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King Abdullah Petroleum Studies and Research Center



KAPSARC Oil Market Outlook (KOMO)

Q4, 2022

Summary

This quarter's highlights:

Declining gross domestic product (GDP) growth in Q4 2022 will add downward pressure to the underlying seasonality of oil demand trends in several countries, playing an important role in oil demand declines this quarter. OECD countries in North America and Europe are expected to witness overall declines in oil demand as winter sets in. In non-OECD regions, both the Middle East and Eurasia are also expected to witness declines. Nevertheless, both Africa and Asia will counteract these declines, bringing overall demand growth to over 510,000 barrels per day (Kb/d).

OECD Asia, particularly Japan and South Korea, is expected push demand up by 740 Kb/d (460 Kb/d from Japan and 240 Kb/d from South Korea). India is also expected to witness strong demand growth of 410 Kb/d due to its harvest season and religious celebrations. Demand in China is also expected to grow by 360 Kb/d as it intensifies its infrastructure development while also trying to export more diesel to Europe for the winter season, all bolstered by softer COVID-19 restriction expectations.

Since Q3 of this year, global oil demand has finally caught up to its pre-pandemic levels. Overall, we anticipate quarter-on-quarter (QoQ) growth in OECD consumption of roughly 640 Kb/d, while oil demand growth in non-OECD countries is expected to decline by roughly 120 Kb/d.

It is also expected that Europe and several other regions will increase their fuel oil demand this winter. Refineries that were supposed to retrofit to limit their sulfur content according to the IMO 2020 regulations did so two years ago. Several other refineries that have not been retrofitted seem to be in luck this year. This is because the need for switching gas to liquids this quarter has made burning fuel oil for heat and electricity generation profitable; exporting fuel oil with high sulfur content was until recently uneconomic.

On the supply side, it was expected that we would witness 230 Kb/d of net global growth this quarter. However, OPEC and its allies concluded their 33rd OPEC and non-OPEC ministerial meeting on October 5 and agreed to *“Adjust downward the overall production by 2 MMb/d from the August 2022 required production levels, starting November 2022.”* This means that OPEC+ will witness an overall QoQ decline of 465 Kb/d, bringing global production to a QoQ decline of only 400 Kb/d. Despite healthy growth from non-OPEC+ producers, they are expected to stagnate this quarter with a mere 65 Kb/d. One of the leading reasons for the stagnating production growth in liquids this quarter comes from Brazil's seasonal biofuels, which tends to peak in Q3 then decline in Q4.

Summary continued...

Total global oil consumption is still expected to increase year-on-year (YoY) by 2.16 million barrels per day (MMb/d) in 2022 to 99.89 MMb/d. This is a minor upward revision of 10,000 barrels per day (Kb/d) from our previous KOMO forecast in Q3 2022. These revisions reflect healthy reports by several countries on road, air and maritime activity, and slower economic activity in others, through 2022.

YoY, OECD demand growth will contribute 960 Kb/d of the overall demand growth in 2022. Given a challenging GDP forecast for the first half of 2023 for several OECD countries, OECD demand in 2023 is only expected to grow by another 520 Kb/d. For 2022, OECD Americas, led by the United States (U.S.), will carry 490 Kb/d of this year's growth. Europe will follow with growth of 320 Kb/d, with the United Kingdom (U.K.) representing 40% of OECD Europe's demand growth. The remaining growth is expected to come from OECD Asia-Oceania, with South Korea representing roughly 50% of the region's growth.

Non-OECD demand growth is expected to reach 1.20 MMb/d this year and 1.39 MMb/d next year. Significant changes for this quarter's forecast have been made for non-OECD countries. Our previous 270 Kb/d estimate of China's 2022 demand growth has been revised down to 90 Kb/d. This downward revision comes as a result of lower GDP growth projections, with lower transport activity accompanying China's continuing stringent zero-COVID-19 strategy. Indeed, China's demand seems to have declined in both of the first two quarters of 2022, while demand in Q3 stagnated. Although we still expect a strong comeback of 360 Kb/d in Q4, this remains contingent on government support for infrastructure work and China's ability to meet its new increased export quotas. Another non-OECD country that had a significant revision is Saudi Arabia. The Kingdom's demand growth has been revised upward (to 180 Kb/d growth in 2022). While GDP growth plays an important factor in estimating demand growth for oil, we notice that Saudi aviation activity has almost doubled since last year and maritime activity has continued to rise.

Global oil demand growth will continue its recovery from COVID-19 through 2024. The modest numbers for H1 2022 reflect greater clarity about the evolution of several features of that recovery, such as raising interest rates, a rising U.S. dollar, continued lockdowns in China, rising inflation, as well as new supply disruptions caused by the Russia-Ukraine conflict. Indeed, strengthening economy-wide demand, encouraged by elevated financial liquidity during the COVID-19 lockdown era, has led to continued supply chain disruptions and tightening labor markets in both the developed and developing worlds. High inflation continues across a wide array of commodities, but especially in energy commodities, as production is not yet able to catch up to demand growth. Additionally, global refining capacities remain below their average levels, for a variety of reasons, including planned and unplanned maintenance, and lack of investment adding an extra layer of price pressure. These features are evolving as we expected them to in our previous three publications. Interestingly, compared with the global economic situation, the Russia-Ukraine conflict has had a relatively minor effect on global oil demand so far in 2022. Thus, our demand forecasts remain similar to previous quarters' forecasts.

Summary continued...

The downside risks remain more probable than the upside ones for early 2023. As a result, we modified our growth projections by 1.90 MMb/d, mostly due to recession/stagflation risks. However, there is a potential for upside growth if the economic forecast improves, if China eases its lockdowns, or if global aviation demand picks up at a faster pace. Indeed, although overall demand levels have reached pre-pandemic levels, demand from certain countries and/or sectors continue to remain below their pre-pandemic levels.

Economic growth expectations remain the greatest driver of KOMO's oil demand projections. The International Monetary Fund (IMF) predicts global economic growth of around 3.2% in 2022 and 2.7% in 2023 (its expectations for 2022 and 2023 were set at 3.6% in April). The OECD has also revised its global growth forecast down to 3% in 2022 (1.5% less than its December forecast) and expects 2023 to witness growth of 2.2% (0.6% lower than its December 2021 forecast). Despite the recent economic outlook revisions for the next two years, uncertainty remains high, with the risk of future oil demand being lower than our current estimations.

Recent outlooks and reports by agencies such as the OECD, the IMF and the United Nations (U.N.), have signaled that the current risks of rising food and energy prices, and tougher financial conditions, are impacting multiple economies. On April 13, 2022, a U.N. report, "Global Impact of war in Ukraine on food, energy and finance systems," stated that 69 economies are facing this challenging trifecta. As of the drafting of this report on October 6, 2022, these factors remain.

Lower economic growth, including the risks of either stagflation or a recession, represents a significant downside risk to the KOMO oil demand forecast. Stagflation is a term used to describe an economy that suffers low economic growth and high inflation. Part of the KOMO reporting practice is to conduct a biannual survey that feeds into its forecast. Our experts posed the following question, "After Sri Lanka, do you expect economic downturns in other developing countries?" with a 100% consensus on "Yes." Although the risk of an economic downturn in a few developing countries may not alter global economic growth, the risk is non-negligible and could impact oil demand. Furthermore, indicators are signaling declining GDP for two or three consecutive quarters in some OECD countries to begin either now or by the first quarter of 2023. For a deeper understanding of this possible recession, refer to our KOMO Q3 2022 report where we discussed the issues in more detail.

Total global oil supply is expected to grow by about 4.10 MMb/d in 2022 (about 300 Kb/d less than our Q3 2022 forecast), and by 2.64 MMb/d in 2023 (about 600 Kb/d less than our Q3 2022 forecast). The downward revision for 2022 is partly due to OPEC's recent declaration of cuts for November and December as well as reduced shale production. Based on reported drilling activity and production from the first half of this year, KOMO's 2022 shale production forecast has been revised down. Offsetting this, however, is the impact of sanctions on Russia's production so far this year, which has not been as significant as some reports had predicted. The revisions for 2023 assume that OPEC+ will continue with the same levels of cuts as those made in Q4 2022 for Q1 2023. These are roughly 1.33

Summary continued...

MMb/d (with an easing from March). We expect them to continue reducing production by 300 Kb/d each quarter, since the declaration of cooperation (DOC) period has now been extended to December 2023. Despite the large cut declared, OPEC+ production is estimated to stagnate in Q1 2023 as the exempted members continue to increase production while other members reach their targets of under production. Based on this assumption, OPEC+ is expected to increase production by 2.43 MMb/d in 2022 and 360 Kb/d in 2023.

In the KOMO Q3 2022 report we stated “OPEC needs to weigh the value of using its spare capacity to balance the market against the value of preserving spare capacity to reassure the market. Indeed, OPEC’s spare capacity has always served as a buffer against unpredictable global supply disruptions and price volatility, but it was not designed to handle a supply disruption involving sanctions against a producer the size of Russia. The current question for OPEC in general, and Saudi Arabia in particular, is ‘Should OPEC sacrifice its spare capacity in order to reduce prices, or wait for non-OPEC production to balance the market? Is the increased risk premium of zero spare capacity worse than the situation now?’”

If China recuperates its lost growth this year, or if aviation activity accelerates, oil markets risk losing spare capacity, rendering them vulnerable to any shocks in the mid- to long-term. Preserving spare capacity is more important than one might think. Despite claims of the pressure these cuts may have on prices at the pump, stable prices may be more beneficial than might be assumed. Ultimately, it is better to have and not need a backup plan than to need and not have one. The cuts are a temporary measure and can be undone quickly if needed.

Furthermore, Russia’s trend of supply shrinkage may reverse in 2023. We expect the ongoing conflict between Russia and Ukraine to impact Russian supply next year, with Russian production declining by roughly 780 Kb/d in 2023. This decline will, however, be offset by a corresponding increase in global production due to three consecutive quarters of elevated prices encouraging non-OPEC+ countries to increase production. The net effect will be an upward revision in 2023 production.

For now, most companies are sticking to their modest production growth strategies while OPEC+ rebuilds its spare capacity. International oil companies (IOCs) around the world are expected to continue their long-term trend of diversifying their portfolios toward offshore, renewables, and other growth opportunities in search of higher value and lower risk.

OPEC countries are, collectively, expected to reach their pre-COVID-19 levels of production by the end of 2023 or early 2024. While some countries have been able to increase their production capacities since 2016, an environment of low investment and volatile geopolitics, compounded by the economic slowdown in the aftermath of COVID-19, has impacted the production capacities of countries such as Nigeria and Angola.

Summary continued...

The supply/demand balance is expected to experience a deficit of 600 Kb/d this year, before reversing to produce a surplus in 2023 of 140 Kb/d. Given our assumption of gradual production increments by OPEC+ post-Q1 2023, the supply/demand deficit is expected to end in Q1 2023 and gradually increase for four consecutive quarters.

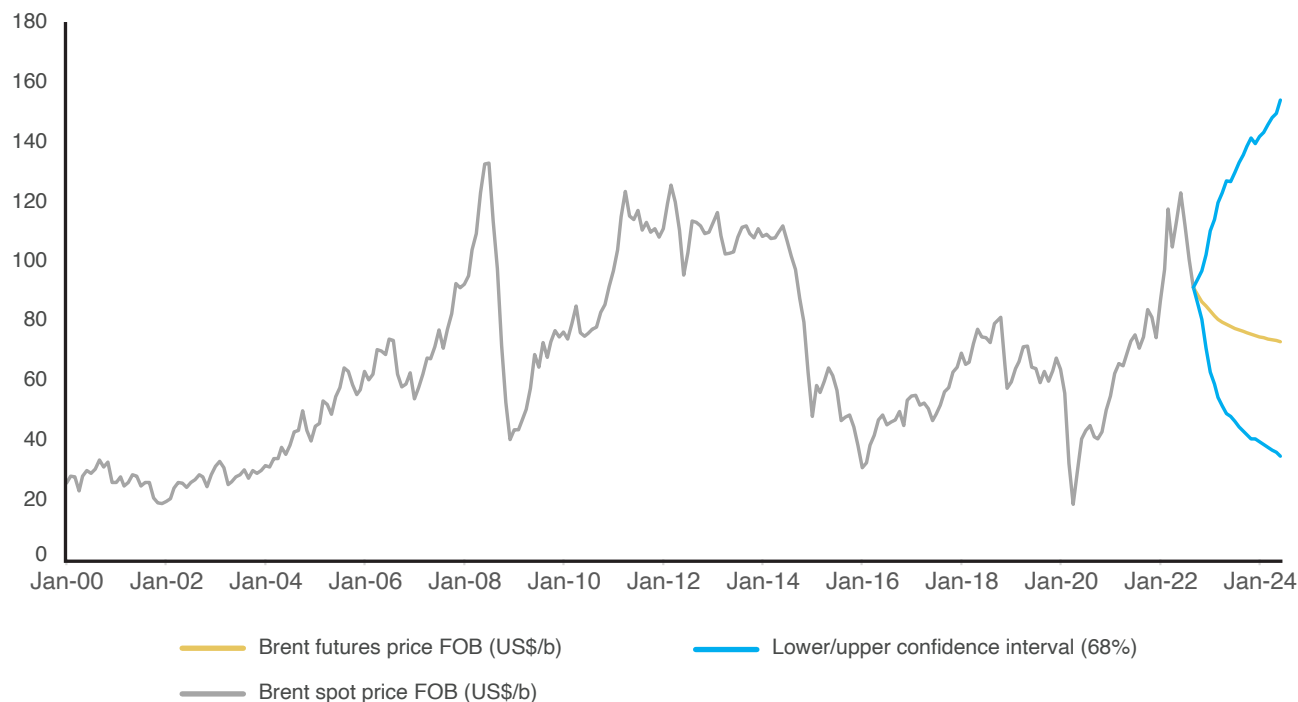
Under these assumptions, target inventory levels for the OECD are expected to decline by 132 MMb to 4,179 MMb in 2022 and should increase by 378 MMb in 2023, unless countries continue releasing their strategic petroleum reserves (SPRs). This rebound is higher than what we estimated previously, but we believe that the refilling of inventories will be gradual despite target inventories needing to increase proportionately to the rising economic and geopolitical risks. Real inventory levels are expected to grow gradually from Q2 2023, remaining below the new target levels throughout the next two years. This indicates that inventories may be insufficient to address future shocks, adding another layer of risk to oil markets beyond all the fundamentals throughout this period. Much of that will depend on governments refilling their inventories at a lower cost than the average yearly cost that they sold it for in 2022, which is around US\$103 per barrel (b).

	2019	2020	Growth	2021	Growth	2022	Growth	2023	Growth	2024	Growth
Demand	101.0	92.1	(8.8)	97.7	5.6	99.9	2.2	101.8	1.9	103.0	1.3
Supply	99.9	93.5	(6.4)	95.2	1.7	99.3	4.1	101.9	2.6	103.9	1.9
Δ	(1.1)	1.3		(2.6)		(0.6)		0.1		0.8	

Summary (Prices)

The confidence interval is derived from options market prices and the futures curve, which represent the views of a wide array of market participants, such as producers, refiners, airlines, speculators, and others.

Brent crude oil price and 68% confidence intervals US\$/b



Source: KAPSARC calculations based on NYMEX data, CME Group, FINCAD, September 2022.

US\$/b	Q4 2022	Q1 2023	Q2 2023	Q3 2023	Q4 2023	Q1 2024	Q2 2024	Q3 2024	Q4 2024
Futures	86.60	81.74	78.67	76.81	75.43	74.17	73.18	72.24	71.50
50% CI	\$81.27 - \$94.02	\$65.13 - \$102.68	\$57.35 - \$107.93	\$53.03 - \$111.30	\$49.70 - \$114.48	\$47.44 - \$115.97	\$44.91 - \$119.29	\$42.58 - \$122.57	\$40.51 - \$126.21
68% CI	\$78.92 - \$97.43	\$58.50 - \$114.46	\$49.37 - \$125.42	\$44.48 - \$132.72	\$40.78 - \$139.54	\$38.38 - \$143.37	\$35.62 - \$150.41	\$33.14 - \$157.51	\$30.95 - \$165.27
95% CI	\$72.41 - \$109.05	\$42.36 - \$159.04	\$31.42 - \$197.34	\$26.18 - \$225.83	\$22.45 - \$253.60	\$20.25 - \$271.93	\$17.71 - \$302.84	\$15.55 - \$335.76	\$13.73 - \$373.00

Note: CI = confidence interval.

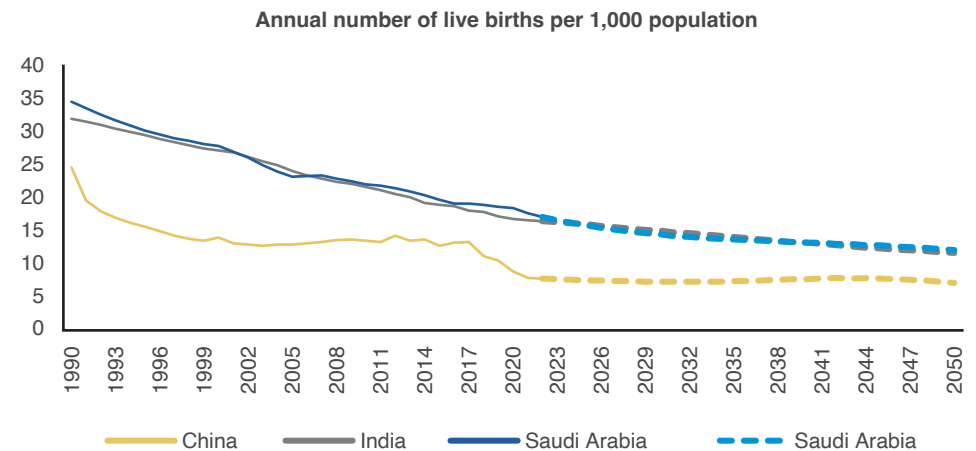
Key Issues for the Oil Market in 2022, 2023 and 2024

The key oil market issues remain the same on October 6, when this analysis was finalized, as in the previous quarter's outlook. These include, among others, the Russia-Ukraine conflict, inflation (particularly in food and energy prices), the risk of a recession, the lack of investment in energy supply, China's lockdowns and turbulent economy, stringent monetary policies, protectionist industrial policies, and supply chain security. New risks introduced over the last quarter are the potential for further infrastructure disruptions such as the Nordstream gas pipeline sabotage and the OPEC+ DOC's announcement of an additional 2 MMb/d production cut starting November 2022.

In our previous report, we devoted this section to exploring the risks of a possible economic recession/stagflation. However, since the risks remain the same, we have decided to dig a little deeper into what is going on and, more importantly, why.

The World Bank classifies a recession as a significant decline in economic activity, typically lasting at least six months (World Bank 2020). Although we had anticipated a recession in 2022, forecasts are now indicating a more delayed onset, with negative QoQ GDP growth expected in France, Canada, Poland, and Brazil around the fourth quarter of this year and the first quarter of 2023. Germany and Italy are expected to experience a recession one quarter earlier, and the U.S. in Q1 of 2023. It has already witnessed negative GDP growth in Q1 and Q2 this year.¹ An economic slowdown in China does not necessarily mean negative GDP growth, but only significantly lower growth than expected. Perhaps growth below 2% would be sufficient to trigger an economic recession in that economy or bring other economies down. Indeed, China's growth between 2000 and 2021 averaged 8.5%, whereas the U.S., European Union (EU) and the world average stood at 2%, 1.5% and 3.5% respectively.² Since China

relies on its exports for economic growth, declining activities in other economies could impact its GDP projections. Accordingly, the latest OECD Outlook report on China stated that its "GDP growth slowed to 1.3% quarter-on-quarter in the first quarter of 2022 from 1.5% in the fourth quarter of 2021. This partly reflected the stringent measures that remain in place to eradicate the spread of COVID-19, resulting in strict lockdowns in key economic centers such as Shanghai and Beijing." Earlier this year, it was expected that a recession could originate either from Europe or the U.S. However, now we see that it could also start from China.



Source: UN Population Division, Department of Economic and Social Affairs, 2022.

¹ BEA. 2022. "Gross Domestic Product (Third Estimate), GDP by Industry, and Corporate Profits (Revised), 2nd Quarter 2022 and Annual Update." <https://www.bea.gov/data/gdp/gross-domestic-product>

² International Monetary Fund (IMF). 2022. "International Monetary Fund datasets." <https://www.imf.org/external/datamapper/datasets/whdREO>

Key Issues for the Oil Market in 2022, 2023 and 2024...

Governments around the world are trying their best to address the current economic situation by hiking interest rates to reduce inflation and limiting exports to maintain supply chains. Others are considering providing targeted monetary/fiscal exemptions, among other measures. However, China seems to accept the economic fallout of its various policies, including its zero-COVID-19 policy. Why is that?

The economic slowdown in China originated with the fall of the Evergrande Group in the summer of 2021 when the company faced a liquidity crisis that continued to trickle down to several other companies. This crisis was compounded when several countries in the Belt and Road Initiative, as well as non-BRI countries in Africa and Asia, were unable to pay their debts to China following the economic slowdowns following the COVID-19 lockdowns. Alongside its slowing economy, China also faces challenges from changing demographics. The Evergrande crisis was the result of policies the government reinstated several years ago to deflate its construction bubble by limiting bank lending to construction firms. The Chinese government has also created many policies in recent years to reduce cost-of-living disparities, since the gaps between the rich and poor had been growing. At the end of the day, CCP stands for “Chinese Communist Party,” and despite its economic liberation policies in the past two decades, China’s philosophy is equal standards of living for all.

Figure 1 shows that China is facing a similar crisis to that of Japan, with exceedingly low birth rates for an emerging economy despite the recent loosening of its childbirth rate policies. The younger generation may also have different priorities than their elders. At the global level, Millennials and Generation Z appear to be less interested in home ownership, career security, or starting families and are more focussed on travel and new experiences. The idea of a mortgage for 20 to 30 years remains foreign to many of them. Some of this is simply due to having different values, but rising prices and the costs associated with raising children also play a role. The different priorities for these two generations differ from country to country, but the basic trend is global and the underlying causes are common. In China, this demographic shift may prove to be more important over the long term than the current lending crisis.

The Chinese government has been trying to address the challenges its younger citizens face by introducing policies to reduce income disparities. While this may lead to short-term economic pain, it may produce benefits over the long term. The Kingdom of Saudi Arabia also had to take several unpopular measures in 2016 to correct its growth trajectory as part of Vision 2030. Although Saudi Arabia had different reasons for introducing these measures, the idea behind them was similarly to take decisive action early so that the benefits would continue to develop over the long term.

While several OECD countries continue raising interest rates, China is trying to cushion the blow of its economic slowdown by reducing its interest rates. Unfortunately, there is no magic pill to address all issues, because as the U.S. continues to increase its interest rates, it risks increasing the value of the dollar, making all commodities more expensive and thus increasing inflationary pressures. KOMO’s Q3 2022 report goes into much more detail than this report about the economics governing the current and future economic situations. In that report, we highlighted inflationary pressures, recession risks, geopolitical tensions, investments and energy security, exchange rates, and the interplay between these issues.

Another risk around forecasting these coming eight quarters has to do with the divergent views among several outlooks. For example, the forecast growth for China this year varies among agencies and organizations. We found that the outlook for China’s demand growth for 2022 ranges between +300 Kb/d to – 400 Kb/d. A similar challenge applies to GDP and price forecasts.

Regardless of what happens, our forecast remains predicated on slowing global economic growth, high prices capping demand, and a ‘cool heads’ supply scenario with gradual OPEC+ increments and production elasticity responding to elevated pricing, particularly in non-OPEC+ countries. As such, we have trimmed our 2023 demand forecast and shifted our growth projections to 2024. We anticipate oil consumption growth in 2022 averaging 2.16 MMb/d, with non-OECD and countries

Key Issues for the Oil Market in 2022 and 2023...

leading growth at around 1.20 MMb/d, and OECD lagging with 960 Kb/d. As mentioned in our earlier report, we believe that global oil demand finally caught up to its pre-pandemic levels in Q3 2022. Nevertheless, GDP forecasts seem to be pessimistic for 2023. However, consumption is still expected to grow in 2023 by around 1.90 MMb/d and in 2024 by 1.25 MMb/d.

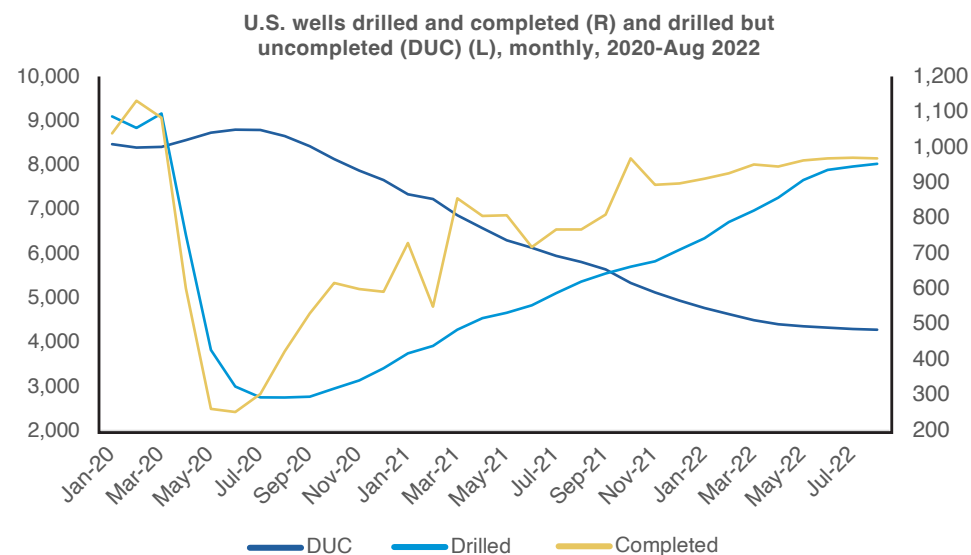
The outlook for production in 2022, 2023 and 2024 has much to do with the price curve of the past few months and with what is happening with Russia. The latest data indicates that Russian production has not been impacted, as some earlier estimates had warned. Although earlier this year there were estimates of Russian production declines of up to 4 MMb/d, we think that it has stabilized, and annual production should even increase slightly by 80 Kb/d. Once the European winter ends, substitution for oil is likely. Nevertheless, Russia has the technical potential to divert 60%-80% of its current European exports elsewhere, so a decline in 2023 may be limited to 780 Kb/d.

The United States is also increasing production significantly this year. Shale, especially natural gas liquids (NGLs), is expected to grow by 945 Kb/d this year and by roughly another 770 Kb/d in 2023. Furthermore, other conventional projects that were in the pipeline have also started producing this year, pushing U.S. total production up by roughly 1.13 MMb/d in 2022.

Although West Texas Intermediate (WTI) prices have been relatively high throughout the year, we notice that increased shale production has been driven mainly by independent producers. Furthermore, we notice that drilled but uncompleted wells (DUCs) have been declining steadily while drilling activity has continued to decelerate in the past few months. The shale industry continues to take a cautious approach by focusing on returns to investors and avoiding large expansions over fears of declining prices next year. Other downside risks to drilling include rising costs and labor shortages in the shale industry, among other inputs.

As a result, it is expected that global production growth for this year will reach 4.10 MMb/d, 2.65 MMb/d in 2023 and 940 Kb/d in 2024. OPEC will lead the production growth in 2022 then stagnate in 2023 with a muted growth of 360 Kb/d and 550 Kb/d in 2024. This is partially due to it maintaining its spare capacity, while non-OPEC+ producers are expected to lead growth in 2023 and 2024.

KOMO's supply/demand forecast is an average for each quarter and does not consider short-term volatility. Actual changes to supply and demand will, of course, remain volatile, reflecting the responses to current geopolitical changes and the duration of the COVID-19 pandemic. Other challenges may include unexpected oil supply cuts due to hurricanes, OPEC+ compliance, and geopolitical tensions escalating/diminishing, among others.



Source: Drilling Productivity Report, EIA, September 2022.

Demand Forecast

Global oil consumption is projected to grow by 2.16 MMb/d in 2022, increase by an additional 1.90 MMb/d in 2023 YoY, and by 1.25 MMb/d in 2024. Seeing that the drivers of demand are similar to those in the previous quarter, we have maintained our previous demand forecast for 2022. However, economic indicators now show several OECD countries are at risk of recession starting this quarter, so demand growth may slow in 2023.

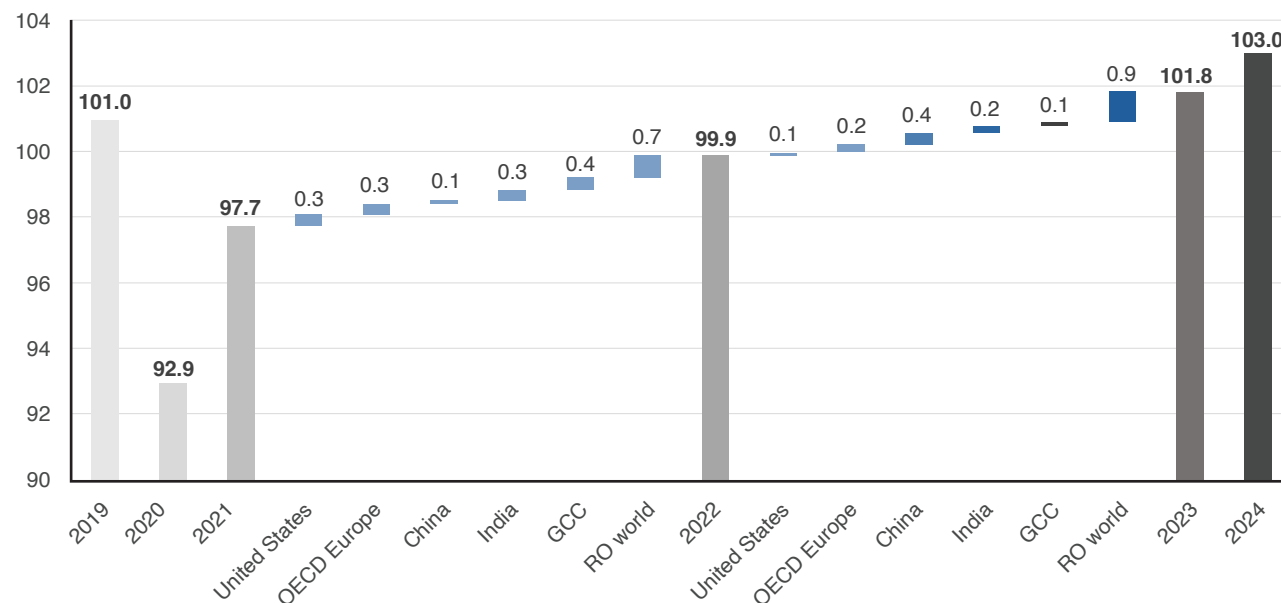
Over the past year, fears over the global economic and geopolitical situation have pushed our demand forecast for 2022 down. Indeed, this year's first two KOMO reports had much higher hopes for stronger growth in 2022, but the first half of the year witnessed declines in consumption. Q3 growth was higher, at 1.76 MMb/d, but the approaching winter season and lower GDP growth expectations for some countries has caused us to reduce demand growth expectations for this quarter to only 510 Kb/d.

An interesting insight to share in this outlook is that even if there were to be a recession in 2023, YoY demand would continue to grow. Moving forward, YoY growth projections are bounded, and are not expected to surpass 1.5 MMb/d. However, since we expect a demand rebound in China next year, and for several OECD countries the year after that, the next two years' growth projections should continue to be elevated, exceeding the growth projections prior to 2020.

Another interesting thing to watch out for this winter is heavier fuels and fuel oil consumption exceeding previous forecasts. Indeed, high sulfur fuel oil has not been profitable for a while and exporting it produced low profit margins. However, given the lack of gas in Europe, burning fuel oil for heating could

become profitable this winter. In the U.S., heavy-light differentials have risen significantly. This has led to increased variable cash refining margins for heavy end configurations for Western Canada Select as high as US\$40 in April-July this year.

Annual global oil demand growth, MMb/d, 2019 - 2024



Source: KAPSARC, October 2022.

Demand Levels, MMb/d

2020	Q1	Q2	Q3	Q4	2020
OECD	46.2	38.9	42.1	43.3	42.6
Non-OECD	48.2	48.8	50.2	50.9	49.5
Global demand	94.4	87.7	92.3	94.2	92.1

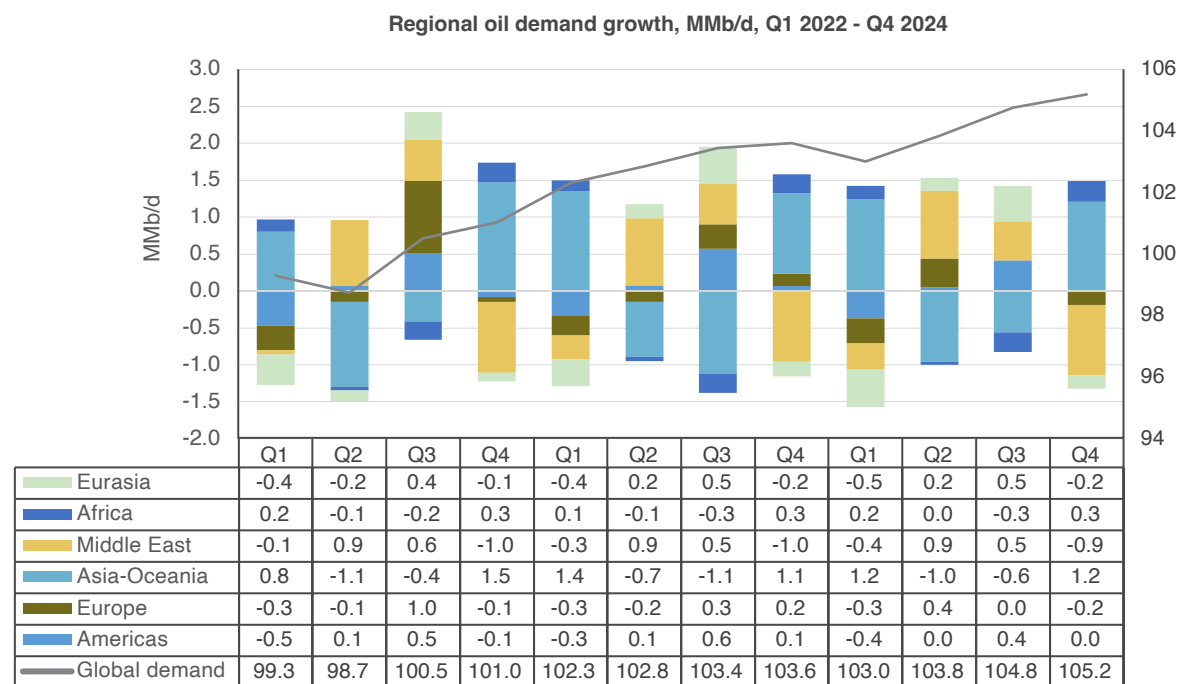
2021	Q1	Q2	Q3	Q4	2021
OECD	43.4	44.8	46.2	46.2	45.2
Non-OECD	51.2	52.4	53.3	53.4	52.6
Global demand	94.6	97.2	99.5	99.6	97.7

2022	Q1	Q2	Q3	Q4	2022
OECD	46.0	44.9	46.5	47.1	46.1
Non-OECD	53.3	53.8	54.0	53.9	53.8
Global demand	99.3	98.7	100.5	101.0	99.9

2023	Q1	Q2	Q3	Q4	2023
OECD	46.9	45.7	46.6	47.3	46.6
Non-OECD	54.3	55.7	55.5	55.1	55.2
Global demand	101.2	101.5	102.0	102.5	101.8

2024	Q1	Q2	Q3	Q4	2023
OECD	46.9	46.3	46.7	47.2	46.8
Non-OECD	55.4	56.5	56.7	56.4	56.3
Global demand	102.3	102.8	103.4	103.6	103.0

Non-OECD countries are expected to retain a 54% share of global oil consumption in 2022 and 2023. They are also expected to account for 56% and 73% of growth in 2022 and 2023, respectively. Asia-Oceania is expected to witness the largest QoQ growth at around 1.5 MMb/d as OECD Asia, China, and India are all expected to increase their consumption this quarter. The Middle East is expected to witness the strongest decline, as the demand for oil to generate electricity during the summer season declines significantly during winter by around -1 MMb/d.



Source: KAPSARC, October 2022.

United States

MMb/d	2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024
United States	20.0	20.3	20.2	20.5	20.5	20.4	20.3	20.2	20.5	20.6	20.4	20.4	20.3	20.5	20.5	20.4

2022-2023

The KOMO model expects U.S. oil consumption to grow by around 350 Kb/d in 2022 and 60 Kb/d in 2023, reaching its 2019 levels in Q3 2022.

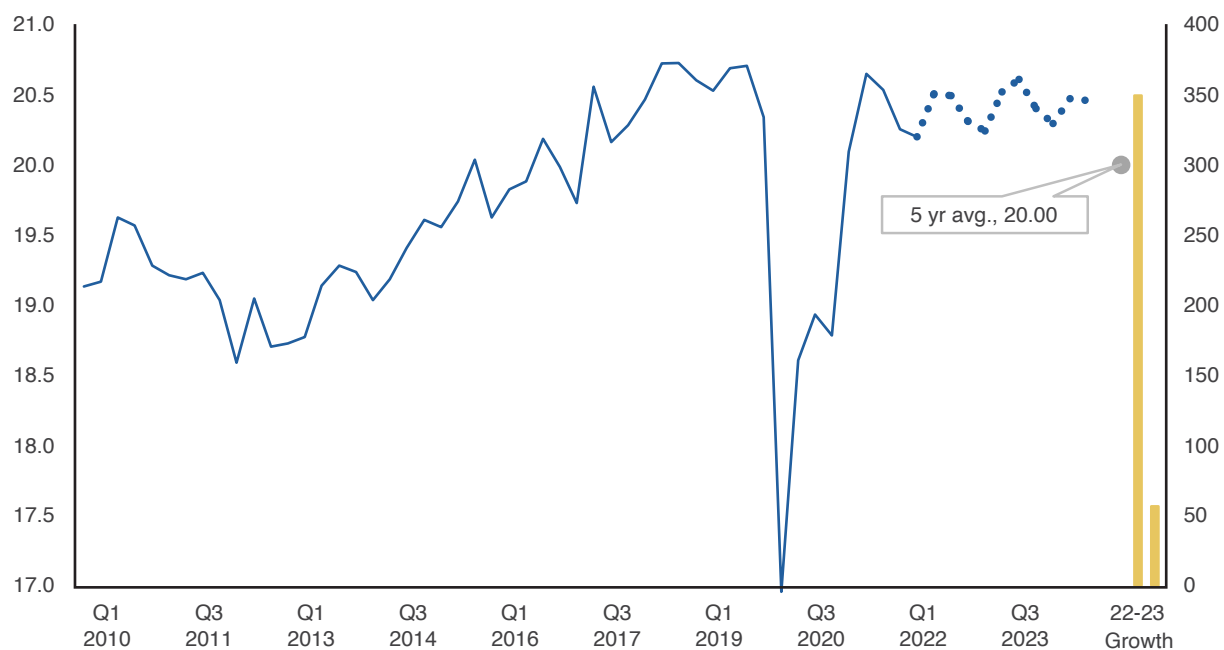
Transportation fuel consumption was hit hardest in 2020 but recovered the fastest in 2021 and continues to do so in 2022. Both aviation and road transportation activities have reached pre-COVID-19 levels and, some days, have even surpassed their 2019 numbers. The semiconductor shortage and other supply chain issues resulted in higher new vehicle prices and a surge in sales of less fuel-efficient second-hand vehicles during 2021. We expect continued inflation in new vehicle prices this year and, as a result, we estimate vehicle fuel demand will remain modest but with the potential to increase. Increasing gasoline consumption despite historically high retail prices exceeding US\$5 per gallon mid-year indicates robust demand. Annual 2022 gasoline consumption should see strong growth (160 Kb/d), especially as the price of regular gasoline has now declined to roughly US\$3.70 per gallon. Following gasoline growth is gasoil/diesel (70 Kb/d), liquified petroleum gas (LPG) (40 Kb/d), and other heavy fuels.

Q4 2022

We expect this quarter's U.S. demand to result in a QoQ decline of 10 Kb/d. Despite falling fuel prices, particularly gasoline and diesel, the consumption of most fuels is expected to decline this quarter, following

the pattern of seasonal demand. Demand for transport fuels is expected to decline, but heating fuel demand is expected to increase, with LPG growing by 310 Kb/d, gas/diesel oil by 150 Kb/d, and fuel oil by 50 Kb/d.

United States, MMb/d (L) and 22-23 growth Kb/d (R)



Source: KAPSARC, October 2022.

OECD Europe

MMb/d	2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024
OECD Europe	13.3	13.3	13.2	14.1	14.1	13.7	13.8	13.6	14.0	14.1	13.9	13.8	14.2	14.2	14.0	14.0

2022-2023

OECD Europe's oil consumption is expected to grow by 320 Kb/d in 2022 (70 Kb/d more than in our Q3 2022 report as the risk of recession this year has softened), and another 230 Kb/d in 2023 (150 Kb/d less than our previous forecast due to several countries in that region facing GDP declines in the first half of the year).

OECD Europe's oil demand had been expected to recover from COVID-19 declines much faster, but it has been subdued due to the recent geopolitical tensions and continued elevated inflation rates. Demand may even decline further, based on how these situations unfold, especially with Germany, France, and Poland facing GDP declines this quarter.

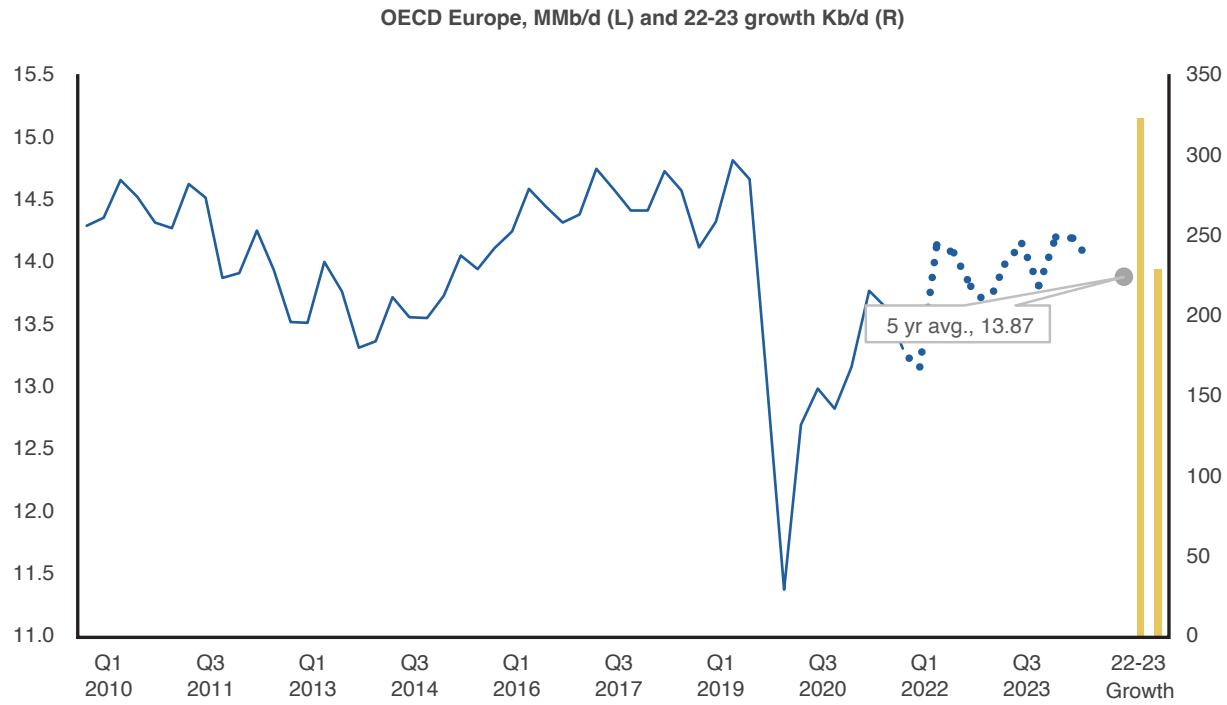
We currently expect modest 2022 demand growth, with consumption increasing between 20 Kb/d and 40 Kb/d for all fuels, except diesel, which is expected to grow by roughly 140 Kb/d in 2022. However, if Russia and Ukraine reach a ceasefire or long-haul international travel rebounds more strongly than expected, then numbers for OECD Europe could be significantly higher. Furthermore,

if the EU places a price cap on the price of Russian oil imports, then consumption has the potential to increase further. While Europe is anticipating shortages of heating fuels this winter, and although switching from gas to liquid fuels could increase oil demand, technical capacity limits how much fuel substitution could actually occur. According to an S&P report published on September 7, "Global gas-to-oil fuel switching to jump 80% as European, Asian gas prices soar," gas-to-oil fuel switching in Europe could reach levels as high as 300 b/d of liquids demand in Q1 2023.

Q4 2022

OECD Europe is expected to witness some economic slowdown this quarter, which will affect demand. We anticipate an overall QoQ decline of 60 Kb/d. Although diesel consumption is expected to grow by 100 Kb/d, LPG by 50 Kb/d, and both jet fuel and fuel oil by 20 Kb/d each, the expected declines in gasoline consumption and heavier products will counteract this growth.

OECD Europe...



Source: KAPSARC, October 2022.

China

MMb/d	2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024
China	15.0	15.2	14.9	14.9	15.3	15.1	15.4	15.7	15.3	15.4	15.5	15.7	15.9	15.9	16.1	15.9

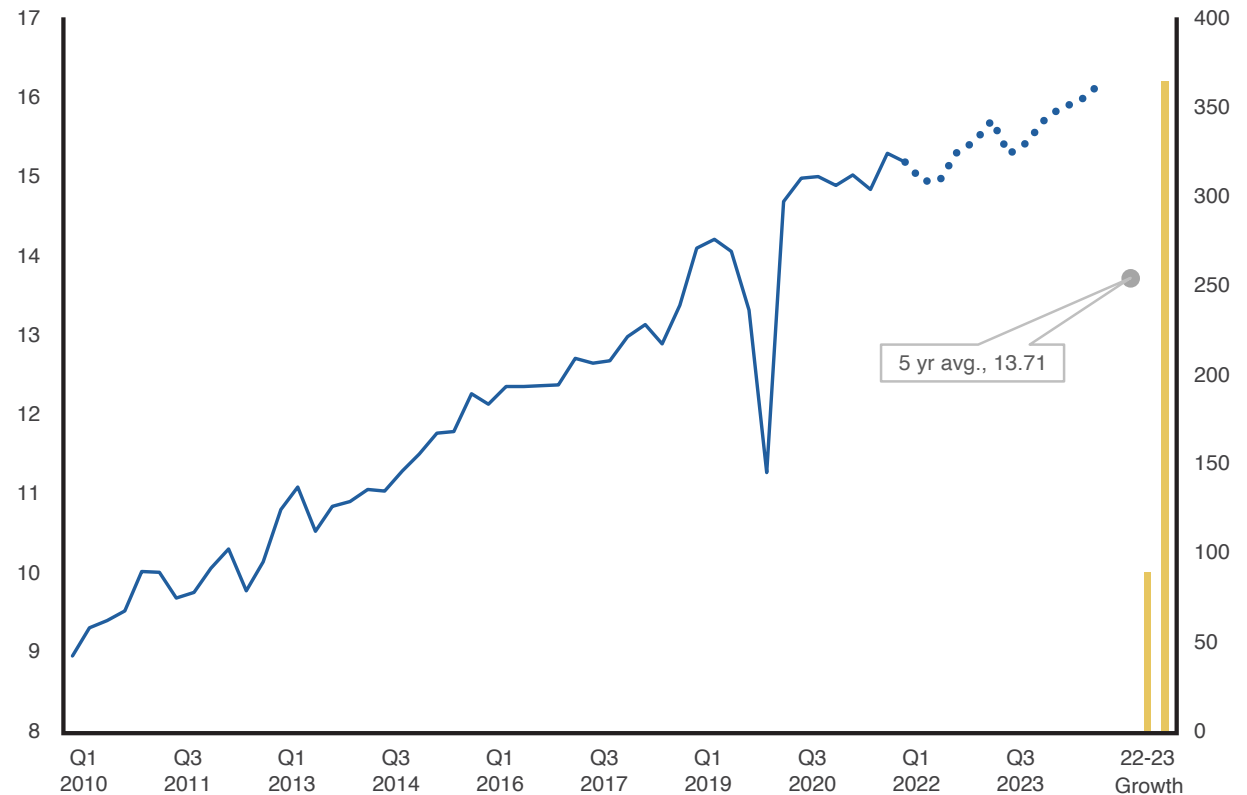
2022-2023

China's oil consumption is expected to grow by around 90 Kb/d in 2022 and 360 Kb/d in 2023. China's economy is losing momentum this year, and its recent COVID-19 lockdowns throughout the year did not help. As a result, we estimate modest increases in the consumption of all fuels of between 10 Kb/d-90 Kb/d, except for jet fuel and kerosene, which are estimated to witness declines of 30 Kb/d. Surprisingly, diesel demand remained muted this year, with most of the demand shifting toward heavier fuels for building roads.

Q4 2022

China's QoQ oil consumption is expected to grow by 360 Kb/d. Although we expected growing demand for heavy fuels, we now expect transport fuels will lead the growth this quarter as COVID-19 restrictions begin to ease. Hence, we expect diesel to grow by roughly 140 Kb/d followed by gasoline at 40 Kb/d. For now, jet fuel growth is estimated to remain muted at 20 Kb/d, but heavier fuels are also expected to grow by 90 Kb/d.

China, MMb/d (L) and 22-23 growth Kb/d (R)



Source: KAPSARC, October 2022.

India

MMb/d	2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024
India	4.9	5.3	5.4	4.9	5.3	5.2	5.6	5.7	5.0	5.4	5.4	5.7	5.8	5.0	5.5	5.5

2022-2023

India's oil consumption is expected to grow by around 340 Kb/d in 2022 and 200 Kb/d in 2023. Although 2022 should see healthy growth, 2022 and 2023 will also see state elections leading up to the general election of 2024. We expect higher demand this year due to the Indian government's intention to front-load its welfare and economic growth-oriented policies. The new fuel tax structure also became effective on May 22. It aims to insulate consumers from rising gasoline and diesel prices, and thus could see demand increase. Still, it could represent a loss for the government of more than one trillion Indian rupees in annual revenue. Before the pandemic, the government intended to provide tax breaks to kickstart the Indian economy. However, crude prices have remained high during the past two quarters, reflected in higher gasoline and diesel prices at the pump. Recent state elections returned a positive result for the ruling party, indicating a continuation of the current fuel policies.

A substantial portion of India's economic growth stems from its industrial sector. However, in 2021 and 2022, the country's GDP growth has been carried more by the services sector. As such, oil demand may lag GDP growth. Nevertheless, India's ability to buy Russian oil at

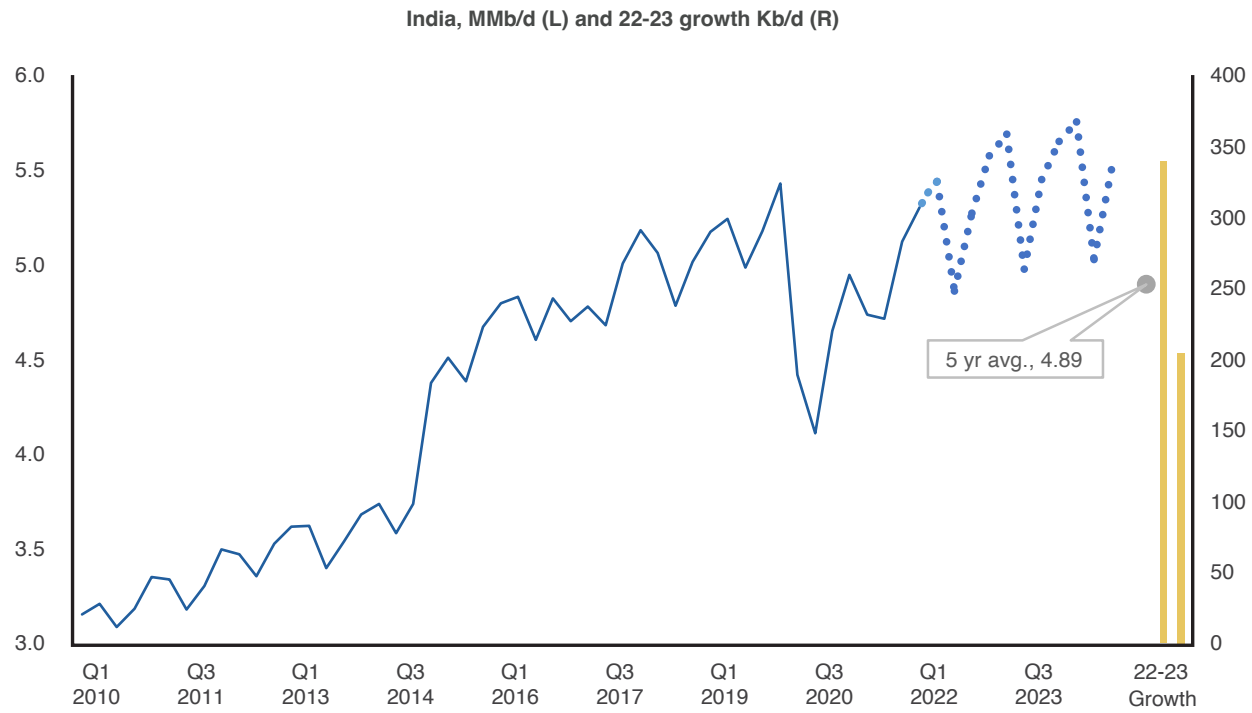
a discount will increase its consumption relative to other countries. We expect diesel to represent one-third of demand growth this year, followed by heavier products used for infrastructure development, and gasoline and LPG at 60Kb/d each.

India and China are expected to maximize their refinery runs to export more fuels to Europe and this might support higher domestic demand from both countries for 2023.

Q4 2022

India is expected to witness a healthy rebound in demand after its monsoon season, with QoQ growth of 410 Kb/d. We expect the agricultural sector to rebound during the harvest season, pushing diesel consumption up by 290 Kb/d. Heavy fuels are also expected to witness growth of 70 Kb/d and LPG by 50 Kb/d. The remaining fuels are not expected to experience significant changes in demand.

India...



Source: KAPSARC, October 2022.

Saudi Arabia

MMb/d	2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024
Saudi Arabia	3.6	3.2	3.9	4.3	3.6	3.8	3.2	4.0	4.4	3.6	3.8	3.2	4.0	4.4	3.6	3.8

2022-2023

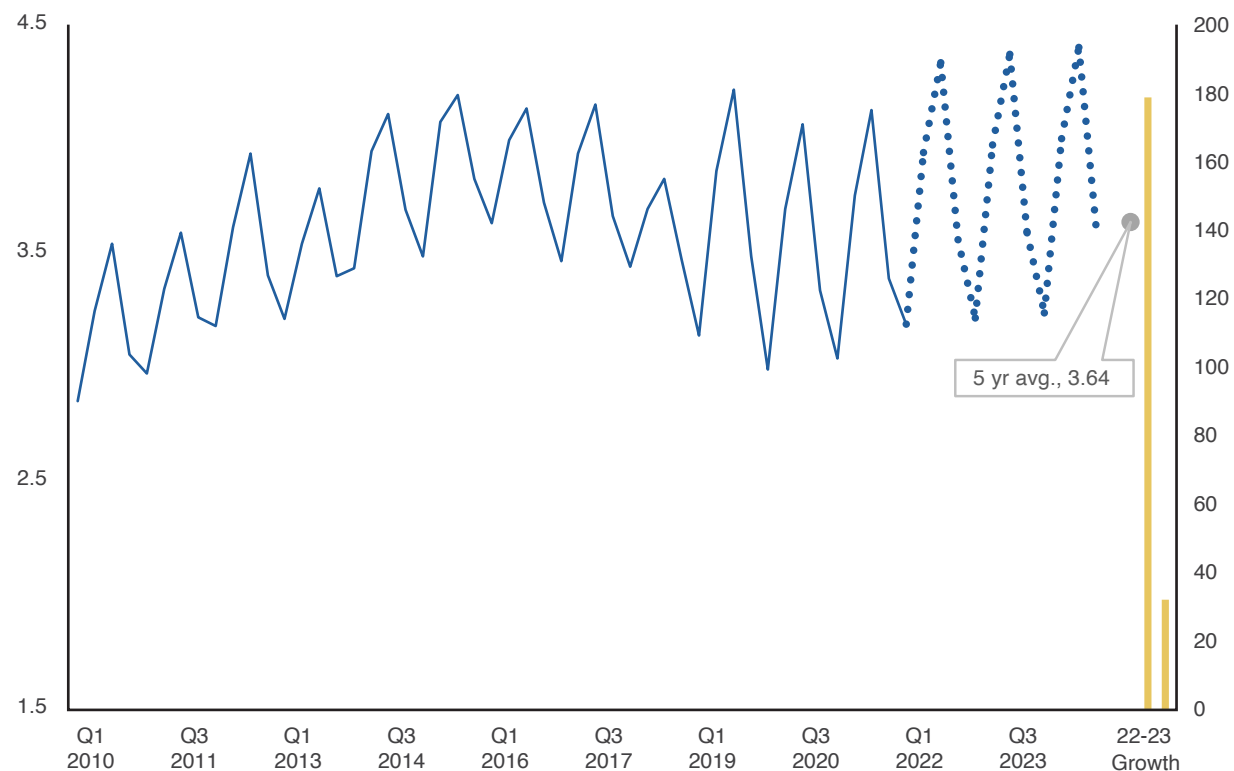
Saudi Arabia's oil consumption is expected to grow by 180 Kb/d in 2022 and 35 Kb/d in 2023.

With high oil prices giving Saudi Arabia a large GDP boost, the drivers of its oil demand growth are increased transport activity and electricity generation, with demand for diesel and fuel oil increasing significantly during the summer. Furthermore, Saudi aviation demand has almost doubled compared to 2021, and its maritime sector has continued growing. Hence, we expect jet fuel to represent 31% of Saudi Arabia's 2022 oil consumption growth, followed by heavier fuels growing at around 40 Kb/d for the ongoing megaprojects. Naphtha and LPG demand, however, is expected to remain muted this year.

Q4 2022

Saudi Arabia is expected to witness a QoQ demand decline of 780 Kb/d as summer ends and the demand for power generation decreases. We estimate diesel consumption to decline by 190 Kb/d and fuel oil and other heavier fuels/crudes to decline by 220 Kb/d each.

Saudi Arabia, MMb/d (L) and 22-23 growth Kb/d (R)



Source: KAPSARC, October 2022.

Discussion

Risk and oil markets have gone together for as long as the market has existed. In KOMO's three years, every quarter has had its own challenges, but this quarter seems more uncertain than any previous time in KOMO's history. The pandemic was a challenge for the demand side, but now supply risk is coming to the fore. As has been the case for the last six months, the prime risk is the Ukraine conflict and the associated supplies from one of the largest producers, Russia. All other risks are downstream and lead to vastly different market outcomes.

In previous KOMO editions we spoke of two futures where Russian supply was either “unpopular or unavailable,” but the split has now evolved into one of “finance versus physics.” Both the western powers and Russia see the current energy crisis as a contest of endurance and are playing to their strengths. The western powers, including the G7 and particularly the EU, want to slowly starve Russia's economy of funds so that it becomes impossible for it to continue the conflict in Ukraine. They plan on doing so (and preserving their own economy) by setting a price cap that would allow Russian producers to continue providing liquids to the market but not allow the Russian government to profit from high prices. Economic warfare is a softer option than direct confrontation, but it is difficult to implement when Russia has alternative trade partners (sanctions busters), and is relatively resilient when it comes to basics like food, water, and energy.

On the other hand, Russia is staging a siege of its own. By cutting off energy supplies (especially gas) to Europe, they are leveraging the chill of winter and the physics of entropy to their advantage in negotiations. Can the Europeans hold on until spring? A cursory examination of Russia's finances indicates they can survive for almost two years under current spending with limited energy revenues if they choose to do so. Whether this turns into a slow decline or a play for all-or-nothing determines everything else.

This quarter, we built our base case scenario on the premise that all leaders will make reasonable choices and “cool heads” will prevail. In this scenario, the general outcome looks much like the current situation, without a price cap or an embargo, effectively a draw between the two sides. Our base case scenario assumes a price cap is instituted but largely ignored: Global prices do not rise or fall dramatically, global supply is not hugely increased or curtailed, Europe does not freeze, Russia does not run out of money, and both sides can claim some sort of victory.

Unfortunately, this scenario may not be what unfolds, as evidenced by the recent sabotage of the Nordstream pipeline, the election of a far-right government in Italy, and other issues increasing geopolitical tensions. Alternative scenarios are discussed in the following discussion.

Highlights from this edition are:

- OPEC+ is waiting for December, when a possible price cap, economic slowdown or embargo are enacted.
- Shale producers are waiting patiently for better conditions.
- Geopolitical developments and energy security are concerns for everyone.

Supply Forecast

Under the “cool heads” scenario, global liquids supply is expected to grow by about 4.10 MMb/d in 2022 to reach an average of 99.29 MMb/d for the year. We expect 2023 to see a further 2.65 MMb/d increase in supply, with OPEC+ cuts gradually easing, for an average supply of 101.93 MMb/d for the year. This reflects a tamer impact on Russian supply than we had originally projected at the beginning of the conflict, but our outlook for 2023 and beyond remains the same.

Our risk profiles are unchanged, as the survey from which they are derived will next be run in December. However, most details pertaining to the new interpretation of the risk metrics can be found in the qualitative discussion of this report. The updated version of the risk table in the next edition could well be a complete departure from the last survey and change our views entirely, depending on the responses from participants.

Non-OPEC+ growth for 2022 is settling towards 1.67 MMb/d, with the Americas as the clear driver. The U.S., Brazil, Canada, Guyana, and Argentina each contribute 100 Kb/d – 200 Kb/d, with the U.S. producing 1.13 MMb/d across all fuel sources. With the exception of Norway (spurred on by regional demand), we anticipate the Americas to be the main supply center in 2023 as well.

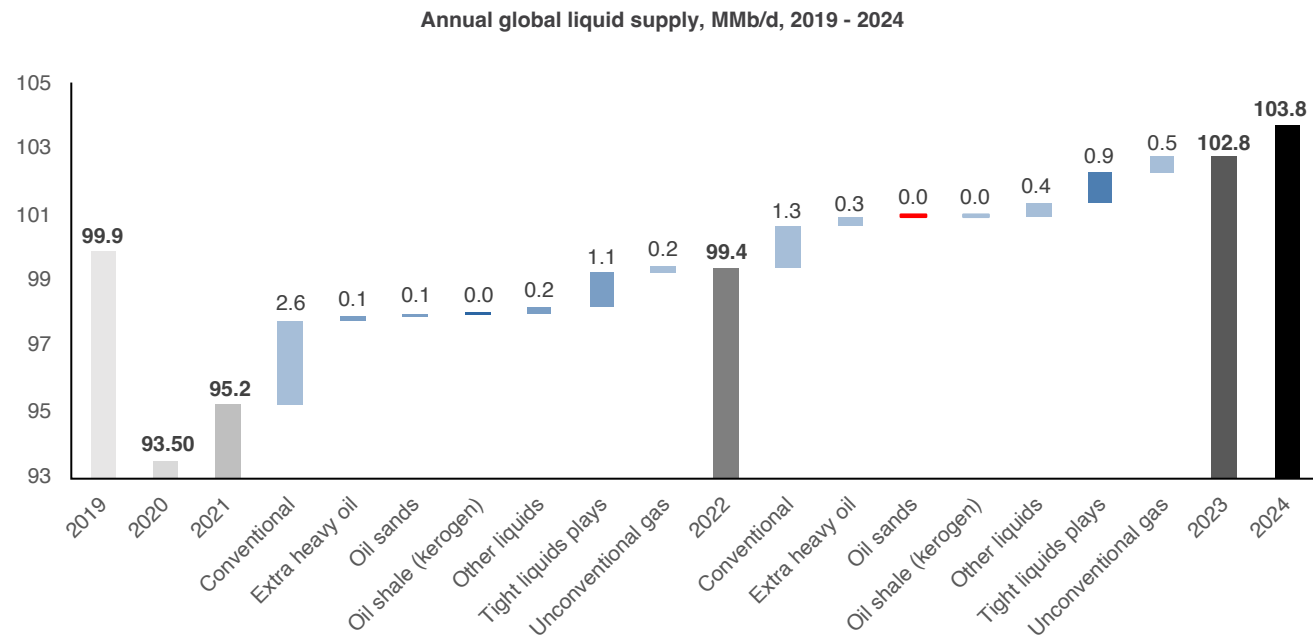
Shale supply was supposed to recover this year as we exited the pandemic, but its performance continues to be lackluster, as also noted in prior editions of KOMO. Interestingly, a shift toward more gas drilling is increasing the supply of NGLs, while crude and condensate supplies were revised down. The outlook for 2022 appears to be an increase of 945 Kb/d total liquids from U.S. shale, with a more muted 2023 delivering an additional 770 Kb/d. In a future of sharp price increases, domestic American political pressures could result in policies that stimulate more production, especially as the 2024 presidential election comes into view. Alternately, if more supplies are available, then stronger policy action will probably discourage further production.

The recent optimism of the Canadian oil sands producers in increasing their supplies to Europe and acting as heroes is being paired with grand plans to deploy carbon capture utilization and storage (CCUS) and other technologies to meet climate targets. This comes at a time when environmental reports indicate that investments in emission reduction mechanisms are far below the level needed to meet emission reduction goals. Nevertheless, oil sands production in 2022 was largely flat at 60 Kb/d, due to various pitfalls and outages, and the growth is expected to remain at this level for the foreseeable future.

OPEC+’s behavior under the cool heads scenario is proactive, with the group’s recently imposed cut providing more breathing room to respond to future uncertainty. There is now some increased supply cushion if Russian supply were curtailed. If Russian supply were to increase under a successful price cap, it is probable that the cut would be maintained for longer to reduce volatility. Otherwise, 2022 sees 2.4 MMb/d growth, with some underperformance compared to earlier estimates. Supply in 2023 is estimated to grow by 360 Kb/d, assuming cuts are eased throughout the year.

The future for supply will likely be known around December 5. This is the day the EU embargo on Russian crude and a possible price cap will be implemented, and just after the next OPEC+ meeting. Bring a jacket, it might get cold.

Supply forecast...



Source: KAPSARC, October 2022.

OPEC+

OPEC+ currently holds an uneasy position, attempting to bridge the interests of their member states and clients. As such, the choice between being proactive or reactive to the market is a tricky one. On the one hand, in the run-up to December, increased purchases of Russian crude (buy now, while supplies last!) and concerns over demand were pushing prices steadily downward in a way that physical balances might not have agreed with. The decision to cut supply in the October meeting was met with significant consternation in the West, but our updated results clarify OPEC's reasons for its supply cut. The optionality of the cut was done to stave off a worst case scenario for the market.

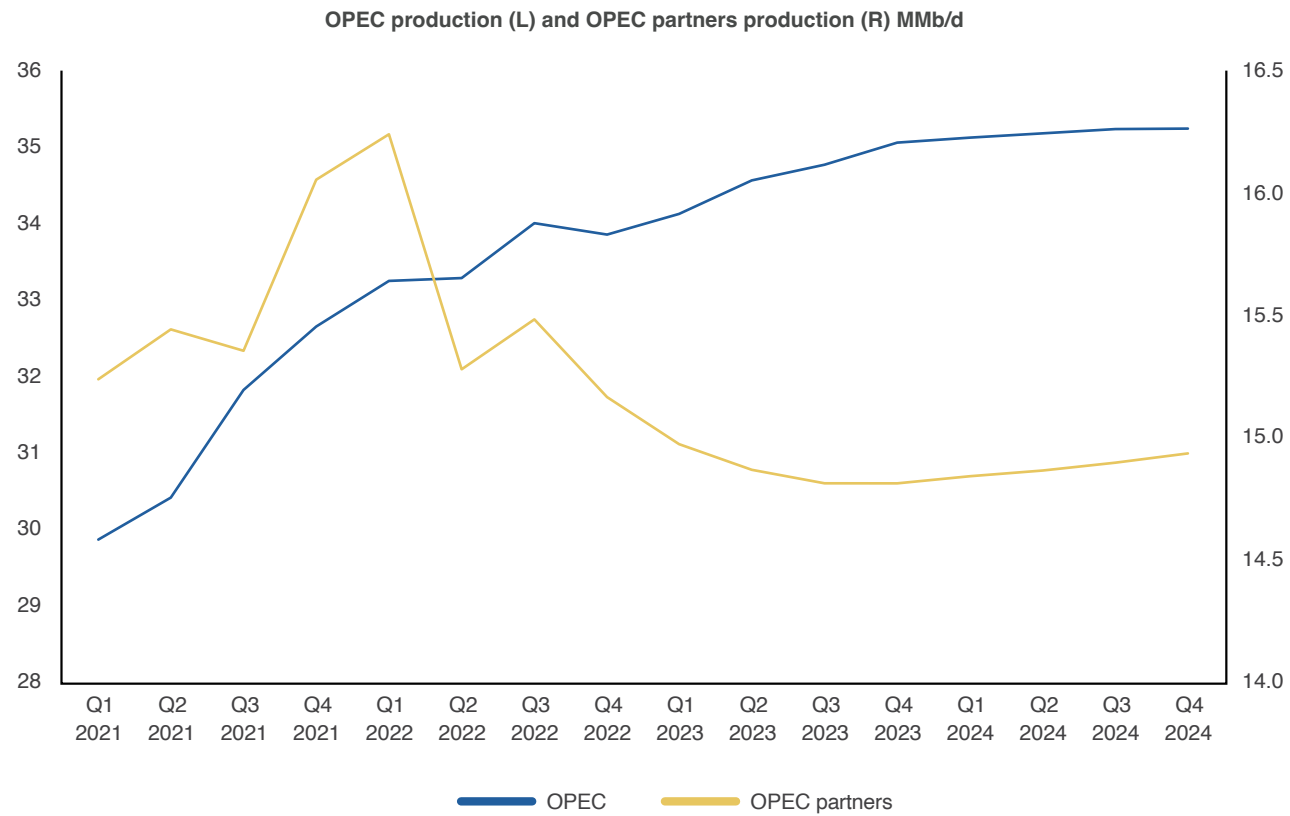
The worst case scenario, however, is somewhat perspective dependent. While OPEC does not seek high oil prices, it does benefit from them in the short term. Longer-term issues such as demand destruction are also on the minds of member states, which is why stability and reduced volatility have become the group's core message to the market. The worst case scenario for the group, ironically, is our base case this quarter.

A resolution to the conflict, one way or the other, would be better for OPEC+ than prolonged uncertainty. Concerns surrounding the security of energy supplies will push developed markets toward faster transitions, while developing economies will focus on cheaper Russian crude grades, when available. The prospect of short-term profits for OPEC countries exporting to the West at the expense of long-term revenues from the East is a difficult dilemma. In the short term, members are providing preferential pricing for Asian markets to maintain market share while competing with Russian discounts.

The exempt OPEC+ members are also starting to be problematic. Venezuela's deal to export to the EU in exchange for debt is seeing pushback, as they need finished fuels and investment in their upstream and downstream. The Joint Comprehensive Plan of Action (JCPOA) with Iran appears to have stalled, with a deal on the table but no agreement. Iranian negotiators may feel they have leverage because of market conditions, while the U.S. is pushing increased sanctions on third-country firms that have been facilitating the illicit trade of Iranian production. Libya may have recovered from a recent shutdown caused by unrest, but it is vulnerable to an unstable political situation that could easily cause more interruptions.

Now OPEC+ has created a spare capacity buffer, they can use it to stabilize future shocks. Stability, in whatever form, is the goal.

OPEC+...



Source: KAPSARC, October 2021.

OPEC and Partners Supply Changes for 2022 - 2024, Kb/d

	2021	2022	2023
Mexico	(84.1)	76.8	(105.7)
South Sudan	1.1	17.8	3.2
Equatorial Guinea	(7.0)	(10.7)	(20.6)
Sudan	(3.5)	(16.7)	(10.0)
Brunei	11.6	(8.9)	(1.6)
Bahrain	3.6	9.9	(4.4)
Gabon	12.9	(13.0)	(10.4)
Malaysia	1.4	59.3	(33.4)
Congo	9.1	(23.1)	(17.3)
Azerbaijan	(42.5)	10.2	9.5
Oman	76.4	30.3	8.1
Algeria	98.6	32.1	14.9
Nigeria	(205.2)	(90.4)	(0.0)
Kazakhstan	(107.5)	36.7	99.4
Kuwait	275.2	48.5	62.2
Iran	128.7	132.5	232.6
Venezuela	149.8	140.7	(6.8)
UAE	286.8	(22.6)	56.3
Saudi Arabia	1,303.5	296.3	195.4
Iraq	383.9	106.6	46.3
Libya	(222.6)	220.4	127.1
Russia	126.3	(699.9)	(56.2)
OPEC	2,275.9	814.8	531.1
OPEC partners	(17.1)	(484.6)	(90.9)
OPEC+ TOTAL	2,258.8	330.2	440.2

	Kb/d
	50
	0
	-50
	-100
	-400

OPEC+ Spare Capacity

In the current market, spare capacity is the hottest topic of debate and uncertainty. If Russian volumes become widely available, there is no shortage and the OPEC+ cut merely brought balance. If Russia goes completely offline, global oil markets might face challenges (but at least there is some known capacity that could return to the market).

By making a cut, OPEC+ has removed some uncertainty in a very uncertain time. We know that there is at least 1 MMb/d of spare capacity (after prorating the 2 MMb/d cut across under-performers). Lately, much of the movement in price and trading has been driven by non-fundamentals. Concerns around demand weakness and high supply pushing prices down justified the (entirely reversible) decision to cut some production and create a safety buffer.

Market supply anxiety is mostly focussed on the underperformance of OPEC+ in hitting its targets, but it is mostly unfounded. From a buyer's perspective, the market was already relatively balanced (if they don't mind buying from Russia). The level of spare capacity if core OPEC is fully operational (and not including the exempt members) should be somewhat stable after the cut, at about 3 million barrels going forward. This is plenty to absorb the impact of normal

shocks. Pessimistically, assuming half of the pre-cut underproduction for the whole group of 3.5 MMb/d was merely lagging and not permanently lost, there should have been approximately 1.75 MMb/d to work with, which is also plenty under normal circumstances. Since production growth was lagging, this cut should also provide some space to complete the much needed maintenance of production facilities that will also increase capacity.

Among the members with lagging production (excluding Russia), Nigeria is by far the largest at about 500 Kb/d under target. Debate in local media blames theft for these unaccounted volumes, but this is a questionable claim for a few reasons. First, that would be over 20% of their production lost to graft, and the scale and collusion required for such a heist is difficult to imagine. Second, from a global perspective, the market is indifferent to how oil reaches it. Illicit oil is still supply, and counts toward the balance... so is Nigeria that far below their target? We may never know.

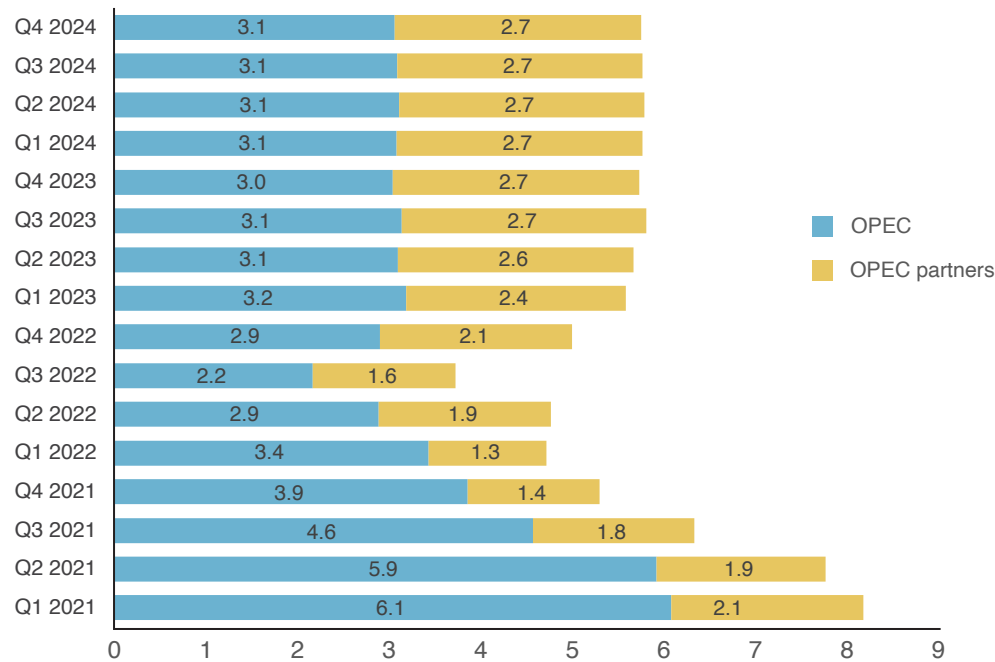
With falling prices, and a slightly looser market, an early cut prepared everyone for a potentially difficult winter (and created some spare emergency supply). At the moment, OPEC+ targets are partly symbolic and hold much more meaning as signals to a market that

is unsure of itself. Clear messaging is what is needed, even if it is something consumers do not want to hear. If factually increasing spare capacity, by whatever measure, increases market confidence and reduces volatility, then it is a net benefit even if prices are somewhat elevated.

As per the last few editions of the KOMO, the spare capacity measure below includes Russia as they are not exempt, and the other non-exempt member contributions are set based on their declared targets versus their underlying production capacity.

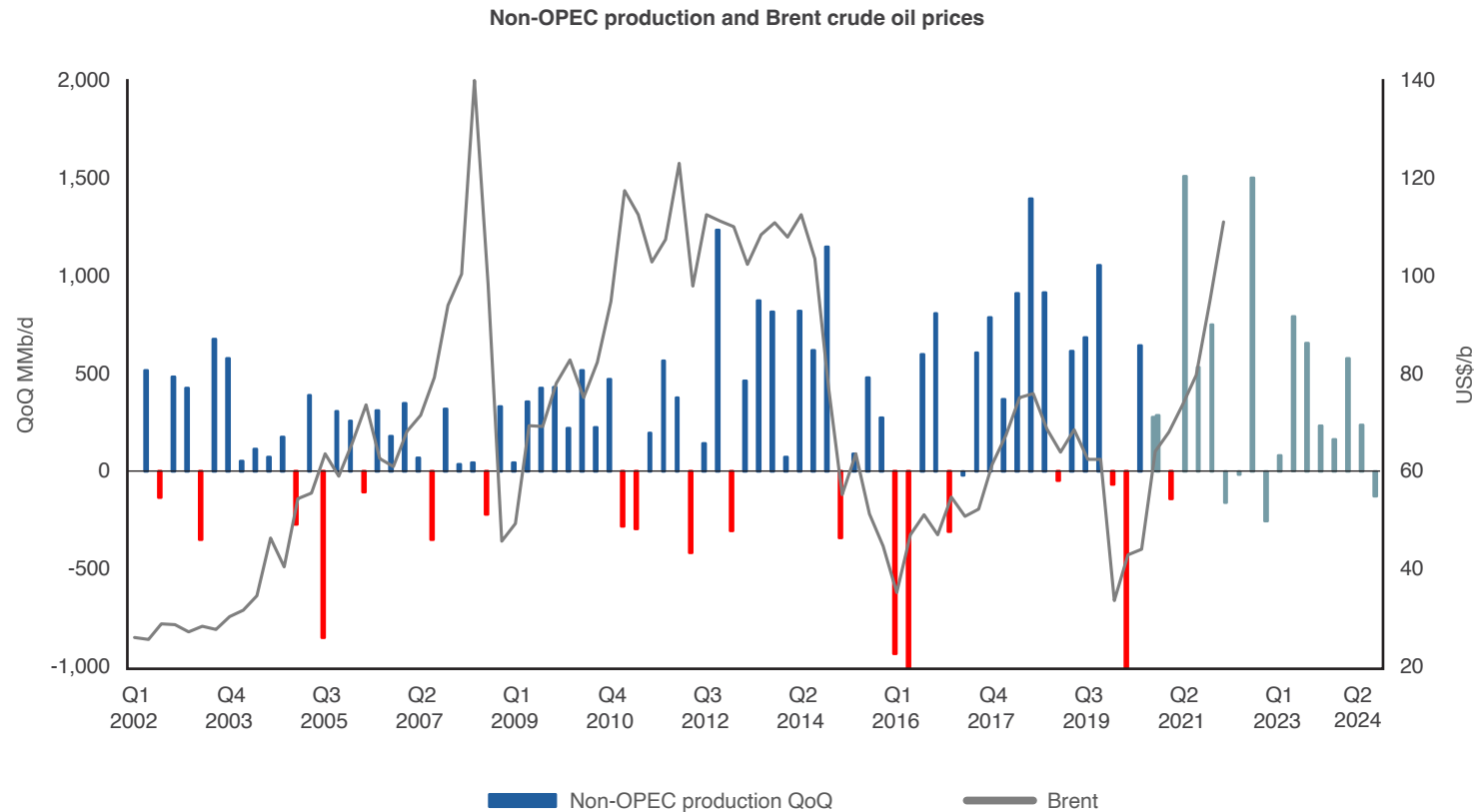
OPEC+ spare capacity...

OPEC and partners spare capacity, MMb/d
Technical base



Source: Rystad; KAPSARC, October 2022.

Non-OPEC+



Source: IEA, September 2022; KAPSARC, October 2022.

Non-OPEC+ growth:

- In 2022, we expect the supply of global tight oil to rise by 1.09 MMb/d, unconventional gas liquids to rise by 180 Kb/d, and oil sands to reclaim 65 Kb/d.
- In 2023, we expect the outlook for global tight oil to grow by 940 Kb/d, with unconventional gas liquids growing by 550 Kb/d, and oil sands staying effectively flat.
- Key issues for non-OPEC+ producers include responding to the push-pull of regulation that promotes energy security while also protecting the environment.

Non-OPEC (Tight Oil and Oil Sands)

At a workshop attended by our experts on shale production held this quarter in Houston, the tone was melancholy. Ignoring the industry cheerleaders and complaints about politicians, the actual members of industry seemed resigned to their lot, and spoke of sustainable growth at 5% per year and serving their shareholders.

From the shale producer's perspective, they must say these things. After years of hard gambling and poor returns, these companies need to show some sort of contrition, or their investors would abandon them entirely. During the workshop, the speakers also provided several examples of the challenges they face: "pipeline capacity will limit growth soon," "peak demand means no upside," "the service companies are understaffed," and "innovation has slowed." Nevertheless, we believe that all these challenges are unlikely to stop a determined producer, especially when there are gains to be made, and the private firms have proven to be determined for now.

The speakers' questions also highlighted the industry's dilemma: "Why would Biden ask OPEC for oil, when we are right here?," "Have you seen the growth of the private firms?," "Can't the government commit to refilling the SPR with shale?" The shale industry is just waiting for the right conditions and highlighting the shortcoming of recent policies. Given a good enough reason, they can fire up their rigs again.

The most likely driver to unleash another major shale boom is patriotism. If the government asks producers to drill, then they are serving their country. Unfortunately, the likelihood of this occurring is all too high in the medium-term. A smooth and orderly energy transition requires a smooth and orderly world, which today's events are not providing, making for a difficult transition.

Three reasons, all interrelated, will likely clear the way for the next shale bonanza in the medium to long-term:

1. High prices lead to a friendlier administration (ongoing).
2. The energy transition disappoints, probably due to critical minerals access (possible).
3. The conflict in Ukraine escalates and pulls in other nations (less likely).

These are all fundamentally energy security issues, and they trump (pun intended) everything else, because international affairs usually take a backseat to problems at home. In the meantime, things are not so bad for the major shale producers. They can complain about high oil prices and enjoy the revenues and increases in their stock values that it brings. While capital expenditure (capex) spending may be officially limited by investor commitments, mergers and acquisitions are still an option, allowing them to buy the acreage and wells they need without spending on drilling. Offloading

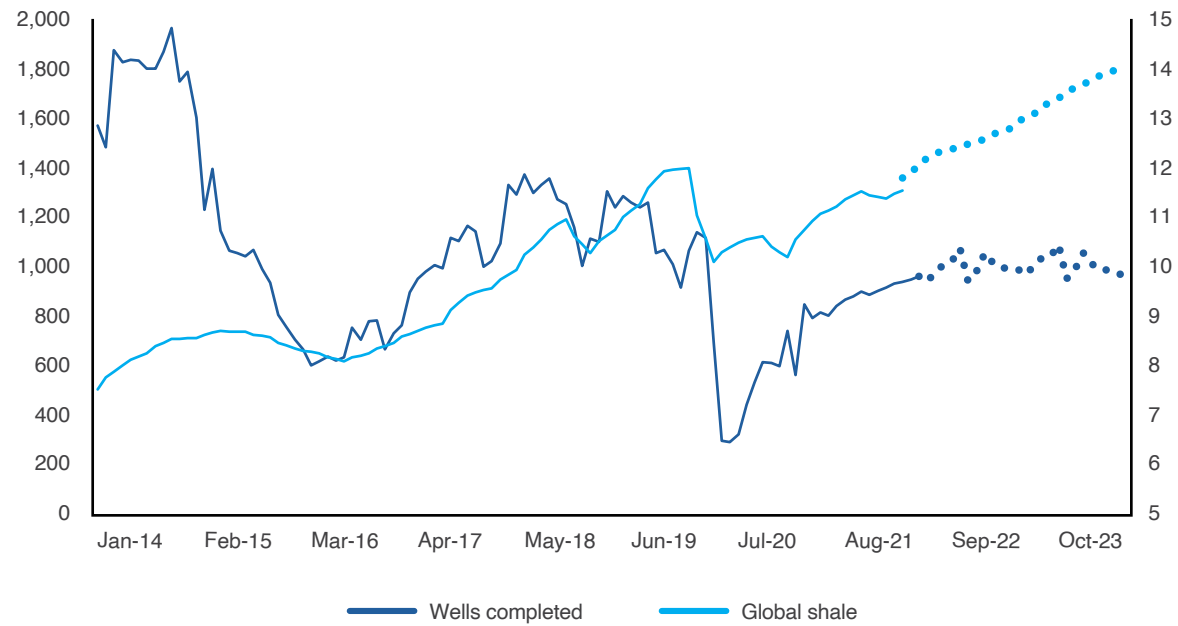
poorly producing assets to private firms also improves their emissions intensity and lowers the burden of decommissioning assets on the balance sheet.

Lastly, the new environmental provisions of the Inflation Reduction Act were welcomed by the largest shale producers. Not necessarily because it will help them, but because they limit competition with independent and smaller producers that cannot afford to upgrade their disjointed holdings. The next dip in prices could trigger a fire sale of small assets, squeezing out competitors and joining huge tracts of land for professional development. Expect future shale growth to follow political needs and pricing. This makes OPEC's spare capacity more valuable in the long run, but the transition will be bumpy.

Proclamations that "shale is dead" are understandable given the recent lack of movement from producers, but a lightning-fast development cycle allows producers to be patient.

Non-OPEC (tight oil and oil sands)...

Monthly U.S. drilling activity (L) vs. global shale production (MMb/d) (R)

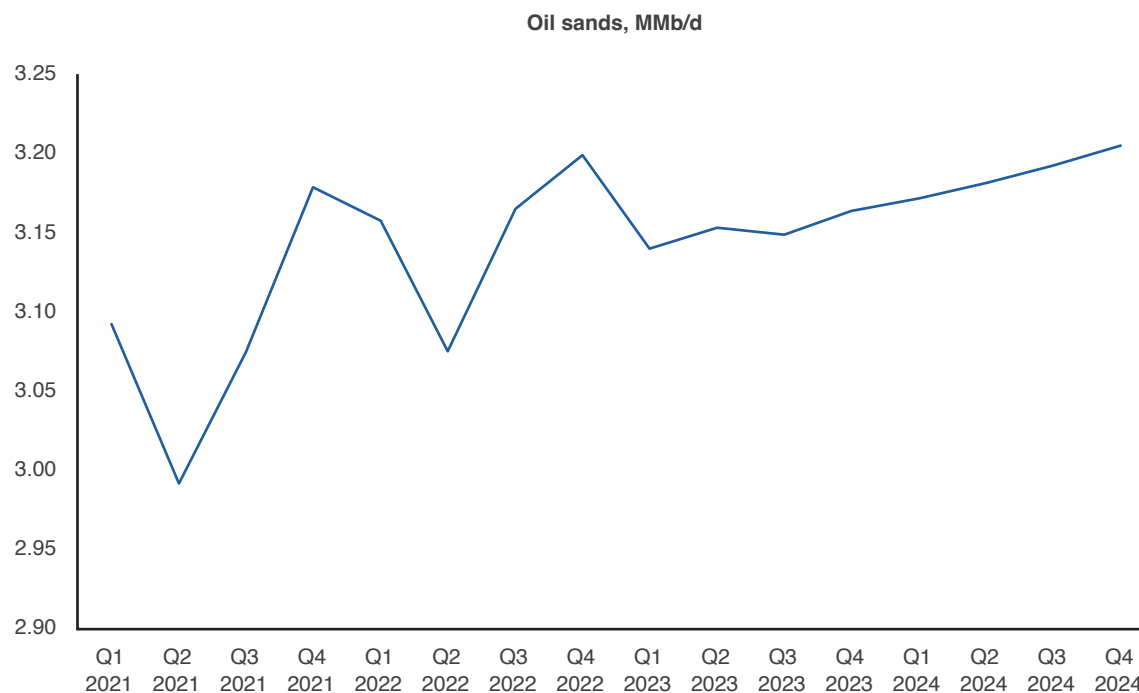


Source: KAPSARC, October 2022.

Non-OPEC (Tight Oil and Oil Sands)...

Oil sands production is hitting a plateau for now, according to our model. The rebound from the pandemic has almost played out, and the upside from here is very gradual. Proclamations of significant growth by oil sand producers, alongside complaints about unrealistic emissions targets, make for a murky outlook. Increased pipeline capacity should ease some of this uncertainty, but much of the flow into a new pipeline would likely be shifted from existing rail cargoes in the medium term.

The Transmountain Pipeline, the next major upgrade to oil transport, has been repeatedly delayed (now due late 2023) and has tripled in cost. Wildfires in British Columbia slowing the work, environmental concerns, funding and debt issues, insurance problems, and the realization that the pipeline may never be profitable have all taken a toll on the project. Transmountain, Enbridge Line 3, and other planned expansions to the network should open more space for production, but it may be closer to the second half of this decade before the benefits are fully realized. Furthermore, the latter scenario falls outside our eight-quarter window. For now, expect the current situation to continue. Hopefully more investment in CCUS and other technologies will make the oil sands more resilient in the long term.



Source: KAPSARC, October 2022.

Risk Scenarios June 2022

*The KOMO survey is conducted on a semi-annual basis in Q1 and Q3, with results holding over to the subsequent quarter.

KOMO's risk categories are based on current events impacting the oil industry.

KOMO uses the risk table to estimate potential impacts, taking two components into account: probability and impact.

Probability: A shaded chart at the top right of this slide shows the probability of a risk occurring (the darker the shade, the more likely it is to happen).

Impact: The impact is calculated as a percentage of exports (as domestic supply is often protected), or estimated into the demand model through a multiplier or a change in gross domestic product (GDP).

For supply risks, we multiply the probability by the potential impact.

For demand risks, the model either (i) examines historical incidents as multipliers then applies a similar response to future demand, or (ii) estimates the potential impact on GDP and channels it through the model, via changes in the exogenous variables, to determine the implications for future oil demand.

Risk category	Item	Supply/demand	Impact (Kb/d)	2022	2023	2024
Producer supply risks	EU sanctions on Russian crude	Supply	↓ 500 - 1,000*			
	Guyana & Namibia strong YoY growth	Supply	↑ 100 - 150*			
	U.S. production increase beyond 1 MMb/d	Supply	↑ 500 - 800*			
	JCPOA progress and more production from Iran	Supply	↑ 150 - 250			
	Venezuela increasing production	Supply	↑ 50 - 200			
	UAE, Kuwait and Iraq capacity to increase	Supply	↑ 500*			
Demand risks	Economic downturn	Demand	↓ 260 - 500			
	Continued inflation	Demand	↓ 230 - 500			
	China's lockdowns	Demand	↓ 60 - 200			
	Long haul/international aviation rebound	Demand	↑ 240 - 430			
	India's growth in oil demand exceeding pre-pandemic levels	Demand	↑ 0 - 170			

A resolution to the Russia-Ukraine conflict	Yes	65%
Oil prices remaining above US\$100/b	Yes	80%
OECD energy transition acceleration	No	55%
Tourism activity to resume to pre-pandemic levels	Yes	70%
U.S. dollar to continue getting stronger	Yes	50%
Euro exchange rate to remain weak against the US\$	Yes	75%
Future domestic unrest	Yes	95%
Future economic downfalls in developing countries	Yes	100%
SPR releases to have an impact on oil prices	No	70%
Nigeria and Angola to reach pre-pandemic production levels	No	60%
Supply chain challenges impacting production	Yes	90%
Aviation to contract in some regions due to high prices	Yes	65%
U.S. taking further measures to address fuel prices	Yes	70%

The results are based on a survey conducted biannually.

* The survey results agree with the underlying model or assumptions, so the net impact is already accounted for.

2022 and 2023 Balances

Given the recent changes to KOMO's supply/demand balances and the current price levels, we estimate an average deficit in 2022 of around 600 Kb/d, followed by a surplus of 140 Kb/d in 2023. There was a very sharp surplus in Q3 of 1 MMb/d prior to the announced cuts in October 2022. Although the recent cuts maintain a declining supply over the next two quarters, this has created a gradual supply build-up, allowing OPEC+ to address any shocks over the next two years.

The KOMO forecast assumes that demand will continue to grow modestly, despite the downside economic risks. It also assumes that OPEC+ will carry most of the supply growth in 2022, before stagnating in 2023 and taking a 'wait and see' approach.

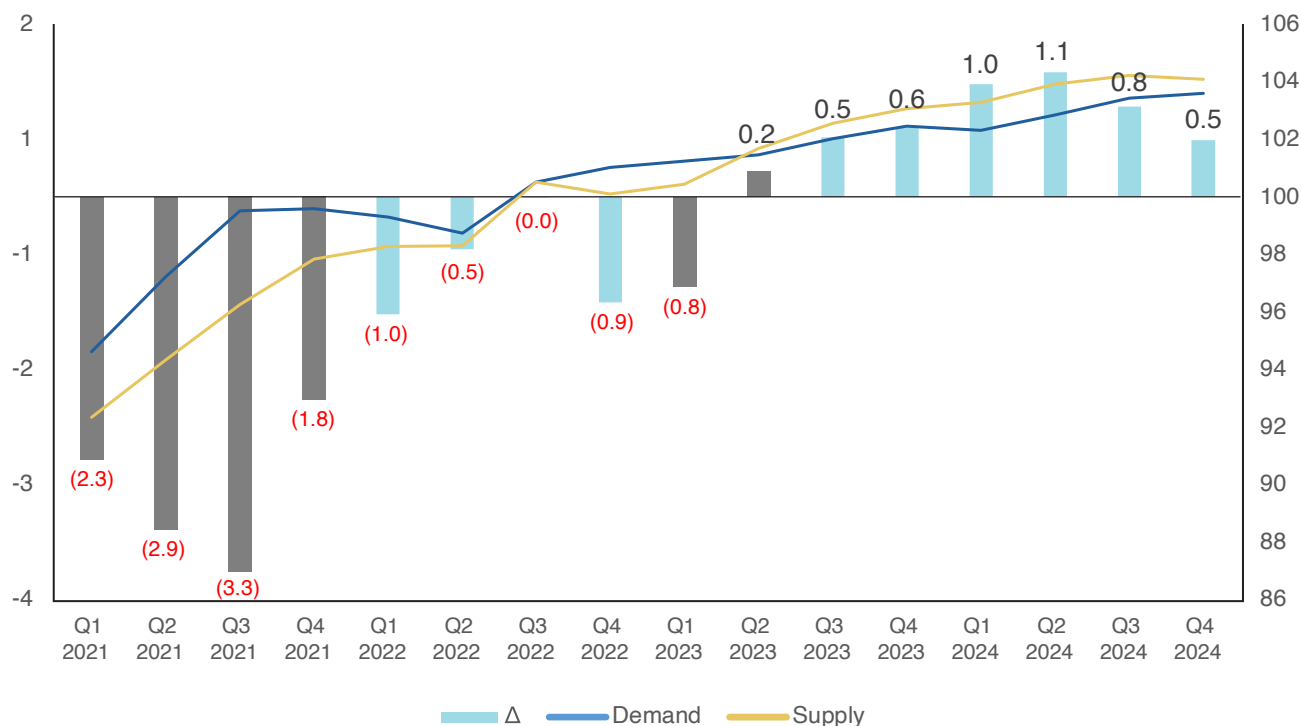
Throughout 2022, we expect a supply deficit in each quarter, except for Q3, when SPR releases balanced the market, bringing the supply of liquids in parity with demand. The production deficit in Q3 was 1.3 MMb/d. However, as the SPR releases ramped up, they are estimated to have accounted for roughly 1.33 Mb/d. The SPR releases are due to mostly end in October, which is why we are expecting to witness a continued supply deficit thereafter. Much of the supply growth for 2023 and 2024 will depend on non-OPEC+ countries, which means OPEC+ may give up some market share in its pursuit of reduced market volatility.

On the other hand, we expect 2023 to witness an overall surplus of 140 Kb/d, despite a continued deficit in Q1 and Q2. Part of this surplus is due to an expected timid

demand growth from OECD countries in the first half of 2023, and the impact of high prices on non-OPEC+ producers, since oil prices have averaged around US\$103/b in 2022.

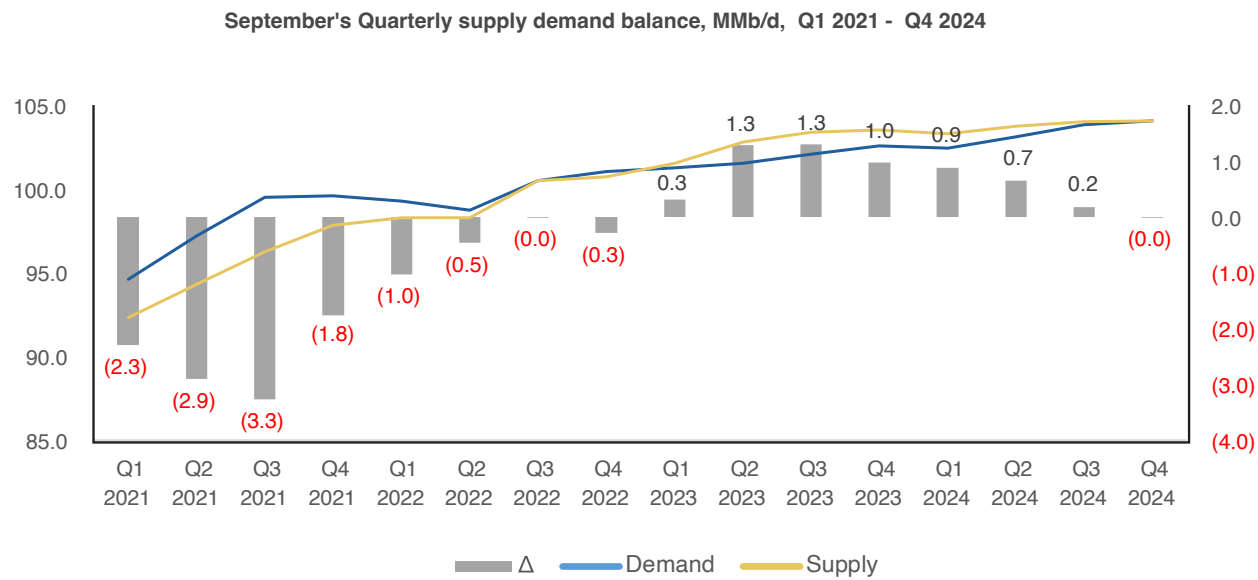
The main question going forward has to do with future SPR releases. Will OECD countries continue releasing from their inventories after October through the first half of 2023? And will they increase production in the second half to refill them?

October's Quarterly supply demand balance, MMb/d, Q1 2021 - Q4 2024



Source: KAPSARC, October 2022.

2022 and 2023 Balances...



Source: KAPSARC, September 2022.

Price Fundamentals (Inventories)

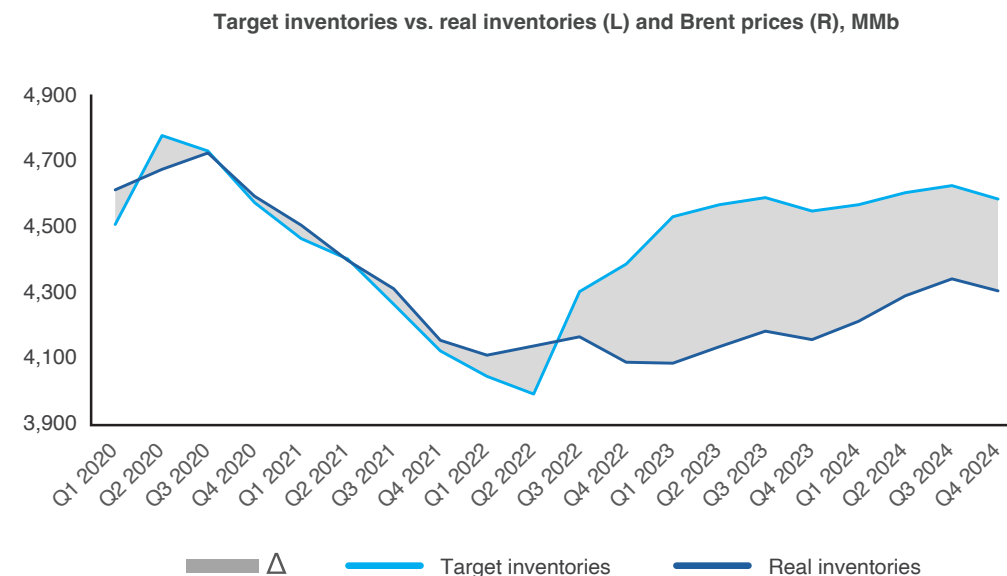
Price movements for the foreseeable future will continue to be mainly influenced by evolving inventory levels, recession risk, and the Russia-Ukraine conflict. As a surplus starts to be felt in mid-2023, with demand anticipated to slow in OECD countries, prices will decline.

Surprisingly, prices were not significantly affected by the recent OPEC+ ministerial declaration to cut production by 2 MMb/d.

It is important to mention the fact that the KOMO target inventory model is a theoretical construct reflecting the aggregated “normal” level of inventories desired by the oil industry to meet contractual obligations, provide a cushion for the complex supply chain that tends to deliver the product in batches, and buffer unanticipated changes in the supply of and demand for crude oil. It is derived from OECD inventory data using a trend component reflecting long-term economic growth, and a seasonal component reflecting phenomena such as the winter heating season and summer driving and cooling seasons. In short, it suggests a reversion to a long-term trend that is almost linear. However, it also puts into question whether OECD inventories will return to their 2019 levels or continue their trend as if COVID-19 was a short-term supply disruption, as opposed to a long-term or permanent market disruption. In this forecast, we have it returning to its normal trend levels (a form of long-term mean reversion), but in a more gradual manner. If this assumption is correct, then we also estimate that prices may fall gradually. However they could decline at a faster pace if OECD SPR releases continue. So, will OECD countries deplete their inventories in the face of the current risks facing the global community?

If this is the case, then shouldn't there be a cushion of spare capacity to address any future risk?

In this regard, target inventory levels for the OECD are expected to decline by 132 MMb to 4,179 MMb in 2022 and grow again by 378 MMb in 2023. This decline represents the SPR releases that took place this year. Real inventory levels are expected to decline by 217 MMb and then increase by 15 MMb/d in 2023 to reach 4,138 MMb.



Source: EIA; KAPSARC, October 2022.

Price Fundamentals (Brent)

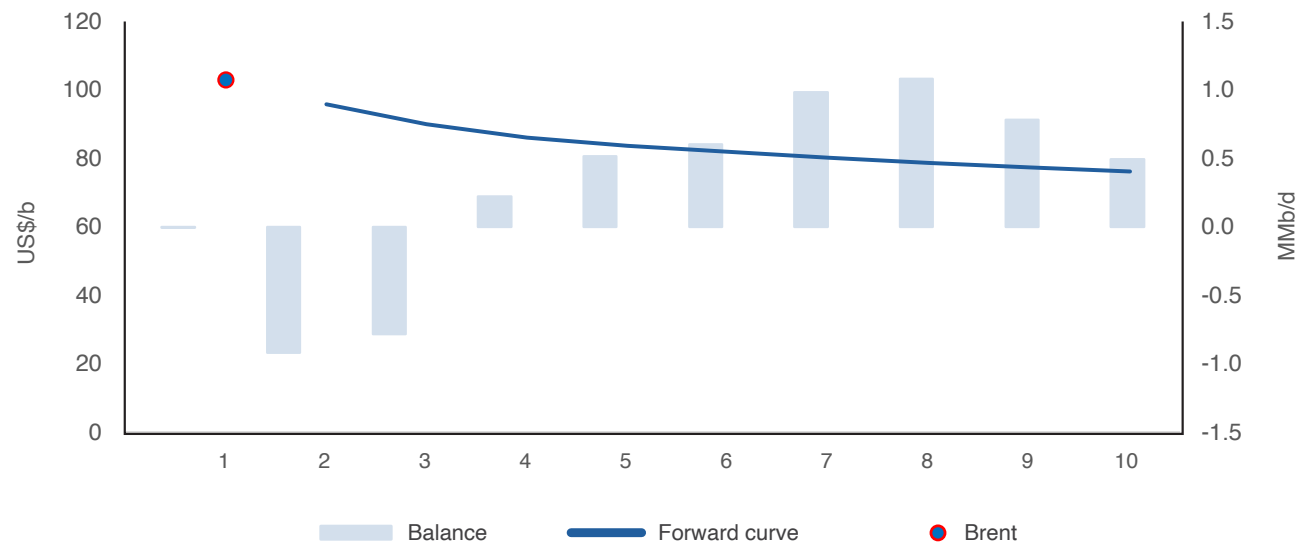
	Q3 2022	Q4 2022	Q1 2023	Q2 2023	Q3 2023	Q4 2023
Bloomberg	107.54	99.76	97.93	93.58	93.74	
Market sentiment	100.75	100.25	101.67	97.67	91.33	83.00

	2022	2023	2024
Bloomberg	103.41	92.30	84.50
Market sentiment	100.08	93.42	

Source: Bloomberg, September 29, 2022.

*Market sentiment is based on publicly available forecast data.

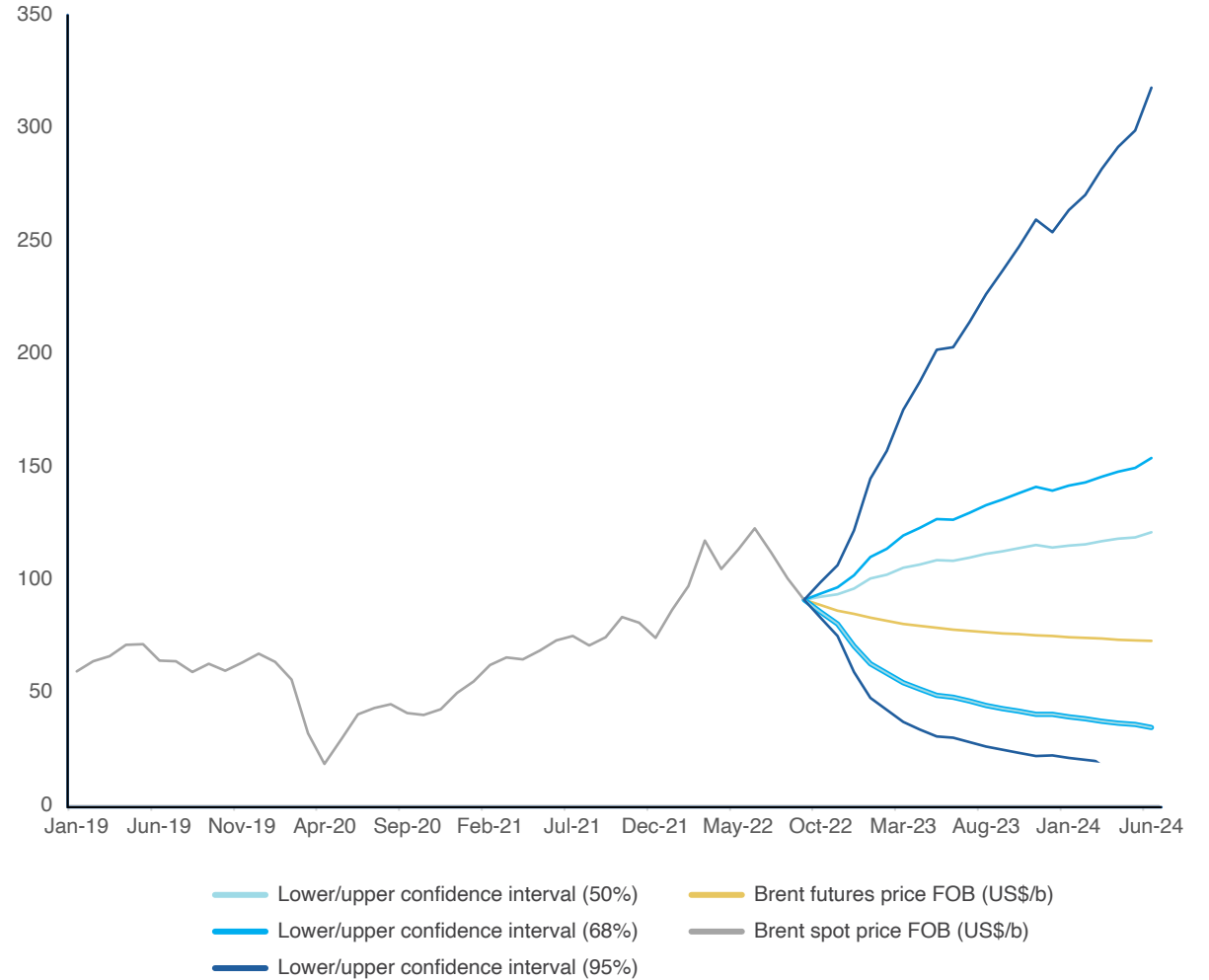
Balances and forward curve



Price Fundamentals (Forward and Future Curves)

The graph opposite depicts confidence intervals at the 50%, 68%, and 95% levels derived from options market information for at-the-money options contracts.

Brent crude oil price and 50%, 68%, 95% confidence intervals US\$/b



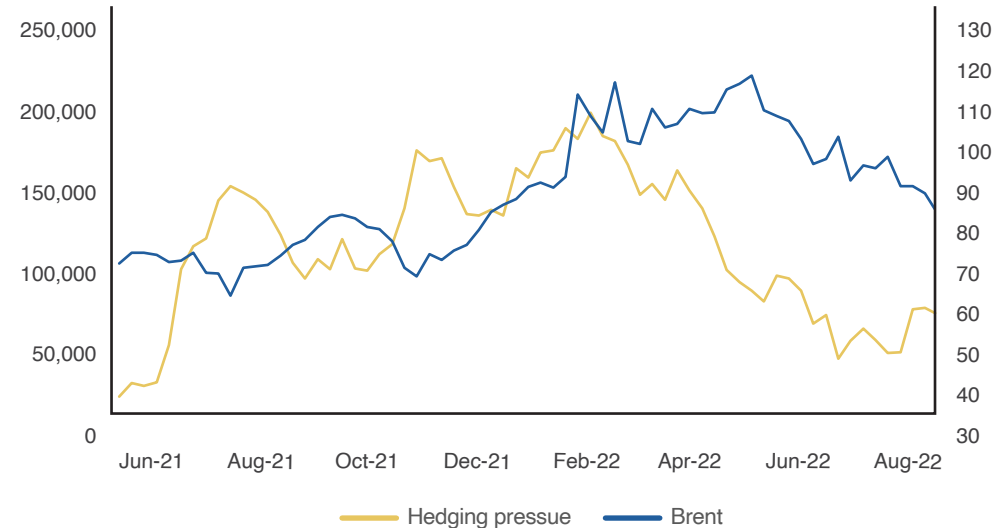
Source: KAPSARC calculations based on NYMEX data, CME Group, FINCAD, October 2022.

Price Fundamentals (Markets)

Hedging pressure (HP): The graph opposite shows the settlement price for Brent against hedging pressure. Hedging pressure is a measure of physical commercial (producers/merchants/processors/users) net short positions relative to net managed money long positions. It indicates a negative relationship between Brent prices and market hedgers. The falling hedging pressure despite elevated prices in 2022 could either mean that there are a considerable number of long positions or that short positions are in decline. The numbers indicate that both are happening simultaneously, which could create high prices. However, what is really significant is that the financial markets are wary of falling market prices and future volatility. In addition, market volatility has driven up the costs of hedging, causing a number of medium and small producers to exit the market, driving oil trading activity down to levels not seen for seven years. Going forward, has the OPEC+ cut addressed these fears?

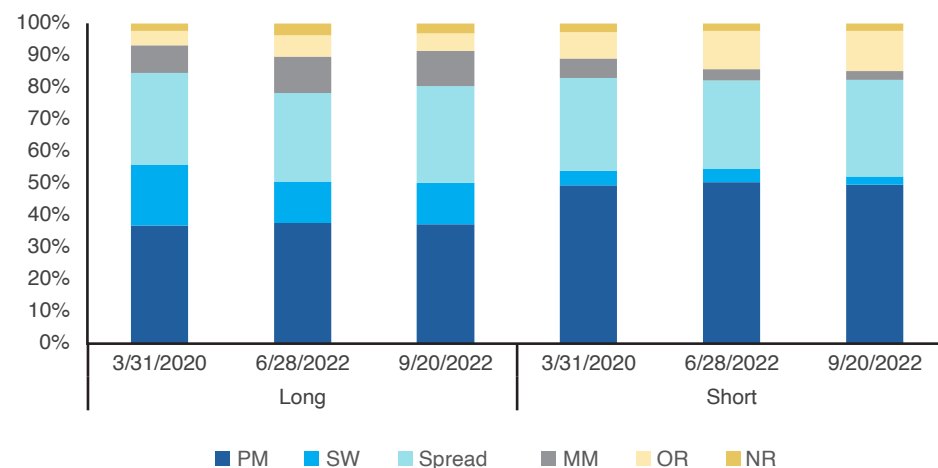
Trader class shares: Despite the continued high prices of oil and other commodities, the overall number of trader positions has been declining. In fact, the daily number of trades between March 31, 2022, and September 20, 2022, has shrunk by roughly 32%. This means they are either exiting the market or finding lucrative opportunities in other commodities. Despite money managers and producers maintaining similar quantities of long trades as in Q2 2022, other reporters and non-reporters have been taking fewer long positions.

Weekly - hedging pressure (L) vs. ICE Brent price (R)



Source: Bloomberg, September 29, 2022.

Traders class shares of longs and shorts



Note: Refer to the glossary for abbreviations.
Source: Bloomberg, September 29, 2022.

Price Fundamentals (Markets)

U.S. Dollar Index: Although the U.S. Dollar Index (DXY) sometimes has a negative relationship with commodity prices, Brent and the DXY have both been trending upward recently. This has partly been fueled by the U.S. Federal Reserve (Fed) raising its interest rates alongside increased oil demand. Indeed, the U.S. economy is improving relatively quickly compared to other parts of the world, despite its declining financial markets. As stated in the summary of this report, inflation has been playing a role in this trend, and it is expected to maintain this role in the coming quarters.



Source: Bloomberg, September 29, 2022.

Editorial: Embedding an Economic Agent in Building Energy Models

Contributed by Walid Matar, KAPSARC

KAPSARC research has explored the idea of embedding households, or more broadly economic agents, in building energy models. This approach internalizes electricity use decisions households make, particularly in response to higher electricity prices. Economic theory states that households maximize their utility, or welfare, subject to their income and other expenditures. Thus, these decisions are made by representing households with a utility function and a monetary budget constraint. The utility problem then interacts with a building energy model that adheres to physical principles. The building energy model calculates the heat flows inside a living space. This framework has been linked with the KAPSARC Energy Model, a partial equilibrium model of the greater energy system.

The framework does not take aggregate price elasticities as inputs. Rather, it outputs the changes in demand for services that use electricity, which can then be translated into implied price elasticities of electricity demand. For example, households make explicit behavioral adjustments or energy efficiency purchase decisions in response to electricity price changes to maximize their welfare. In the framework, those decisions entail a combination of thermostat set-point adjustments, turning off lights, rearranging the appliance loads, and the ability to purchase from a given slate of energy efficiency measures. The latter include improved air conditioner performance, upgrades to the thermal insulation of dwellings, more efficient lighting, and efficient window panels. Using Saudi Arabia as a case study, the following key insights are derived from performing a modeling analysis for archetypical villas:

- By raising the monetary incentives that result in less personal expenditure on energy efficiency, households lessen their energy conservation measures.
- As energy efficiency subsidies and electricity prices rise, the difference in household spending on other goods and services widens between the highest efficiency case and no added efficiency. This indirect rebound effect causes a situation where firms may increase their production to meet the additional demand from households for their goods, which requires more energy.
- Complex physical interactions take place when energy efficiency measures are compounded. As such, those measures deemed sensible at the outset may not be so after another measure is installed first.

Furthermore, the hard linkage of the residential electricity use framework and the bottom-up energy systems model explores the potential effects of time-varying electricity prices on households and the power system simultaneously. This work is not meant to encourage or envisage real-time electricity prices in Saudi Arabia. It primarily investigates their effects on the Saudi energy system. The households' electric power load profiles change during the year due to those behavioral and energy efficiency decisions. The results show that households would exhibit great behavioral adjustment under real-time prices (RTP). The Saudi power system experiences these two benefits in the long run from charging RTP for electricity, in particular:

- RTP reduces the variability of the marginal costs to Saudi power utilities throughout the day.
- The lowered investment in power plants brought upon by introducing RTP would more than cover the costs of residential smart meter replacement.

One area being explored deals with the linkage between the utility-maximization problem and the building energy model. This involves using data of an actual household and testing more flexible utility functional forms. I have tried Cobb-Douglas and Constant Elasticity of Substitution functions in past work. Given the heterogeneity of households, this requires devising many versions of the residential electricity use framework that also differ according to the physical characteristics of the dwelling.

Editorial: Saudi Arabian Refineries and Refineries of the Future

Contributed by Evar Umeozor, KAPSARC

In a study published this year, KAPSARC categorized existing global crude oil refineries into a group of 40 unique refining configurations.³ Each configuration represents the series of processing equipment and operations involved in the conversion of crude blends into product slates. Usually, the choice of a refining configuration is tailored to the available crude feed and the products in high demand within targeted market(s) – in order to maximize profitability, while satisfying all performance and regulatory requirements.

As various jurisdictions announce their net-zero emission targets and timelines, with transportation GHG emissions from fossil fuel vehicles a major focus, the global refinery landscape is starting to witness efforts aimed at further petrochemicals diversification. Following these announcements, current crude oil demand for transportation fuels has been projected to peak within the next decade, and crude oil conversion to petrochemical value chains will start to dominate demand.

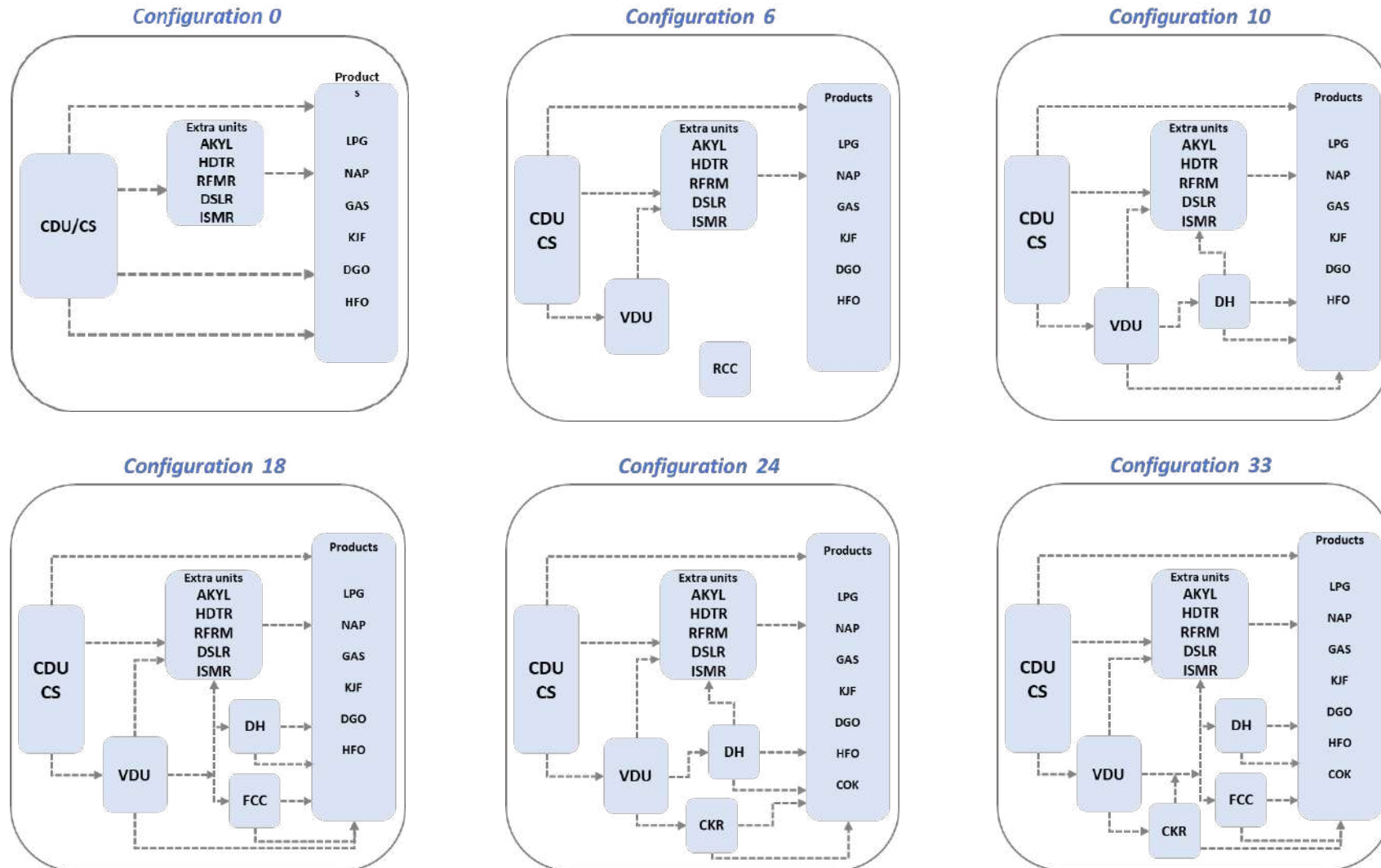
According to the KAPSARC Oil Value-Chain Analyzer (KOVA) model, existing refineries in Saudi Arabia consist of configurations 0, 6, 10, 18, 24 and 33, accounting for a total crude oil processing capacity of about 2.92 MMb/d. Figure 1 shows simplified process diagrams of the various configurations of refineries in the Kingdom. Figure 2 shows the evolution of those refineries' capacities between 2005 and 2020. It is observed that there is a growing complexity in the Kingdom's refining landscape, which may be ascribed to the effort to extract more value from each processed crude oil feed. This results in higher yields of fuels and petrochemical feedstocks.

However, it is anticipated that refineries of the future will either optimize their configurations and operations for higher yields of petrochemical feedstocks and light olefins, or adopt emerging transformative processing technologies for the direct conversion of crude to petrochemicals and fine chemicals. For example, adopting process units and operations, such as high severity fluid catalytic cracking (FCC) or high-olefin FCC, can improve propylene yields from about 4% to 20%. Currently, the total global capacity of high olefin FCC is about 283 Kb/d, which is domiciled in China, South Korea and India.

³ Evar Umeozor. 2022. "Global Crude Oil Refinery Configurations." KAPSARC Data Insight.

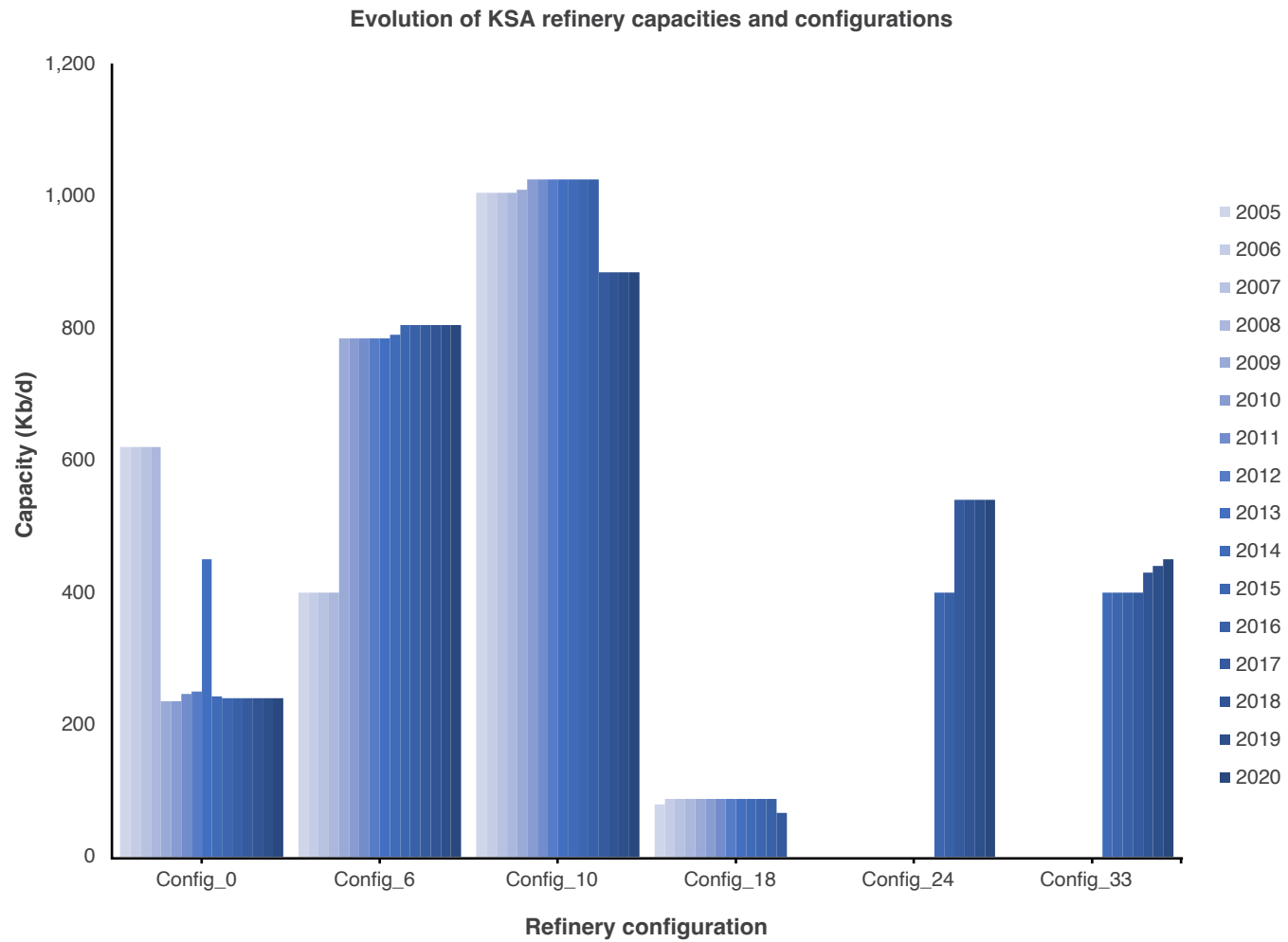
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Figure 1. Illustrative diagrams of Saudi Arabian crude oil refining configurations.



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Figure 2. The evolution of crude oil processing capacities and configurations of refineries in Saudi Arabia.



Source: KAPSARC (KOVA Model).

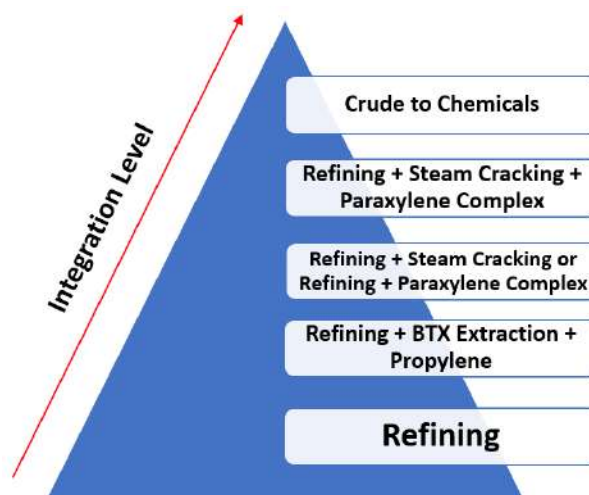
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Global high olefin FCC capacities (Kb/d, based on 2020 data from S&P Global)

Country	Capacity
China	125
South Korea	76
India	80

Ongoing transformations in the industry involve capacity and capability upgrades of process equipment and operations to increase yields of LPG, naphtha, ethylene, propylene, benzene, toluene, and xylenes. Future operations would deploy technologies that are being developed and de-risked now for the direct, one-step conversion of crude oil to basic chemicals such as ethylene, propylene, benzene, toluene, and xylenes. As depicted in Figure 3,⁴ IHS Markit categorized a set of five phases in the evolution of the refining landscape, which include a more complex integration of crude oil refining and petrochemical value chains.

Figure 3. Integration of crude oil refining with petrochemicals production.



Source: Adapted from IHS Market.

⁴ Marcio Wagner da Silva. 2022. "Integrated Refining Schemes - Changing the Focus of the Downstream Industry." LinkedIn Blog article.

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Industry experts project that modifying existing refinery technologies through more complex, integrated operations would increase the yields of chemicals from each barrel of crude from about 10% to 50%. Aramco has set a target of 70%-80% conversion of each barrel of crude oil into chemicals using innovative catalysis and separation processes with low carbon footprints and costs. However, increasing the petrochemical integration level of a refinery requires significant capital investment in additional process equipment and technology licensing acquisitions. Hence, there is a need for optimum capital efficiency through optimal integrated design strategies and operational flexibilities with respect to process technology, crude feed and product slate choices.



Appendix

World oil demand, 2021 - 2024 (MMb/d)

		2021	Q1	Q2	Q3	Q4	2022	Q1	Q2	Q3	Q4	2023	Q1	Q2	Q3	Q4	2024	
Americas	OECD	United States	20.0	20.3	20.2	20.5	20.5	20.4	20.3	20.2	20.5	20.6	20.4	20.4	20.3	20.5	20.5	20.4
		Canada	2.4	2.4	2.3	2.4	2.4	2.4	2.4	2.3	2.5	2.5	2.4	2.5	2.4	2.5	2.5	2.5
		Mexico	1.7	1.8	1.8	1.8	1.9	1.8	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0	2.0
		Chile	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.4
		Total	24.5	24.8	24.7	25.1	25.1	24.9	24.9	24.8	25.3	25.4	25.1	25.1	25.0	25.3	25.3	25.2
	Non-OECD	Argentina	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7
		Brazil	3.0	3.0	3.0	3.1	3.1	3.0	3.0	3.0	3.1	3.1	3.1	3.0	3.1	3.2	3.2	3.1
		Venezuela	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
		RO Latin America	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.4	2.4	2.5	2.6	2.5	2.5
		Total	6.3	6.3	6.5	6.6	6.5	6.5	6.4	6.5	6.7	6.6	6.6	6.5	6.6	6.8	6.7	
Total Americas		30.8	31.1	31.2	31.7	31.6	31.4	31.3	31.4	31.9	32.0	31.7	31.6	31.7	32.1	32.1	31.9	
Europe	OECD	Germany	2.2	2.2	2.2	2.3	2.3	2.2	2.2	2.2	2.3	2.3	2.2	2.3	2.3	2.3	2.3	
		France	1.6	1.7	1.6	1.7	1.7	1.6	1.7	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.6	
		United Kingdom	1.3	1.4	1.4	1.5	1.5	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
		Poland	0.7	0.6	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.8	0.8	
		Turkey	1.0	0.9	1.0	1.1	1.0	0.9	1.1	1.1	1.2	1.1	1.1	1.0	1.0	1.0	0.9	
		RO OECD Europe	6.6	6.5	6.3	6.9	6.9	6.6	6.8	6.5	6.6	6.6	6.9	6.7	6.8	6.9	6.8	
Total OECD Europe		13.3	13.3	13.2	14.1	14.1	13.7	13.8	13.6	14.0	14.1	13.9	13.8	14.2	14.2	14.0		
Asia-Oceania	OECD	Australia	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.2	
		Japan	3.5	3.8	3.1	3.3	3.7	3.5	4.0	3.3	3.3	3.6	3.5	3.8	3.1	3.3	3.6	
		Republic of Korea	2.5	2.7	2.4	2.4	2.7	2.6	2.7	2.5	2.5	2.7	2.6	2.6	2.4	2.4	2.6	
		New Zealand	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.2	
		Total	7.1	7.7	6.8	7.0	7.7	7.3	8.0	7.0	7.1	7.6	7.4	7.7	6.8	7.0	7.6	
	Non-OECD	China	15.0	15.2	14.9	14.9	15.3	15.1	15.4	15.7	15.3	15.4	15.5	15.7	15.9	15.9	16.1	
		India	4.9	5.3	5.4	4.9	5.3	5.2	5.6	5.7	5.0	5.4	5.4	5.7	5.8	5.0		
		Indonesia	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.9	2.0	1.9	1.8		
		RO Asia	6.7	6.9	6.7	6.7	6.7	6.8	7.3	7.1	7.1	7.1	7.1	7.5	7.3	7.3		
		Total	28.3	29.2	28.9	28.4	29.1	28.9	30.2	30.4	29.2	29.8	29.9	30.9	30.8	30.1		
Total Asia		35.4	36.9	35.7	35.3	36.8	36.2	38.1	37.4	36.3	37.4	37.3	38.6	37.7	37.1			
Middle East	OECD	Israel	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
		Bahrain	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
	Non-OECD	Iraq*	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9		
		Kuwait	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.5			
		Oman	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
		Saudi Arabia	3.6	3.2	3.9	4.3	3.6	3.8	3.2	4.0	4.4	3.6	3.8	3.2	4.0			
		Qatar	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.3			
		UAE	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1			
		Total GCC	6.1	5.8	6.6	7.2	6.3	6.5	5.9	6.8	7.3	6.4	6.6	6.0	6.9			
		Iran	1.8	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	2.0	2.0			
RO Middle East	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.5					
Total	8.3	8.1	8.9	9.5	8.6	8.8	8.2	9.1	9.7	8.7	8.9	8.4	9.3					
Total Middle East		8.6	8.3	9.2	9.7	8.8	9.0	8.5	9.4	9.9	9.0	9.2	8.6					
Africa	Non-OECD	Egypt	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7				
		South Africa	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6				
		Other Africa	2.7	2.8	2.8	2.6	2.8	2.7	2.9	2.9	2.7	2.9	2.8	3.1				
	Total Africa		4.0	4.1	4.1	3.9	4.1	4.1	4.3	4.2	3.9	4.2	4.2	4.4				
Eurasia	Non-OECD	Russia	3.7	3.7	3.4	3.6	3.6	3.6	3.4	3.4	3.7	3.7	3.6	3.4				
		RO Eurasia	2.0	1.8	2.0	2.2	2.1	2.0	1.9	2.0	2.2	2.1	1.9	2.0				
	Total Eurasia		5.7	5.5	5.4	5.8	5.6	5.6	5.3	5.5	6.0	5.8	5.6	5.3				
Global Demand		97.7	99.3	98.7	100.5	101.0	99.9	101.2	101.5	102.0	102.5	101.8	102.3					

World oil supply, 2022 - 2024 (MMb/d)

	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Africa	7.47	7.13	7.17	7.28	7.39	7.47	7.52	7.54	7.52	7.48	7.43	7.36
Americas	33.61	34.72	35.74	35.84	35.88	36.59	37.18	37.35	37.46	37.99	38.18	37.97
Asia	9.17	9.21	9.24	9.12	9.23	9.29	9.32	9.31	9.29	9.26	9.22	9.19
Eurasia	14.40	13.43	13.58	13.27	13.08	12.98	12.92	12.93	12.97	13.02	13.07	13.13
Europe	4.01	3.74	4.03	4.16	4.31	4.43	4.49	4.52	4.52	4.54	4.56	4.61
Middle East	29.60	30.06	30.75	30.44	30.56	30.94	31.10	31.40	31.53	31.64	31.76	31.83
Total	98.27	98.29	100.50	100.10	100.45	101.69	102.54	103.06	103.29	103.92	104.22	104.09
	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Conventional	71.02	70.24	71.58	71.01	71.07	71.39	71.50	71.68	71.60	71.49	71.40	71.33
Extra heavy oil	3.37	3.39	3.40	3.50	3.62	3.68	3.71	3.72	3.71	3.70	3.69	3.69
Oil sands	3.16	3.07	3.16	3.20	3.14	3.15	3.15	3.16	3.17	3.18	3.19	3.20
Oil shale (kerogen)	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07
Other liquids	6.57	6.98	7.25	7.07	6.99	7.45	7.67	7.48	7.34	7.76	7.96	7.74
Tight oil	11.52	11.87	12.28	12.39	12.56	12.78	13.08	13.39	13.68	13.90	14.05	14.15
Unconventional gas	2.58	2.68	2.77	2.88	3.02	3.18	3.37	3.57	3.73	3.83	3.86	3.91
Total	98.27	98.29	100.50	100.10	100.45	101.69	102.54	103.06	103.29			104.09
	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Algeria	0.97	1.00	1.02	1.02	1.02	1.03	1.04	1.05	1.05	1.05	1.05	1.04
Angola	1.15	1.19	1.15	1.19	1.19	1.18	1.16	1.13	1.08	1.04	1.00	0.96
Congo	0.27	0.29	0.28	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.23	0.23
Equatorial Guinea	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.05
Gabon	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.17	0.17	0.17	0.16	0.16
Iran	2.55	2.53	2.50	2.50	2.53	2.66	2.65	2.78	2.75	2.85	2.94	3.00
Iraq	4.30	4.42	4.53	4.52	4.52	4.54	4.56	4.58	4.60	4.60	4.60	4.60
Kuwait	2.61	2.69	2.79	2.68	2.68	2.74	2.76	2.78	2.80	2.80	2.80	2.80
Libya	1.06	0.76	0.94	0.99	1.07	1.14	1.19	1.23	1.26	1.28	1.29	1.31
Nigeria	1.27	1.11	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Saudi Arabia	9.93	10.15	10.58	10.46	10.46	10.54	10.62	10.70	10.77	10.77	10.77	10.77
UAE	2.94	3.04	3.10	2.95	2.95	2.97	3.00	3.02	3.04	3.04	3.04	3.04
Venezuela	0.70	0.72	0.67	0.77	0.83	0.86	0.87	0.86	0.85	0.85	0.85	0.85
Oil field production	28.03	28.18	28.87	28.62	28.79	29.18	29.36	29.63	29.70	29.76	29.82	29.82
Other production	5.21	5.10	5.13	5.24	5.33	5.38	5.41	5.42	5.43	5.43	5.42	5.43
OPEC	33.24	33.28	34.00	33.86	34.12	34.57	34.77	35.06	35.13	35.18	35.24	35.24
	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Call on OPEC	34.27	33.74	34.01	34.78	34.90	34.34	34.26	34.45	34.15	34.10	34.46	34.75
OPEC	33.24	33.28	34.00	33.86	34.12	34.57	34.77	35.06	35.13	35.18	35.24	35.24
OPEC Partner	16.24	15.28	15.48	15.16	14.97	14.87	14.81	14.81	14.84	14.86	14.90	14.93
Non-OPEC	48.78	49.72	51.02	51.08	51.35	52.25	52.96	53.19	53.33	53.88	54.08	53.92
Total	98.27	98.29	100.50	100.10	100.45	101.69	102.54	103.06	103.29	103.92	104.22	104.09

Glossary

MMb/d	Million barrels of oil per day
Kb/d	Thousand barrels of oil per day
Target inventories	A theoretical construct reflecting the aggregated 'normal' level of inventories desired by the oil industry to meet contractual obligations, provide a cushion for the complex supply chain that tends to deliver the product in batches, and buffer unanticipated changes in the supply of and demand for crude oil. It is derived from OECD inventory data using a trend component reflecting long-term economic growth, and a seasonal component reflecting phenomena such as the winter heating season, and summer driving and cooling seasons.
Real inventories	Represents the real inventory levels based on KOMO's forecast of supply/demand and inventory surplus/deficit balances.
Hedging pressure	<p>HP = PMnS – MMnL, where PMnS is producer/merchant/processor/user net short, and MMnL is managed money net long.</p> <p>Note that HP is always positive, meaning that managed money net longs are insufficient to meet all of the desired hedging of the PM traders. Also, a negative relationship between price and HP is expected. This is because as HP increases, there is expected to be downward pressure on price: more shorts seeking counterbalancing longs will put downward pressure on the price. The increased hedging pressure costs the short hedgers more because they have to accept lower prices.</p>
PM	Producers/merchants/processors/users
SW	Swap dealers
MM	Managed money
OR	Other reporters
NR	Non-reporters
OPEC partners	Azerbaijan, Bahrain, Brunei, Kazakhstan, Malaysia, Mexico, Oman, Russia, South Sudan and Sudan

About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia's energy sector and inform global policies through evidence-based advice and applied research.



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KOMO usually uses the IMF’s GDP forecasts. However, due to the timing of this publication, Oxford Economics’ GDP forecast numbers were used, rather than those of the IMF.

Same information as of October 2022 was used in the preparation of this Report.



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