with a widening difference between IEA and OPEC assessments.

Following a decline in 2016, non-OPEC liquids supply grew in 2017 followed by even faster growth in 2018. As **Figure 5** indicates, non-OPEC liquids supply growth is projected to increase further still in 2019, though at a slower rate than in 2018. However, there is a substantial difference of 0.7 mb/d between IEA and OPEC projections, with OPEC showing more bullish projections on non-OPEC supply growth.

**Figure 5. Short-term Non-OPEC Liquids Supply Annual Growth**



**Figure 5 data sources:** IEA OMR Dec 2018, Table 1; OPEC MOMR Dec 2018, Table 11 - 1.

**Figure 5 notes:** Congo joined OPEC in June 2018. Congo produced 320,000 b/d in November 2018 according to secondary sources cited in OPEC's December 2018 MOMR

Differences in short-term liquids supplies outlooks reside in the OECD Americas, and FSU region arising from differences in historical baseline data and projections of unconventional growth and compliance with production adjustments.

While OPEC supply estimates converge, differences in estimates for OPEC NGLs and unconvensionals persist at 0.7 mb/d and 0.6 mb/d in 2018 and 2019 respectively.

**Table 7** displays a detailed comparison of short-term liquids supply outlooks by region. The IEA-OPEC difference in non-OPEC supply decreases from the difference in baseline (2017) supply data of 0.5 mb/d (see **Table 3**) to 0.4 mb/d in 2018 and to 0.3 mb/d in 2019. Regional differences emerge from FSU nations (0.3 mb/d in 2018 and 2019), stemming from differences in historical data along with different projections for the extension of production adjustments in coordination with OPEC. An even larger difference (-0.5 mb/d in 2019) appears in projections from OECD Americas in 2019, highlighting different estimates about North American unconventional supply volumes, in addition to growth rates highlighted in **Figure 5**.

Variation also emerges between the two estimates for OPEC supplies. While total OPEC supplies in 2018 are 38.8 mb/d in both projections, this convergence masks substantial differences in estimates for OPEC NGLs and unconvensionals, where the IEA projects 0.7 mb/d more than OPEC. In 2019, the overall difference in OPEC supplies grows to 0.8 mb/d, stemming from a 0.6 mb/d difference in OPEC NGLs and unconvensionals supplies. These differences reflect continued divergence in baseline (2017) data of 0.7 mb/d for OPEC NGLs and unconvensionals, shown in **Table 3**.

Neither the IEA nor OPEC make projections for short-term OPEC crude, but the difference between their constructed estimates for OPEC supply has grown from 0 mb/d in 2017 (the baseline year) to 0.6 mb/d in 2017 and 0.3 mb/d in 2018. These differences are well below those observed in last year's report, where OPEC crude projections varied by as much as 2.8 mb/d in 2018. This merits further 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 unconvensionals supply from world liquids demand projections, since neither the IEA nor OPEC projects OPEC crude production in their monthly 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.

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

	2018			2019		
	IEA	OPEC	Difference (IEA-OPEC)	IEA	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>27.9</b>	<b>28.0</b>	<b>-0.1</b>	<b>29.1</b>	<b>29.7</b>	<b>-0.6</b>
OECD Americas	23.8	23.8	0.0	24.9	25.4	-0.5
OECD Europe	3.7	3.8	-0.1	3.7	3.8	-0.1
Asia Oceania	0.4	0.4	0.0	0.52	0.46	0.06
<b>Total Non-OECD</b>	<b>30.0</b>	<b>29.8</b>	<b>0.2</b>	<b>30.35</b>	<b>30.18</b>	<b>0.17</b>
Asia	7.32	7.46	-0.14	7.25	7.37	-0.12
China	3.9	4.0	-0.1	3.88	3.93	-0.05
Other non-OECD Asia	3.45	3.51	-0.06	3.37	3.44	-0.07
Middle East	1.3	1.2	0.1	1.3	1.2	0.1
Latin America	5.2	5.2	0.0	5.6	5.5	0.1
FSU	14.6	14.3	0.3	14.7	14.4	0.3
Non-OECD Europe	0.1	0.1	0.0	0.1	0.1	0.0
Africa	1.5	1.5	0.0	1.4	1.6	-0.2
<b>Processing gains</b>	<b>2.3</b>	<b>2.3</b>	<b>0.0</b>	<b>2.3</b>	<b>2.3</b>	<b>0.0</b>
<b>Total Non-OPEC</b>	<b>60.4</b>	<b>60.0</b>	<b>0.4</b>	<b>61.9</b>	<b>62.2</b>	<b>-0.3</b>
<b>Total OPEC <sup>(a)</sup></b>	<b>38.8</b>	<b>38.8</b>	<b>0.0</b>	<b>38.7</b>	<b>37.9</b>	<b>0.8</b>
Call on OPEC crude + stock ch. & misc. <sup>(b)</sup>	31.8	32.4	-0.6	31.7	31.4	0.3
OPEC NGLs + unconventional	7.0	6.3	0.7	7.0	6.5	0.6
<b>World Supply <sup>(c)</sup></b>	<b>99.2</b>	<b>98.8</b>	<b>0.4</b>	<b>100.6</b>	<b>100.1</b>	<b>0.5</b>

**Table 7 data sources:** IEA OMR Dec 2018, Table 1; IEA Oil 2018, Table 5 & 5a; OPEC MOMR Dec 2018, Table 5 - 2, 5 - 3, 11 - 1.

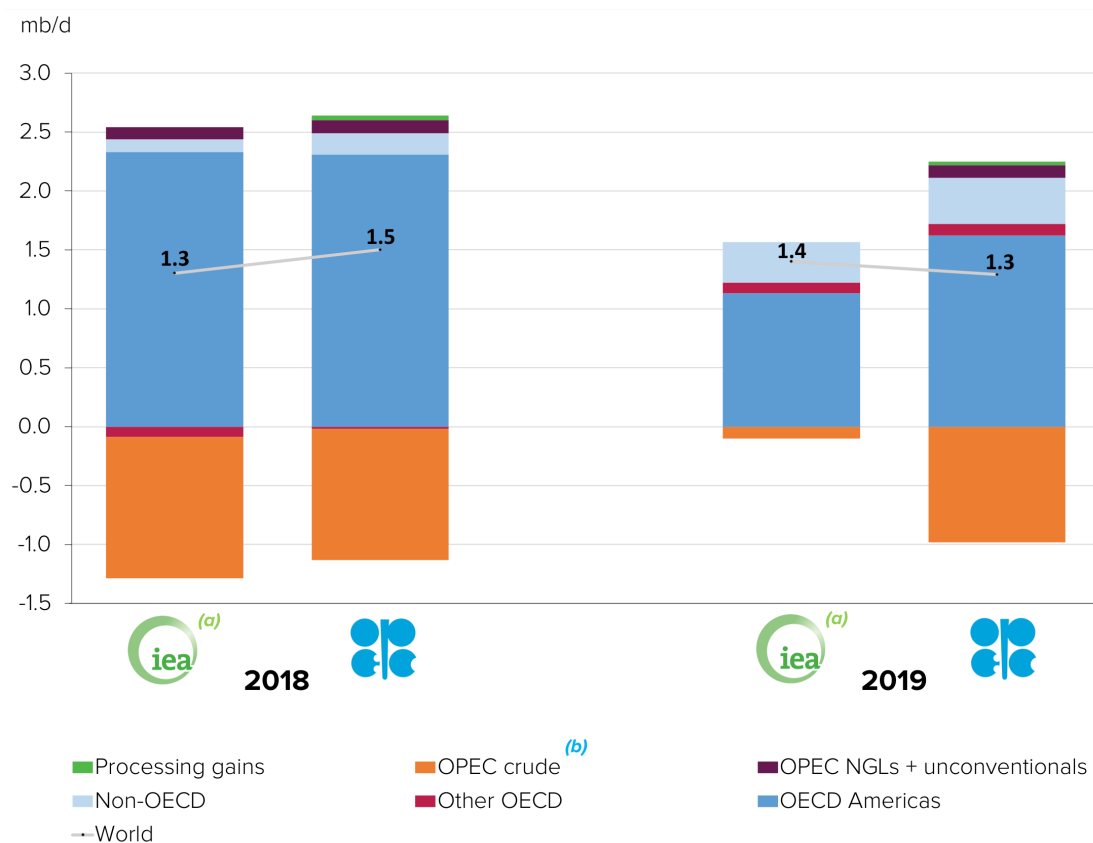
**Table 7 notes:** Numbers rounded to nearest significant digit.

<sup>(a)</sup> Biofuels from IEA Oil 2018 are added to IEA regional oil supply data for comparability with OPEC estimates.

<sup>(b)</sup> Equals total liquids demand minus non-OPEC supply minus OPEC NGLs/unconventionals.

<sup>(c)</sup> 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. Congo is included as an OPEC member.

**Figure 6. Short-term Liquids Supply Net Annual Growth Forecast**



**Figure 6 data sources:** IEA OMR Dec 2018, Table 1; IEA Oil 2018, Table 5 & 5a; OPEC MOMR Dec 2018, Table 5 - 2, 5 - 3, 11 - 1.

**Figure 6 notes:** Numbers rounded to nearest significant digit.

(a) Biofuels from the IEA Oil 2017 report are added to IEA regional oil supply data for comparability with OPEC estimates..

(b) IEA and OPEC do not forecast OPEC crude; this estimate is constructed as the “call on OPEC crude” including “stock change and miscellaneous”. Congo is included as an OPEC member.

Both the IEA and OPEC make their medium-term projections through to 2023 and use 2017 as a base year.

## 5. Medium-Term Oil Outlooks

Our comparison of medium-term outlooks assesses the IEA's Oil 2018 published in March 2018, and OPEC's World Oil Outlook (WOO) published in September 2018 (**Table 1**). Both organisations make their medium-term projections through 2023, using 2017 as a base year. However, there is a six-month gap between publication dates of the two reports, and given the dynamic nature of market conditions, this gap complicates the comparison of the projections.

### 5.1 Oil Price and Economic Growth Assumptions

#### 5.1.1 Oil Price

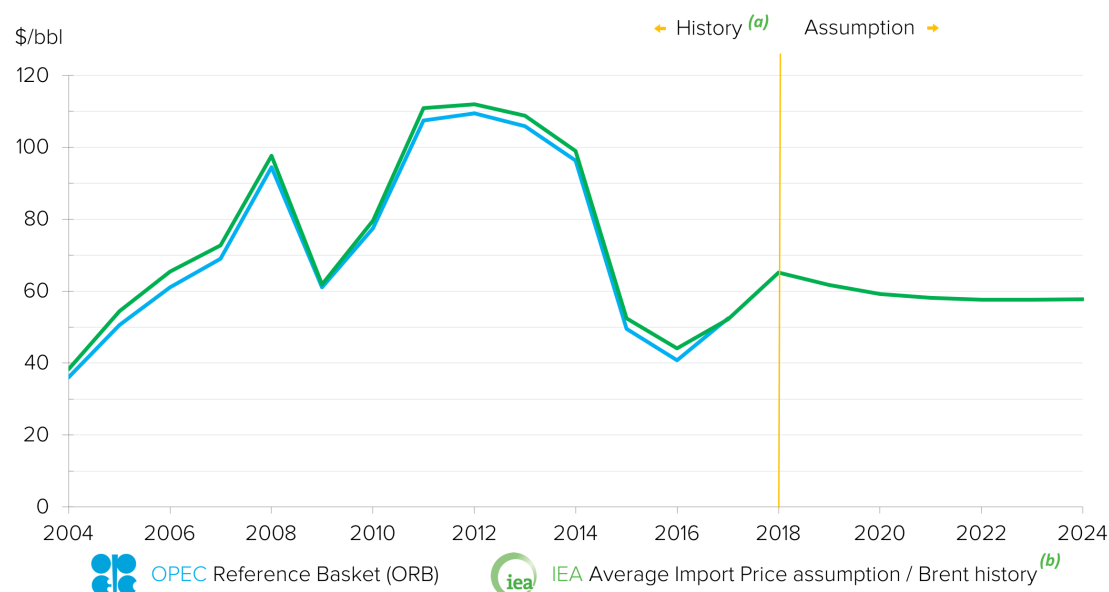
The price of oil is one of the primary factors influencing the projections of oil demand. Since 2017, OPEC has not published its oil price assumptions for the medium-, or long-term, preventing detailed comparison between the IEA and OPEC.

As in previous years, 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. The IEA uses an "IEA Average Import Price", which reflects the IEA's perspective on its member countries' future crude import prices.

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. In previous years, OPEC's medium-term price assumptions mainly reflect its assumptions on the ORB price detailed above, while its longer-term price assumptions have also taken into account its estimates of the cost of supplying the marginal barrel.

As **Figure 7** illustrates, the IEA's Medium-Term Oil 2018, published in early 2018, shows the nominal "IEA Average Import Price" growing through 2018 to average US\$65/bbl, then declining slightly over the coming years, reaching \$58/bbl by 2024.

**Figure 7. Oil Price History and Medium-Term IEA Assumptions (nominal US\$)**



**Figure 7 data sources:** Historical OPEC ORB price from [https://www.opec.org/opec\\_web/en/data\\_graphs/40.htm](https://www.opec.org/opec_web/en/data_graphs/40.htm). Annual average IEA import price provided via internal communication and Brent history from [https://www.quandl.com/data/ODA/POILBRE\\_USD-Brent-Crude-Oil-Price](https://www.quandl.com/data/ODA/POILBRE_USD-Brent-Crude-Oil-Price)

**Figure 7 notes:** Numbers rounded to nearest significant digit.

(a) Only historical prices up to the time IEA and OPEC released their reports were included.

(b) IEA Average Import Price assumption is based on the Brent futures strip.



Both the IEA and OPEC adjusted medium-term global economic growth projections. For 2023 the IEA projects global economic growth at 3.8% while OPEC estimates it to reach 3.4%.

## 5.1.2 Economic Growth

Both the IEA and OPEC have modestly adjusted their expectations for medium-term global economic growth compared to last year, and some notable differences emerge in global and regional projections. The IEA (based on IMF forecasts) raised its growth estimate for the early years of the forecast period, increasing from 3.6% to 3.9% in 2018, with later-period projections holding steady at 3.8% in 2021. OPEC's expectations for early-period growth also increased, from 3.5% to 3.8% in 2018, though its later year projections fell from 3.7% to 3.5% in 2022. Estimates of global growth varied in 2023 with the IEA projecting 3.8% per year and OPEC projecting 3.4% (**Table 8**).

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

	2018	2019	2020	2021	2022	2023
<b>OPEC</b>	3.8	3.6	3.6	3.5	3.5	3.4
<b>IEA</b>	3.9	3.9	3.7	3.8	3.8	3.8

**Table 8 data sources:** IEA MT Oil 2018, Table 1.3; OPEC WOO 2018, Table 1.4. IEA's forecast relies on IMF's January 2018 World Economic Outlook.

Regional economic growth projections vary. The IEA estimates growth in India to reach 8.2% while OPEC projects economic growth to reach 7.0% in 2023.

Under both projections, OECD and non-OECD economies expand over the medium-term, with non-OECD nations generally growing at a faster rate. Projections vary between some key countries, however. For example, OPEC and the IEA both project that China will grow at an annual rate of 5.5% in 2023, while projections for India vary substantially, with OPEC projecting 7.0% and the IEA projecting 8.2% in 2023.

## 5.2 Medium-Term Liquids Demand

### 5.2.1 Global and Regional Demand Growth

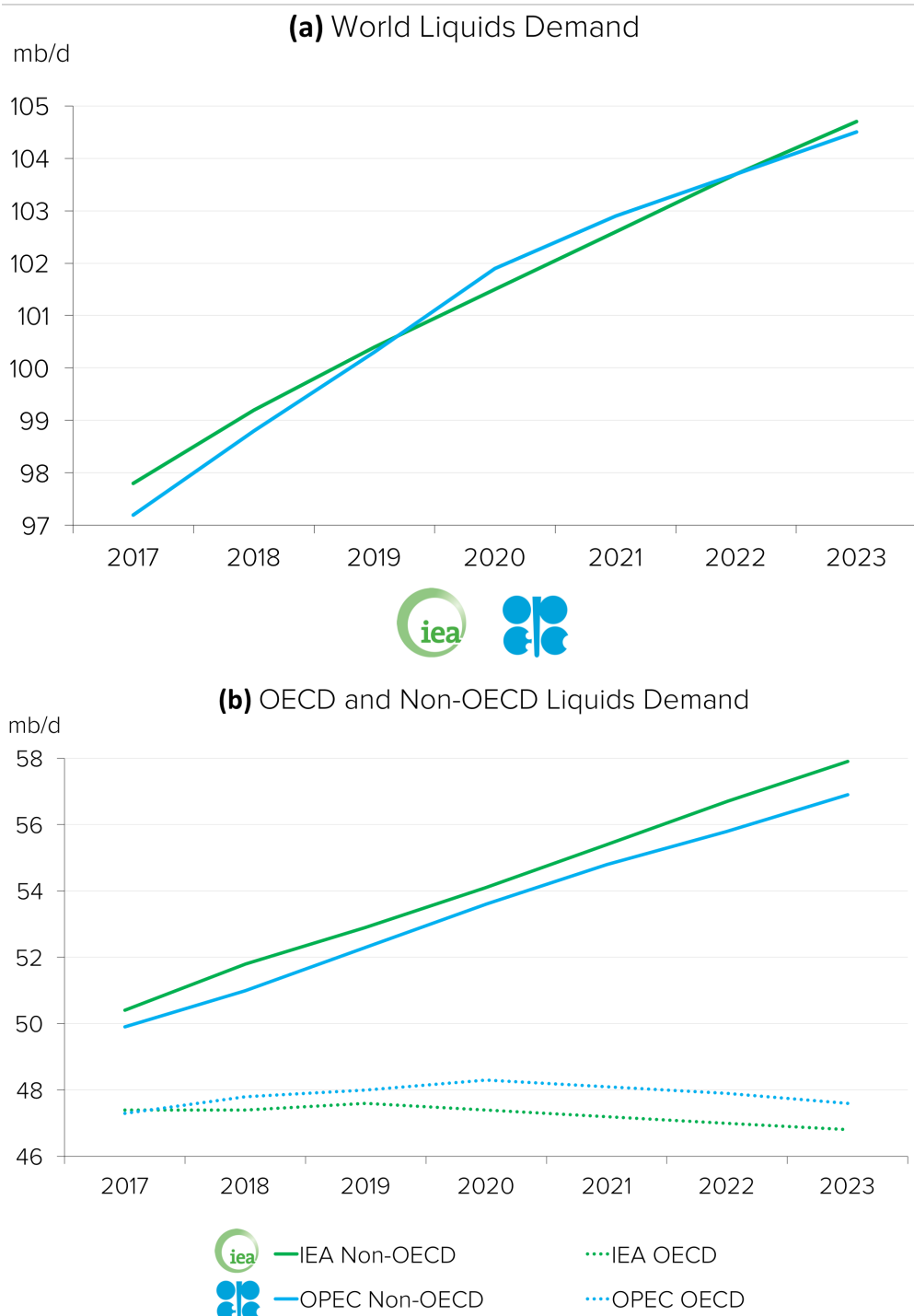
Both the IEA and OPEC expect robust global liquids demand growth over the medium term.

Like last year's assessment, both organisations expect robust medium-term growth in global liquids demand. Liquids demand in the baseline year is 97.2 mb/d for OPEC and 97.8 mb/d for the IEA, a difference of 0.6 mb/d, roughly half of the baseline difference observed in last year's report. As **Table 9** shows, both project annual average growth of 1.2 mb/d in global liquids demand, with OPEC reaching 104.5 mb/d in 2023 and the IEA reaching 104.7 (**Figure 8(a)**).

OPEC is more bullish about medium-term demand growth in the OECD than the IEA projecting annual average growth of 0.03 mb/d compared to an annual average decline of 0.1 mb/d respectively.

Both organisations project average annual demand growth of 1.2 mb/d from non-OECD nations, while OPEC is more bullish about the OECD, projecting annual average growth of 0.03 mb/d compared with the IEA's projected annual average decline of 0.1 mb/d. The divergence in oil demand growth between OECD and non-OECD nations reinforces how global oil markets have transformed, with non-OECD nations far outpacing demand in the OECD in the years to come. By 2023, the non-OECD respectively consumes 9.4 mb/d and 11.1 mb/d more than the OECD under OPEC's and the IEA's projections (**Figure 8(b)**).

**Figure 8. Medium-term Liquids Demand**



By 2023, the non-OECD consumes 9.4 mb/d and 11.1 mb/d more than the OECD under OPEC's and the IEA's projections respectively.

OPEC's medium-term projections are generally higher for OECD regions, while the IEA's projections are generally higher for the non-OECD.

**Figure 8 data sources:** IEA Oil 2018, Table 2; OPEC WOO 2018, Table 3.1.

**Table 9** presents a detailed comparison of the IEA and OPEC medium-term liquids demand outlooks for comparable regions. Modest differences arise in projected 2023 demand across numerous regions, with OPEC's projections generally higher for OECD regions, and the IEA's projections generally higher for the non-OECD. Comparison of non-OECD regions is complicated by the fact that, in the WOO 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. To allow for comparison across the regions where OPEC members are located, we group together the Middle East, Africa and Latin America for regional demand projections, which allows for the inclusion of all OPEC members into this category.

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

	2023		Avg. annual growth (2017-2023)		
	IEA	OPEC	IEA	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>46.8</b>	<b>47.6</b>	<b>-0.1</b>	<b>0.1</b>	<b>-0.2</b>
OECD Americas	24.9	25.6	0.0	0.1	-0.1
OECD Europe	14.1	14.2	0.0	0.0	0.0
Asia Oceania	7.9	7.8	-0.05	-0.05	0.0
<b>Total Non-OECD</b>	<b>57.9</b>	<b>56.9</b>	<b>1.23</b>	<b>1.17</b>	<b>0.07</b>
Asia	30.3	30.1	0.8	0.8	0.0
China	14.4	14.3	0.3	0.3	0.0
India	5.9	5.9	0.2	0.2	0.0
Other non-OECD Asia	10.0	9.9	0.2	0.2	0.0
Middle East, Africa & Latin America <sup>(a)</sup>	21.5	21.0	0.4	0.4	0.0
Europe & Eurasia	6.1	6.0	0.1	0.1	0.1
<b>World</b>	<b>104.7</b>	<b>104.5</b>	<b>1.15</b>	<b>1.22</b>	<b>-0.07</b>

**Table 9 data sources:** IEA Oil 2018, Table 2; OPEC WOO2018, Table 3.1.

**Table 9 notes:** Numbers rounded to nearest significant digit.

<sup>(a)</sup> OPEC calculates demand from OPEC member countries as a whole by excluding them from corresponding geographical region. To allow for comparison across the regions where OPEC members are located, we group together the Middle East, Africa and Latin America for regional demand projections, which allows for the inclusion of all OPEC members into this category.

### 5.2.2 Sectoral Demand

The WOO2018 provides sectoral oil demand projections for 2017 through 2023, identifying road transport as the largest source of cumulative growth at 3.0 mb/d. The petrochemicals sector grows by a total of 1.5 mb/d, followed by aviation at 0.9 mb/d through 2023.

The IEA's medium-term Oil 2018 report does not include detailed global sectoral data. However, the report does discuss some key shifts in oil market dynamics, with a particular focus on growing demand in the petrochemicals sector. The report highlights petrochemical projects under development in the United States, China, Russia, and elsewhere, and notes that demand for liquefied petroleum gases (LPG) and ethane is projected to grow by 2.6% per year to 2023, while demand for naphtha grows at 1.9% per year.

Both organizations take note of the 2020 changes in fuel specifications from the International Marine Organization, which will reduce demand for high sulphur fuel oil, currently accounting for roughly 75% of bunker fuel demand. OPEC notes that a variety of uncertainties remain regarding the compliance rate and choice of compliance mechanism among shipping companies, which in turn drives uncertainty over demand for different bunker fuels. Without this certainty, refiners may not invest in new systems to satisfy changing demand patterns by 2020. OPEC notes that this lack of refining investment may lead to an oversupply of high sulphur fuel oil in early compliance years, along with increased demand and higher prices for low sulphur fuel oil and diesel. The IEA also describes substantial uncertainties surrounding implementation, noting that low sulphur products will be in high demand, and describing it as a "huge challenge." It describes its assumptions for implementation of the IMO rules in detail in Oil 2018.

The IEA highlights growing demand in the petrochemicals sector noting that demand for LPG and ethane is expected to grow by 2.6% per year to 2023 and demand for naphtha grows at 1.9% per year.

Both the IEA and OPEC note that a variety of uncertainties remain regarding the IMO's fuel specification standards entering into effect in 2020 adversely affecting investment in new refinery systems and challenging demand patterns.

## 5.3 Medium-Term Liquids Supply

### 5.3.1 Liquid Fuels Classification and Projection Methodology

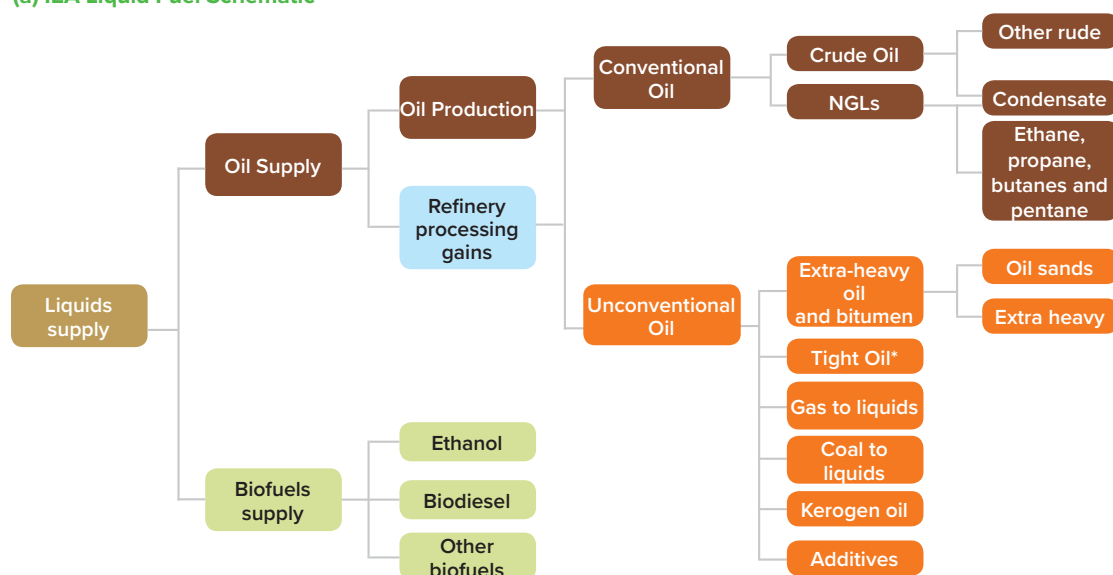
For their medium-term liquids supply outlooks, both the IEA and OPEC take a “bottom-up” approach of assessing field-level supply capabilities for each country. However, they may take different upstream oil production projects into account and estimate different levels of productivity for each field. 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 to enhance 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. **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,” including tight oil, into another. OPEC, as shown in **Figure 9(b)** accounts for tight crude in its “crude oil” category and distinguishes between conventional and unconventional NGLs. It groups other unconventional liquids such as oil sands and oil shale into its “non-crude supply” category.

**Figure 9. Liquid Fuels Categorisation by the IEA and OPEC**

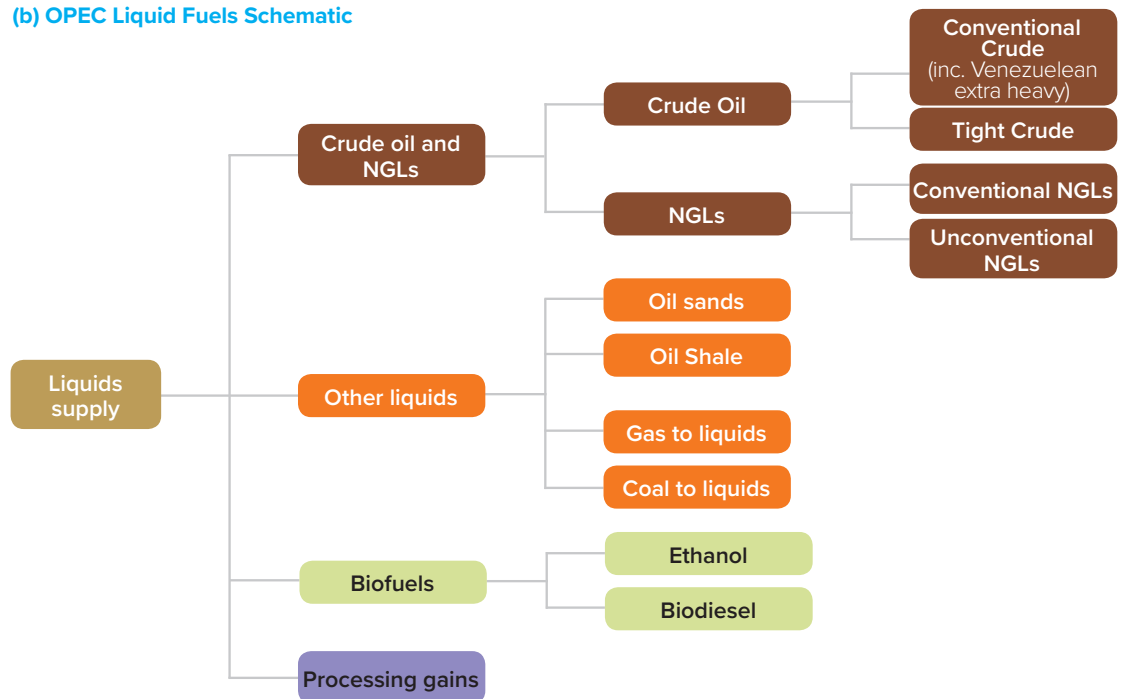
**(a) IEA Liquid Fuel Schematic**



**Figure 9(a) data sources:** Resources for the Future and IEF based on IEA WEO 2018, Figure C.1.

\* IEA previously referred to “tight oil” as “light tight oil”.

(b) OPEC Liquid Fuels Schematic



**Figure 9(b) data sources:** Resources for the Future and IEF based on IEA WOO 2018, and internal communication.

### 5.3.2 Global and Regional Liquids Supply

After non-OPEC supply grew substantially with OPEC and the IEA growth estimates at around 2.0 mb/d and 1.8 mb/d respectively for 2018, both organisations project production growth to decline over the medium-term.

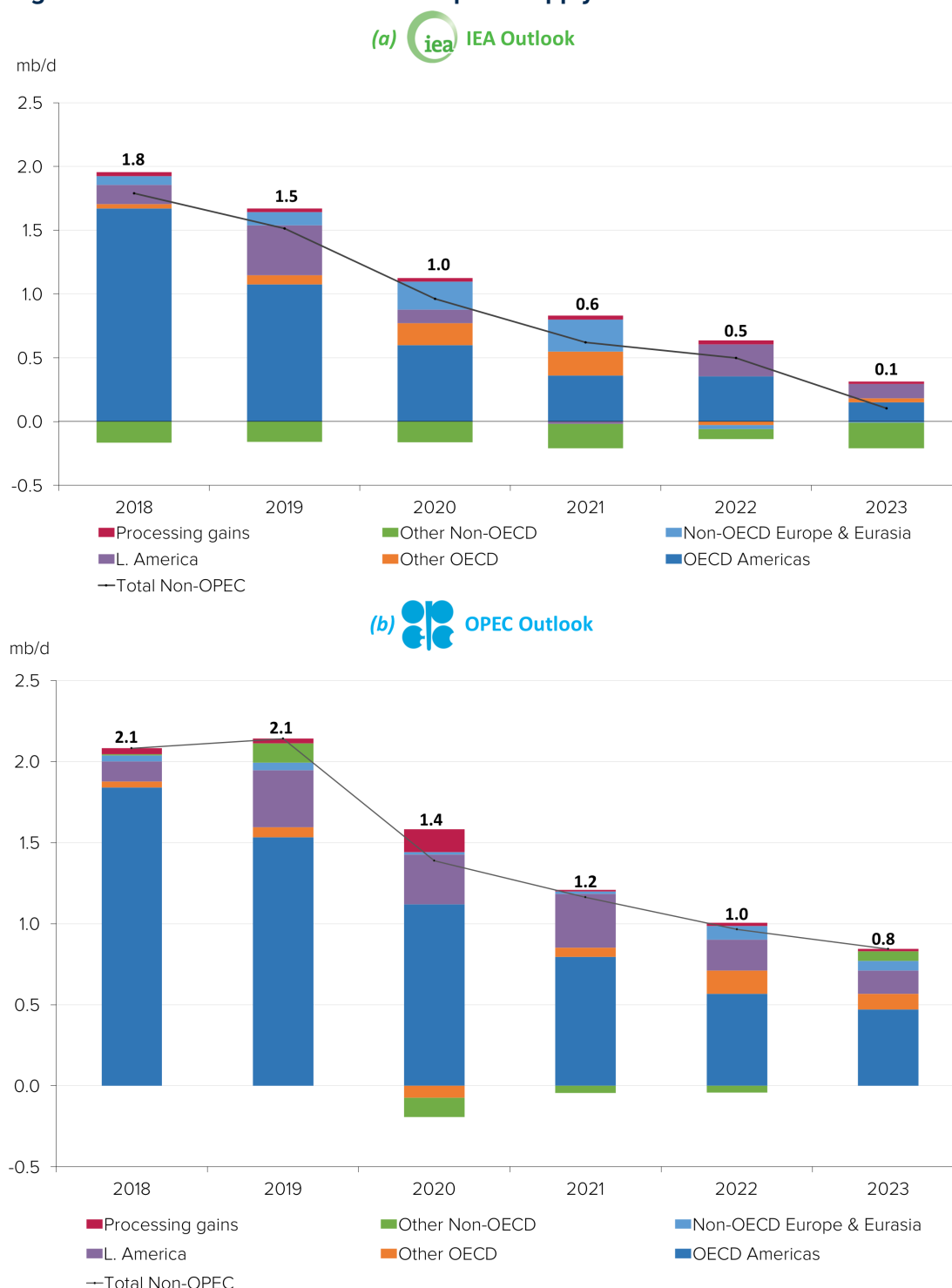
OPEC projects a net increase of 8.6 mb/d in non-OPEC production by 2023, while the IEA forecasts 5.5 mb/d, well above levels seen in last year's reports.

Both projections show steady growth in non-OPEC Latin America, with net gains of 1.5 mb/d estimated by OPEC and 1.0 mb/d by the IEA.

As oil prices increased through October 2018, non-OPEC supply grew substantially. This was driven primarily by increased production in OECD Americas and, to a lesser extent, Latin America (**Figure 10(a)** and **Figure 10(b)**). OPEC estimates 2018 net growth of roughly 2.0 mb/d, while the IEA estimates growth of 1.8 mb/d. OECD Americas, driven by tight oil production in the United States, increases its production by 1.8 mb/d and 1.7 mb/d under OPEC and IEA estimates, respectively.

Both organisations project production growth to decline over the medium-term, though the cumulative level of growth varies substantially. OPEC projects a net increase of 8.6 mb/d in non-OPEC production by 2023, while the IEA forecasts 5.5 mb/d. Both of these figures are well above those seen in last year's reports, where OPEC and the IEA respectively estimated cumulative growth of 4.9 mb/d and 3.3 mb/d from 2016 to 2022. Once again, the bulk of this growth comes from the OECD Americas, which in the WOO2018 grows its production by 6.3 mb/d over the projection period, compared to 4.2 mb/d of growth in the IEA's Oil 2018. Both projections show steady growth in non-OPEC Latin America, with net gains of 1.5 mb/d estimated by OPEC and 1.0 mb/d by the IEA. The forecasts diverge somewhat on production from non-OECD Europe and Eurasia, with OPEC projecting cumulative growth of 0.3 mb/d compared with the IEA's projection of 0.6 mb/d in growth over the projection period.

**Figure 10. Medium-Term Non-OPEC Liquids Supply Annual Growth**



**Figure 10 data sources:** IEA Oil 2018, Table 3, Table 5, Table 5a; OPEC WOO 2018, Table 4.1 and internal communication.

**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. Congo, which joined OPEC in June 2018 and produced 320,000 b/d in November 2018 according to OPEC's December 2018 Oil Market Report, is included in OPEC's data but excluded from the IEA's because of the timing of the relevant publications. Sums may differ due rounding.

**Table 10** provides a detailed regional comparison of medium-term liquids supply between the two outlooks. As noted above, OPEC's projections show substantially stronger non-OPEC supply growth than the IEA, particularly for the OECD Americas. OPEC projects 27.8 mb/d from OECD Americas in 2023, well above previous medium-term projections of 24.6 mb/d in 2022 (WOO2017) and 21.6 mb/d in 2021 (WOO2016). The IEA's projection for the region of 25.6 mb/d in 2023 is well above projections from the previous two years

Liquids supply projections of the IEA and OPEC for the OECD Americas region are well above previous medium term projections.

of 23.0 mb/d in 2022 (Oil2017) and 22.9 mb/d in 2021 (MTOMR 2016). OPEC's projections for supplies from non-OECD Asia at 7.5 mb/d in 2023 are also well above IEA estimates of 6.9 mb/d. As with other areas of comparison, OPEC's higher supply estimates from non-OPEC nations may be explained in part by the later publication date of OPEC's outlook, as oil futures rose during the course of the year.

In total, the IEA forecasts 62.7 mb/d in liquids supply from non-OPEC nations in 2023, while OPEC estimates 66.1 mb/d, a 3.4 mb/d difference.

In total, the IEA forecasts 62.7 mb/d in liquids supply from non-OPEC nations in 2023, while OPEC estimates 66.1 mb/d, a 3.4 mb/d difference. The IEA's projections imply supply from OPEC member nations of 42.0 mb/d, 3.4 mb/d higher than the assessments by OPEC. Interestingly, this results in global liquids supply estimates of 104.7 mb/d in 2023 from both organisations. In the IEA's projection, roughly 60% of global supplies come from non-OPEC sources in 2023, while OPEC projects 63%.

Average annual growth figures shown in **Table 10** are somewhat complicated by divergent baseline (2017) data for certain regions. For example, the IEA's estimates for non-OECD supplies in 2017 are 0.3 mb/d higher than OPEC's, driven by a 0.3 mb/d difference in FSU nations. OPEC and IEA estimates for liquids supplies from OPEC also vary substantially, with a 0.7 mb/d difference in OPEC NGLs and unconventionals (note that 2017 baseline data are taken from each organisation's medium-term outlooks).

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

**Table 10 data sources:** IEA Oil 2018, Tables 3, 5, and 5a; OPEC WOO2018, Table 4.1.

	2023		Avg. annual growth (2017-2023)		
	IEA <sup>(b)</sup>	OPEC	IEA	OPEC	Difference (IEA-OPEC)
<b>Total OECD</b>	<b>30.3</b>	<b>32.3</b>	<b>0.8</b>	<b>1.1</b>	<b>-0.3</b>
OECD Americas	25.6	27.8	0.71	1.05	-0.34
OECD Europe	4.1	4.0	0.06	0.03	0.02
OECD Asia Oceania	0.6	0.5	0.0	0.0	0.0
<b>Total Non-OECD</b>	<b>29.9</b>	<b>33.8</b>	<b>-0.1</b>	<b>0.3</b>	<b>-0.4</b>
Asia	6.9	7.5	-0.1	0.0	-0.1
China	3.7	4.0	0.0	0.0	0.0
Other non-OECD Asia	3.1	3.5	-0.1	0.0	-0.1
Middle East & Africa	2.7	2.8	-0.1	0.0	-0.1
Latin America	6.2	6.6	0.2	0.3	-0.1
Europe & Eurasia	14.8	14.4	0.0	0.0	0.0
Processing Gains	2.5	2.5	0.03	0.05	-0.02
<b>Total Non-OPEC</b>	<b>62.7</b>	<b>66.1</b>	<b>0.76</b>	<b>1.43</b>	<b>-0.67</b>
<b>Total OPEC</b>	<b>42.0</b>	<b>38.6</b>	<b>0.5</b>	<b>0.0</b>	<b>0.5</b>
OPEC crude <sup>(a)</sup>	34.7	31.6	0.4	-0.2	0.6
OPEC NGLs + unconventionals	7.3	7.0	0.08	0.13	-0.06
<b>World</b>	<b>104.7 <sup>(c)</sup></b>	<b>104.7</b>	<b>1.2</b>	<b>1.4</b>	<b>-0.2</b>

**Table 10 notes:** Numbers rounded to nearest significant digit.

<sup>(a)</sup> Congo, which joined OPEC in June 2018 and produced 320,000 b/d in November 2018 according to OPEC's December 2018 Oil Market Report, is included in OPEC's data but excluded from the IEA's because of the timing of the relevant publications

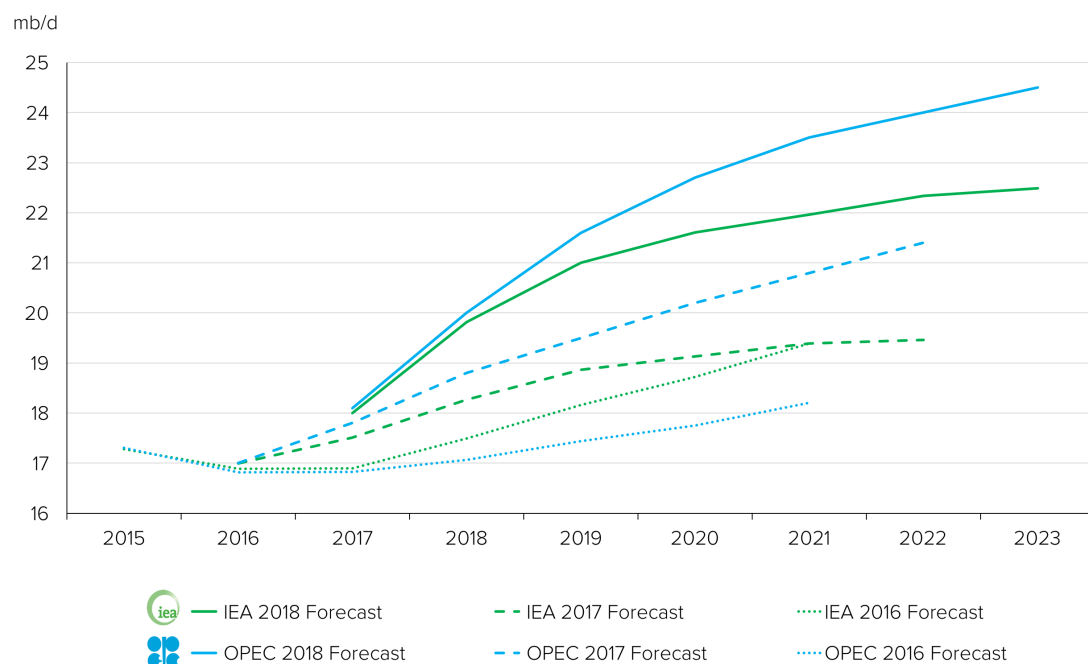
<sup>(b)</sup> For IEA includes stock change and miscellaneous. OPEC also includes stock change in medium-term and long-term projections. IEA regional supply estimates include biofuels, based on IEA Oil 2018 Tables 5 and 5a.

<sup>(c)</sup> Estimates for total OPEC supply and world supply are constructed from other components because IEA does not directly provide these forecasts in their reports.

The difference in projected supply by the end of the forecast period is substantial, reflecting different assumptions about technologies and oil prices largely in relation to U.S. tight oil.

Compared with recent years, both the IEA and OPEC increased their projections for the cumulative growth in medium-term oil supply from the United States and Canada. As noted above, the difference in projected supply by the end of the forecast period is substantial, reflecting different assumptions about technologies and oil prices. For both organisations, the majority of this growth comes from U.S. tight oil (**Figure 11**).

**Figure 11. Medium-term US and Canadian Oil Supply (excluding biofuels)**



**Figure 11 data sources:** IEA Oil 2018 Table 3; OPEC WOO 2018 Tables 4.5 and 4.10; IEA Oil 2017 Table 3; OPEC WOO2017, Table 4.1; IEA MTOMR 2016 Table 3; OPEC WOO2016, Table 4.1



The IEA and OPEC long-term projections extend to 2040 but this year are based on different baseline years complicating comparisons.

## 6. Long-Term Energy Outlooks

The following comparison of long-term outlooks evaluates the IEA's World Energy Outlook 2018 (WEO2018) and OPEC's World Oil Outlook 2018 (WOO2018). In these reports, the IEA and OPEC make projections extending through to 2040. However, as noted earlier, the two organisations use different baseline years for their projections. The IEA uses 2016 as a baseline year and provides an estimate for 2017 demand for both primary energy and oil, while OPEC uses 2015 as its baseline year for primary energy and 2017 for oil.

Differences between the IEA and OPEC in their choice of units for primary energy demand also create challenges in making comparisons. OPEC uses million barrels of oil equivalent per day (mboe/d), while the IEA most frequently uses million tons of oil equivalent (mtoe) per year. Where necessary, we convert the IEA's units of primary energy from mtoe per year to mboe/d by multiplying by 7.37<sup>4</sup> mboe/mtoe and dividing that total by 365 days per year, yielding a conversion factor of 0.0202 mboe/d/mtoe.

An additional challenge in comparing long-term outlooks arises from differences in regional groupings between the IEA and OPEC. While OPEC reports its main regional results in terms of OECD status (i.e., OECD Americas, OECD Europe, non-OECD Asia, etc.), the IEA does not group countries according to OECD status in its main results and Annex tables. The IEA has graciously provided additional data with these regional groupings for this report to enhance comparability.

### 6.1 Key Assumptions

#### 6.1.1 Scenarios and Sensitivity Cases

As in previous years, the IEA presents three scenarios on the future of energy. Alternatively, OPEC focuses on a single Reference Case, then provides a more limited range of sensitivity analyses to address uncertainties through 2040. **Table 11** lists key assumptions for core scenarios included in the WEO2018 and WOO2018. A more detailed comparison is provided in **Annex 1**, and a comparison of key outlook results for each scenario is featured in **Annex 2**.

**Table 11. Long-term Scenario Key Assumptions**

IEA WEO Scenarios	OPEC WOO Scenarios
<b>Current Policies Scenario:</b> Only considers policies that have been enacted as of mid-2018	<b>Reference Case:</b> Only considers policies that have been enacted, but also accepts that the policy process will evolve over time
<b>New Policies Scenario:</b> Considers both policies in place and commitments announced	<b>Sensitivity Analysis:</b> Considers cases with different levels of African energy demand, electric vehicle deployment, tight oil growth, energy efficiency, and renewables
<b>Sustainable Development Scenario:</b> Includes the energy-related objectives included in the United Nation's 2030 Agenda for Sustainable Development	

The IEA has retained its three core scenarios—the New Policies Scenario (NPS), Current Policies Scenarios (CPS), and Sustainable Development Scenario (SDS), which replaced the 450-ppm scenario in 2017. The New Policies Scenario, the central scenario in the

<sup>4</sup> IEA, Oil Information 2015, IV.93. In WEO2018 (p. 618), the IEA notes that there is no standard conversion factor from boe to toe, with common factors ranging from 7.15 to 7.40. Exact factors depend on the type of oil. Per internal communication, OPEC uses a factor of 7.33, which would result in a conversion factor of 0.02008.

All three IEA scenarios share the same GDP and population assumptions, while variations in policy affect technological development and energy markets.

The OPEC Reference Case is the central scenario that not only considers enacted policies, but also accepts that the policy process evolves over time.

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.

Both the IEA and OPEC assume that population growth will be highest in the Africa Middle East region, and India, notwithstanding differences in base line years and regional groupings.

WEO series, considers both policies in place as well as policies and commitments 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 SDS creates an energy path consistent with the United Nations' Sustainable Development Goals, and projects that carbon dioxide emissions from fossil fuel consumption will decline through 2040 consistent with the long-term temperature goals outlined in the 2015 Paris climate agreement. All three IEA scenarios share the same GDP and population assumptions, while variations in policy affect technological development and energy markets.

OPEC employs sensitivity analysis to examine specific issues in the WOO2018, building upon its World Energy Model (OWEM) for upstream liquids demand and supply projections. In the WOO series, the Reference Case is the central scenario. The Reference Case not only considers enacted policies, but also accepts that the policy process evolves over time, with regional policy assumptions highlighted in Section 1.3 and Chapter 8 of WOO2018. Because OPEC's Reference Case is not strictly based on energy policies already in place, it is challenging to find a single counterpart in IEA's WEO2018 for comparison. As a result, we compare the WOO2018 Reference Case with both the IEA's Current Policies Scenario and the New Policies Scenario, selectively providing other scenarios and sensitivity cases for additional context.

OPEC examines several sensitivity cases for specific topics in WOO2018. The first focuses on alternative growth rates for economic growth in Africa, with a Reference Case and a "high growth" sensitivity which leads to substantial additional demand for energy, met primarily by oil, natural gas, and non-hydro renewables such as wind and solar. A second sensitivity focuses on the penetration of electric vehicles, with "fast penetration" and "slow penetration" cases, which respectively see electric vehicles growing to account for 37% and 7% of the global passenger car fleet by 2040, compared with roughly 15% in the Reference Case. Global oil demand in 2040 in the "fast penetration" sensitivity is 2.9 mb/d lower than the Reference Case, while demand under the "slow penetration" sensitivity is 1.3 mb/d higher. Third, as in previous years, the WOO2018 includes a sensitivity analysis of higher and lower U.S. tight oil production, with output ranging roughly 3 to 4 mb/d above and below the Reference Case by 2040. Finally, OPEC considers two long-term energy demand scenarios labelled Sensitivities A and B. Sensitivity A envisions substantial gains in energy efficiency with a relatively constant fuel mix, while Sensitivity B adds substantial penetration of renewable energy.

### 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 by different base years of 2016 for the IEA and 2015 for OPEC, and by different regional groupings. Globally, the IEA projects growth of 0.9% per annum through 2040, while OPEC projects annual average growth of 1.0%. This difference is partly due to different baseline population levels, with OPEC using 7.35 billion people in 2015 and the IEA using 7.42 billion in 2016. In 2040, the IEA assumes 9.14 billion and OPEC assumes 9.16 billion people.

For both outlooks, the large bulk of new population comes from developing countries. According to the IEA's assumptions, population growth rates from 2016 to 2040 are highest in Africa (2.2% p.a.), the Middle East (1.4% p.a.), and India (0.9% p.a.). OPEC makes similar assumptions, with population growth rates from its non-OPEC Middle East and Africa grouping at 2.9%, OPEC nations at 2.3%, and India at 1.0%. India is likely to overtake China as the world's most populous country in the 2020s, growing to a population of

more than 1.6 billion by 2040.

Urbanisation is strongest in Africa and non-OECD Asia and continues to accelerate under both projections, with the share of people living in cities growing from 54% in 2016 to 63% in 2040.

In addition to population growth assumptions, urbanisation continues to accelerate under both projections, with the share of people living in cities growing from 54% in 2016 to 63% in 2040. This trend occurs most rapidly in Africa and non-OECD Asia, with China in particular accelerating urbanisation from a rate of 57% in 2016 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 use slightly different assumptions, though both project that annual average global economic growth through 2040 will be 3.4%.

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, though both project that annual average global economic growth through 2040 will be 3.4%.

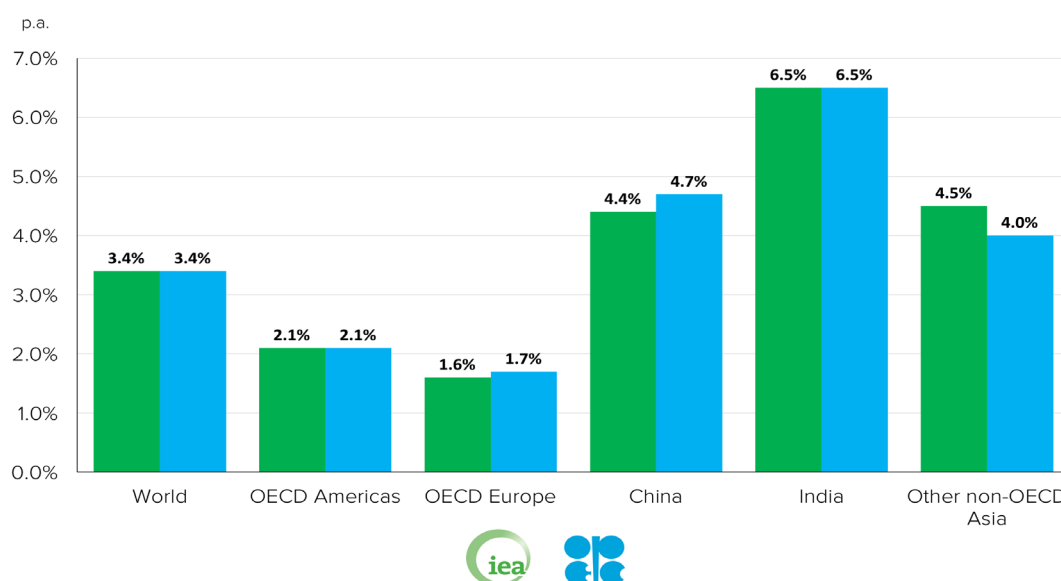
The IEA and OPEC both use 2017 as a base year, and make GDP assumptions in Purchasing Power Parity (PPP) terms<sup>5</sup>. However, the two organisations use different projection years in their outlooks to calculate compound average annual growth. OPEC publishes growth assumptions from 2017-2040, with increments of 2017-2023, 2023-2030, and 2030-2040. The IEA also publishes assumptions from 2017-2040, but with increments of 2017-2025, and 2025-2040.

Long-term economic growth projections of the IEA and OPEC differ most for China and non-OECD Asian nations.

To allow for comparability, we use standardised annual economic growth estimates from 2017-2040 in **Figure 12**. As noted above, comparisons between regions are complicated by different regional groupings and by OPEC's separation of its member countries into a distinct "OPEC" category. Still, some comparisons are instructive. For example, OPEC projects annual average growth in China of 4.7%, compared with 4.4% for the IEA. This trend reverses when examining other non-OECD Asian nations (excluding India), where OPEC's projection of 4.0% is well below the IEA's forecast of 4.5% in its "Southeast Asia" grouping. Projections are similar for other key regions, including OECD Americas, OECD Europe, and India.

<sup>5</sup> 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.

**Figure 12. Annual Average GDP Growth Assumptions for Selected Regions, 2017-2040**



**Figure 12 data sources:** IEA WEO 2018 Table B.2; OPEC WOO2018 Table 1.5.

**Figure 12 notes:** Because the IEA and OPEC's regional classifications differ, we construct the following regional classifications to allow for intercomparison: OECD Americas is North America for IEA, and OECD Americas for OPEC; OECD Europe is the European Union for IEA, and OECD Europe for OPEC, Other non-OECD Asia is Southeast Asia for IEA, and Other non-OECD Asia for OPEC.

### 6.1.4 Oil Prices

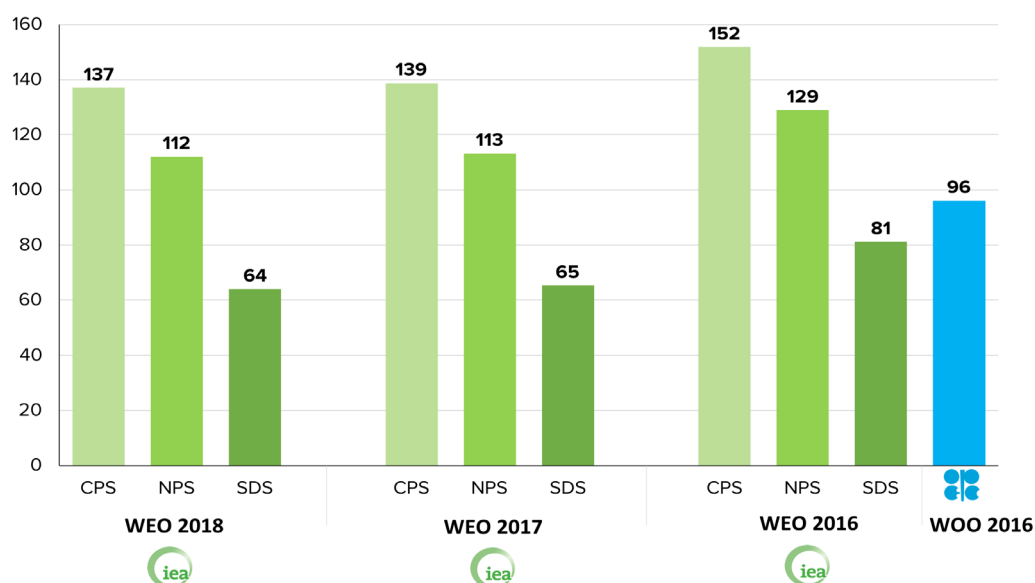
The IEA's long-term price assumptions are based on the equilibrium prices reached in a supply-demand model. OPEC does not publish medium-, or long-term oil price assumptions since 2017.

As stated above, in its WOO2018, OPEC does not publish its medium-, or long-term oil price assumption. The IEA WEO series takes a different approach from its Medium-Term Oil 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, and country-specific policy and risk factors.

As shown in **Figure 13**, the IEA's Current Policies Scenario has the highest oil price assumptions due to higher oil demand, leading to a difference of US\$25/bbl in 2040 relative to the New Policies Scenario. In the IEA's Sustainable Development Scenario, where global oil demand declines substantially, oil prices in 2040 are US\$48/bbl below those found in the New Policies Scenario. The IEA's long-term oil price assumptions are similar to those found in the WEO2017 and in OPEC's WOO2016 (the most recent year for which price assumptions are available), though they are well below the price assumptions included in the IEA's WEO2016 report.

**Figure 13. Long-Term Oil Price Assumptions in 2040**

2017 US\$/bbl



**Figure 13 data sources:** IEA WEO2018 Table B.4, IEA WEO2017 Table 1.4, IEA WEO2016 Table 1.4, OPEC WOO 2016 Figure 1.9.

**Figure 13 notes:** OPEC did not publish medium- or long-term oil price assumptions in WOO2017 or WOO2018.

### 6.1.5 Energy and Environmental Policies

Since the announcement of the 2015 Paris Climate Agreement, policies related to climate change have received substantial attention.

Each year, projections incorporate new policies, enacted or proposed. Since the announcement of the 2015 Paris Climate Agreement, policies related to climate change have received substantial attention. For the most part, these policies have remained in place, with the notable exception of the United States, which announced its intention to withdraw from the agreement and to relax or eliminate a suite of federal climate policies. However, other nations appear committed to pursuing their INDCs and various domestic policies. In WEO2018, the IEA highlights this and other changes in national and subnational policies in major energy consuming nations, laying out key policy assumptions in its Introduction and providing details in Annex B.

This year, OPEC dedicates Chapter 8 of its WOO2018 to policy issues with a focus on climate change policies. It describes policies related to road transportation, electric vehicles, the electricity mix, and more for the United States, the EU, China, India, and other regions.

## 6.2 Long-Term Energy Demand

### 6.2.1. Primary Energy Consumption

Global energy demand continues to grow through 2040, though the rate of growth is slower, absolute levels are similar to previous decades and fossil fuels continue to dominate the primary energy mix.

Despite continued developments in energy markets, the overarching trends in global energy consumption are similar to those described in previous years. 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 78% of the total share in all the scenarios excluding the IEA Sustainable Development Scenario and OPEC's Sensitivity B Analysis, where fossil fuels satisfy 60% and 63% of respective global demand. 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.

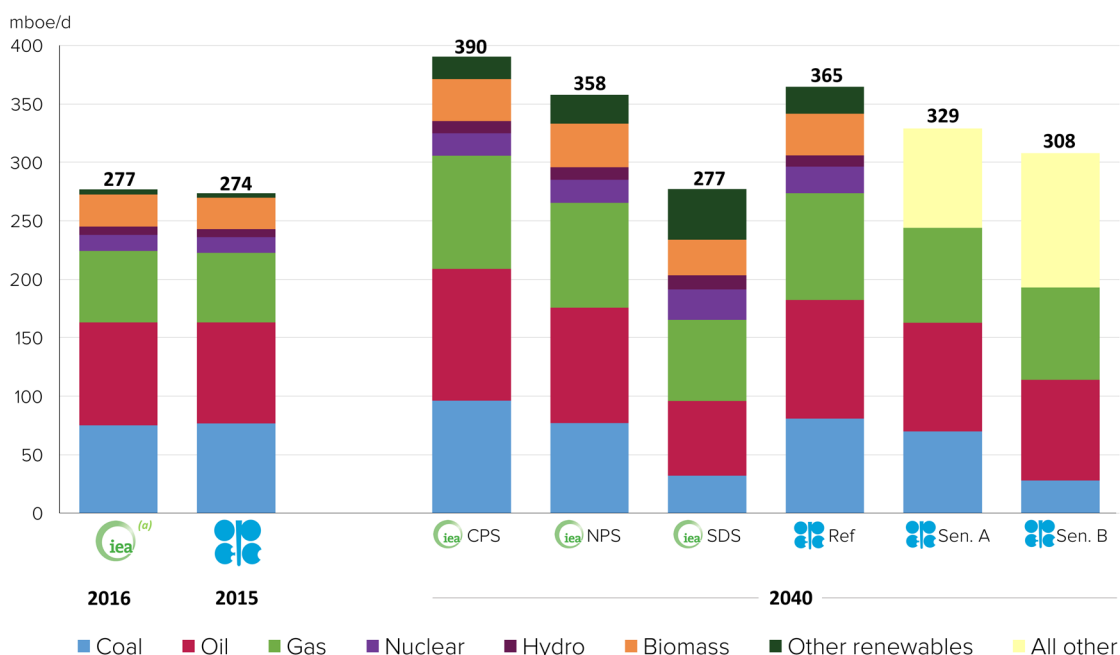
Significant uncertainties remain regarding policy and technological development, which play important roles in shaping the pace of demand growth and the composition of the fuel mix.

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.

Total primary energy demand grows by 1.4%, 1.1%, and 0.002% per annum in the IEA's Current Policies, New Policies, and Sustainable Development Scenarios, respectively. In OPEC's projections, demand grows annually by 1.2%, 0.7%, and 0.5% respectively in the Reference Case, Sensitivity A, and Sensitivity B Analysis. By 2040, global demand is 358 mboed in the IEA's New Policies Scenario, slightly higher than the WEO 2017 projection of 355 mboed in 2040. Under OPEC's Reference Case, global demand in 2040 is 365 mboed, slightly below the WOO2017 projection for 2040 of 372 mboed.

**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, oil, and gas consumption is 15 mboe/d, 11 mboe/d, and 6 mboe/d higher, respectively, than OPEC's Reference Case. 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 coal (-4 mboe/d), oil (-2 mboe/d), and natural gas (-2 mboe/d). The IEA's Sustainable Development Scenario includes substantially slower growth in overall primary energy demand approximating a halt in demand growth over the projection period, with a notable decrease in the share of fossil fuels in the primary energy mix. As the scenarios tighten to meet climate goals, coal is the biggest loser of relative market share. In OPEC's Sensitivity A, more robust energy efficiency measures reduce the rate of demand growth, while the share of fossil fuels in the energy mix is roughly equal to the Reference Case. In Sensitivity B, where both energy efficiency and renewables deployment increase rapidly, overall energy demand grows slower still, with a larger share of primary energy demand met by non-fossil fuels.

**Figure 14. World Primary Energy in 2015/2016 and Outlook for 2040**



**Figure 14 data sources:** IEA WEO 2018, Annex Tables; OPEC WOO2018, Table 2.2 and 9.10.

**Figure 14 notes:**

(a) IEA primary energy is converted from mtoe per year to mboe/d by multiplying by 0.0202 mboed/mtoe. OPEC Sensitivity Scenarios A and B do not provide fuel-specific data for non-fossil fuels.

While oil maintains its position as the leading fuel, natural gas grows at the fastest pace in all long-term scenarios.

**Figure 15** presents the share of each fuel in the global energy mix in 2015 (for OPEC) and 2016 (for the IEA), along with projections for 2040. In the IEA's Current Policies Scenarios and New Policies Scenario, along with all of OPEC's scenarios shown below, oil is expected to maintain its position as the leading fuel in 2040, though its share shrinks

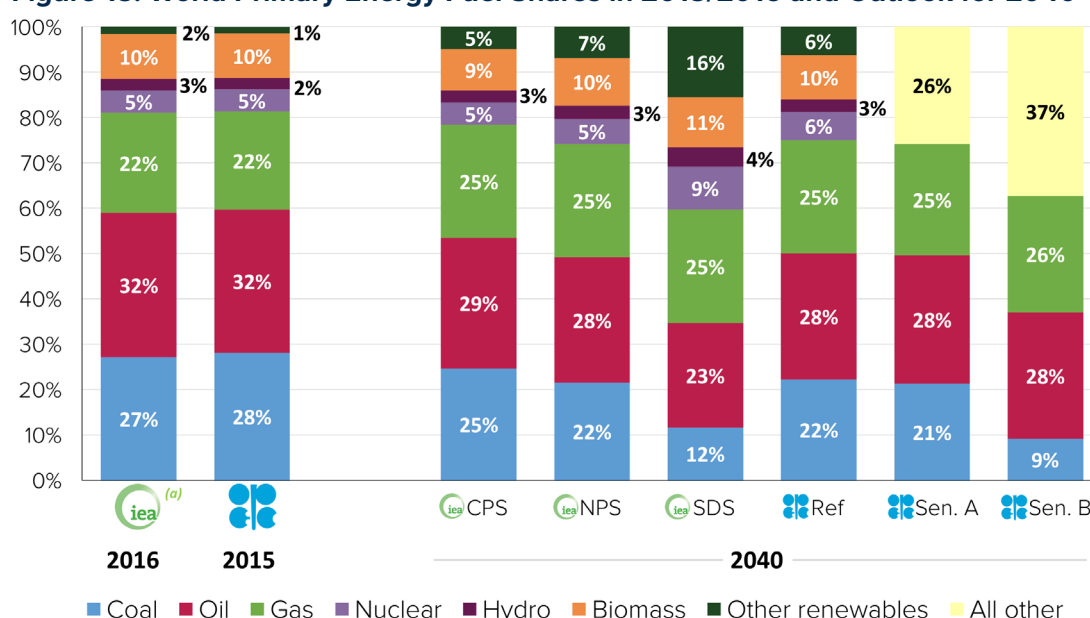


Renewables' shares lie far apart, ranging from 17% to 31% across scenarios to 2040.

from 32% in the base year to 29% in the IEA Current Policies Scenario and 28% in the IEA New Policies Scenario and all three of OPEC's Scenarios. Coal's share of the primary energy mix declines under all scenarios, from 27% (IEA) and 28% (OPEC) in the base year to 25% in the IEA Current Policies Scenario, and to 22% in both the IEA New Policy Scenario and OPEC's Reference Case. In the IEA Sustainable Development Scenario and OPEC's Sensitivity B, coal's share declines to 12% and 9%, respectively, due to the different underlying assumptions as highlighted above.

Natural gas is set to grow the fastest among fossil fuels in absolute and percentage terms under all scenarios, including the IEA Sustainable Development Scenario. Although it does not attain the status of leading fuel source (as it did in some 2016 scenarios), it overtakes coal and reaches 25% of global primary energy demand in all scenarios other than OPEC's Sensitivity B, where it reaches 26%. The share of renewables, which is currently dominated by biomass, is projected to increase in all scenarios from 14% in the base year to 17% under the IEA's Current Policies Scenario, 19% in OPEC's Reference Case, 20% under the IEA's New Policies Scenario, and 31% under the IEA's Sustainable Development Scenario. Virtually all of this growth comes from renewable electricity such as wind, solar, and hydro. OPEC's Sensitivity scenarios do not provide fuel-specific data for non-fossil fuels.

**Figure 15. World Primary Energy Fuel Shares in 2015/2016 and Outlook for 2040**



**Figure 15 data sources:** IEA WEO 2018, Annex Tables; OPEC WOO2018, Table 2.2 and 9.10.

**Figure 15 notes:**

<sup>(a)</sup> IEA primary energy is converted from mtoe per year to mboe/d by multiplying by 0.0202 mboe/d/mtoe. Sums in the data callouts may not total due to rounding. OPEC Sensitivity Scenarios A and B do not provide fuel-specific data for non-fossil fuels.

## 6.2.2 Liquids Demand

Comparing liquids demand across long-term outlooks has become somewhat easier in 2018, as the IEA has begun publishing additional biofuels data.

Comparing liquids demand across long-term outlooks has become somewhat easier in 2018, as the IEA has begun publishing additional biofuels data. However, differences in regional classifications continue to require adjustments.

As in previous years, 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 short-, and medium-term outlooks (but not in 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.<sup>6</sup> We also must convert IEA biofuels data from energy equivalent units to volumetric units for comparison with OPEC.<sup>7</sup>

Third, 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 WOO2018 leads to a substantially larger number than that reported under the “bunkers” category in the WEO2018. 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.

Fourth, 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 WEO2018 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 three central cases. Although the share of oil in the world primary energy mix is expected to decrease, the level of oil demand still enjoys robust growth over the projection period. In IEA's New Policies Scenario and OPEC's Reference Case, world liquids demand reaches 112.7 mb/d and 111.7 mb/d, respectively, by 2040. In the IEA's Current Policies Scenario, 2040 world liquids demand grows to 125.2 mb/d. In terms of average annual growth rates, OPEC's Reference Case projects liquids demand growth of 0.6 mb/d, equal to the IEA's New Policies Scenario projection of 0.6 mb/d, but well below the IEA's Current Policies Scenario forecast of 1.2 mb/d per year.

Although the share of oil in the world primary energy mix is expected to decrease, the level of oil demand still enjoys robust growth.

<sup>6</sup> These biofuels projections are aggregated from IEA WEO 2018 Annex A Tables.

<sup>7</sup> The IEA has provided, via internal communication, biofuels demand data by OECD status, in energy-equivalent units (mboed). We convert from these energy-equivalents to physical units (mb/d) using a factor of 1.355467. This factor is derived from published 2016 biofuels demand data of 1.7 mboed (see WEO2018 Annex Tables) and 2.4 mb/d (based on IEA Oil2018 Tables 5 and 5a).



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

	2040			Growth p.a. (2017-2040)			Difference (IEA-OPEC)	
	IEA NPS <sup>(a)</sup>	IEA CPS	OPEC Ref.	IEA NPS	IEA CPS	OPEC Ref.	NPS	CPS
<b>Total OECD</b>	<b>35.7</b>	<b>39.7</b>	<b>38.7</b>	<b>-0.33</b>	<b>-0.16</b>	<b>-0.36</b>	<b>0.03</b>	<b>0.20</b>
OECD Americas	21.9	23.7	20.9	-0.1	0.0	-0.2	0.1	0.2
OECD Europe	8.5	10.3	11.6	-0.2	-0.1	-0.1	-0.1	0.0
Asia Oceania	5.3	5.7	6.2	-0.1	-0.1	-0.1	0.0	0.0
<b>Total Non-OECD</b>	<b>64.9</b>	<b>72.4</b>	<b>73.0</b>	<b>0.7</b>	<b>1.1</b>	<b>1.0</b>	<b>-0.3</b>	<b>0.1</b>
Asia	35.5	40.2	40.7	0.5	0.7	0.6	-0.1	0.1
China	16.4	19.2	17.4	0.2	0.3	0.2	0.0	0.1
India	9.3	10.2	10.4	0.2	0.2	0.2	0.0	0.0
Other non-OECD Asia	9.7	10.8	12.9	0.1	0.2	0.2	-0.1	0.0
Middle East & Africa	7.6	8.2	7.3	0.1	0.1	0.1	0.0	0.0
Latin America	16.9	18.6	6.3	0.2	0.3	0.1	0.1	0.2
Europe & Eurasia	5.3	5.8	6.4	0.0	0.0	0.0	0.0	0.0
Bunkers <sup>(b)</sup>	11.4	13.2	n/a	0.1	0.2	n/a	n/a	n/a
<b>World</b>	<b>112.7</b>	<b>125.3</b>	<b>111.7</b>	<b>0.6</b>	<b>1.2</b>	<b>0.6</b>	<b>0.0</b>	<b>0.6</b>

**Table 12 data sources:** IEA WEO 2018, Table 3.2, Annex A Tables, and internal communication; OPEC WOO2018, Table 34.6.

**Table 12 notes:** Regional estimates exclude OPEC member nations. IEA 2017 data are preliminary. Numbers rounded to nearest significant digit. IEA and OPEC regional classifications differ. IEA oil demand figures that align with OPEC's regional classification system were provided via internal communication.

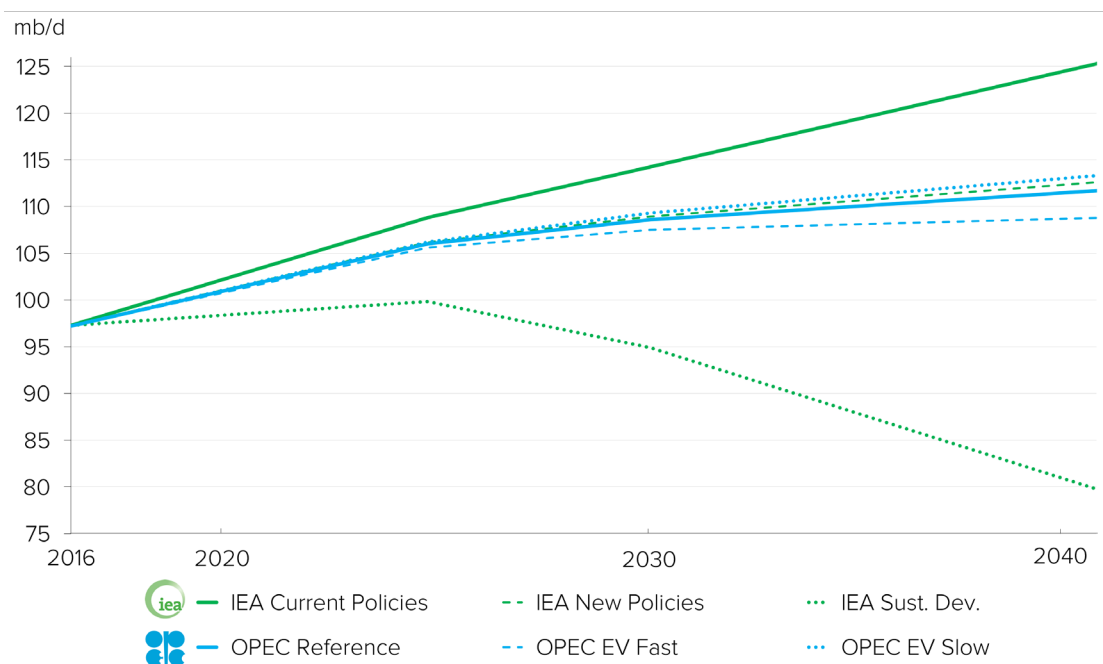
<sup>(a)</sup> Biofuels from IEA WEO 2018 (provided via internal communication) are added to IEA regional oil demand data for comparability with OPEC estimates.

<sup>(b)</sup> Global bunkers in the IEA WEO include international marine bunkers and aviation fuels. In the OPEC WOO, all bunkers are included within regional demand.

The difference between the highest and lowest scenario projections for 2040 world liquids demand is 45.5 mb/d, well above the range of 42 mb/d found last year.

The difference between the highest (IEA Current Policies Scenario) and lowest (IEA Sustainable Development Scenario) projections for 2040 world liquids demand is 45.5 mb/d, well above the range of 42 mb/d found in the WEO2017. **Figure 16** also suggests that demand growth will slow in the coming decades, but to varying degrees. In the IEA's Current Policies Scenario, demand growth slows little after 2025, while a slowing rate of growth is more apparent in the IEA's New Policies Scenario and OPEC's Reference Case. Under the IEA's Sustainable Development Case, there is little growth through 2025, followed by substantial declines in absolute levels of demand through 2040. Different rates of electric vehicle deployment, highlighted in OPEC's two EV sensitivity cases, result in relatively modest changes in long-term liquids demand relative to the Reference Case.

**Figure 16. World Liquids Demand Projections in Various Scenarios**

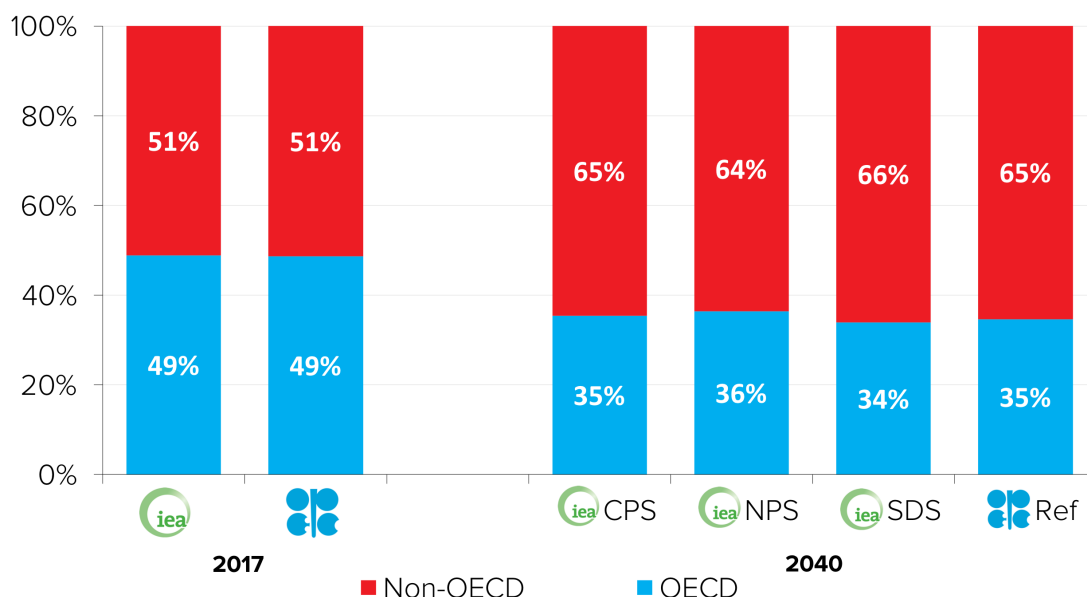


**Figure 16 data sources:** IEA WEO 2018, Annex A Tables, internal communication; OPEC WOO 2018, Box 3.1, Figure 3.

The IEA and OPEC generally agree that OECD nations will experience a decline in oil demand, yet this decrease is more than offset by robust demand growth in non-OECD nations.

Projections for the share of liquids demand from aggregate OECD and non-OECD groups are remarkably similar across all scenarios. All agree that OECD nations will experience a decline in oil demand in absolute and relative terms, yet this decrease is expected to be more than offset by robust demand growth in non-OECD nations, with the exception of the IEA's Sustainable Development Scenario. The centre of demand growth continues to shift to developing countries, with non-OECD nations' share of global liquids demand increasing from 51% in 2017 to between 64% and 66% by 2040 (**Figure 17**).

**Figure 17. OECD and Non-OECD Shares of Liquids Demand**



**Figure 17 data sources:** IEA WEO 2018, Table 3.2, Annex A Tables, and internal communication; OPEC WOO 2018, Table 4.6.

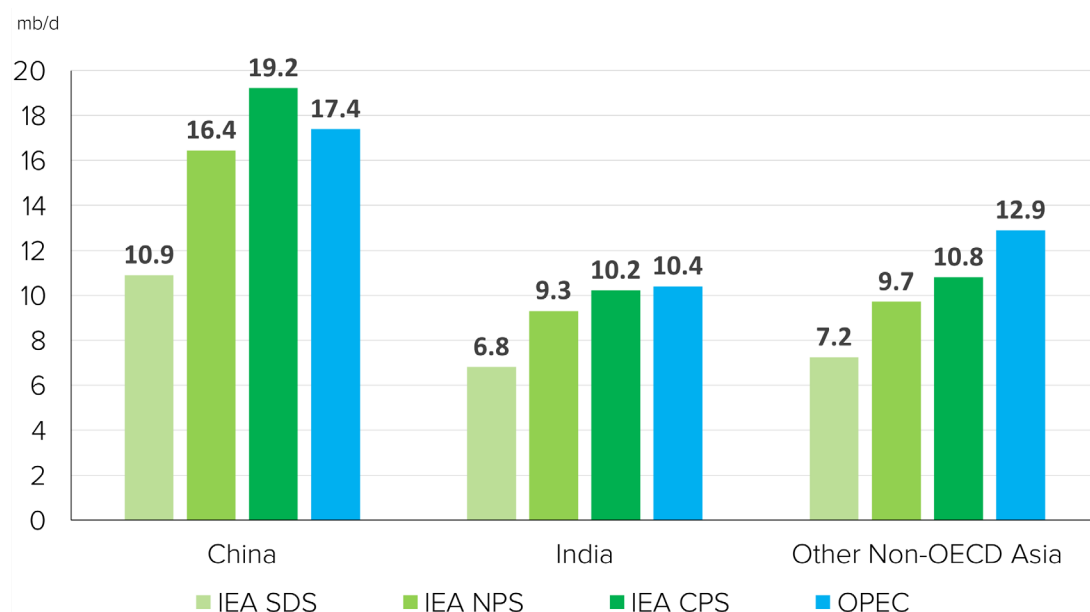
**Figure 17 notes:** IEA 2017 data are preliminary.

<sup>(a)</sup> The "bunkers" group in the IEA's WEO report is excluded from calculation for OECD and non-OECD oil demand shares.

<sup>(b)</sup> Biofuels from IEA WEO 2018 (provided via internal communication) are added to IEA regional oil demand data for comparability with OPEC estimates.

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 that non-OECD Asia will lead consumption growth over the forecast period. **Figure 17(a)** shows projected oil demand for China, India, and other non-OECD Asia in 2040. OPEC's projections appear substantially more bullish than the IEA's, even under the Current Policies Scenario. However, direct comparisons between regions are challenging, because OPEC includes bunker fuels within these regional estimates, while the IEA does not.

**Figure 17(a). Non-OECD Asia Oil Demand in 2040**



**Figure 17(a) data sources:** IEA WEO 2018, Annex A Tables and internal communication; OPEC WOO 2018, Tables 3.2.

**Figure 17(a) notes:** Regional demand projections from OPEC WOO 2018 include bunker fuels, while the IEA does not. Biofuels from IEA WEO 2018 (provided via internal communication) are added to IEA regional oil demand data for comparability with OPEC estimates.

Both the IEA and OPEC agree that the transportation and petrochemical sectors remain the largest oil consumers and make up the majority of demand growth.

Perspectives on sectoral trends are broadly consistent between the IEA and OPEC. Transportation and the petrochemicals industry expect to remain the largest oil consumers and contribute to 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 petrochemicals become larger.

## 6.3 Long-Term Energy Supply

### 6.3.1 Mathematical Models

The IEA and OPEC use different long-term supply methodologies.

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<sup>8</sup>. In addition, unanticipated technological advancements may substantially affect the economic viability of known resources.

Like the previous years, the WOO2018 includes a detailed assessment of active tight oil plays in the United States (Section 4.3.1). And similar to previous years, it includes sensitivity cases for higher or lower U.S. tight oil supply (Box 4.1). The WOO2018 also updates its estimates for tight oil supplies outside of the U.S. (Section 4.3.2).

The IEA employs a bottom-up modelling approach for its long-term oil supply projection. Unlike in the IEA Medium-Term Oil 2018, however, the IEA largely 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 most countries 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.

However, the IEA in 2016 began estimating U.S. tight oil production on a play-by-play basis, and in the WEO2018 estimates production from 23 plays or sub-plays. These estimates endogenously incorporate a certain level of learning, which affects production costs over time. WEO2018 also dedicates a full chapter (Chapter 11) to the topic of lifecycle environmental attributes of oil production from different regions, including the energy intensity of different types of oil production (e.g., onshore, shallow water, deepwater, etc.), along with data on natural gas flaring and venting, refining, and crude/product transport.

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 Oil2017. In the long-term WEO model, however, supplies from OPEC Member Countries are projected using the same methodology used for non-OPEC nations.

### 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. The IEA's New Policies Scenario and OPEC's Reference Case forecast similar global supply in 2040 of 112.6 mb/d and 111.9 mb/d, respectively, while the IEA's Current Policies Scenario projects 125.3 mb/d. These projections are higher than those made last year by both organisations, when projections for 2040 were 109.0 mb/d under the IEA's New Policies Scenario, 111.3 mb/d under OPEC's Reference Case and 122.0 mb/d under the IEA's Current Policies Scenario. On an annualised basis, the IEA's Current Policies Scenario grows at 1.2 mb/d while the New Policies Scenario and OPEC's Reference Case each grow by 0.6 mb/d.

Other differences emerge regarding regional supplies when biofuels are excluded. First, the IEA's projections for supplies from the OECD Americas under the New Policies and Current Policies Scenarios are respectively 1.3 mb/d and 3.6 mb/d higher than OPEC's Reference Case in 2040. This is particularly interesting given OPEC's stronger projections for OECD Americas supplies in the medium term. The IEA New Policies Scenario shows that total OPEC supplies in 2040 are 3.0 mb/d lower than OPEC's projection, while the IEA Current Policies Scenario projects OPEC supplies in 2040 to be 1.2 mb/d above OPEC's estimate. These differences are due to substantial differences in both OPEC crude and OPEC NGLs/unconventionals.

The IEA's New Policies Scenario and OPEC's Reference Case forecast similar global supply in 2040 of 112.6 mb/d and 111.9 mb/d, respectively, higher than last year.

The IEA's projections to 2040 for OECD Americas supplies are higher than those of OPEC under the main scenarios, reversing differences in medium-term assessments.

<sup>8</sup> 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>.

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

	2040			Growth p.a. (2017 - 2040)			Difference (IEA-OPEC)	
	IEA NPS	IEA CPS	OPEC Ref. <sup>(a)</sup>	IEA NPS	IEA CPS	OPEC Ref.	IEA NPS	IEA CPS
<b>Total OECD</b>	<b>29.0</b>	<b>31.6</b>	<b>27.2</b>	<b>0.2</b>	<b>0.3</b>	<b>0.1</b>	<b>0.1</b>	<b>0.2</b>
OECD Americas	25.3	27.6	24.0	0.21	0.30	0.15	0.05	0.15
OECD Europe	2.6	2.7	2.8	0.0	0.0	0.0	0.0	0.0
Asia Oceania	1.1	1.2	0.4	0.0	0.0	0.0	0.0	0.0
<b>Total Non-OECD</b>	<b>74.4</b>	<b>85.6</b>	<b>81.4</b>	<b>0.2</b>	<b>0.7</b>	<b>0.5</b>	<b>-0.2</b>	<b>0.2</b>
Asia	5.8	6.9	5.9	-0.07	-0.02	-0.06	0.00	0.04
China	55.8	64.0	8.3	0.38	0.72	0.05	0.33	0.67
Other non-OECD Asia	13.8	14.8	14.5	0.09	0.14	0.03	0.07	0.11
Processing Gains	2.9	3.3	3.0	0.0	0.0	0.0	0.0	0.0
World Biofuels	6.3	4.8	3.6	0.2	0.1	0.0	0.2	0.1
<b>Total Non-OPEC</b>	<b>66.3</b>	<b>72.3</b>	<b>59.0</b>	<b>0.3</b>	<b>0.6</b>	<b>0.2</b>	<b>0.2</b>	<b>0.4</b>
<b>Total OPEC</b>	<b>46.3</b>	<b>53.0</b>	<b>49.3</b>	<b>0.28</b>	<b>0.56</b>	<b>0.43</b>	<b>-0.15</b>	<b>0.12</b>
OPEC crude <sup>(b)</sup>	35.9	41.1	39.9	0.1	0.3	0.3	-0.2	0.0
OPEC NGLs + unconventional	10.5	11.9	9.4	0.15	0.21	0.13	0.02	0.07
<b>World Liquids Supply</b>	<b>112.6</b>	<b>125.3</b>	<b>111.9</b>	<b>0.6</b>	<b>1.2</b>	<b>0.6</b>	<b>-0.02</b>	<b>0.51</b>

**Table 13 data sources:** IEA WEO 2018, Annex A Tables, with biofuels data based on biofuels demand projections provided via internal communication; OPEC WOO2018, Table 4.6 and 4.10.

**Table 13 notes:** Regional groupings exclude OPEC member nations. IEA 2017 data are preliminary. Numbers rounded to nearest significant digit.

<sup>(a)</sup> The IEA WEO does not include regional biofuels supply. Regional biofuels supply (OPEC WOO2018 Table 4.10) is therefore subtracted from each of OPEC's regional total liquids supply (OPEC WOO2018, Table 4.6) and only world biofuels supply is provided.

<sup>(b)</sup> The IEA WEO classifies Venezuela extra-heavy oil as "OPEC unconventional," while OPEC classifies it as "OPEC crude." We have adjusted IEA data to match OPEC's definition. As a result, the "OPEC crude" category includes Venezuelan extra heavy oil.

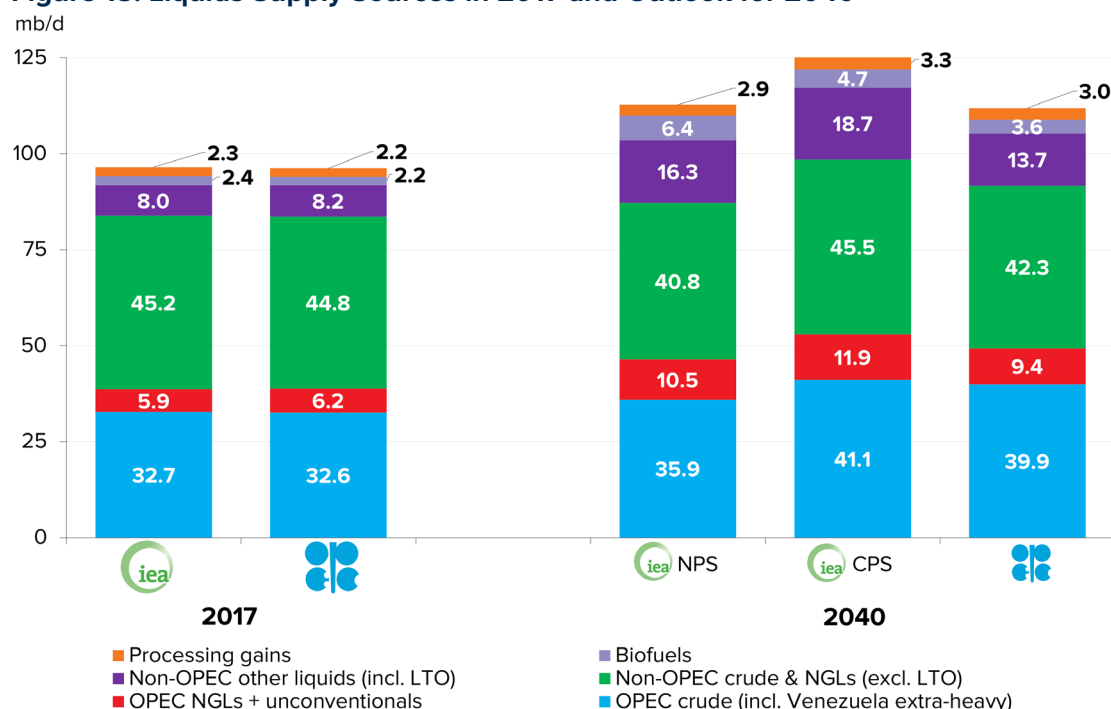
In contrast to OPEC, the IEA sees tight oil peaking at higher levels and later in the long-term projection period of main scenarios.

OPEC and the IEA differ somewhat in their projections for global unconventional supplies. Both organizations project growth in tight oil supplies, with OPEC estimating global tight crude supplies reaching a peak of 10.2 mb/d in 2030 before declining to 8.5 mb/d in 2040. The IEA shows tight crude peaking at higher levels: 11 mb/d in the New Policies Scenario and 12.1 mb/d in the Current Policies Scenario in 2040. Under the Sustainable Development Scenario, global tight oil production reaches 9.1 mb/d in 2025 before declining to 7.3 mb/d in 2040. In each of these scenarios, tight oil production is dominated by the U.S.

OPEC's share of global supply rises under all scenarios ranging from 41% to 44% in main IEA and OPEC scenarios to 2040.

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 liquids supply both from OPEC and non-OPEC sources, with the majority of growth coming from non-crude liquids such as tight oil, NGLs, and unconventional. **Figure 19** shows OPEC's share of global supply rising under all scenarios, from the current level of around 40% to roughly 41% in the IEA's New Policies Scenario, 42% in the Current Policies Scenario, and 44% in OPEC's Reference Case. These shares are equal to those projected in 2017.

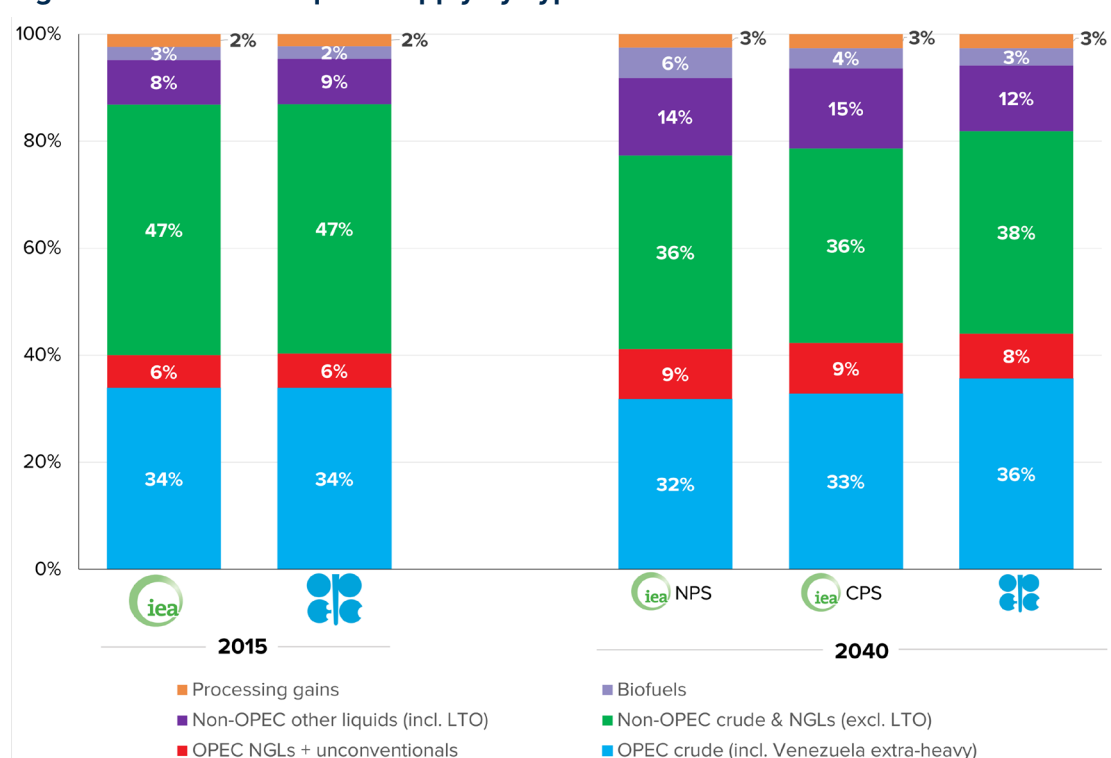
**Figure 18. Liquids Supply Sources in 2017 and Outlook for 2040**



**Figure 18 data sources:** Internal communication with IEA; IEA WEO2018 Tables 3.3 and 3.4; OPEC WOO2018, Table 4.6.

**Figure 18 notes:** IEA 2017 data are preliminary. The IEA WEO classifies Venezuela extra-heavy oil as “OPEC unconventional,” while OPEC classifies it as “OPEC crude.” We have adjusted IEA data to match OPEC’s definition. As a result, the “OPEC crude” category includes Venezuelan extra heavy oil.

**Figure 19. Shares of Liquids Supply by Types in 2017 and Outlook for 2040**



**Figure 19 data sources:** See Figure 18.

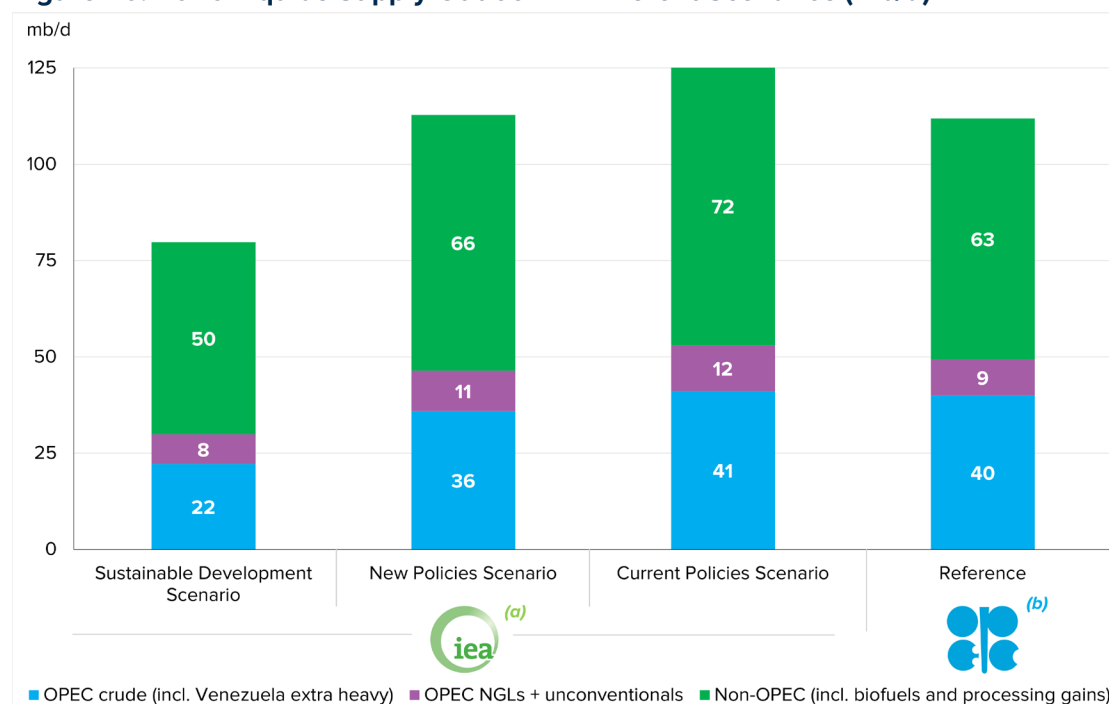
**Figure 19 notes:** Sums in the data callouts may not total due to rounding. IEA 2017 data are preliminary.

The IEA’s Sustainable Development Scenario shows far lower liquids supplies than any of the other three scenarios examined.

Finally, **Figure 20** presents a comparison of world liquids supply forecasts from the three WEO2018 scenarios and the WOO2018 Reference Case. This figure highlights how dramatically world supply outlooks can be affected by different scenario assumptions. The IEA’s Sustainable Development Scenario demonstrates far lower liquids supplies than any

of the other three scenarios examined here, at 29% below the IEA's New Policies Scenario and the OPEC Reference Case, and 36% below the IEA's Current Policies Scenario. In the Sustainable Development Scenario, OPEC's share of global liquids supplies falls to 37%.

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



**Figure 20 data sources:** See Figure 18.

**Figure 20 notes:**

<sup>(a)</sup> The IEA WEO classifies Venezuela extra-heavy oil as “OPEC unconventional,” while OPEC classifies it as “OPEC crude.”

<sup>(b)</sup> We have adjusted IEA data to match OPEC’s definition. As a result, the “OPEC crude” category includes Venezuelan extra heavy oil.



## 7. Final Remarks

Oil market volatility increases due to a confluence of variables that are difficult to predict slowing down investment in conventional supply.

2018 witnessed substantial volatility in oil prices, with Brent spot prices rising from the mid-\$60/bbl range in the early part of the year to highs near \$85/bbl in early October, followed by a sharp drop to the low-\$50/bbl range by the end of 2018.

This volatility is attributable to a range of factors, including uncertain prospects for global economic growth in the context of international trade disputes, the extension of coordinated adjustments to production from OPEC members in collaboration with several non-OPEC countries, unexpectedly rapid growth in U.S. tight oil production, the effects of U.S. sanctions on Iranian oil exports, and more. As always, substantial uncertainties will continue to weigh on oil markets in the years to come.

Looking to 2019, markets will continue to be influenced by the decisions taken by OPEC and non-OPEC nations with regard to the potential extension of production adjustments. Other key areas of interest will include the growth rate of U.S. tight oil supplies, global economic growth rates, and the extent of U.S. sanctions on Iranian oil exports.

As major emerging economies mature, and environmental efforts come into effect, global oil demand growth rates will likely decline.

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 known, oil in 2040 – along with other fossil fuels – is currently on a path to maintain a central position in the global fuel mix. However, as major emerging economies mature, new and more efficient technologies are deployed, and environmental efforts announced under the Paris Agreement come into effect, global oil demand growth rates will likely be tempered.

OPEC member countries will likely play an increasing role in global oil supply as high cost non-OPEC supplies remain under pressure.

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 conventional projects and support demand growth. As in 2017, non-OPEC supply from unconventional plays has grown strongly, driven by U.S. tight oil. The industry has made efficiency gains to cope with lower oil prices, though infrastructure constraints in certain key producing regions have the potential to slow output growth. In addition, it is unclear to what extent declining investment in higher cost conventional 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 market volatility, moderate growth in prices, and shifting consumer preferences.

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 Ninth 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:

- Advancing efforts to standardise regional classifications across long-term outlooks;
- Advancing efforts to increase comparability of medium-, and long-term oil price assumptions;



- Ongoing analysis of differences in historical data, particularly in non-OECD demand, as well as FSU and OPEC NGLs/unconventionals supply;
- 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	New Policies	Current Policies	Sustainable Development
<b>Global Economic Growth Rate (2017-2040)</b>	3.4%	3.4%	same as New Policies	same as New Policies
<b>Population, Billion (2016-2050)</b>	2016: 7.5; 2040: 9.2	2017: 7.5; 2040: 9.2	same as New Policies	same as New Policies
<b>Oil Price Assumptions (in 2017 \$)</b>	Not specified	2025: \$88/bbl; 2040: \$112/bbl	2025: \$101/bbl; 2040: \$137/bbl	2025: \$74/bbl; 2040: \$64/bbl
<b>Oil Investment (2018-2040 in 2017 \$)</b>	Upstream (oil only): \$8.3 trillion; Midstream and downstream (oil only): \$2.5 trillion	Upstream: \$15.7 trillion; Midstream and downstream: \$5.0 trillion.	Upstream: \$19.5 trillion; Midstream and downstream: \$5.8 trillion.	Upstream: \$9.8 trillion; Midstream and downstream: \$3.6 trillion.
<b>Energy and Environmental Policies</b>	Primarily considers policies that have been enacted, but attempts to reflect policy developments as they emerge over time	Considers both policies in place and announced intentions.	Only policies enacted by mid-2018	Universal energy access by 2030; fully aligned with Paris Agreement's climate targets; dramatically reduces air pollution from energy.
<b>Carbon Prices (per tonne in 2017 \$)</b>	Not specified	2040: \$39 in Canada; \$20 in Chile; \$36 in China; \$43 in EU; \$44 in Korea; \$24 in S. Africa	2040: \$39 in Canada; \$5 in Chile; \$31 in China; \$38 in EU; \$39 in Korea	2040: \$140 in Advanced Economies; \$125 in select developing economies

## Annex 2: Long-term Outlook Results

	OPEC		IEA			
	Base Year	2040 Ref. Case	Base Year	2040 Scenario		
				New Policies	Current Policies	Sustainable Development
<b>Global Energy Demand (mboe/d)<sup>(a)</sup> (2015/2017-2040)</b>	2015: 273.7	364.7	2016: 276.9	357.8	390.4	277
<b>Global Liquids Demand (mb/d) (2017-2040)</b>	97.2	111.7	97.3	112.7	125.3	79.8
<b>Non-OPEC Supply (mb/d)<sup>(b)</sup> (2017-2040)</b>	57.5	62.6	58	66.3	72.3	59
<b>OPEC Crude (mb/d)<sup>(c)</sup> (2017-2040)</b>	32.6	39.9	32.7	35.9	41.1	22.2
<b>OPEC NGLs and Other Liquids (mb/d) (2017-2040)</b>	6.2	9.4	6.9	10.5	11.9	7.7

### Annex 2 notes:

<sup>(a)</sup> IEA primary energy is converted from mtoe per year to mboe/d by multiplying by a factor of 0.0202 mboed/mtoe.

<sup>(b)</sup> Include biofuels and processing gains.

<sup>(c)</sup> OPEC crude includes Venezuela extra-heavy oil.



# NINTH IEA IEF OPEC SYMPOSIUM ON ENERGY OUTLOOKS

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