



IEA IEF OPEC
Symposium on
Energy Outlooks



Outlooks Comparison Report

February 2023

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Introduction: IEA-IEF-OPEC Trilateral Program of Work Bolsters Energy Data Transparency and Market Stability

- IEA and OPEC energy outlooks shape consensus views and influence policy and investment decisions worldwide. Given their influence, it is vital to understand these outlooks and the assumptions underlying the various scenarios.
- The Cancun IEF Ministerial Declaration (2010) called for the IEA, IEF, and OPEC to organize an annual symposium on energy outlooks. This mission has only become more important considering the recent global pandemic, geopolitical upheaval, and progress toward energy transitions.
- This report will inform the 13th IEA-IEF-OPEC Symposium by comparing the key scenarios and underlying methodologies of IEA and OPEC’s most recent outlooks and placing them in the broader context of outlooks produced by other key industry organizations and market players.
- Promoting greater transparency of energy outlook methodologies, assumptions, and data comparability can help bring stability to the market by driving informed policies and informed investment decisions.

Primary Outlooks Compared in this Report			
		Short-term	Long-term
IEA	Report Name	Oil Market Report	World Energy Outlook
	Publication Date	Dec 2022	Oct 2022
OPEC	Report Name	Monthly Oil Market Report	World Oil Outlook
	Publication Date	Dec 2022	Oct 2022
EIA	Report Name	Short-term Energy Outlook	N/A
	Publication Date	Dec 2022	N/A

Wide-Ranging Energy Outlooks Underscore Importance of Clear, Predictable, and Achievable Policies

- Successive shocks have rocked the world, including energy markets, over the past several years. Since last year's Outlook Symposium, the economic outlook for the near-term has deteriorated significantly while the geopolitical risks, and price volatility, across the energy sector have surged. For policymakers, security of supply has re-emerged as a top priority.
- Long-term demand uncertainty is now compounded by acute near-term risks, particularly in oil and gas markets. Market uncertainty fuels price volatility – harming consumers, investors, businesses, and governments.
- The only sure antidote to high energy prices and volatility is ensuring adequate investment and supplies for both now and the future. Underinvestment threatens to undermine energy security and it can also stall progress on climate goals by increasing reliance on more carbon-intensive options in the short-term.
- Energy investment decisions are informed by energy demand outlooks and scenarios. While aspirational scenarios are essential for tracking global progress towards climate goals, it is equally important to provide outlooks based on current policy and consumer trends. Investment decisions should be based on scenarios anchored in reality in order to prevent future supply shortfalls.
- Clear descriptions or assessments on the likelihood of scenario outcomes based on recent trends, investment levels, consumer behavior and policy enforcement could enhance the usefulness of outlooks for investors and policymakers.
- The wide range of energy scenarios presented in this report underscores the importance for policymakers to provide clear, predictable, and achievable policies/regulations and highlights the challenges ahead for achieving a just and orderly transition for all.

2022-2023 Forecast Highlights:

- The following is based on December 2022 monthly reports from IEA, OPEC, and EIA.
- Agencies' 2022 estimates largely align:
 - Global demand grew by 2.3-2.6 mb/d year-on-year
 - Non-OPEC + OPEC NGLs supply grew by 2.0-2.1 mb/d
- The range for 2023 forecasts widens amid uncertainty around (1) OECD demand growth; (2) Chinese demand growth; (3) Russian production; and (4) US supply.
- 2023 demand growth forecasts range between 1.0-2.2 mb/d.
 - EIA is on the low end and is the only agency to forecast a contraction in OECD demand.
- 2023 non-OPEC + OPEC NGLs supply growth forecasts range between 0.7-1.6 mb/d.
 - OPEC is on the high end and sees Russian supply falling by 0.9 mb/d vs. IEA and EIA's forecast of a 1.4 mb/d year-on-year drop in Russian supply.
- All three agencies imply a higher "call on OPEC" in 2023 compared to 2022, but the amounts diverge by >1.0 mb/d due to different demand and non-OPEC supply forecasts.
- IEA's 2023 forecasts imply the highest "call on OPEC" at 29.9 mb/d – which is 0.7 mb/d higher than OPEC's actual production in December 2022 (based on IEA's estimate of 29.2 mb/d).

2030 Outlook Highlights:

- Typically, this report would compare IEA and OPEC medium-term outlooks. IEA's medium-term oil outlook was scheduled to be released in March 2022. However, due to the unique market upheaval that occurred following Russia's invasion of Ukraine, IEA did not publish its medium-term oil outlook. Therefore, this report will compare outlooks to 2030 using IEA's WEO 2022 and OPEC's WOO 2022 and resume detailed medium-term comparisons in next year's report.
- Only IEA's NZE scenario shows a substantial ~10% decline in total primary energy demand by 2030. Meanwhile, base case scenarios show an 8-12% increase.
- Renewable, hydro, biomass, and nuclear are expected to grow by a total 32-67% by 2030 in all 6 scenarios.
- While 3 of the 6 IEA and OPEC scenarios see total fossil fuel demand falling between 2021 and 2030, fossil fuel's share of total primary demand will remain a robust 62-77% (vs. 80% in 2021).
 - Oil demand increases between 2021 and 2030 in 4 of the 6 scenarios. Non-OECD will drive the growth.
 - Natural gas demand only grows to 2030 in 3 of the 6 scenarios.
 - Coal demand is expected to fall in all scenarios. The size of the decline ranges from 5% (in OPEC Ref and LF scenarios) to 46% in IEA's NZE scenario.
- Liquids supply is expected to rise 5-13 mb/d in IEA's STEPS and APS and OPEC Reference scenarios (the remaining 3 scenarios did not provide this data). The drivers of liquids supply growth include OPEC countries, Latin America and OECD Americas.
 - Biofuels share of total liquids supply will increase from 3% to 7% in IEA's APS. (The share remains roughly flat in STEPS and OPEC Ref.)

2045 Outlook Highlights:

- Global GDP growth will slow to under 3% per year following 2030.
- 3 of the 6 scenarios see robust growth in primary energy demand to 2045 (up 16% to 28% compared to 2021). However, IEA's NZE scenario shows primary energy demand plummeting by 15% by 2045 vs. 2021 – illustrating a break with the historical relationship between economic growth and energy demand growth.
- Renewable, hydro, biomass, and nuclear are expected to grow by a total 90-218% by 2045 in all 6 scenarios.
- While renewables are expected to see substantial growth across all scenarios – non-fossil fuel demand (renewables, biomass, nuclear, hydro, etc.) will not reach fossil fuel's 2021 demand levels by the end of the forecast period.
 - IEA's NZE scenario has the highest non-fossil fuel energy forecast for 2050 at 211 mboe/d, but this is still slightly below IEA's estimate of 2021's fossil fuel demand of 239 mboe/d.
- 4 of the 6 scenarios show fossil fuels accounting for more than 50% of primary energy in 2045 (vs. current share of ~80%).
- Liquid demand grows and plateaus in IEA STEPS and OPEC Ref, while it peaks and declines in IEA's APS and NZE.
 - The NZE scenario assumes by 2030, 60% of all cars sold are EVs and no new ICE light-duty vehicles are sold after 2035.
- IEA STEPS and APS and OPEC's Ref all see higher oil demand in the petrochemical sector at the end of the forecast period.
- Liquids supply increases by 14-15% by 2045 in IEA STEPS and OPEC Ref scenario driven by OPEC members, Latin America, and biofuels.

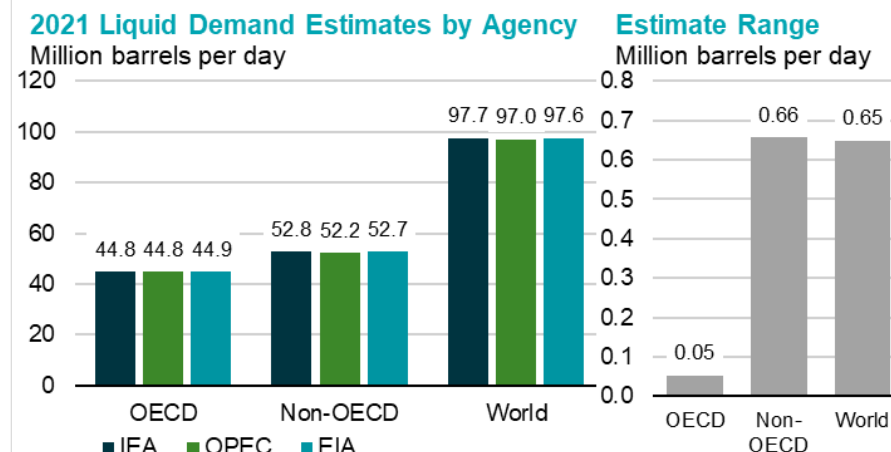
Comparing IEA and OPEC to Other Long-Term Energy Outlooks:

- To gain a better sense of how IEA and OPEC projections compare against other industry-leading energy outlooks, we gathered data on 18 additional scenarios from 7 sources.
- 75% of all scenarios surveyed show end-period primary energy demand at higher levels than 2021.
- Forecasts for total liquids demand in 2050 diverge by 92 mb/d – slightly smaller than the size of today’s global market. Scenarios based on current trends and policies show demand plateauing, while net zero scenarios show a peak and collapse.
- Excluding a high outlier, scenarios for natural gas demand in 2050 diverge by 5,100 bcm – an amount that is still 25% larger than today’s global gas market.
- More than half of all scenarios show:
 - Coal demand falling by more than 50% by 2050
 - Fossil fuels accounting for more than 50% of total primary energy demand in 2050
 - Nuclear demand increasing by more than 50% by 2050
- The range of projections for renewable demand in 2050 is four times greater than current global renewable demand.
- Most scenarios show electricity demand growing by 80% by 2050, with more ambitious net zero scenarios showing up to 200% growth vs. 2021.
- Most net zero scenarios show carbon capture expanding to 6-8 Gt of CO₂/year by 2050.
- The wide range in scenarios underscores the uncertainty in future energy demand, the wide-ranging potential impact of policies, and the immense challenge ahead for achieving a smooth and equitable transition.

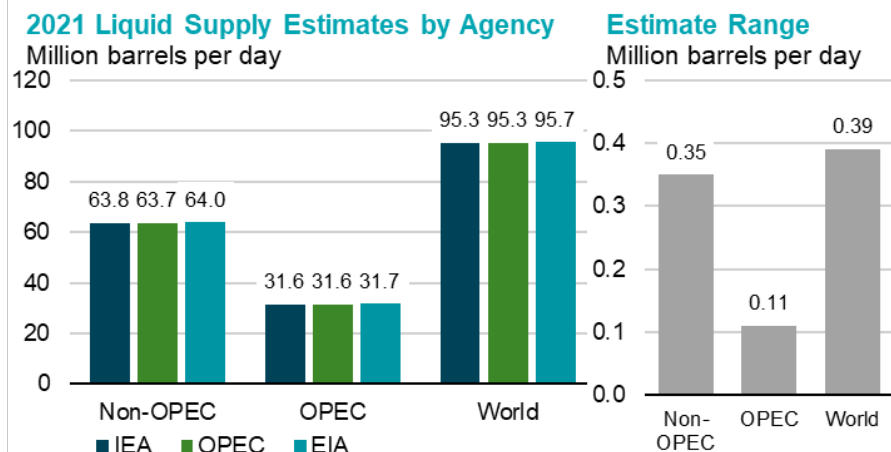
IEA OMR and OPEC MOMR Baseline 2021 Liquids Data (as of December 2022)

Divergences Still Exist in Historical Liquids Baseline Data – Particularly in Non-OECD Demand Estimates

- Comparability of baseline historical data is the first step toward enhancing comparability of outlooks.
- The largest divergences in current baseline data exist in non-OECD demand – similar to previous years.
- IEA and OPEC have made significant progress in recent years in making data comparable, but some issues still exist classification of bunker fuels, biofuels, and some other products.
- While OPEC includes biofuels in each region’s total liquids supply, IEA only includes global biofuels supply separately. Unless otherwise states, this report adds IEA regional biofuels data – both historical and forecast data – to IEA’s regional liquids supply data.
- EIA supply includes refinery processing gains in country-level supply and does not separate them out as in IEA and OPEC data. This report subtracts estimated regional processing gains in historical and forecasted EIA data to make it more comparable to IEA and OPEC.



Source: IEF, IEA Dec '22 OMR, OPEC Dec '22 MOMR, EIA Dec '22 STEO



Source: IEF, IEA Dec '22 OMR, OPEC Dec '22 MOMR, EIA Dec '22 STEO

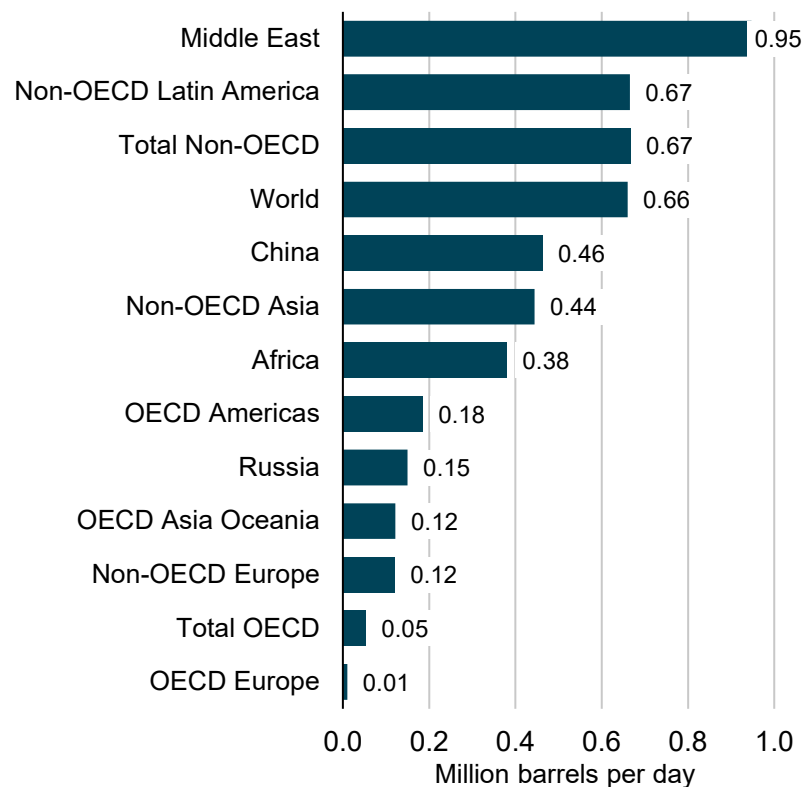
Largest Baseline Demand Divergences Stem from the Middle East, Latin America, and China

Non-OECD demand estimates range 0.7 mb/d vs. OECD demand's 0.0 mb/d

2021 Total Liquid Demand Estimates by Agency

<i>million barrels per day</i>	IEA	OPEC	EIA	Range (high-low)
Total OECD	44.83	44.83	44.88	0.05
Americas	24.32	24.32	24.50	0.18
Europe	13.13	13.13	13.12	0.01
Asia Oceania	7.38	7.38	7.26	0.12
Total Non-OECD	52.85	52.18	52.68	0.67
Asia	28.81	28.37	28.50	0.44
China	15.43	14.97	15.27	0.46
Middle East	8.48	7.79	8.74	0.95
Latin America	5.94	6.23	5.56	0.67
Europe and Eurasia	5.63	5.58	5.51	0.12
Russia	3.66	3.61	3.51	0.15
Africa	3.99	4.22	4.37	0.38
World	97.67	97.01	97.56	0.66

Range in Agencies' 2021 Liquid Demand Estimates



Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

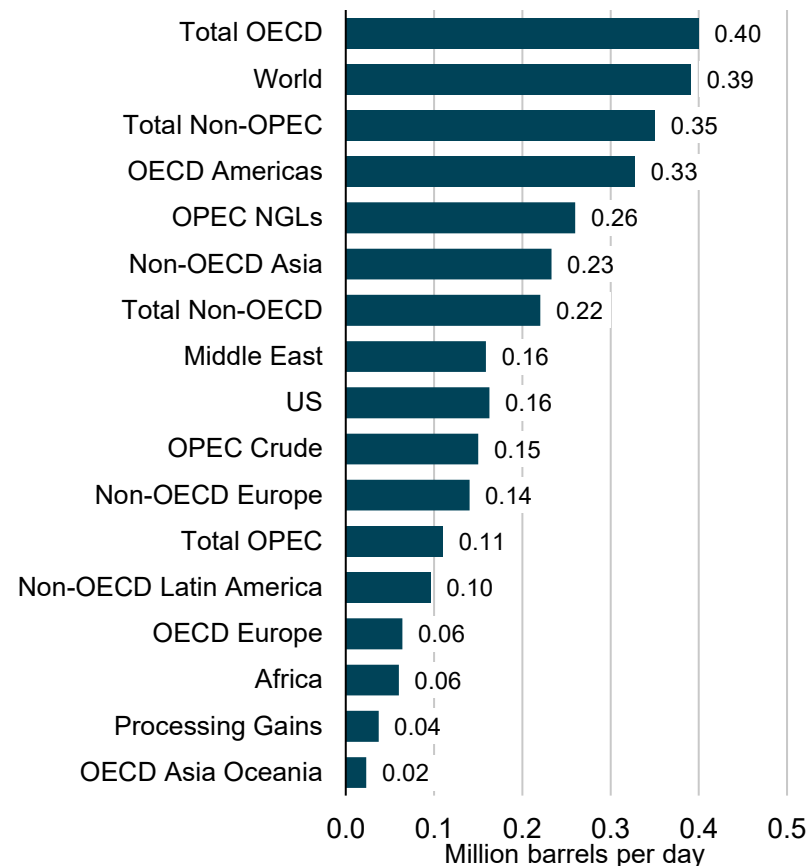
* The data in this section reflect the estimates as of the December 2022 publications. Since December, EIA has revised down 2021 global demand by a significant 0.44 mb/d, including a 0.08 mb/d reduction to OECD estimates and a 0.36 mb/d reduction to non-OECD demand estimates. It now sees 2021 global demand at 97.12 mb/d.

OECD Americas, OPEC NGLs and Non-OECD Asia Drive Baseline Supply Differences

2021 Total Liquid Supply Estimates by Agency

<i>million barrels per day</i>	IEA*	OPEC	EIA**	Range (high-low)
Total OECD	29.89	29.52	29.92	0.40
Americas	25.56	25.25	25.58	0.33
<i>United States</i>	17.97	17.85	18.01	0.16
Europe	3.80	3.76	3.82	0.06
Asia Oceania	0.53	0.51	0.52	0.03
Total Non-OECD	31.65	31.87	31.86	0.22
Asia	7.37	7.49	7.60	0.23
Middle East	3.08	3.24	3.08	0.16
Latin America	5.99	5.95	6.05	0.10
Europe and Eurasia	13.88	13.84	13.74	0.14
Africa	1.33	1.35	1.39	0.06
Processing Gains	2.25	2.29	2.25**	0.04
Total Non-OPEC	63.79	63.68	64.03	0.35
Total OPEC	31.55	31.63	31.66	0.11
OPEC Crude	26.43	26.35	26.28	0.15
OPEC NGLs	5.12	5.28	5.38	0.26
World	95.34	95.31	95.70	0.39

Range in Agencies' 2021 Liquid Supply Estimates



Source: IEF, IEA Dec '22 OMR, OPEC Dec '22 MOMR, EIA Dec '22 STEO

* Regional biofuels were added to IEA total liquids supply using IEA's OMR Table 17 World's Biofuels Production estimates

** Regional refinery processing gains were estimated using EIA and IEF data and subtracted from EIA regional total liquids supply

Agencies Largely Agree on OECD Stock Change But Net Global Stock Change and Miscellaneous to Balance Estimates for 2021 Differ By >0.6 mb/d

- The net global stock change and miscellaneous items equal the difference between annual global supply and global demand estimates.
- In 2021, IEA estimated the net global stock change and miscellaneous items was at -2.33 mb/d compared to OPEC's -1.70 mb/d. This is primarily due to IEA's higher global demand estimate (97.67 mb/d vs OPEC's 97.01 mb/d).
- Within the components of miscellaneous items, IEA saw a 0.05 mb/d decrease in oil-on-water while OPEC estimated a 0.15 mb/d increase.

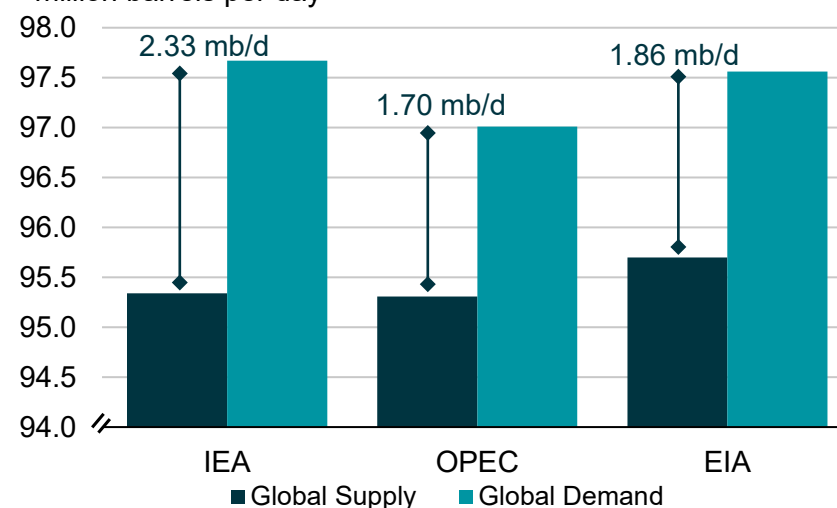
2021 Stock Change and Miscellaneous Items				
million barrels per day	IEA	OPEC	EIA	Range (high-low)
Total OECD	-1.22	-1.21	-1.18	0.04
Commercial	-1.06	-1.06	-1.06	0.00
Government/SPR	-0.16	-0.16	-0.12	0.04
Oil-on-water	-0.05	0.15	-0.68*	0.21
Miscellaneous to balance	-1.07	-0.63		0.45
Net Global Stock Change and Miscellaneous Items	-2.33	-1.70	-1.86	0.66

Some differences may exist due to rounding

* EIA does not provide a breakdown of oil-on-water and miscellaneous to balance

2021 Global Oil Balances

million barrels per day

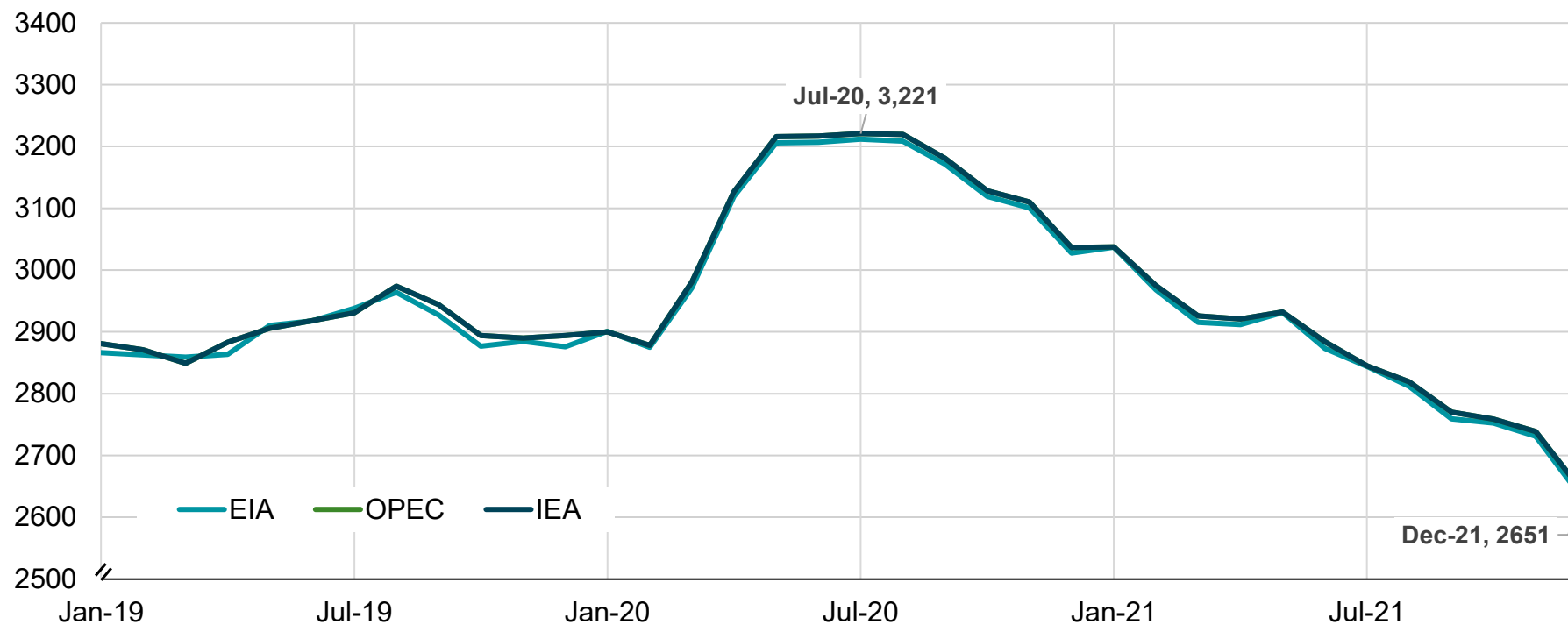


Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

IEA, OPEC, and EIA All Estimate OECD Commercial Inventories End 2021 at ~2650 mb, Down Nearly 600 mb from 2020 Highs

OECD Commercial Inventories

Million barrels



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

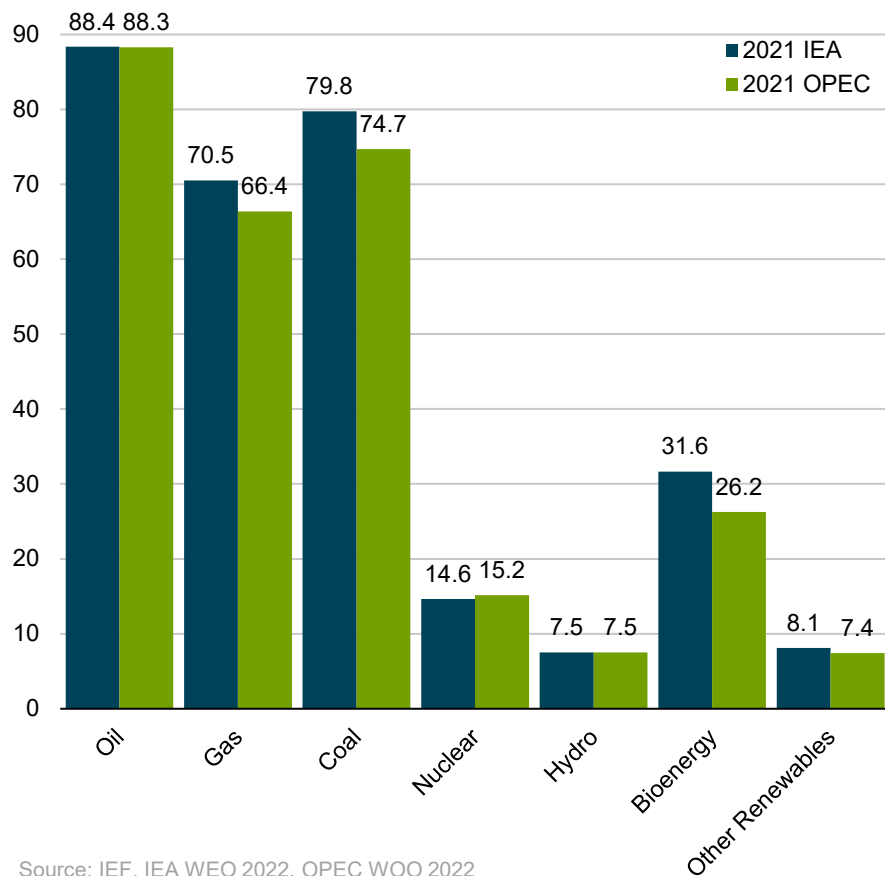
IEA WEO and OPEC WOO Baseline Energy Data

Largest Baseline Divergences in the Long-Term Outlooks Exist in Bioenergy, Coal, and Gas

Different conversion efficiency assumptions could contribute to the gaps in historical data

2021 World Primary Energy

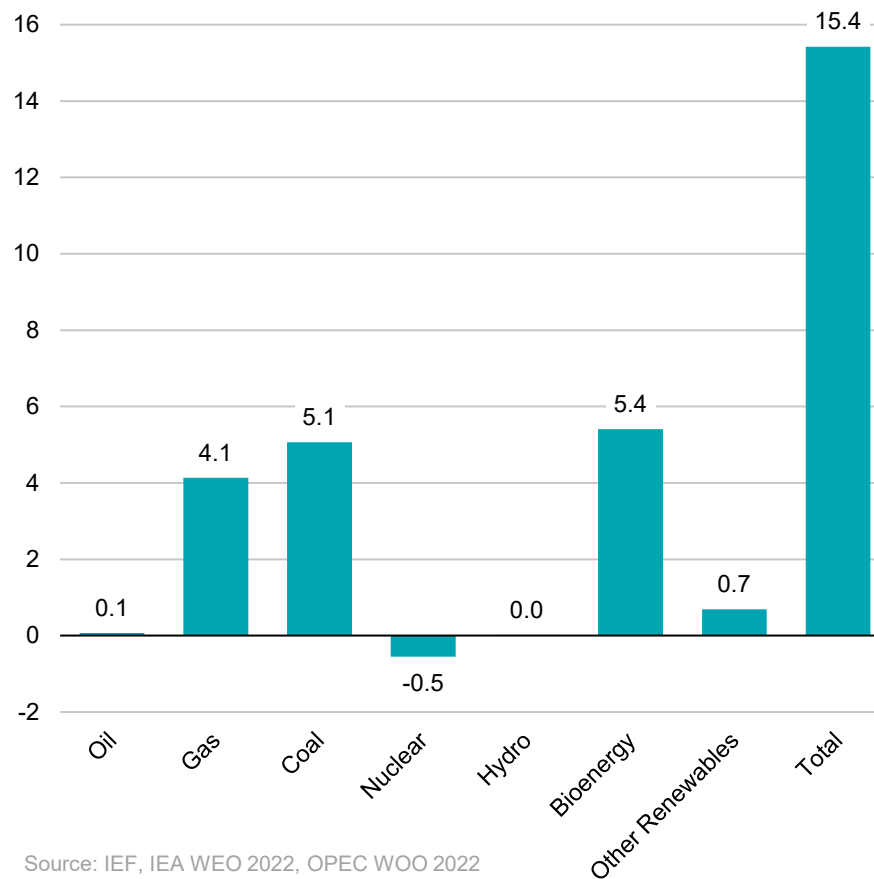
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

IEA vs. OPEC: 2021 World Primary Energy

Million barrels of oil equivalent per day



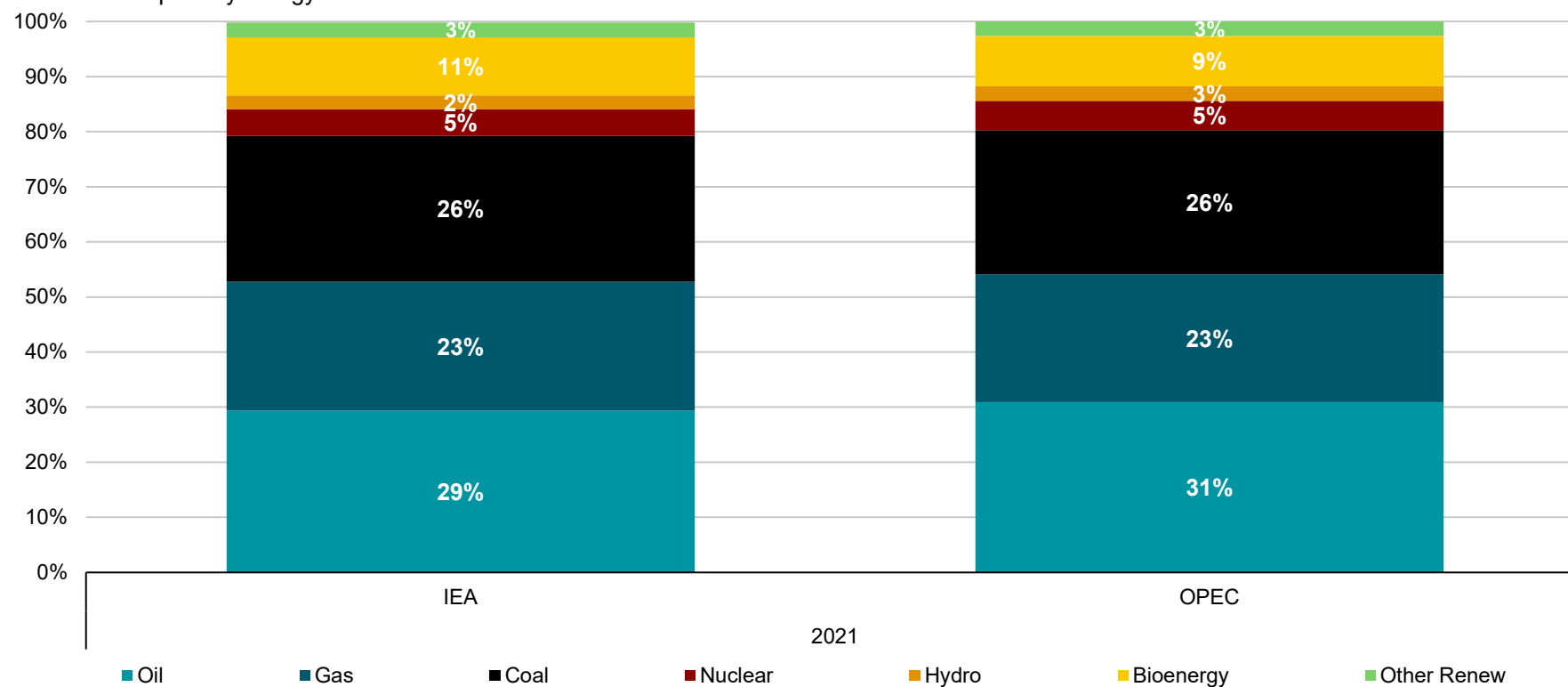
Source: IEF, IEA WEO 2022, OPEC WOO 2022

The Largest Differences in IEA and OPEC Estimates of 2021 Fuel Share of Total Primary Energy Are in Oil and Bioenergy

IEA sees 15.4 mboe/d higher total primary energy demand in 2021 vs. OPEC

2021 World Primary Energy Fuel Share

Percent of total primary energy



Source: IEF, IEA WEO 2022, OPEC WOO 2022

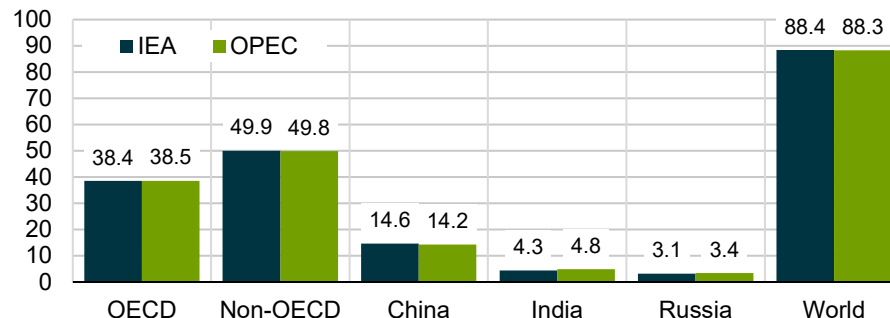
Baselines for Natural Gas and Coal Diverge More than Oil

Non-OECD coal demand estimates for 2021 diverge by >5 mboe/d

- The lack of baseline data harmonization can make it difficult to compare historical and projected data.
- Enhancing transparency on conversion assumptions can help enable data harmonization.
- Additionally, harmonizing treatment of bunkering fuels can improve comparability.
- IEA's WEO includes bunkering fuels in the global energy estimates but not in regional estimates. Whereas OPEC includes bunkering in the regional estimates.

2021 Oil Demand

Million barrels of oil equivalent per day

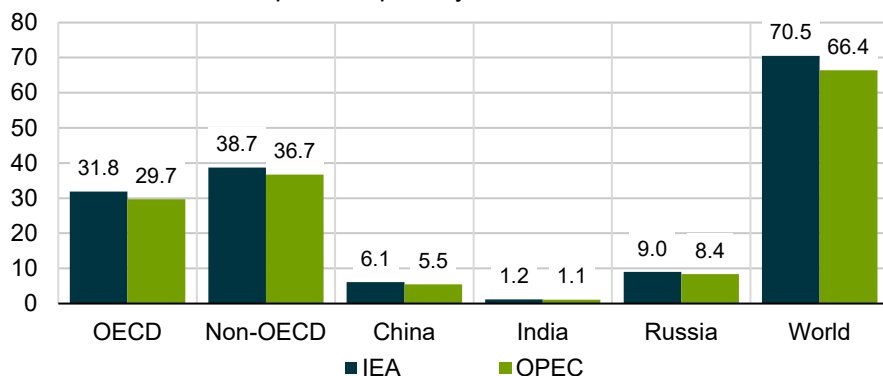


*IEA WEO excludes bunkering fuels from regional estimates. This chart has been adjusted to include regional bunkering in IEA estimates to make it comparable to OPEC.

Source: IEF, IEA WEO 2022, OPEC WOO 2022

2021 Natural Gas Demand

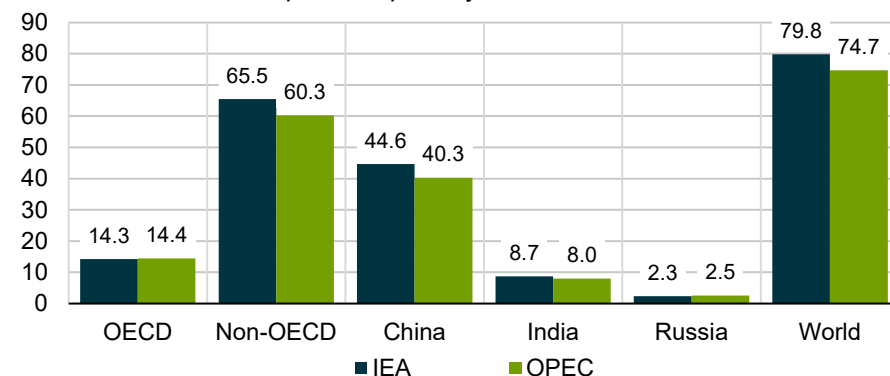
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

2021 Coal Demand

Million barrels of oil equivalent per day

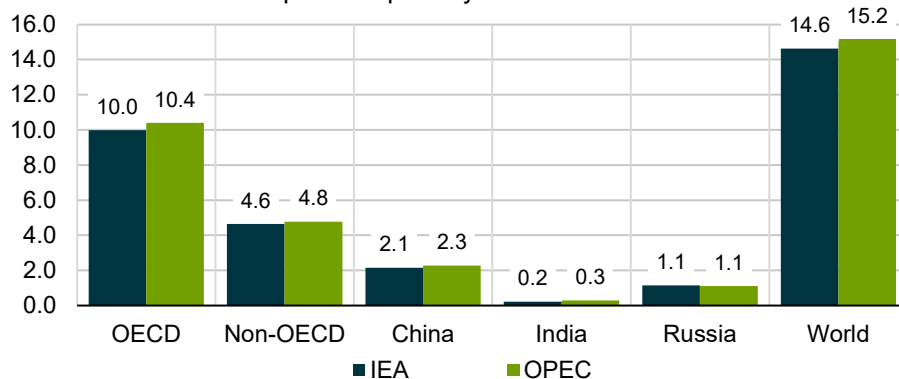


Source: IEF, IEA WEO 2022, OPEC WOO 2022

Biomass Baseline Data Differs by 5.4 mboe/d with Significant Differences in Both OECD and Non-OECD Regional Data

2021 Nuclear Demand

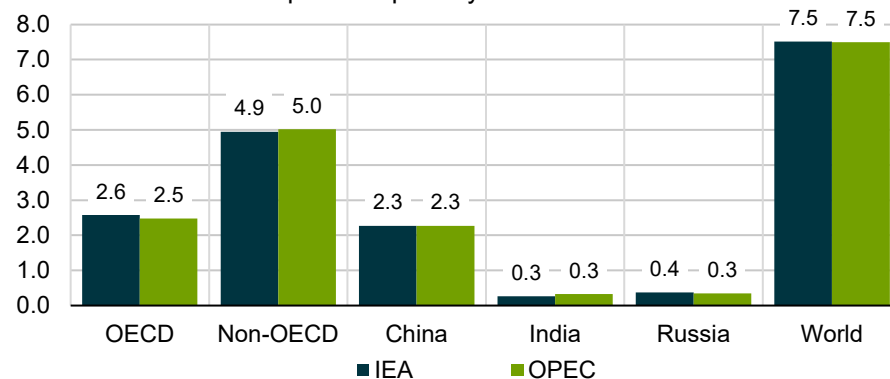
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

2021 Hydro Demand

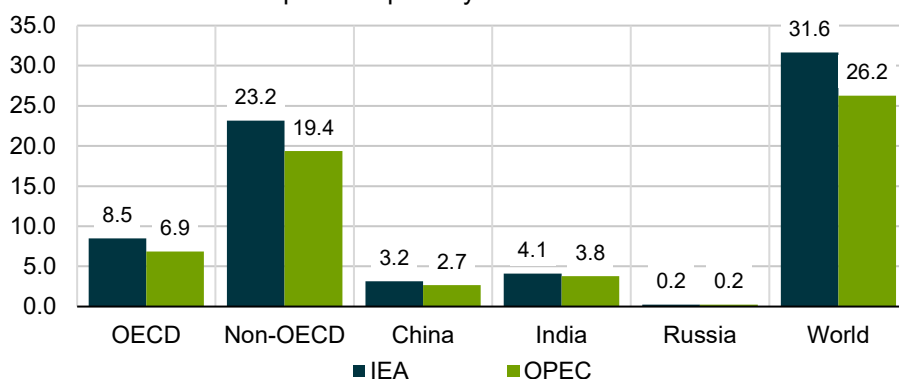
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

2021 Biomass Demand

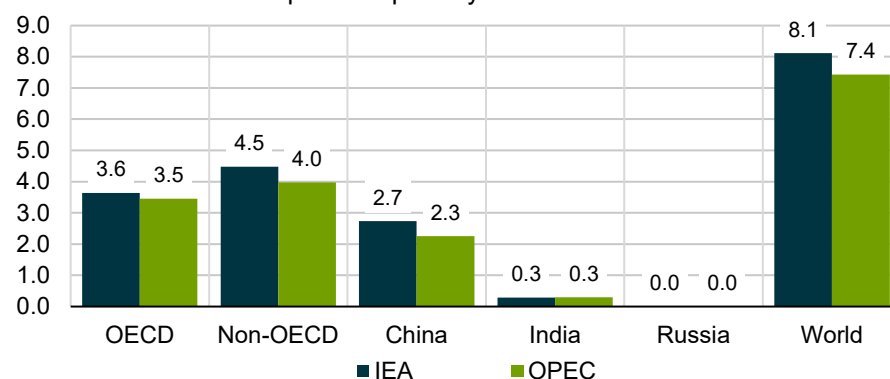
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

2021 Other Renewables Demand

Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

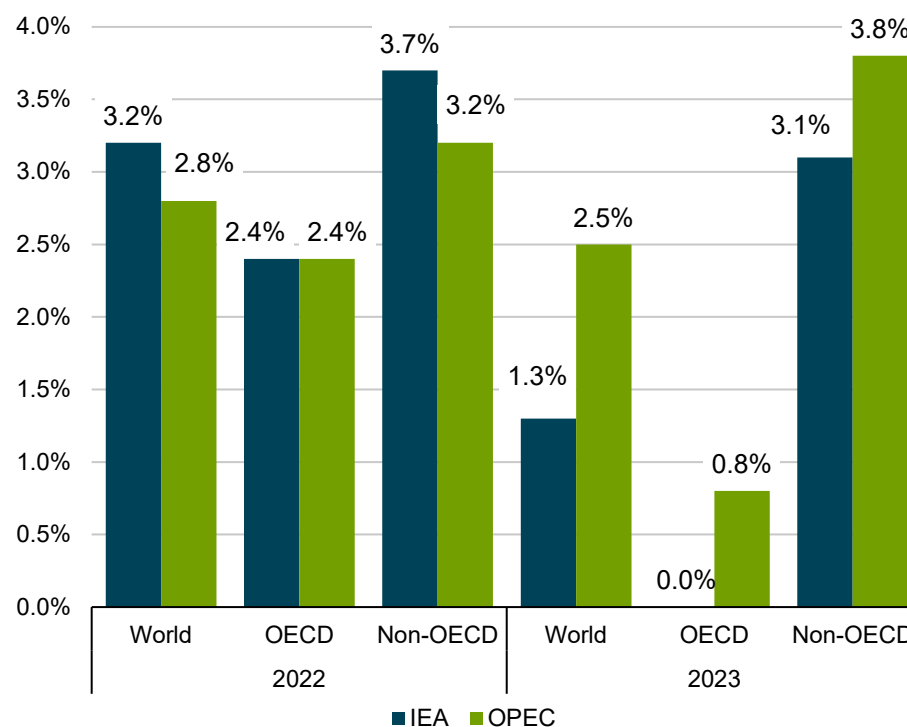
IEA OMR and OPEC MOMR's 2022-2023 Liquids Outlook (as of December 2022)

Both IEA and OPEC See Global Economic Outlook Deteriorating in 2023

IEA sees a steeper drop in growth with OECD coming to a standstill and Russia posting a second year of negative growth

Short-term GDP Growth Assumptions						
	2022			2023		
	IEA	OPEC	Range	IEA	OPEC	Range
World	3.2%	2.8%	0.4	1.3%	2.5%	1.2
OECD	2.4%	2.4%	0.0	0.0%	0.8%	0.8
US	2.1%	1.7%	0.4	0.1 %	0.8%	0.7
EU*	3.3%	3.0%	0.3	0.0 %	0.3%	0.3
Japan	1.5%	1.5%	0.0	0.7%	1.0%	0.3
Non-OECD	3.7%	3.2%	0.5	3.1%	3.8%	0.7
China	3.0%	3.1%	0.1	4.5%	4.8%	0.3
India	6.8%	6.5%	0.3	4.4%	5.6%	1.2
Brazil	2.8%	1.5%	1.3	1.0%	1.0%	0.0
Russia	-3.0%	-5.7%	2.7	-2.9%	0.2%	3.1

IEA and OPEC GDP Growth Assumptions
Annual growth



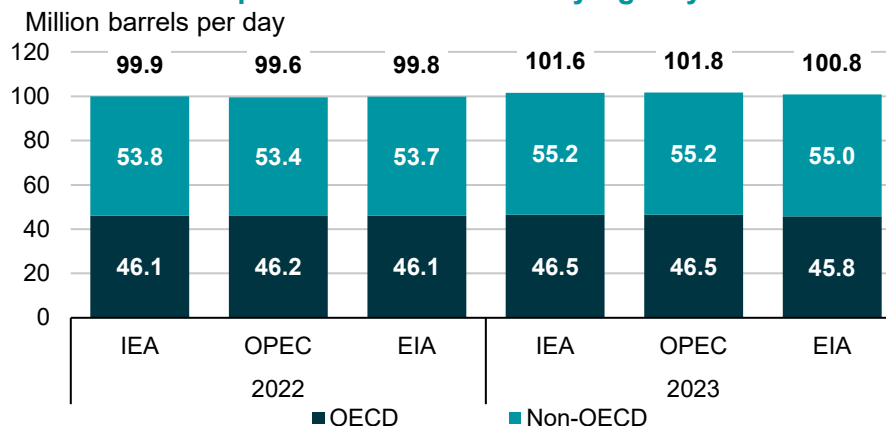
Note: IEA GDP assumptions are based on analysis from Oxford Economics
* IEA provides estimates for the EU while OPEC uses Euro Zone grouping

Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 WEO

Range in Agency Forecasts Widens in 2023 Driven by OECD Demand and Russian Supply

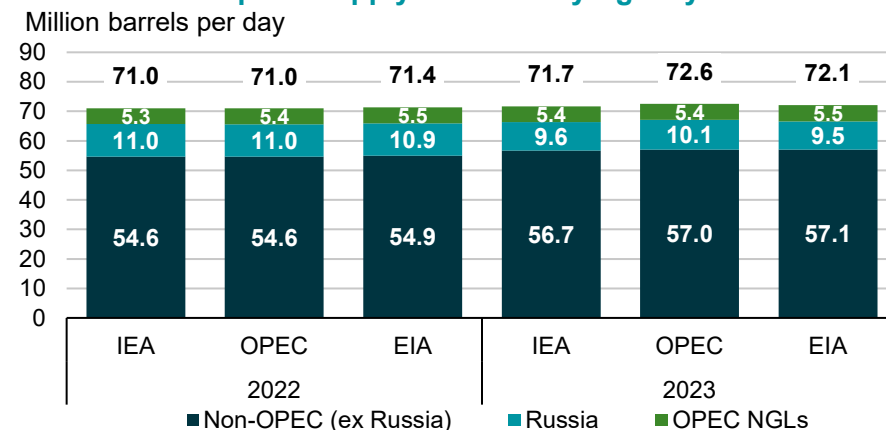
- IEA, OPEC, and EIA are fairly aligned on 2022 global demand estimates, with only a 0.3 mb/d range between the high (IEA) and low (OPEC).
- The range for 2023 demand widens to 1.0 mb/d with OPEC forecasting the highest and EIA the lowest.
- Notably, EIA sees 2023 OECD demand at 0.7 mb/d below IEA and OPEC's forecast.
- Agencies' 2022 non-OPEC and OPEC NGLs supply estimates range 0.4 mb/d with EIA seeing stronger non-OPEC (excluding Russia) supply.
- 2023 supply forecasts diverge by 0.9 mb/d, with Russian outlooks ranging 0.6 mb/d.

2022 & 2023 Liquid Demand Forecast By Agency



Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

2022 & 2023 Liquids Supply Forecast By Agency

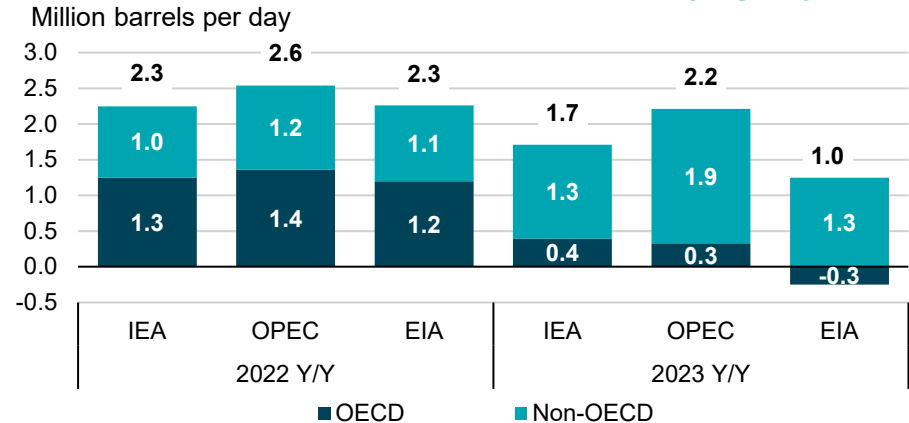


Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

Annual Demand Growth Forecasts for 2023 Span 1.2 mb/d While Non-OPEC Supply + OPEC NGLs Range 0.9 mb/d

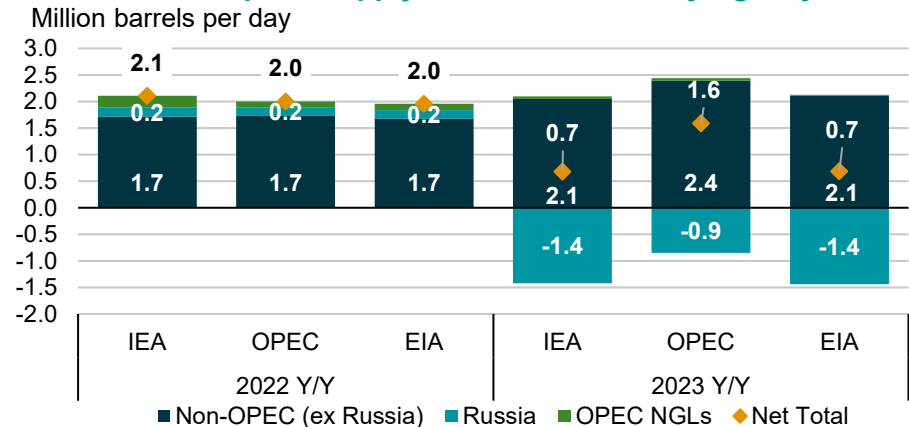
- Global demand growth is expected to slow in 2023 (vs. 2022) as growth in OECD countries weakens substantially.
- EIA sees the weakest global demand growth (1.0 mb/d y/y) and is the only forecast of the three to see a demand contraction in the OECD.
- Non-OECD demand is expected to rise faster in 2023 vs. 2022 as a bounce back in Chinese demand offsets slowdowns elsewhere.
- On the supply side, the largest divergence in 2023 growth is in Russian production forecasts.
- IEA and EIA both expect a 1.4 mb/d y/y drop in Russian output in 2023, while OPEC sees a 0.9 mb/d annual decline.

2022 & 2023 Liquid Demand Growth Forecast By Agency



Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

2022 & 2023 Liquids Supply Growth Forecast By Agency



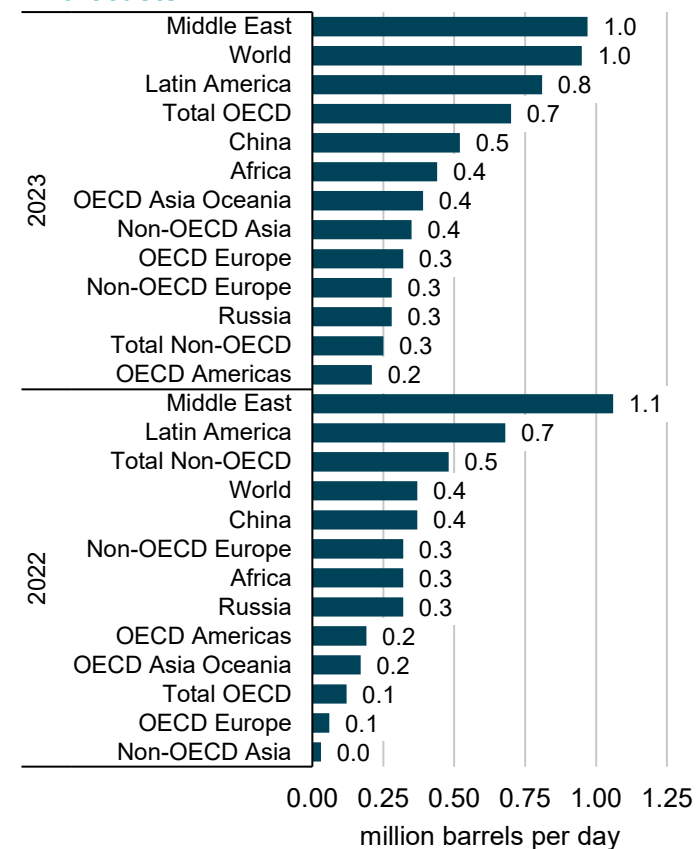
Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

Largest 2022-23 Demand Divergences Stem from Middle East, Latin America, and China

2022-2023 Liquid Demand Forecast by Agency

million barrels per day	2022				2023			
	IEA	OPEC	EIA	Range (high-low)	IEA	OPEC	EIA	Range (high-low)
Total OECD	46.08	46.20	46.08	0.12	46.47	46.53	45.83	0.70
Americas*	25.00	25.08	25.19	0.19	25.13	25.34	25.19	0.21
Europe	13.64	13.65	13.59	0.06	13.74	13.68	13.42	0.32
Asia Oceania	7.44	7.47	7.30	0.17	7.61	7.51	7.22	0.39
Total Non-OECD	53.84	53.36	53.74	0.48	55.16	55.24	54.99	0.25
Asia	28.90	28.93	28.92	0.03	30.23	30.05	29.88	0.35
China	15.01	14.79	15.16	0.37	15.83	15.31	15.76	0.52
Middle East**	9.04	8.22	9.28	1.06	9.14	8.55	9.52	0.97
Latin America	6.09	6.41	5.73	0.68	6.12	6.55	5.74	0.81
Europe and Eurasia	5.64	5.44	5.32	0.32	5.52	5.54	5.26	0.28
Russia	3.72	3.53	3.40	0.32	3.57	3.61	3.33	0.28
Africa**	4.17	4.36	4.49	0.32	4.15	4.55	4.59	0.44
World	99.93	99.56	99.82	0.37	101.64	101.77	100.82	0.95

Range in Agencies' 2022-2023 Demand Forecasts



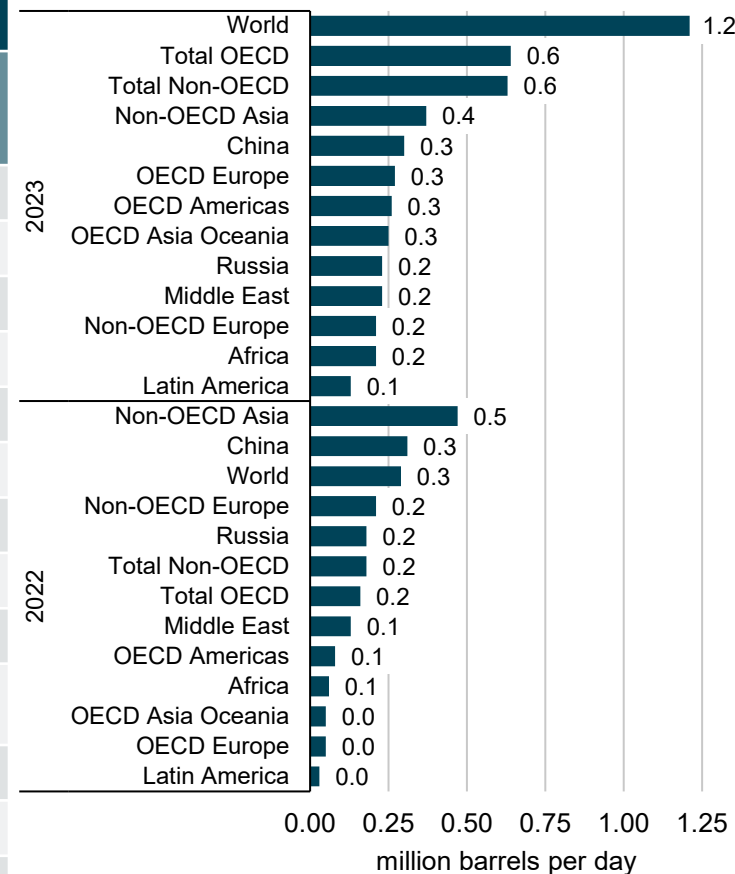
Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022

Range in 2023 Global Demand Growth is 4x Larger Than 2022 With Uncertainty Evenly Dispersed Across OECD and Non-OECD Regions

2022-2023 Liquid Demand Growth Forecast by Agency

	2022 vs. 2021				2023 vs. 2022			
	IEA	OPEC	EIA	Range (high-low)	IEA	OPEC	EIA	Range (high-low)
<i>million barrels per day</i>								
Total OECD	1.25	1.37	1.20	0.16	0.39	0.33	-0.25	0.64
Americas*	0.68	0.76	0.69	0.08	0.13	0.26	0.00	0.26
Europe	0.51	0.52	0.47	0.05	0.10	0.03	-0.17	0.27
Asia Oceania	0.06	0.09	0.04	0.05	0.17	0.04	-0.08	0.25
Total Non-OECD	1.00	1.18	1.06	0.18	1.32	1.89	1.25	0.63
Asia	0.09	0.57	0.42	0.47	1.33	1.11	0.96	0.37
China	-0.42	-0.18	-0.11	0.31	0.82	0.51	0.60	0.30
Middle East**	0.56	0.42	0.54	0.13	0.10	0.33	0.24	0.23
Latin America	0.15	0.18	0.17	0.03	0.03	0.15	0.01	0.13
Europe and Eurasia	0.02	-0.13	-0.19	0.21	-0.12	0.10	-0.06	0.21
Russia	0.07	-0.08	-0.11	0.18	-0.15	0.08	-0.07	0.23
Africa**	0.18	0.14	0.12	0.06	-0.02	0.19	0.10	0.21
World	2.27	2.55	2.26	0.29	1.71	2.22	1.00	1.21

Range in Agencies' 2022-2023 Demand Growth Forecasts



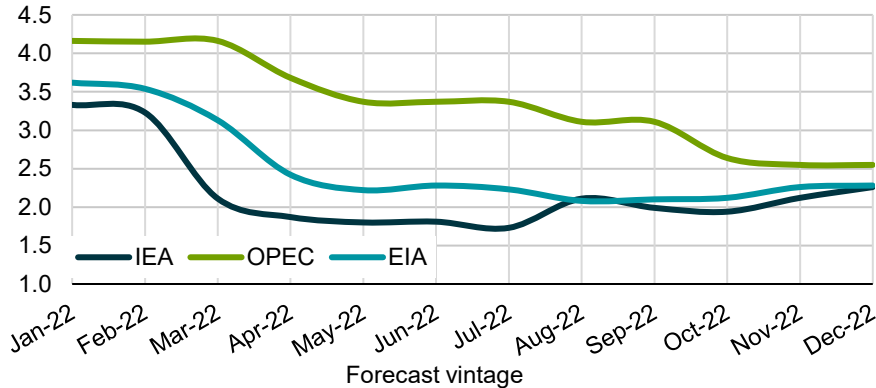
Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

Agencies Lowered 2022 Global Demand Growth Forecasts Steadily Through the Year & Are Now Converging ~2.4 mb/d

IEA estimated >0.2 mb/d steeper decline in Chinese demand growth at end-2022

Global Demand Growth: Evolution of 2022 Forecasts

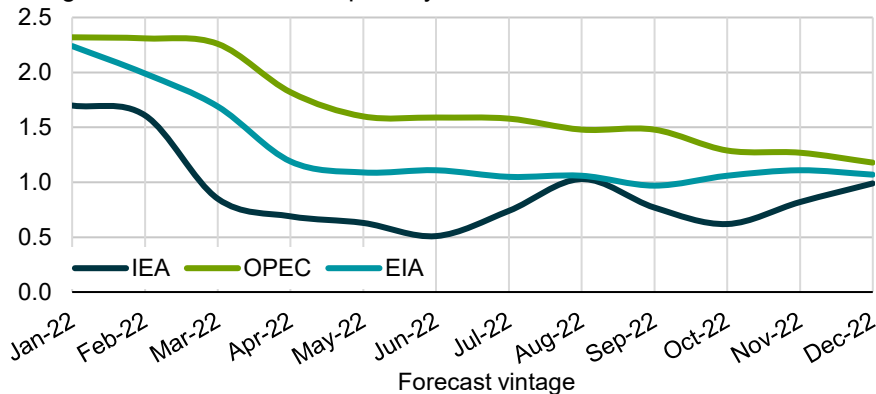
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Non-OECD Demand Growth: Evolution of 2022 Forecasts

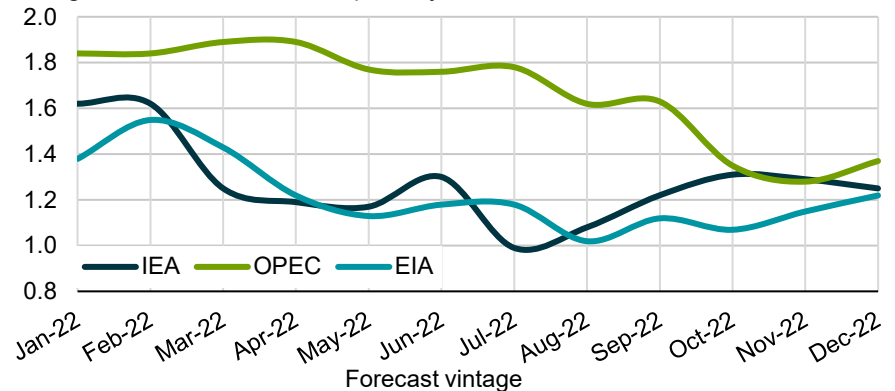
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

OECD Demand Growth: Evolution of 2022 Forecasts

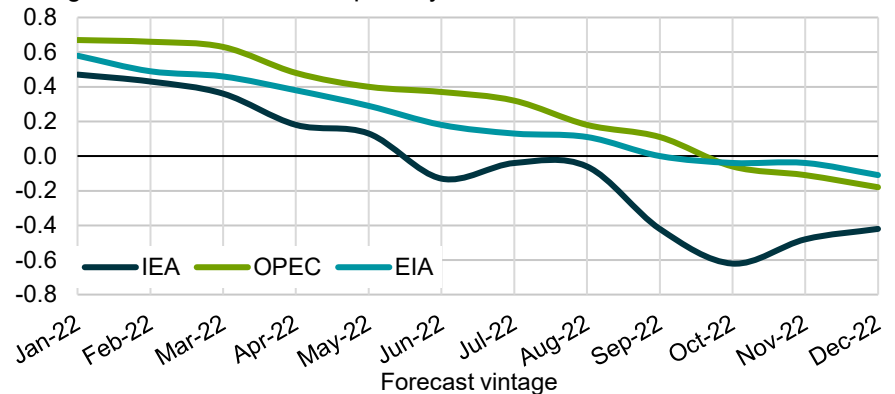
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Chinese Demand Growth: Evolution of 2022 Forecasts

Y/Y growth in million barrels per day



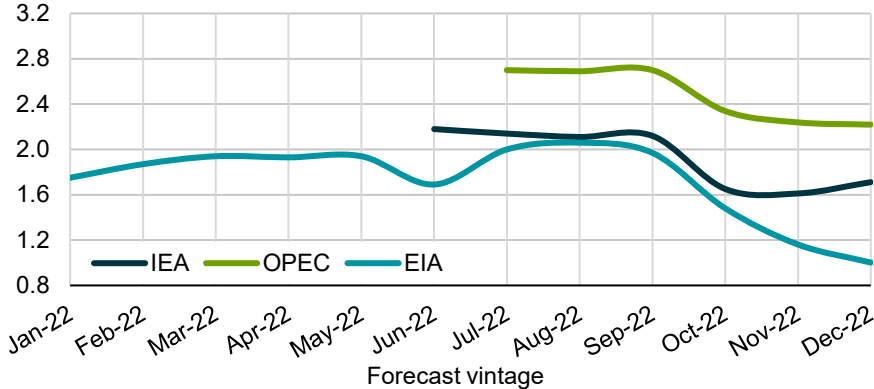
Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Uncertain Economic Headwinds Drive Widening Divergences in 2023 Demand Growth Forecasts

EIA alone sees declining OECD demand; OPEC sees higher non-OECD (ex-China) growth

Global Demand Growth: Evolution of 2023 Forecasts

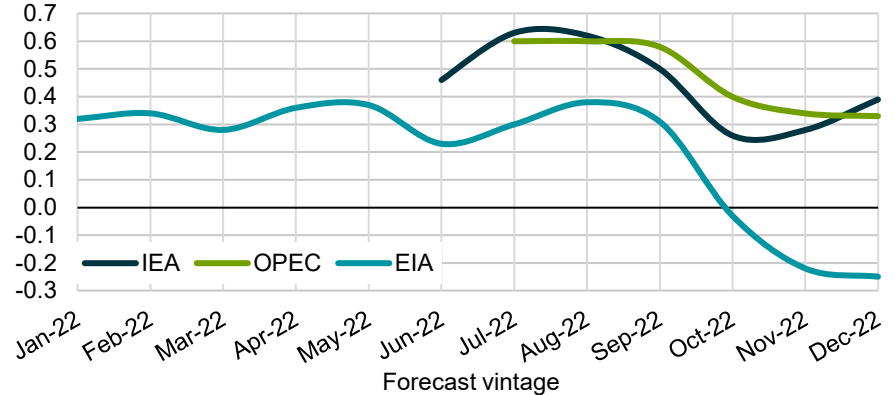
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

OECD Demand Growth: Evolution of 2023 Forecasts

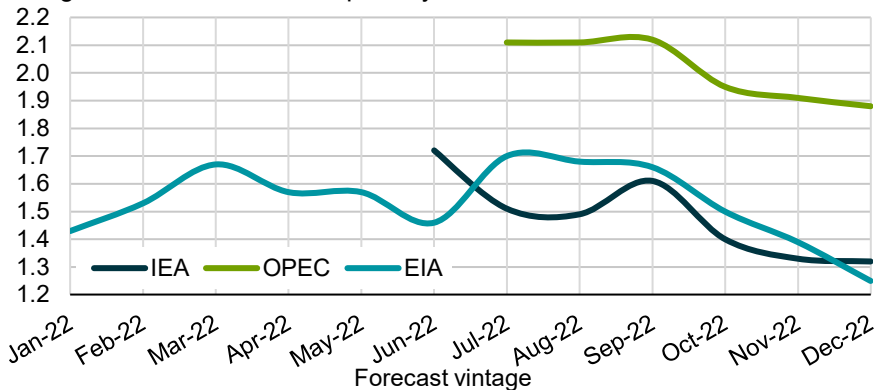
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Non-OECD Demand Growth: Evolution of 2023 Forecasts

Y/Y growth in million barrels per day

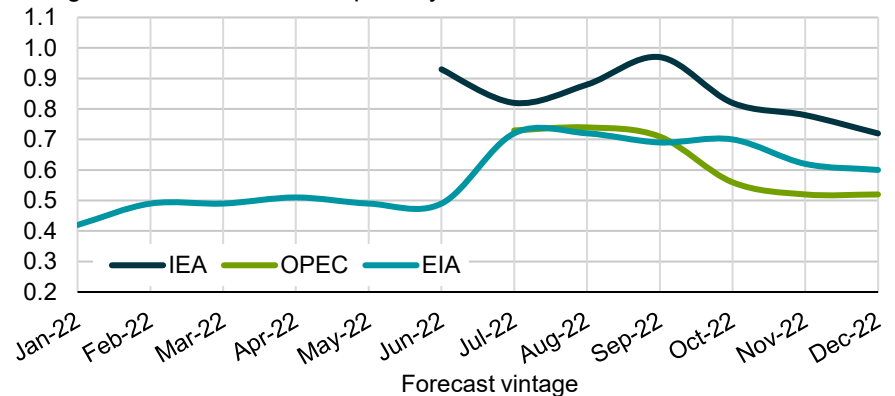


Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

* EIA first published a 2023 forecast in Jan 2022; IEA in June 2022; and OPEC in July 2022

Chinese Demand Growth: Evolution of 2023 Forecasts

Y/Y growth in million barrels per day



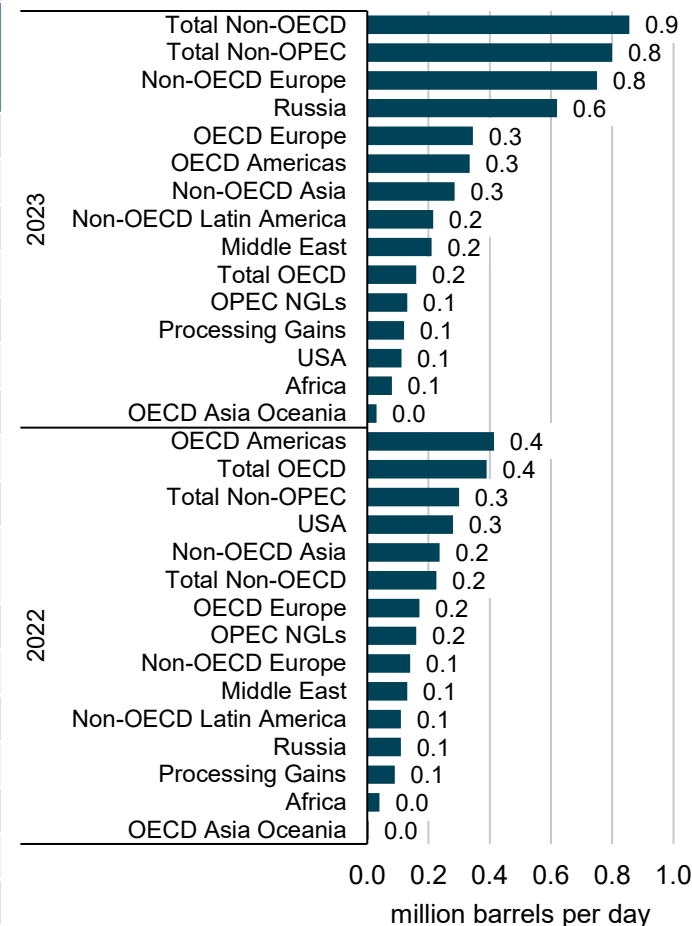
Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Russia Drives Largest Divergence of 2023 Supply Forecasts

2022-2023 Liquid Supply Forecasts by Agency

million barrels per day	2022				2023			
	IEA*	OPEC	EIA**	Range (high-low)	IEA*	OPEC	EIA**	Range (high-low)
Total OECD	31.12	30.73	31.09	0.39	31.52	32.36	32.52	0.16
Americas	27.05	26.64	26.85	0.41	28.21	27.95	27.88	0.33
USA	19.24	18.98	19.26	0.28	20.22	20.13	20.11	0.11
Europe	3.58	3.60	3.75	0.17	3.83	3.91	4.17	0.35
Asia Oceania	0.49	0.49	0.49	0.00	0.48	0.50	0.47	0.03
Total Non-OECD	32.24	32.44	32.47	0.23	30.43	32.29	31.67	0.86
Asia	7.42	7.53	7.66	0.24	7.47	7.63	7.76	0.29
Middle East	3.21	3.34	3.21	0.13	3.24	3.37	3.16	0.21
Latin America	6.36	6.34	6.45	0.11	6.81	6.68	6.90	0.22
Europe and Eurasia	13.95	13.91	13.81	0.14	12.65	13.27	12.52	0.75
Russia	11.04	10.96	10.93	0.11	9.62	10.11	9.49	0.62
Africa	1.30	1.32	1.34	0.04	1.27	1.35	1.34	0.08
Processing Gains	2.31	2.40	2.31	0.09	2.35	2.47	2.35	0.12
Total Non-OPEC	65.68	65.57	65.87	0.30	66.31	67.11	66.54	0.80
Total OPEC	n/a	n/a	34.11	n/a	n/a	n/a	34.52	n/a
OPEC Crude	n/a	n/a	28.61	n/a	n/a	n/a	29.00	n/a
OPEC NGLs	5.34	5.39	5.50	0.16	5.39	5.44	5.52	0.13
World	n/a	n/a	99.98	n/a	n/a	n/a	101.06	n/a

Range in Agencies' 2022-2023 Supply Forecasts



Source: IEF, IEA Dec '22 OMR, OPEC Dec '22 MOMR, EIA Dec '22 STEO

* Regional biofuels were added to IEA total liquids supply using IEA's OMR Table 17 World's Biofuels Production estimates

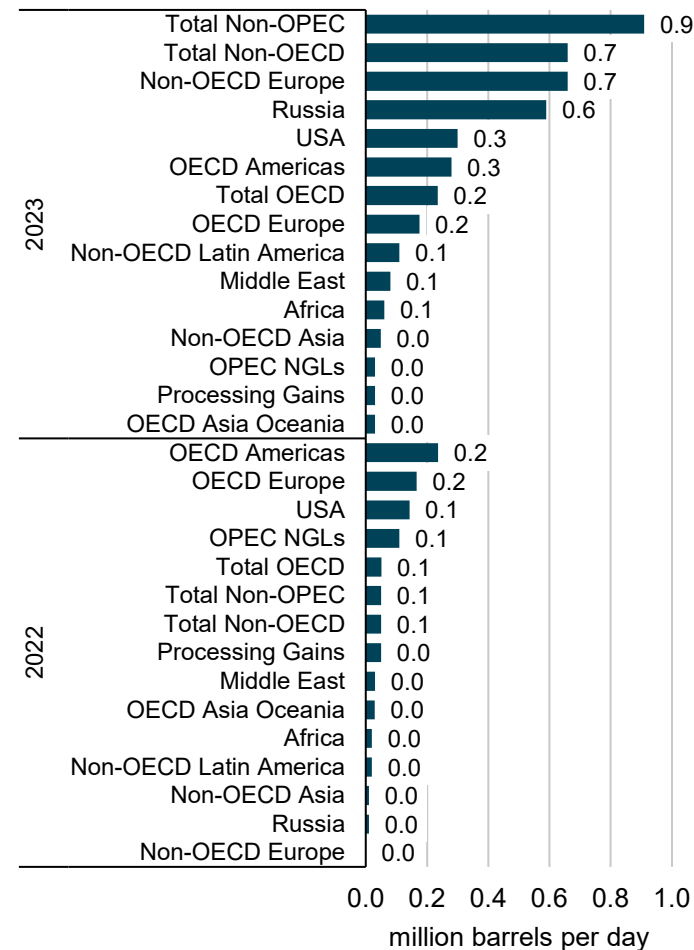
** Regional refinery processing gains were estimated using EIA and IEF data and subtracted from EIA regional total liquids supply

2023 Russian and US Supply See Largest Range in Growth

2022-2023 Liquid Supply Growth Forecasts by Agency

million barrels per day	2022 vs. 2021				2023 vs. 2022			
	IEA*	OPEC	EIA**	Range (high-low)	IEA*	OPEC	EIA**	Range (high-low)
Total OECD	1.23	1.21	1.18	0.05	1.40	1.63	1.43	0.23
Americas	1.50	1.39	1.26	0.24	1.16	1.31	1.03	0.28
USA	1.27	1.13	1.25	0.14	0.98	1.15	0.85	0.30
Europe	-0.22	-0.16	-0.05	0.17	0.25	0.31	0.42	0.17
Asia Oceania	-0.05	-0.02	-0.03	0.03	-0.01	0.00	-0.02	0.03
Total Non-OECD	0.59	0.57	0.62	0.05	-0.81	-0.16	-0.80	0.66
Asia	0.06	0.04	0.06	0.01	0.05	0.09	0.09	0.05
Middle East	0.13	0.10	0.13	0.03	0.03	0.04	-0.05	0.08
Latin America	0.38	0.39	0.37	0.02	0.45	0.33	0.44	0.11
Europe and Eurasia	0.07	0.07	0.07	0.00	-1.30	-0.64	-1.29	0.66
Russia	0.17	0.16	0.16	0.01	-1.42	-0.85	-1.44	0.59
Africa	-0.03	-0.03	-0.01	0.02	-0.03	0.02	0.00	0.06
Processing Gains	0.06	0.11	0.06	0.05	0.04	0.07	0.04	0.03
Total Non-OPEC	1.89	1.89	1.84	0.05	0.63	1.54	0.67	0.91
Total OPEC	n/a	n/a	2.45	n/a	n/a	n/a	0.41	n/a
OPEC Crude	n/a	n/a	2.33	n/a	n/a	n/a	0.39	n/a
OPEC NGLs	0.22	0.11	0.12	0.11	0.05	0.05	0.02	0.03
World	n/a	n/a	4.28	n/a	n/a	n/a	1.08	n/a

Range in Agencies' 2022-2023 Supply Growth Forecasts



Source: IEF, IEA Dec '22 OMR, OPEC Dec '22 MOMR, EIA Dec '22 STEO

* Regional biofuels were added to IEA total liquids supply using IEA's OMR Table 17 World's Biofuels Production estimates

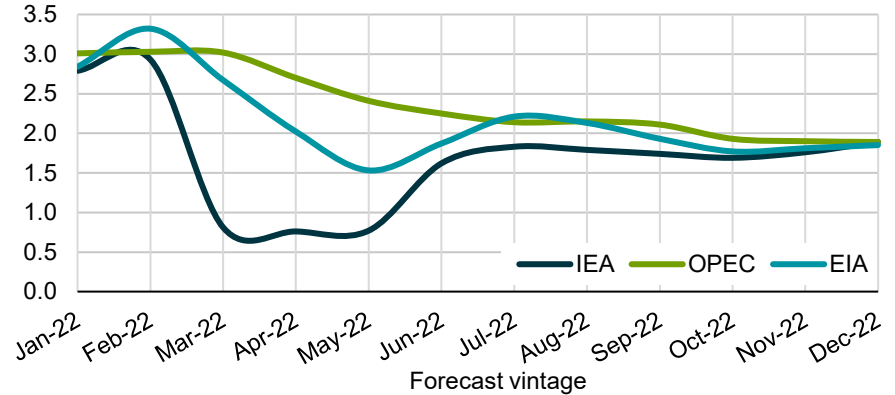
** Regional refinery processing gains were estimated using EIA and IEF data and subtracted from EIA regional total liquids supply

2022 Non-OPEC Supply Growth Estimates Have Converged ~1.9 mb/d

- The evolution of forecasts shows how Russian supply was much more resilient in 2022 compared to some early estimates.
- Russian supply is now estimated to have seen a slight year-on-year increase in 2022.
- US production is estimated to have increased by ~1.1-1.3 mb/d in 2022, accounting for 60-70% of total net non-OPEC production growth.

Non-OPEC Liquid Supply Growth: Evolution of 2022 Forecasts

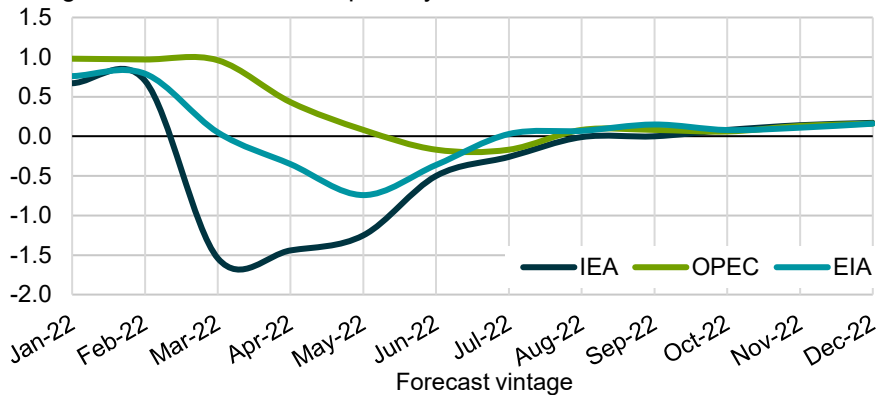
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Russian Liquid Supply Growth: Evolution of 2022 Forecasts

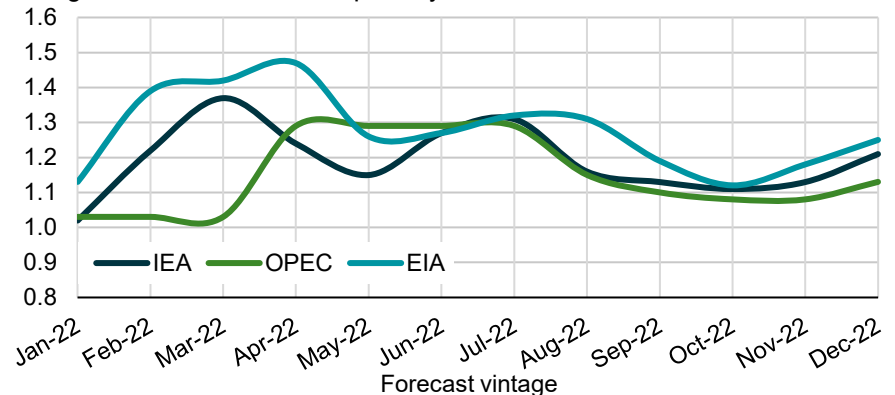
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

US Liquid Supply Growth: Evolution of 2022 Forecasts

Y/Y growth in million barrels per day

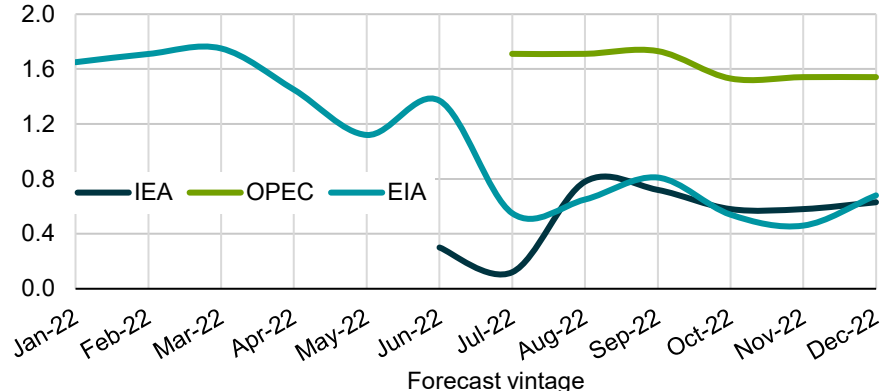


Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

2023 Non-OPEC Supply Growth Forecasts Range From 0.6 mb/d to 1.5 mb/d With Diverging Views on Russia and US

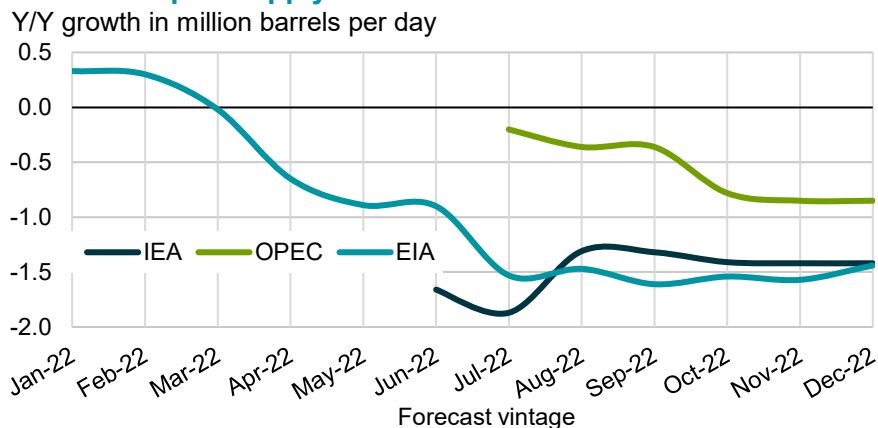
- OPEC sees ~0.9 mb/d stronger non-OPEC supply growth in 2023 compared to IEA and EIA.
- OPEC's forecast shows more robust growth from the US and less steep of a fall in Russian supply.
- IEA and EIA forecasts show Russian production declines fully offsetting US production gains in 2023.

Non-OPEC Liquid Supply Growth: Evolution of 2023 Forecasts
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

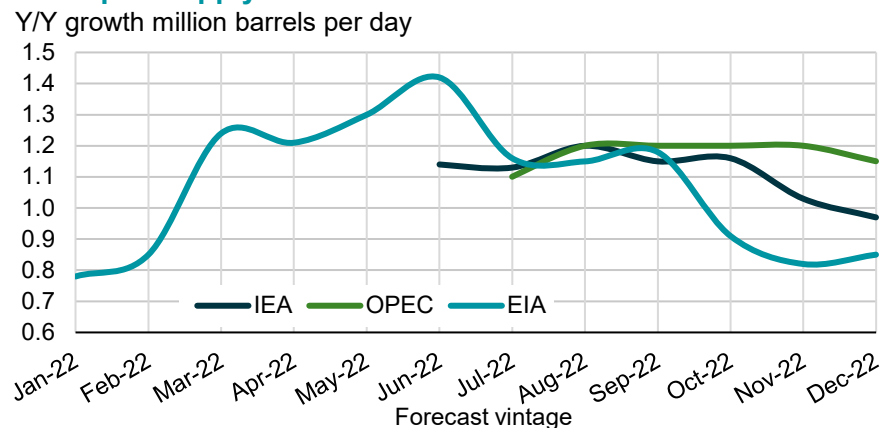
Russian Liquid Supply Growth: Evolution of 2023 Forecasts
Y/Y growth in million barrels per day



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

* EIA first published a 2023 forecast in Jan 2022; IEA in June 2022; and OPEC in July 2022

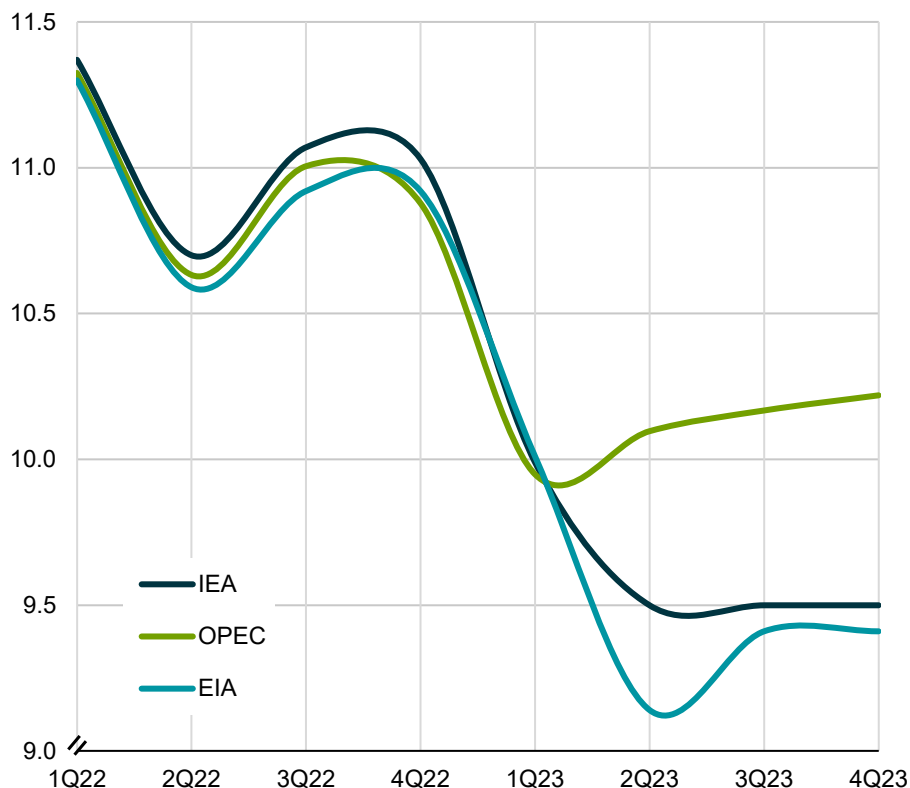
US Liquid Supply Growth: Evolution of 2023 Forecasts
Y/Y growth million barrels per day



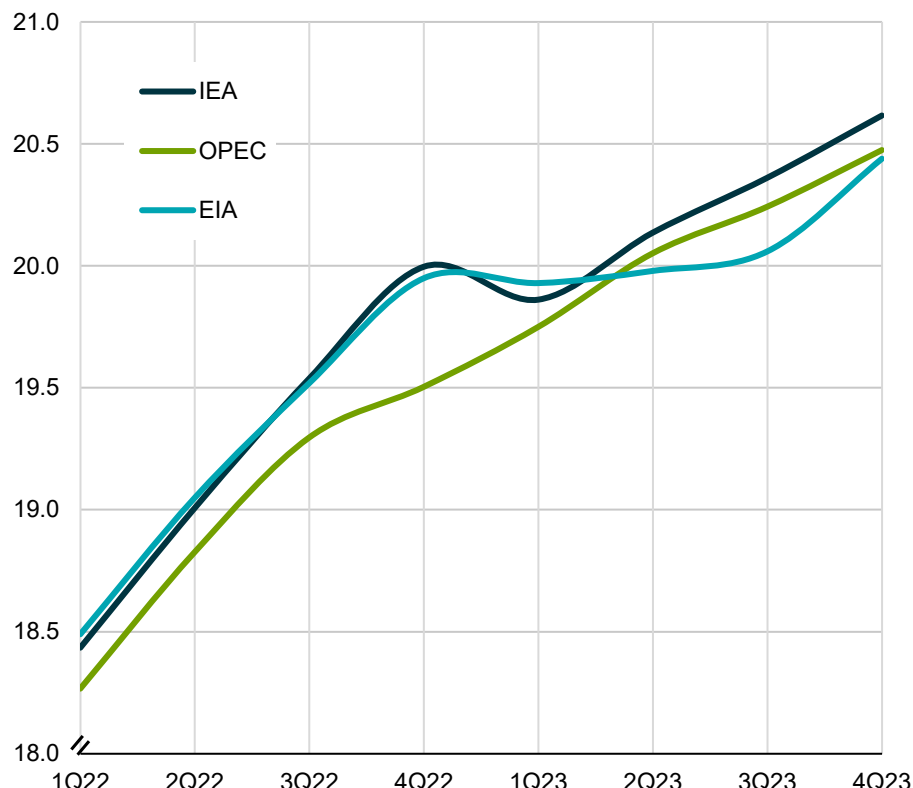
Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

OPEC Sees More Resilient Russian Supply in 2023 and Weaker US Supply in 2022 Compared to Both IEA and EIA

2022-2023 Quarterly Russian Production Forecasts By Agency
million barrels per day



2022-2023 Quarterly US Production* Forecasts By Agency
million barrels per day



* Includes onshore and offshore crude, condensate, NGLs, biofuels, and other liquids except for refinery processing gains

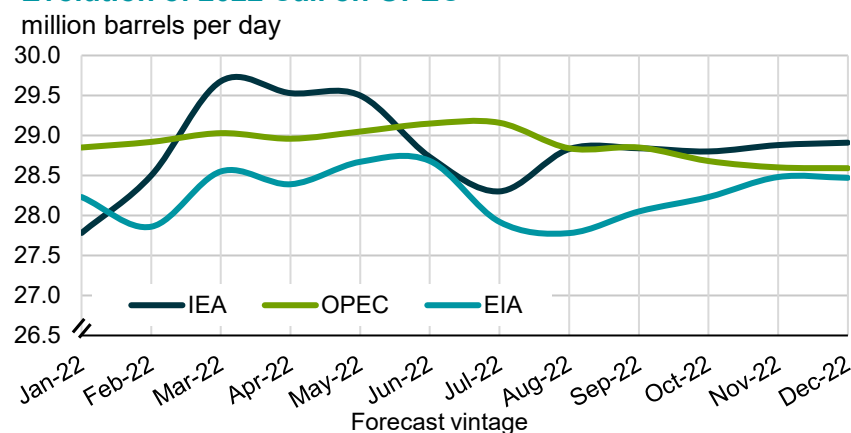
Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

Source: IEF, IEA Dec 2022 OMR, OPEC Dec 2022 MOMR, EIA Dec 2022 STEO

IEA, OPEC, and EIA See the “Call on OPEC Crude” Rising in 2023 as Demand Rises Faster than Non-OPEC Supply

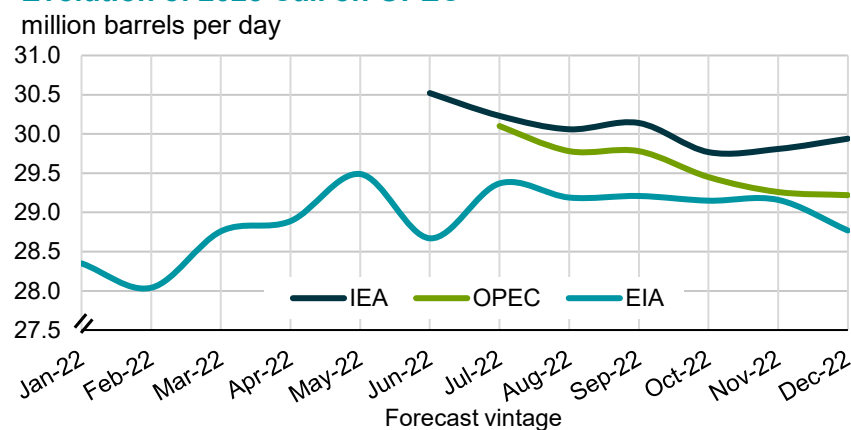
- The “call on OPEC crude” is a calculation and not a forecast of actual OPEC production.
- It is estimated by subtracting a forecast for non-OPEC production and OPEC NGLs from global demand.
- The “call on OPEC” estimates what OPEC would need to produce to balance global supply and demand.
- All three agencies show a higher “call on OPEC” in 2023 compared to 2022, but the amounts diverge by >1.0 mb/d due to different demand and non-OPEC supply forecasts.
- IEA’s 2023 forecasts imply the highest “call on OPEC” at 29.9 mb/d – which is 0.7 mb/d higher than OPEC’s actual production in December 2022 (based on IEA’s estimate of 29.2 mb/d).

Evolution of 2022 Call on OPEC



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

Evolution of 2023 Call on OPEC



Source: IEF, IEA OMR, OPEC MOMR, EIA STEO

* EIA first published a 2023 forecast in Jan 2022; IEA in June 2022; and OPEC in July 2022

IEA and OPEC Outlooks to 2030

IEA and OPEC Scenario Descriptions and Assumptions

IEA WEO 2022 Scenarios

Stated Policies Scenario (STEPS):

This scenario looks at what governments are actually doing to reach the targets and objectives they have set out. It considers policies that have been implemented or are under development.

This pathway is associated with an average increase of 2.5 °C by 2100 (with a 50% probability).

Announced Pledges Scenario (APS):

This scenario assumes that governments will meet in full and on time, all of the climate-related commitments that have been announced, including net zero emissions targets and pledges in NDCs.

This pathway is associated with an average increase of 1.7 °C by 2100 (with a 50% probability).

Net Zero Emissions by 2050 (NZE):

This scenario works backwards from the defined outcome of achieving net zero emissions by mid-century and stabilizing temperatures at 1.5°C above pre-industrial levels.

OPEC WOO 2022 Scenarios

Reference Case:

This scenario assumes continued progress in energy policies that have been announced and enacted to the extent they are technically and financially viable.

Advanced Technology Scenario (AT):

This scenario provides an alternative emissions reduction pathway consistent with the long-term goals of the Paris Agreement. It focuses on greater deployment of CCUS, hydrogen, and increased adoption of the circular carbon economy (CCE).

Laissez-Faire Scenario (LF):

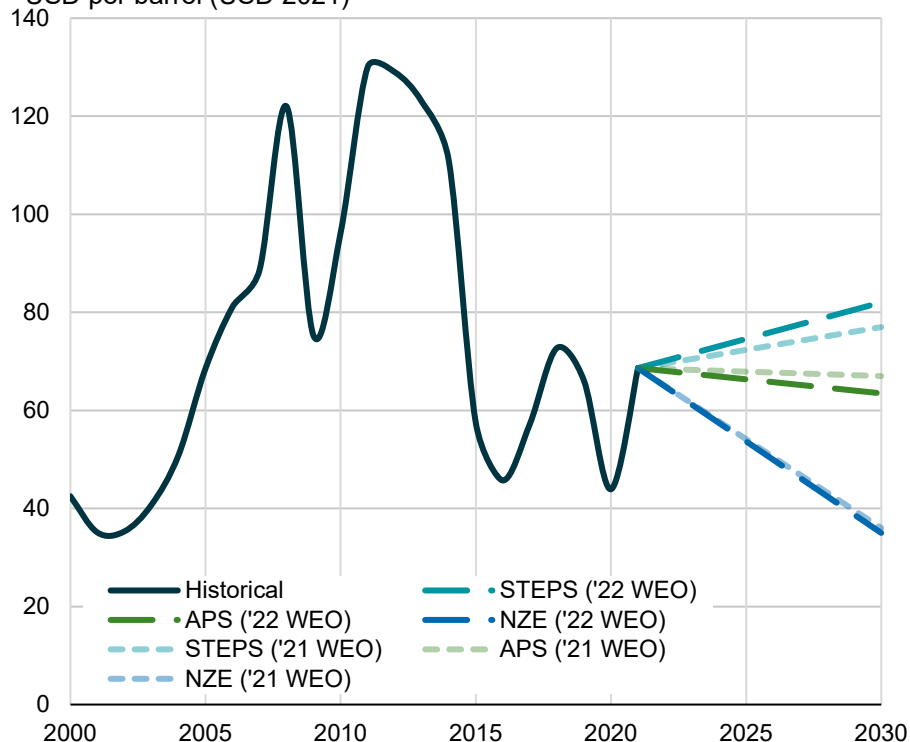
This scenario assumes improved energy access in least developed countries and a quicker transition to modern energy sources. It assumes policies will be tightened in the future but in a more isolated manner.

IEA and OPEC Assume 3.2%-3.3% Global Growth This Decade, With Some Differences at the Regional-Level

IEA's oil price assumptions are largely in line with last year's publication; OPEC does not provide price assumption data

IEA Crude Oil Price Assumptions by Scenario

USD per barrel (USD 2021)

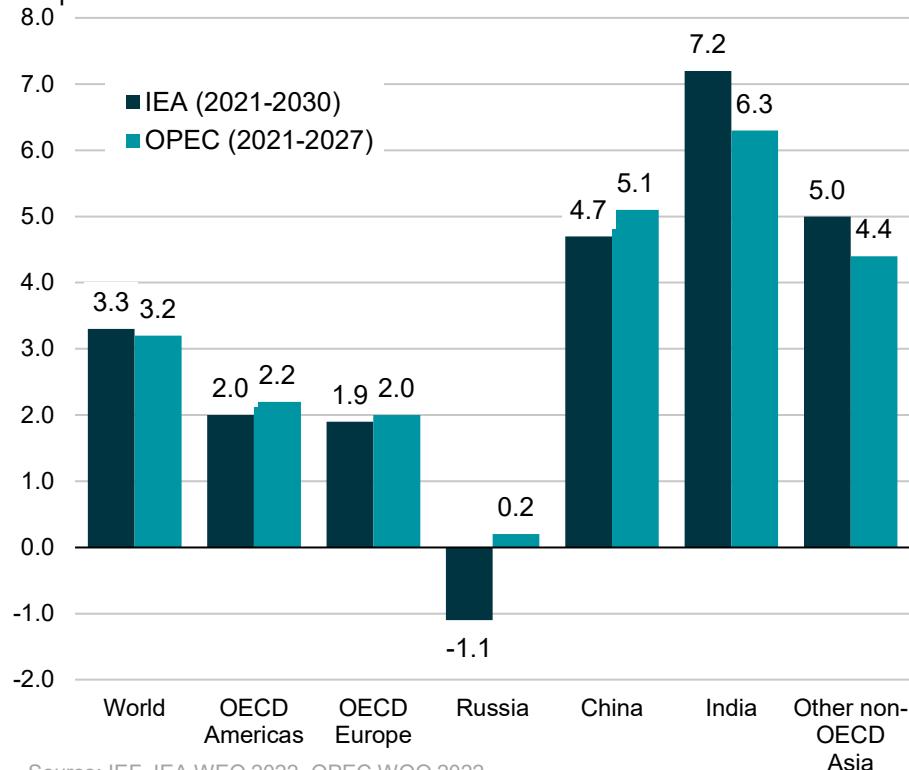


Source: IEF, IEA WEO 2022

* IEA and OPEC's regional classifications differ, so 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.

Average Annual Real GDP Growth Rates*

% per annum



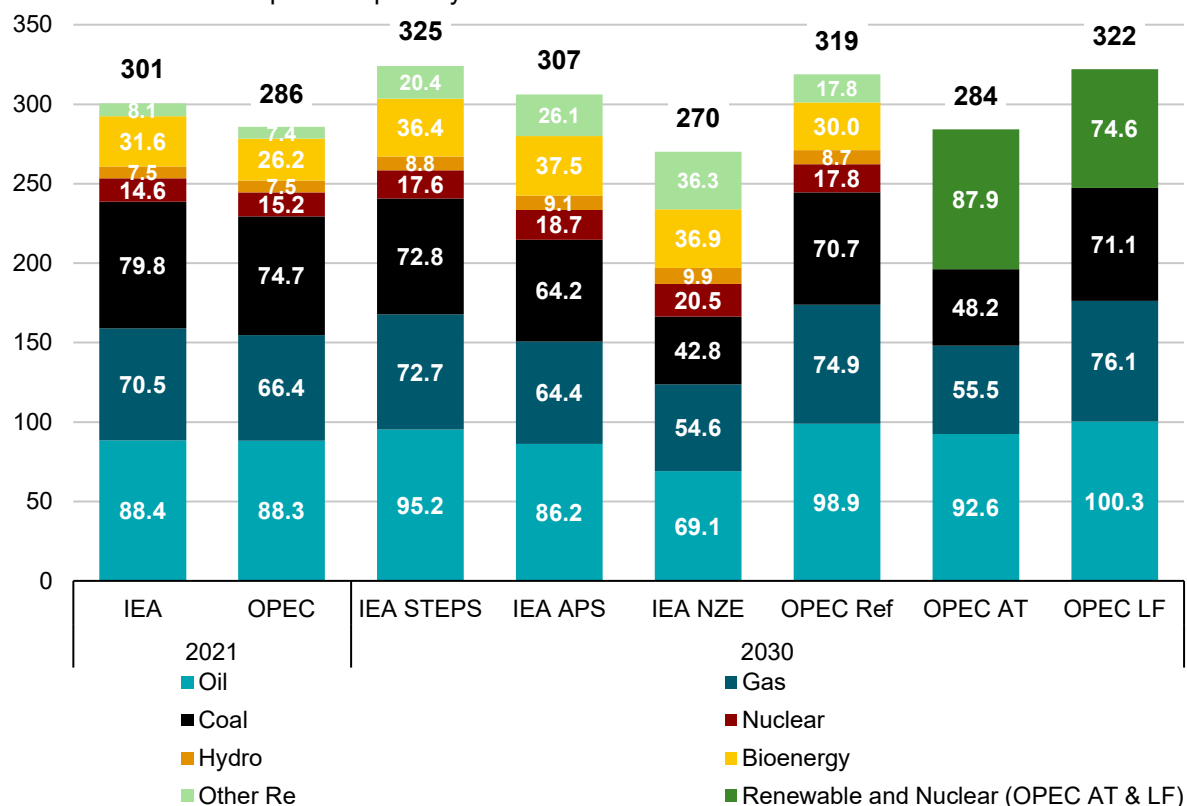
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Reference Scenarios Show Primary Energy Demand Growing Between 2021 and 2030

Renewable energy is set to more than double in most scenarios, but fossil fuels will still account for 62-77% of total primary demand in 2030

World Primary Energy Demand Outlook to 2030

Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

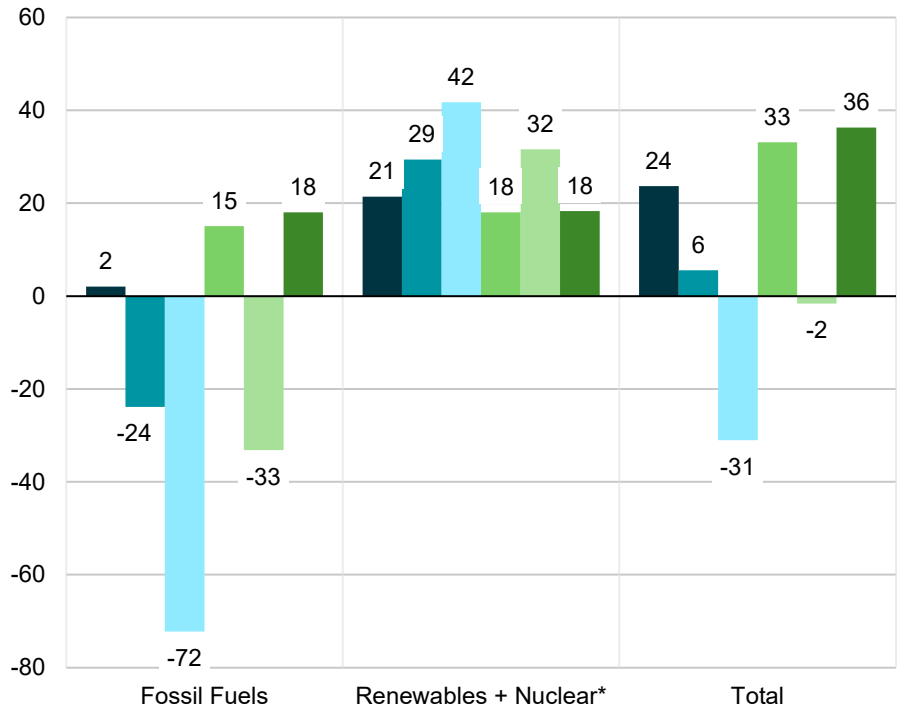
- Only IEA's NZE sees a substantial fall in global primary energy between 2021 and 2030.
- OPEC AT shows a marginal decline and IEA APS shows a slight increase.
- IEA STEPS is most similar to OPEC Ref and LF, although STEPS sees stronger renewable demand than both OPEC scenarios.
- Oil demand is seen increasing in all scenarios except IEA NZE and APS.
- Coal demand is expected to fall in all scenarios. The size of the decline ranges from 5% (in OPEC Ref and LF scenarios) to 46% in IEA's NZE.

All of the Scenarios See Renewables + Nuclear Growing By >30% Between 2021 and 2030

Half of the scenarios show fossil fuel demand growing between 2021 and 2030

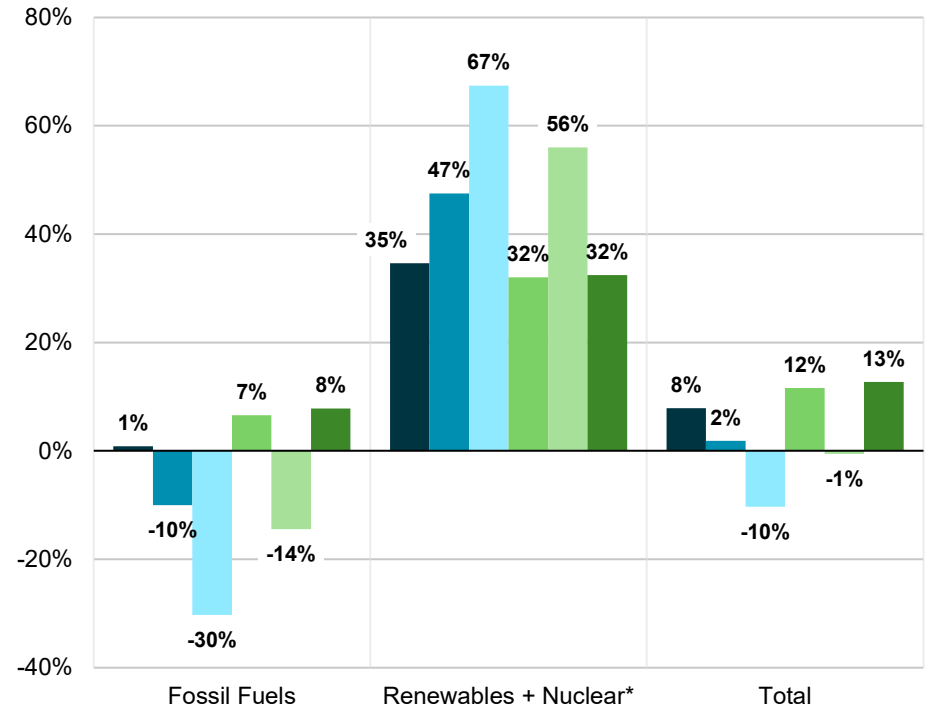
Change in World Primary Energy by Source: 2030 vs 2021

Million barrels of oil equivalent per day



% Change in World Primary Energy by Source: 2030 vs. 2021

% change by energy source



■ IEA STEPS ■ IEA APS ■ IEA NZE ■ OPEC Ref ■ OPEC AT ■ OPEC LF

■ IEA STEPS ■ IEA APS ■ IEA NZE ■ OPEC Ref ■ OPEC AT ■ OPEC LF

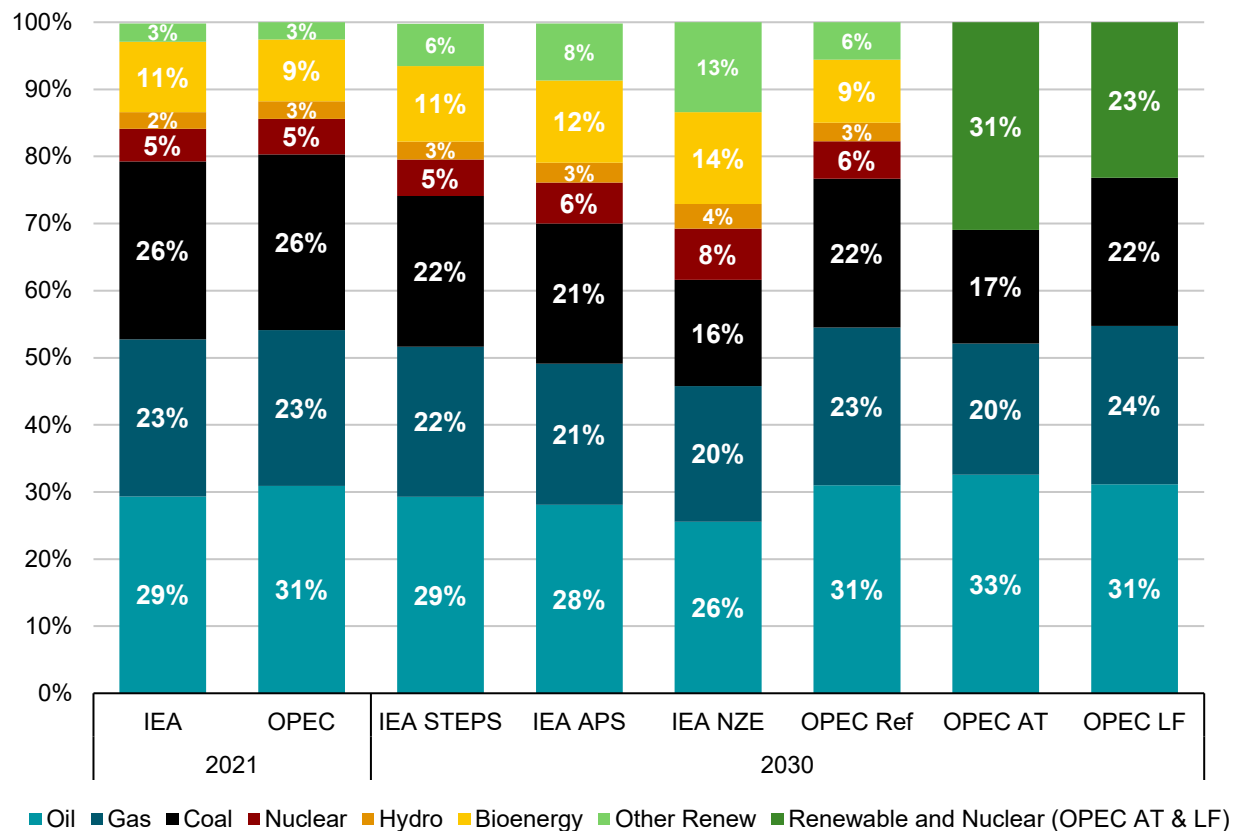
* Renewables + Nuclear includes nuclear, hydro, biomass, and other renewables
 * Renewables are grouped with nuclear to be able to compare all scenarios. OPEC's LF and AT only report the aggregate and not components for renewables and nuclear.
 Source: IEF, IEA WEO 2022, OPEC WOO 2022

* Renewables + Nuclear includes nuclear, hydro, biomass, and other renewables
 * Renewables are grouped with nuclear to be able to compare all scenarios. OPEC's LF and AT only report the aggregate and not components for renewables and nuclear.
 Source: IEF, IEA WEO 2022, OPEC WOO 2022

Fossil Fuels Will Still Account For 62-77% of Total Primary Energy Demand in 2030 (vs. ~80% in 2021)

World Primary Energy Demand Fuel Share Outlook to 2030

Percent of total primary energy



- Oil's share of total primary energy demand is expected to remain flat or grow in 4 of the 6 scenarios.
- Nuclear's share of primary energy demand is expected to stay flat or grow in IEA scenarios and OPEC reference (OPEC AT and LF scenarios only report nuclear demand aggregated with renewables).
- Renewable demand (excluding hydro and bioenergy) is expected to more than double in all IEA scenarios and OPEC reference.

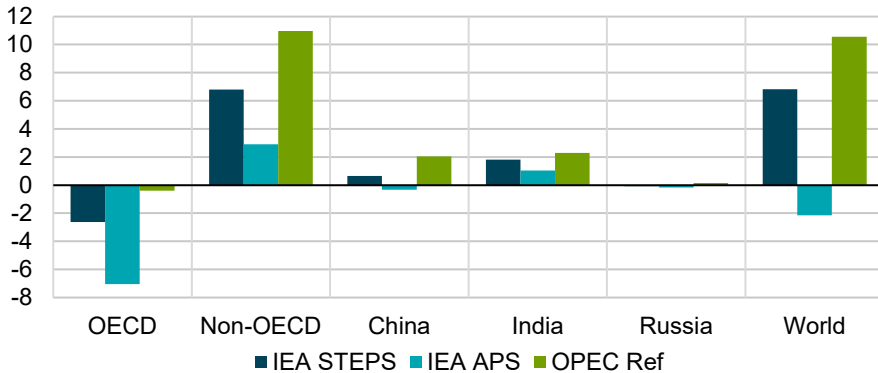
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Non-OECD Countries Drive Growth in Fossil Fuel Demand to 2030

Nearly all scenarios show declining OECD demand for oil, gas, and coal by 2030

Change in Oil Demand: 2030 vs. 2021

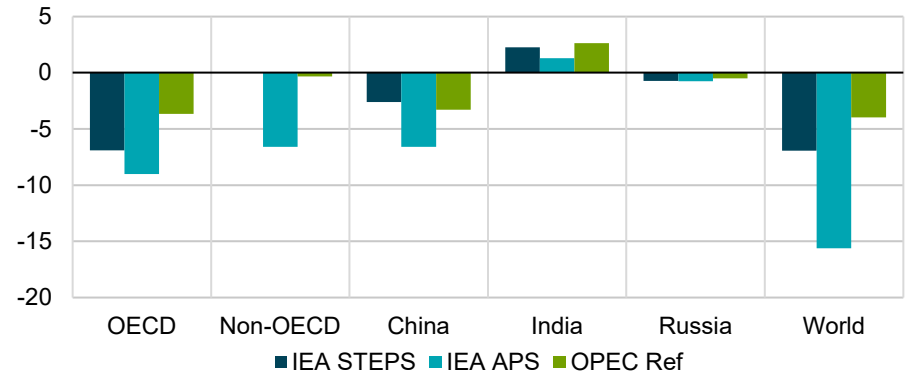
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Coal Demand: 2030 vs. 2021

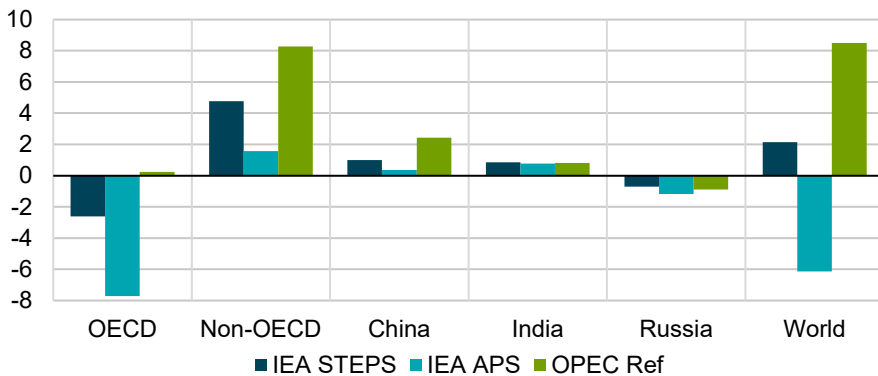
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Natural Gas Demand: 2030 vs. 2021

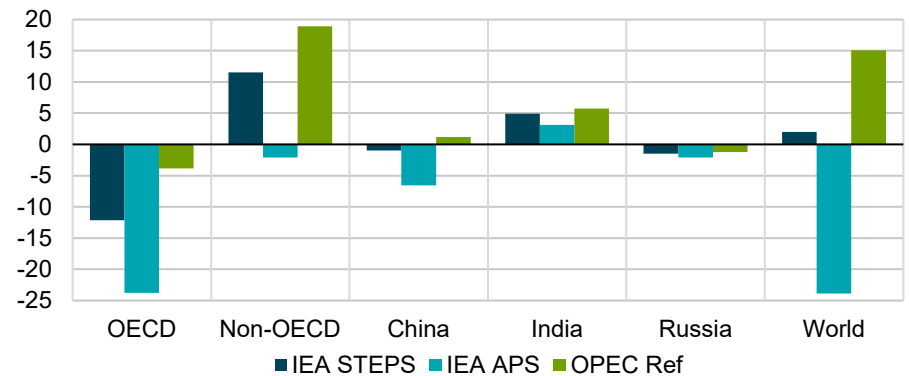
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Fossil Fuel Demand: 2030 vs. 2021

Million barrels of oil equivalent per day

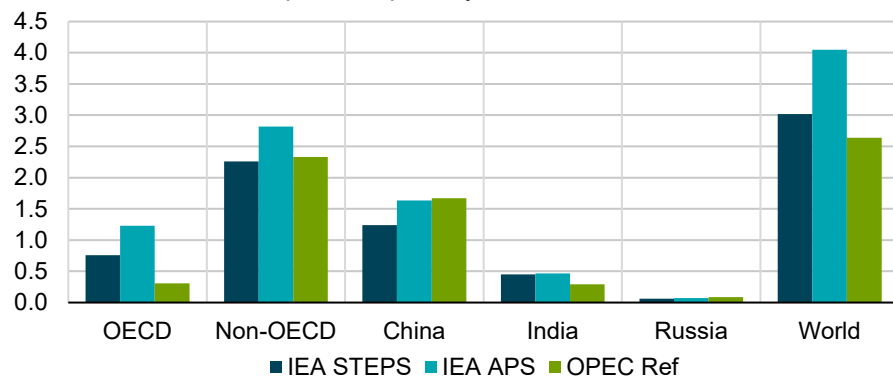


Source: IEF, IEA WEO 2022, OPEC WOO 2022

Non-OECD Countries Lead Growth in Nuclear, Hydro, and Other Renewables Demand

Change in Nuclear Demand: 2030 vs. 2021

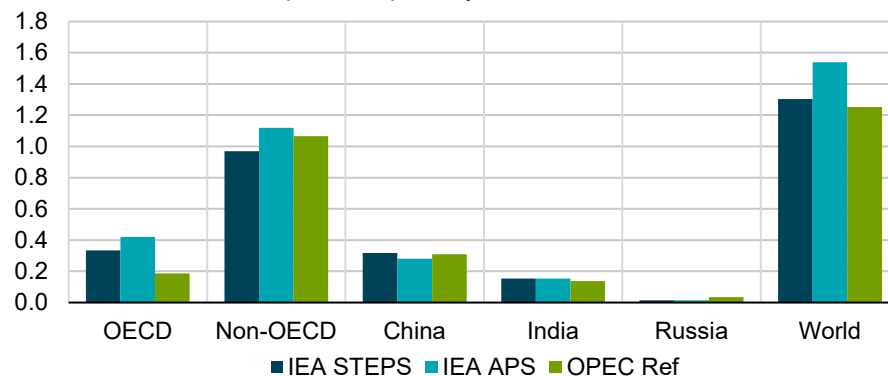
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Hydro Demand: 2030 vs. 2021

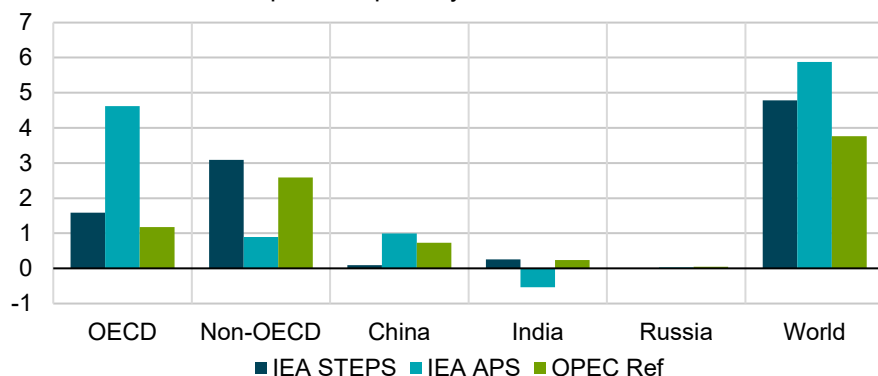
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Biomass Demand: 2030 vs. 2021

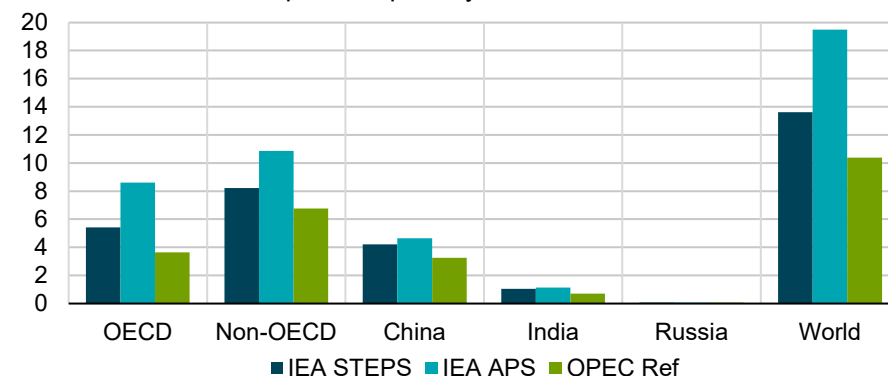
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Other Renewables Demand: 2030 vs. 2021

Million barrels of oil equivalent per day



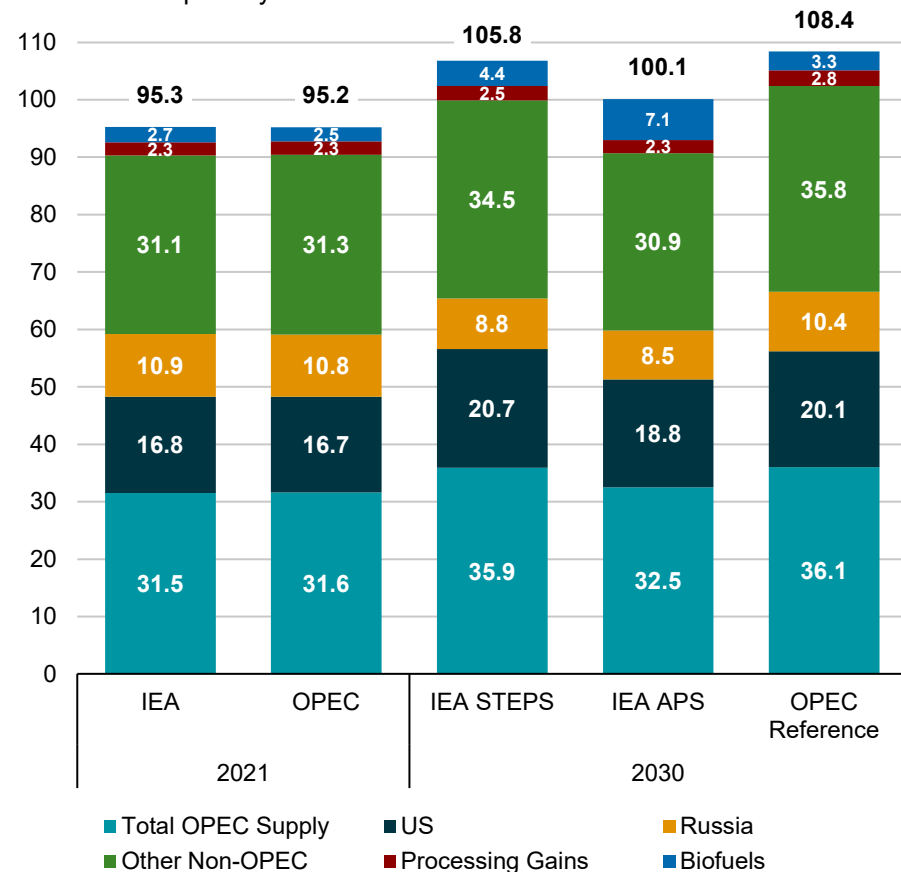
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Biofuels Play a Bigger Role in IEA APS – Accounting for 7% of Total Liquids Supply by 2030

OPEC’s reference case shows ~2.6 mb/d higher liquids supply vs. IEA STEPS in 2030

Liquids Supply Sources by Scenario

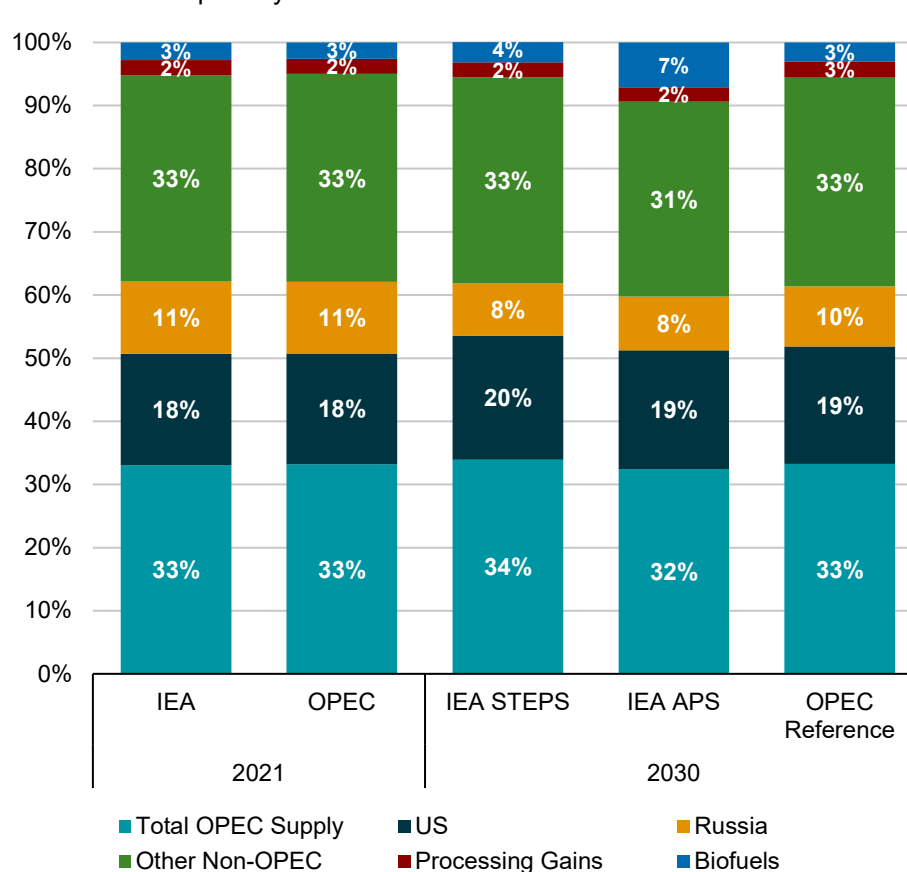
Million barrels per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Liquids Supply Sources by Scenario

Million barrels per day



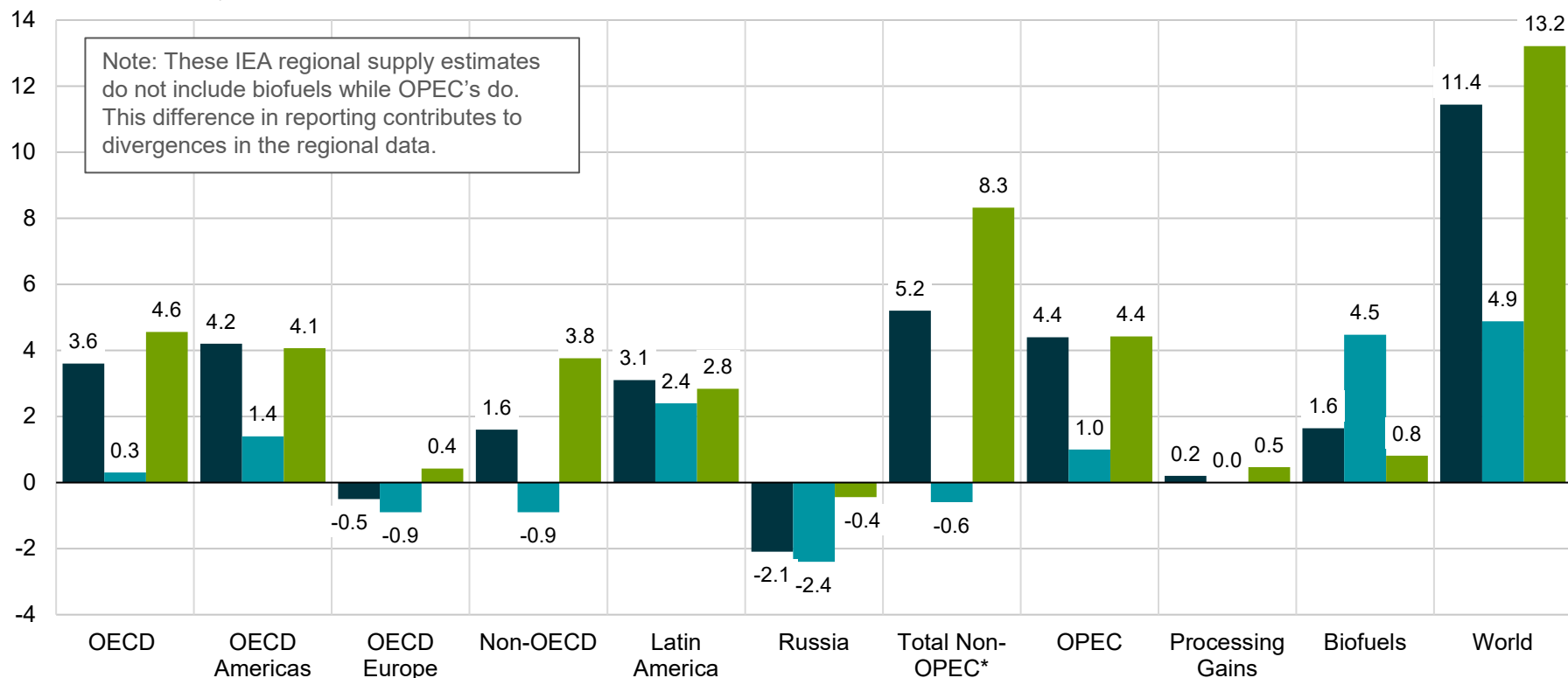
Source: IEF, IEA WEO 2022, OPEC WOO 2022

OPEC Reference Sees a Less Steep Decline in Russian Supply Compared to IEA Scenarios

IEA APS sees more robust biofuels growth and lower OPEC-member growth

Liquids Supply by Source: 2030 vs. 2021

Million barrels per day



*Total non-OPEC excluding processing gains
Source: IEF, IEA WEO 2022, OPEC WOO 2022

■ IEA STEPS ■ IEA APS ■ OPEC Reference

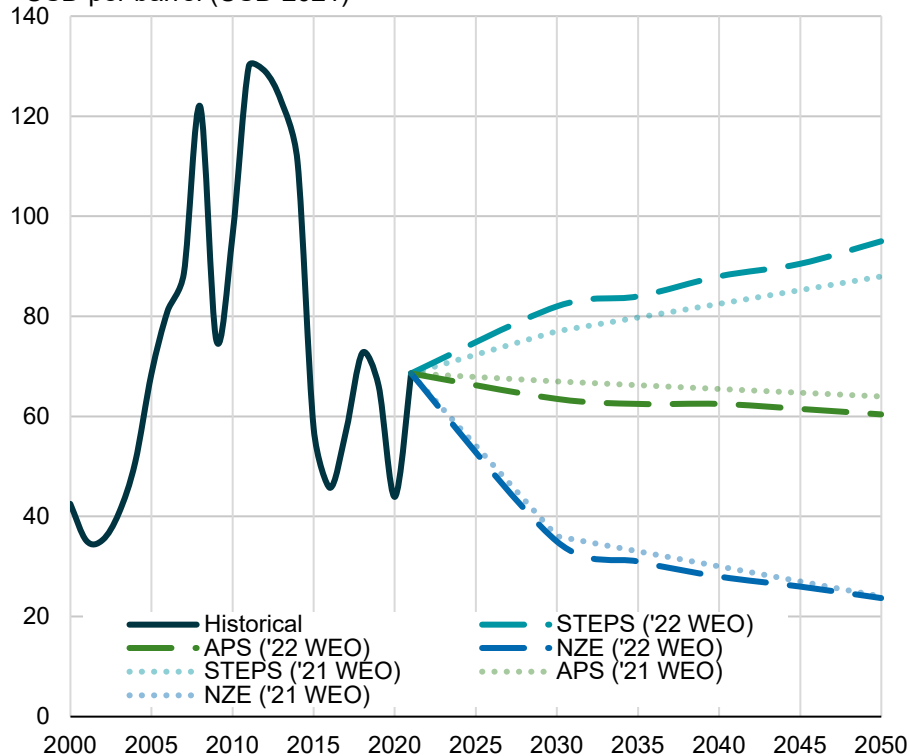
IEA and OPEC Outlooks to 2045

Agencies See Global Growth Moderating at Below 3% Per Annum with Large Divergences Seen in Non-OECD Asia

IEA's oil price assumptions are largely in line with last year's publication; OPEC does not provide price assumption data

IEA Crude Oil Price Assumptions by Scenario

USD per barrel (USD 2021)

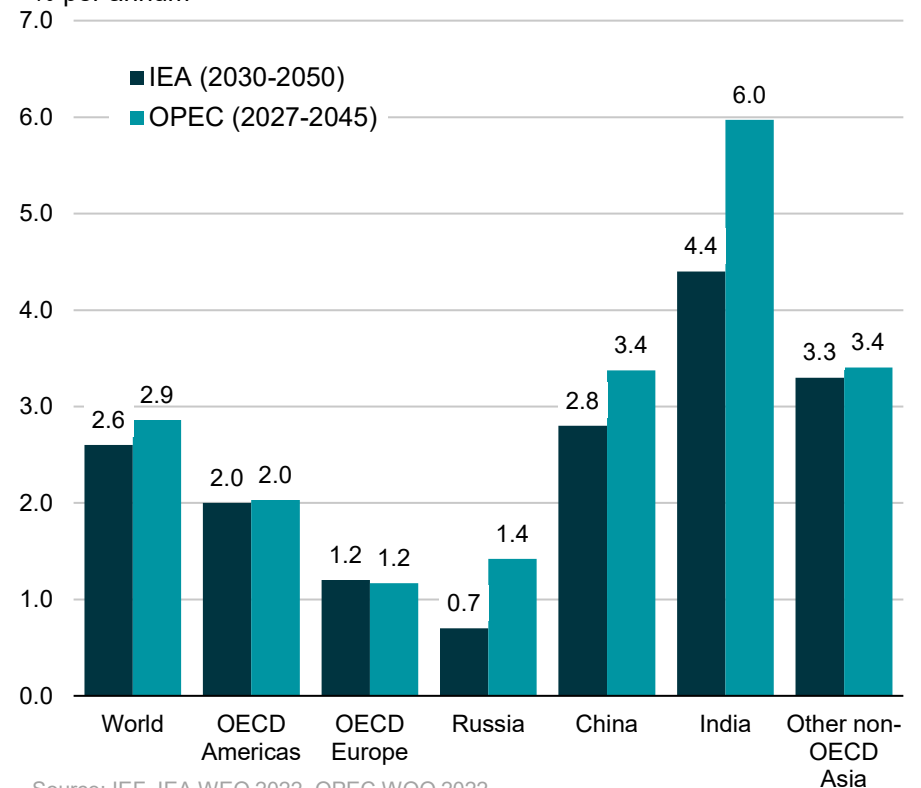


Source: IEF, IEA WEO 2022

* 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.

Average Annual Real GDP Growth Rate*

% per annum



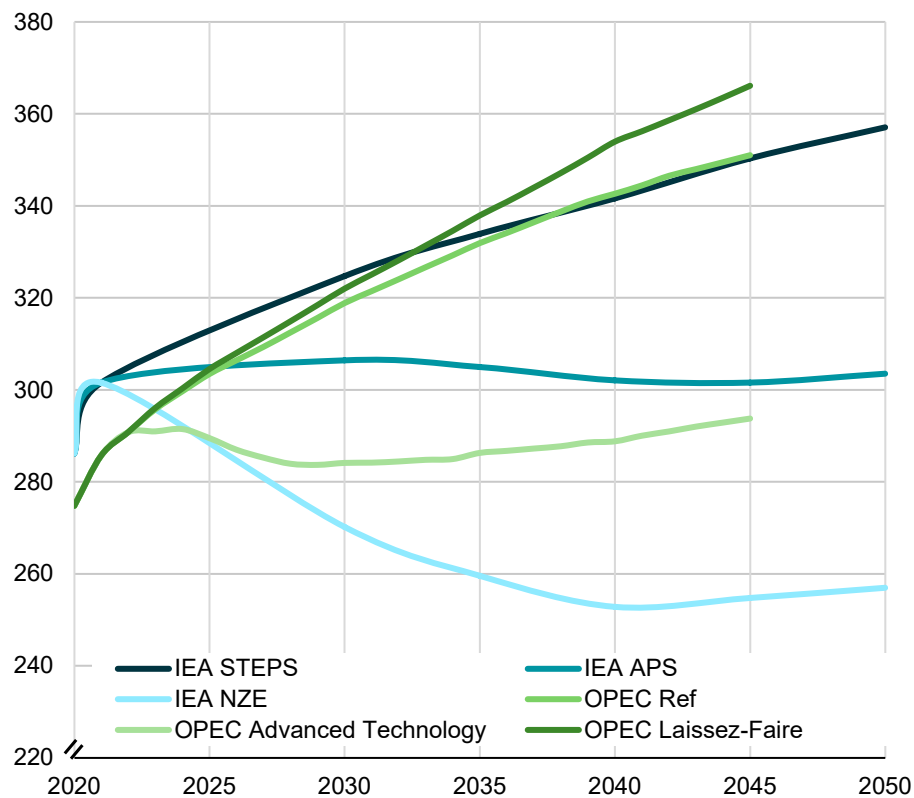
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Half of the Scenarios See Robust (+16% to 28%) Growth in Primary Energy Between 2021 and 2045

OPEC Reference and IEA STEPS show plateauing liquids demand while APS and NZE show a peak and decline

Global Primary Energy Outlook

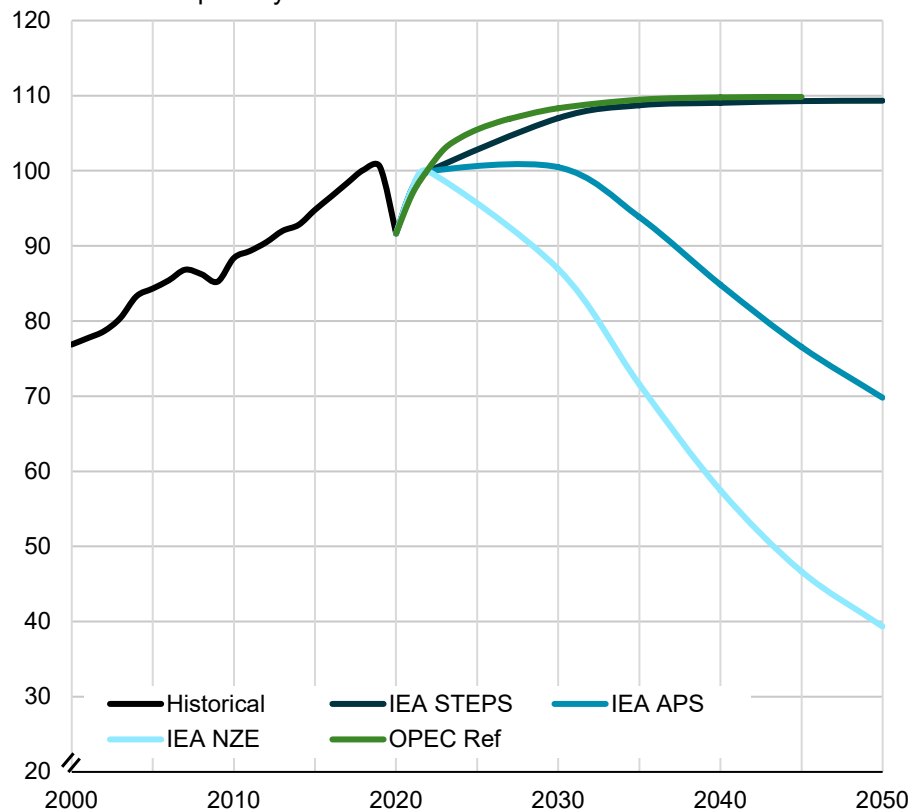
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO

Global Liquids Demand

Million barrels per day

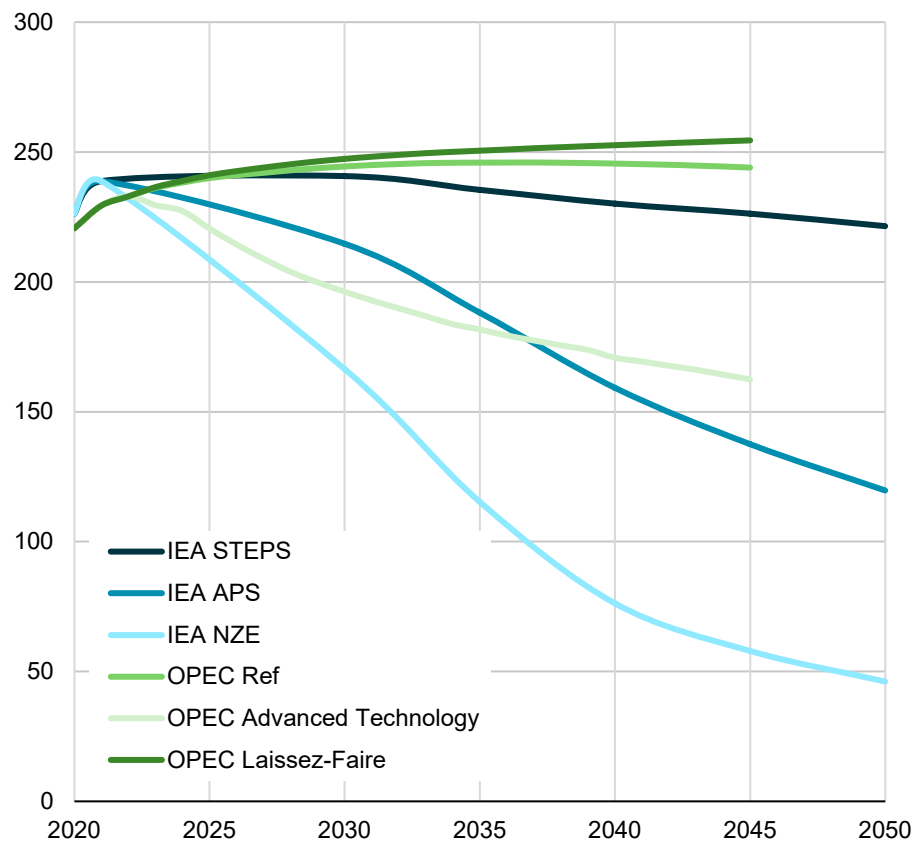


Source: IEF, IEA WEO 2022, OPEC WOO 2022

Despite Robust Growth, Non-Fossil Fuel Demand Will Not Surpass Fossil Fuel's 2021 Levels in the Forecast Period

Fossil Fuel Primary Energy Outlook

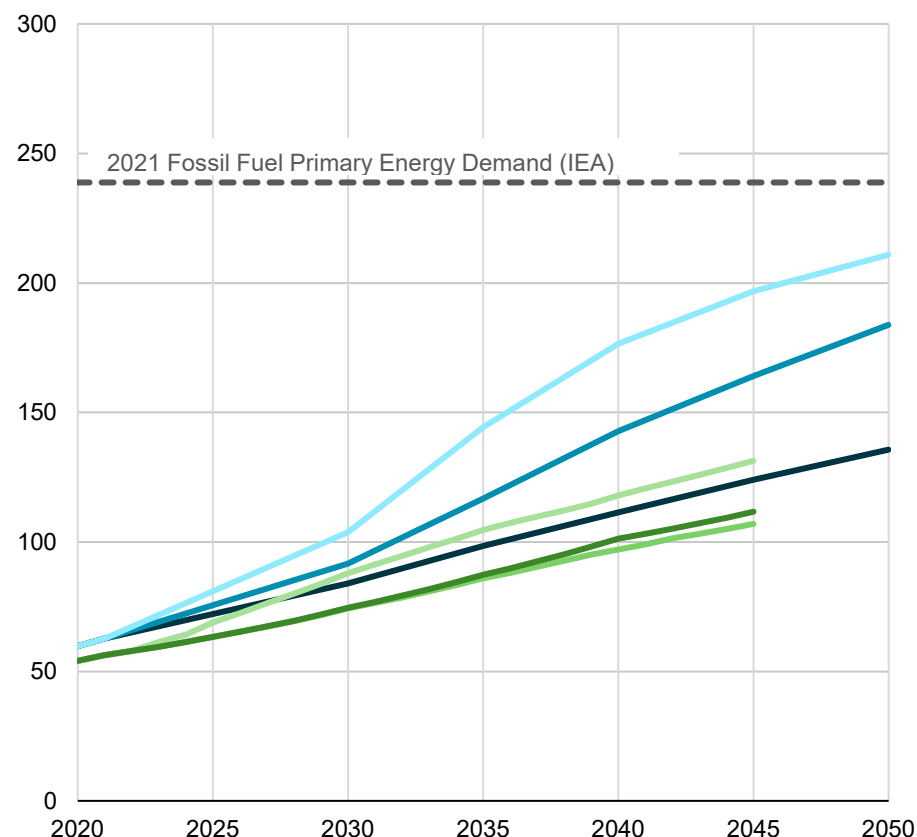
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO

Non-Fossil Fuel Primary Energy Outlook

Million barrels of oil equivalent per day

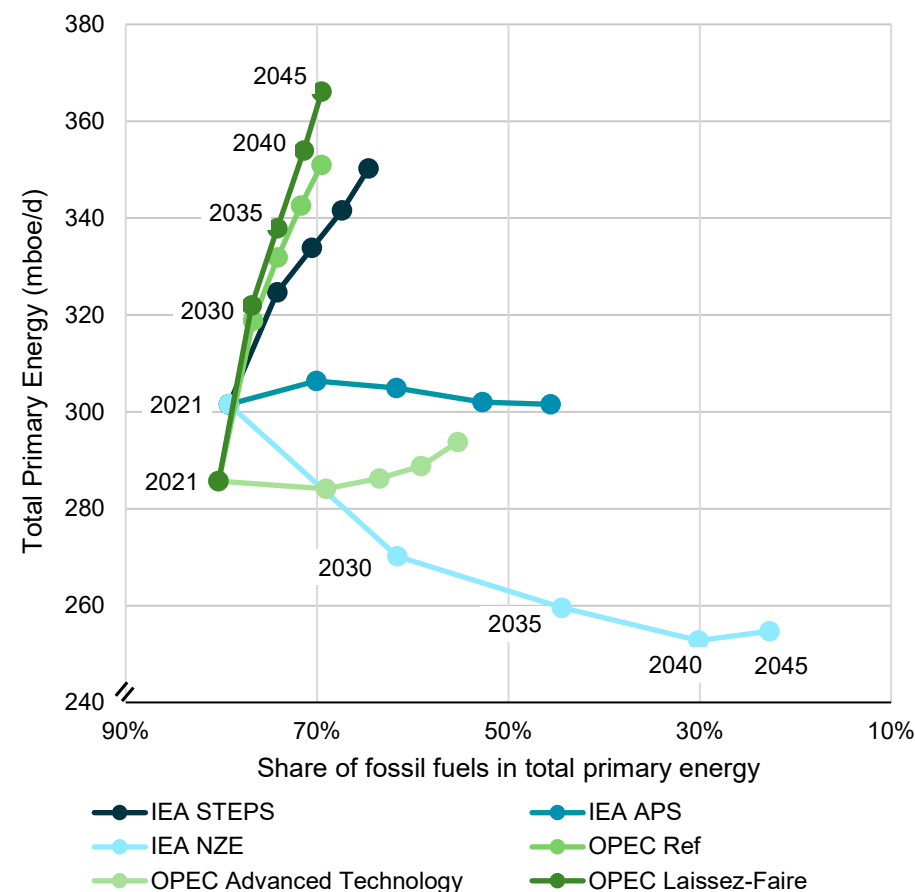


Source: IEF, IEA WEO 2022, OPEC WOO

Two-Thirds of the Scenarios Show Fossil Fuels Accounting for >50% of Total Primary Energy in 2045 vs. 80% in 2021

- Fossil fuel's share of total primary demand declines over time in all scenarios, albeit at different paces.
- Scenarios showing a substantial increase in total primary energy demand have the highest share of fossil fuels in 2045.
- IEA's NZE shows the most aggressive phase-out of fossil fuels and is accompanied by a 15% decline in total primary energy by 2045.
- NZE shows the share of fossil fuels in total primary energy reaching 62% by 2030, lower than the proportion reached 15 years late (2045) in STEPS and OPEC's Reference and Laissez-Faire.

Share of Fossil Fuels in Total Primary Energy Demand



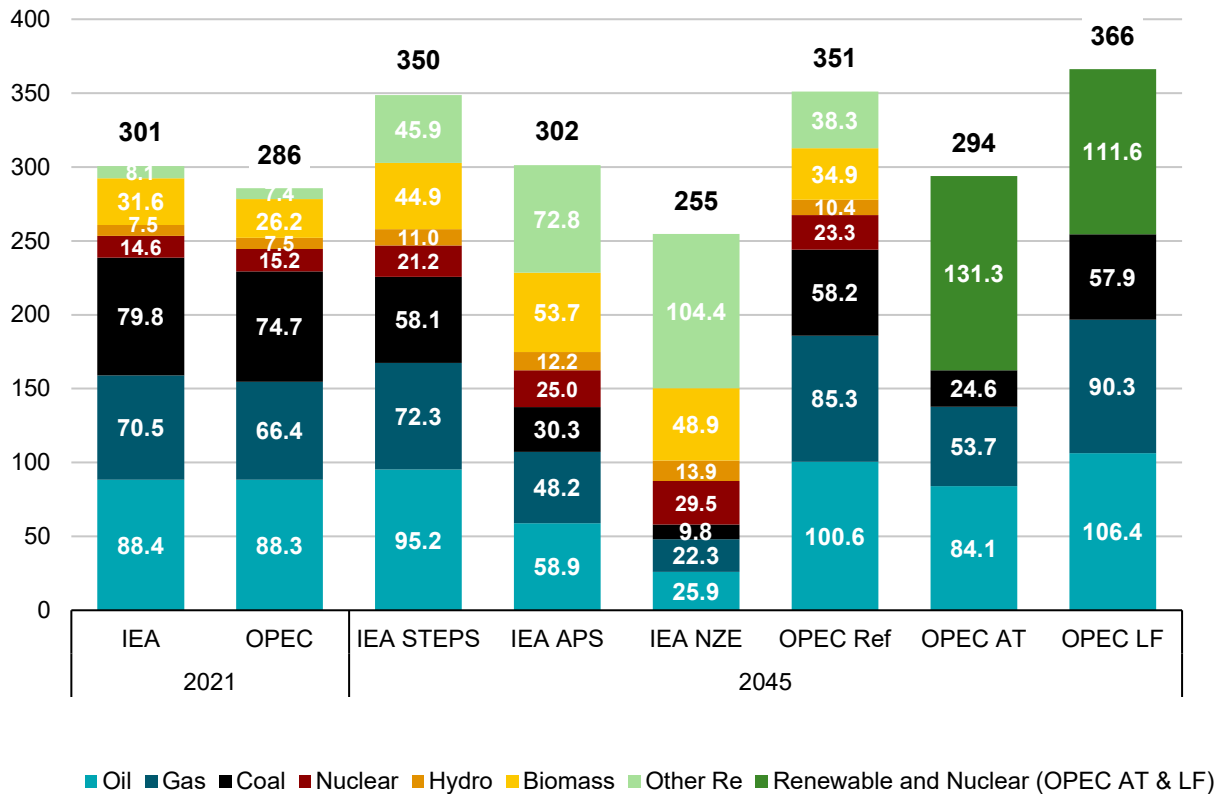
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Primary Energy Demand Grows Between 2021 and 2045 in Base Case Scenarios

“Other renewables” see the most significant growth across all scenarios to 2045

World Primary Energy Outlook to 2045

Million barrels of oil equivalent per day



- Scenarios consistent with the Paris Agreement show Primary Energy roughly at or below 2021 levels in 2045 – implying a decoupling of GDP growth and energy demand growth.
- IEA scenarios and OPEC reference scenario show “other renewables” at 4-12 times higher in 2045 compared to 2021 levels.
- Oil demand and natural gas demand are higher in 2045 in IEA STEPS and OPEC reference and laissez-faire scenarios.
- IEA STEPS and OPEC Reference see very similar total primary energy demand in 2045 – although OPEC sees a higher share of fossil fuel demand.

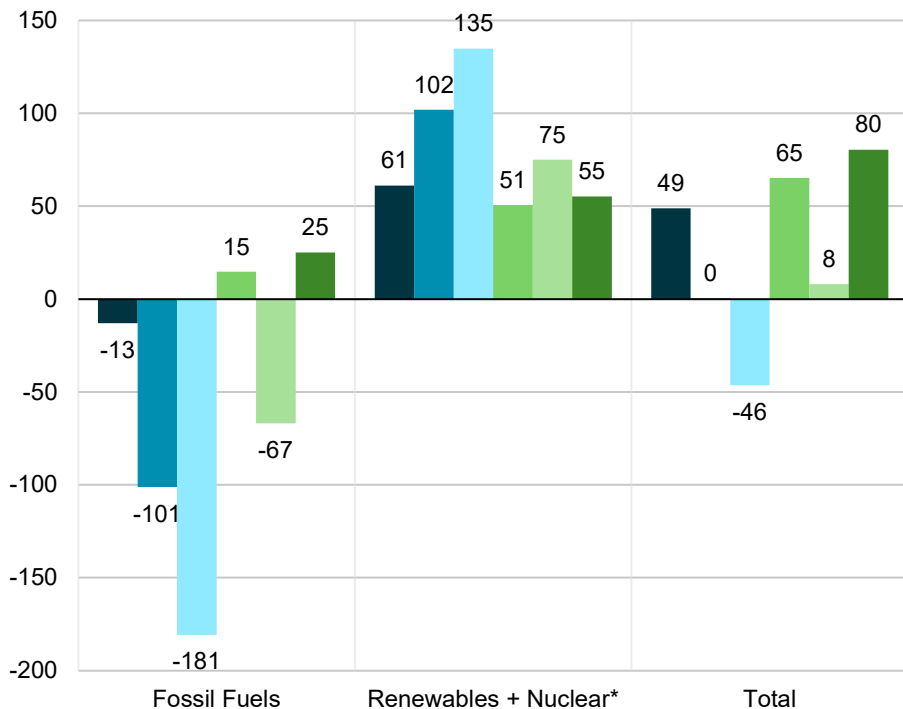
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Renewables + Nuclear Primary Energy See 90%-220% Increase Between 2021 and 2045

Coal sees sharp decline in all scenarios driving fossil fuel demand lower

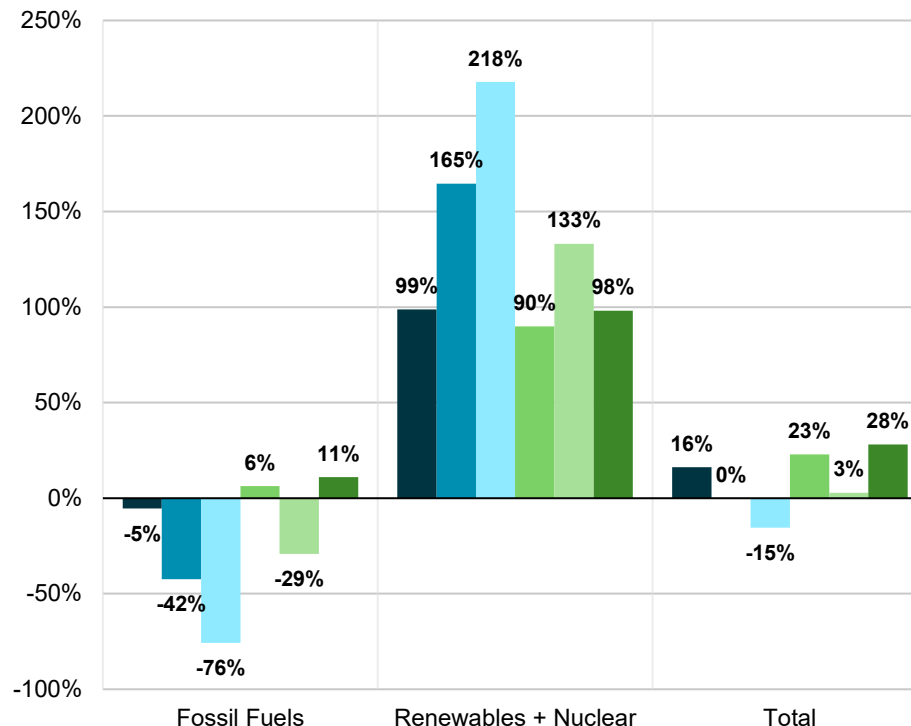
Change in World Primary Energy by Source: 2045 vs. 2021

Million barrels of oil equivalent per day



% Change in World Primary Energy by Source: 2045 vs. 2021

% change by energy source



■ IEA STEPS ■ IEA APS ■ IEA NZE ■ OPEC Ref ■ OPEC AT ■ OPEC LF

■ IEA STEPS ■ IEA APS ■ IEA NZE ■ OPEC Ref ■ OPEC AT ■ OPEC LF

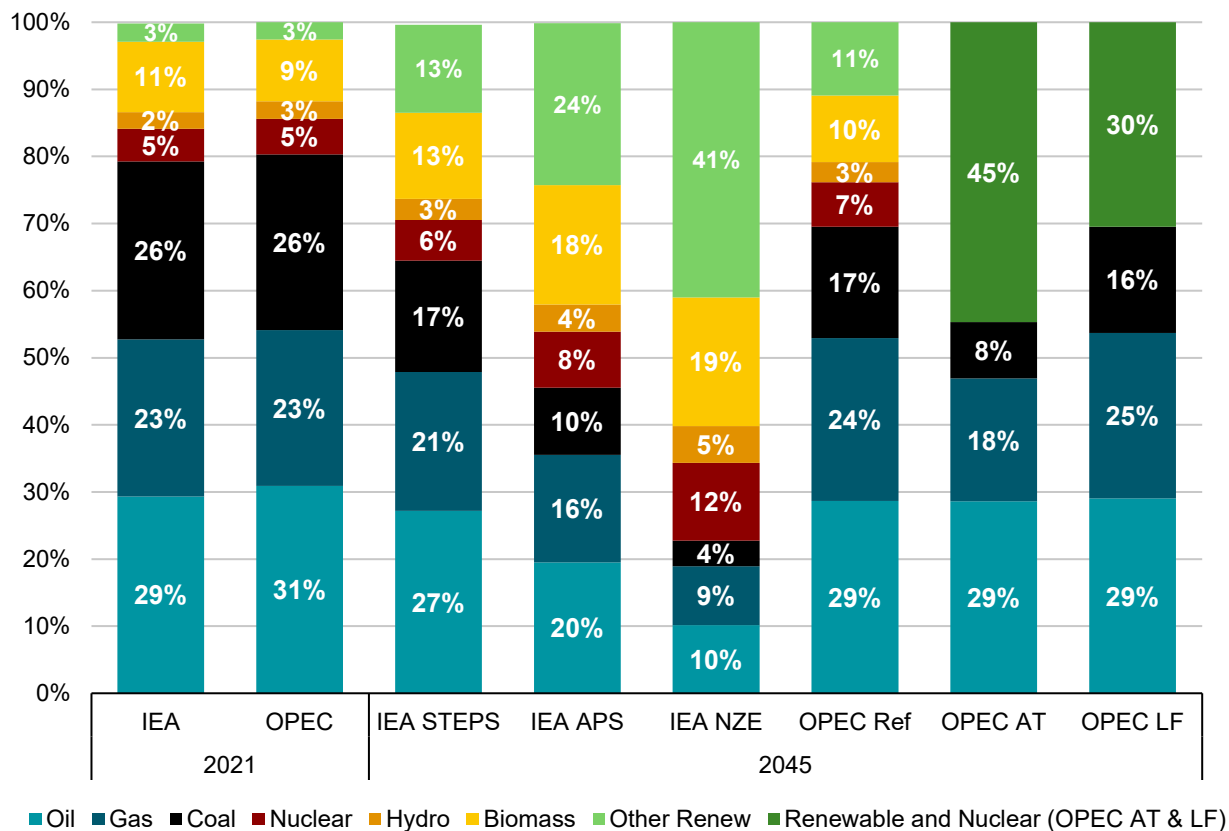
* Renewables + Nuclear includes nuclear, hydro, biomass, and other renewables
 * Renewables are grouped with nuclear to be able to compare all scenarios. OPEC's LF and AT only report the aggregate and not components for renewables and nuclear.
 Source: IEF, IEA WEO 2022, OPEC WOO 2022

* Renewables + Nuclear includes nuclear, hydro, biomass, and other renewables
 * Renewables are grouped with nuclear to be able to compare all scenarios. OPEC's LF and AT only report the aggregate and not components for renewables and nuclear.
 Source: IEF, IEA WEO 2022, OPEC WOO 2022

Renewables + Nuclear Share of Primary Demand Increases From ~20% in 2021 to 30%-77% in 2045

World Primary Energy Fuel Share Outlook to 2045

Percent of total primary energy



Source: IEF, IEA WEO 2022, OPEC WOO 2022

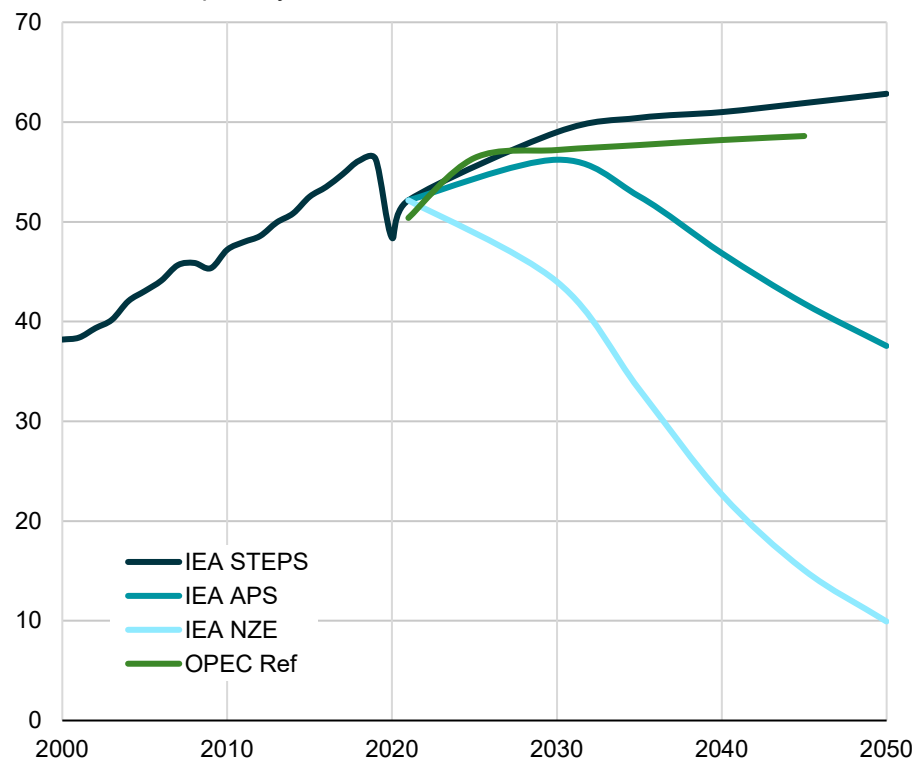
- IEA's NZE scenario shows "other renewables" share of primary demand increasing from 3% in 2021 to 41% in 2045 with solar increasing from 1% to 21% and wind increasing from 1% to 15%.
- OPEC scenarios all see only a 2 percentage point decrease in oil's share of primary energy between 2021 and 2045.
- Natural gas' share of primary energy demand declines in all scenarios except OPEC's reference and LF scenarios.
- Coal sees the sharpest decrease in share of primary energy between 2021 and 2045. Coal shrinks from 26% of total primary energy in 2021 to as little as 4% in IEA's NZE or as much as 17% in IEA's STEPS and OPEC's reference.

Oil Demand in the Transportation Sector Plateaus for the Next 20 Years in IEA STEPS and OPEC Reference, But Peaks and Declines in IEA APS and NZE

- The transportation sector accounts for more than 50% of current oil demand.
- The pace of EV penetration into the global vehicle fleet will greatly impact future oil demand.
- OPEC's reference case assumes ~11% of the global fleet will be EVs by 2035 and 21% by 2045 – up from 1% in 2021. This assumes that by 2045, 40% of total car sales will be EVs.
- By contrast, IEA's NZE assumes that by 2030, 60% of all new car sales are electric (compares with 35% in APS and 25% in STEPS). NZE also assumes no new ICE light-duty vehicles will be sold after 2035.

Oil Product + Biofuel Demand in the Transportation Sector (excl. bunkering)

Million barrels per day



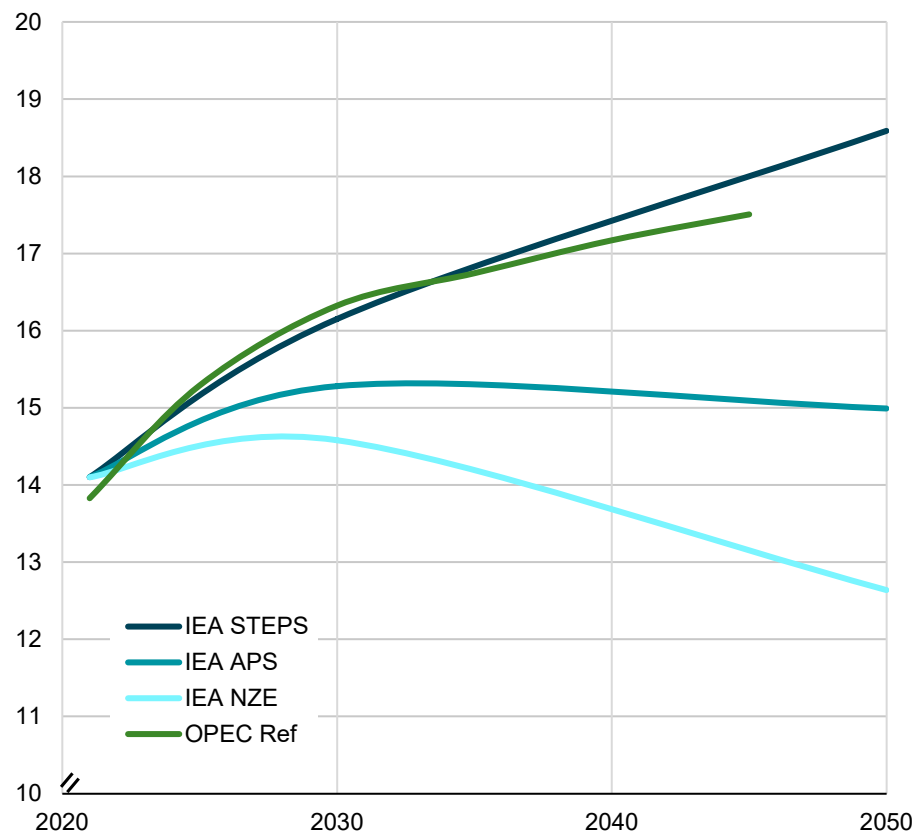
Source: IEF, IEA WEO 2022, OPEC WOO 2022

75% of Scenarios See Higher Oil Demand in the Petrochemical Sector in 2045 vs. 2021

- Petrochemicals are used for plastics, fertilizers, clothing, tires, and many other things used in modern society.
- Petrochemical demand is set to continue to be a significant portion of future oil demand and demand growth.
- OPEC notes that the largest incremental demand is expected in the Middle East where locally sourced ethane and LPG will be used as feedstocks. China and other Asian countries will also see growth, but will primarily use naphtha as a feedstock.
- Oil use as petrochemical feedstock falls in IEA's NZE Scenario due to alternative feedstocks and increased recycling. However, petrochemicals still account for more than half of oil demand in 2050 in NZE.

Oil Demand in Petrochemical Sector

Million barrels per day



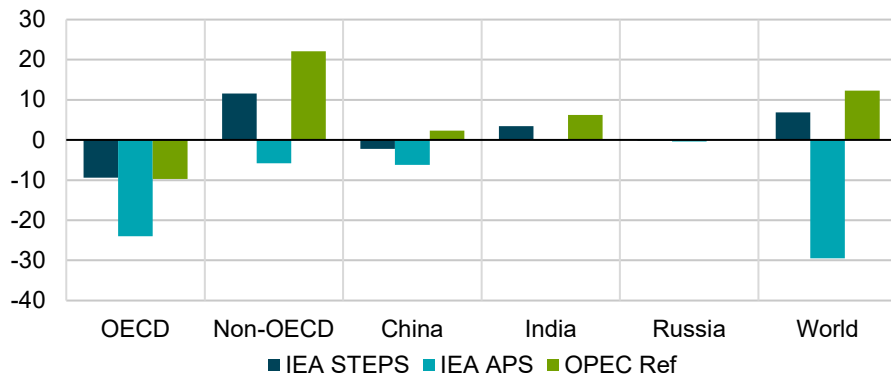
Source: IEF, IEA WEO 2022, OPEC WOO 2022

IEA STEPS and OPEC Reference Show Higher Oil and Gas Demand in 2045 vs. 2021 Driven By Non-OECD Countries

IEA scenarios show Chinese oil demand peaking ~2030, with 2045 levels below 2021's

Change in Oil Demand: 2045 vs. 2021

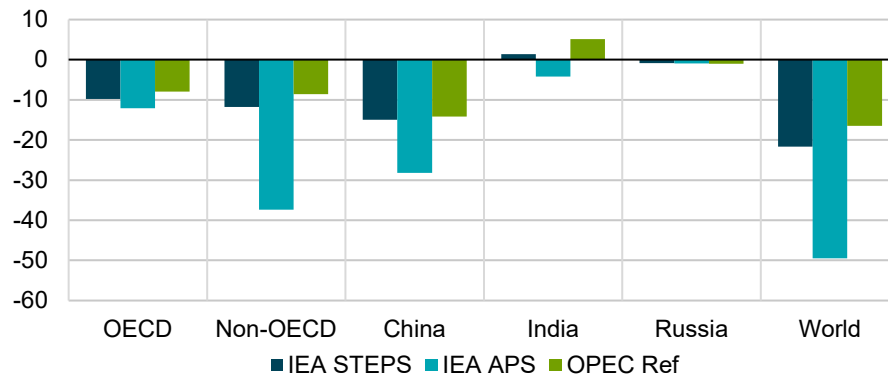
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Coal Demand: 2045 vs. 2021

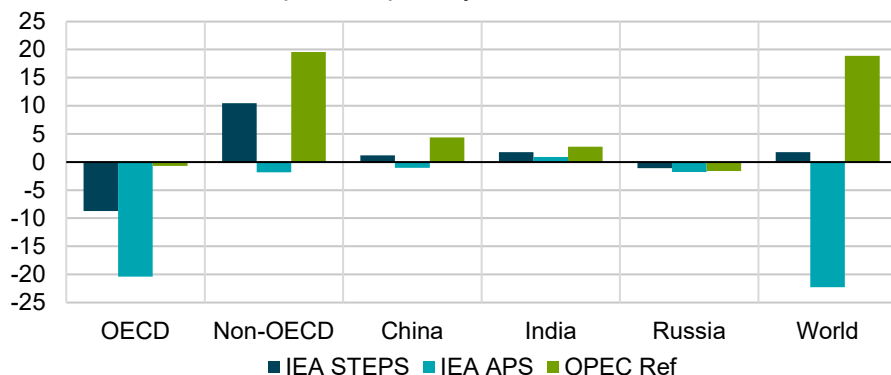
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Natural Gas Demand: 2045 vs. 2021

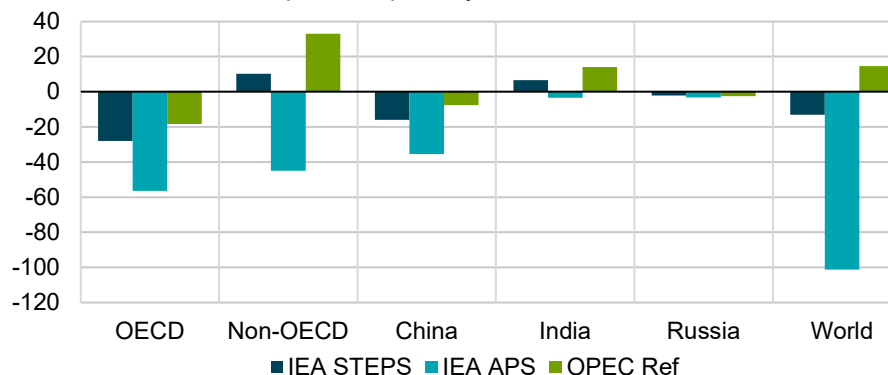
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Fossil Fuel Demand: 2045 vs. 2021

Million barrels of oil equivalent per day

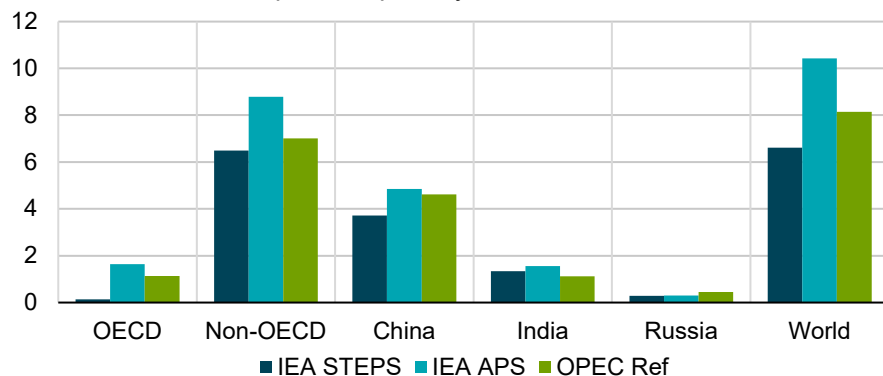


Source: IEF, IEA WEO 2022, OPEC WOO 2022

Nuclear, Hydro, Biomass, and Other Renewables See Growth Across the Board Between 2021 and 2045

Change in Nuclear Demand: 2045 vs. 2021

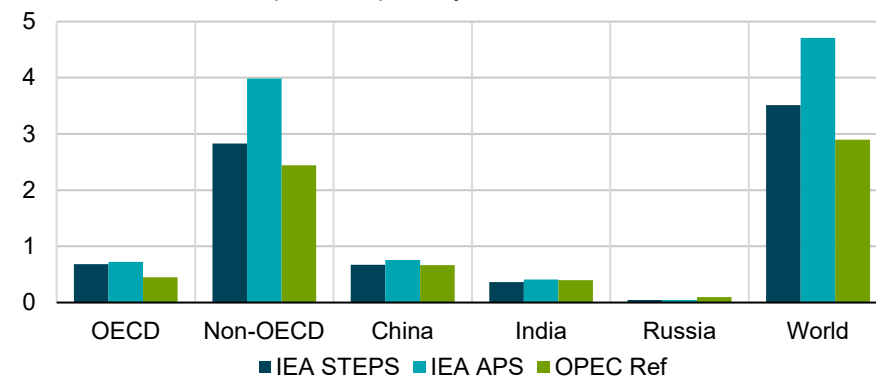
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Hydro Demand: 2045 vs. 2021

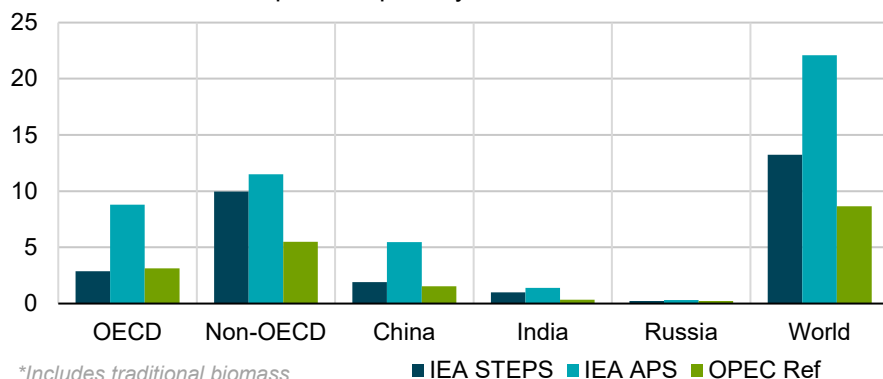
Million barrels of oil equivalent per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Biomass* Demand: 2045 vs. 2021

Million barrels of oil equivalent per day

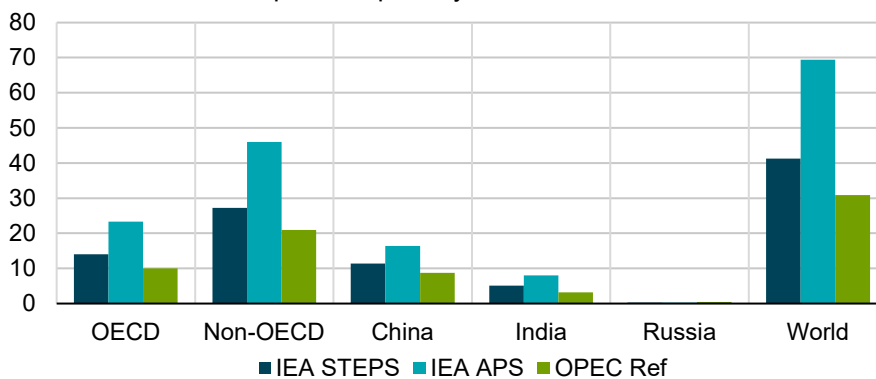


*Includes traditional biomass

Source: IEF, IEA WEO 2022, OPEC WOO 2022

Change in Other Renewables Demand: 2045 vs. 2021

Million barrels of oil equivalent per day



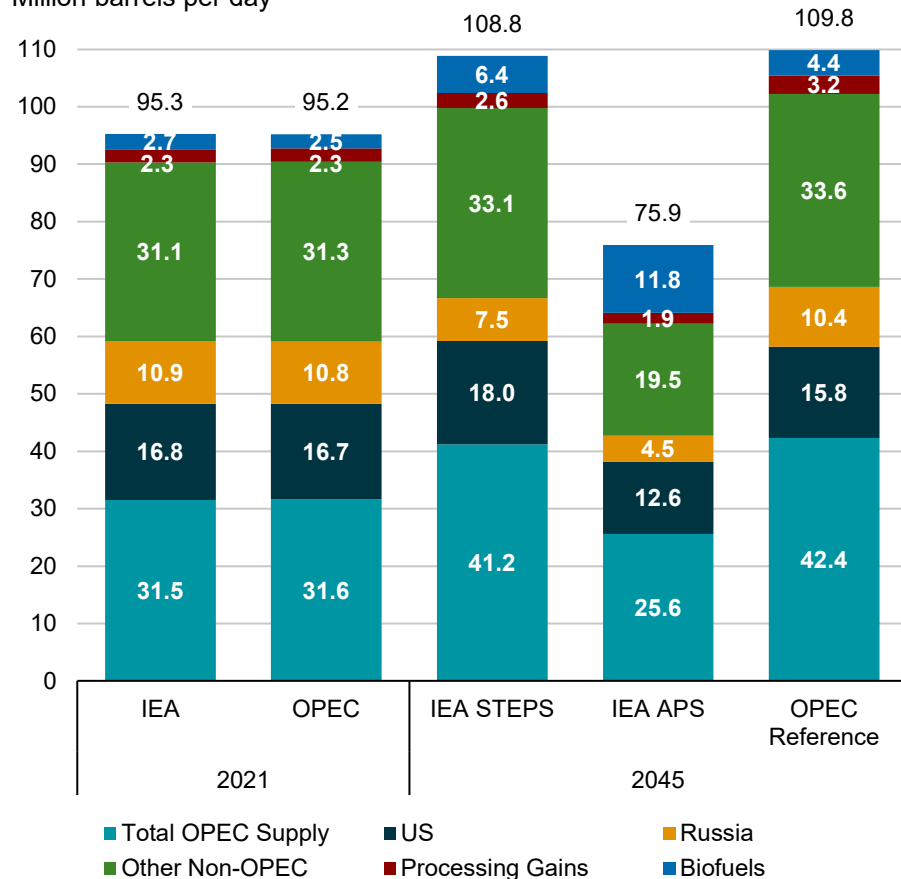
Source: IEF, IEA WEO 2022, OPEC WOO 2022

OPEC Members and Biofuels See Rising Share of Total Liquids Supply By 2045 in STEPS, APS and OPEC Ref

US production is seen rising only in IEA STEPS

Liquids Supply Sources by Scenario

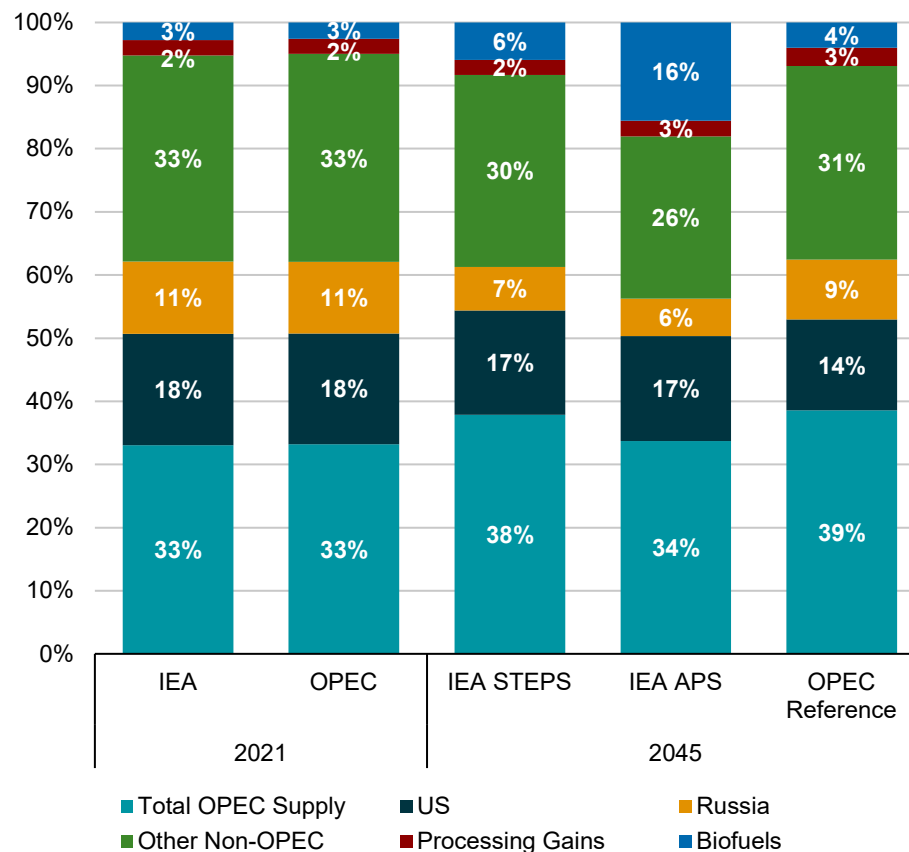
Million barrels per day



Source: IEF, IEA WEO 2022, OPEC WOO 2022

Liquids Supply Sources by Scenario

% of total liquids supply



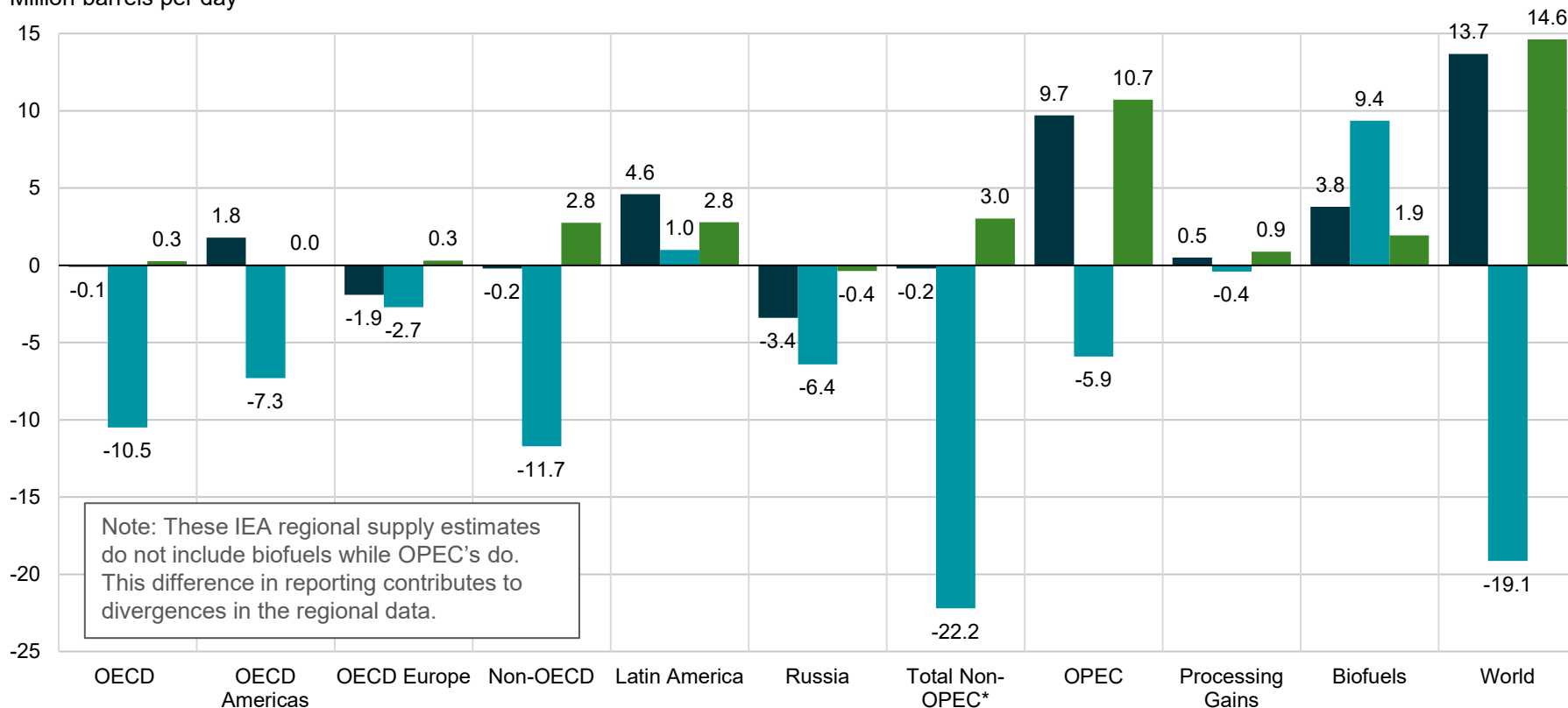
Source: IEF, IEA WEO 2022, OPEC WOO 2022

IEA APS Sees a Steep Drop in Liquids Supply By 2045 Despite Robust Growth in Biofuels

STEPS sees more robust growth in the Americas, biofuels and less steep decline in Russia vs. OPEC's Reference

Liquids Supply by Source: 2045 vs. 2021

Million barrels per day



Note: These IEA regional supply estimates do not include biofuels while OPEC's do. This difference in reporting contributes to divergences in the regional data.

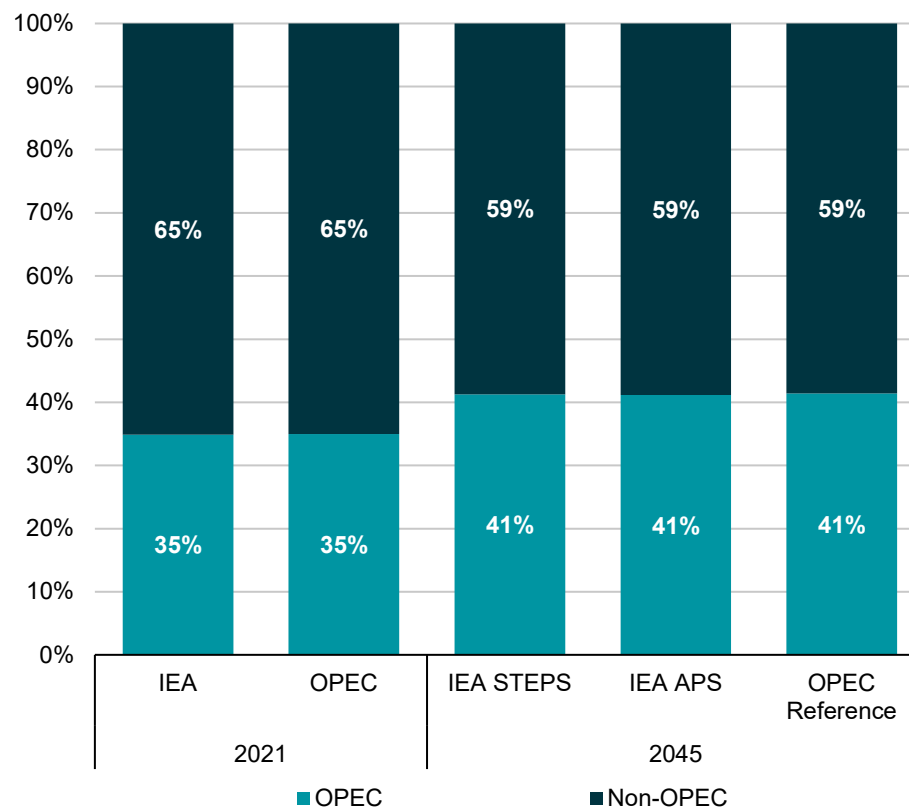
*Non-OPEC excluding processing gains
Source: IEF, IEA WEO 2022, OPEC WOO 2022

■ IEA STEPS ■ IEA APS ■ OPEC Reference

OPEC Market Share of Total Oil Production Rises From 35% in 2021 to 41% in IEA and OPEC Scenarios

- IEA STEPS and OPEC Reference show OPEC production higher in 2045 vs. 2021.
- While OPEC does not provide country-level forecasts for OPEC members, IEA does provide partial data.
- IEA STEPS forecast for 2045 shows OPEC production at 5.3 mb/d higher than 2021 levels driven primarily by increased output from:
 - Saudi Arabia (+1.8 mb/d);
 - Iraq (+1.3 mb/d);
 - Venezuela (+1.1 mb/d);
 - Iran (+0.9 mb/d); and
 - UAE (+0.7 mb/d)
- IEA's WEO notes that in its APS and STEPS scenarios, OPEC members' share of the global oil market will continue rising to 43% by 2050 – its highest level since 1979.

OPEC and Non-OPEC Market Share of Global Oil Production*
% of global oil production



*Excludes biofuels and processing gains
Source: IEF, IEA WEO 2022, OPEC WOO 2022

Additional Context: IEA and OPEC Scenarios Alongside Other Industry and Agency Outlooks

Additional Scenario Descriptions and Assumptions

BNEF	NZS	Scenario consistent with limiting end-century warming to 1.5°C and achieving global net-zero emissions by 2050.	IEEJ	Reference	Incorporates past trends and expected impact of current and expected policies.
	Economic Transition Scenario (ETS)	A baseline assessment. Assumes no further major climate policy intervention.		Advanced Technology (ATS)	Energy and environmental technologies are introduced to the maximum extent possible.
BP	Accelerated	Broadly in line with IPCC 2°C. Total final consumption peaks around 2030.	IPCC	ModAct	NDCs are implemented. Current trajectory leads to >2°C warming.
	Net Zero	Broadly in line with IPCC 1.5°C. Total final consumption peaks in the early 2020s.		IMP-Neg (2C)	Limits warming to 2C; higher deployment of carbon capture technology.
	New Momentum	Follows the current trajectory of energy policies. Total final consumption peaks in mid-2040s.		IMP-Ren (1.5)	Limits warming to 1.5C with greater emphasis on renewables.
Equinor	Walls	Current trends in market, technology and policies.		IMP-LD (1.5)	Limits warming to 1.5C with greater emphasis on demand reduction.
	Bridges	Broadly consistent with IPCC 1.5°C.	IRENA	Planned	Projects future trends based on current and announced policies (including NDCs on emissions reductions)
GECF	Reference (RCS)	Current and likely policies. Energy demand will rise by 29% by 2050.		1.5-S	Scenario consistent with limiting end-century warming to 1.5°C Both the planned and 1.5-S were originally published in the World Energy Transitions Outlook 2021 and unchanged in the 2022 edition.
	Hydrogen (HS)	Assumes aggressive hydrogen development			
	Energy Transition (ETS)	Consistent with IPCC 2°C.			

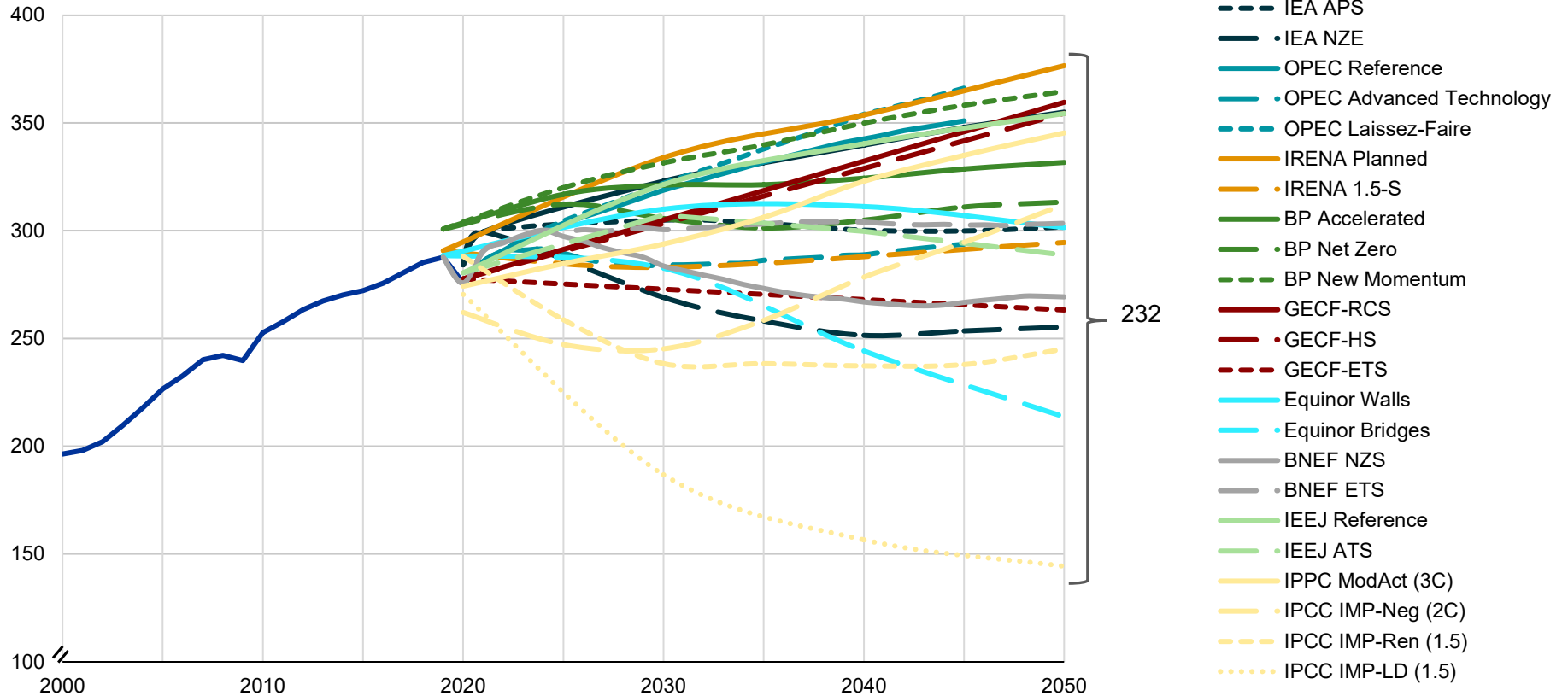
* See descriptions of IEA and OPEC scenarios on page 35

Total Primary Energy Demand: 75% of Scenarios Show End-Period Primary Demand at Higher Levels Than 2021

Excluding the IPCC IMP-LD outlier, the range between the high-low forecasts for 2050 would be 163 mboe/d (compared to the actual 2021 primary demand of 276 mboe/d)

Total Primary Energy Demand Scenarios Through 2050

Million barrels of oil equivalent per day

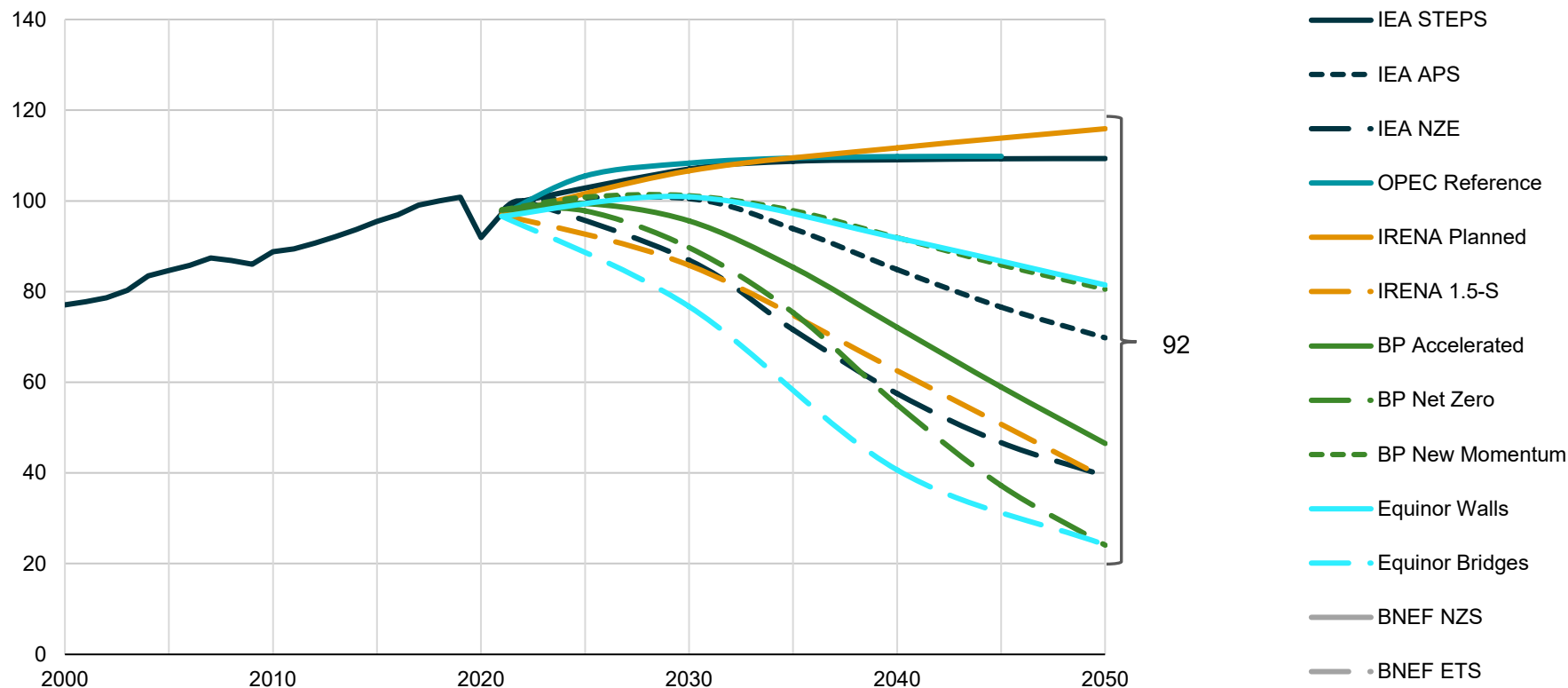


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2022 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Total Liquids Demand: OPEC Ref, IEA STEPS, and IRENA Planned (Base Case Scenarios) Show Plateauing Demand While Most Others Show a Peak and Decline Before 2035

Total Liquids Demand Scenarios Through 2050

MBOE/D



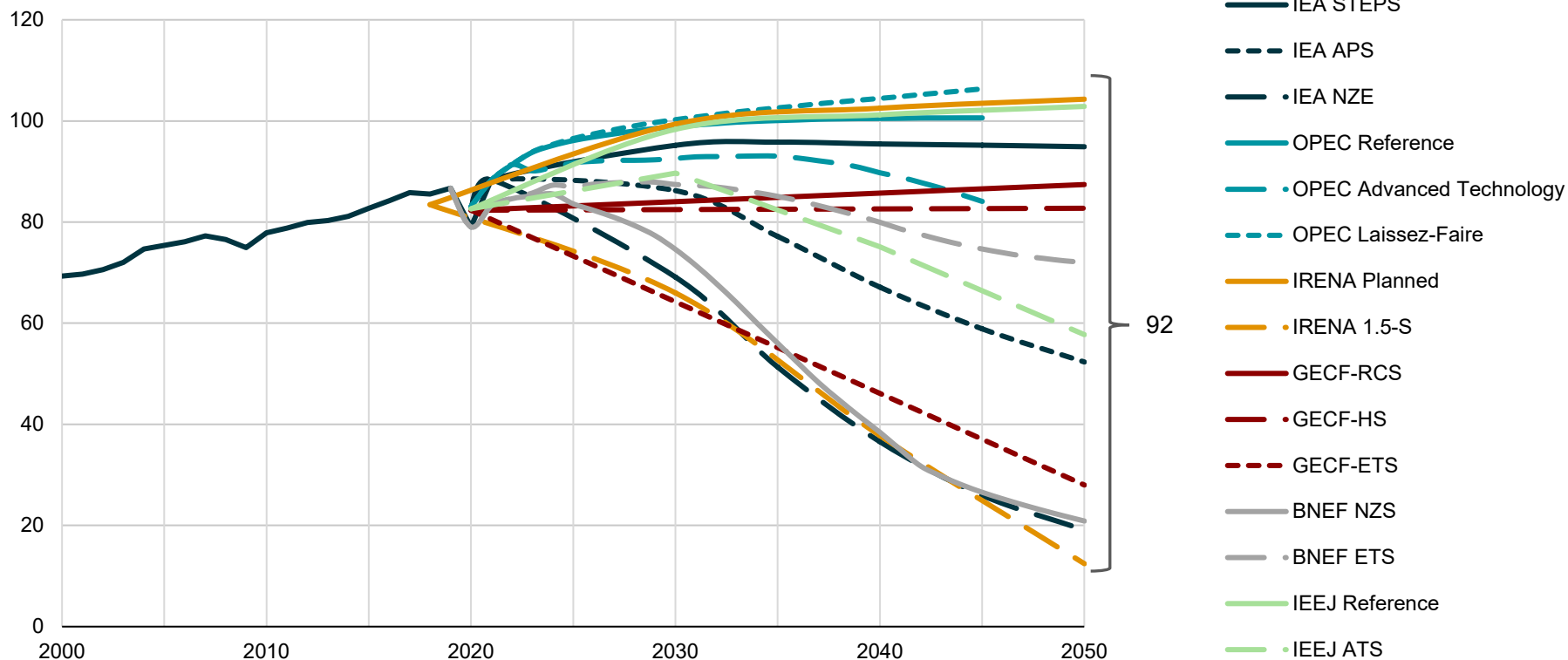
Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022

Oil Demand: Most Scenarios Show a Peak and Decline In Oil Demand in the 2020's or 2030's

However, several reference case scenarios show growth and a plateau at 100-105 mb/d

Oil Demand Scenarios Through 2050

Million barrels per day

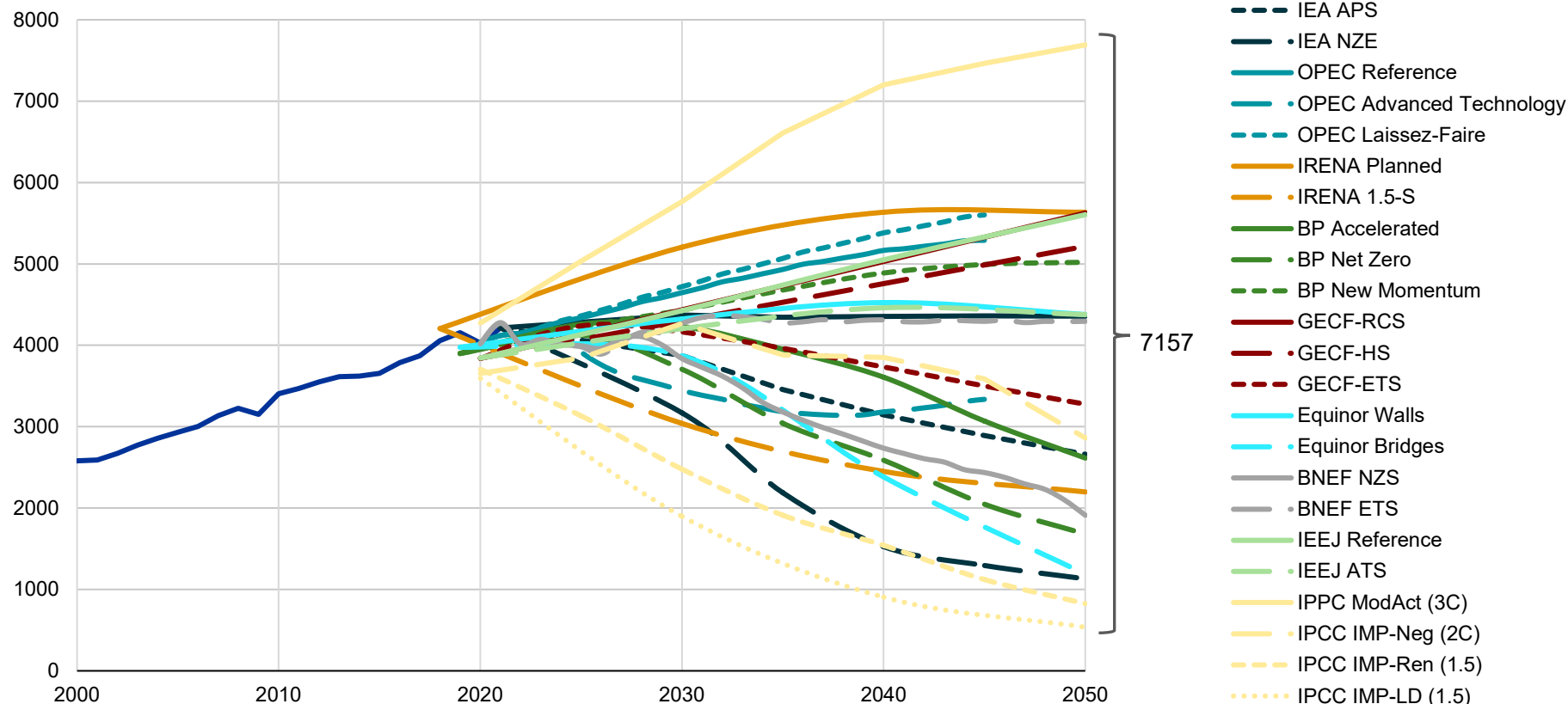


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, GECF 2022 Global Gas Outlook to 2050, BNEF New Energy Outlook 2022, IEEJ Outlook 2023

Natural Gas Demand: Excluding the High Outlier, the Range Between the High and Low Forecast is 5,100 bcm or ~25% Larger than Today's Global Gas Market

Natural Gas Demand Scenarios Through 2050

Billion cubic metres

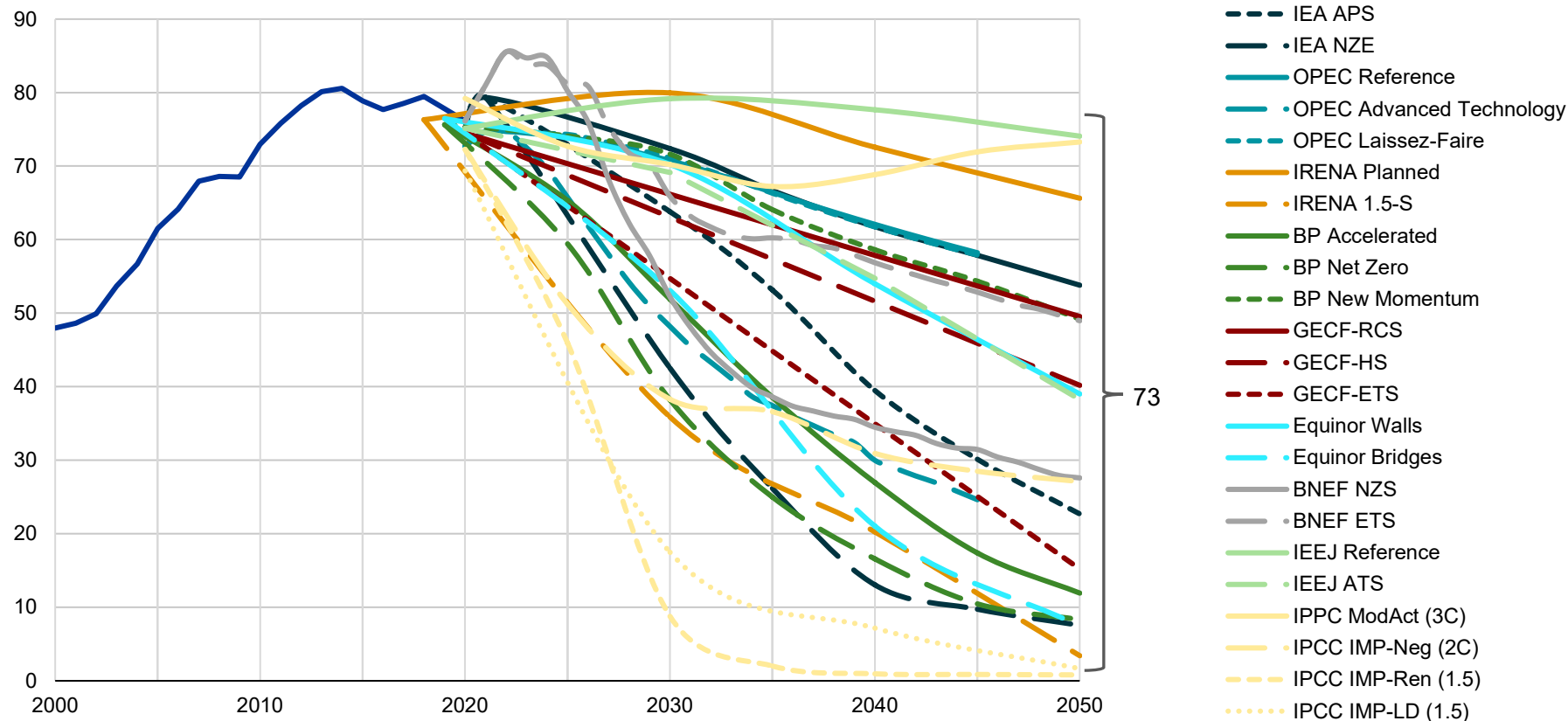


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Coal Demand: More than Half of All Scenarios Show Coal Demand Falling By >50% By 2050

Coal Demand Scenarios Through 2050

Million barrels of oil equivalent per day

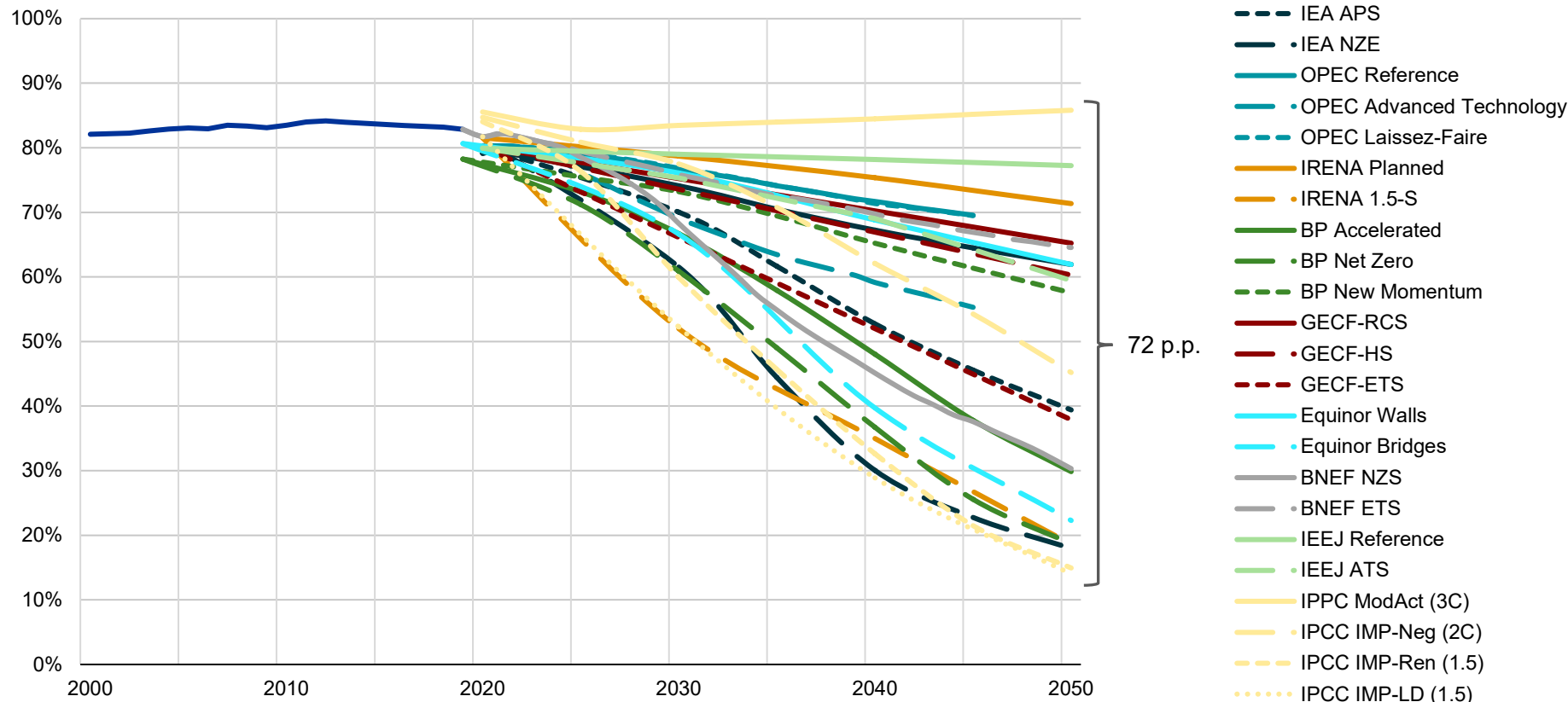


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Fossil Fuels Share of Primary Energy: Around Half of All Scenarios Have Fossil Fuels Accounting For More Than 50% of Total Primary Energy Demand in 2050

Fossil Fuels Share of Primary Energy Scenarios Through 2050

% of Primary Energy

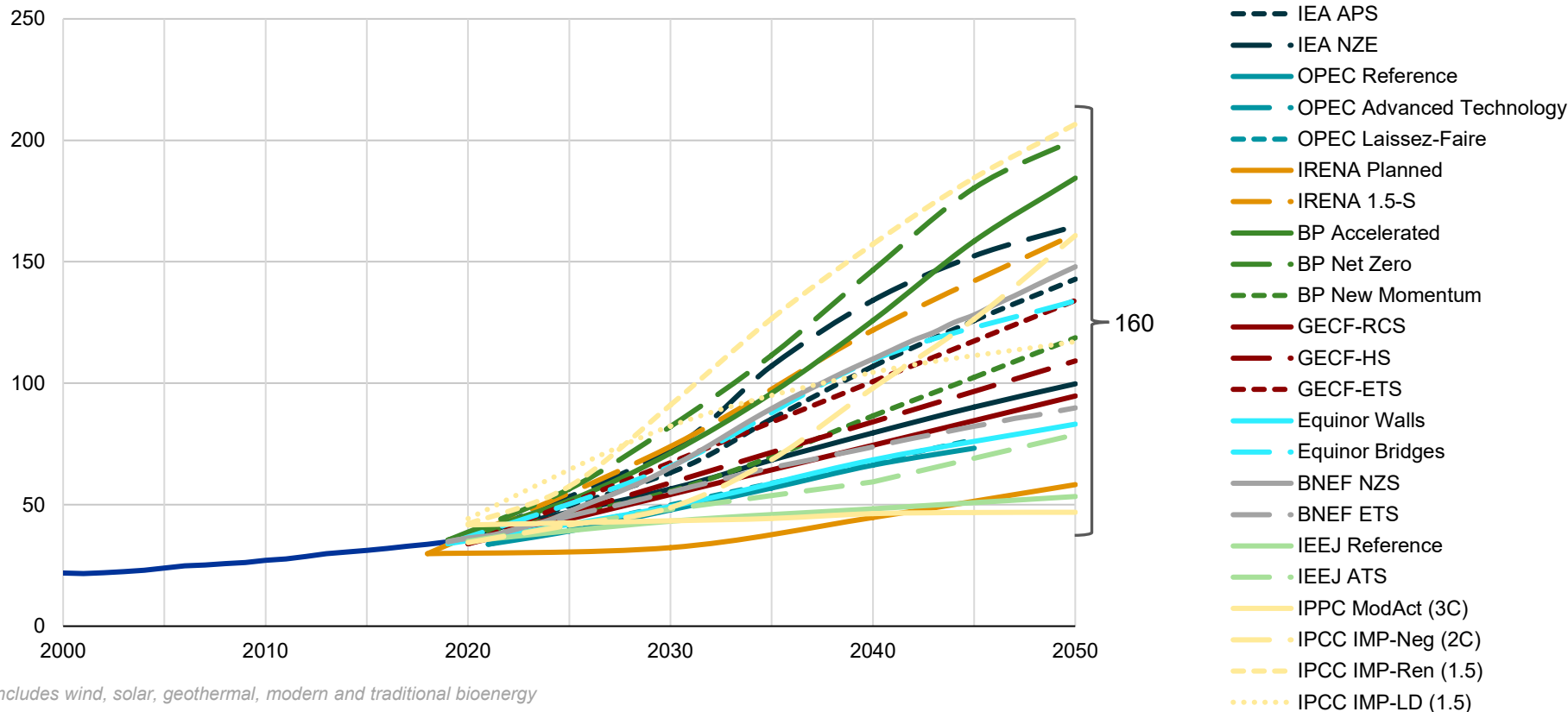


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Renewables Demand: the Range of the High-Low Forecasts For Renewable Demand in 2050 is ~4 Times Greater than Current Renewable Demand

Renewable Demand Scenarios Through 2050

Million barrels of oil equivalent per day



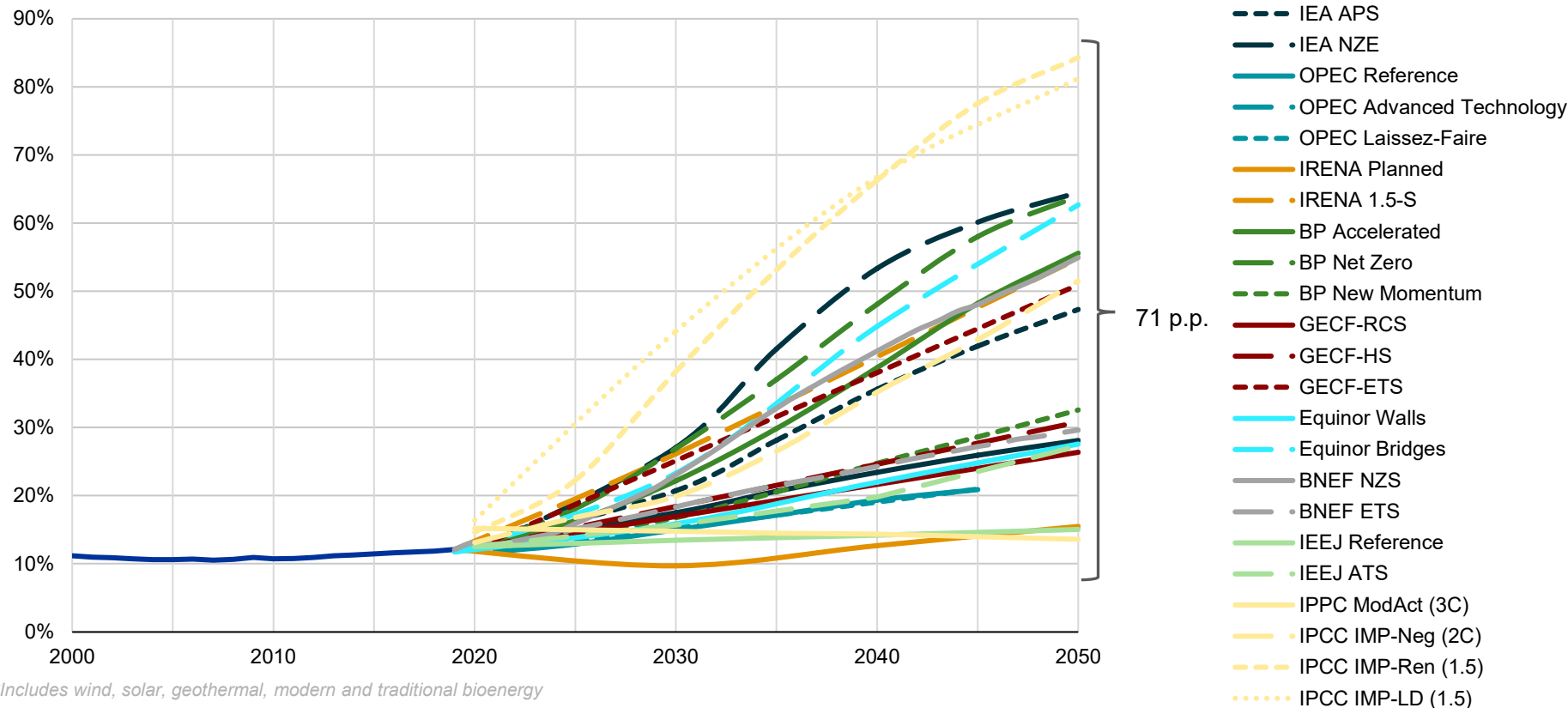
*Includes wind, solar, geothermal, modern and traditional bioenergy

Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2022 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Renewables Share of Primary Energy: A Third of Scenarios Show Renewable's Share of Primary Demand in 2050 at ~30% and Nearly Another Third Show the Share at ~50%

Renewable Demand Share of Total Primary Energy Demand Scenarios to 2050

Share of Primary Energy Demand



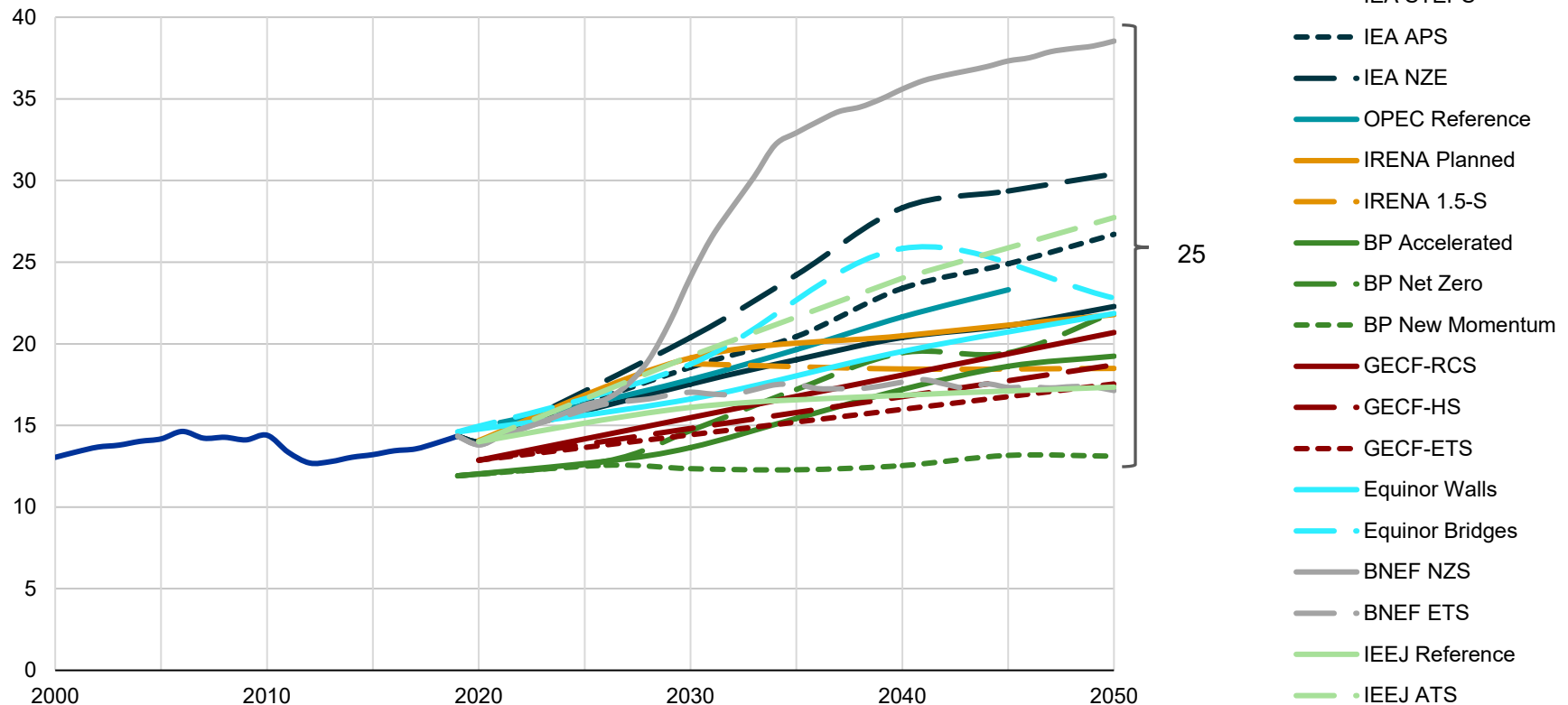
*Includes wind, solar, geothermal, modern and traditional bioenergy

Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Nuclear Demand: More than Half of All Scenarios Show Nuclear Demand Increasing By >50% in 2050 Compared to 2021 Levels

Nuclear Demand Scenarios Through 2050

Million barrels of oil equivalent per day



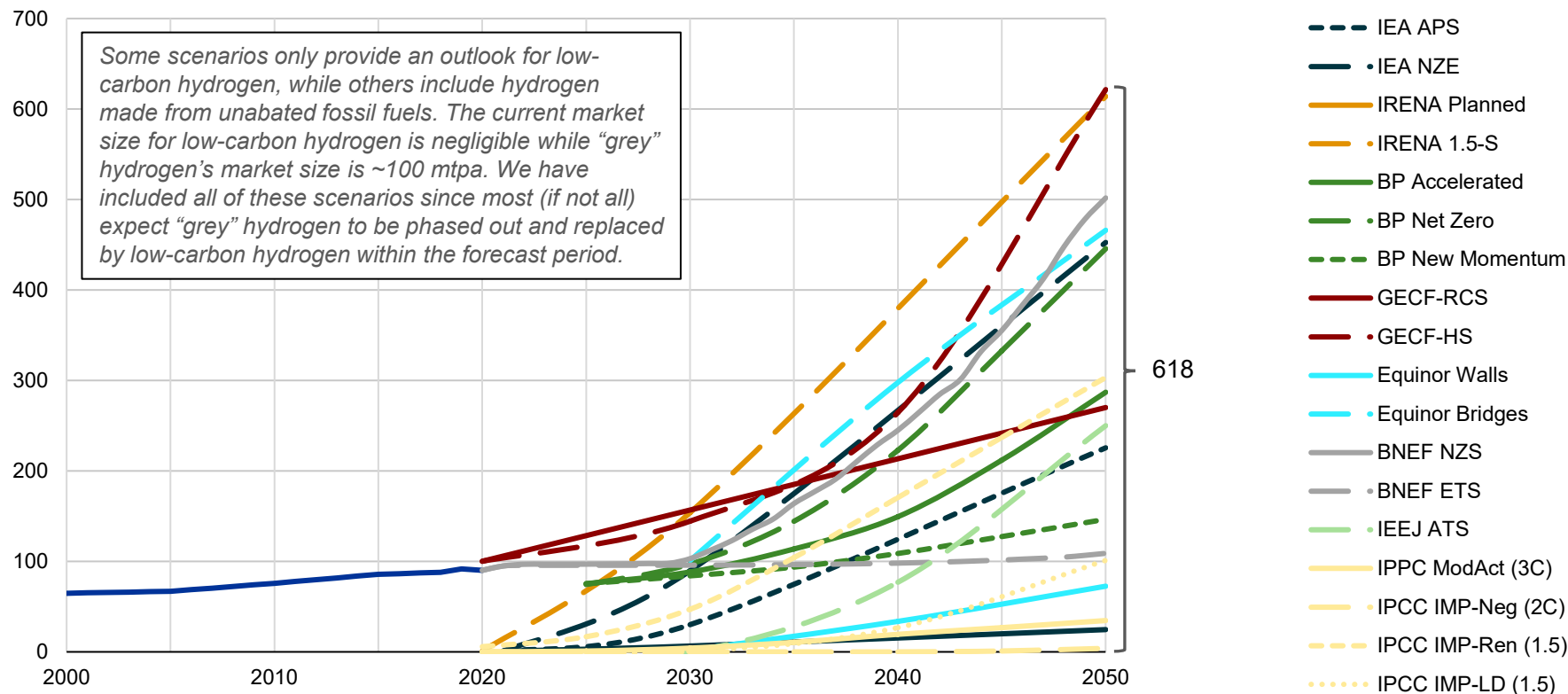
*Differences in baselines may stem from different primary energy conversion efficiency assumptions.

Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Hydrogen Demand: Some Net Zero Scenarios See Low-Carbon Hydrogen Market Expanding By 600x By 2050

Hydrogen Demand Scenarios* Through 2050

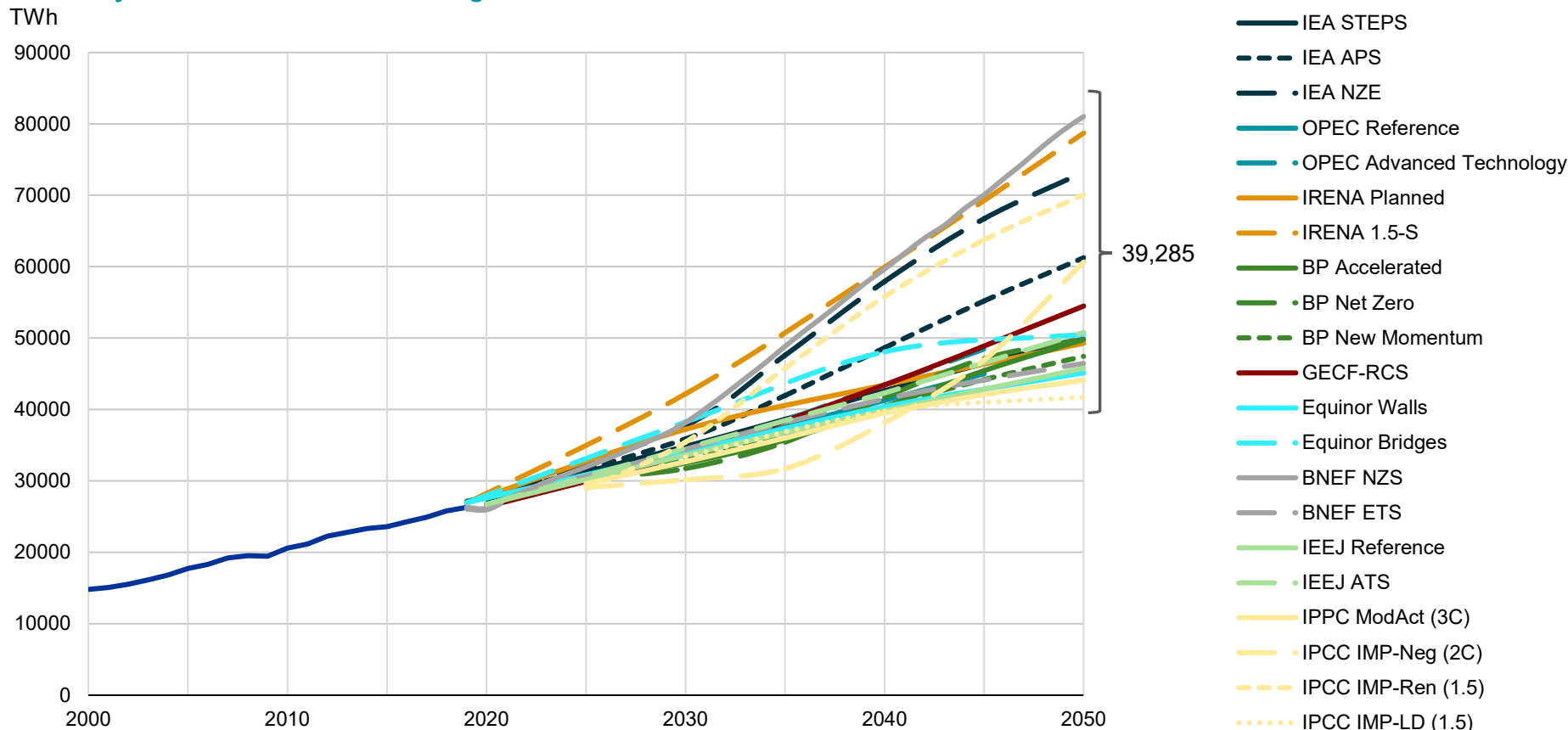
Million metric tonnes per year



Source: IEF, IEA WEO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Electricity Generation: Most Scenarios Show Electricity Demand Growing By ~80% By 2050, With More Ambitious Net Zero Scenarios Showing Up to ~200% Growth vs. 2021

Electricity Generation Scenarios Through 2050

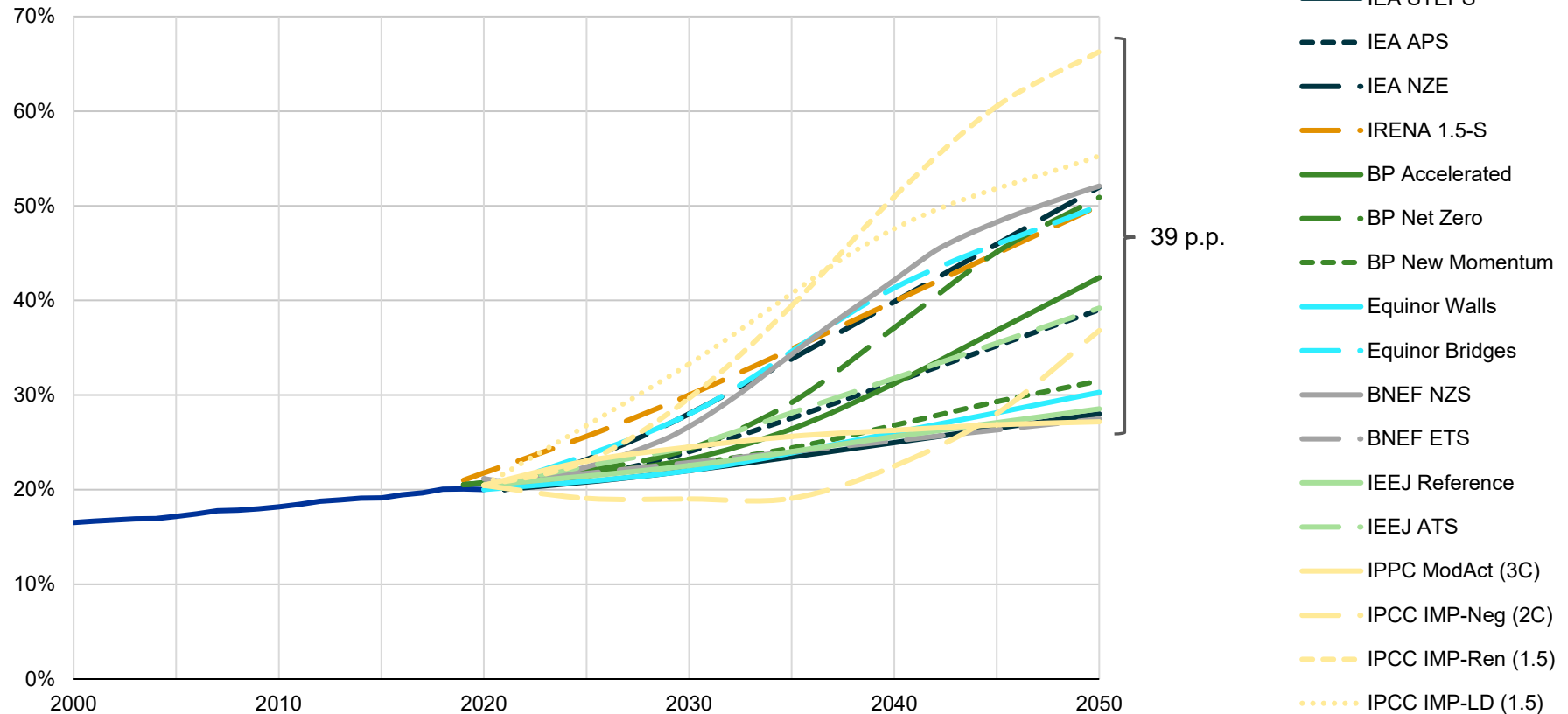


Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Electricity Share of Final Demand: Many Scenarios Show Electricity's Share Growing from ~20% in 2021 to 30% in 20250, With More Ambitious Scenarios Showing ~50% Share

Electricity Share of Final Energy Demand Scenarios Through 2050

Share of final energy demand

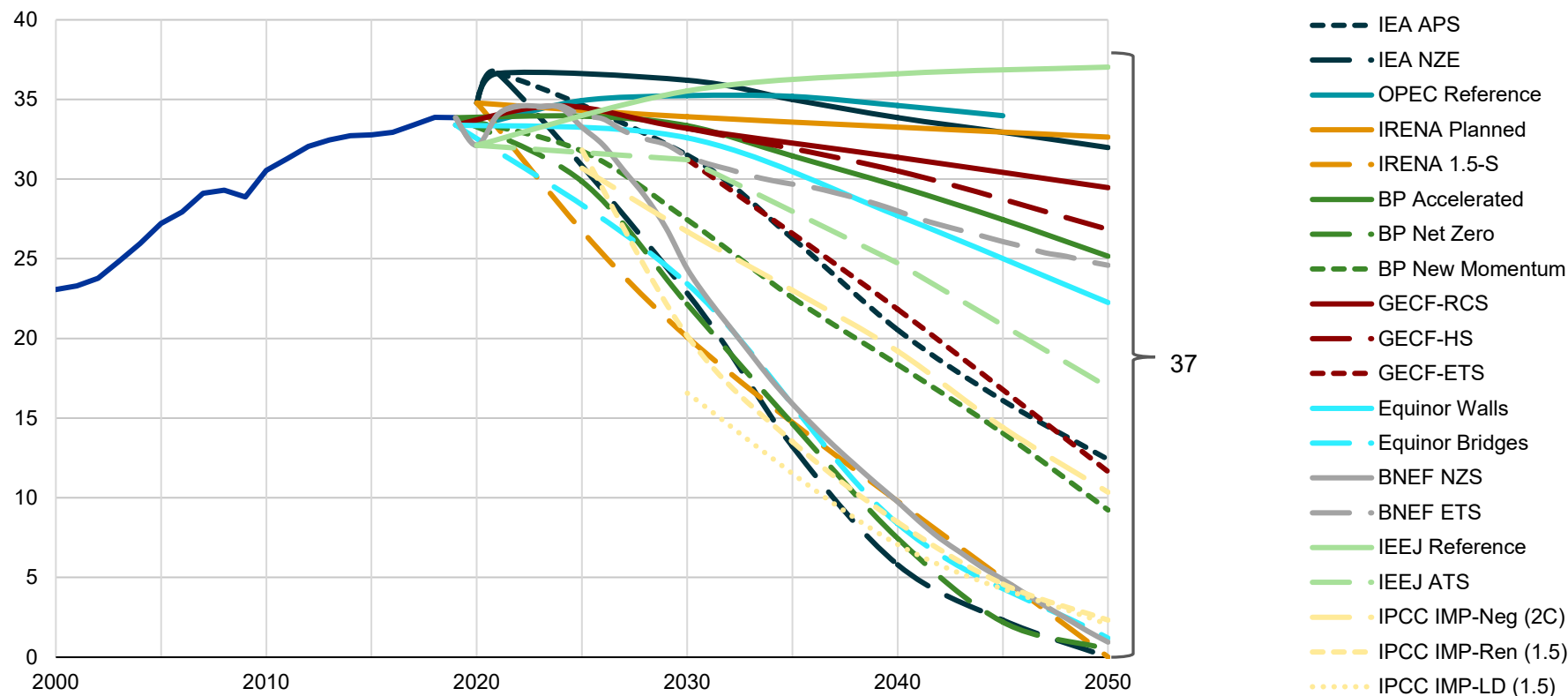


Source: IEF, IEA WEO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Carbon Dioxide Emissions: 40% of Scenarios Show at Least a 40% Drop in Emissions by 2050

CO₂ Emissions Scenarios Through 2050

Gt CO₂/year



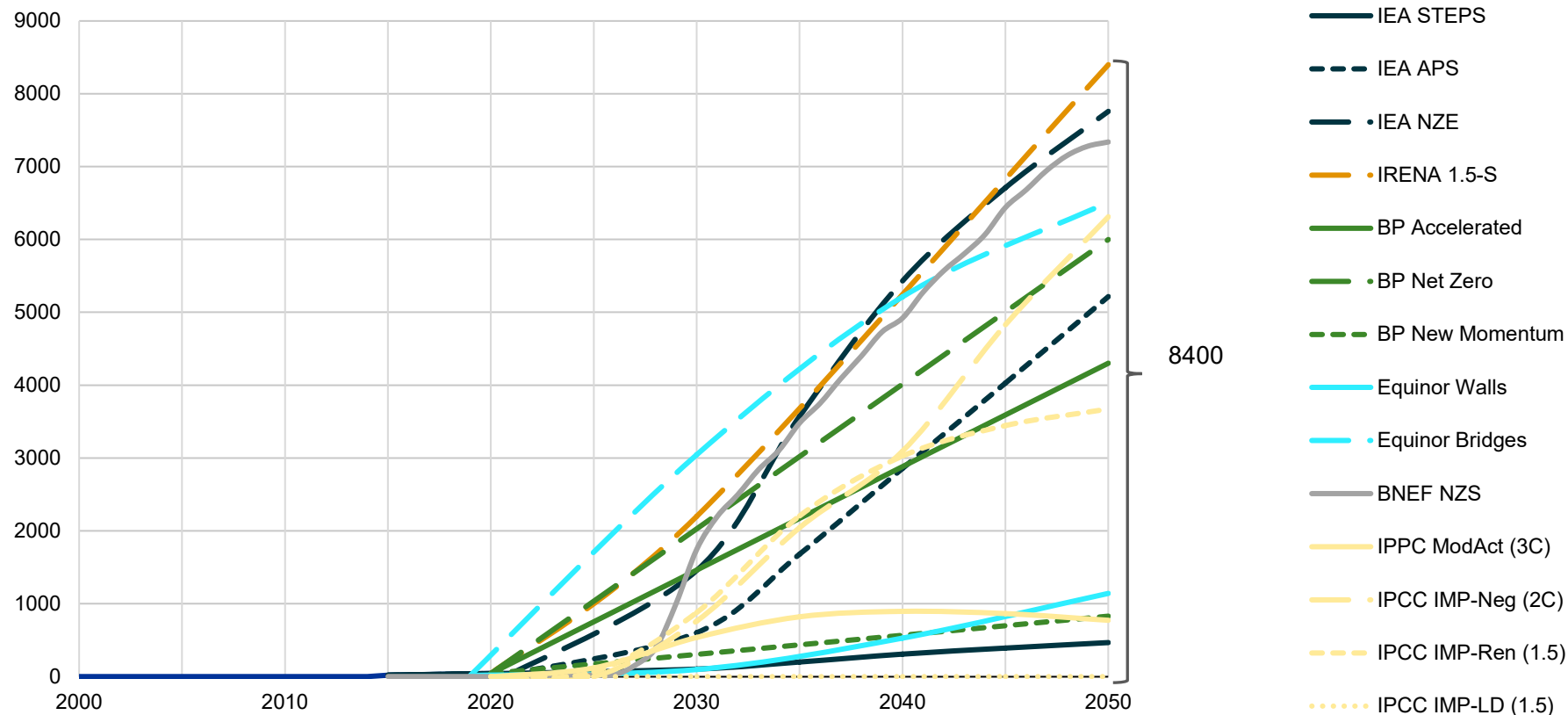
*IEA includes industrial process emissions which may contribute to their higher starting baseline.

Source: IEF, IEA WEO 2022, OPEC WOO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, GECF 2021 Global Gas Outlook to 2050, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IEEJ Outlook 2023, IPCC Climate Change 2022: Mitigation of Climate Change

Carbon Capture: Carbon Capture Expands to ~6-8 Gt of CO₂ per Annum in Many of the Ambitious Net Zero Scenarios

Carbon Capture (including CCS, DACC, and BECCS)

Mt CO₂/year



Source: IEF, IEA WEO 2022, IRENA World Energy Transitions Outlook 2022, BP Energy Outlook 2022, Equinor Energy Perspectives 2022, BNEF New Energy Outlook 2022, IPCC Climate Change 2022: Mitigation of Climate Change

Appendix

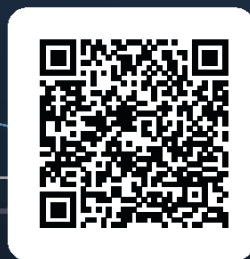
Notes:

- Data in tables and charts may not sum due to rounding.
- Some divergences may be explained by different energy conversion efficiency assumptions.
- To enable comparability between agencies, biofuels (volumetric equivalent) were added to IEA regional oil supply data unless stated otherwise (slides 43 and 57).
- Processing gains were subtracted from EIA regional oil supply data to enable comparability.
- Primary energy was converted from EJ per year to mboe/d by multiplying by 0.4825 mboed/EJ.
- In most instances in this report, oil is reported in energy equivalent units (mboe/d) to allow for a comparison between different fuel types. These figures are not directly comparable to the volumetric units (mb/d) for total liquids. Total liquids include biofuels, coal-to-liquids, gas-to-liquids, and processing gains while the reporting of oil on slides 37-40, 49-51, 54, 63 do not include these other liquids.

Acknowledgements:

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