IEF RFF Outlooks Comparison Report

RESOURCES *for the* FUTURE

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A report by the International Energy Forum and Resources for the Future

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About the International Energy Forum

The International Energy Forum is the leading global facilitator of dialogue between sovereign energy market participants. It incorporates members of International Energy Agency and the Organization of the Petroleum Exporting Countries, and also key players including China, India, Russia, and South Africa. The forum's biennial ministerial meetings are the world's largest gathering of energy ministers, where discussions focus on global energy security and the transition towards a sustainable and inclusive energy future. The forum has a permanent secretariat of international staff based in the Diplomatic Quarter of Riyadh, Saudi Arabia.

About Resources for the Future

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement.

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Acronyms and Abbreviations

APS	Announced Pledges Scenario (IEA)
APT	Accelerated Policy and Technology Case (OPEC)
ATS	Advanced Technologies Scenario (IEEJ)
RCS	Reference Case Scenario (GECF)
ETS	Energy Transition Scenario (GECF)
HS	Hydrogen Scenario (GECF)
bbl	Barrel
CCE	Circular Carbon Economy (G20)
CPS	Current Policies Scenario (IEA)
CTLs	Coal to Liquids
EIA	U.S. Energy Information Administration
DRS	Delayed Recovery Scenario (IEA)
EOR	Enhanced Oil Recovery
FSU	Former Soviet Union
GDP	Gross Domestic Product
GECF	Gas Exporting Countries Forum
GHG	Greenhouse gas
GTLs	Gas to Liquids
IEA	International Energy Agency
IEEJ	Institute of Energy Economics Japan
IEF	International Energy Forum
IMF	International Monetary Fund
IRENA	International Renewable Energy Agency
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
NDC	Nationally Determined Contribution (UN)
NGLs	Natural Gas Liquids
NPV	Net Present Value
NZE2050	Net Zero Emissions by 2050 Scenario (IEA)
OECD	Organization 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
STEPS	Stated Energy Policy Scenario (IEA)
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 Key Points

Comparability Beyond Compare

1. The impact of energy outlooks on policy and investment decisions and public views of energy trends and transitions continues to grow steadily since the UN Paris Agreement and Sustainable Development Goals were adopted in 2015 to achieve shared goals.
2. Increasingly diverse outlook findings enrich the energy dialogue but also warrant greater scrutiny and alignment of methods, categories, baseline data, and time frames to improve comparability and deepen understanding.
3. Though considerable advances have been made by both IEA and OPEC, IEF Ministers should ensure their Agencies accelerate work on aligning conventions and techniques that outlooks are based on and make all data public.
4. Peer review will bolster the global energy dialogue and improve policy and investment decisions to address challenges regarding energy security, market stability and just and orderly transitions as called for by the G20 Leaders gathered under the Italian Presidency of Italy in Rome.

1.2 Long-Term Outlooks Highlights

Widening Gaps and Unprecedented Changes

1. IEA's SDS, NZE, and APS, envision a world in which demand for all fossil fuels, including oil and other liquids, declines considerably in the coming decades. Many of these scenarios, including IEA's SDS and NZE, as well as Equinor Rebalance, project that global energy demand in 2050 will be below 2020 levels, reflecting a major change in the historical relationship between economic growth and energy demand growth.
2. The annually growing "gap" in liquid demand scenarios between OPEC's High GDP Growth Case and IEA's NZE Scenario rises to 84.6 mb/d in 2045 reflecting growing uncertainty in respect of security of demand. When other scenarios are considered, the "gap" reaches about 105 mb/d between the highest scenario (EIA Reference) and lowest scenario (IRENA 1.5°C) by 2050.

Global Energy Mix

Oil

3. In IEA and OPEC main scenarios, oil maintains its position as the leading primary energy source globally while IEA NZE is the only scenario where natural gas takes over this role. In OPEC's Reference Case oil slightly decreases from 30 percent in their 2020 baseline to 28 percent in 2045, while IEA STEPS reports a dip from 29 percent to 27 percent in the same period.

Gas

4. In 2050, natural gas demand under IEA's STEPS scenario reaches 4192 mtoe while the OPEC Reference scenario projects 4267 mtoe in 2045, 26 percent and 28 percent over 2020 demand of 3323 mtoe, respectively. The projections from GECF RCS, IRENA Planned, and IEEJ Reference sit higher than these baseline policy scenarios, growing to reach 4810 mtoe, 4845 mtoe, and 4855

mtoe in 2050, respectively. Equinor's Reform has the lowest projection of mid-century natural gas demand of the baseline policy scenarios with 3840 mtoe.

5. In the more ambitious and "Paris-aligned scenarios", natural gas demand flattens or declines in the coming decades. In IEA's APS, natural gas demand remains nearly level with 2020, sitting at 3182 mtoe in 2050. GECF ETS follows a similar trend before natural gas demand begins to dip beyond 2040. IEA SDS and IRENA 1.5°C scenarios fall significantly to 2035 mtoe and 1890 mtoe in 2050, but IEA NZE sees the largest decrease in natural gas demand to only 1450 mtoe.

Nuclear

6. From 702 mtoe in 2020, nuclear demand under IEA's STEPS scenario gradually reaches 967 mtoe in 2050, while OPEC's Reference scenario projects 1095 mtoe in 2045. The Equinor Reform and GECF RCS scenarios fall between these two projections, reaching 998 and 1030 mtoe by 2050, respectively.

7. Nuclear demand grows much more rapidly under climate and technology scenarios from these outlooks. In IEA's APS, nuclear demand increases to 1158 mtoe in 2050, a nearly 20% increase over the STEPS projection. The IEEJ ATS has a similarly large rise to 1399 mtoe in 2050. The IEA NZE scenario sees the most dramatic increase of nuclear demand in the period, to 1448 mtoe, nearly a 50 percent increase compared to IEA STEPS. Equinor's Rebalance lands just below IEA NZE with 1311 mtoe in nuclear energy demand by the half century. GECF ETS and IRENA 1.5-S lie slightly lower than other climate scenarios, reaching 889 and 928 mtoe in 2050.

Renewables

8. For renewables that include solar, wind, hydropower, biomass, and other renewables, demand goes from 1636 mtoe in 2020 to reach 4598 under IEA's STEPS scenario in 2050, while OPEC's Reference scenario projects 4188 mtoe in 2045. The IRENA Planned scenario projects 4208 mtoe by 2050. The GECF RCS and Equinor Reform scenarios land higher, reaching 4911 and 4978 mtoe in 2050, respectively.

9. The IRENA 1.5°C scenario projects the highest renewables demand, at 10686 mtoe by 2050, more than a six-fold increase over IEA STEPS demand in 2020. The IEA NZE and IEA SDS scenarios reach the next highest levels at 8649 mtoe and 7558 mtoe mid-century. The APS scenario has still considerably higher demand than the STEPS scenario, with 5933 mtoe projected by 2050, a 29 percent increase over the STEPS projection. GECF's ETS scenario sees significant growth by 2050, rivalling some "Paris-aligned" scenarios with 7012 mtoe of renewables demand. Equinor's Rebalance scenario sits lowest among climate policy scenarios with 2050 renewables demand of 5651 mtoe.

CCUS

10. While many outlooks show a gradual acceleration into CCUS, GECF HS stands out with the most aggressive CCUS scenario, growing from 80 million metric tons (mmt) in 2025 to 3214 mmt in 2050. IEEJ ATS has a similarly robust projection of CCUS to reach 2128 mmt.

11. Comparatively, central and some alternative climate scenarios project a slower deployment of CCUS, with the IEA APS, Equinor Reform, and IEA SDS modestly exceeding 500 mmt in 2050. Without additional policy to incentivize carbon capture, the IEA STEPS scenario keeps CCUS constant at less than 1 mmt for the entire period.

12. Climate target scenarios mostly still follow a gradual build-up of CCUS, albeit with a greater rate of growth. IEA NZE grows to 1186 mmt of CCUS by 2050, while the Equinor Rebalance reaches 2000 mt.

1.3 Medium-term Outlooks Highlights

1. While both IEA and OPEC project demand strong growth in the medium-term, OPEC has a slightly more ambitious expectation for demand growth emerging from the pandemic with a difference of 0.5 mb/d compared to the IEA in 2022. Forecasts converge in 2026 with IEA projecting global demand at 104.1 mb/d compared to OPEC's 104.4 mb/d. While IEA reduced its projections compared to last year, OPEC largely retains a similar outlook.
2. Both organizations are relatively aligned in their outlooks for non-OECD countries where most demand growth is concentrated. However, estimates for OECD countries diverge in 2023 with OPEC reporting 46.6 mb/d compared to IEA's 45.8 mb/d but forecasts converge towards 2026.
3. Both organizations offer different perspectives on the medium-term supply picture. While there is relative alignment on growth in 2022, OPEC projects greater growth from 2023 onwards punctuated with a 0.6 mb/d growth in 2026 versus a 0.2 mb/d decline reported by IEA.
4. Much of this difference is owed to OPEC's more optimistic liquids supply growth forecasts in 2026 for Latin America, Middle East and Africa, and Europe and Eurasia. However, OPEC projects less growth in OECD Americas and OECD Europe compared to IEA and its own projections from last year. OPEC also projects greater non-OPEC growth by 1.2 mb/d between 2020-2026 compared to IEA's 0.7 mb/d with overall supply of 70 mb/d and 68 mb/d, respectively.

1.4 Short-term Outlooks Highlights

1. As an outcome of the collaborative work on historical baseline data, the IEA, OPEC, and the US EIA oil demand and supply base year 2020 data is mutually consistent.
2. The IEA, OPEC, and EIA estimated global liquids demand growth rates between 5.0 and 6.0 mb/d for 2021. OPEC estimated higher global liquids demand growth, mostly driven by a greater estimate of growth in non-OECD regions while the EIA consistently reported more non-OECD growth over the course of 2021. Liquids demand projections for 2022 show larger differences reflecting the elevated uncertainty related to impact of the continued COVID-19 pandemic.
3. For 2021 IEA, OPEC, and EIA estimate non-OPEC liquid supply to increase by 0.7 mb/d, 0.7 mb/d, and 0.9 mb/d, respectively. Estimates for growth in 2022 are more aligned, with both the IEA, OPEC, and EIA estimating increases of around 3 mb/d. Notable differences emerge for the OECD Americas, with IEA projecting 0.36 mb/d and 0.48 mb/d in additional supplies relative to OPEC in 2021 and 2022, respectively. The EIA reports even higher estimates than IEA by 0.84 mb/d and .99 mb/d in 2021 and 2022 respectively. The Americas drive differences in the OECD category.

2. 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 scenario insights shape perceptions on how energy markets might evolve and influence policy and investment decisions around the world. For the purposes of this report, US Energy Information Administration (EIA) forecasts are also included where appropriate.

Since the Cancun IEF Ministerial Declaration (2010) called for the IEA, IEF, and OPEC to organize annual Symposia on Energy Outlooks and Physical and Financial Market Interactions, the impact of scenarios on policy making, investment decisions and public perceptions of energy market trends and transition pathways has grown. This has not only invited more inclusive debate on their increasingly diverse findings but also warrants greater transparency of methods, assumptions, and data comparability.

Complementing the continued support of IEF energy ministers for the trilateral programme of work, and mindful of the many challenges energy markets face today, G20 leaders gathered in Rome on 30-31 October 2021 called on the IEF to intensify dialogue between producers and consumers to bolster the efficiency, transparency, and stability of the energy markets to maintain energy security, while addressing climate change, and guaranteeing just and orderly transitions.

The IEF-RFF Outlooks Comparisons Report has informed each Symposium by comparing the key scenarios and underlying methodologies of most recent outlooks prepared by the IEA and OPEC and places these in the broader context of a growing number of such assessments issued by other organizations such as IRENA, the GECF, companies, national agencies, and research centres.

Table 1 lists the publications used for comparison in Chapters 1-6 of this introductory paper and placed alongside outlooks produced by IRENA, GECF, Equinor and IEEJ in Chapter 7 to provide additional context. Note that the IEA Medium-Term Oil 2021 report was published in March 2021, eight months earlier than the release of OPEC's Medium-Term projections in its 2021 World Oil Outlook (WOO2021). This could lead to some differences in output that are due to different information at publication.

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

	IEA		OPEC		EIA	
Report type	**Report name**	**Publication date**	**Report name**	**Publication date**	**Report name**	**Publication date**
Short-term	Oil Market Report (OMR)	Dec. 2021	Monthly Oil Market Report (MOMR)	Dec. 2021	Short-term Energy Outlook	Dec. 2021
Medium-term	Oil 2021	Mar. 2021	World Oil Outlook (WOO 2021)	Sep. 2021	N/A	N/A
Long-term	World Energy Outlook (WEO 2021)	Oct. 2021	World Oil Outlook (WOO 2021)	Sep. 2021	International Energy Outlook	Oct. 6 2021

3. Baseline 2020 Liquids Data

The comparability of baseline historical data between the IEA OPEC, and EIA is a necessary step to enhance the comparability of their outlooks. **Table 2, Table 3,** and **Table 4** compare IEA, OPEC, and EIA base year (2020) demand, supply, and stock change data, respectively, primarily using the IEA's December OMR, OPEC's December MOMR, and EIA's December STEO. Note that as an outcome of the collaborative work on historical baseline data, IEA, OPEC, and EIA have mutually consistent base year oil demand data in their reports.

Reflecting the early impacts of the Covid-19 pandemic that broadly depressed oil markets, **Table 2** and **Table 3** show that world liquids demand and supply baselines have fallen relative to previous years. For 2020, the difference between IEA, OPEC, and EIA estimates stand modestly at 0.15 mb/d for demand and 0.1 mb/d for supply.

Table 2 provides details on IEA's, OPEC's, and EIA's estimates for 2020 baseline liquids demand data by region. IEA estimates global demand of 90.83 mb/d for 2020; 0.15 mb/d lower than OPEC and close to 1 mb/d compared to EIA. Contrary to previous years' assessments where non-OECD Asia was attributed for much of the disagreement, the difference this year is largely spread across the non-OECD regions. While IEA presents demand in China 0.4 mb/d higher than OPEC, OPEC in turn estimates greater demand by 0.4 mb/d in Latin America and 0.3 mb/d in Africa. EIA sees greater Chinese demand compared to both IEA and OPEC for 2020.

Table 2. Liquids Demand in 2020 (mb/d)

	IEA	OPEC	EIA	Difference (IEA-OPEC)
Total OECD	**42.02**	**42.02**	**42.0**	**0.00**
OECD Americas	22.44	22.44	22.0	0.00
OECD Europe	12.44	12.44	13.0	0.00
Asia Oceania	7.14	7.14	7.0	0.00
Total Non-OECD	**48.80**	**48.96**	**50.0**	**-0.15**
Non-OECD Asia	26.47	26.16	27.2	0.31
China	13.88	13.52	14.4	0.36
Other non-OECD Asia	12.59	12.64	12.8	-0.05
Middle East	7.72	7.55	7.9	0.18
Latin America	5.59	6.01	5.8	-0.42

Non-OECD Europe and Eurasia	5.22	5.16	4.6	0.06
Africa	3.80	4.08	4.2	-0.29
World	**90.82**	90.98	**91.81**	**-0.16**

Table 2 data sources: IEA OMR Dec 2021, Table 1; OPEC MOMR Dec 2021, Table 4 – 1, 4 – 2, EIA STEO Dec 2021
Table 2 note: Sums may not total due to rounding.
EIA does not report South Korean demand for Asia Oceania
EIA does not include Colombia and Costa Rica as part of its OECD classification

As for world liquids supply, **Table 3** also shows several modest differences. Globally, the IEA and EIA estimate liquids supply at 93.8 mb/d, only 0.1 mb/d higher than OPEC. Despite near level world figures, the organizations diverge in their estimates of non-OECD supply with the largest difference between IEA and OPEC at 1.4 mb/d. The largest differences are in the estimates for Chinese liquids supply, which OPEC estimates at .11 mb/d higher than IEA in 2020.

While OPEC and EIA include biofuels in each region's total liquids supply, the IEA only includes global biofuels supply separately. This paper adds these IEA regional biofuels data – both historical and forecast data – to each region's oil supply data. EIA supply includes the production of lease condensates, NGLs, biofuels, other liquids, and refinery processing gains and does not separate them out as in IEA and OPEC reports.

Table 3. Liquids Supply in 2020 (mb/d)

	IEA[a]	OPEC	EIA	Difference (IEA-OPEC)
Total OECD	**29.39**	**29.12**	**30.6**	**0.27**
OECD Americas	24.93	24.70	25.8	0.23
OECD Europe	3.92	3.90	4.2	0.02
Asia Oceania	0.55	0.52	0.5	0.03
Total Non-OECD	**31.46**	**32.90**	**32.58**	**-1.44**
Non-OECD Asia	7.34	7.43	7.6	-0.09
China	4.05	4.16	4.9	-0.11
Other non-OECD Asia	3.29	3.27	2.7	0.01
Middle East	3.01	3.19	3.1	-0.18

Latin America	6.07	6.04	6.2	0.03
Non-OECD Europe and Eurasia	13.63	13.62	13.4	0.01
Africa	1.40	1.41	1.4	-0.01
Processing gains	2.11	2.15	N/A	-0.04
Total Non-OPEC	**63.01**	**62.97**	**63.1**	**0.04**
Total OPEC[b]	**30.76**	**30.70**	**30.7**	**0.06**
OPEC crude	25.69	25.65	25.6	0.04
OPEC NGLs + unconventionals	5.07	5.05	5.1	0.02
World	**93.77**	**93.67**	**93.84**	**0.10**

Table 3 data sources: IEA OMR Dec 2021, Table 1; IEA Oil 2021, Tables 5, 5a; OPEC MOMR Dec 2021, Tables 5-1 and 5-2, EIA STEO Dec 2021
Table 3 notes: Numbers rounded to two decimal points, and sums may not total due to rounding. IEA liquids supply calculated by summing IEA oil and IEA biofuel estimates.
[a] "OPEC NGLs" includes condensates, oil from non-conventional sources (e.g. Venezuelan Orimulsion) and non-oil inputs (e.g. to Saudi Arabian MTBE).
[b] Total OPEC equals OPEC crude plus OPEC NGLs/unconventionals.
EIA does not include Colombia and Costa Rica as part of its OECD classification
EIA data includes processing gains on a country level

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, the IEA estimates a stock build in 2020 of 2.9 mb/d, while OPEC estimates growth of 2.7 mb/d. The estimates diverge in two categories: "miscellaneous to balance" and "oil-on-water" stock changes. 2020 data shows a positive stock change across all categories, but IEA estimates a 0.5 mb/d greater change in "miscellaneous to balance" while OPEC estimates a 0.3 mb/d greater change in "oil-on-water". The EIA provides the total stock change but does not distinguish between floating storage and miscellaneous draws or break down OECD draws into industry and government in its monthly report.

Table 4. 2020 Stock Change and Miscellaneous Items (mb/d)

	IEA	OPEC	EIA	Difference (IEA-OPEC)
Reported OECD	**0.40**	**0.40**	**0.40**	**0.00**
Industry/commercial	0.38	0.38	N/A	0.00
Government/SPR	0.02	0.02	N/A	0.00
Oil-on-water	**0.05**	**0.32**	**1.6**	**-0.27**
Miscellaneous to balance[a]	**2.48**	**1.98**		**0.51**
Total stock change & misc.	**2.94**	**2.69**	**2.0**	**0.25**

Table 4 data sources: IEA OMR Dec 2021, Table 1; OPEC MOMR Dec 2021, Table 11 - 1.
Table 4 notes: Numbers rounded to two decimal places.
[a] OPEC miscellaneous to balance is computed as the difference between total OPEC stock change/misc. and other reported stock changes.
EIA does not provide breakdown of OECD or floating and miscellaneous draws.

4. Short-term Oil Outlooks

Short-term oil market reports from IEA, OPEC, and EIA forecast oil demand and supply in the future based on regular monitoring of macroeconomic and energy market conditions, technology, and policy developments. IEA and OPEC 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. The reports capture market-moving events and offer in-depth analyses in their respective reports.

In this section, we summarize and compare the IEA, OPEC, and EIA perspectives on short-term macroeconomics, as well as oil demand and supply outlooks[1].

4.1 Economic Growth Assumptions

The IEA and OPEC take different approaches for short-term GDP forecasts. In 2020 IEA transitioned from use of IMF's projections published in the World Economic Outlook and the World Economic Outlook Updates to projections prepared by Oxford Economics. Unlike IEA, OPEC has established its own GDP projections based on a modelling approach. The EIA Short-term energy outlook does not provide global economic growth assumptions.

Following the impact of the COVID-19 pandemic on economic growth in 2020, IEA and OPEC estimates for global economic growth in 2021 are positive and even more dramatic compared to pre-covid estimates. IEA projects a growth rate of 5.9% while OPEC projects growth of 5.5%. For 2022

[1] Though this introductory paper compares data from the December 2021 oil market reports, reports from January to December in 2021 from both organizations were reviewed to assess how their views evolved throughout the year.

both organizations project a return to slower, but still robust, growth rates. IEA projects a growth rate of 4.9% while OPEC projects growth of 4.2%. As **Table 5** shows, there is substantial regional variation across major economies. China and India stand out as having the largest growth rates for 2021 and 2022. In China, IEA and OPEC both estimate an increase of 8.0% for 2021, and 5.6% for 2022. IEA and OPEC diverge in their estimates for India. IEA projects growth of 9.5% in 2021 and 8.5% in 2022. This is significantly higher than OPEC's estimated growth of 8.8% in 2021 and 7.0% in 2022. The U.S., Brazil and Japan also show divergences; IEA consistently projected growth about half a percentage point higher than OPEC in 2021. That gap grew for the U.S. and Japan in 2022, to 0.7pp and 1.0pp respectively. In Brazil the difference was reversed for 2022, with OPEC estimating growth 0.5 pp higher than the IEA. IEA largely estimates higher growth in 2021 compared to OPEC for most regions, excluding the EU where IEA projects growth of 5.0% and OPEC 5.1%.

Table 5. Short-term GDP Growth Assumptions

	2021			2022		
	IEA	**OPEC**	**Difference (IEA - OPEC)**	**IEA**	**OPEC**	**Difference (IEA - OPEC)**
World	**5.9%**	**5.5%**	**0.4%**	**4.9%**	**4.2%**	**0.7%**
US	6.0%	5.5%	0.5%	5.2%	4.1%	1.1%
China	8.0%	8.0%	0.0%	5.6%	5.6%	0.0%
EU[1]	5.0%	5.1%	-0.1%	4.3%	3.9%	0.4%
Japan	2.4%	2.0%	0.4%	3.2%	2.2%	1.0%
India	9.5%	8.8%	0.7%	8.5%	7.0%	1.5%
Brazil	5.2%	4.7%	0.5%	1.5%	2.0%	-0.5%

Table 5 data sources: IMF World Economic Outlook Oct 2021, Table 1.1; OPEC MOMR Dec 2021, Table 3 – 1, IEA GDP assumptions provided via internal communication, based on analysis from Oxford Economics.
Note 1: IEA provides estimates for the European Union, while OPEC uses the Euro Zone grouping.
EIA does not provide global GDP growth assumptions in monthly reports.

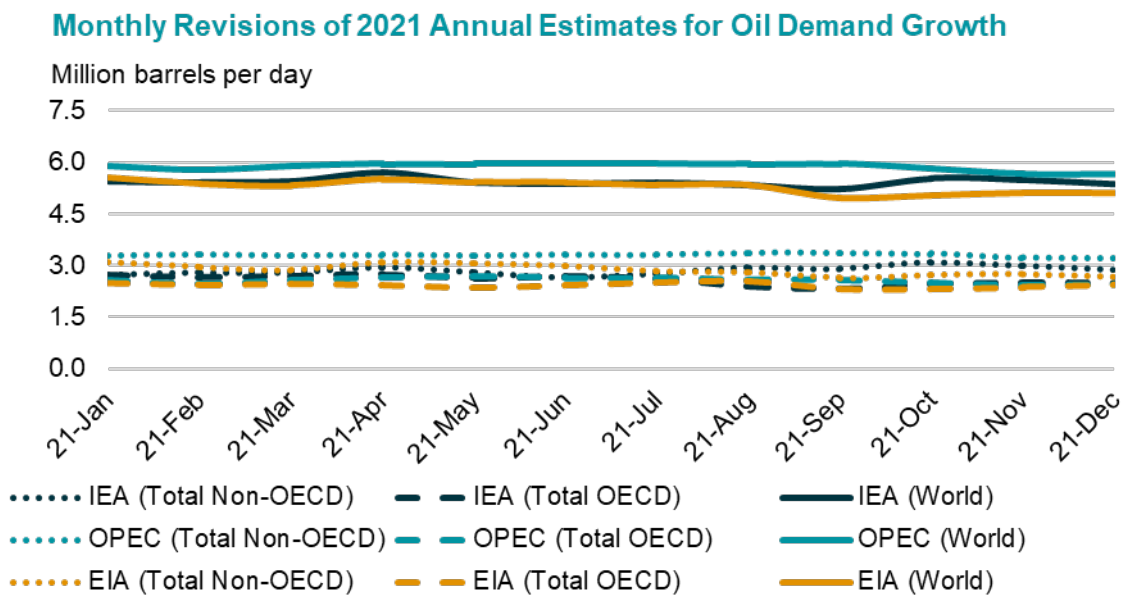
4.2 Short-term Liquids Demand

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

Compared to 2020, which witnessed major changes to global liquids demand growth estimates, 2021 had stable growth estimates. As **Figure 1** illustrates, IEA, OPEC, and EIA estimated global growth rates between 5.0 and 6.0 mb/d. OPEC estimated higher global growth, mostly driven by an estimate of larger growth in non-OECD regions.

Figure 1 indicates changes in projected growth rates for the world (solid line), OECD (dashed lines), and non-OECD (dotted lines). Estimates for OECD and non-OECD nations alike were remarkably stable, especially compared to the dramatic shift in 2020. Both IEA and OPEC estimated higher growth for non-OECD regions than OECD regions by the end of the year, but OPECs estimates were more in line with those they had at the beginning of 2021. In comparison, IEA had projected much more similar growth rates for OECD and non-OECD regions at the start of the year but began to estimate greater growth in non-OECD nations mid-year, while slightly decreasing growth rate estimates for OECD regions. EIA consistently reported more non-OECD growth over the course of 2021 although much closer to its OECD growth than both IEA and OPEC.

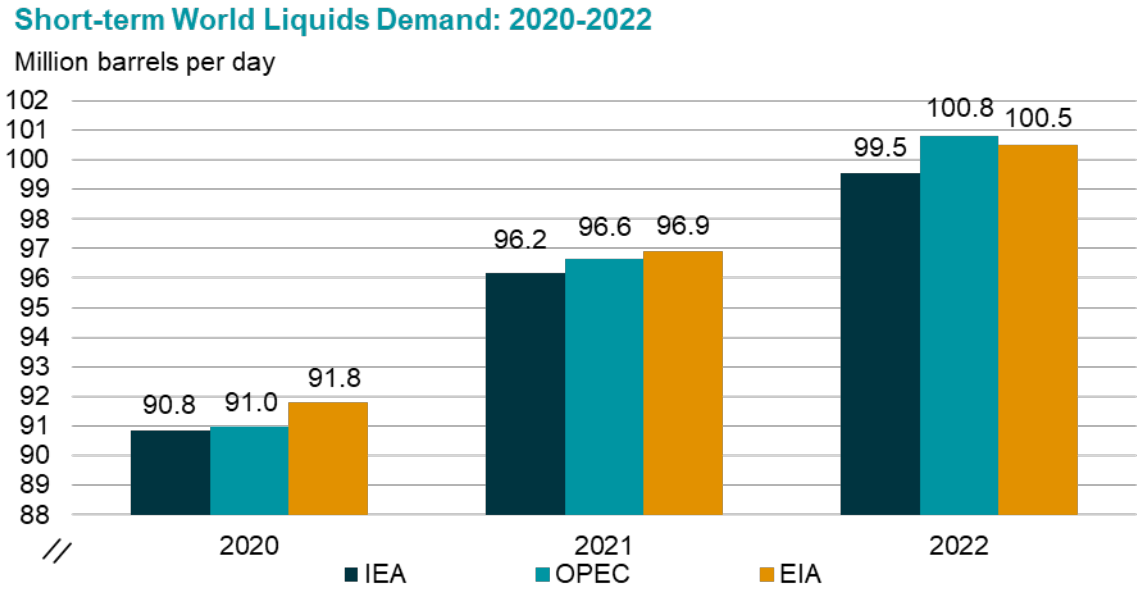
Figure 1: Global demand remains stable over the course of 2021 after pandemic-related drop



Source: IEF, IEA OMR Dec 2021, OPEC MOMR Dec 2021, and EIA STEO Dec 2021

Looking forward in **Figure 2**, the IEA and OPEC project that global liquids demand will grow by roughly 6 mb/d in 2021. In 2022, both organizations project continued demand growth, but at a lower level. The IEA projects growth of 3.3 mb/d, OPEC projects growth of 4.2 mb/d, and EIA projects growth of 3.6 mb/d. For these three years, OPEC estimates are consistently higher than those of the IEA. In 2022, IEA and OPEC see world liquids demand reaching 99.5 mb/d and 100.8 mb/d, respectively.

Figure 2: Short-term global demand for IEA, OPEC, and EIA



Source: IEF, IEA OMR Dec 2021, OPEC MOMR Dec 2021, and EIA STEO Dec 2021
Notes: 2020 are historical data and 2021/2022 are projections. Sums in data callouts may not total due to rounding.

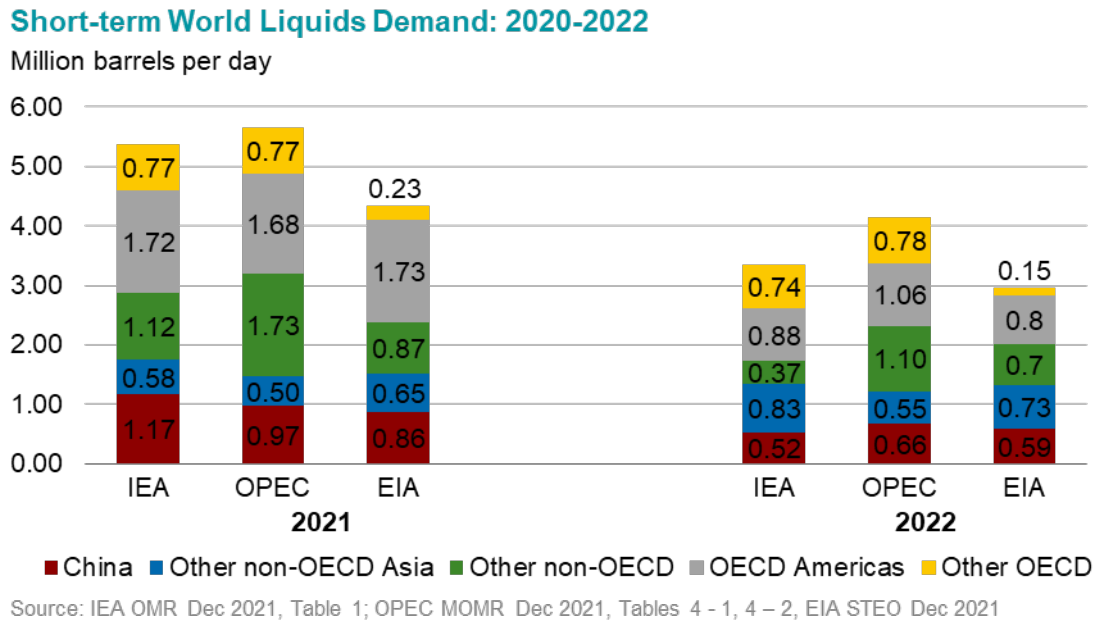
IEA, OPEC, and EIA regional liquids demand outlooks for 2021 and 2022, as well as the differences between them, are summarized in **Table 6**. These short-term demand outlooks have historically varied most widely in regions that have large differences in historical data – particularly in non-OECD regions 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.[2] Over subsequent years these differences have become smaller, in part an outcome of the joint analysis of discrepancies in historical baseline data that both organizations pursue on the IEF platform. Though 2021 and 2022 projections show large differences, these reflect the elevated uncertainty related to impact of the continued COVID-19 pandemic—particularly in 2022—and the implications for liquid demand.

Between 2021 and 2022, the IEA, OPEC, and EIA estimate positive demand growth across all major regions. **Figure 3** illustrates that OPEC projects slightly less growth coming out of 2021 than IEA, but

[2] See Table 2 from the Introductory Paper to the 7th IEA-IEF-OPEC Symposium, published in February 2017.

greater growth in 2022 than both IEA and EIA. The IEA OPEC, and EIA are fairly aligned in their projections for growth across other categories, with OECD Americas being a significant source of growth in 2021 by all organizations' estimations. The most notable differences are between non-OECD regions in 2022, where the IEA projects greater growth in non-OECD Asia, and OPEC projects greater growth in other non-OECD regions (particularly Europe and Eurasia). Table 6 provides a more detailed geography breakdown of the trends illustrated in **Figure 3**.

Figure 3: Short-term global supply growth for IEA, OPEC, and EIA



Source: IEA OMR Dec 2021, Table 1; OPEC MOMR Dec 2021, Tables 4 - 1, 4 – 2, EIA STEO Dec 2021

Table 6: Short-term Liquids Demand Annual Growth by Geography

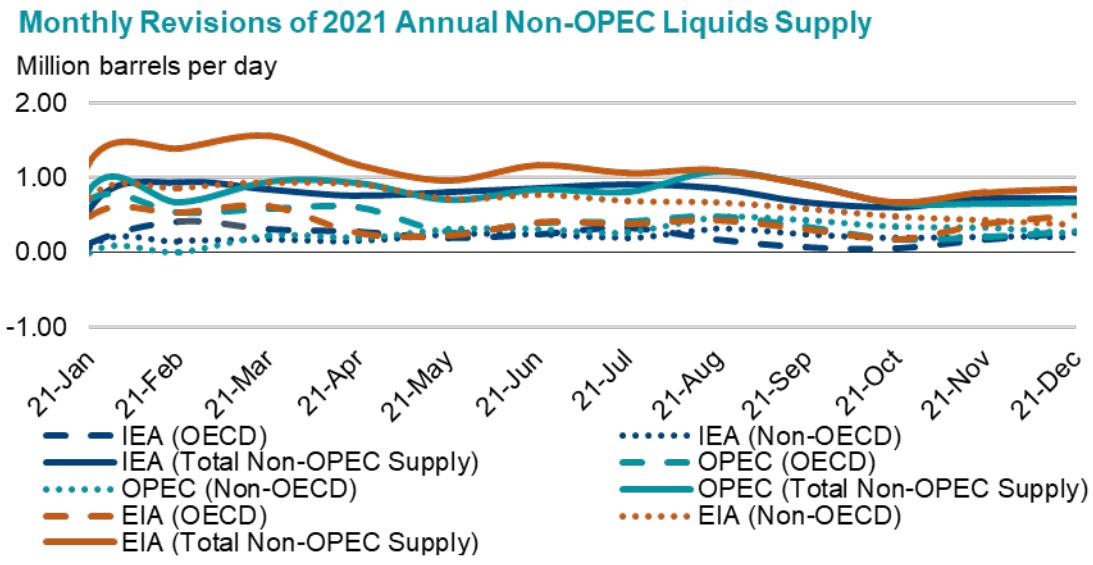
	2021-2020				2022-2021			
	IEA	**OPEC**	**EIA**	**Diff (IEA-OPEC)**	**IEA**	**OPEC**	**EIA**	**Diff (IEA-OPEC)**
Total OECD	**2.49**	**2.46**	**2.42**	**0.04**	**1.62**	**1.84**	**1.32**	**-0.22**
Asia Oceania	0.26	0.23	N/A	0.03	0.20	0.17	N/A	0.03
OECD Europe	0.51	0.54	0.49	-0.03	0.54	0.61	0.37	-0.08
OECD Americas	1.72	1.68	1.73	0.04	0.88	1.06	0.80	-0.18
Total Non-OECD	**2.87**	**3.20**	**2.68**	**-0.33**	**1.73**	**2.32**	**2.22**	**-0.59**
China	1.17	0.97	0.86	0.20	0.52	0.66	0.59	-0.15

Other Non-OECD Asia	0.58	0.50	0.65	0.09	0.83	0.55	0.73	0.28
Latin Americas	0.39	0.31	0.40	0.08	0.08	0.18	0.17	-0.10
Middle East	0.21	0.45	0.33	-0.24	0.08	0.27	0.39	-0.18
Africa	0.21	0.17	0.20	0.03	0.06	0.14	0.16	-0.08
Non-OECD Europe and Eurasia	0.31	0.42	0.26	-0.11	0.15	0.06	0.17	0.09
World	**5.37**	**5.65**	**5.10**	**-0.29**	**3.34**	**4.15**	**3.55**	**-0.81**

4.3 Short-term Liquids Supply

Changes in short-term projections for global non-OPEC liquids supply over 2021 by IEA, OPEC, and EIA was much lower than demand growth at below 1 mb/d for 2021. As **Figure 4** reveals, annual supply growth estimates were relatively stable throughout the year. Early in 2021, when the pandemic appeared to be waning, prompted the highest growth estimates for OECD supply. Those estimates dipped in the summer but stayed mostly stable throughout the year. IEA, OPEC, and EIA projected that the OECD would see slightly greater growth by the end of the year as compared to non-OECD producers.

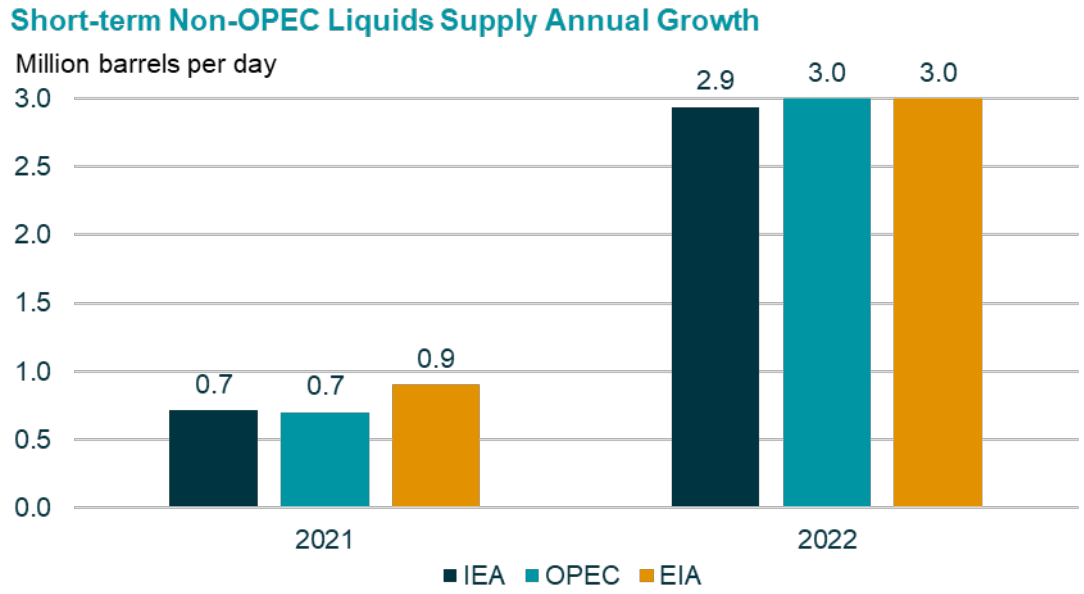
Figure 4: Global non-OPEC supply growth in 2021



Source: IEA OMR Jan-Dec 2021, Table 1; OPEC MOMR Jan-Dec 2021, Table 11 – 1, EIA STEO Jan-Dec 2021

Following robust growth in 2019, non-OPEC liquids supplies suffered a steep contraction in 2020 and are projected to only modestly recover in 2021, with a more sizeable recovery expected in 2022. As **Figure 5** indicates, in 2021, differences in supply estimates continue with IEA, OPEC, and EIA estimating non-OPEC liquid supply to increase by 0.7 mb/d, 0.7 mb/d, and 0.9 mb/d, respectively. Estimates for growth in 2022 are aligned, with both IEA, OPEC, and EIA estimating increases of around 3 mb/d, growth that surpasses that in 2019.

Figure 5: Global non-OPEC supply growth in 2021 and 2022



Source: IEF, IEA OMR Dec 2021, Table 1; OPEC MOMR Dec 2021, Table 11 – 1, EIA STEO Dec 2021

Table 6 provides a detailed comparison of short-term liquids supply outlooks by region. While projections for the annual rate of growth of non-OPEC liquids supply are largely similar between the IEA, OPEC, and EIA as shown in **Figure 5**, that growth builds upon differing baseline data, as shown in Table 3. Notable differences emerge for the OECD Americas, with IEA projecting 0.36 mb/d and 0.48 mb/d in additional supplies relative to OPEC in 2021 and 2022, respectively. The EIA reports even higher estimates than IEA by 0.84 mb/d and .99 mb/d in 2021 and 2022 respectively. The Americas drive differences in the OECD category. In the Non-OECD category, OPEC's and EIA's estimates trend higher than the IEA. OPEC estimates 0.21 mb/d higher supply that the IEA from non-OCED regions in 2021 and 0.45 higher supply in 2022.

Variation emerges between the two organizations in estimates for OPEC supply as well. Looking at the composition of these supplies, the trend is largely driven by greater call-on crude figures for OPEC over the IEA. This merits some discussion, since neither the IEA nor OPEC make projections for short-term OPEC crude. "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 changes & miscellaneous"

is a constructed item. This item is calculated by subtracting total non-OPEC supply as well as OPEC NGLs and unconventionals supply from world liquids demand projections, since neither the IEA nor OPEC projects OPEC crude production in their monthly oil market reports. Therefore, differences between the IEA and OPEC in the "Call on OPEC crude + stock changes & miscellaneous" item do not directly reflect different views regarding OPEC crude supply; rather the differences reveal their distinct projections of global liquids demand and non-OPEC crude supply.

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

	2021				2022			
	IEA	**OPEC**	**EIA**	**Difference (IEA-OPEC)**	**IEA**	**OPEC**	**EIA**	**Difference (IEA-OPEC)**
Total OECD	**29.81**	**29.41**	**31.05**	**0.39**	**31.26**	**30.77**	**32.63**	**0.49**
OECD Americas	25.46	25.11	26.3	0.36	26.81	26.34	27.8	0.48
OECD Europe	3.81	3.80	4.14	0.01	3.91	3.90	4.25	0.01
Asia Oceania	0.54	0.51	0.46	0.03	0.55	0.54	0.48	0.01
Total Non-OECD	**31.75**	**31.96**	**32.95**	**-0.21**	**33.06**	**33.51**	**34.4**	**-0.45**
Non-OECD Asia	7.33	7.51	7.58	-0.18	7.38	7.54	7.51	-0.17
China	4.18	4.32	5.01	-0.15	4.22	4.37	5.02	-0.14
Other non-OECD Asia	3.16	3.19	2.65	-0.03	3.15	3.18	2.49	-0.02
Middle East	3.09	3.24	3.19	-0.15	3.24	3.35	3.25	-0.11
Latin America	6.11	6.04	6.17	0.06	6.37	6.32	6.66	0.04
Non-OECD Europe and Eurasia	13.89	13.82	13.70	0.07	14.80	15.03	14.66	-0.23
Africa	1.32	1.34	1.37	-0.02	1.28	1.25	1.33	0.02
Processing gains	2.25	2.28	N/A	-0.03	2.38	2.39	N/A	-.01
Total Non-OPEC	**63.73**	**63.65**	**64.00**	**0.08**	**66.66**	**66.67**	**67.03**	**-0.01**
OPEC NGLs + unconventionals	5.17	5.14	5.33	0.03	5.38	5.27	5.52	0.11
Call on OPEC crude + stock ch. & misc.[b]	**27.30**	**28.82**	**26.30**	**-1.52**	**27.50**	**28.85**	**28.38**	**-4.50**

Table 7data sources: IEA OMR Dec 2021, Table 1; IEA Oil 2021, Table 5 & 5a; OPEC MOMR Dec 2021, Table 5 - 1, 5 - 2, 11 -1.

Table 7 notes: Numbers rounded to two decimal places.

[a] Biofuels from IEA Oil 2021 are added to IEA regional oil supply data for comparability with OPEC estimates.

[c] Equals total liquids demand minus non-OPEC supply minus OPEC NGLs/unconventionals.

5 Medium-term Oil Outlooks

Our comparison of medium-term outlooks assesses IEA's Oil 2021 report published in March 2021, and OPEC's World Oil Outlook (WOO) published in September 2021 (**Table 1**). Both organizations make their medium-term projections through 2026, using 2020 as a base year. However, there is an eight-month interval between publication dates of the two reports, and given the dynamic nature of market conditions, this gap can complicate the comparison of the projections.

5.1 Oil Price and Economic Growth Assumptions

5.1.1 Oil Price

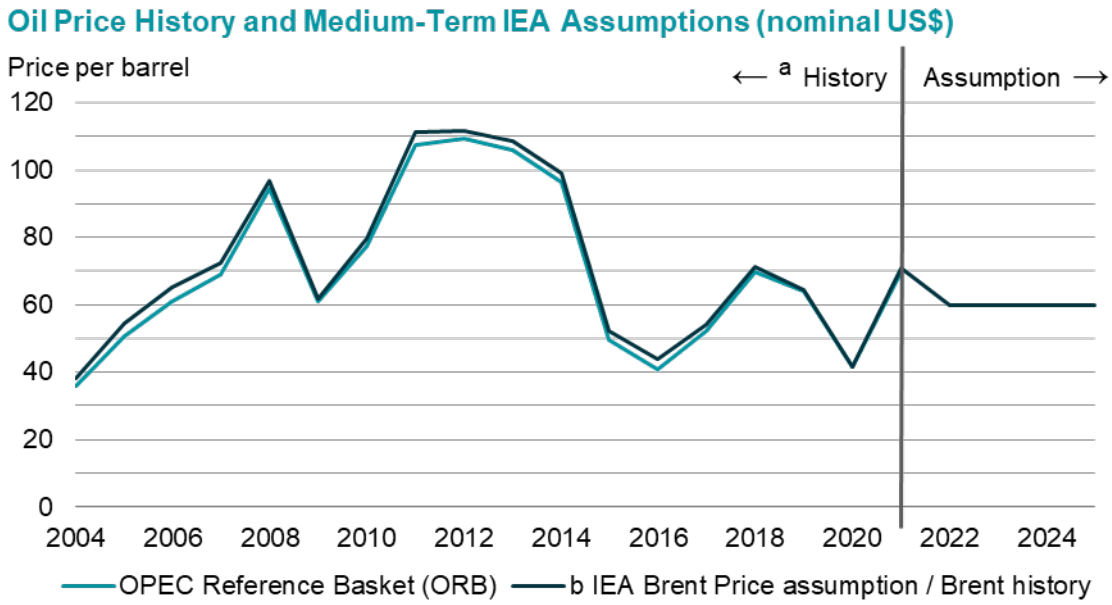
The price of oil is one of the primary factors influencing the projections of oil demand. Since 2017, OPEC has not published its oil price assumptions for the medium or long term, preventing detailed comparison between IEA and OPEC.

When considering historical and future prices, 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 several representative OPEC crudes driven by the cost estimates of marginal supply. IEA uses an "IEA Average Import Price," which reflects the IEA's perspective on its member countries' future crude import prices.

IEA utilizes 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 reflected 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.

Figure 6 illustrates a rise in Brent oil prices from an average of US$41.50/bbl in 2020 to $69.90/bbl in 2021. However, in their modelling within the Oil 2021 report, IEA assumes a constant price of $60/bbl from 2019 through 2025.

Figure 6: IEA forecasts $60 per barrel from 2019-2025



Source: Historical OPEC ORB price from https://www.opec.org/opec_web/en/data_graphs/40.htm.
Historical Brent price from US EIA at https://www.eia.gov/opendata/qb.php?category=1039852&sdid=STEO.BREPUUS.A
Figure 7 note: a Only historical prices up to the time IEA and OPEC released their reports were included
b IEA Brent Price assumption is based on the Brent futures strip.

5.1.2 Economic Growth

As shown in **Table 8**, IEA revised its medium-term economic assumptions to reflect the COVID-19 pandemic recovery. OPEC has revised their 2021 and 2022 growth assumptions upward, projecting stronger growth compared to last year's report. OPEC's estimates further in the future stabilize around 3.2%. IEA's GDP assumption in 2021 is lower than OPEC's, but their future assumptions are slightly higher. Overall, IEA's projections offer a slow ramp up to growth rates similar to those before the pandemic, while OPEC estimates more robust growth for two years prior to a return to more normal global growth.

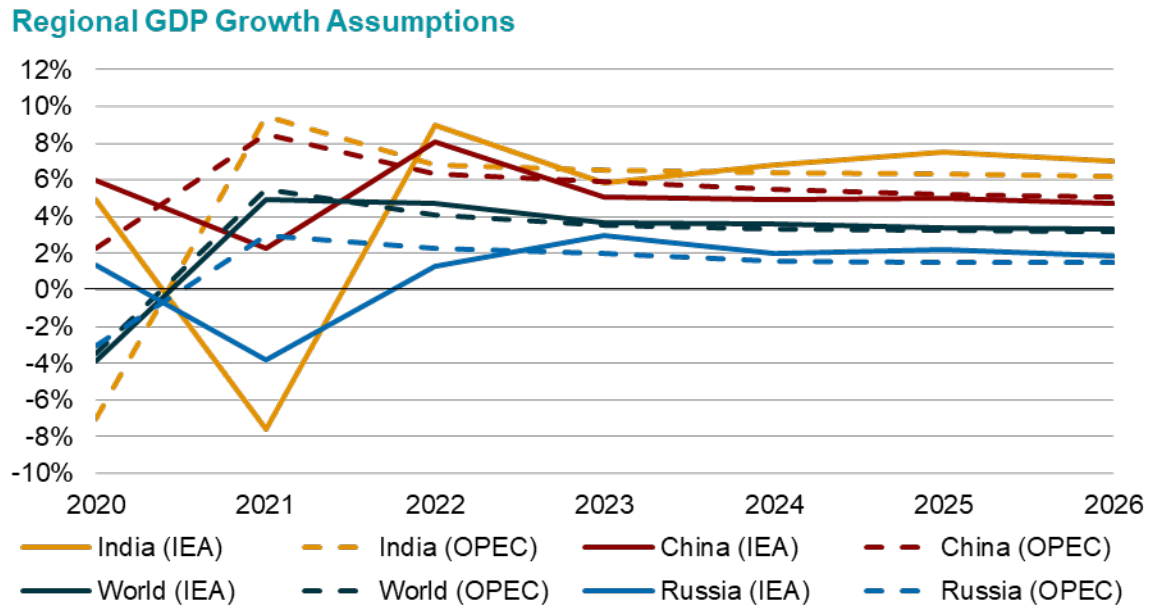
Table 8. Medium-term Annual GDP Growth Assumptions (%)

	2021	2022	2023	2024	2025	2026
OPEC	5.5	4.1	3.5	3.3	3.2	3.2
IEA	4.9	4.7	3.7	3.6	3.4	3.3

Table 8 data sources: IEA Oil 2021, Table 1.3; OPEC WOO 2021, Table 1.4. IEA's forecast relies on IMF, OECD, and IEA information.

Differences in projections exist among some key countries, shown in Error! Reference source not found. **s7**. For example, the OPEC assumptions for GDP growth in China and India are substantially higher than the global average, with India having extremely steep growth coming out of the pandemic and stabilizing at over 6 percent annually after 2022. In contrast, OPEC, and IEA estimate growth around 3.5 percent for the global average after 2022. There is a lot of noise in the projections prior to 2022, likely reflecting uncertainty about how the ongoing COVID-19 pandemic will affect global economies.

Figure 7: India sees greatest GDP growth from 2022-2026



Source: IEA Oil 2021, Table 1.3; OPEC WOO 2021, Table 1.4. IEA's forecast relies on IMF, OECD, and IEA information

5.2 Medium-term Liquids Demand

5.2.1 Global and Regional Demand Growth

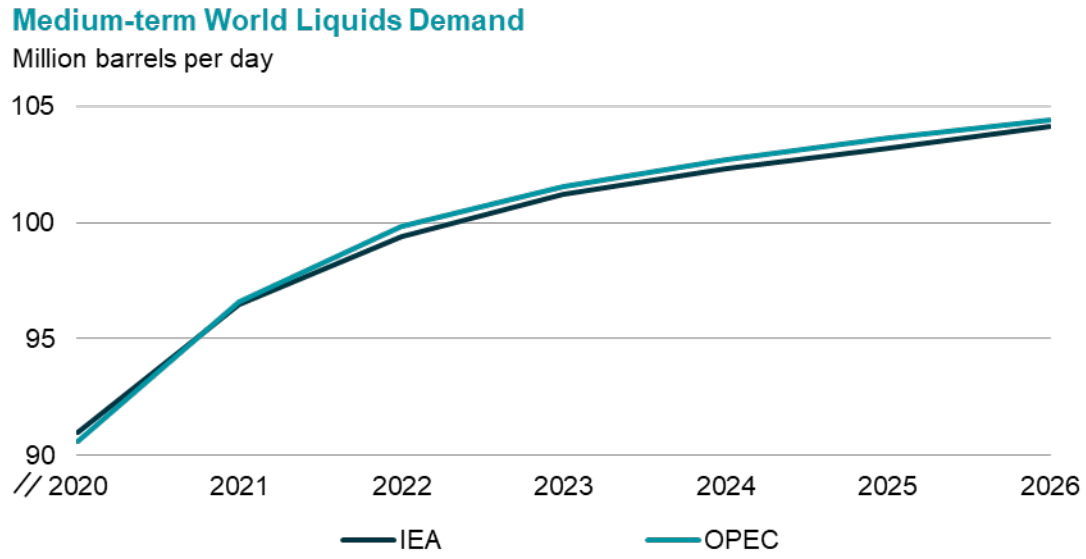
Both organizations' medium-term outlooks project relatively strong medium-term growth in global liquids demand, showing recovery following the drop off in demand caused by the COVID-19 pandemic. Liquids demand in the baseline year of 2020 is 90.6 mb/d for OPEC and 91.0 mb/d for the IEA, a difference of 0.4 mb/d, slightly larger than the baseline difference of 0.3 mb/d observed in last year's report.

As Figures 8a and 8b illustrate and **Table 9** shows in detail, OPEC has a slightly more ambitious expectation for demand growth coming out of the pandemic. The projections reach their peak divergence in 2022, where OPEC estimates demand 0.5 mb/d higher than IEA. By 2026 the

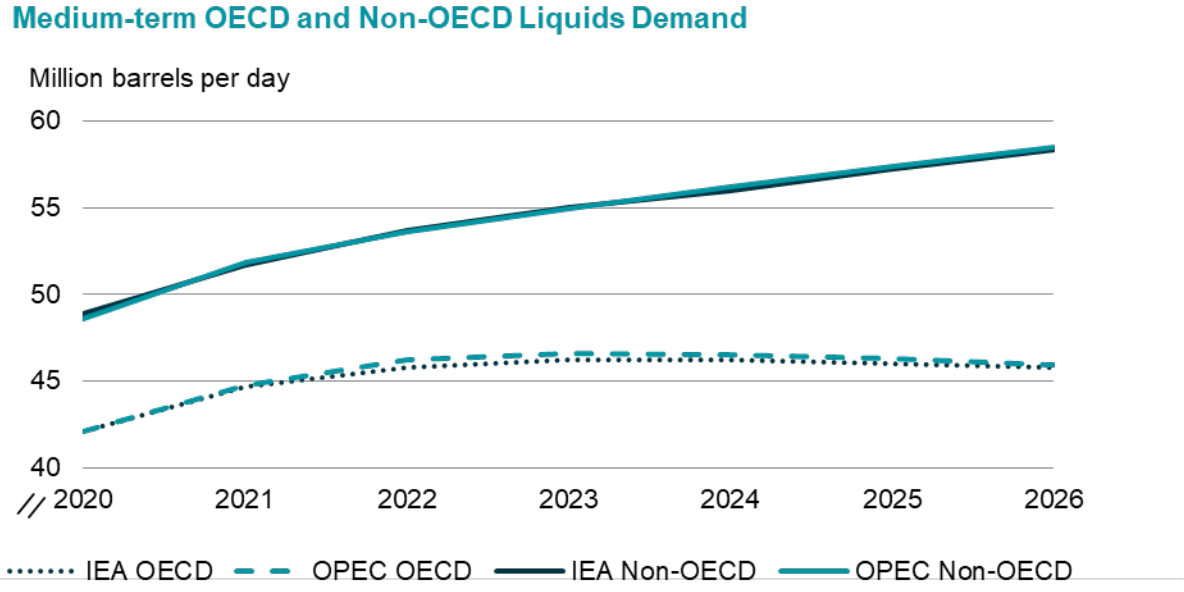
projections are slightly closer, with OPEC's projection only 0.3 mb/d higher than IEA's, reaching 104.4 mb/d compared to the IEA estimate of 104.1. OPEC's higher estimates are also reflected in the average annual growth rate, which is estimated at 2.3 mb/d compared to 2.2 mb/d from the IEA. The IEA has significantly reduced their projections compared to last year, now estimating 2.5 mb/d lower demand in 2025. In contrast, OPEC's projections are much more similar, with only 0.1 mb/d lower demand estimated in 2025 compared to last year's reports.

The OECD region demonstrates strong growth after the pandemic, then flattens, while non-OECD continues to grow in 2022-2026. IEA and OPEC are relatively aligned on their estimates for growth in non-OECD nations, with differences ranging from 0.1 mb/d to 0.2 mb/d from 2020 to 2026. In contrast, estimates for OECD nations diverge, particularly in 2023, where OPEC estimates demand of 46.6 mb/d and IEA projects demand of 45.8 mb/d. This divergence is obscured in the average growth rate because OPEC and the IEA are highly aligned in their estimates for 2020 and 2026 for OECD nations.

Figures 8a and 8b: non-OECD regions drive Liquids demand growth to 2026



Source: IEA Oil 2021, Table 2; OPEC WOO 2021, Table 3.1



Source: IEA Oil 2021, Table 2; OPEC WOO 2021, 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 2026 demand, with IEA's projections generally lower than the OPECs for most regions, a reversal of last year's trend. Last year we considered OPEC's lower estimates to be partially attributed to their later publication date that allowed more time to incorporate COVID-19 effects.

When looking at specific regions, we can see that the IEA projects 0.03 mb/d slower annual growth relative to OPEC forecasts for the OECD from 2020 to 2026. Of non-OECD nations, the IEA estimates .48 mb/d more liquids demand in China in 2026 compared to OPEC. 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)

	2026		Avg. annual growth (2020-2026)		
	IEA	OPEC	IEA	OPEC	Difference (IEA-OPEC)
Total OECD	**45.80**	**45.95**	**0.62**	**0.65**	**-0.03**
OECD Americas	25.00	25.41	0.40	0.47	-0.07
OECD Europe	13.30	13.19	0.15	0.13	0.02
Asia Oceania	7.50	7.35	0.07	0.05	0.02
Total Non-OECD	**58.30**	**58.46**	**1.58**	**1.37**	**0.22**
Asia	32.00	31.52	0.92	0.95	-0.03
China	16.10	15.62	0.37	0.40	-0.04
India	5.70	6.14	0.20	0.27	-0.07
Other non-OECD Asia	10.20	9.76	0.35	0.27	0.08
Middle East, Africa & Latin America[a]	20.20	20.60	0.53	0.23	0.30
Europe & Eurasia	6.10	5.84	0.13	0.11	0.03
World	**104.10**	**104.41**	**2.18**	**2.30**	**-0.11**

Table 9 data sources: IEA Oil 2021, Table 2; OPEC WOO2021, Table 3.1.
Table 9 notes: Numbers rounded to two decimal places.
[a] OPEC calculates demand from OPEC member countries as a whole by excluding them from the 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 WOO2021 provides sectoral oil demand for the medium and long term. Here, we focus on the medium term with transportation being identified as the largest source of growth, with a 1.7 mb/d increase between 2019 and 2025. Road transport demand shrinks between 2019 and 2020 from 44.6 to 40.0 mb/d, respectively, before recovering to 46.3 mb/d in 2025. Similarly, aviation demand nearly halves from 6.7 mb/d in 2019 to 3.5 mb/d in 2020 before recovering to 7.1 mb/d in 2025. The petrochemicals sector also sees notable growth over the period by a total of 1.1 mb/d from 2019 to 2025.

The IEA's medium-term Oil 2021 report does not include detailed global sectoral data, but instead focuses on the composition of liquids demands through different products. The 2021 report highlights petrochemicals as a key driver of demand growth, particularly in light of the product's ability to maintain positive growth throughout the pandemic. The report also discusses the impact of increased vehicle efficiency on fuel demand growth. In fact, the report suggests that 2019 was likely the global gasoline demand peak, and that we are unlikely to ever return to that point. The Oil 2021 report also mentions the potential impact of teleworking on oil demand in the United States and Europe. The IEA suggests this impact will be minimal, since only 25% of jobs outside the OECD are eligible for remote work, and the impact on total fuel consumption is relatively low even in countries with more eligible work.

5.3 Medium-term Liquids Supply

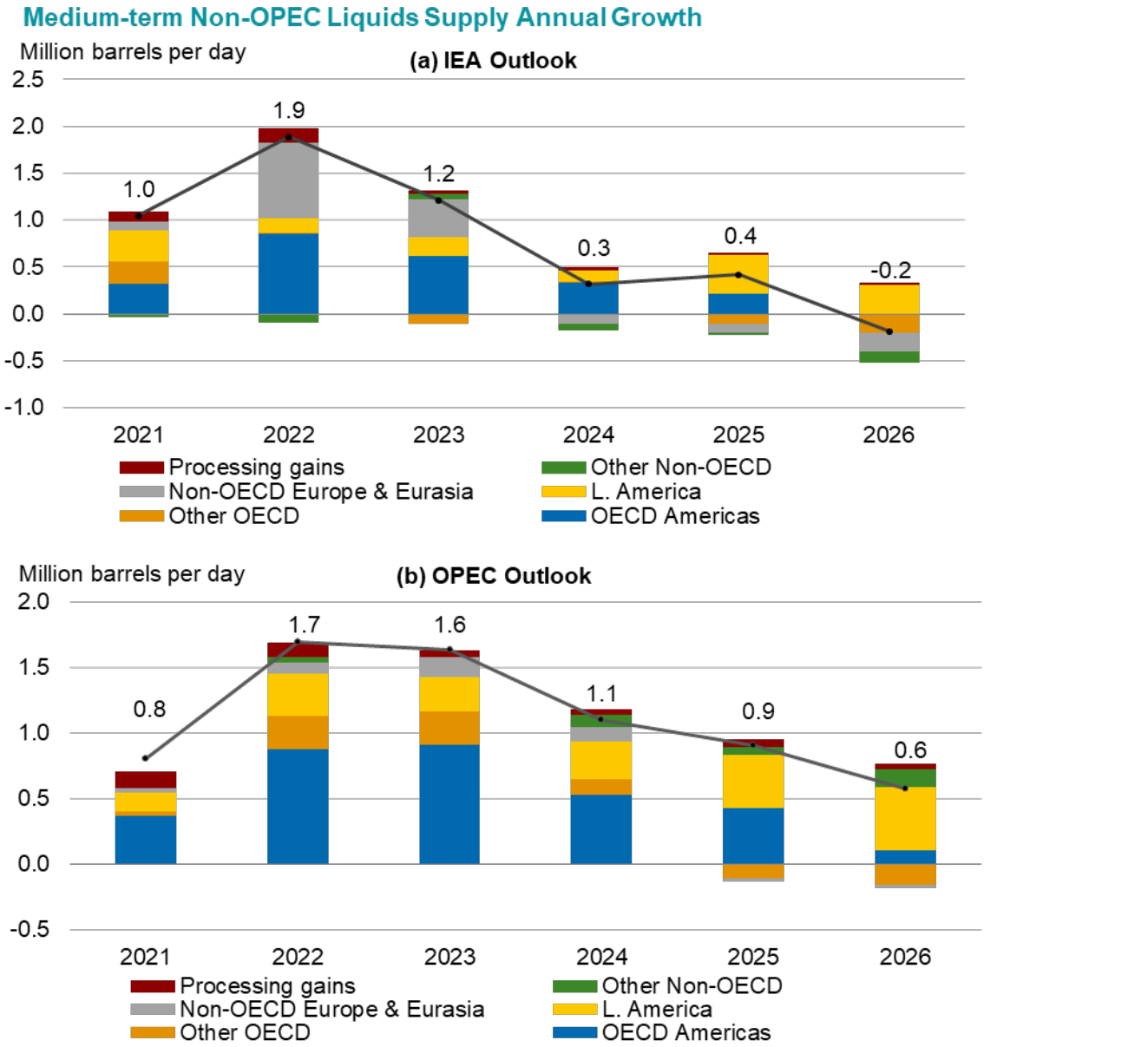
5.3.1 Global and Regional Liquids Supply

OPEC and the IEA projections offer different pictures of estimated non-OPEC supply growth in the near term (see **Figure 9**). Both estimate growth during recovery from the COVID-19 pandemic, but OPEC estimates a more dramatic change from 2021 to 2022 than IEA projections, due to their lower estimates for 2021 growth. OPEC also estimates consistently higher growth in further projections, while the IEA considers a more substantial slowing of growth starting in 2023. IEA projects a peak cumulative growth of 1.9 mb/d in 2022, while OPEC projects 2.1 mb/d in growth the same year. However, OPEC estimates growth will still be at 0.6 mb/d in 2026, while IEA estimates a decline in non-OPEC supply of 0.2 mb/d.

The distribution of growth by region is also quite different for OPEC and the IEA. OPEC's larger estimates in future years are in part driven by larger estimates for the OECD Americas and Latin America regions. Additionally, OPEC estimates continued growth in the "other non-OECD" regions (Middle East & Africa and Non-OECD Asia) in 2025 and 2026, compared to the IEA which projects a decline in their supply for those years. Finally, while IEA estimates that non-OECD Europe and Eurasia

will decrease their supply in 2025 and 2026 OPEC projects relatively flat growth. Furthermore, the two organizations show a significant difference in production growth in 2022 and 2023.

Figure 9: Non-OPEC supply growth falls into 2026



Source: Figure 10 data sources: IEA Oil 2021, Table 3, Table 5, Table 5a; OPEC WOO 2021, Table 4.1. Sums may differ due rounding. Figure 10 notes: Other OECD is the sum of data from OECD Europe and Asia Oceania; Other Non-OECD is the sum of data from Middle East & Africa and Non-OECD Asia.

Table 9 provides a detailed regional comparison of medium-term liquids supply between the two outlooks. Compared to the IEA's projections for March 2021, the later OPEC figures have both higher and lower estimates varying from region to region. OPEC projects 27.9 mb/d from OECD Americas in 2026, while the IEA sees production in the region of 27.2 mb/d. OPEC also revised their Europe estimates downward to 4.2 mb/d in 2026 from 4.5 mb/d estimated for 2025 last year. The IEA held their estimate for the region constant at 3.8 mb/d. OPEC also projects greater supply from Latin America (8.0 mb/d compared with 7.6 mb/d for the IEA) and Non-OECD Europe and Eurasia (14.8 mb/d compared with 14.5 mb/d for the IEA). These disparities are more modest than those observed last year.

In total, the IEA forecasts 67.6 mb/d in liquids supply from non-OPEC nations in 2026, while OPEC estimates 70.4 mb/d. The IEA's projections imply supply from OPEC member nations of 39.8 mb/d, 5.7 mb/d higher than the assessments by OPEC. The IEA projects overall greater supply in 2026, with a total of 107.4 mb/d compared to OPEC's projection of 104.6 mb/d for the same year. In that year, the IEA projects that OPEC provides 37% of global liquids, compared with an estimate of 33% from OPEC.

Despite differences in projected regional growth from 2020 and 2026, average annual growth over the period remains close between both organizations' regional forecasts, with two notable exceptions: aggregated OECD nations for which OPEC projects growth averaging 0.4 mb/d greater annually than the IEA; and growth in total OPEC supply, which the IEA estimates suggest will grow at an average of 0.9 mb/d higher than OPEC's projections.

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

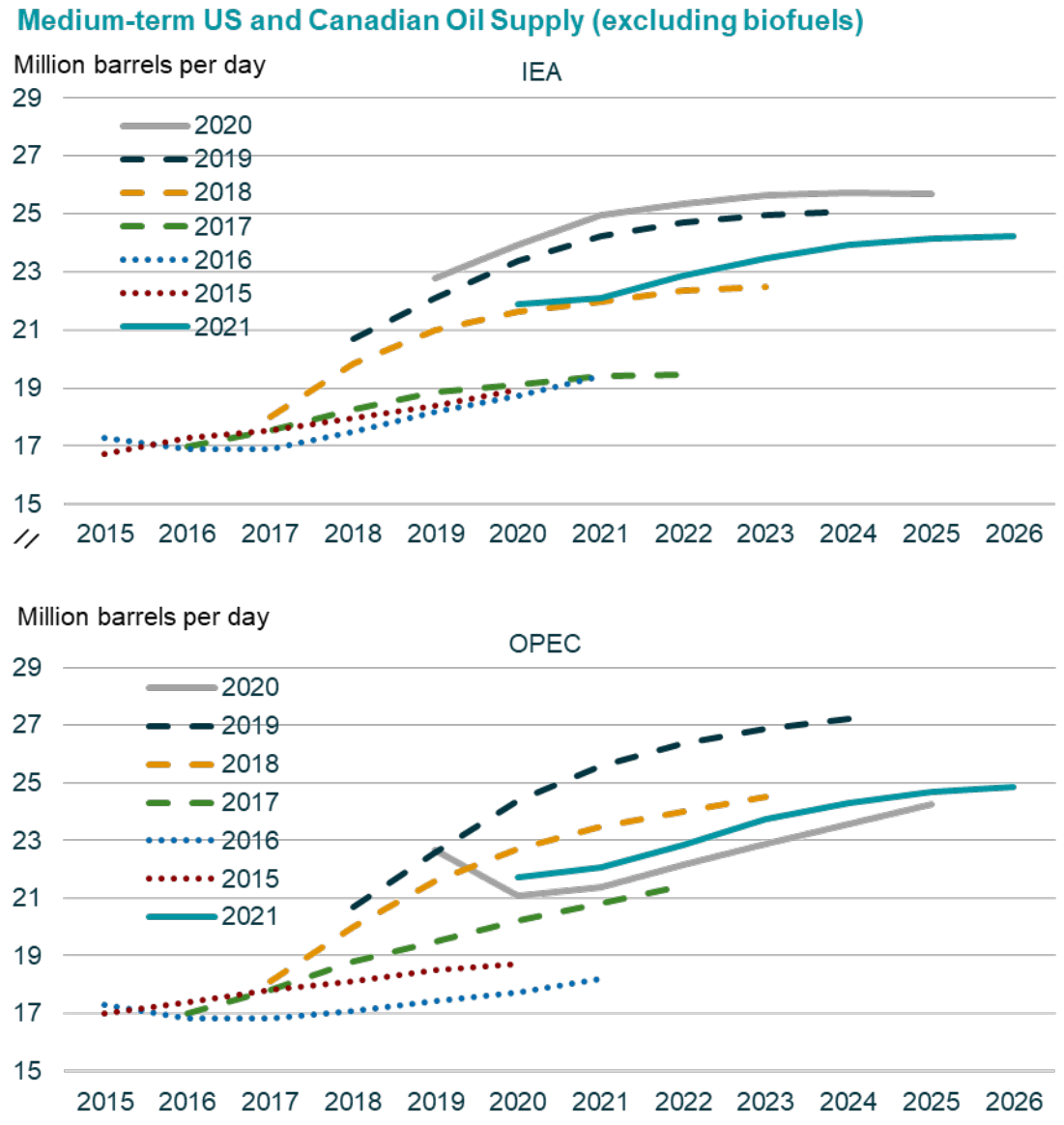
	2026		Avg. annual growth (2020-2026)		
	IEA[b]	OPEC	IEA	OPEC	Difference (IEA-OPEC)
Total OECD	**30.55**	**32.73**	**0.20**	**0.60**	**-0.40**
OECD North America	27.21	27.91	0.39	0.53	-0.14
OECD Europe	3.81	4.21	-0.01	0.05	-0.06
Asia Oceania	0.43	0.61	-0.02	0.01	-0.03
Total Non-OECD	**33.64**	**35.13**	**0.34**	**0.58**	**-0.24**
Asia	6.85	7.21	-0.09	-0.03	-0.06
China	3.88	4.14	-0.03	0.00	-0.03

Other non-OECD Asia	2.97	3.07	-0.06	-0.03	-0.02
Middle East & Africa	4.70	5.15	0.03	0.09	-0.06
Latin America	7.59	7.96	0.26	0.32	-0.06
Europe & Eurasia	14.52	14.81	0.15	0.20	-0.05
Processing Gains	2.49	2.58	0.06	0.07	-0.01
Total Non-OPEC	**67.58**	**70.44**	**0.75**	**1.25**	**-0.50**
Total OPEC	**39.81**	**34.14**	**1.49**	**0.58**	**0.91**
OPEC crude[a]	34.11		1.40		
OPEC NGLs + unconventionals	5.70		0.08		
World	**107.39**	**104.58**	**2.23**	**1.82**	**0.41**

Table 10 data sources: IEA Oil 2021, Tables 3, 5, and 5a; OPEC WOO2021, Table 4.1.
Table 10 notes: Numbers rounded to two decimal places.
[a] 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 2021 Tables 5 and 5a.
[b] Estimates for total OPEC supply and world supply are constructed from other components because IEA does not directly provide these forecasts in their reports.

Figure 10 illustrates projections for medium-term oil supply by the IEA and OPEC, which are relatively aligned in the near term. Last year, projections were impacted substantially by the unmatched episode of energy market volatility in the eight months between the publication of the two medium-term reports due to the COVID-19 pandemic. This year, projections out to 2026 are relatively similar, with OPEC estimating slightly greater oil supply from the US and Canada, excluding biofuels.

Figure 10: North America liquid supply growth continues to 2026



Source: IEA Oil 2021 Table 3; OPEC WOO 2021 Tables 4.1 and 4.2, Figure 4.7. IEA Oil 2020 Table 3; OPEC WOO 2020 Tables 4.1 and 4.2, Figure 4.7. IEA Oil 2019 Table 3; OPEC WOO 2019 Tables 4.1 and 4.2, Figure 4.7; 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

6 Long-term Energy Outlooks

The following comparison of long-term outlooks focuses on the IEA's World Energy Outlook 2021 (WEO2021) and OPEC's World Oil Outlook 2021 (WOO2021). In these reports, the IEA makes projections extending through to 2050, and OPEC makes projections through 2045. Unlike some previous years, these long-term outlooks base their projections on the common baseline year of 2020, facilitating comparison.

Differences between the IEA and OPEC in their choice of units for primary energy demand create some challenges in making comparisons. OPEC uses million barrels of oil equivalent per day (mboe/d), while the IEA uses exajoules (EJ) for primary energy projections (the IEA also publishes fuel-specific volumetric data for certain measures). Where necessary, we convert the IEA's units of primary energy from EJ per year to mtoe by multiplying by a factor of 23.8864 mtoe/EJ, and to mboe/d by multiplying by 7.37[3] mboe/mtoe and dividing that total by 365 days per year, yielding a conversion factor of 0.0202 mboed/mtoe.

A more substantial 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.), and the IEA publishes aggregate projections for the broader OECD and non-OECD categories, since 2018 it no longer groups regions according to OECD status in its main results and Annex tables. The IEA has provided additional data with these regional groupings for this report to enhance comparability.

6.1 Key Assumptions

6.1.1 Outlook Scenarios

Similar to the previous year's report, in the WEO2021 the IEA has introduced a novel scenario design, reflecting the deep uncertainty surrounding a global energy transition in the face of mounting climate policy efforts. Because of these uncertainties, the IEA did not publish a "Current Policies Scenario" that reflects current pathway dependency or the baseline in scenario modelling. Instead, the IEA focuses on the Stated Policies Scenario (STEPS) and the Sustainable Development Scenario (SDS). It also provides projections for certain policy measures under two new scenarios: the Announced Pledges Scenario (APS) and the Net Zero Emissions by 2050 (NZE).

As in previous years, OPEC focuses on a single Reference Case and has this year included an Accelerated Policy and Technology Case (APT) and Higher and Lower GDP and Supply growth sensitivity cases, respectively. **Table 11**. lists key assumptions for the scenarios included in the WEO2021 and WOO2021. A more detailed comparison is provided in **Annex 1**, and a comparison of key outlook results for each scenario is featured in **Annex 2**.

[3] IEA, Oil Information 2015, IV.93. In WEO2019 (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.

Table 12. Long-term Scenario Key Assumptions

IEA WEO Scenarios	OPEC WOO Scenarios
Stated Policies Scenario (STEPS) Considers both policies in place and announced targets	**Reference Case** Considers policies that have been enacted as well as viable evolution of these policies guided by announced targets
Announced Pledges Scenario (APS) Assumes that currently in place climate targets and commitments from countries, such as nationally determined contributions (NDCs) and long-term net zero targets, are completed on time	**Accelerated Policy and Technology Case (APT)** Additional energy policies are adopted across all major sectors, resulting in faster adoption of energy efficiency technologies
Sustainable Development Scenario (SDS) Ensures universal energy access by 2030; sharply reduces air pollution; aligns with Paris Agreement goals to limit global warming "well below 2°C"	**Higher and Lower GDP Cases** Sensitivity cases that assume greater and lower GDP growth rates relative to the Reference case, reflecting different pandemic recovery speeds
Net Zero by 2050 Scenario (NZE) Lays out additional measures that would need to be adopted over the next 10 years to put the world on track to reach net zero emissions by mid-century	**Higher and Lower Supply Cases** Sensitivity cases that consider greater and lower non-OPEC oil supply, with US tight oil production particularly variable

Like last year, the STEPS considers both policies in place as well as policies and commitments that have been announced. It also includes forward looking assumptions about the continued evolution of technologies, including cost reductions associated with increased deployment and “learning-by-doing.” The SDS models an energy path consistent with the United Nations’ Sustainable Development Goals, and projects that carbon dioxide emissions from fossil fuel consumption will decline through 2050 consistent with the long-term temperature goals outlined in the 2015 Paris climate agreement. These two IEA scenarios, along with the NZE scenario, share the same GDP and population assumptions, while variations in policy affect technological development and demand-supply patterns in energy markets. The SDS and NZE scenarios are normative in their modelling, assuming that climate and development targets are achieved, while the other IEA and OPEC scenarios are forward looking from their baseline assumptions.

In the APS, the IEA considers a scenario where countries uphold their existing climate targets and commitments on time to complete their climate goal. In the NZE, the IEA lays out energy system

changes that go beyond those seen in the SDS to achieve net zero greenhouse gas emissions by 2050.

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 Chapter 7 of WOO2021. Chapter 8 of the WOO2021 also includes several sensitivity cases that explore GDP and liquids supply variability within the Reference case, as well as the Accelerated Policy and Technology Case (APT) that considers the impact of additional energy policy on oil demand.

While OPEC's Reference Case considers new policies and pledges to fulfil both climate and sustainable development goals, like the IEA WEO scenarios, it is challenging to find a single counterpart in IEA's WEO2021 for comparison. As a result, we focus on a comparison between the WOO2021 Reference Case and the IEA's STEPS and SDS, selectively providing other IEA scenarios and OPEC sensitivity cases for

6.1.2 Demography

As in previous outlooks, both the IEA and OPEC base their demographic assumptions primarily on projections made by the Population Division of the United Nations Department of Economic and Social Affairs. However, the organizations differ slightly in their baseline 2020 population estimates. OPEC assumes a world population of 7,792 million while the IEA assumes a world population of 7,749 million in 2020. Both OPEC and the IEA assume annual population growth rates of roughly 0.8% from 2020 through 2045 and 2050, respectively.

For both outlooks, the largest population growth comes from developing countries. For OPEC, the non-OECD region grows by 1.0% p.a., while the OECD experiences annual growth of roughly 0.2% p.a. For the IEA, the most rapid population growth rates are seen in Africa (2.1% p.a.) and the Middle East (1.2% p.a.). OPEC did not publish specific population growth assumptions for Africa in 2021.

In addition to population growth assumptions, urbanization continues to accelerate under both projections, with the share of people living in cities growing from 56% in 2020 to 68% in 2050. This trend occurs most rapidly in Africa and non-OECD Asia. Other crucial demographic factors that may impact energy consumption include age and global migration patterns.

6.1.3 Economic growth

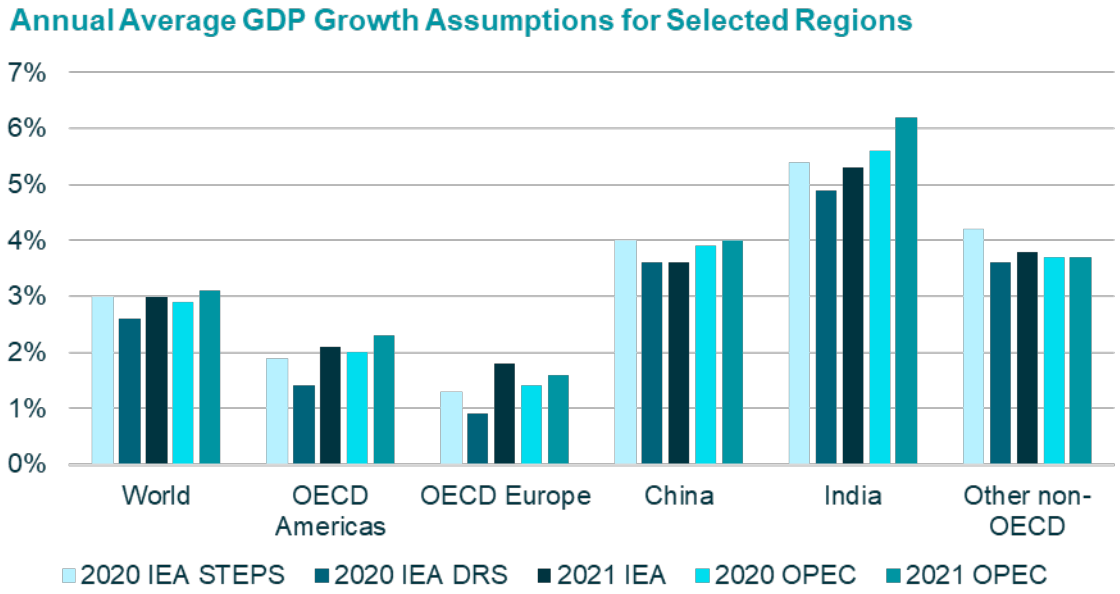
The IEA and OPEC take similar approaches in deriving GDP assumptions. For medium-term projections, both use internal expertise in combination with economic forecasts published by the IMF, World Bank, and other organizations. Their long-term projections, however, are based on assumptions about working population and productivity levels, key factors in determining economic growth rates. The IEA and OPEC both use 2020 as a base year and make GDP assumptions in Purchasing Power Parity (PPP) terms. Note that OPEC's projection period in the WOO2021 extends through to 2045, while the IEA's projections extend through to 2050 in the WEO2021.

This year the IEA uses the same GDP assumptions for each of its scenarios. The IEA assumes average annual GDP growth of 3.0% from 2020 to 2050, compared with OPEC's assumption of 3.1% from 2020 through 2045 in the Reference case. These figures reflect slight revisions upward from last

year's assumptions. In OPEC sensitivity cases, growth rates of 2.9% and 3.3% are assumed for the Lower GDP and Higher GDP cases, respectively.

Figure 11 illustrates annual average growth over each projection period globally and in key regions, highlighting the revisions being made with a persistent COVID-19 pandemic generating additional uncertainties. 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 assumes approximately the same growth in China as last year, though growth in India has increased from 5.6% to 6.2%. The IEA's growth assumptions are roughly level for India at about 5.3%, while their China estimate has fallen from 4.0% in 2020 STEPS to 3.6% in 2021. In OECD Americas and OECD Europe, both the IEA and OPEC have revised their growth assumptions upwards. Revisions for economic growth in China are more modest, ranging from 0.1% year-over-year from OPEC to a 0.4% reduction in WEO2021 IEA from last year's DRS.

Figure 11: India sees greater GDP growth compared to other countries and regions



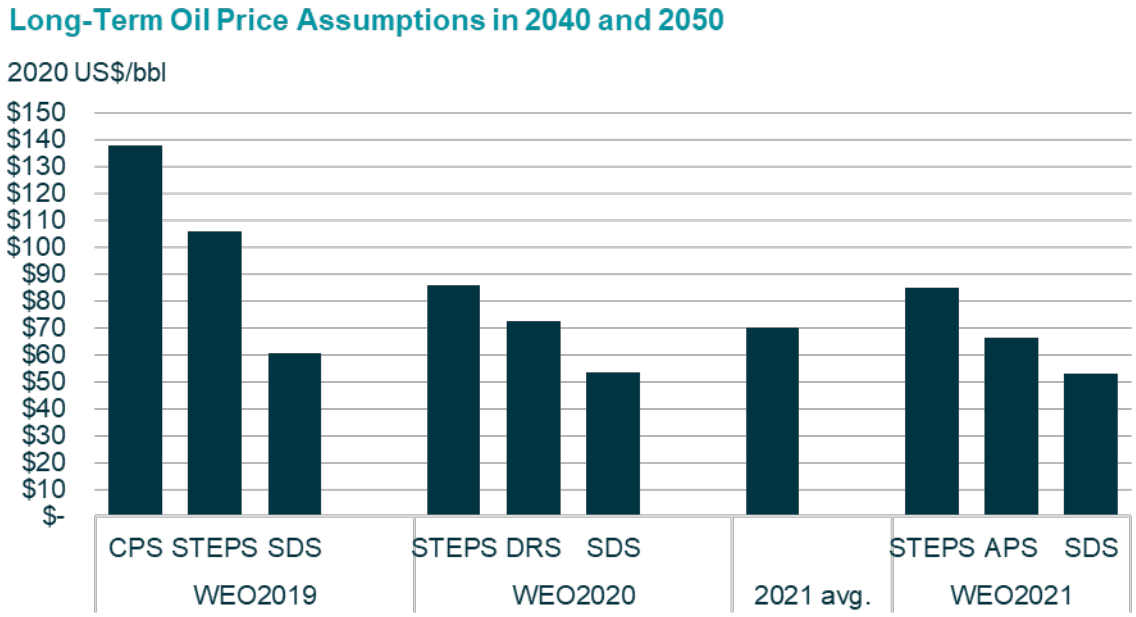
Source: IEA WEO 2021 Table 2.1; OPEC WOO2021 Table 1.5.
Notes: the IEA's 2021 assumptions extend from 2020 through 2050, while their 2020 assumptions are from 2020 to 2040. OPEC's assumptions extend from 2020 through 2045, which results in a higher annual average growth rate because growth is slower near the end of the projection period. 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. In 2021, OPEC moved from using a 2011 base year to a 2017 base year.

6.1.4 Oil Prices

The IEA WEO series takes a different approach from long-term scenarios to derive oil prices 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 stated above, OPEC has not published its medium- or long-term oil price assumption since 2016.

As shown in **Figure 12**, the IEA's future price assumptions are largely consistent with those used last year. Oil prices diverge slightly year-over-year under STEPS and SDS. Under the new APS, oil prices descend modestly after 2030, reaching $64/bbl in 2050. In 2020, the IEA's STEPS assumed a 2040 oil price of $42/bbl. We do not cover alternative OPEC scenarios in this figure because they do not provide cost projections for their long-term analyses.

Figure 12: Sustainable Development scenarios see lowest price assumptions



Source: Figure 13 Data Sources: IEA WEO 2019 and 2020 Table B.4, IEA WEO 2021 Annex Tables. US EIA for 2021 average Brent price.
Note: OPEC has not published medium- or long-term oil price assumptions since WOO2016.

6.1.5 Energy and Climate Policies

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 prominent attention. For the most part, these policies have remained in place or have strengthened since 2015.

Most nations have committed to pursuing their NDCs through various domestic policies, and major economies including the European Union, India, Japan, the Republic of Korea, Saudi Arabia, Russia, the United Arab Emirates, the United States, and many others have announced goals of achieving net-zero greenhouse gas emissions by 2045 through 2070. In WEO2021, the IEA highlights various 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, including details on carbon pricing, air pollution, transport policies, and energy efficiency standards. With the addition of the APS and inclusion of the NZE, the IEA is identifying the gap between current policy, current commitments, and climate ambitions through the differences between the STEPS, APS, and SDS and NZE scenarios.

In WOO2021, OPEC dedicates Chapter 7 to energy policy issues with a focus on climate change trends and policies, discussing developments among Paris Agreement parties and assessing the emissions gap from existing NDCs. It also describes policies related to sustainable development, paying particular attention to the potential of hydrogen in decarbonization efforts. OPEC additionally includes the Accelerated Policy and Technology Case (APT) in chapter 8, which considers faster implementation of additional energy policy and subsequently quicker energy efficiency technology adoption.

6.2 Long-term Energy Demand

6.2.1 Primary Energy Consumption

Despite the effects of COVID-19 on the global economy near-term energy demand-supply balances, public policies, and energy technology, the central projections from both the IEA and OPEC see global energy demand rising through 2045 for OPEC and 2050 for IEA. Although the percentage rate of growth is slower, absolute levels of growth are similar to previous decades. Consumption growth is driven primarily by an expanding population and economy, with the majority of new demand coming from developing countries, particularly in Asia. Fossil fuels continue to dominate the primary energy mix, with oil, natural gas, and coal providing 68% under IEA STEPS, and 70% under OPEC's Reference scenario in 2045, though this is notably less than their current share of about 80%. Fossil fuels in IEA APS stand at 57% in 2045, while the SDS and NZE scenarios see fossil shares of 42% and 27%, respectively. Both SDS and NZE scenarios are assumed 'compatible' with the long-term goals of the Paris agreement.

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.

Total primary energy demand grows under three of the five scenarios considered here, increasing by 0.9% per year on average for the IEA STEPS and by 1.0% per year under OPEC's Reference case from their respective 2020 baselines through 2045. Under the IEA SDS, global energy demand

declines by an average of -0.1% per year, significantly more modest than last year's SDS projection of -0.5% annually, and with 6.5% higher total demand in 2040 than the previous projection.

Error! Reference source not found. provides a comparison of projections for total primary energy demand by energy source, highlighting a number of differences. Overall, the IEA STEPS and OPEC Reference scenarios see very similar energy demand profiles in 2045, while the APS, SDS, and NZE see incrementally more significant changes from 2020.

OPEC's Reference Case projects coal demand to decline by 12 mboe/d from 2020 to 2045, while IEA's STEPS projects a coal decline of 14 mboe/d. Oil consumption sees large increases in both scenarios, by 17 mboe/d for OPEC's Reference Case and by 13 mboe/d under IEA STEPS. Similarly, natural gas demand grows by a sizeable 17 mboe/d in IEA STEPS and 22 mboe/d in OPEC Reference.

Under the "Paris-aligned" scenarios, the IEA's SDS and NZE, global coal demand falls by 54 mboe/d and 64 mboe/d, respectively. The APS, SDS, and NZE scenarios show progressively lower levels of oil and gas demand looking at 2045. For these three scenarios, oil demand falls by 9/32/55 mboe/d, while gas drops 2/21/35 mboe/d.

Under all scenarios, hydro, other renewables, and nuclear grow considerably over the coming decades. Hydropower grows by 3 mboe/d under both IEA STEPS and OPEC Reference scenarios. Other renewables, led by wind and solar, grow by 30 and 32 mboe/d under OPEC's Reference Case and IEA STEPS, respectively, while surging in the other IEA scenarios. In IEA APS, SDS, and NZE, non-hydro and non-biomass renewables gain a massive 49/67/92 mboe/d between 2020 and 2045. Nuclear energy rises by at least 5 mboe/d in all scenarios, and as high as 13 mboe/d in IEA NZE. We do not include alternative OPEC scenarios because they do not provide energy source breakdown projections in their long-term analyses outside of the reference case.

Figure 13: Other renewables see greater growth in sustainable and net-zero scenarios

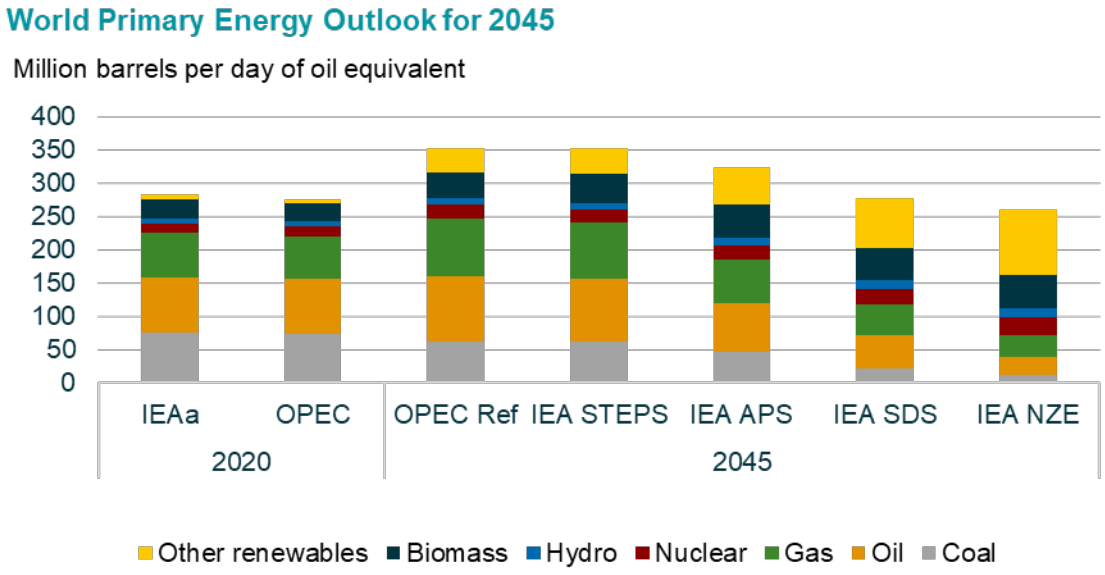


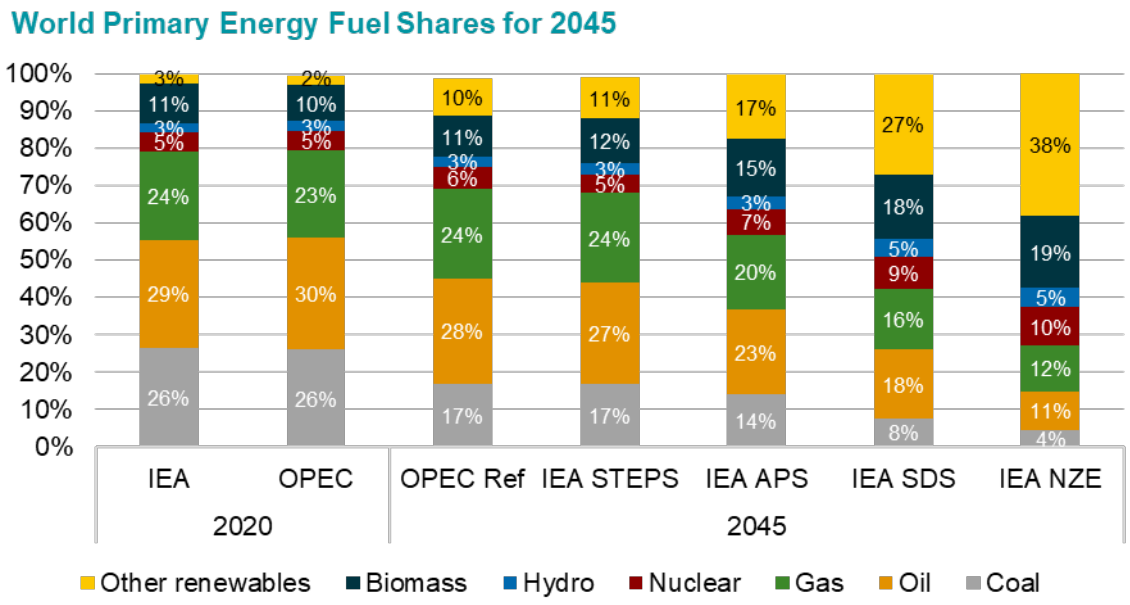
Figure 14 data sources: IEA WEO 2021, Annex Tables; OPEC WOO2021, Table 2.1 for Reference Case.
Figure 14 note: a IEA primary energy is converted from EJ per year to mboe/d by multiplying by 0.4825 mboed/EJ. OPEC Sensitivity Scenarios do not provide fuel-specific data for non-fossil fuels.

Figure 14 presents the share of each fuel in the global energy mix in 2020 along with projections for 2045. In nearly all scenarios examined here, where other renewables are disaggregated to solar and wind, oil maintains its position as the leading primary energy source globally; only in the IEA NZE does oil fall below demand for natural gas, biomass, solar, and wind. In OPEC's Reference Case oil slightly decreases from 30% in their 2020 baseline to 28% in 2045, while in IEA STEPS it dips from 29% to 27% in the same period. We do not include alternative OPEC scenarios because they do not provide energy source breakdown projections in their long-term analyses outside of the reference case.

Coal's share of the mix declines substantially under all scenarios, falling to 17% of global primary energy supply under both IEA STEPS and OPEC's Reference scenarios. In contrast to last year's report which saw natural gas increases from 2019 to 2040, under this year's central scenarios we see the natural gas share virtually level at about 24% from 2020 to 2045. Under the "Paris-aligned" scenarios', natural gas' share falls in tandem with oil.

The share of renewables, which is currently dominated by biomass and includes hydropower, is projected to increase in all scenarios from roughly 15% in 2020 to 24% in OPEC's Reference Case, 26% under IEA STEPS, and 36% under the IEA's APS in 2045. The more ambitious IEA SDS and NZE scenarios see the renewables share at 49% and 63%, respectively. Virtually all this growth comes from renewable electricity such as wind, solar, and hydro.

Figure 14: Fossil fuels show great variance between 27 and 69 percent in 2045



Source: See Figure 13. Sums in the data callouts may not total due to rounding.

6.2.2 Liquids Demand

Several differences between the IEA and OPEC create challenges in directly comparing long-term liquids demand projections.

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. To adjust for this difference, we aggregate the IEA's oil and biofuels demand for each region, making the numbers comparable with OPEC's.[4] In some cases, we must also convert IEA biofuels data from energy equivalent units (mboed) to volumetric units (mb/d) for comparison with OPEC.[5]

Additionally, 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. OPEC also does not differentiate between international and domestic aviation fuels. 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.

Finally, 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 the IEA reported the Middle East and Africa regions separately, OPEC groups them together as a single category. This paper aggregates the Middle East and Africa in WEO2021 to compare oil demand projections between the two organizations more directly.

Incorporating these adjustments, we compare long-term world liquids demand projections using the major scenarios from WEO2021 and WOO2021. Although the share of liquids in the world primary energy mix is expected to decrease relative to 2020, the level of demand still enjoys growth over the projection period under baseline scenarios. In IEA's STEPS and OPEC's Reference Case, world liquids demand reaches 108.8 mb/d and 108.2 mb/d, respectively, by 2045. In the IEA's SDS, 2045 world liquids demand shrinks to 63.0 mb/d. The lowest liquids demand estimate of the group of scenarios is associated with the IEA NZE at 22.1 mb/d in 2045.

Of particular interest is the widening gap observed between the IEA STEPS and OPEC Reference scenarios, the IEA APS, and the "Paris-aligned" IEA SDS and NZE scenarios. In 2045, the gap between the IEA STEPS and OPEC Reference scenarios and the IEA SDS is roughly 45 mb/d, and 78 mb/d for the IEA NZE. This difference illustrates the annually growing "gap" between current and planned policies (OPEC Reference and IEA STEPS), announced policies (IEA APS), and policies assumed consistent with the long-term goals of the 2015 Paris climate agreement (IEA SDS and NZE).

Figure 15 also suggests that liquids demand growth may slow considerably in the coming decades from 2020 through to 2030, the IEA STEPS projects demand to grow by 16.7 mb/d compared with

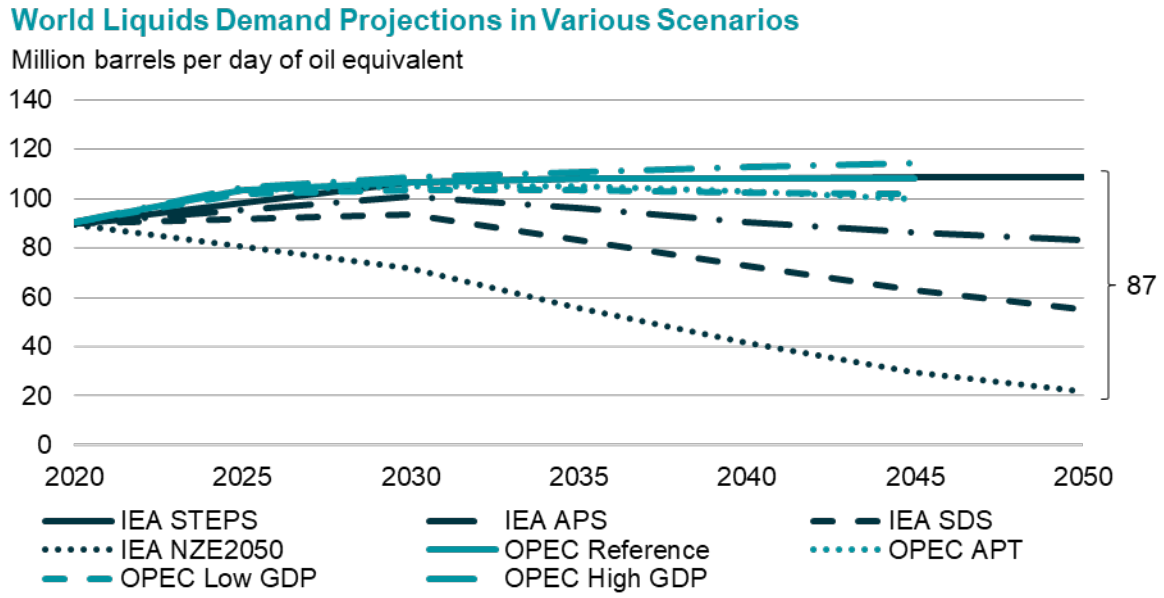
[4] These regional biofuels projections were provided via internal communication with and the IEA and supplemented with data from the WEO2021 Annex Tables.

[5] 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 0.7397. This factor is derived from the IEA's medium term Oil2020 report, which reports 2019 global biofuels demand of 2.8 mb/d (physical units), and IEA's WEO, which reports 2019 global biofuels demand of 2.1 mboe/d (energy equivalent units)

16.0 mb/d under OPEC's Reference scenario, after which demand growth tapers off. The IEA's APS and SDS scenarios see more modest demand increases by 2030 relative to 2020 levels and decline from 2030 onwards. Under the IEA NZE, liquids demand immediately and consistently decreases through the projection period.

OPEC also projects different liquids demand futures with their alternative economic growth cases and APT case. Their sensitivity analysis around potential future GDP growth impacts liquids demand as may be predicted: Higher GDP case assumptions leads to higher demand. The APT case sees less demand relative to the Reference case by 2045, to 99.8 mb/d, aligning closely with the demand in the Lower GDP growth case. The annually growing "gap" in liquid demand scenarios rises between OPEC's High GDP Growth Case and the IEA's NZE Scenario to 84.6 mb/d in 2045 reflecting growing uncertainty in respect of liquids demand trends.

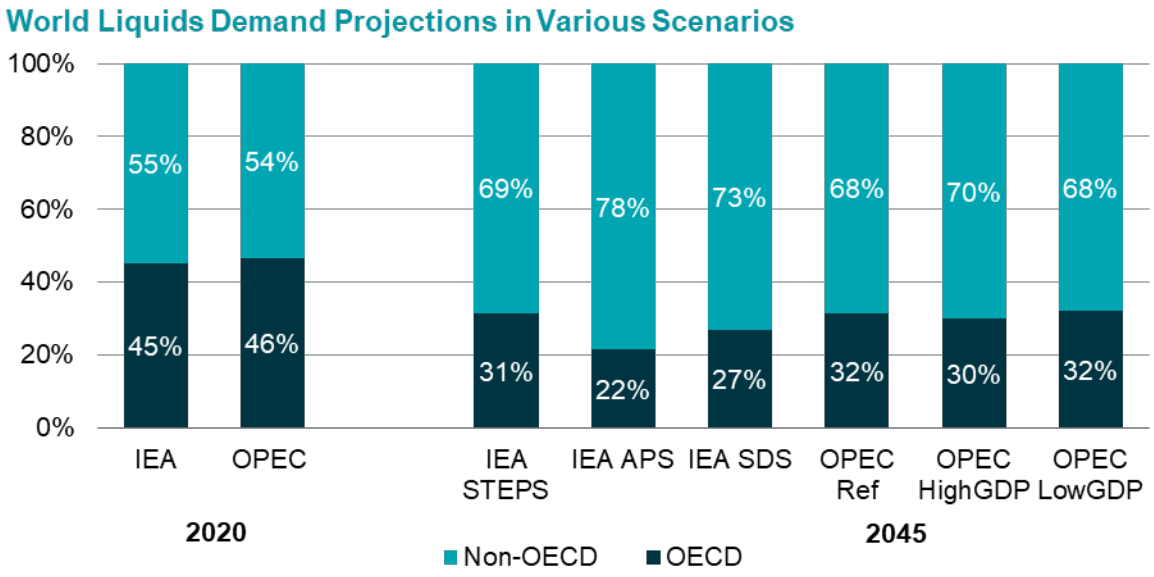
Figure 15: IEA and OPEC scenarios show large divergence on long-term forecasts



Source: IEA WEO 2021, Annex Tables; OPEC WOO 2021, Table 3.2 for Reference Case

Projections for the share of liquids demand from aggregate OECD and non-OECD groups are similar across all scenarios. Both organizations 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. The centre of demand growth continues to shift to developing countries. Non-OECD nations' share of global liquids demand increases from 55% to between 68% and 78% by 2045 (**Figure 16**) under different projections.

Figure 16: The Non-OECD region accounts for over 60 percent of liquids demand in all scenarios into 2045



Source: IEA WEO 2021, Annex Tables and internal communication; OPEC WOO 2021, Table 3.2.
a The "bunkers" group in the IEA's WEO report is excluded from calculation for OECD and non-OECD oil demand shares.
b Biofuels from IEA WEO 2021 (provided via internal communication) are added to IEA regional oil demand data for comparability with OPEC estimates.

Perspectives on sectoral trends are broadly consistent between the IEA and OPEC. The transportation and the petrochemicals industries remain the largest oil consumers and contribute most of the demand growth. Oil consumption for power generation is projected to decrease in all regions. As a result, shares of oil consumption in transport and petrochemical sectors continue to grow.

6.3 Long-term Oil Supply

6.3.2 Liquids Supply

Direct comparison of liquids supplies between the IEA and OPEC is challenging. As in previous years, OPEC includes biofuels supplies within its regional liquids supply estimates, while the IEA does not. OPEC also publishes region-specific biofuels production data, allowing us to adjust OPEC data to match the IEA's regional liquids supply projections (which exclude biofuels). One additional challenge is that OPEC does not publish data on the composition of OPEC supplies (i.e., OPEC crude and OPEC NGLs + unconventionals).

The IEA's STEPS projects 108.8 mb/d in supplies in 2045, compared with 108.2 for OPEC's Reference Case. Under the IEA's APS, global supplies decline to 86.2 mb/d by 2045.

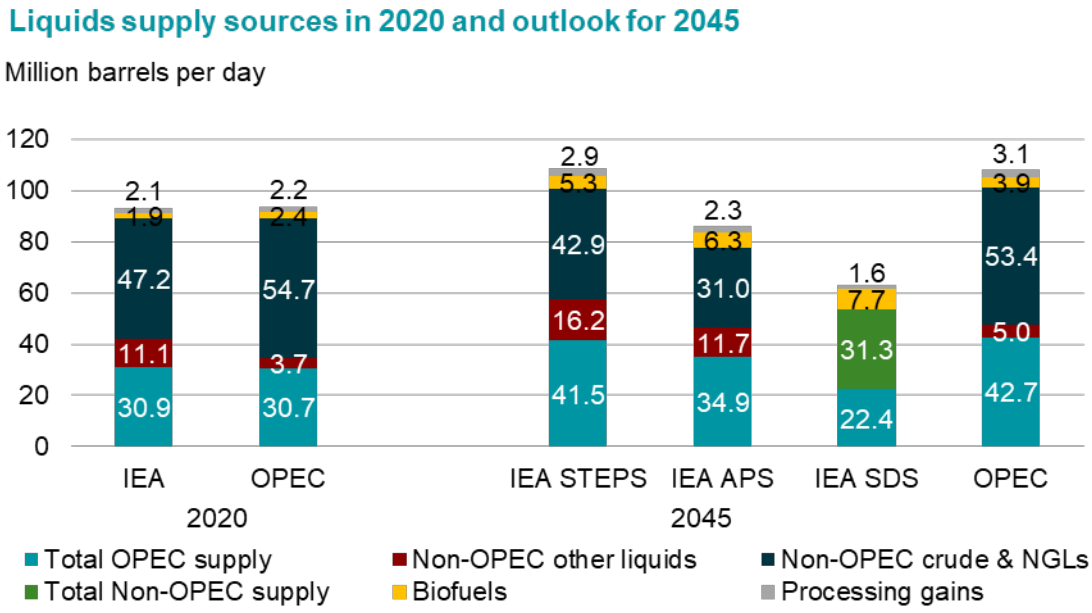
Despite the similar estimates for global supplies under the IEA STEPS and OPEC Reference policy scenarios, some differences emerge regarding regional supplies. Perhaps the most notable difference is between projections for Chinese production. IEA's STEPS projects supply from China to be 2.6 mb/d compared to OPEC's reference projection of 3.7 mb/d in 2045. In contrast, some regions have smaller disparities than in previous years. For example, IEA's STEPS projects OECD Americas to be

only 0.4 mb/d higher than under OPEC's Reference Case by 2045, and total OECD supplies to be only 0.1 mb/d lower than OPEC's projection. Larger difference emerges from the non-OECD region, where OPEC projects supplies in 2045 to be 7.5 mb/d higher than IEA's STEPS.

OPEC and the IEA differ in their projections for global unconventional supplies. Overcoming the effects of the pandemic and uncertainty over finances for US tight oil producers, both organizations project continued growth in US tight crude supplies. Under IEA STEPS, US tight crude production increases from 7.3 mb/d in 2020 to 11.6 mb/d by 2045. Under OPEC's Reference Case, US tight crude also starts at 7.3 mb/d in 2020, but peaks at 9.7 mb/d in 2030 before declining to 7.1 mb/d by 2045. Tight liquids production also grows in Canada, Argentina, and Russia, but most supplies emerge from the United States, led by the Permian basin region.

The IEA and OPEC use different classification systems for liquids fuels, presenting challenges when comparing long-term supply forecasts.[6] Analysis of the IEA's and OPEC's views about the composition of world supply by fuel type, as shown in **Figure 17** and **Figure 18**, also yields notable points. **Figure 17** shows that baseline policy scenarios project increasing liquids supply, mostly from OPEC sources. **Figure 18** shows OPEC's share of global supply growing under both baseline policy scenarios, increasing from 33% to 38% under IEA STEPS and 39% under OPEC's Reference Case. This increase in supply share comes at the reduction in the share of supply provided by non-OPEC crude and NGLs in particular. The estimate of the non-OPEC crude and NGL share of supply decreases by 12 percentage points in the IEA STEPS case and 9 percentage points in the OPEC Reference Case by 2045 from their respective 2020 baselines. We do not include alternative OPEC scenarios in Figures 19, 20 or 21 because they do not provide supply source breakdown in their long-term analyses outside of the reference case.

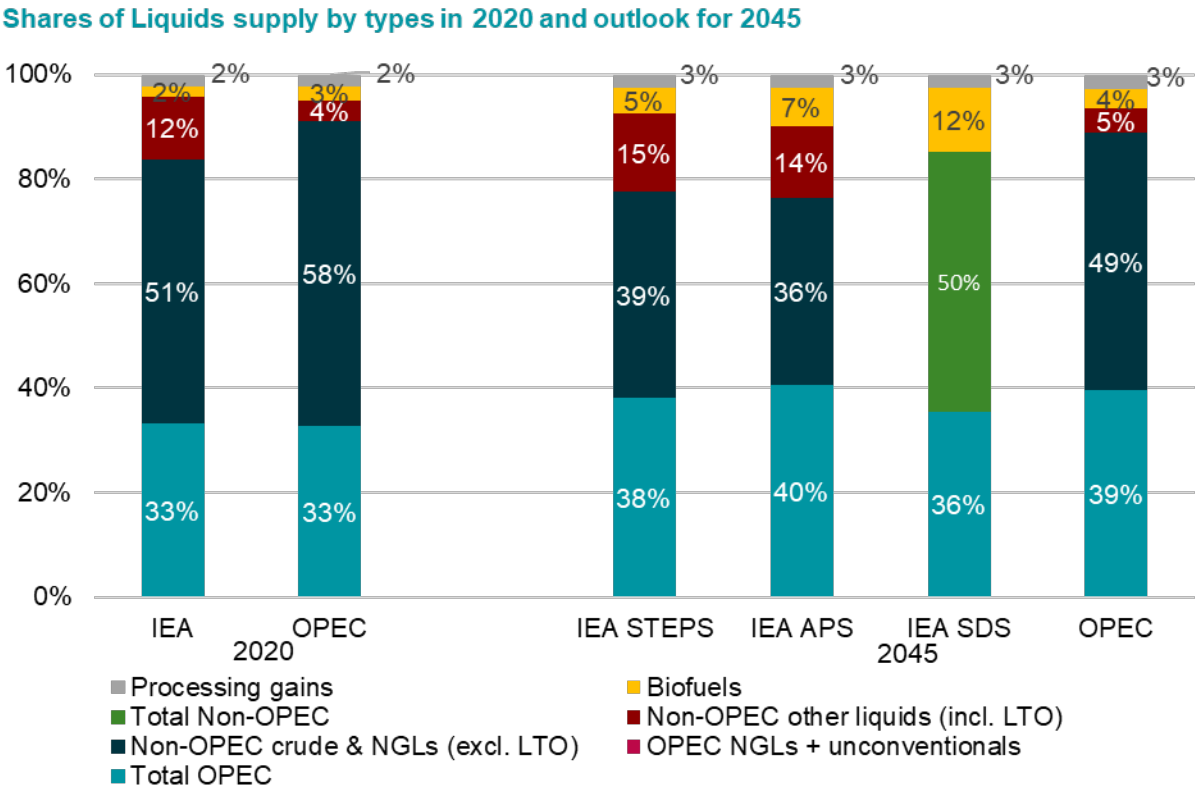
Figure 17: OPEC and non-OPEC supply see production parity in the IEA STEPS scenario



Source: IEA WEO2021 Annex Tables; OPEC WOO2021, Table 4.2 through 4.18
Note: The IEA includes LTO and oil sands in Non-OPEC other liquids, whereas OPEC includes LTO and unconventional NGLs in Non-OPEC crude & NGLs

[6] For further information on the classification of IEA and OPEC liquids supplies, see Figures 10(a) and (b) in the *11th IEA-IEF-OPEC Symposium on Energy Outlooks*

Figure 18: OPEC's share of supply increases in 2045

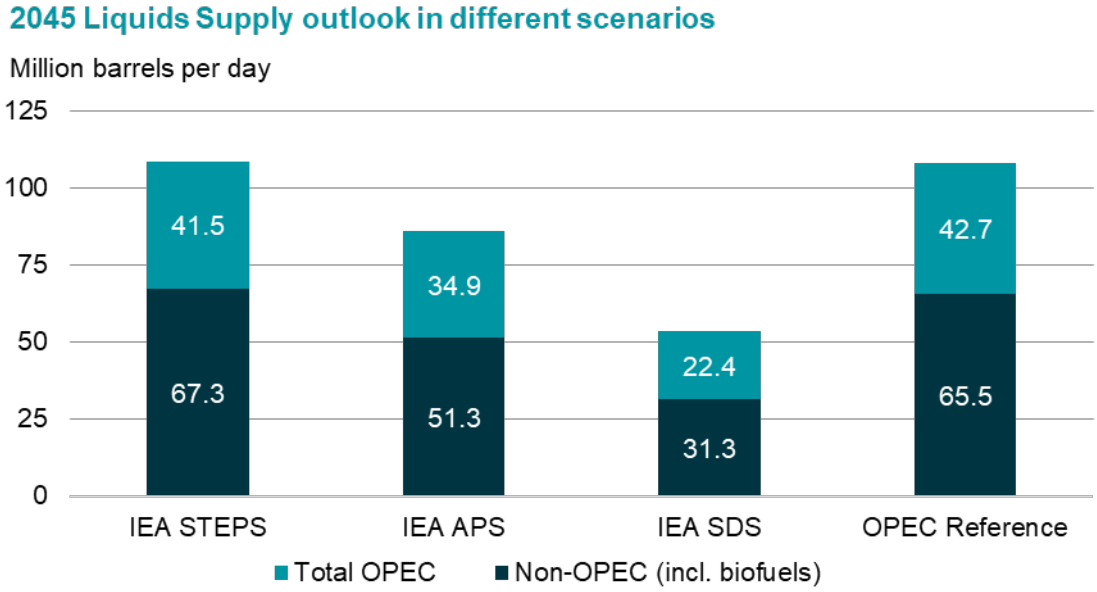


Source: Sums in the data callouts may not total due to rounding.
Note: The IEA includes LTO and oil sands in Non-OPEC other liquids, whereas OPEC includes LTO and unconventional NGLs in Non-OPEC crude & NGLs.

Finally, **Figure 19** presents a comparison of world liquids supply forecasts from the two baseline policy scenarios. This figure highlights how dramatically world supply outlooks are affected by different scenario assumptions. The IEA's SDS demonstrates far lower liquids supplies than any of the other scenarios, with OPEC production 19.1 mb/d lower than the IEA STEPS projection, and non-OPEC production 36.0 mb/d lower than the IEA STEPS.

OPEC's Reference case is similar to IEA STEPS in 2045, with slightly greater total OPEC and slightly lower non-OPEC production levels. The Lower Supply and Higher Supply cases from the WOO2021 diverge expectedly, with their projections of non-OPEC supply reaching 59.4 and 69.3 mb/d in 2045, respectively.

Figure 19: World supply outlooks are affected by different scenario assumptions



Sources: IEA WEO2021 Annex Tables. OPEC WOO2021 Table 4.3.
Figure 21 notes: OPEC did not publish details on the composition of OPEC supplies (e.g., NGLs and unconventionals) in WOO2021. Processing gains are included for OPEC Reference scenario only.

7 Additional context: IEA and OPEC scenarios alongside other outlooks

This section of the report focuses on comparing data and projections from the IEA and OPEC and considers how they compare with other organizations that produce long-term energy outlooks. These include energy companies such as Equinor, along with intergovernmental organizations such as the International Renewable Energy Agency (IRENA) and the Gas Exporting Forum (GECF), as well the EIA Reference scenario from the International Energy Outlook 2021. This section provides a comparison of these outlooks.

7.1 Scenarios

We include two scenarios from IRENA's 2021 World Energy Transitions Outlook: 1.5°C Pathway. These are the Planned Energy Scenario, which projects future trends based on policies and announcements as of 2021, including Nationally Determined Contributions (NDCs) on emissions reductions; and the 1.5°C Scenario, which directs the energy system on a path consistent with limiting end of century global temperature rise to 1.5°C.

We also include relevant data from the GECF's Reference Case Scenario (RCS), Energy Transition Scenario (ETS), and Hydrogen Scenario (HS) of the 2021 edition of the Global Gas Outlook 2050 to complete the comparison. The RCS accounts for existing policies and announced ambitions to reduce emissions and rapidly deploy new technologies such as electric vehicles but assumes that some of these targets will be missed. Under the ETS, renewables and natural gas displace coal and oil more

rapidly towards deep decarbonization. And in the HS, both blue and green hydrogen breaks through significantly into the energy system.

Scenarios from the IEEJ are also included this year, with their Advanced Technologies Scenario (ATS) and Reference scenarios from the Outlook 2022 present. The Reference scenario reflects energy trends under current energy and environmental policy. The ATS accounts for additional energy and environmental technology deployment towards combating climate change and improving energy supply stability.

Finally, we include three scenarios from Equinor's Energy Perspectives 2021: Rivalry, which assumes that climate policies are not major priorities for most nations, and that a variety of factors lead to slower economic growth, greater protectionism, and less international cooperation; Reform, which assumes that global efforts to address climate change strengthen, but that not all long-term targets are achieved; and Rebalance, which assumes policies that are assumed consistent with the Paris Agreement goal of limiting temperature rise to 2°C by 2100.

7.2 Primary Energy Mix

Figure 20 illustrates the high variability of projections between different scenarios from these organizations for the global primary energy mix in 2040. In baseline policy scenarios, total primary energy growth from 2020 through to 2040 is between 14% (EIA Reference) and 26% (IRENA Planned). Under the "Paris-aligned" scenarios, total primary energy consumption remains level or declines considerably through 2040, rising just 3% in IRENA's 1.5°C scenario and falling by 1% under IEA SDS, 5% in Equinor Rebalance, and 9% under IEA NZE. New scenarios in the IEA APS and GECF HS see sizeable increases in total primary demand of 14% and 18%, respectively. We do not include alternative OPEC scenarios in this figure because they do not provide energy mix breakdown in their long-term analyses outside of the reference case.

In nearly all scenarios, global coal demand falls, ranging from a slight increase of 9% under EIA Reference to over a 60% decline in the IEA SDS, IEA NZE, IRENA 1.5°C and Equinor Rebalance scenarios.

Wide variation is also apparent in different scenarios for natural gas, particularly in "Paris-aligned" scenarios. Under baseline policy scenarios through to 2040, relative to the 2020 IEA baseline, natural gas consumption increases by 22% and 25% for IEA and OPEC respectively, compared with 46% for IRENA's Planned, 33% for IEEJ Reference, 32% for GECF RCS, 20% for EIA Reference, and 18% for Equinor's Reform scenario.

In "Paris-aligned" scenarios, natural gas use increases by 3% in Equinor's Rebalance scenario but falls in all others between 2020 and 2040. Natural gas use declines considerable in IEA SDS (-22%), IEA NZE (-46%), and IRENA's 1.5°C scenario (-37%).

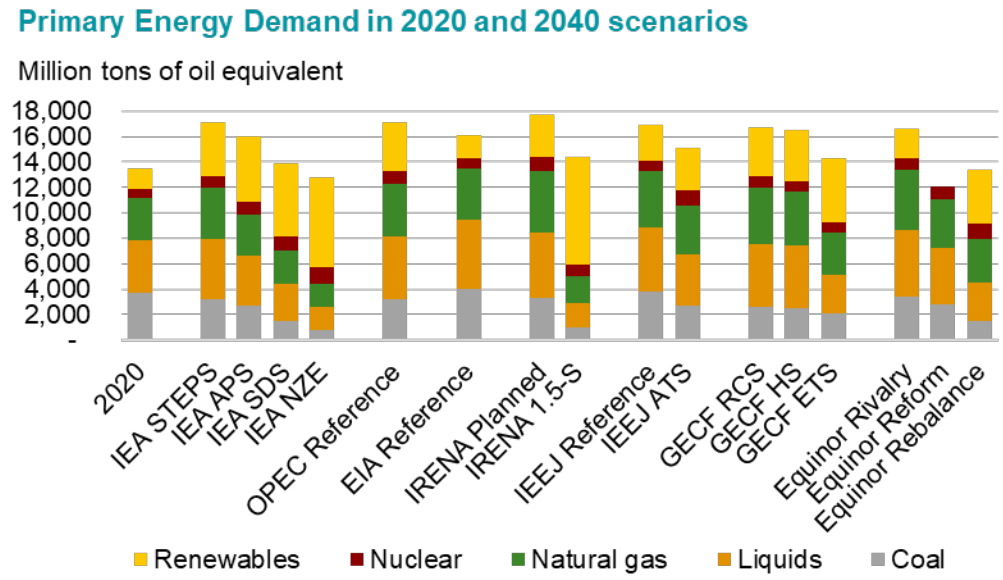
The fastest growing energy source in percentage terms and, in some cases, absolute terms, in these scenarios is renewable energy (including hydropower). Baseline policy scenarios show renewable levels grow from 2020 to 2040 by 135% in OPEC's Reference, 134% in GECF RCS, 154% in IEA's STEPS, 102% in IRENA's Planned Energy Scenario, 119% in Equinor's Reform, and 206% for GECF

ETS. The EIA Reference scenario projects the smallest renewables growth in 2040, just 11% greater than in 2020.

For “Paris-aligned” scenarios, growth is even more robust. Renewables increase by 160% in Equinor Rebalance, 249% in IEA SDS, 330% in IEA NZE, and 420% in IRENA’s 1.5°C scenario. For each of these scenarios, renewables become the largest energy source in 2040.

Nuclear energy adds to the energy mix in all scenarios, with growth from 2020 to 2040 ranging from as low as 18% (GECF’s HS) to 85% under IEA’s NZE. IEA STEPS projects nuclear growth of 31%, while OPEC Reference sees 47% over the same period. Most “Paris-aligned” scenarios project more rapid growth, though IRENA sees more in the Planned scenario (56%) than their 1.5°C scenario (32%).

Figure 20: Coal demand falls in most long-term scenarios



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix.
Figure 22 notes: “Renewables” include hydro, biomass, and other renewables such as wind, solar, and geothermal. OPEC liquids is only primary energy demand for oil.

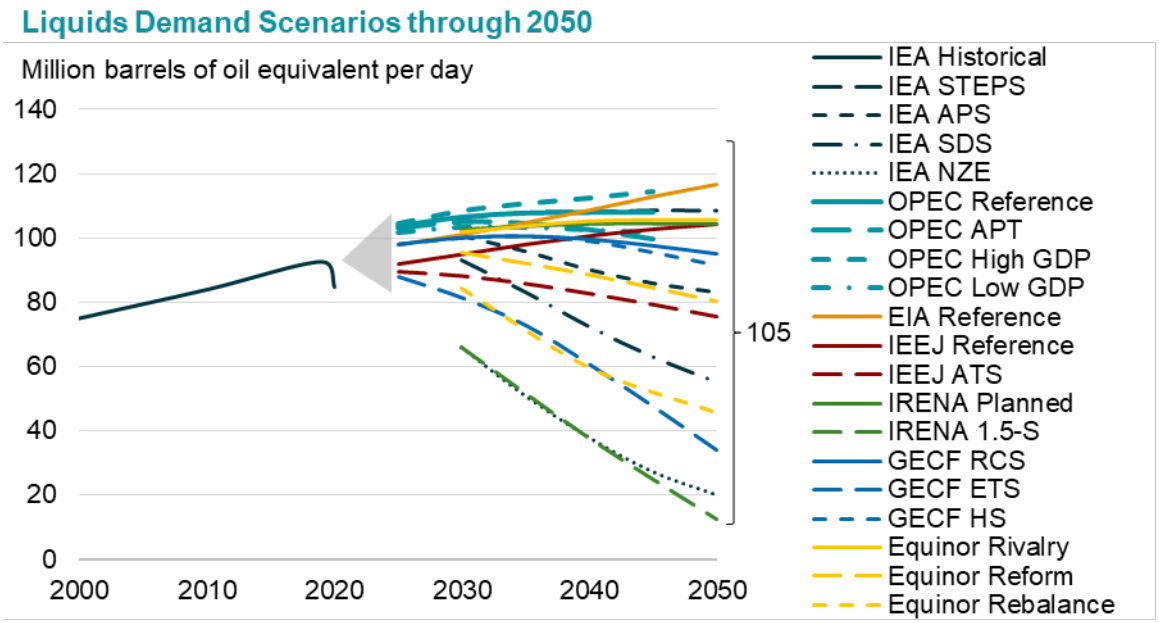
7.3 Liquids demand

Figure 21 illustrates how each scenario envisions the evolution of global liquids demand through 2050. As noted above (see **Figure 15**), baseline policy scenarios from the IEA and OPEC see liquids growth reaching roughly 108 mboe/d by 2045, with significantly lower levels envisioned in “Paris-aligned” scenarios. The EIA Reference scenario shows the most robust liquid demand, reaching 117 mboe/d in 2050. Other organizations’ and market stakeholders’ scenarios, however, show lower liquids demand in 2050. IEEJ’s Reference and IRENA’s Planned Energy Scenario both project 104 mboe/d, GECF RCS project 95 mboe/d, and Equinor’s Reform scenario projects 80 mboe/d.

"Paris-aligned" scenarios' from these organizations show further declines, with Equinor's Rebalance scenarios projecting liquids demand 46 mboe/d in 2050. IRENA's 1.5°C scenario stands out with the lowest projected liquids demand of just 12 mboe/d in 2050.

By 2050, the gap between the highest scenario (EIA Reference) and lowest scenario (IRENA 1.5°C) is 105 mb/d. Note that in **Figure 21**, the grey shaded area represents the range of implied natural gas demand from 2020 through 2025, as most outlooks do not provide projections during this period.

Figure 21: the gap between the highest scenario (EIA Reference) and lowest scenario (IRENA 1.5°C) is 105 mb/d in 2050



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 3.2, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied natural gas demand during this period.

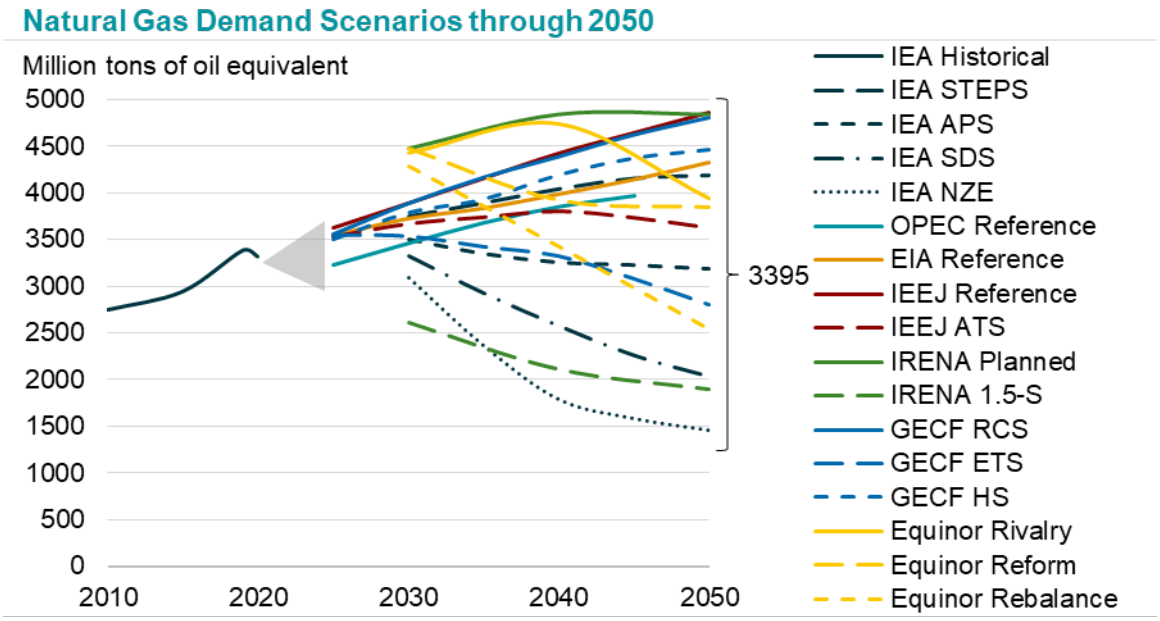
7.4 Demand for other energies and technologies

Looking beyond outlooks for primary energy mixes and liquids demand, **Figure 22** illustrates the projections for natural gas demand to mid-century. We do not include alternative OPEC scenarios in the following figures as they do not provide projections of non-liquids demand for their alternative cases. In 2050, natural gas demand under the IEA's STEPS scenario reaches 4192 mtoe while the OPEC Reference scenario projects 4267 mtoe in 2045, 26% and 28% over 2020 demand of 3323 mtoe. The projections from GECF RCS, IRENA Planned, and IEEJ Reference sit higher than these baseline policy scenarios, growing to reach 4810 mtoe, 4845 mtoe, and 4855 mtoe in 2050, respectively. Equinor's Reform has the lowest projection of mid-century natural gas demand of the baseline policy scenarios with 3840 mtoe.

In the more ambitious and “Paris-aligned” scenarios, natural gas demand flattens or declines in the coming decades. In the IEA’s APS, natural gas demand remains nearly level with 2020, sitting at 3182 mtoe in 2050. GECF ETS follows a similar trend before natural gas demand begins to dip beyond 2040. IEA SDS and IRENA 1.5°C scenarios fall significantly to 2035 mtoe and 1890 mtoe in 2050, but IEA NZE sees largest decrease in natural gas demand to only 1450 mtoe.

The difference between the projections for highest (IEEJ Reference) and lowest (IEA NZE) natural gas demand is 3395 mtoe in 2050.

Figure 22: the difference between the projections for highest (IEEJ Reference) and lowest (IEA NZE) natural gas demand is 3395 mtoe in 2050



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

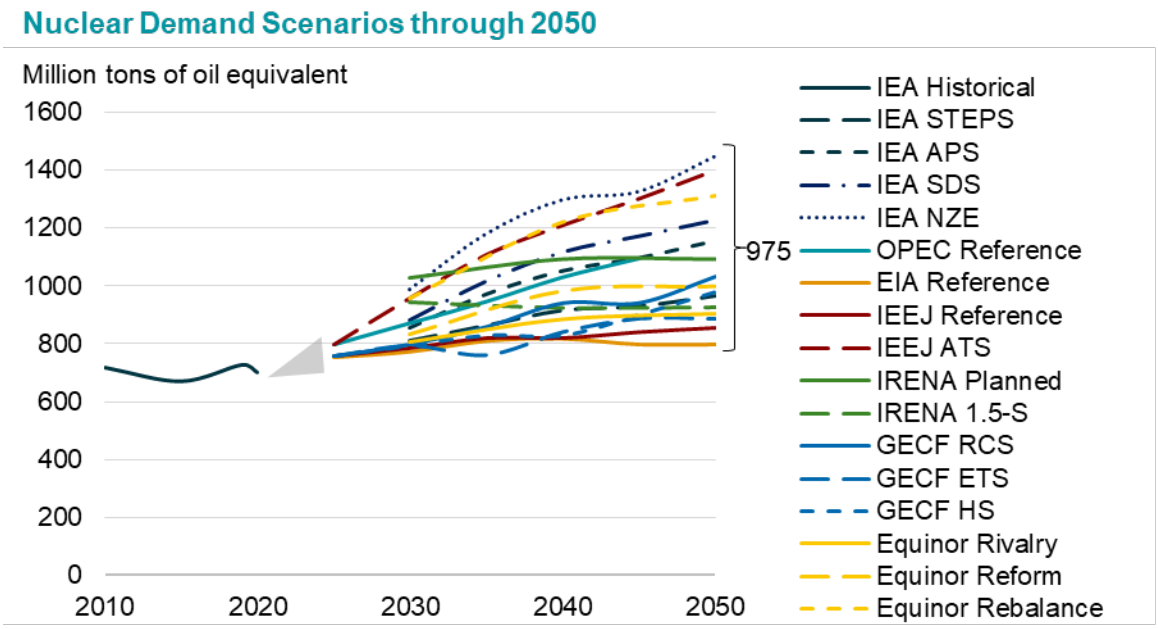
Figure 23 plots the projections for nuclear demand for the same period. From 702 mtoe in 2020, nuclear demand under the IEA’s STEPS scenario gradually reaches 967 mtoe in 2050, while the OPEC Reference scenario projects 1095 mtoe in 2045. The Equinor Reform and GECF RCS scenarios fall between these two projections, reaching 998 and 1030 mtoe by 2050, respectively.

Nuclear demand grows much more rapidly under climate and technology scenarios from these outlooks. In the IEA’s APS, nuclear demand increases to 1158 mtoe in 2050, a nearly 20% increase over the STEPS projection. The IEEJ ATS has a similarly large rise to 1399 mtoe in 2050. The IEA NZE scenario sees the most dramatic increase of nuclear demand in the period, to 1448 mtoe, nearly a 50% increase compared to IEA STEPS. Equinor’s Rebalance lands just below the IEA NZE with

1311 mtoe in nuclear energy demand by the half century. GECF ETS and IRENA 1.5-S lie slightly lower than other climate scenarios, reaching 889 and 928 mtoe in 2050.

The IEA NZE and EIA Reference scenarios have the largest difference in natural gas demand in 2050, with 975 mtoe between them.

Figure 23: Nuclear demand grows much more rapidly under climate and technology scenarios



Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

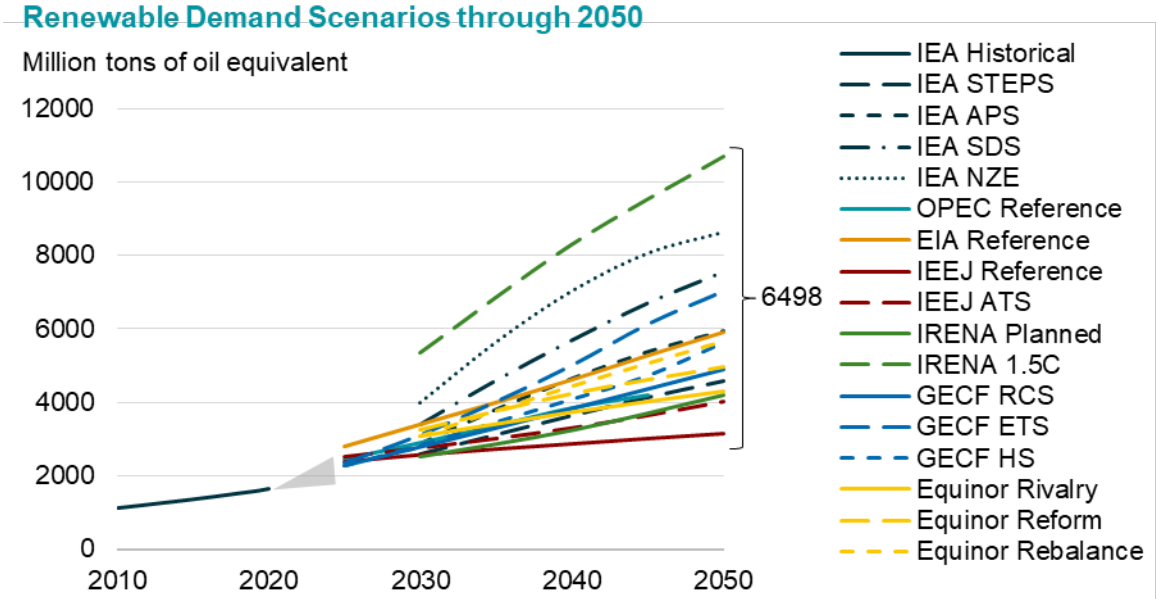
As **Figure 24** shows, demand for renewables (including hydropower) steadily increases across all scenarios to 2050, but different scenarios do impact the rate of the increased demand.

From demand of 1636 mtoe in 2020, renewables demand under the IEA's STEPS scenario reaches 4598 mtoe in 2050, while the OPEC Reference scenario projects 4188 mtoe in 2045. The IRENA Planned scenario projects 4208 mtoe by 2050. The GECF RCS and Equinor Reform scenarios land higher, reaching 4911 and 4978 mtoe in 2050, respectively.

The IRENA 1.5°C scenario projects the highest renewables demand, at 10686 mtoe by 2050, more than a six-fold increase over IEA STEPS demand in 2020. The IEA NZE and IEA SDS scenarios reach the next highest levels at 8649 mtoe and 7558 mtoe mid-century. The APS scenario has still considerably higher demand than the STEPS scenario, with 5933 mtoe projected by 2050, a 29% increase over the STEPS projection. GECF's ETS scenario sees significant growth by 2050, rivalling some "Paris-aligned" scenarios with 7012 mtoe of renewables demand. Equinor's Rebalance scenario sits lowest among climate policy scenarios with 2050 renewables demand of 5651 mtoe.

The difference in renewables demand between the highest (IRENA 1.5°C) and lowest (OPEC Reference) 2050 demand projections sit at 6498 mtoe.

Figure 24: Renewable demand increases across all scenarios to 2050 albeit at different rates



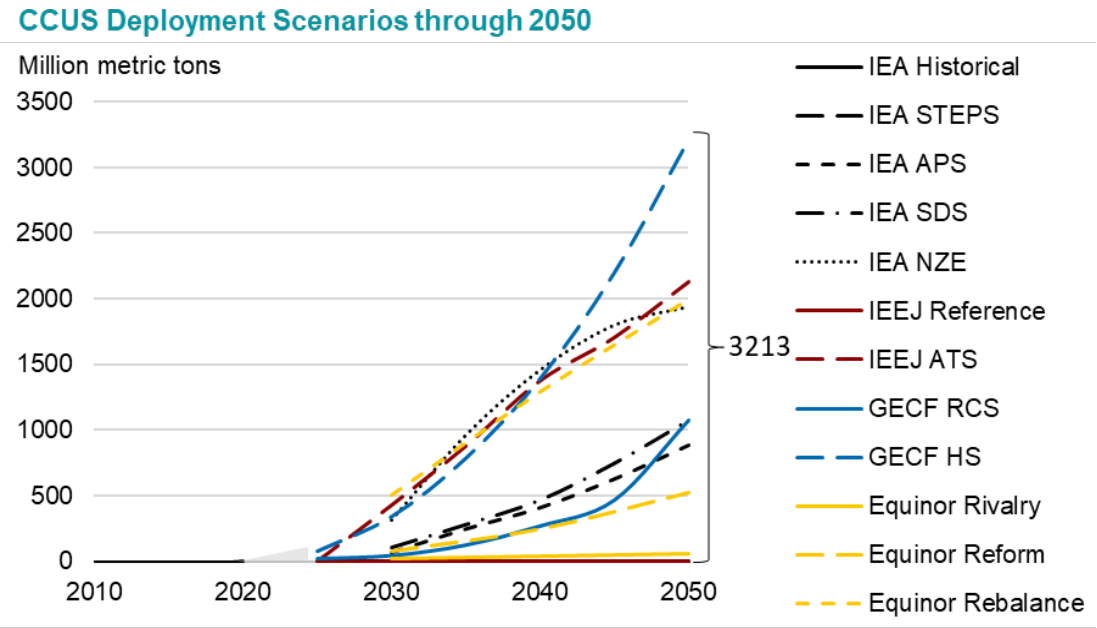
Source: IEA WEO2021 Annex Tables, OPEC WOO2021 Table 2.1, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

CCUS deployment is projected to grow at widely different rates by the outlooks evaluated here, as presented in **Figure 25**. While many outlooks show a gradual acceleration into CCUS, GECF HS stands out with the most aggressive CCUS scenario, growing from 80 million metric tons (mmt) in 2025 to 3214 mmt in 2050. Below this level, IEEJ ATS, Equinor Rebalance and IEA NZE have a similarly robust projection of CCUS around 2000 mmt in 2050.

In comparison, central and some of the alternative climate scenarios project a slower deployment of CCUS, with GECF RCS, IEA SDS, and IEA APS near 1000 mmt and Equinor Reform modestly exceeding 500 mmt in 2050. Without additional policy to incentives carbon capture, the IEA STEPS scenario keeps CCUS constant at 1 mmt for the entire period.

We do not include alternative OPEC scenarios in this figure because they do not provide CCUS projections for their alternative scenarios.

Figure 25: CCUS shows growth across all scenarios with GECF HS being the most aggressive



Source: IEA WEO2021 Annex Tables, EIA International Energy Outlook 2021; IEEJ Outlook 2022, IRENA World Energy Transitions Outlook: 1.5°C Pathway and 2021 edition GECF Global Gas Outlook 2050 data provided via internal communication, Equinor Energy Perspectives 2021 Data Appendix. Because most outlooks do not provide projections from 2020 through 2025, the grey shaded area represents the range of implied liquids demand during this period.

7.8 Carbon pricing and emissions

Carbon pricing policies are one of the most powerful and prevalent tools that governments have used to reduce carbon dioxide emissions. These policies can incentivize fuel switching, as well as the development and deployment of new technologies, including energy efficiency, renewable energy, CCUS, nuclear, hydrogen, and other approaches to reduce emissions.

Under the IEA STEPS, carbon prices rise slowly through 2050, reaching more than $90 per tonne (in 2020 US dollars) in the EU and Republic of Korea, $75 in Canada, $55 in China, and $30 in Chile and Colombia. By 2050, global carbon dioxide emissions under this scenario are beginning to fall and dip below 2020 levels. The APS and SDS scenarios have some carbon pricing assumptions in common, with both advanced economies with net-zero pledges having a $200 price in 2050, $160 in emerging markets and developing countries with net-zero pledges, and $160 in China. This results in global CO_2 emissions reducing by 39% between 2020 and 2050 under APS, while the additional carbon pricing of $160 in other advanced economies and $95 in other selected emerging markets and developing countries leading to a 76% reduction under SDS. To reach net-zero emission in the WEO2021 NZE scenario, advanced economies reach a $250 per tonne price in 2050, major emerging economies a $200 price, and all other emerging markets and developing economies a carbon price of $55.

IRENA's 2021 World Energy Transitions Outlook: 1.5°C Pathway report does not explicitly reference carbon pricing policy assumptions, but the 2020 Global Renewables Outlook does provide some

estimation of the cost of emissions reductions. They estimate that reaching net zero carbon dioxide emissions by 2060 would cost $100 per tonne, and that reaching zero emissions (i.e., no negative emissions from land use, CCUS, or other technologies) by 2060 would cost $156 per tonne.

GECF's carbon pricing assumptions are not available at the time of this writing for the 2020 outlook. In its 2020 release of the Global Gas Outlook 2050, GECF includes carbon price assumptions for the European Union, Japan, and South Korea. Carbon prices in the EU ETS reach roughly $55 per tonne by 2050, $25 in the Japanese Trading System, and $35 in the South Korean Trading System.

Although Equinor's carbon price assumptions are not stated in its Energy Perspectives 2021, its three scenarios suggest large differences in climate policy and associated carbon prices. In its Rivalry scenario, global emissions decrease by just 4% from 2018 through 2050, but decline by 26% under the Reform scenario, and by 73% under the Rebalance scenario.

8 Final Remarks

The Covid-19 pandemic has altered daily life and global economic conditions in profound and unexpected ways. Following the historically unprecedented volatility experienced through 2020, markets in 2021 remain fragile in the face of unprecedented energy market volatility, supply chain bottlenecks and geopolitical risks. Recovery remains slow and unevenly distributed.

Looking ahead to 2022, much remains unknown. While over 50% of the world population has been vaccinated against Covid-19 by January 2022, the emergence of variants and challenges in further vaccine distribution, particularly in developing countries, have made predicting the end of the pandemic difficult. Although some nations have returned to relatively strong economic growth rates, economic outlooks for most of the world remains highly uncertain. These uncertainties are reflected in some of the scenarios produced by the IEA and OPEC.

Over the longer term, considerable uncertainties once again arise. Under baseline policy scenarios, both the IEA (STEPS) and OPEC (Reference scenario) project continued growth in demand for liquid fuels, although the rate of growth is slower than observed in previous years. Under these scenarios, OPEC's share of global liquids supplies increases through to 2045, while the share of supplies from non-OPEC nations declines modestly. Production from OECD Americas, led by tight oil from the United States, remains a major source under these scenarios.

However, alternative scenarios such as the IEA's SDS, NZE, and APS, envision a world in which demand for all fossil fuels decline considerably in the coming decades. These scenarios, along with other "Paris-aligned" scenarios produced by organizations such as IRENA, IEEJ and Equinor, project that global energy demand in 2045 and 2050 will be *below* 2020 levels, reflecting a major change in the historical relationship between economic growth and energy demand growth. These scenarios assume rapid growth of renewables, energy efficiency, nuclear, electric vehicles, carbon capture and storage, and other technologies, which entail numerous technological, political, and socioeconomic challenges.

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 harmonize 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 to better inform stakeholders worldwide.

As a continuous effort, the Twelfth 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 standardize regional classifications across long-term outlooks;
- Advancing efforts to increase comparability of medium- and long-term oil price assumptions;
- Advancing efforts to increase comparability and transparency of liquids supplies, particularly concerning biofuels and the composition of OPEC liquids supplies;
- Ongoing analysis of differences in historical data, particularly in non-OECD demand, as well as Russian, Eurasian, and OPEC liquids supply;
- 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 analyzing potential enhancement of long-term oil supply projection models, particularly with respect to unconventional resources; and
- Standardizing unit conversion processes across EJ, mb/d, mboe/d, and mtoe.

As observed in the introduction of this paper, the impact of scenarios on policy making, investment decisions and public perceptions of energy market trends and transition pathways has grown. This has not only invited more inclusive debate on their increasingly diverse findings but also warrants greater transparency of methods, assumptions, and data comparability.

In accordance with the call of G20 leaders on the IEF to intensify dialogue between producers and consumers to bolster the efficiency, transparency, and stability of the energy markets to maintain energy security, while addressing climate change, and guaranteeing just and orderly transitions at their meeting on 30-31 October in Rome under the G20 Presidency of Italy, IEF Ministers could help ensure that further progress is made in these areas and elevate the global energy dialogue to the level that current challenges in respect of energy security, market stability and just and orderly transitions require.

Annex 1: Long-term Outlook Assumptions

	OPEC	IEA			
Variables	**Reference Case**	**STEPS**	**APS**	**SDS**	**NZE**
Global Economic Growth Rate	3.1% (2020-2045)	3.0% (2020-2050)	Same as STEPS	Same as STEPS	Same as STEPS
Population, Billions	2020: 7.8; 2045: 9.5	2020: 7.7; 2050: 9.7	Same as STEPS	Same as STEPS	Same as STEPS
Oil Price Assumptions (2050 in 2020$)	Not specified	$88/bbl	$64/bbl	$50/bbl	-
Average annual oil and gas investment (in billions, 2019$)	(2021-2045, oil only, 2021$) Upstream: $368.8 Midstream: $43.2 Downstream: $58.8	(2021-2050, oil and gas): $871	(2021-2050, oil and gas): $649	(2021-2050, oil and gas): $496	-
Energy and Environmental Policies	Takes into account enacted policies in most countries and announced targets. However, not all announced targets are incorporated.	Considers both policies in place and announced intentions.	Accounts for all governmental climate commitments, including NDCs and net zero targets.	Universal energy access by 2030; fully aligned with Paris Agreement's climate targets; dramatically reduces air pollution from energy.	Same as SDS; net-zero global CO_2 emissions in 2050; global temperature rise limited to 1.5°C.
Carbon prices (per tonne in 2020$)	Not specified	2050: $75 in Canada; $30 in Chile and Colombia; $55 in China; $90 in EU; $90 in Korea	2050: $200 in Advanced economies with net-zero pledges; $160 in emerging markets and developing countries with net-zero pledges; $160 in China	APS assumptions, as well as: 2050: $160 in other advanced economies; $95 in other select emerging and developing economies	2050: $250 in advanced economies; $200 major emerging economies; $55 in other emerging markets and developing economies

Annex 2: Long-term Outlook Results

	OPEC		IEA			
	2020	2045 Reference Case	2020	2045		
				Stated Policies	Announced Pledges	Sustainable Development
Global energy demand (mboe/d)[a]	275.4	352.0	284.2	353.3	324.6	277.3
Global Liquids Demand (mb/d)	90.6	108.2	89.7	108.8	86.1	63.0
Non-OPEC Supply (mb/d)[b]	62.9	65.5	62.3	67.3	51.3	31.3
Total OPEC Supply (mb/d)[c]	30.7	42.7	30.9	41.5	34.9	22.4
OPEC Crude (mb/d)[d]	-	-	-	-	-	-
OPEC NGLs and Other Liquids (mb/d)[e]	-	-	-	-	-	-

Annex 2 notes:

[a] IEA primary energy is converted from EJ per year to mboe/d by multiplying by a factor of 0.4825 mboed/EJ.

[b] Includes biofuels and processing gains.

[c] OPEC did not publish the composition of OPEC liquids supply (e.g., crude, NGLs, other unconventionals) in WOO2021.

[d e] IEA did not publish OPEC crude or OPEC NGLs and other liquids in the WEO2021.