

# Global Energy Paper

## Medium-term oil outlook

### Oil markets: balanced in the midst of a geopolitical storm

Robust US shale supply growth, warm winter weather, more renewables, and fast interest rate hikes have forced OPEC+ to pare back oil production for 18 months now to firm up crude markets, even as geopolitics have turned more complex. What does this mean for oil prices? While OPEC+ has shown it can set a floor of \$70/bbl, two factors could also help cap oil below \$100/bbl: an increase in spare production capacity to ~5mn b/d (as a result of volume cuts) and substantial non-OPEC+ supply growth over the next few years. This means oil prices should stay anchored near-term, likely allowing for some monetary policy easing in 2H24 and 2025. Thus, we reiterate our forecast that Brent will average \$80/bbl or so this year and next, down from \$82/bbl in 2023 & \$99/bbl in 2022.

### We see Brent crude prices averaging \$60-80/bbl into 2029

Over the medium term, the picture does not change substantially. As we projected in 2021 and 2022, we continue to expect Brent prices to average \$60 to \$80/bbl through 2029 so oil markets can stay balanced, up from the \$50-70/bbl range we forecast during the 2016 to 2021 period. As a reference point, prompt and 5y forward Brent prices have averaged ~\$72 and ~\$62/bbl, respectively, in the past five years. What fundamental assumptions back our price view? Following a big jump of 2.3mn b/d in 2023 that could mark “peak oil demand growth”, we see consumption up 1.3mn b/d in 2024. Thereafter, demand for oil should embark on a slower growth path into 2025 on structural energy transition changes to various sectors, averaging 700k b/d in 2026-29 in our projections.

### Falling oil demand growth meets steady supply growth

Against a slowing global oil demand backdrop, annual non-OPEC supply growth should average 700k b/d in 2024-29, versus our expectation of 860k b/d in 2023-28 last year, and a historical average of 900k b/d in 2017-22. Oil balances imply that OPEC spare capacity should average ~5mn b/d through 2029, up from ~3mn b/d average in the past 20 years. Thus, while OPEC+ will likely try to force oil prices above \$90/bbl, a big price spike seems unlikely barring large supply disruptions. Similarly, prices could eventually come off below \$70/bbl through the cycle if a US or global recession occurs over the 6-year forecast period. How do we think about the key up and downside risks to our view?

### Dramatic oil prices moves are still possible, but unlikely

Looking at global oil inventories, OECD government stocks remain near the lowest levels in decades, while commercial stocks are 130mn barrels below pre-Covid levels. Refilling strategic reserves could support oil prices in the next five years, but low government stocks reduce the buffer against upside price risks, which include (1) sticky inflation that lifts oil production costs, (2) robust OPEC+ cohesion, and (3) a major slowdown in EV sales. In contrast, key downside risks to our view include: (1) an extended period of structural weakness in global economic growth, (2) unforeseen improvements in US shale productivity, and (3) a faster-than-expected move away from thermal fuels.

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Acronyms on page 59

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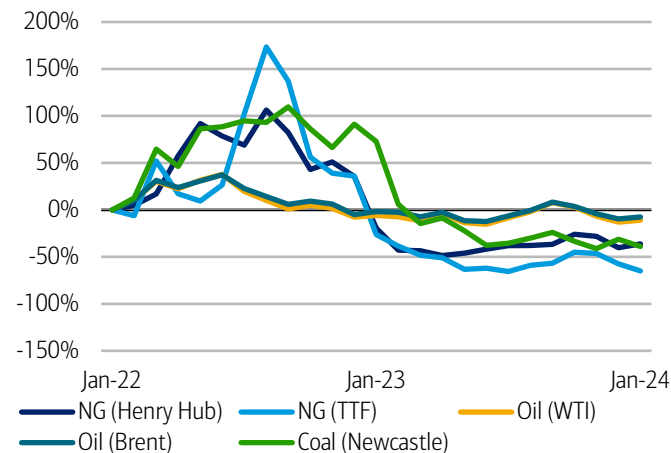
# Medium-term macro outlook for oil

## Energy prices have fallen relative to 3Q23 highs...

From oil, to gas, to coal, global energy prices have been on a downward trend for almost two years now (Exhibit 1). Brent oil fell from a high of \$139/bbl in 2022 to a low of \$70/bbl last year, while European TTF natural gas collapsed from a high of €340/MWh to a low of €23/MWh in June 2023, and winter prices reached as low as €22.40/MWh last week. Since early December, however, oil prices have bucked the trend observed in other energy markets and recovered, pushing up for about 10 weeks now on the back of OPEC+ cuts and an increasingly complex geopolitical landscape (Exhibit 2).

### Exhibit 1: Global energy prices indexed to January 2022

From oil, to gas, to coal, global energy prices have been on a downward trend for almost two years now...

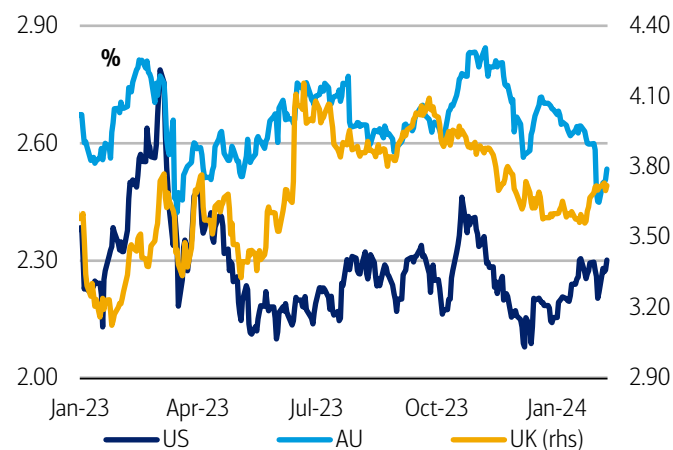


Source: Bloomberg

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### Exhibit 2: 5y5y inflation swaps

...contributing to bring headline inflation lower in the US and around the world



Source: Bloomberg

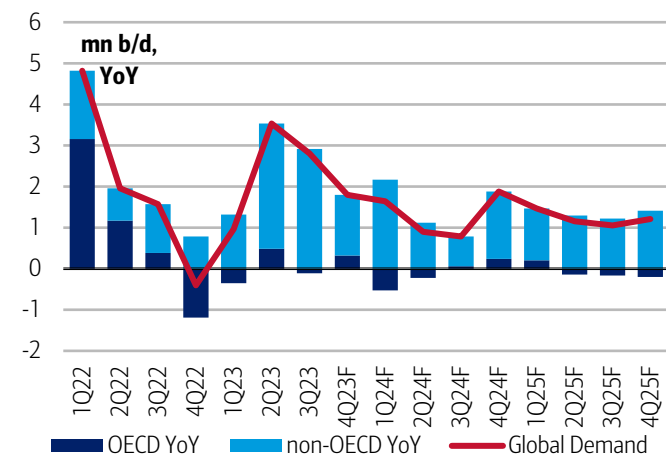
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## ...as slowing demand and a positive supply shock...

Of course, much of the decline in energy prices observed during the past two years since the start of the Russian invasion of Ukraine can be linked to fundamental market developments. For instance, global oil demand growth has been naturally slowing down in recent months after expanding at a breakneck pace during the three-year post Covid recovery period (Exhibit 3). Meanwhile, non-OPEC supply growth has remained very robust for some time too with US shale volumes on the lead, helping push oil prices lower (Exhibit 6).

**Exhibit 3: Global oil demand growth**

Global oil demand growth has been slowing down in recent months after a wild three-year post-Covid recovery

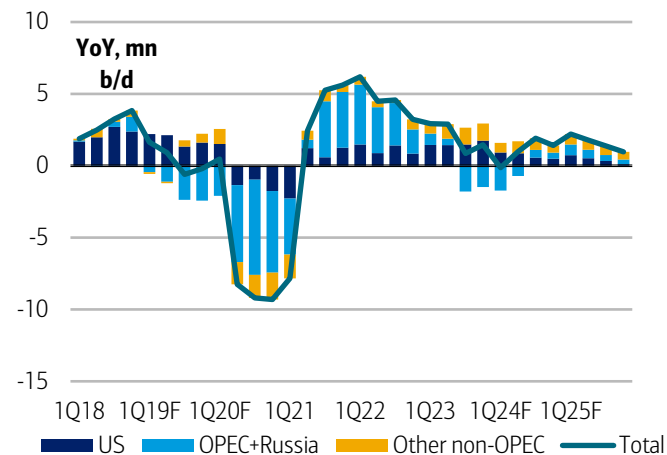


Source: IEA, BofA Global Research Estimates

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**Exhibit 4: Global oil supply growth**

Meanwhile, non-OPEC supply growth has remained very robust for some time, pushing prices lower



Source: IEA, BofA Global Research Estimates

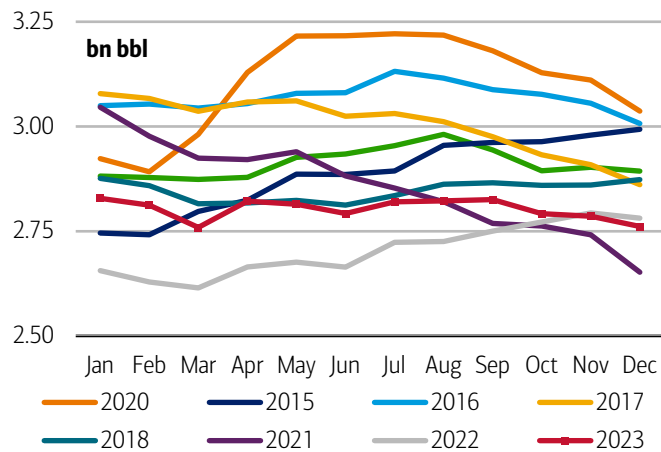
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**...have joined forces to push up commercial stocks...**

In any case, the fundamental drivers of energy markets have been closely reflected in the inventory cycle observed in the past few quarters. A key point to note is that commercial inventories across the OECD have recovered from the lows observed during March 2022 in part due to these opposing trends (Exhibit 5), although total petroleum stocks remain exceptionally low due to the big draws in strategic oil reserves (Exhibit 6). The divergence between strategic and commercial stocks remains a contentious issue for the market.

**Exhibit 5: Industrial OECD oil inventories**

Commercial inventories across the OECD have recovered in part due to these opposing trends...

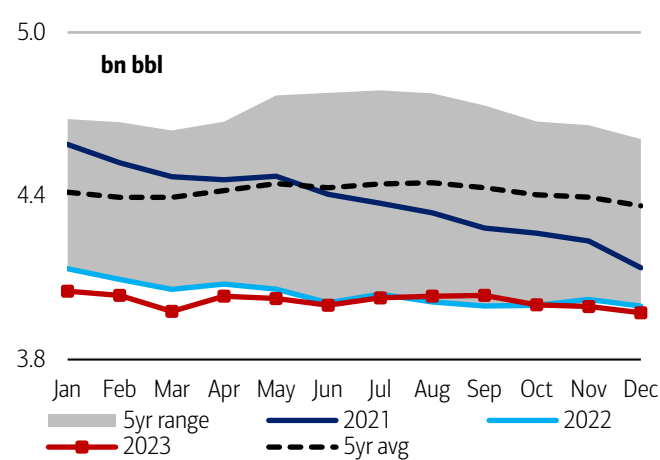


Source: IEA

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**Exhibit 6: Total OECD oil inventories**

...although total petroleum stocks remain exceptionally low due to the big draws in strategic oil reserves



Source: IEA

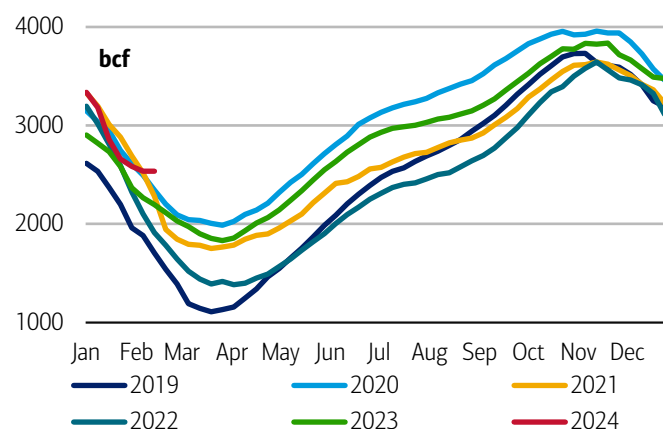
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**...for both oil as well as US and European natural gas**

Should the US government continue to fill strategic stocks when oil prices are in the low \$70s range, as it has been doing, oil prices should struggle to break much lower. Even then, this is not true for other thermal fuels that lack government support. Beyond oil, we would note that inventories of other key fuels, such as US natural gas (Exhibit 7) or European natural gas, remain high as a result of a weak winter heating demand backdrop (Exhibit 8). Warm weather has also negatively impacted oil, but not as much.

**Exhibit 7: US natural gas working storage**

Beyond oil, it is worth noting that inventories of other key fuels, such as US natural gas...

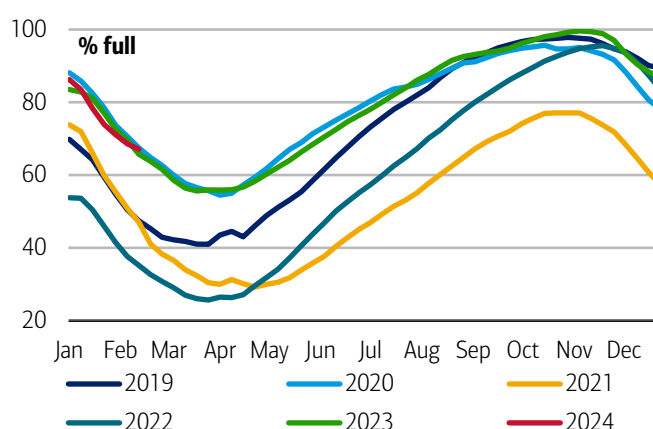


Source: Bloomberg

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**Exhibit 8: Europe gas storage**

...or European natural gas, remain high as a result of a weak winter heating demand backdrop



Source: Bloomberg

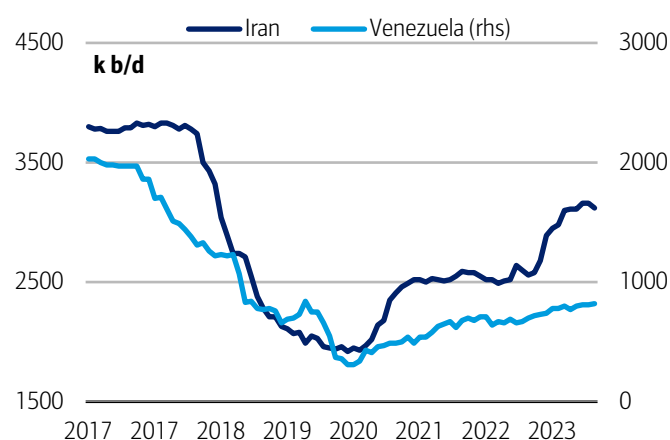
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**Key policy measures by the Biden Administration...**

Beyond the vagaries of fundamental economic and weather drivers for oil prices, we note the very active involvement of the Biden administration in trying to cap (and perhaps even floor) global energy prices to ensure a smooth landing for inflation and the US economy. Importantly, rising production in Venezuela and Iran (Exhibit 9) have added oil volumes that the market was not expecting. Similarly, despite sanctions on Russian oil exports, levels have remained broadly stable (Exhibit 10).

**Exhibit 9: Crude oil production in Iran and Venezuela**

Venezuela and Iran have added oil volumes that the market was not expecting



Source: Bloomberg

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**Exhibit 10: Russian waterborne crude oil exports**

Despite sanctions on Russian oil exports, levels have remained broadly stable



Source: Bloomberg

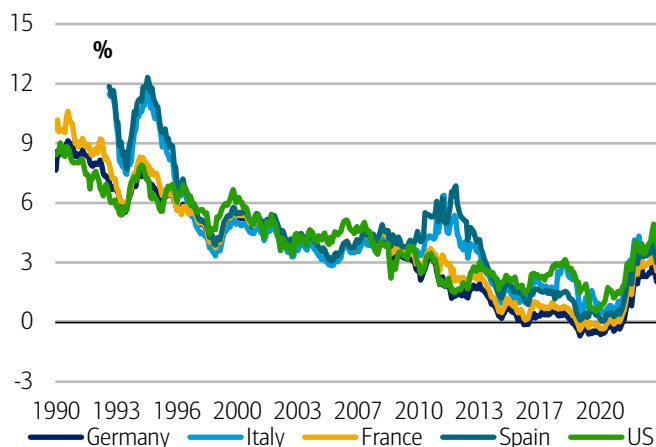
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**...and steep interest rate hikes by the Fed and ECB...**

A macro factor that has also significantly affected oil demand conditions has been the substantial tightening of monetary policy around the world. Sharp increases in interest rates in the US and Europe have likely acted to tame oil demand (Exhibit 11), materially slowing down economic activity. While the inversion of the US yield curve could potentially result in a recession ahead (Exhibit 12), this worst-case scenario for oil demand over the course of the next 18 months is no longer a central scenario for markets.

**Exhibit 11: 10-year government bond yields**

Sharp increases in interest rates in the US and Europe have likely acted to tame oil demand...

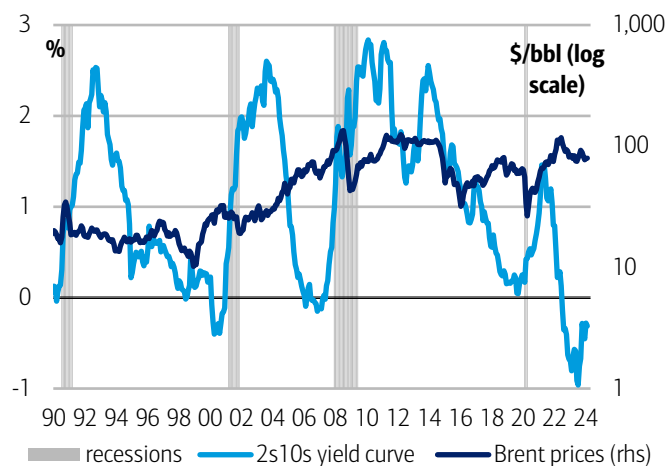


Source: Bloomberg

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**Exhibit 12: Brent prices and 2s10s US Treasury yield curve**

...while the inversion of the US yield curve could potentially result in a recession ahead



Source: Bloomberg

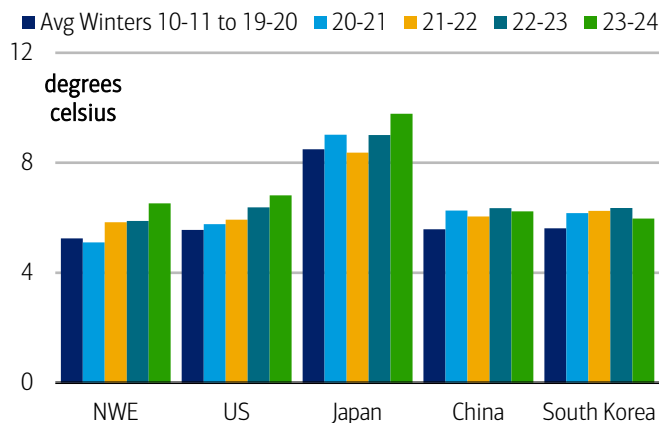
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**...coupled with warm weather and more renewables...**

We highlighted the weather as a key factor negatively impacting oil prices this winter. Of course, warm winter weather reduces demand for petroleum products such as diesel and heating oil (Exhibit 13), as well as propane, which has likely pushed demand lower relative to expectations. Meanwhile, a big ramp up in renewable and nuclear power generation is reducing the use of thermal fuels (Exhibit 14) across the board too.

**Exhibit 13: Winter to date average temperature by country or region**

Importantly, warm winter weather has reduced demand for petroleum products so far this year...

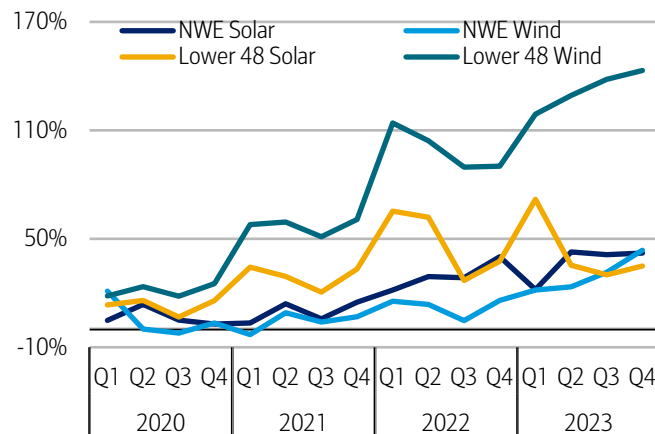


Source: Bloomberg

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**Exhibit 14: Quarterly NWE and Lower 48 wind and solar generation indexed to respective 2019 quarters**

...while a big ramp up in renewable and nuclear power generation is reducing the use of thermal power



Source: Bloomberg

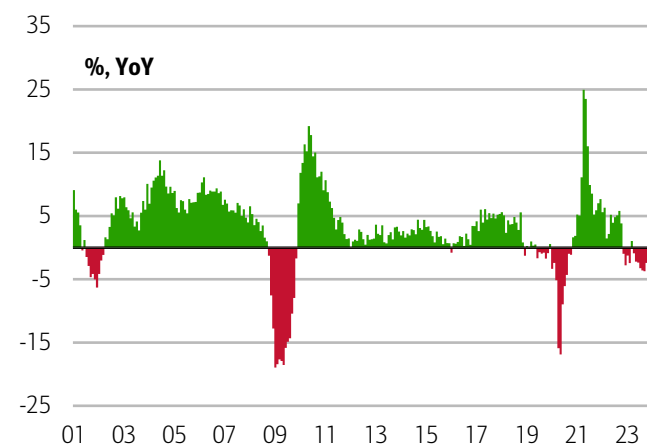
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**...have forced OPEC+ to cut oil production, in turn...**

Softer weather demand trends, coupled with the ongoing major contraction in global trade activity (Exhibit 15) and a major softening in industrial production trends have put the oil market's swing suppliers on the defensive. Specifically, the surplus that has emerged on the back of weaker supply/demand balances pushed OPEC+ to start cutting production 18 months ago, a trend that continued in January (Exhibit 16) with Saudi Arabia convincing other members to pare back output volumes.

**Exhibit 15: Global trade growth**

Softer weather demand trends, coupled with the ongoing major contraction in global trade activity...



Source: Bloomberg

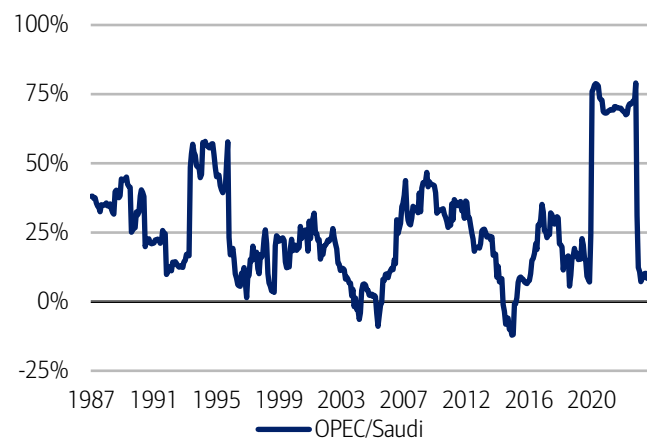
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**...leading to an increase in spare production capacity**

OPEC+ production cuts can generally help stabilize downside risks to oil prices when the market is in surplus. However, the timing, scale, scope, and depth of those cuts matters tremendously to any future price outcome. With Saudi opting to conduct voluntary production cuts, OPEC+ has acted in a less coordinated manner than during the two years following Covid (Exhibit 17). So, OPEC+ cohesion has fallen. Still, we note that a key development here is the big increase in spare production capacity in the group (Exhibit 18).

**Exhibit 17: OPEC cohesion (correlation between Saudi supply changes and other OPEC supply changes)**

While OPEC+ has acted in a less coordinated manner than during the two years following Covid...



Source: IEA, BofA Global Research estimates

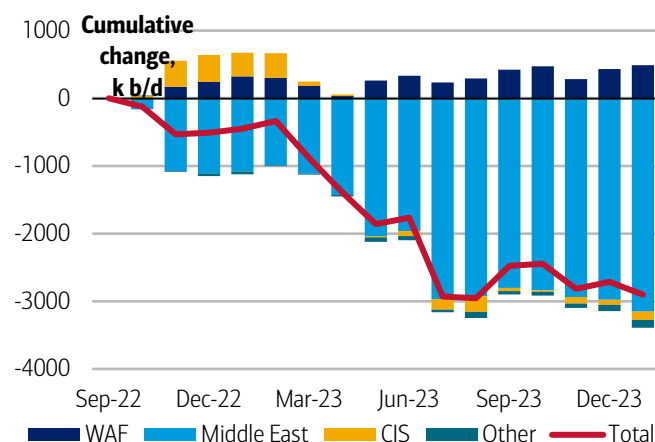
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**A strong dollar may have capped upside pressure too**

The relationship between the US dollar and oil prices has broken down compared to history (Exhibit 19) mostly as a result of the reduction in US foreign fuel dependency. Back in 2008, at the height of the spike in WTI crude oil prices to \$145/bbl and total US crude oil imports hitting 11mn b/d, the DXY touched a low point of 71 and the EURUSD touched 1.60. Yet the correlation between oil prices and the US currency have broken down since thanks to shale, although relatively high petroleum fuel prices in local currencies have likely dented demand at the margin (Exhibit 20).

**Exhibit 16: Cumulative change in OPEC+ production**

...have pushed OPEC+ to cut production for several months now, a trend that continued in January

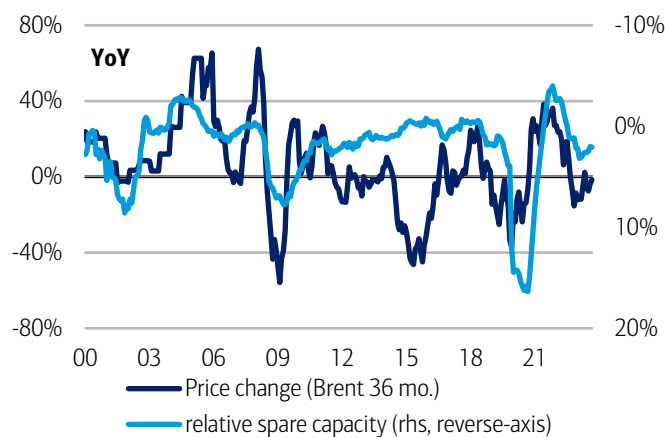


Source: IEA, OPEC, BofA Global Research

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**Exhibit 18: Relative spare capacity (normalized) and price changes**

...we note that the result has nevertheless been a big increase in spare production capacity in the group

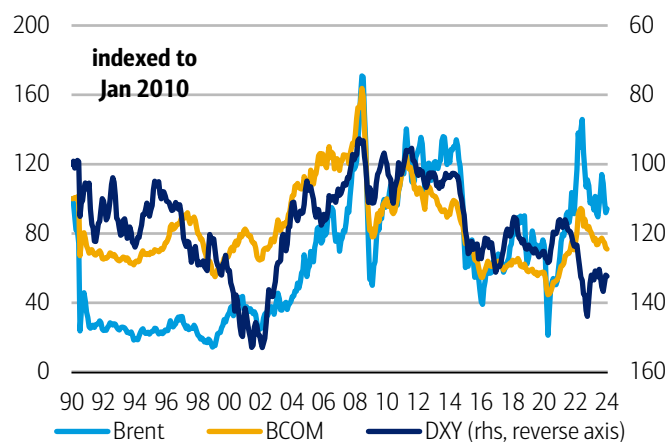


Source: EIA, Bloomberg, BofA Global Research

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**Exhibit 19: BCOM, DXY and Brent crude oil prices**

The relationship between the US dollar and oil prices has broken down compared to history...

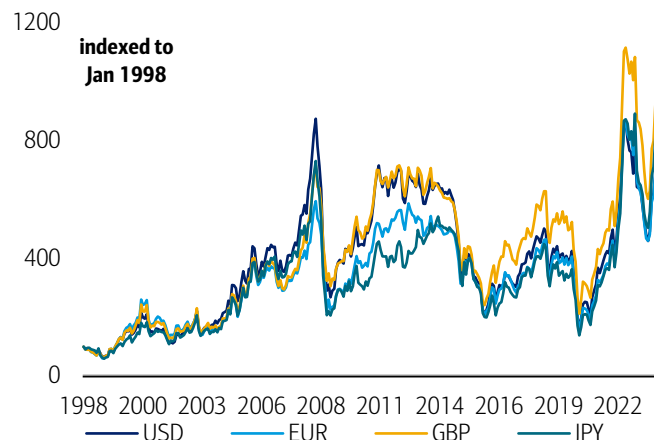


Source: Bloomberg

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**Exhibit 20: Front-month gasoil futures price in local currency indexed to January 1998**

...but relatively high petroleum fuel prices in local currencies have likely dented demand at the margin



Source: Bloomberg, BofA Global Research

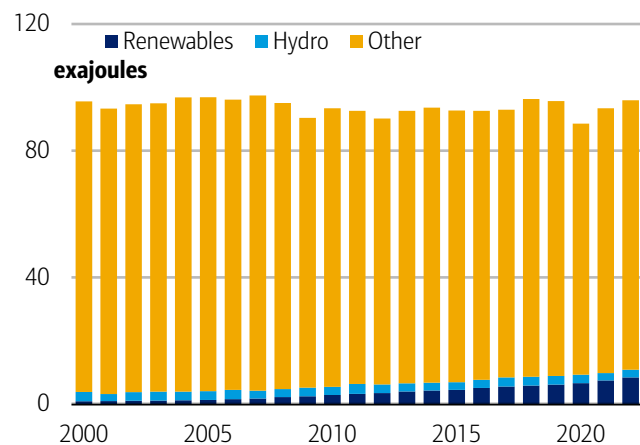
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**Energy imbalances globally are also deflationary...**

There are at least two reasons in our view behind this major macro dislocation. First, the shale revolution has led to a net oil and natural gas production increase in the US of 18mn boe/d since 2008. Second, a more recent push into renewables has started to exacerbate the growing domestic fuel glut in the US (Exhibit 21). Both factors, with production at the helm, have turned America into a net energy exporter while China's energy imports have kept on expanding (Exhibit 22) due to rising domestic production costs.

**Exhibit 21: Primary energy consumption in US by fuel**

The shale revolution and a big push into renewables has led to a domestic fuel glut in the US...

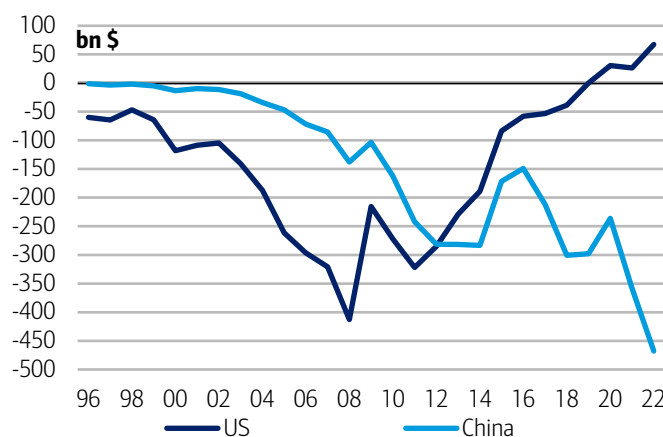


Source: Energy Institute

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**Exhibit 22: Energy trade balance**

...turning America into a net energy exporter while China's energy imports keep expanding



Source: CEIC, BofA Global Research

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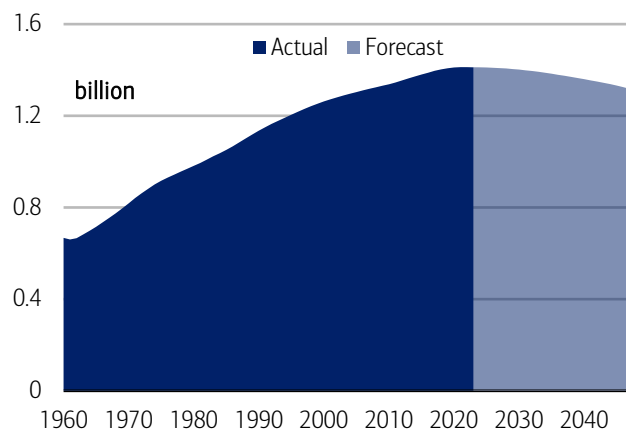
**...especially in the context of a weak China economy**

Even then, the dramatic demographic contraction that China is starting to face (Exhibit 23) could further expand the major deflationary force of shale and renewables in global energy markets, in our view (Exhibit 24). After all, a contracting work force and a declining population trend will likely need less thermal inputs going forward as energy efficiencies and improving non-thermal technology should reduce future demand for fuels. This negative demographic force will likely become a major factor in energy markets over the next 10 years.



**Exhibit 23: Population of China**

Even then, the dramatic demographic contraction that China is starting to face...



Source: World Bank

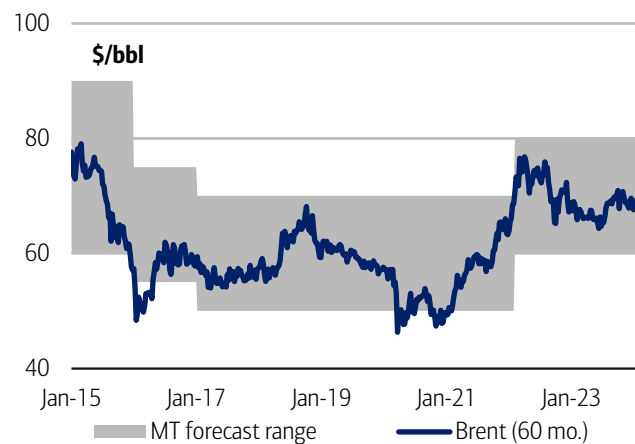
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**However, long dated oil remains anchored at \$70...**

So, what does a slowing US shale production profile set against shrinking demographics in China mean for oil prices? The market seems to assume one will offset the other, perhaps rightly so. Despite the \$70 to \$139 range in prompt oil prices during the past two years, we note that long dated oil remains anchored (Exhibit 25) at around \$70/bbl, at the center of our published 2023 oil price band of \$60-\$80/bbl. Still, fading demographics may not have kicked in yet, as an emerging credit impulse in China points to continued car sales growth, with ICE engines making a modest comeback (Exhibit 26).

**Exhibit 25: Long dated Brent prices**

Despite the \$70 to \$139 range in prompt oil prices during the past two years, we note that long dated oil remains anchored

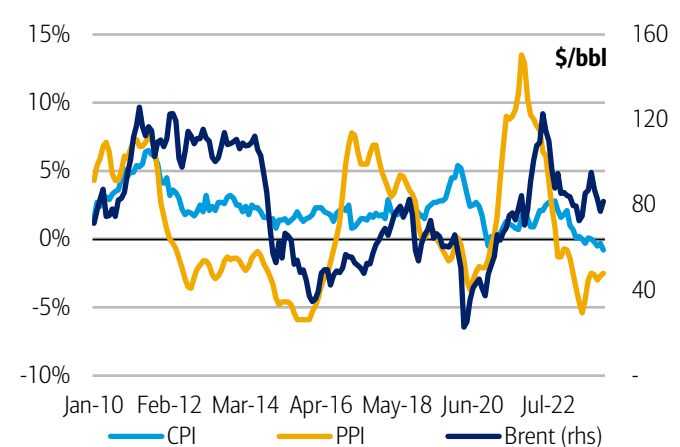


Source: Bloomberg, BofA Global Research

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**Exhibit 24: CPI and PPI in China versus Brent**

...could also turn into a major deflationary force in global energy markets, in our view

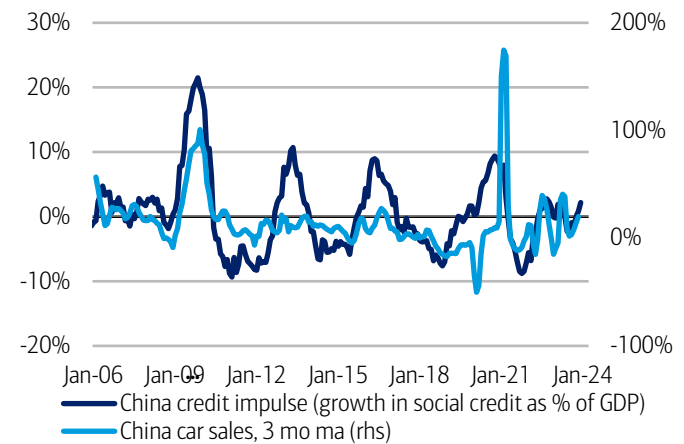


Source: Bloomberg

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**Exhibit 26: China credit impulse and car sales growth**

An emerging credit impulse in China points to continued car sales growth, with ICE engines making a modest comeback



Source: Bloomberg

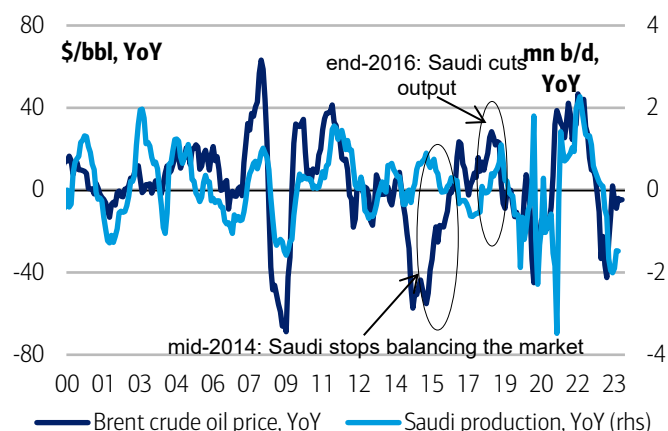
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**...resulting in much flatter global crude oil curves**

Beyond these long-term trends, it is worth noting that Saudi Arabia (and OPEC+) has typically always acted countercyclically to support oil prices with crude production cuts (Exhibit 27), losing market share in the process. Since 2020, OPEC+ (excluding Angola) market share has declined from 43% to 36% in December. Still, Saudi cuts have ultimately allowed for a significant recovery in both Brent and WTI timespreads in recent weeks (Exhibit 28), a supportive factor for markets.

**Exhibit 27: Brent crude oil price and Saudi production changes**

Saudi Arabia (and OPEC+) has typically always acted countercyclically to support oil prices with crude production cuts...



Source: Bloomberg, IEA, OPEC, BofA Global Research

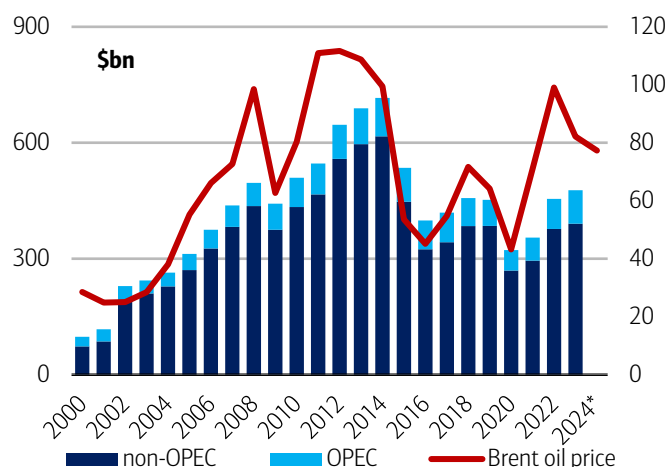
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**As such, global capex trends haven't changed much...**

Another balancing item that has helped prevent a major move in long dated prices is the stabilization of oil and gas capex across the industry. Global oil and gas capex has picked up from the lows of roughly \$320 bn in 2020 and now sits at approximately \$500bn per annum (Exhibit 29), a level sufficient to keep non-OPEC+ volumes on a positive growth trajectory. As such, the global rig count has picked up markedly in recent quarters, but it is still well below the 2019 highs (Exhibit 30).

**Exhibit 29: Global oil and gas capex (nominal)**

Global oil and gas capex has picked up from the lows and now sits at around \$500bn p.a.

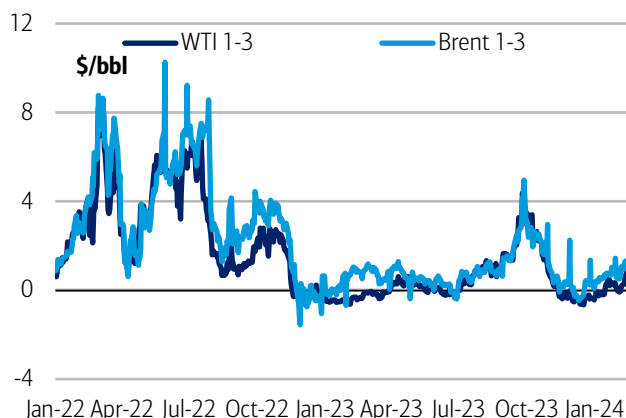


Source: Woodmac

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**Exhibit 28: Brent and WTI 1-3 month timespreads**

...ultimately allowing for a significant recovery in both Brent and WTI timespreads in recent weeks

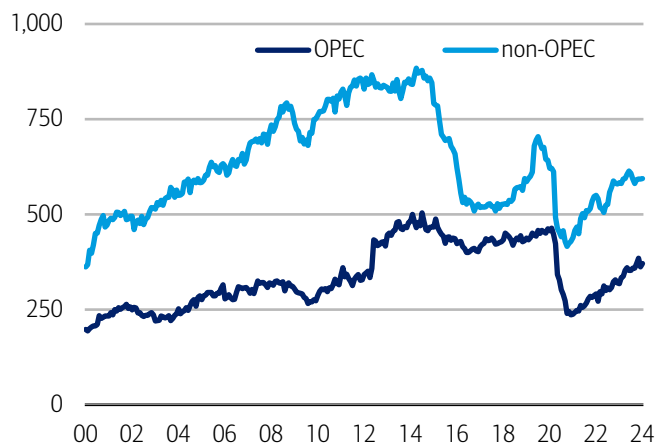


Source: Bloomberg

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**Exhibit 30: Global rig count (excluding NAM)**

The global rig count has picked up markedly in recent quarters, but it is still well below the 2019 highs



Source: Bloomberg

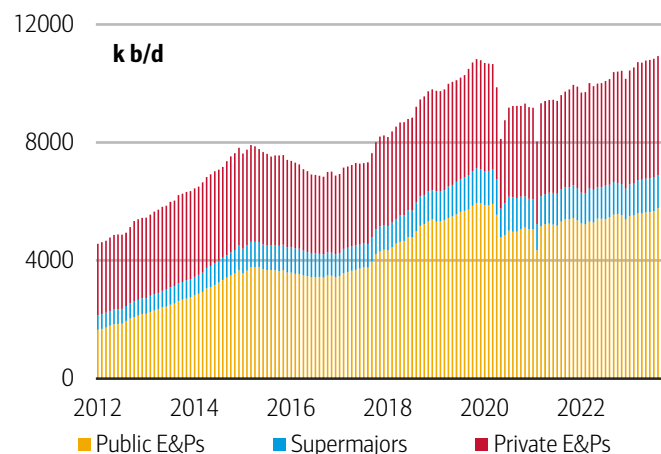
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**...although a wave of US mergers should enhance...**

Even then, we see the recovery in exploration and production capex coming to an end. In part, it is worth noting that much of the growth in US shale oil supply in recent years has been driven by private firms (Exhibit 31), but a frantic wave of mergers has led to a meaningful consolidation of suppliers in recent quarters (Exhibit 32). As a result, we expect capital discipline to kick in and limit volume growth going forward, with less money going into the ground and more profits flowing to shareholders instead.

**Exhibit 31: US onshore crude oil production**

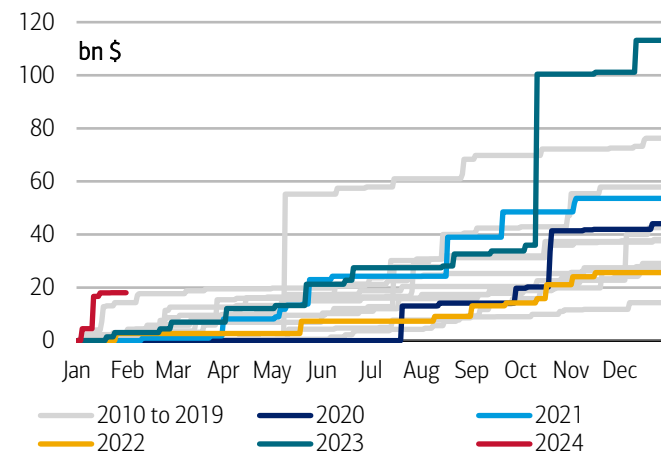
Much of the growth in US shale oil supply in recent years has been driven by private firms...



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**Exhibit 32: US upstream M&A total consideration by year**

...but a frantic wave of mergers has led to a meaningful consolidation of suppliers in recent quarters



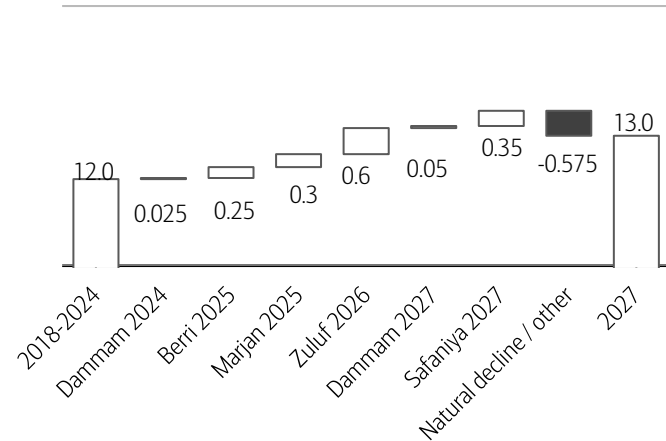
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**...capital discipline, with even Aramco joining the cuts**

Beyond the likely improvement in capital discipline across established western oil producers, it is important to note as well that Aramco announced a meaningful cut to its investment program that will impact production capacity in 2027 (Exhibit 33). Interestingly, capital discipline has occurred against the backdrop of relatively tight sovereign and corporate credit market conditions (Exhibit 34), suggesting that these reductions in spending are driven by shareholder rather than bondholder pressures and are thus more sustainable.

**Exhibit 33: Aramco old MSC delivery plan decomposed (mn b/d)**

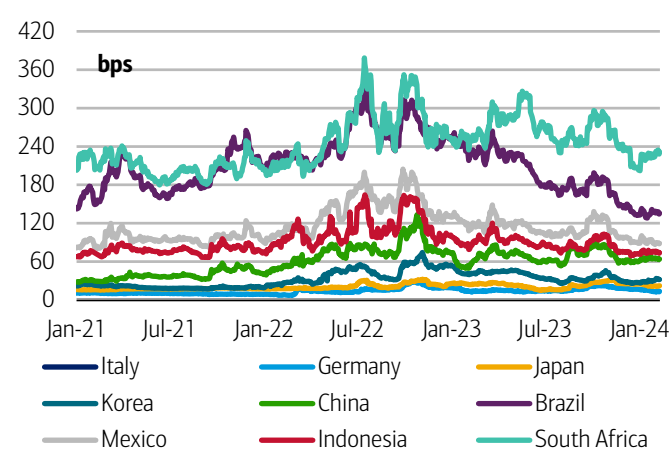
Aramco has announced a meaningful cut to its investment program that will impact production in 2027



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**Exhibit 34: Global sovereign CDS 5Y spreads**

Interestingly, capital discipline has occurred against the backdrop of relatively tight sovereign and corporate credit market conditions



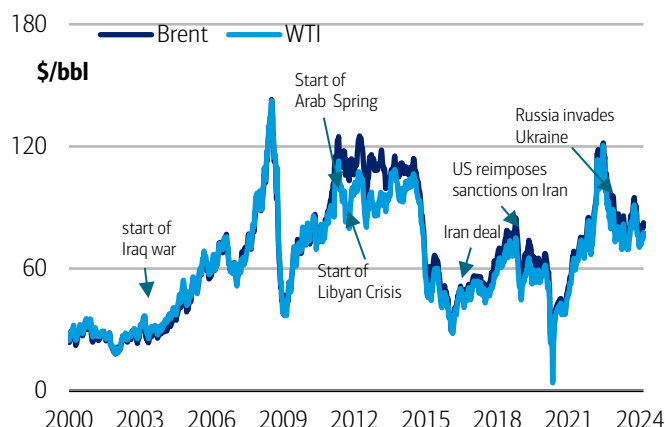
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**Geopolitics remain a major risk to oil prices as...**

Having said all this, we note that oil prices remain at the mercy of geopolitical developments around the world. We have noted repeatedly that geopolitical events have sometimes led to meaningful oil production disruptions in recent decades (Exhibit 35), including events in Kuwait, Venezuela, Iraq, Libya, Iran, and others. Recently, however, the impact of Red Sea dislocations on oil markets has been relatively muted and the effect has been mostly felt on container shipping rates (Exhibit 36).

**Exhibit 35: Brent and WTI prices**

Geopolitical events have sometimes led to meaningful oil production disruptions in recent decades



Source: Bloomberg

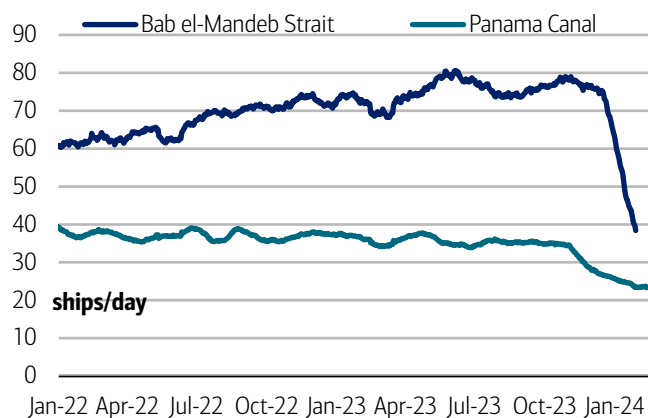
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**...major hotspots have surged around the world**

Albeit for different reasons, freight volumes crossing through both the Panama Canal and the Suez Canal have collapsed (Exhibit 37). A very severe drought and Houthi attacks on ships have forced many companies to send their vessels through the Cape of Good Hope, extending shipping routes and increasing the volumes of oil at sea, although the biggest impact of these dislocations in petroleum markets has been felt in the middle distillate complex. Also, Russian energy supplies into Europe tumbled as a result of the Ukraine War and have yet to recover (Exhibit 38)

**Exhibit 37: 30 day rolling average daily ships through Suez and Panama Canals**

Albeit for different reasons, freight volumes crossing through both the Panama Canal and the Suez Canal have collapsed



Source: IMF Portwatch

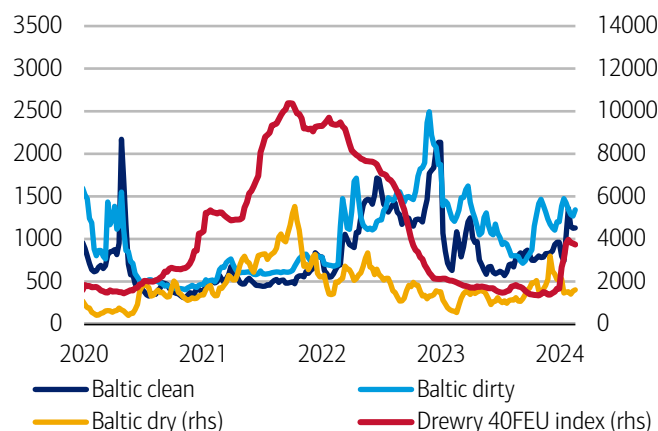
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**Relative to a number of metrics such as income,**

In short, global oil markets remain quite dislocated, with much longer supply chains, but prices have yet to absorb some of these pressures. In fact, gasoline prices relative to average hourly earnings have come down significantly from the 2022 highs (Exhibit 39) and are no longer a pre-eminent political issue in America. Similarly, the cost of energy as a share of total income has now normalized on a spot and forward basis (Exhibit 40) after the great global gas and power crisis of 2022.

**Exhibit 36: Freight rates**

Recently, the impact of Red Sea dislocations has been mostly felt on container shipping rates

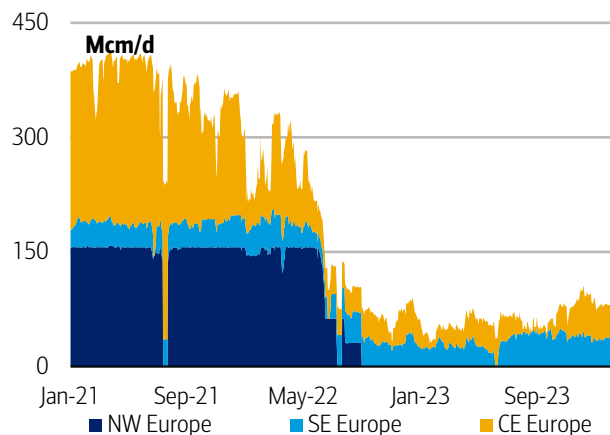


Source: Bloomberg

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**Exhibit 38: Russian pipeline gas imports into Europe**

Russian energy supplies into Europe tumbled as a result of the Ukraine War and have yet to recover



Source: Bloomberg

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**Exhibit 39: US gasoline prices relative to average hourly earnings**

Gasoline prices relative to average hourly earnings have come down significantly from the 2022 highs



Source: Bloomberg

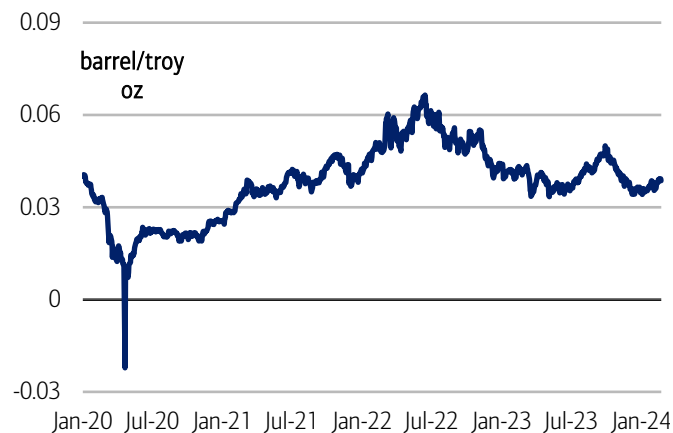
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**...other goods or even history, oil appears cheap**

Importantly, oil and energy prices have not just moderated against both income and wages. Oil measured in gold, a favored asset by central banks these days, looks particularly cheap (Exhibit 41) given the robust performance of the yellow metal in a world of rising inflation, rising deficits, and central bank reserve asset seizures. Also, when measured against other goods in the economy, we note that prompt oil prices do not appear particularly expensive (Exhibit 42), including against autos or shelter.

**Exhibit 41: Brent prices in gold**

Oil measured in gold, a favored asset by central banks these days, looks particularly cheap



Source: Bloomberg

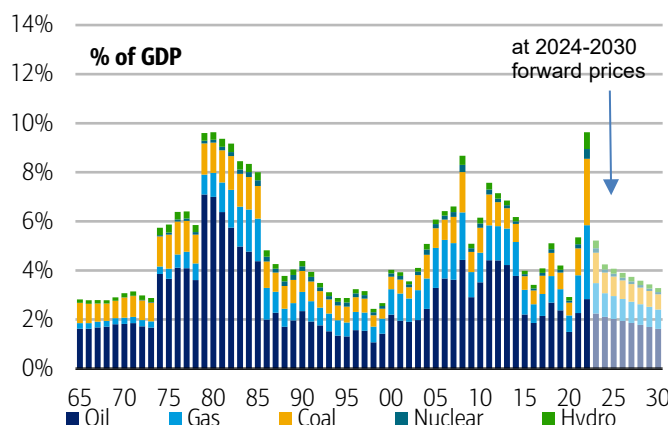
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**With monetary policy across the OECD set to ease...**

With oil prices moderating, how much room is there for the Fed to cut rates? Headline inflation has indeed come down with lower energy costs, yet core inflation as well as wage growth have been stubbornly sticky in the US for some time (Exhibit 43). For now, the fixed income market, and our economists, still expect meaningful interest rate cuts this year (Exhibit 44). Should monetary policy ease, we believe the downward pressure on energy prices observed in the past two years would likely reverse.

**Exhibit 40: Primary energy to nominal GDP ratio - World**

Similarly, the cost of energy as a share of total income has now normalized on a spot and forward basis

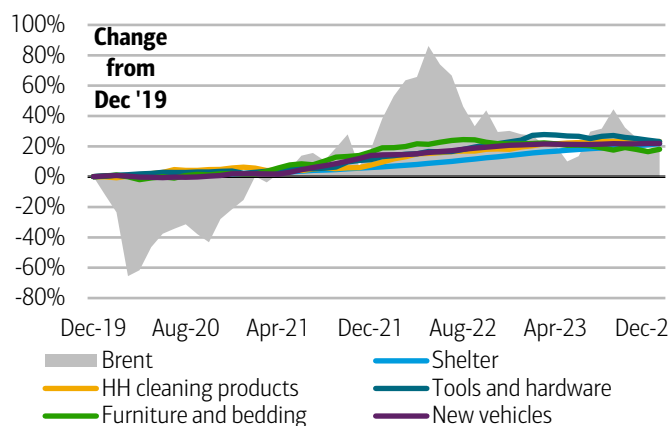


Source: Bloomberg, IMF, BP, IEA, Energy Institute, BofA Global Research estimates

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**Exhibit 42: US consumer prices and Brent crude oil prices**

Measured against other goods in the economy, we note that prompt oil prices do not appear expensive

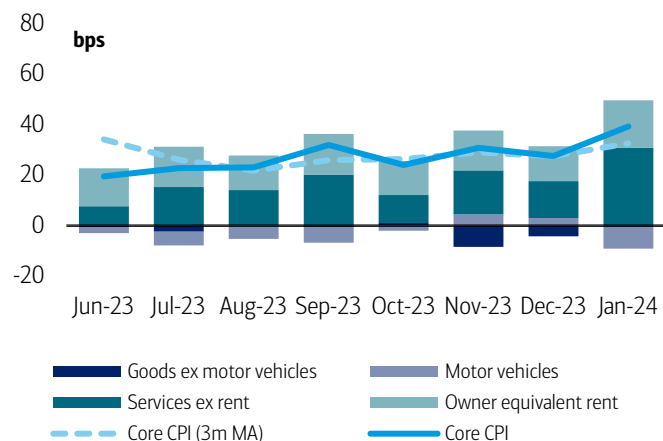


Source: Bloomberg

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**Exhibit 43: Core CPI breakdown**

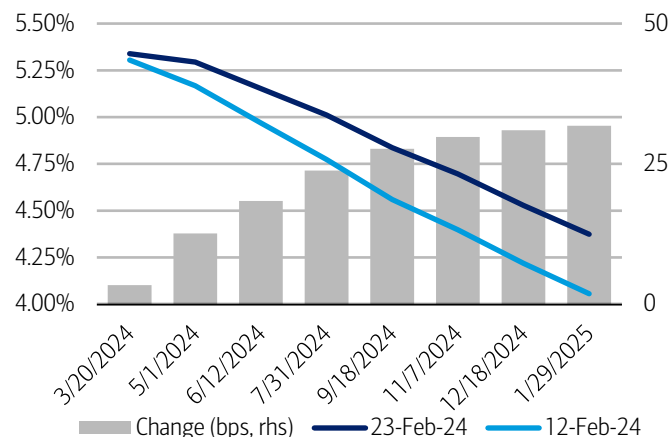
Core inflation as well as wage growth have been stubbornly sticky in the US for some time...



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**Exhibit 44: Fed OIS curve**

...but the fixed income market, and our economists, still expect meaningful interest rate cuts this year



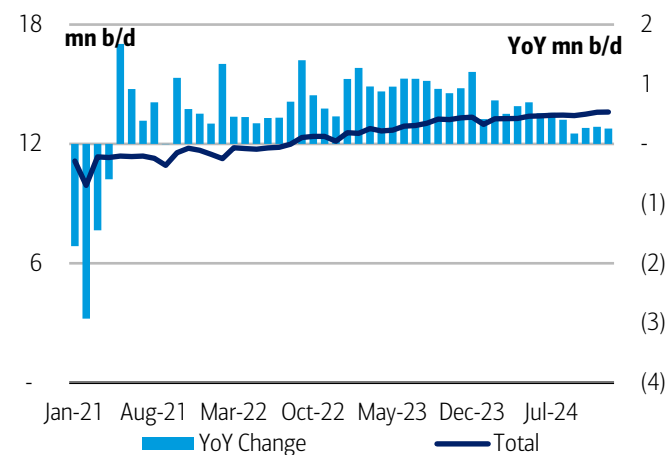
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**...slowing shale and OPEC+ production cuts could...**

In fact, any meaningful reduction in interest rates could also come against a backdrop of declining growth rates for supply. We expect crude oil production to slow down materially YoY in the US into 4Q24 (Exhibit 45), eventually lending support to a recovery in energy prices. In the short run, OPEC+ has committed to meaningful production cuts, and a number of countries beyond Saudi Arabia are starting to deliver (Exhibit 46). OPEC+ production is now down by 6.2mn b/d from April 2020 levels or 3mn b/d below the 3Q22 peak.

**Exhibit 45: US crude oil production**

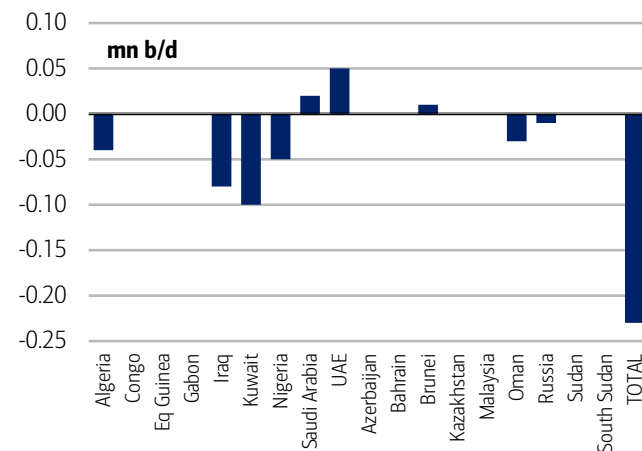
We expect crude oil production to slow down materially YoY in the US into 4Q24



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**Exhibit 46: MoM change in OPEC+ production Jan 24 vs Dec 23**

OPEC+ has committed to meaningful production cuts and a number of countries are starting to deliver



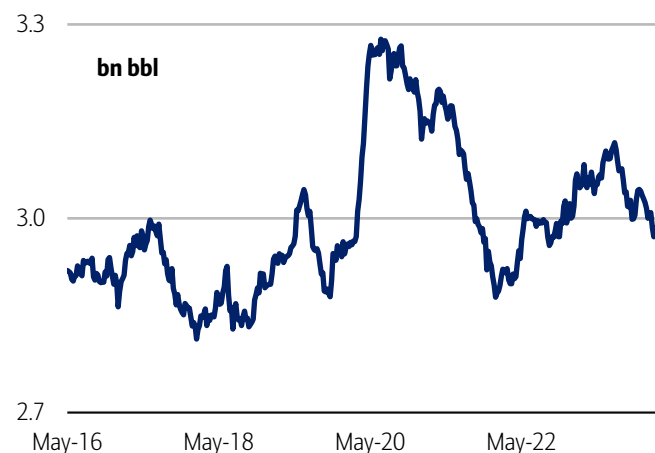
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**...push inventories into a downward trajectory...**

With OPEC+ holding back production, US shale set to slow down materially, and the Fed poised to cut rates over the coming quarters, an inflection point for oil prices may be nigh. In that regard, it is important to remember that global crude oil inventories are now 75mn bbl below last year levels according to Kayrros (Exhibit 47), although floating inventories have increased substantially to deal with the much longer routes (Exhibit 48).

**Exhibit 47: Observed global inventory changes**

Global crude oil inventories are now 75mn bbl below last year levels, according to Kayrros...

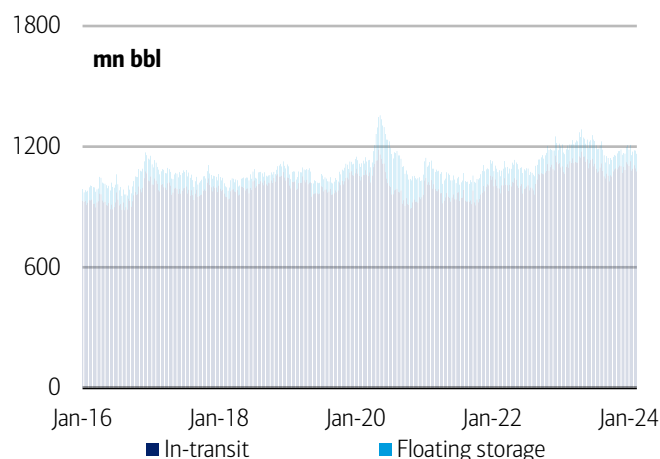


Source: Kayrros

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**Exhibit 48: Floating inventories**

...although floating inventories have increased to deal with the much longer shipping routes



Source: Bloomberg

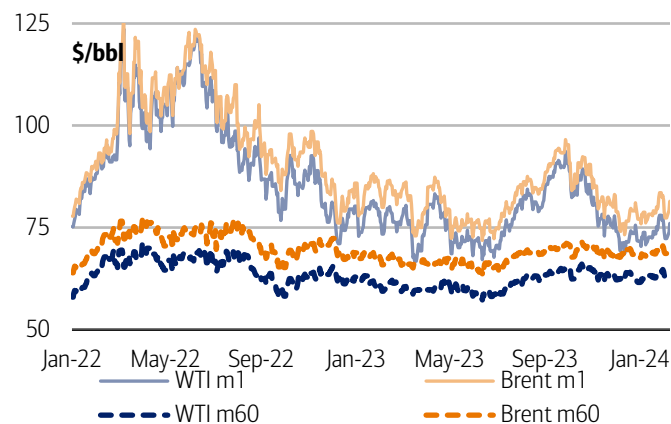
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**...allowing oil to regain the upper hand over money**

The stabilization of global oil supply and demand balances via OPEC+ output management has been so far successful at counterbalancing the aggressive monetary policy tightening cycle implemented by the Fed and the ECB. The proof is that prompt oil prices have now traded substantially above forward prices for more than 2 years running (Exhibit 49). Yet monetary policy easing could become a substantial tailwind for oil prices and total commodity returns (Exhibit 50) going forward if OPEC+ discipline holds.

**Exhibit 49: Brent and WTI prompt and long dated prices**

Prompt oil prices have now traded substantially above forward prices for more than 2 years running

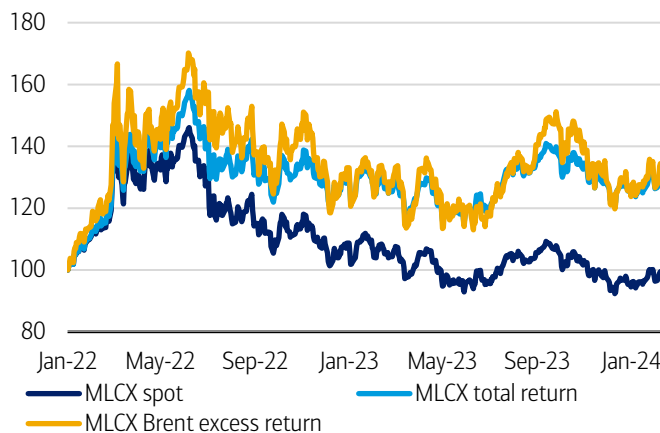


Source: Bloomberg

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**Exhibit 50: MLCX spot, total and excess Brent returns**

Monetary policy easing could become a substantial tailwind for oil prices and total commodity returns



Source: Bloomberg

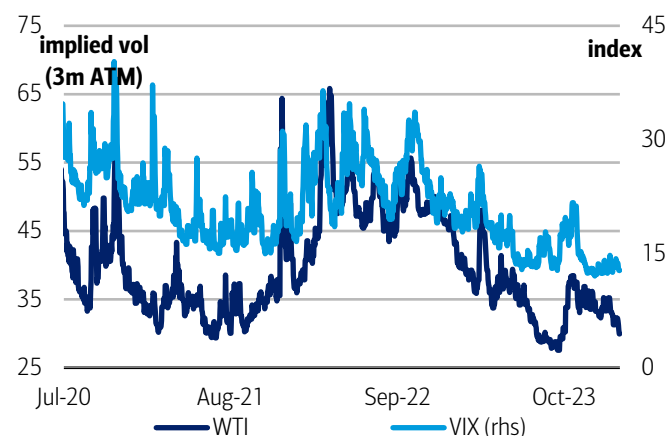
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**Still, we see muted oil volatility in the months ahead**

While many factors have come together to stabilize oil prices around the current range, we believe that volatility may have further room to drop. Even as the VIX has remained muted in the context of rallying equity markets, oil volatility has only recently started to come off (Exhibit 51). In part, implied vol has begun to converge with muted realized volatility in global energy markets (Exhibit 52), a trend that we think will continue as juxtaposing forces extend the recent period of oil price stability, geopolitics permitting.

**Exhibit 51: VIX and 3M implied vol for WTI**

While the VIX has remained muted in the context of rallying equity markets, oil has only recently come off

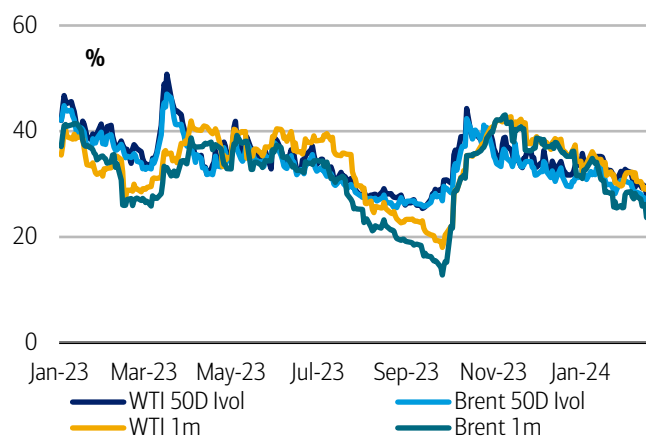


Source: Bloomberg

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**Exhibit 52: Realized and implied volatility**

In part, implied vol has started to converge with muted realized volatility in global energy markets



Source: Bloomberg

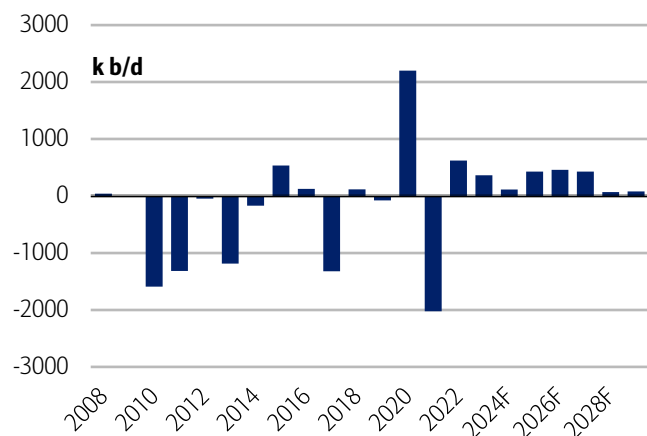
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**Over the medium term, oil balances to loosen**

The oil market is likely to loosen into 2025 as rising non-OPEC supply, specifically from Brazil, Guyana, the US, and Canada, meets slower demand growth (Exhibit 53). Over the medium term, we see a small but persistent surplus emerging, leaving little room for Saudi Arabia to lift output above its current rate of 9mn b/d. In total, global demand growth should average nearly 900k b/d YoY annually during 2024-29 and global supply should ride by closer to 850k b/d YoY over the same period (Exhibit 54). Yet, uncertainty abounds, especially due to rising geopolitical tensions. Will Russian output manage to recover over the medium term? Will Iranian output rebound to pre-sanctions levels? Will the pace of EV adoption miss ambitious estimates? These are questions that could set the market on a more bullish or bearish path over the next six years.

**Exhibit 53: Global oil market imbalance**

The oil market is likely to loosen up into 2025 as rising non-OPEC supply meets slower demand growth

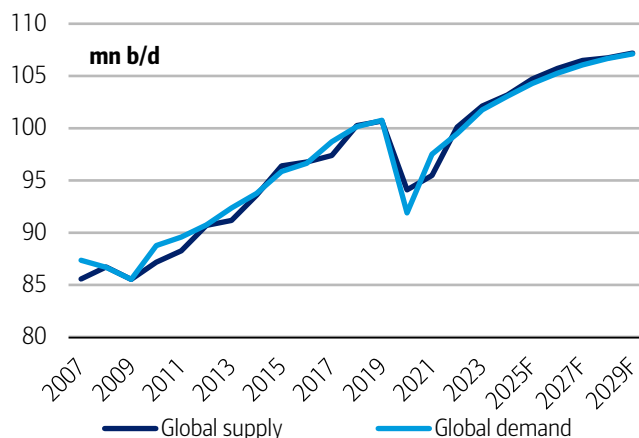


Source: IEA, BofA Global Research estimates

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**Exhibit 54: Global oil demand and supply**

We expect global demand growth to average nearly 900k b/d YoY and global supply growth closer to 850k b/d YoY during 2024-29



Source: IEA, BofA Global Research estimates

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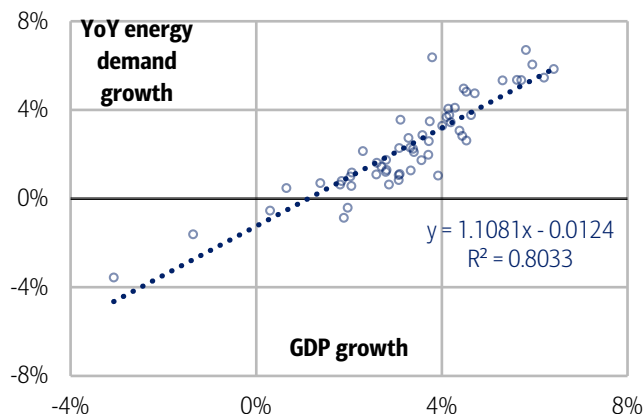
# Medium-term demand outlook for oil

## Energy demand and GDP remain closely interlinked...

As a key driver of productivity, global energy consumption remains very tightly intertwined with economic activity (Exhibit 55), exhibiting an  $R^2$  of around 80% and a beta to GDP of ~1. Energy is often defined as “the ability to do work”, so it should not be surprising that energy and GDP go hand-in-hand, with other key components of economic activity being labor, capital, and technology. Still, not every energy source has a tight relationship with economic activity due to rigid price structures, substitution effects, and efficiency dynamics (Exhibit 56). Being the most flexible energy source, oil has the tightest relationship to GDP followed by gas, while renewables have the loosest.

### Exhibit 55: World GDP and energy demand growth (1966-2022)

As a key driver of productivity, global energy consumption remains very tightly intertwined with economic activity

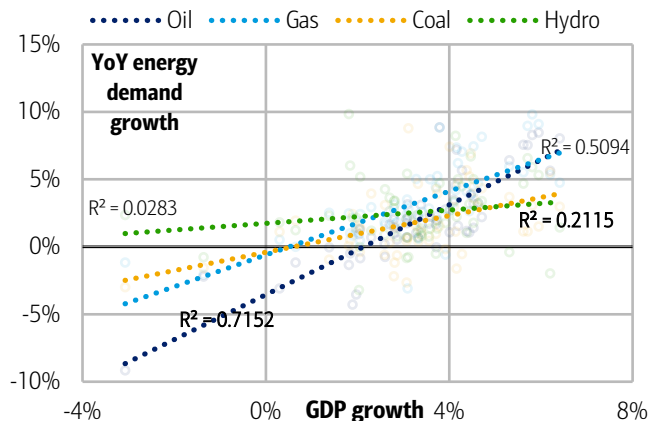


Source: Energy Institute, Bloomberg

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### Exhibit 56: World GDP and energy demand growth by fuel (1966-2022)

Still, not every energy source has a tight relationship with economic activity due to substitution and efficiency dynamics



Source: Energy Institute, Bloomberg

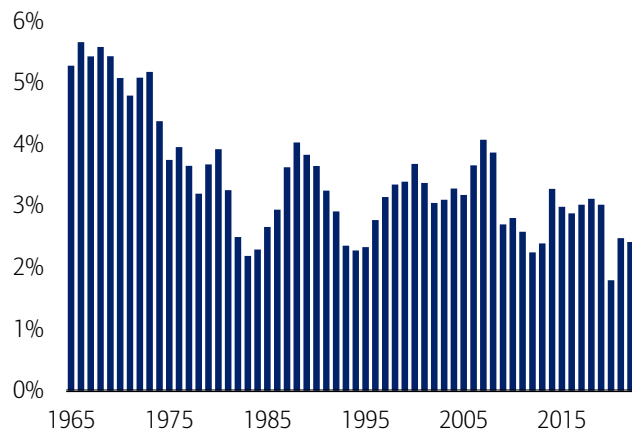
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## ... and slower economic trends point to softer use ahead

What does this mean in the context of the current economic situation around the world? Looking back and looking forward, we note that global GDP trends should materially slow down over the coming decade. World income growth averaged 5% in 1965-75 and more recently approached 3% since 2015 (Exhibit 57). As global growth continues to ease, we expect energy demand trends to slow down too. Note that the slowing rate of growth in world GDP is mostly due to weaker China and Emerging Asia trend growth of around 5% after almost three decades averaging 8-10% (Exhibit 58), while the rest of the world has converged towards steady state growth.

**Exhibit 57: 5-year moving average of real global GDP growth**

Looking back and looking forward, we note that global GDP trends should materially slow down over the coming decade...

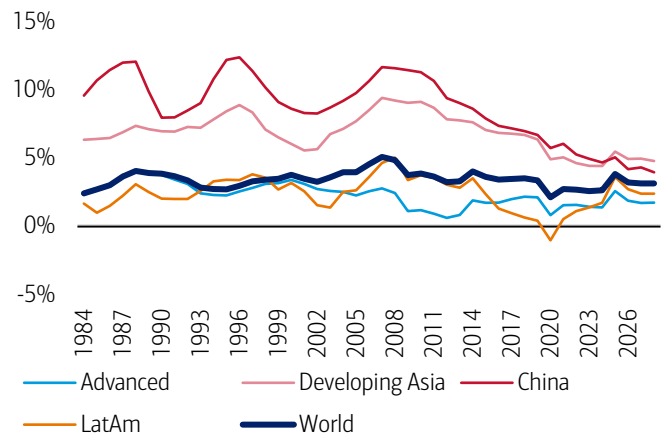


Source: World Bank

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**Exhibit 58: 5-year moving average of real GDP growth and IMF projections by aggregate**

... due to slower China trend growth of 5% after almost three decades averaging 10%, while the rest of the world including emerging economies converge towards steady state growth



Source: IMF

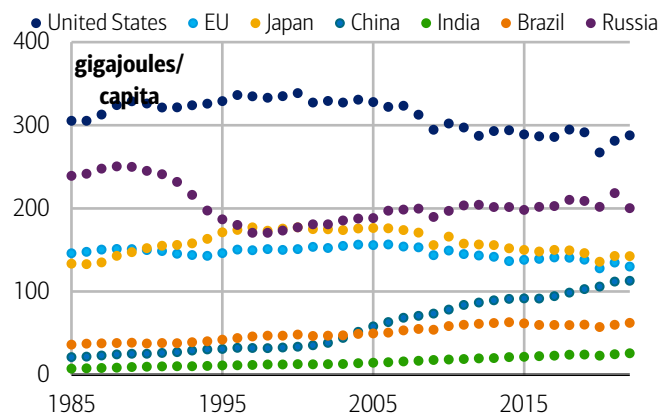
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**Importantly, energy input sources are also changing as...**

On a country-by-country basis, we note that the US remains one of the largest per capita consumers of energy in the world (Exhibit 59). Although demand has fallen roughly 15% from the peak, consumption has been averaging 300GJ per capita in the past year or so. The EU and Japan have experienced similar trends, with energy consumption per head being roughly flat for decades. In contrast, China and India have seen a very strong pick up in energy consumption per head in recent decades. The average American is also a large, albeit declining, consumer of oil in aggregate, but China has ramped up consumption as Japan pulled back (Exhibit 60).

**Exhibit 59: Primary energy consumption per capita**

On a country-by-country basis, we note that the US remains one of the largest per capita consumers of energy...



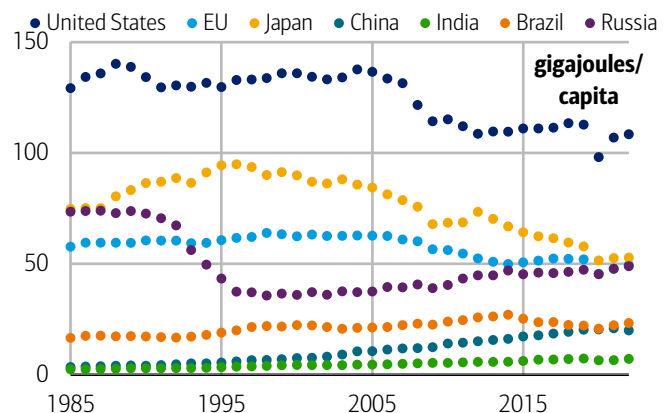
Note: EU consumption excludes Slovenia prior to 1990

Source: Energy Institute, World Bank, BofA Global Research

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**Exhibit 60: Oil consumption per capita**

... as well as one of the biggest consumers of oil in aggregate, but China has increased very quickly to approach Japan



Note: EU consumption excludes Slovenia prior to 1990

Source: Energy Institute, World Bank, BofA Global Research

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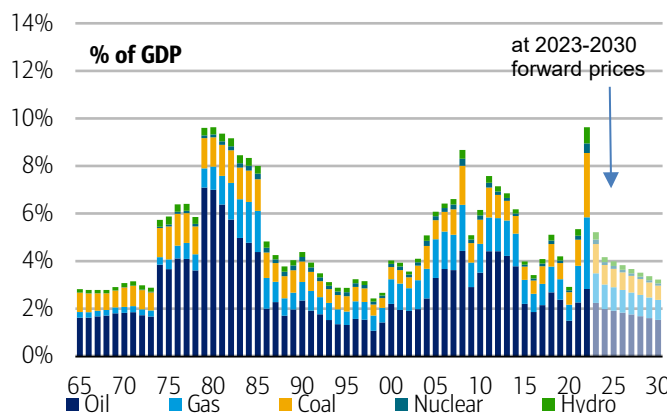
**... substitution and efficiency will keep displacing oil burn**

Given the strong relationship between energy consumption and GDP, as well as the tight relationship between GDP and demographics, it is safe to say that economic activity and population growth into 2050 will likely keep tilting global energy consumption higher for the next two and a half decades. The two big questions are how much energy demand will grow and how the energy mix will look like in the context of the transition. One

crucial input is the energy consumption expenditure as a share of GDP. We note that costs have normalized from the exceptional levels seen in 2022 (Exhibit 40), with thermal fuel demand poised to see a shrinking share due to the very high prices and the push into renewables. In fact, we have already seen a major rotation in energy inputs into GDP in the past five years as a result of COVID-19 and the Ukraine war (Exhibit 62).

#### Exhibit 61: Primary energy to nominal GDP ratio - World

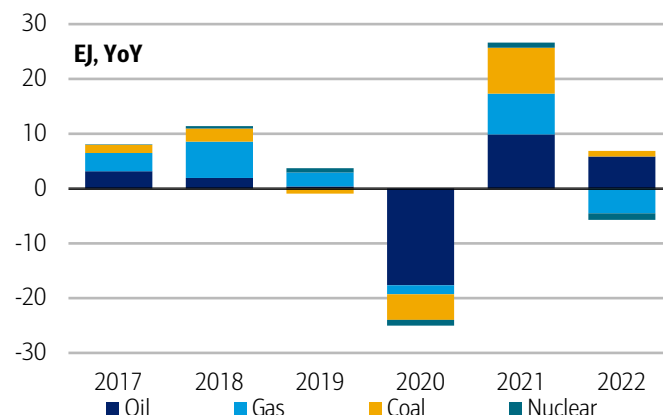
Global energy consumption expenditures as a share of GDP have normalized from the exceptional levels seen in 2022



Source: Bloomberg, IMF, BP, IEA, Energy Institute, BofA Global Research estimates  
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#### Exhibit 62: Primary energy consumption by fuel

Still, we have seen a major rotation in energy inputs into GDP in the past five years as a result of Covid-19 and the Ukraine war



Source: Energy Institute

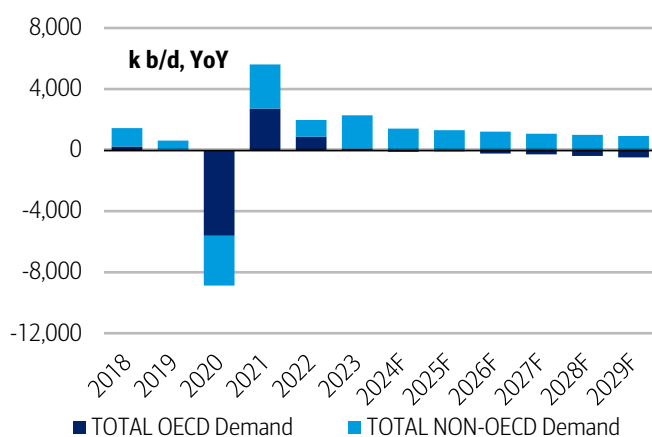
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#### Still, oil demand is back to record levels after COVID-19...

While prior energy demand trends have shifted as a result of recent shocks, we note that global oil demand reached a record of 103mn b/d in 3Q23 as the 2020 COVID-19 contraction to 92mn b/d was offset by three years of break-neck oil demand growth in a post-pandemic recovery that has averaged 100mn b/d in 2021-23. Looking forward, we expect growth to continue in the medium term (Exhibit 63) with total oil consumption reaching 107mn b/d by 2029, adding net growth of about 5mn b/d over the next six-year period on average vs 2023 levels (Exhibit 64). This means that, at 900k b/d YoY, the average demand growth rate into the end of the decade will be a fraction of the past three years.

#### Exhibit 63: Oil demand growth

Global oil demand reached a record of 103 mn b/d by 3Q23 and we expect growth to continue into the coming years...

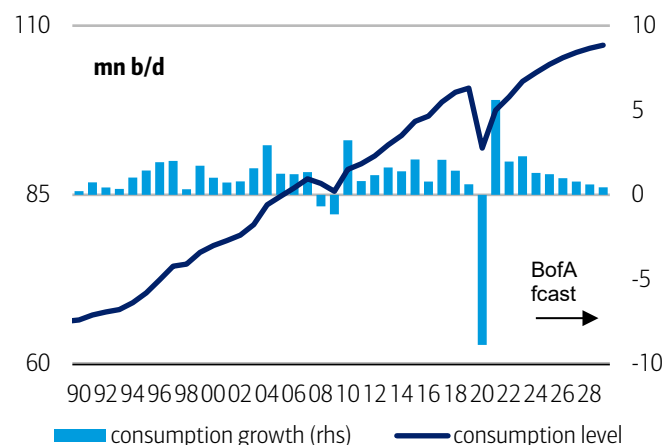


Source: IEA, BofA Global Research Estimates

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#### Exhibit 64: Oil consumption

... with total oil consumption levels reaching ~107mn b/d by 2029, an increase of roughly 5mn b/d versus 2023 levels



Source: IEA, BofA Global Research Estimates

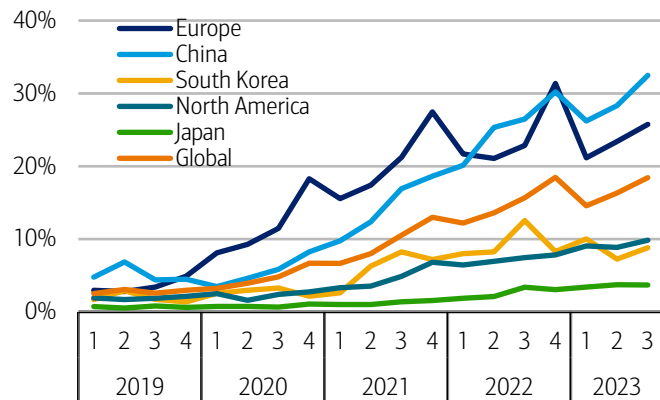
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### ... and slower EV sales point to less substitution near term...

While EV sales have surged in recent years and now make up an average of 18% of total vehicle sales around the world as of 3Q23 (Exhibit 65), a number of factors have played into a modest slowdown in the rate of growth of new EVs entering the global market (Exhibit 66). Still, EVs as a share of total vehicles sold is now at around 26% in Europe and 33% in China, while laggards Korea and Japan have seen a very large increase in the sales of ultra-fuel-efficient hybrids in recent decades. At any rate, we believe the reported deceleration in EV sales does not signal a major change in trend but rather a “speed bump” in the transition towards electric transportation.

#### Exhibit 65: EV share of new passenger vehicles sales

While EV sales have surged in recent years and now make up an average of 18% of total vehicle sales around the world...

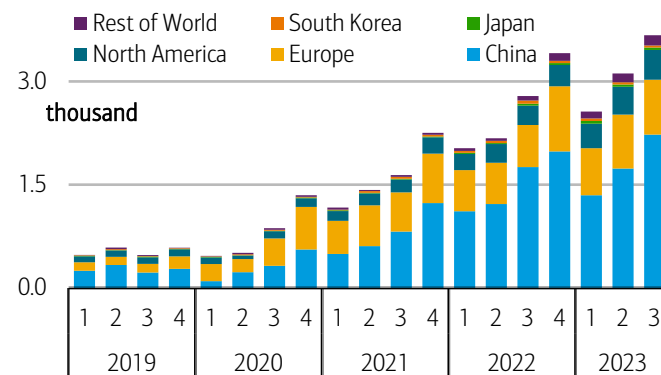


Source: BloombergNEF

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#### Exhibit 66: Global passenger EV sales by region

... a number of factors have played into a modest slowdown in the rate of growth of new EVs entering the global market



Source: BloombergNEF

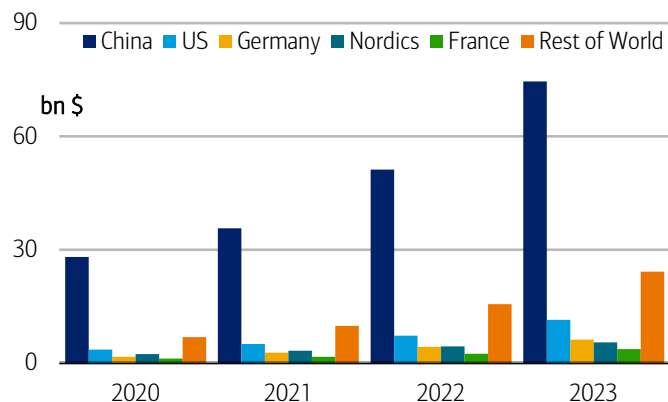
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### ... as EV charging infrastructure and grid spending lags

A major factor that could be holding back EV adoption is the fact that charging infrastructure for electric vehicles has been lagging quite a bit across many markets, although not in China (Exhibit 67) where car sales have continued to grow. Similarly, grid spending remains a major bottleneck in the adoption of renewable technologies to electrify the economy away from fossil fuels (Exhibit 68). The good news for both electrification trends and EVs is that the price of many key energy-transition minerals for batteries has collapsed, with lithium hydroxide prices rolling off 84% from a high of \$85k/MT just over a year ago to just \$13k/MT today (see [Geopolitics blows up lithium](#)).

#### Exhibit 67: EV charging infrastructure investment

Charging infrastructure for electric vehicles has been lagging quite a bit across many markets, although not in China

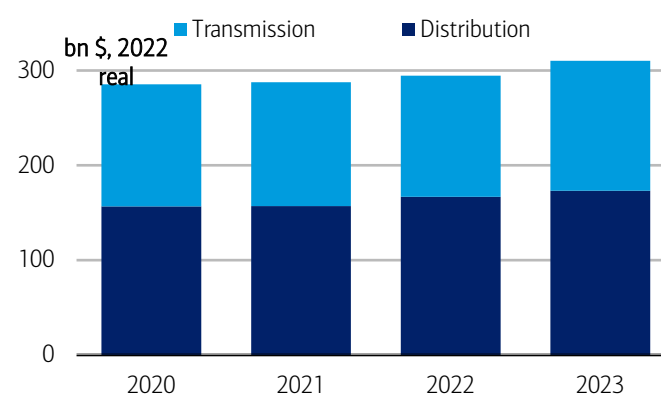


Source: BloombergNEF

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#### Exhibit 68: Global expenditure in power grids by category

Similarly, grid spending remains a major bottleneck in the adoption of renewable technologies to electrify the economy away from fossil fuels



Source: BloombergNEF

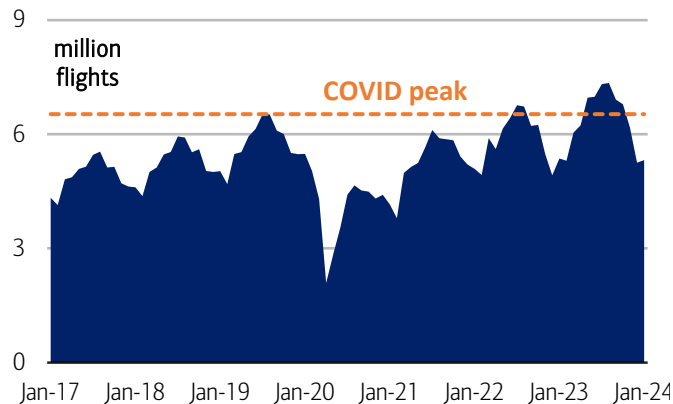
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### The aviation sector tries to shift to more renewables...

With falling raw materials prices key to the electrification of transport, the costs of batteries should follow through and make EVs more affordable. Still, some segments of mobility will be quite hard to decarbonize and the air transportation sector stands out in that regard. While COVID-19 put a major dent in global aviation demand growth, air travel continues to recover globally (Exhibit 69) with international air travel in China being perhaps the biggest laggard across all major airline segments (Exhibit 70). The robust services PMIs and a strong consumer backdrop, coupled with lower rates in EMs and soon in DMs, should further boost air travel.

#### Exhibit 69: Total global flights each month

COVID-19 put a major dent in global aviation demand growth, but air travel continues to recover across all regions...

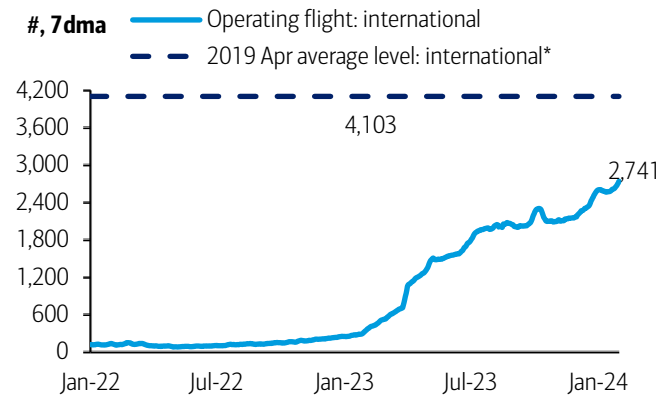


Source: Bloomberg

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#### Exhibit 70: China's operating flights: international

... with international air travel in China being perhaps the biggest laggard across all major airline segments



Source: Wind, BofA Global Research GEM Economics Asia | China, Note: \* benchmark of pre-COVID level reset based on the Apr's press conference by CAAC, data as of Jan 30

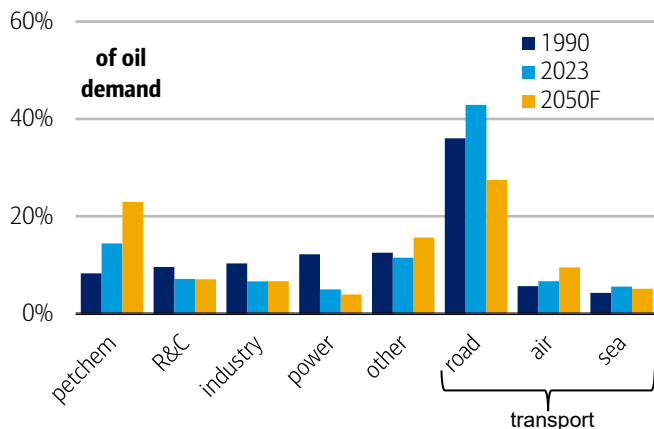
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### ... but jet fuel demand will remain a key petroleum driver...

While we have argued that air travel trends will improve in the short-run, the long-term outlook for the industry is also strong and substitution and efficiency do not play as much of a role here. Across the various oil demand sectors that will continue to grow into 2050, we would highlight aviation and the petrochemical sector (Exhibit 71), with other uses in transportation and industry falling by the wayside as new technology leads to reductions in thermal fuel usage to achieve Net Zero emissions targets. Still, the middle distillate complex has plenty of room to grow, as we believe SAF and other bio/renewable fuels markets will expand relatively slowly (Exhibit 72) and batteries are not very effective for airlines or large industrial equipment.

**Exhibit 71: Evolution of global oil demand**

Across the various oil demand sectors that will continue to grow into 2050, we would highlight aviation and petchems

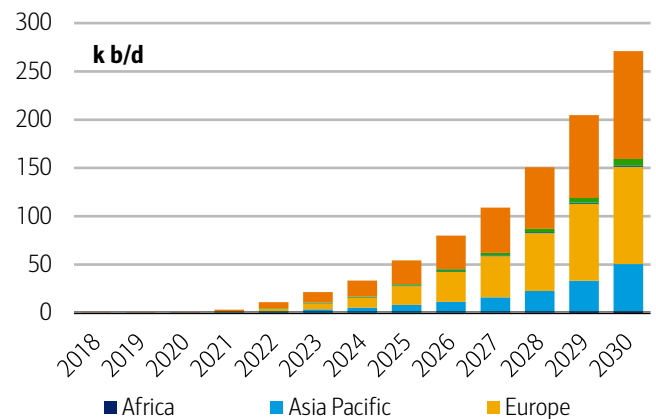


Source: IEA, BofA Global Research estimates

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**Exhibit 72: SAF consumption by region**

The middle distillate complex still has plenty of room to grow, as we believe SAF and other bio/renewable fuels will grow relatively slowly



Source: BNEF

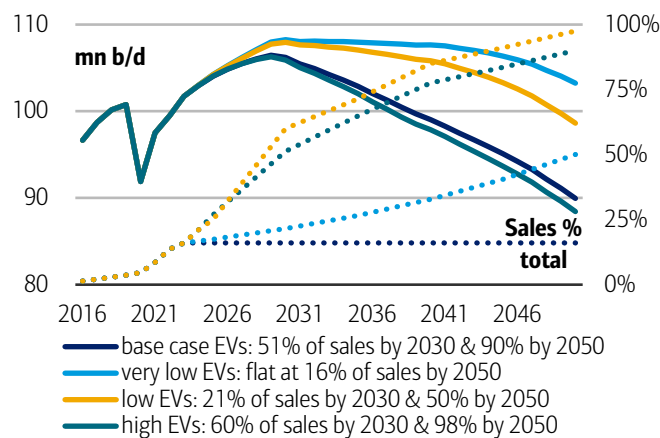
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**... supporting distillates, as gasoline lingers on a bit longer**

In this regard, the storyline for petroleum product fuels has not changed much in recent years. Petrochemical feedstock demand stays robust, together with distillates, as gasoline and residual fuels at the bottom of the barrel suffer. As it relates to light-ends (NGLs, naphtha, gasoline) representing 47% of the oil market today, we expect a shift away from ICE vehicles into EVs to start biting into global gasoline demand by the end of the decade (Exhibit 73) and eventually pick up speed into 2050 when the majority of the stock of vehicles in circulation becomes electric. For the next two or three years, however, we see some support. In Europe, demand for gasoline has picked up as a result of a shift away from diesel passenger vehicles (Exhibit 74), a trend that has some room to run.

**Exhibit 73: Oil demand under EV scenarios**

We expect the shift away from ICE vehicles into EVs to start biting into global gasoline demand by the end of the decade

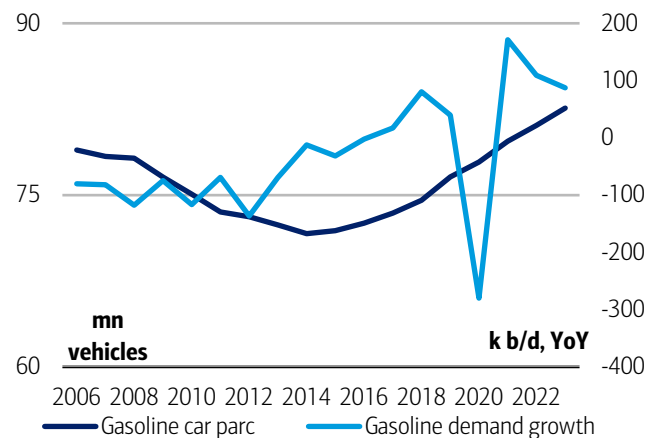


Source: IEA, BofA Global Research estimates

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**Exhibit 74: Gasoline demand growth in Europe**

In Europe, demand for gasoline has picked up in recent years as a result of a shift away from diesel passenger vehicles



Source: IEA, Woodmac

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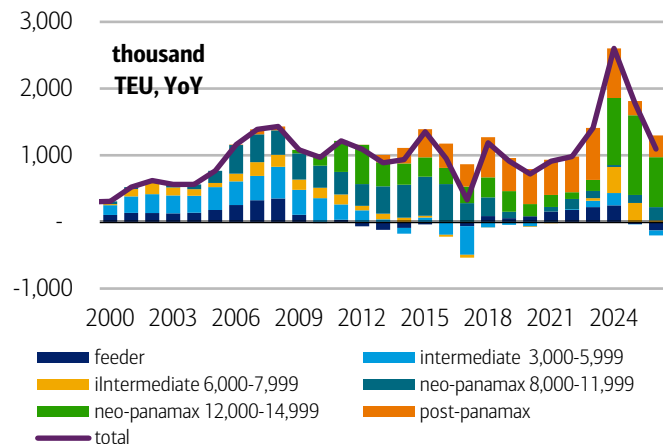
**Marine transportation will still expand in the next decade**

The marine transportation sector sits right in between the airline sector and the passenger road vehicle sector in terms of the difficulty associated with decarbonization. There are alternative fuels that will come in to displace IMO compliant very low sulfur fuel (VLSFO), but the shift to other fuels like LNG or methanol will be gradual. Looking at the order book, we note a continued expansion in the global container fleet supporting

fuel demand in the years ahead (Exhibit 75) and we expect oil bunker fuel demand to start flatlining sometime in the 2030s (Exhibit 76). Another factor that could push marine fuel demand lower would be a reduction in fossil fuel exports, as wet tankers remain a large part of the marine transport fleet.

#### Exhibit 75: Containership fleet growth by ship type

Looking at the order book, we note a continued expansion in the global container fleet supporting fuel demand in the years ahead

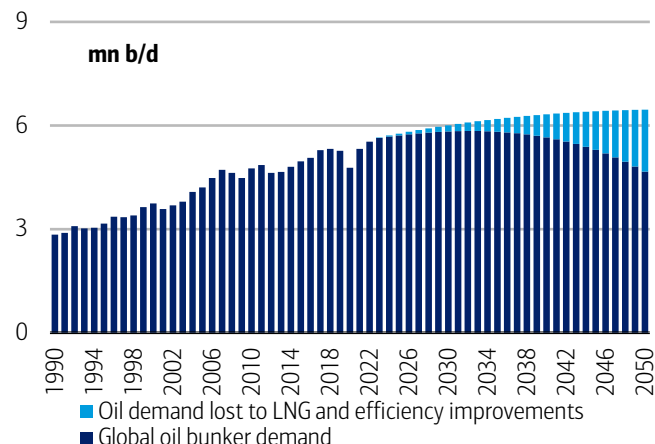


Source: Clarksons, BofA Global Research estimates

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#### Exhibit 76: Global oil bunker demand

... but we still expect oil bunker fuel demand to start flatlining sometime in the 2030s as other fuels like LNG become increasingly prominent



Source: IEA, BofA Global Research estimates

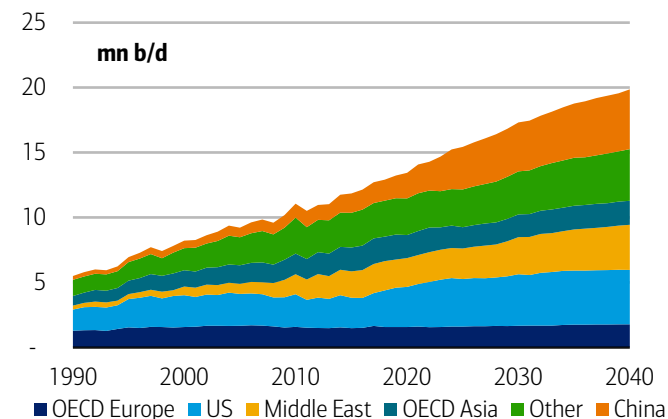
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#### Petrochemical consumption remains an oil market pillar...

Perhaps the sector with the most positive oil demand trajectory into 2050 is petrochemicals. Decarbonizing steel and cement is very hard, but decarbonizing plastics is possibly even harder. Reutilizing old plastics to create new is probably the best way to reduce the sector's high carbon footprint. But without a material change to plastics recycling, petrochemical sector oil demand is likely to continue to rise into 2040 (Exhibit 77). Part of the challenge associated with decarbonizing this sector is also that the growth in petrochemical capacity has been very strong in recent years and continues to expand in line with GDP (Exhibit 78), with little efficiencies.

#### Exhibit 77: Petrochemical sector oil demand

Without a material change to plastics recycling, petrochemical sector oil demand is likely to continue to rise

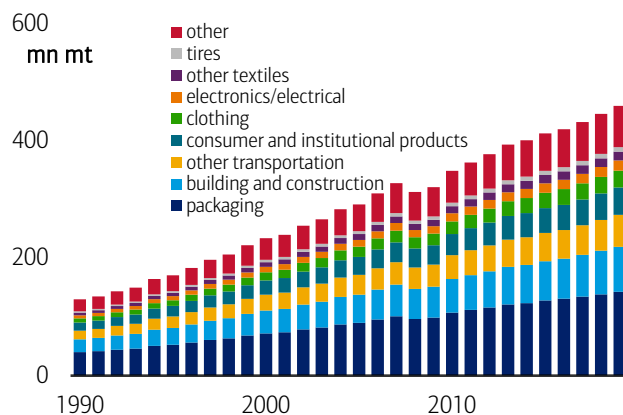


Source: IEA, Woodmac, BofA Global Research estimates

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#### Exhibit 78: Historical plastic use by application

Global plastics demand has risen relentlessly, save for the GFC, clocking an annual growth rate of roughly 3.5% YoY during 2000-19 timeframe



Source: OECD

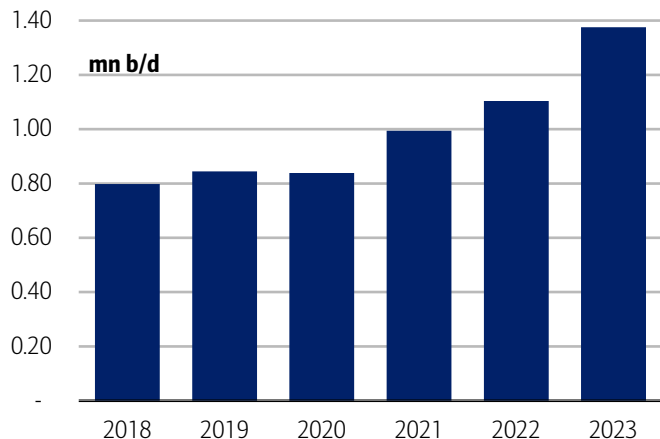
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### ... and we see a continued expansion of demand into 2050...

A great driver of demand for petrochemical inputs including naphthas and liquid petroleum gases such as ethane, propane, and butane is China. In fact, Chinese imports of key petrochemical feedstocks are up 72% since 2018 and reflect the growing plastics demand domestically (Exhibit 79) as well as China's robust manufacturing export industry. On a per capita basis, China already consumes a lot of plastic considering its level of income, while we would also note that India has a long way to go from a demand perspective to converge with wealthier countries (Exhibit 80). Life in plastic, it's fantastic, it seems.

#### Exhibit 79: China imports of LPGs and naphtha

Chinese imports of LPG and naphtha, key petrochemical feedstocks, are up 72% since 2018 and reflect growing plastics demand

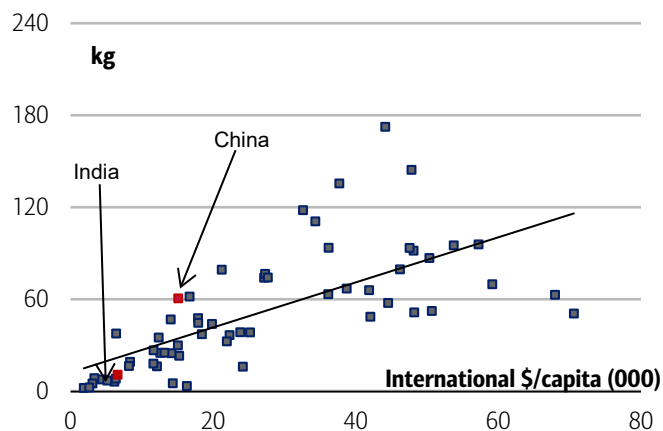


Source: Bloomberg, BofA Global Research

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#### Exhibit 80: Income and plastics demand per capita (2015)

Looking at plastics, we note that India has a long way to go from a demand perspective to converge with wealthier countries



Source: Euromap, BofA Global Research

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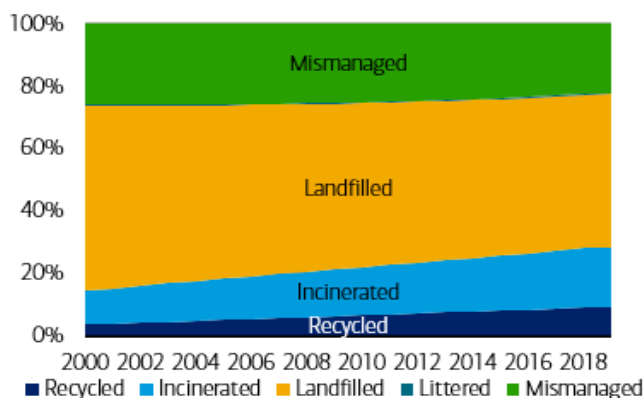
### ... but future growth faces headwinds from plastic recycling

It is hard to construct a bearish argument for plastics and thus petrochemical demand for oil feedstocks based on a somewhat tamer GDP outlook, but just like in steel, aluminum, and other hard to decarbonize industries, recycling could offer a window for decarbonization. In that regard, we note that plastic waste recycling rates remain exceptionally low at about 10% today according to OECD data (Exhibit 81) and thus oil demand could take a hit if the recycling ration was to climb considerably. In any case, demand for oil is unlikely to take a hit on plastics before 2030. While growth is expected to slow for ethylene and PE, propylene and PP capacity growth is set to remain firm for the next few years (Exhibit 82).



**Exhibit 81: Global plastic waste by end-of-life fate**

Plastic waste recycling rates remain exceptionally low at about 10% today according to OECD data

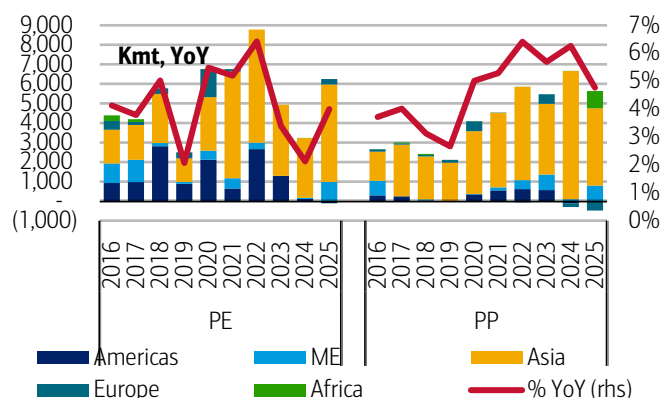


Source: OECD

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**Exhibit 82: Global PE and PP capacity expansions**

While growth is expected to slow for ethylene and PE, propylene and PP capacity growth is set to remain firm next year



Source: Platts

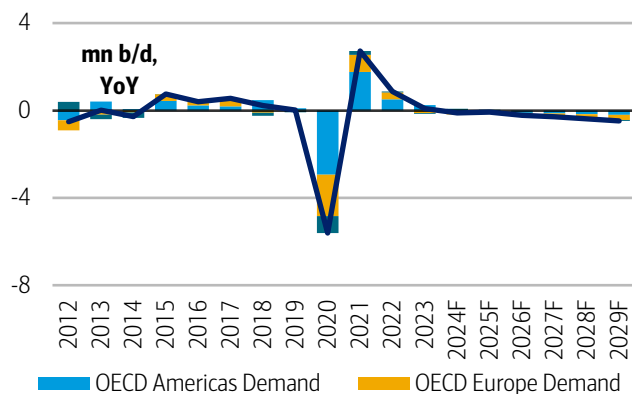
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**Regionally, OECD oil demand has peaked and will fall next**

Moving on from our sector discussion to a geographic one, we highlight the stark contrast in expectations between oil demand in developed and emerging economies. When breaking down demand region by region, we note that OECD consumption will likely contract into the end of the decade to 44mn b/d by 2029 (Exhibit 83). OPEC, Europe, and Asia are more likely to take a bigger hit on aging populations and increased efficiencies and substitution. Sluggish income growth is also likely to play a role here too. In short, oil demand across developed economies is a shrinking piece of a growing pie, with demand falling from a peak of 76% in the late 1960s to just 41% in 2029 (Exhibit 84).

**Exhibit 83: OECD oil demand growth**

When breaking down demand by region, we note that OECD consumption will likely contract into the end of the decade to 44mn b/d by 2029

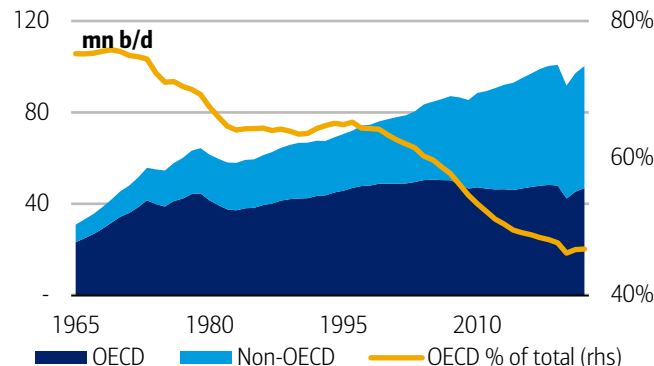


Source: IEA, BofA Global Research estimates

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**Exhibit 84: Global oil demand and OECD share**

Oil demand across developed economies is a shrinking piece of a growing pie, with demand falling from a peak of 51 mn b/d in 2005



Source: Energy Institute

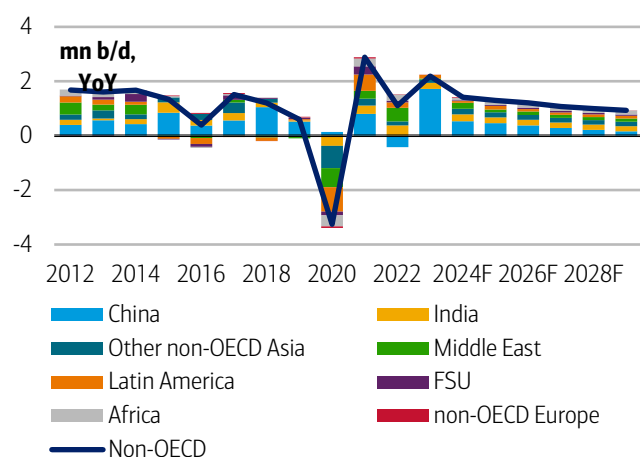
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**Emerging markets will keep oil demand on a growth path**

In contrast to the gloomier outlook for developed markets, Emerging economies, led by China, have remained the main drivers of the global oil market for two decades. But even there, we see a deceleration ahead (Exhibit 85) due to demographic and structural issues. In part, a falling rate of EM oil demand growth has to do with reduced demand growth from China, as well as rising clean energy investments (Exhibit 86). But a shrinking population, a push for electrification, and a stagnating economy do not make a strong cocktail for a roaring fuel demand picture in China beyond the post COVID-19 demand impulse.

**Exhibit 85: Non-OECD demand growth**

Emerging economies, led by China, have remained the main drivers of the global oil market for two decades, but we see a deceleration ahead

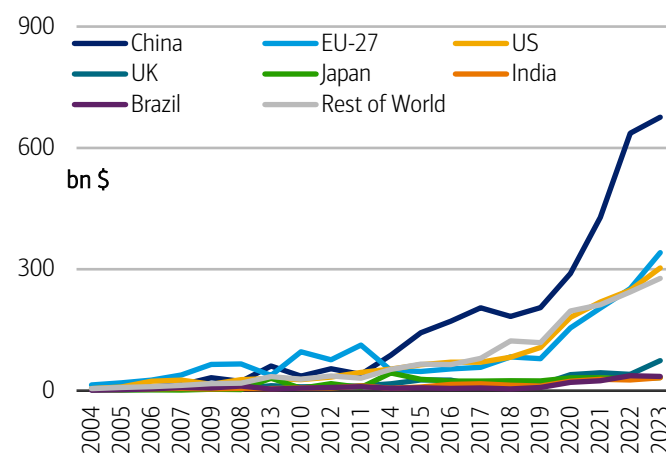


Source: IEA, BofA Global Research estimates

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**Exhibit 86: Energy transition investment by economy**

In part, a falling rate of EM oil demand growth has to do with reduced demand growth from China, as well as rising clean energy investments



Source: BloombergNEF

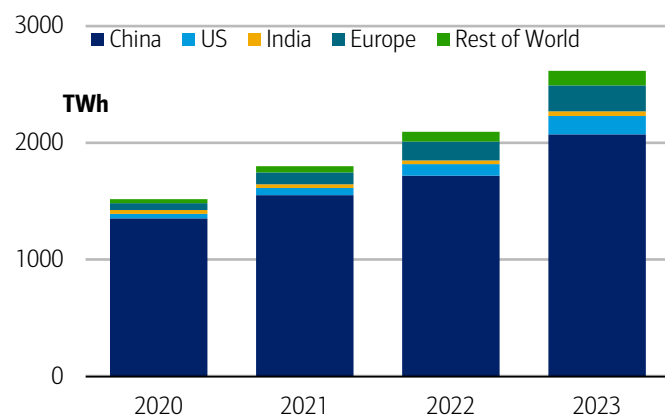
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**Even then, we see Chinese oil consumption peaking too...**

Exceeding 2000 TWh last year, China represented most of the electricity demanded by electric vehicles around the world (Exhibit 87), suggesting that the Asian nation is by far the most advanced across various regions when it comes to creating fuel substitution effects in the oil sector. More importantly, much of China's car industry is gearing up for export and volumes have grown 11 fold since July 2020 through the recent period (Exhibit 88), with the share of EVs in the export mix rising from 7% in March 2021 to a high of 32% in October 2022. In the past quarter, China exported 111 thousand EVs every month!

**Exhibit 87: Estimate electricity demand by electric vehicles**

Exceeding 2000 TWh last year, China represents most of the electricity demanded by electric vehicles around the world

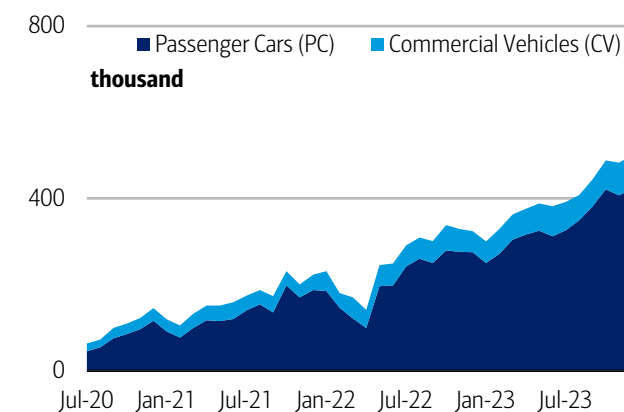


Source: BNEF

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**Exhibit 88: Total automobile exports from China**

Much of China's car industry is gearing up for export and volumes have grown 11-fold since July 2020 through the recent period



Source: China Association of Automobile Manufacturers

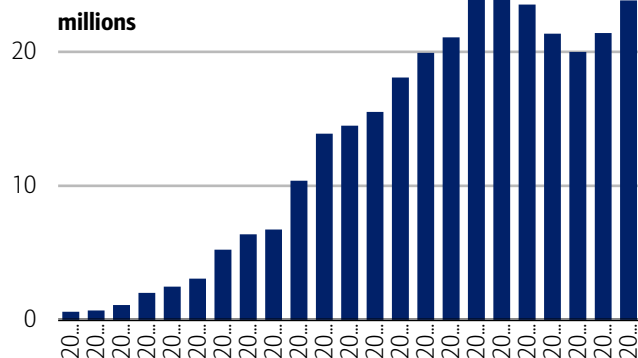
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**... as surging EV sales trigger a big slowdown in fuel demand**

While total auto sales and production in China have been roughly flat for the last three years and have yet to speed up (Exhibit 89), the industry is clearly gearing up for the domestic substitution of ~3.7mn b/d of gasoline and also plans to export its units aggressively over the coming years. In effect, electric vehicle auto sales domestically have sped up pretty significantly during the past three years, gaining tremendous market share (Exhibit 90), and are poised to continue to grow into 2030, eventually denting the strong trajectory of China's oil demand in recent decades.

**Exhibit 89: Annual Chinese automotive car production**

While total auto sales and production in China have been roughly flat for the last three years and have yet to speed up...

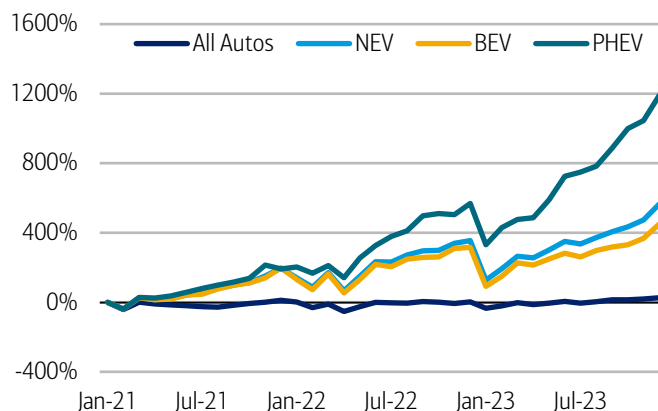


Source: Bloomberg

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**Exhibit 90: Automobile sales in China indexed to Jan 2021**

... electric vehicle auto sales have sped up pretty significantly during the past three years, gaining tremendous market share



Source: China Association of Automobile Manufacturers

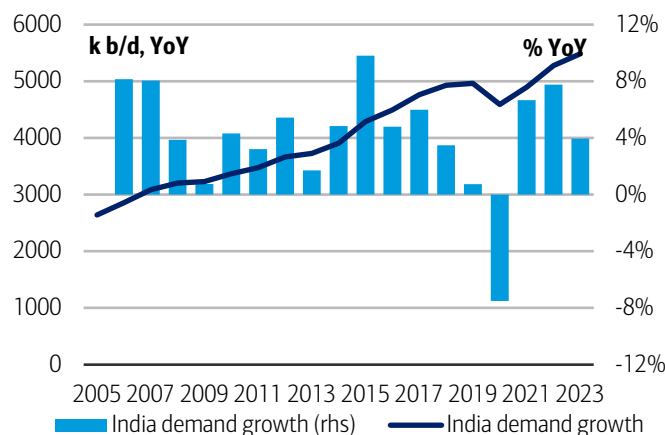
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**India will remain the fastest growing petroleum market (%)...**

China's oil demand has grown from 3mn b/d in 1993 to 16mn b/d in 2022, clocking in an average rate of growth of 6% per annum. During that same period, Indian oil demand expanded from 1.3mn b/d in 1993 at an average annual pace of around 5% to reach 5.5mn b/d in 2023 (Exhibit 91), also an impressive performance. Looking at a breakdown of the various components, we note that Indian fuel consumption has been led by diesel and gasoil (Exhibit 92). On a per head basis, however, China consumes nearly three times more oil than India, a ratio that will likely contract over the coming years as India leads global EMs in terms of growth.

**Exhibit 91: India demand**

Indian oil demand has expanded at a pace of around 6% on average during 2021-23 to reach 5.5mn b/d in 2023

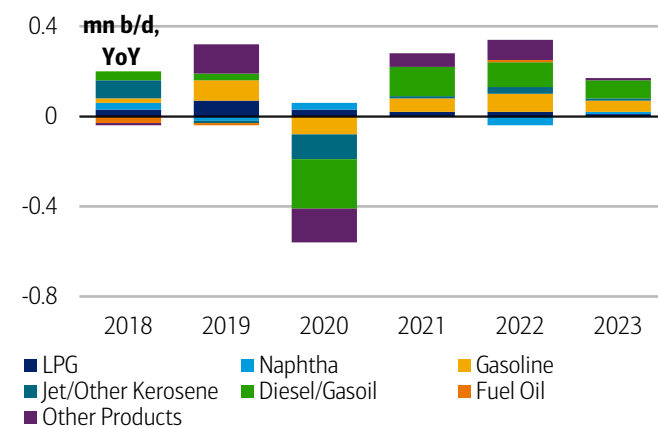


Source: IEA

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**Exhibit 92: India demand growth**

Looking at a breakdown of the various components, we note that Indian fuel consumption has been led by diesel and gasoil



Source: Woodmac

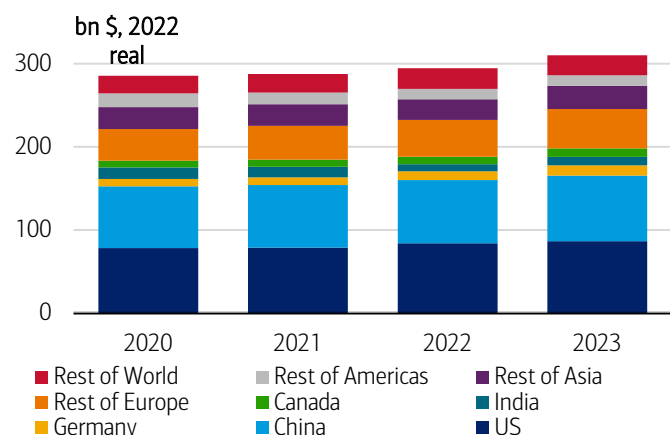
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**... but at a decelerating rate, as substitution bites there too**

We also believe India will become an increasingly important region for global oil suppliers given its reduced ability to substitute away from oil to electrify the economy. Looking at different regions around the world, we note that India has lagged other parts of the world in grid investments (Exhibit 93) and has yet to represent a meaningful portion of global energy transition spending, where China, the EU, the US, and the UK lead (Exhibit 94). As such, we expect Indian oil consumption to grow from 5.5mn b/d last year to 6.7mn b/d in 2029. Note that our expectation is that China's oil demand will grow by nearly 2mn over the same period.

**Exhibit 93: Global power grids investment by region**

Looking at different regions around the world, we note that India has lagged other parts of the world in grid investments...

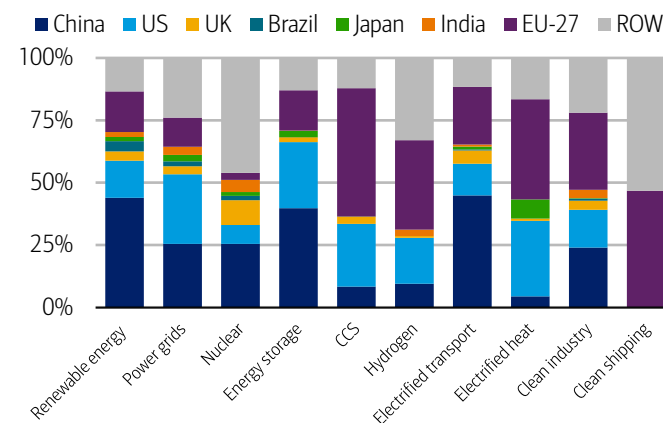


Source: BloombergNEF

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**Exhibit 94: Share of 2023 energy transition investment by country and sector**

... and has yet to represent a meaningful portion of global energy transition spending, where China, the EU, the US and the UK lead



Source: BloombergNEF

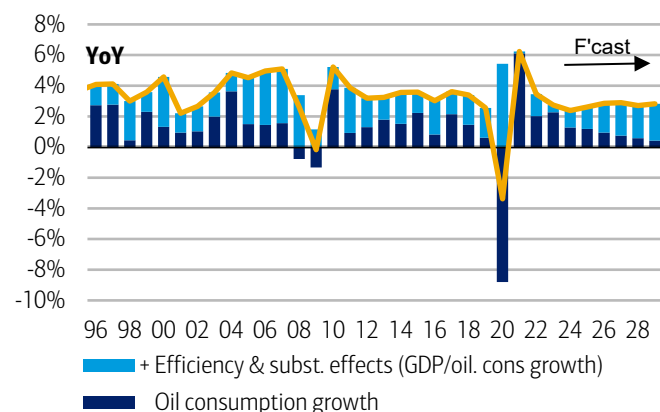
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**Net, oil burn peaks at a higher level, later than expected...**

The themes across regions and segments of the economy vary but also rhyme when it comes to oil demand. To be clear, we see a decelerating trend for global oil consumption growth on the back of efficiency and substitution advances over the coming years (Exhibit 95), although we now believe that oil demand will likely continue to grow, albeit modestly, into 2030. Dislodging oil from the energy sector is not easy because this fuel has an exceptional energy density compared to other alternatives (Exhibit 96). So peak oil demand comes a bit later, and at a higher level than previously expected.

**Exhibit 95: Global oil demand and GDP growth**

We see a decelerating trend for global oil demand growth on the back of efficiency and substitution advances over the coming years

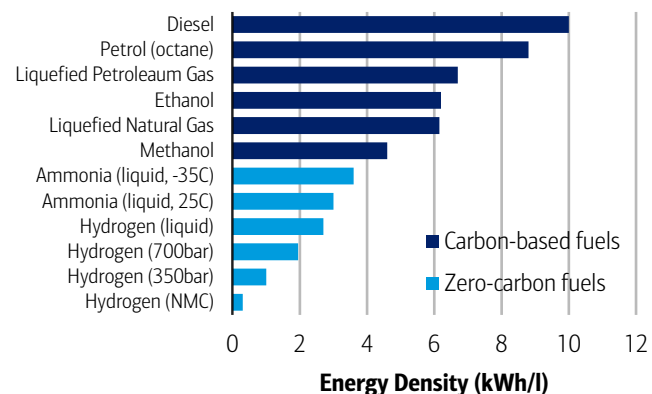


Source: IEA, BofA Global Research estimates

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**Exhibit 96: Energy density by source**

Dislodging oil from the energy sector is not easy because this fuel has an exceptional energy density compared to other alternatives



Source: Green Ammonia, Royal Society Policy Briefing (David et al. 2020)

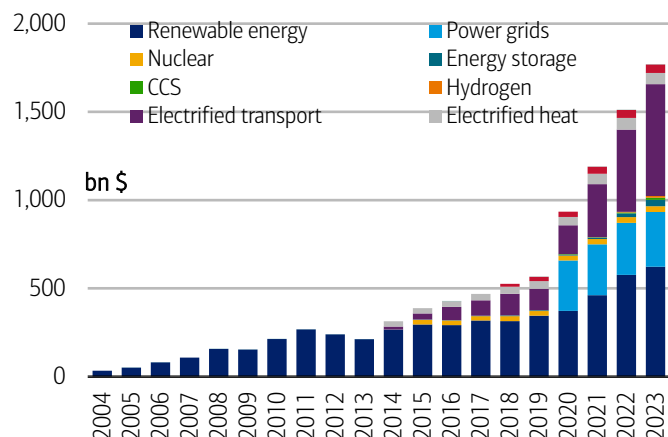
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**... although transition spending is still expanding quickly...**

While recent weeks have seen a slew of news about reduced demand for EVs and missed sales targets, we note that a few datapoints do not make a trend. Global energy transition spending has accelerated quite a bit driven by electric transport, grid, and renewable power generation (Exhibit 97). Regionally, China maintains a strong lead in transition spending over both EMEA and the Americas due to its industrial gearing (Exhibit 98). And crucially, research and development spending has passed beyond internal combustion engines. Better batteries will arrive, and consumers will choose EVs because they are better products, just like we have seen in the case of Tesla.

**Exhibit 97: Global energy transition investment by sector**

Global energy transition spending has accelerated quite a bit, driven by electric transport, grid, and renewable power generation

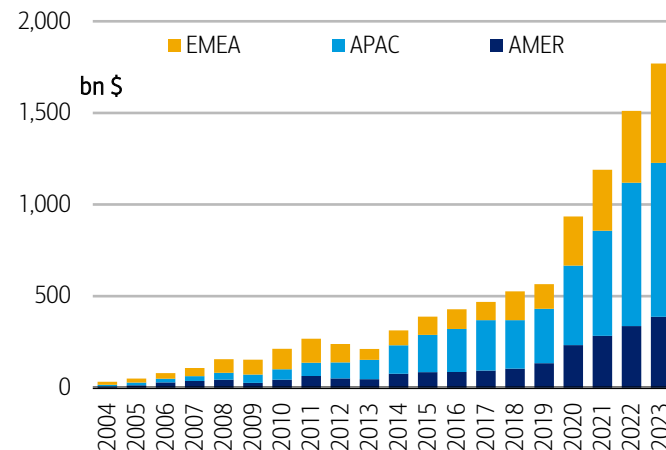


Source: BloombergNEF

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**Exhibit 98: Global energy transition investment by region**

Regionally, China maintains a strong lead in transition spending over both EMEA and the Americas due to its industrial gearing



Source: BloombergNEF

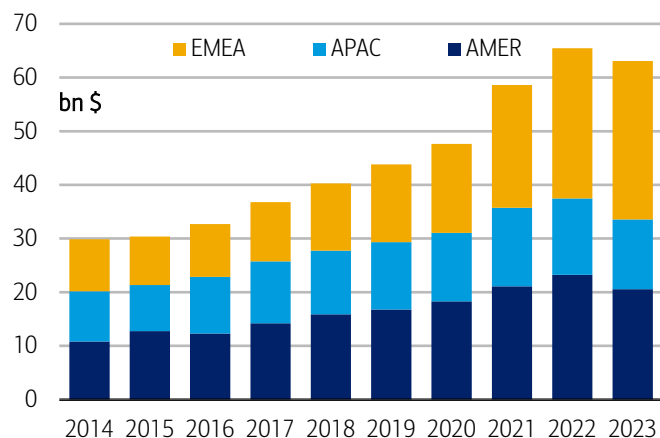
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**... across many different areas such as heating and industry**

Other segments like heating oil will also get hurt over the coming years, in our view. The shift towards electrified heating has continued to grow at a strong pace around the world, helped by distributed energy installations (Exhibit 99). For consumers with access to a reliable grid and ample solar roof-top power, an electric solution is often cheaper, cleaner and more efficient. Plus, investment into green steel and other decarbonizing industrial processes continues to expand around the world (Exhibit 100).

**Exhibit 99: Global electrified heat investment by region**

Electrified heating has continued to grow at a strong pace around the world, helped by distributed energy installations (i.e. solar panels)

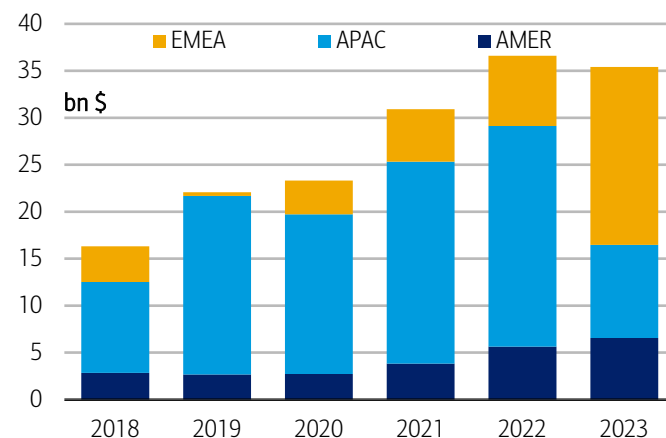


Source: BloombergNEF

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**Exhibit 100: Global investment in clean steel by region**

Investment into green steel and other decarbonizing industrial processes continues to expand around the world



Source: BloombergNEF

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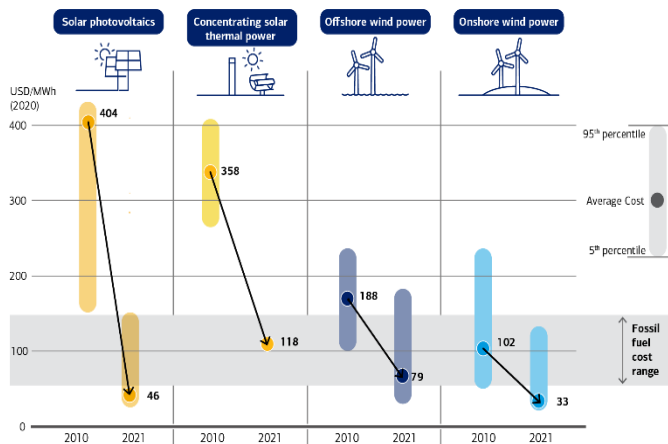
**With renewable costs falling, fuel phase outs are a matter of time**

Ultimately, the energy transition is about renewable energy prices falling to become competitive with thermal fuel alternatives (Exhibit 101). It is about making better and cleaner products that consumers want to buy. And most analyses point to the fact that the levelized cost of energy keeps falling across the board for renewables (Exhibit 102). It does not mean that oil demand will collapse imminently, but it does suggest that decarbonization and electrification trends will have a major impact on fossil fuel consumption in the decades ahead. Following a 2.4mn b/d expansion in 2023, we can conclude that oil demand has not peaked but it is relatively safe to assume that oil demand growth rates have indeed peaked.



**Exhibit 101: Renewable Energy price declines led by wind & solar**

Ultimately, the energy transition is about renewable energy prices falling to become competitive with thermal fuel alternatives...

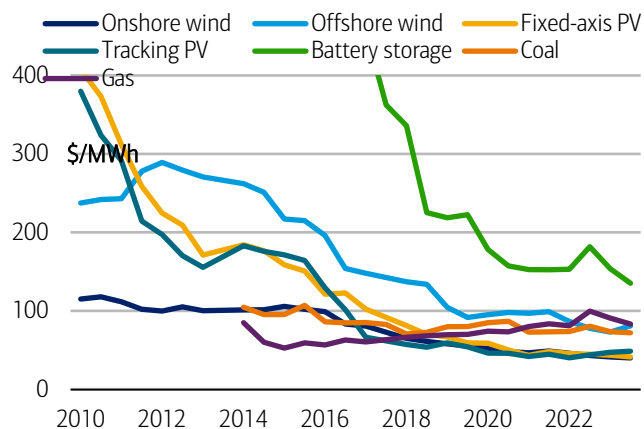


Source: REN21 Renewables 2022 Global Status Report

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**Exhibit 102: Global LCOE**

... and most analyses point to the fact that the levelized cost of energy keeps falling across the board for renewables



Source: BloombergNEF

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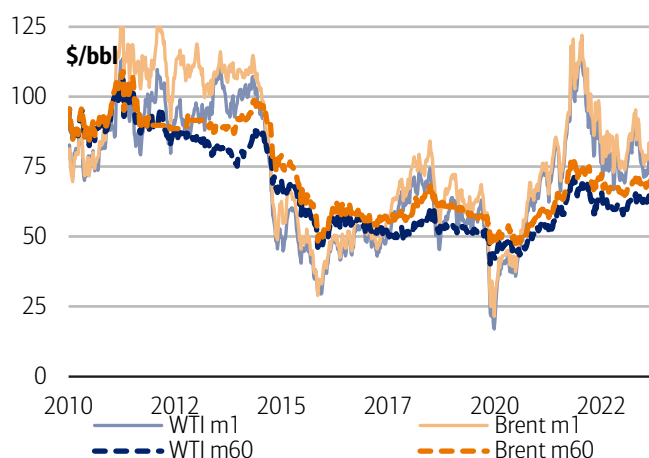
# Medium-term supply outlook for oil

## Global oil prices are on par with 2023 average levels...

Oil prices have receded from the highs of 2022 but remain relatively healthy, with front-month Brent trading around \$83/bbl compared to the previous 10-year average of \$68/bbl (Exhibit 103). Long-dated oil prices have historically been much less volatile, but here too, prices are higher. 5-year forward Brent is currently trading near \$70/bbl, up from the 10-year average of \$64/bbl. Elevated prices across the oil curve (Exhibit 104) should help support near-term cashflows for oil companies and also provide the price deck needed to encourage project sanctioning and boost upstream capex.

### Exhibit 103: WTI and Brent front-month and long-dated oil prices

Oil prices have fallen from the highs of 2022 but remain elevated on a spot and forward basis versus the past decade

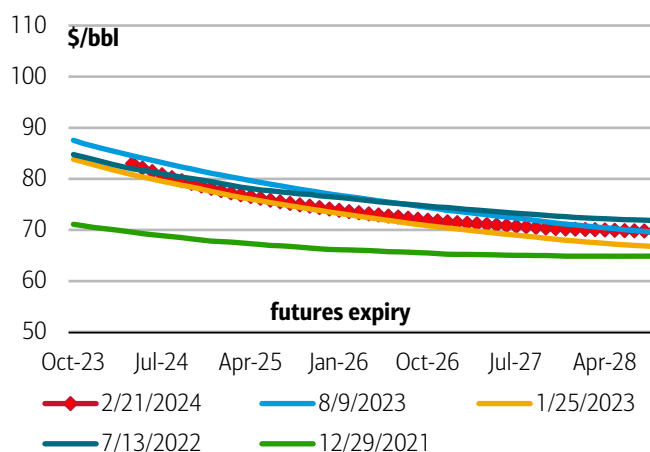


Source: Bloomberg

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### Exhibit 104: Brent forward curve

Elevated prices across the oil curve should support project sanctioning and increase upstream capex this year



Source: Bloomberg

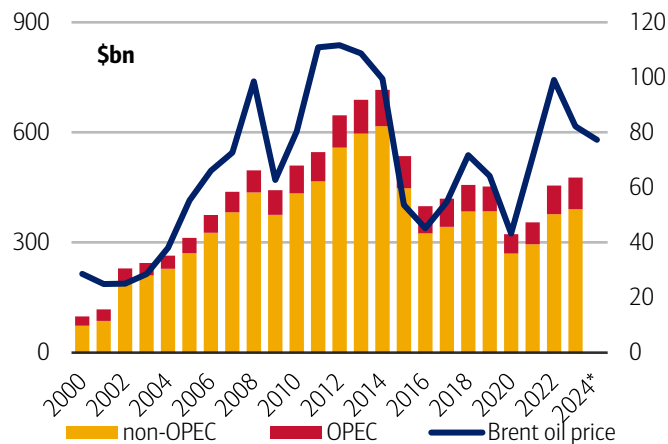
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## ...which support rising international O&G capex in 2024

Upstream capex continued its rise in 2023, even as prices fell due to the lagged effect of capex tied to projects sanctioned in prior years (Exhibit 29 and Exhibit 106). In 2024, drilling and completion capex is expected to rise (+12%), led by offshore, according to BofA Global Research equity analysts (see the report, [2024 Outlook: INTL/Offshore OFS shines bright in a dark macro](#)). Spending in Middle East OPEC countries should remain strong as capacity expansion continues apace, while spending in non-OPEC should continue apace, thanks to development in Brazil and Guyana. Capex growth is likely to be driven by increases in spend on deepwater projects while shale capex declines YoY.

**Exhibit 105: Global oil and gas capex (nominal)**

Upstream capex continued its rise in 2023, even as prices fell...

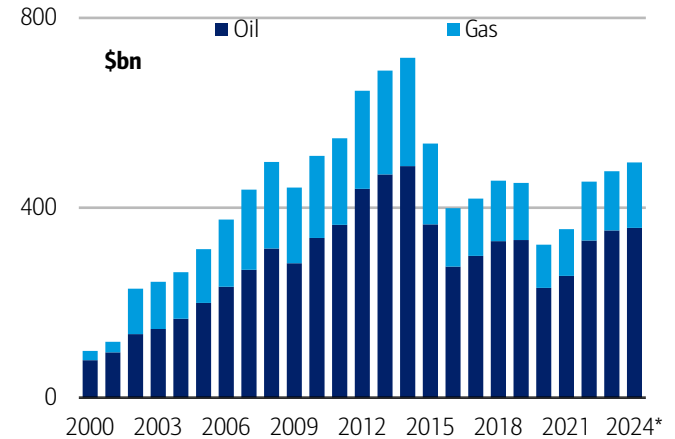


Source: Woodmac

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**Exhibit 106: Global upstream capex by field designation (nominal)**

...due to the lagged effect of capex tied to projects sanctioned in prior years



Source: Woodmac

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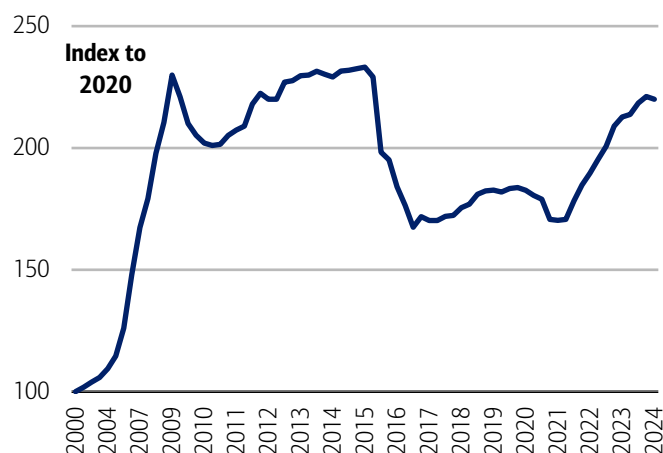
**Rising upstream costs have been partially offset by innovation**

Many cite the decline in global upstream capex since 2014 as a reason for a looming production shortfall. However, this narrative is less compelling when service cost trends are considered. S&P Global Commodity Insights' Upstream Capital Cost Index (UCCI) attempts to capture these trends by tracking the cost of rigs, materials, subsea equipment, etc. In the aftermath of the 2014-15 oil price collapse, demand for oilfield services slowed substantially, as evidenced by the drop in capex. Falling demand loosened up the market for many OFS subsectors, resulting in a nearly 30% decline in the UCCI between 1Q14 and 1Q16 (Exhibit 107). After six years of fairly stable pricing, oilfield service inflation started to tick higher in 2020 and has since risen nearly 30%, driven by OFS attrition and a ramp-up in demand. Now, the UCCI is just 6% below the highs of 2014. Operating costs, which include operations, engineering, labor, etc., have followed a similar trend, which suggests that new project breakevens should resemble something closer to what they would have during 2014. However, the oil and gas industry radically overhauled how it designs and develops projects since 2014, which has helped depress project breakevens as input costs rise. The Upstream Innovation Index (UII) attempts to capture this dynamic and has declined 24% since 2014, helping counter much of the recent rise in UCCI (Exhibit 108).



**Exhibit 107: Upstream Capital Cost Index (UCCI)**

After six years of fairly stable pricing, oilfield service inflation started to tick higher in 2020 and has since risen nearly 30%

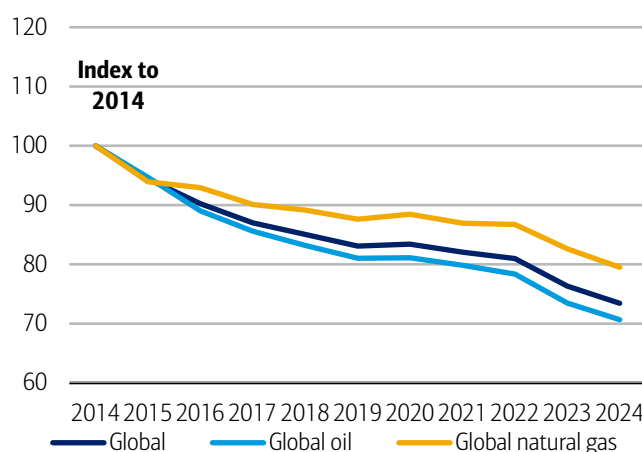


Source: S&P Global Commodity Insights.

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**Exhibit 108: Upstream Innovation Index**

Upstream innovation is estimated to have helped cut overall project costs by 24% since 2014



Source: S&P Global Commodity Insights.

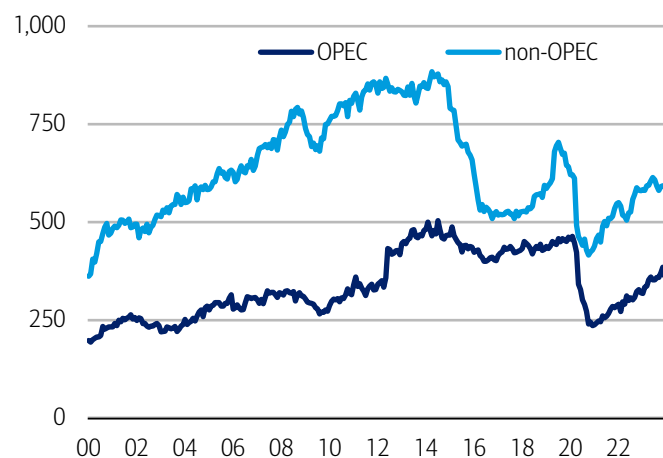
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**International drilling activity has steadily risen since 2020...**

Drilling activity collapsed in the aftermath of the pandemic, with rigs deployed in OPEC countries falling 50% from December 2019 to December 2020 and rigs operating in non-OPEC countries (excluding North America) falling by roughly 1/3rd over the same period (Exhibit 109). As prices recovered, so did drilling activity. As of December 2023, rigs in OPEC and non-OPEC (excluding North America) countries stood at 362 and 593, respectively, or 22% and 8% below pre-Covid levels. The recovery in drilling has varied by region, led by Canada (+30% versus 2019 levels) and followed by Asia and Latin America (roughly -5% versus 2019 levels) (Exhibit 110).

**Exhibit 109: Global oil and gas rig count (ex NAM)**

As of December 2023, rigs in OPEC and non-OPEC (excluding North America) stood at 362 and 593, respectively, or 22% and 8% below pre-Covid levels

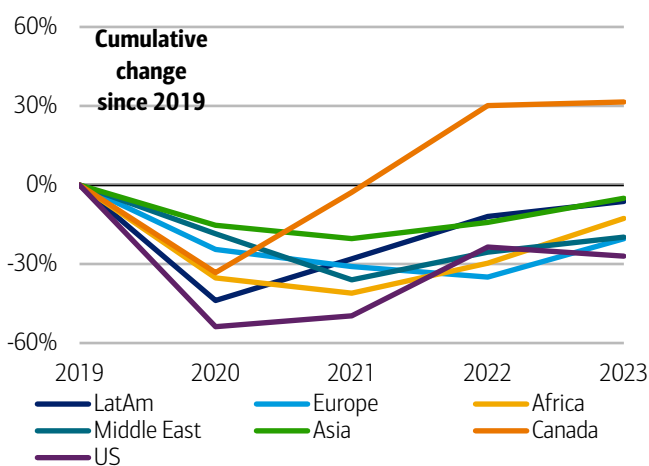


Source: Bloomberg

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**Exhibit 110: Cumulative change in rig count by region since 2019**

The recovery in drilling has varied by region, led by Canada followed by Asia and Latin America



Source: Bloomberg

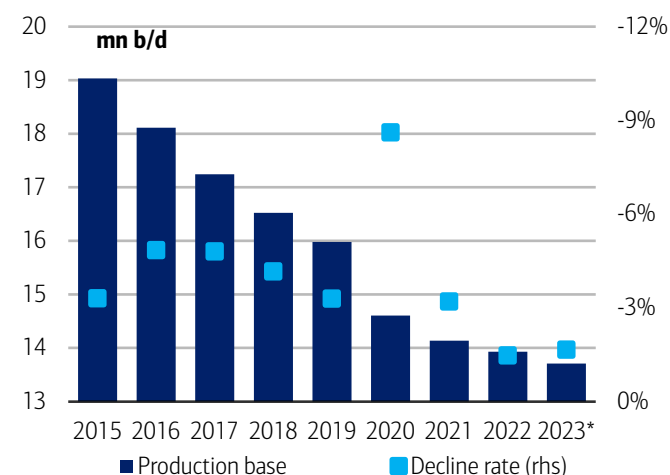
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**...which contributed to lower decline rates for many countries**

The crash in drilling activity coincided with a sharp acceleration in field-level decline rates, but the subsequent recovery has pushed decline rates to some of the lowest levels seen the past decade (Exhibit 111). Indeed, fields and regions where production peaked prior to 2010 saw decline rates fall from highs of 8-9% in 2020 to just 1-2% in 2022-23. Decline rates accelerated in the US, Norway, and UK, eased in Mexico and Brazil, and shrank to nearly zero in China (Exhibit 112).

**Exhibit 111: Estimated decline rates for select non-OPEC fields and regions peaking by 2010 (%YoY)**

Fields and regions where production peaked prior to 2010 saw decline rates fall from highs of 8-9% in 2020 to just 1-2% in 2022-23

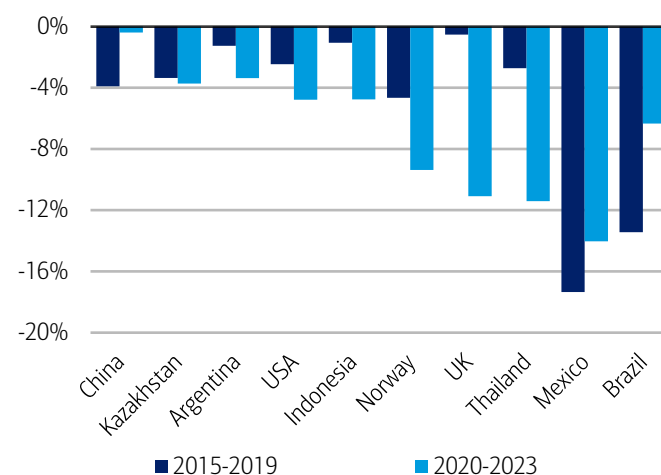


Note: 2023 data through 3Q. Source: IEA, BofA Global Research estimates

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**Exhibit 112: Estimated decline rates by country for select non-OPEC fields and regions peaking by 2010 (%YoY)**

Decline rates accelerated in the US, Norway, and UK, eased in Mexico and Brazil, and shrank to nearly zero in China



Note: 2023 data through 3Q. Source: IEA, BofA Global Research estimates

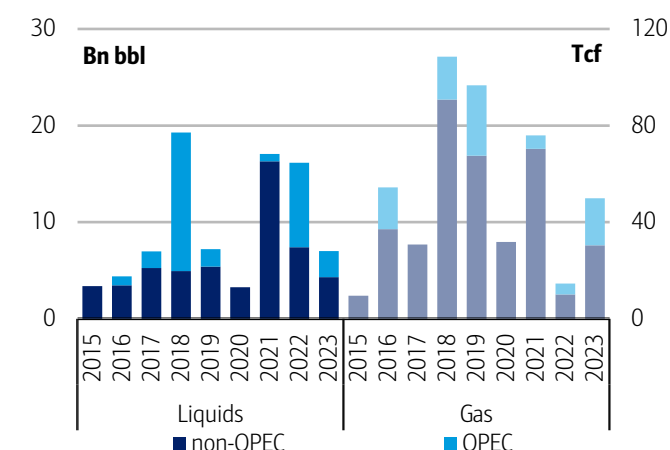
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**Project sanctioning slowed YoY in 2023 as oil prices softened...**

Rising oil prices over 2021-22 led to a surge in upstream oil project FIDs, with over 33bn bbl of liquid reserves sanctioned (Exhibit 113). The amount of reserves sanctioned fell to just 7bn bbl in 2023, driven in part by lower oil prices. Notable projects sanctioned last year included Qatar's North Field South, an LNG project with nearly 1bn bbl of liquids reserves, Iraq's Eridu field (1.2bn bbl), UAE's Hail and Ghasha project (950mn bbl), and Exxon's Uaru FPSO in Guyana, which is tied to roughly 1bn bbl of liquid reserves. These larger projects are expected online during 2026-28, but between now and then, a significant amount of new project starts are expected tied to sanctioning decisions made during the 2015-23 timeframe (Exhibit 114).

**Exhibit 113: Oil and gas project FIDs by reserves and sanction year**

Rising oil prices over 2021-22 led to a surge in upstream oil project FIDs, with over 33bn bbl of liquid reserves sanctioned...

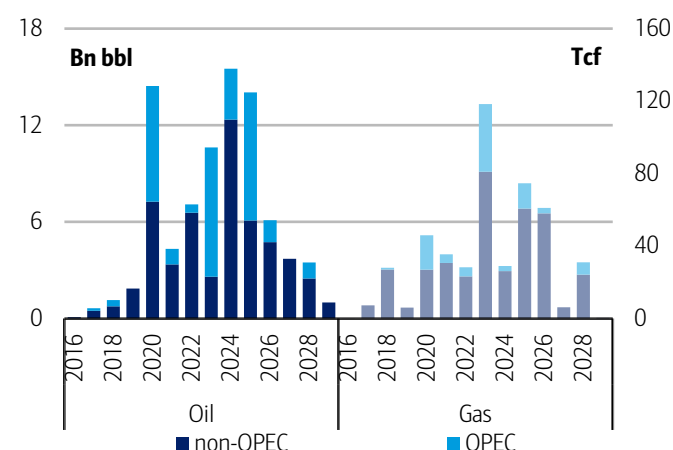


Source: Woodmac

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**Exhibit 114: Oil & gas project FIDs (2015-23) by reserves and start year**

These larger projects are expected online during 2026-28 but between now and then, we expect a significant amount of new project starts tied to sanctioning decisions made during the 2015-23 timeframe



Source: Woodmac

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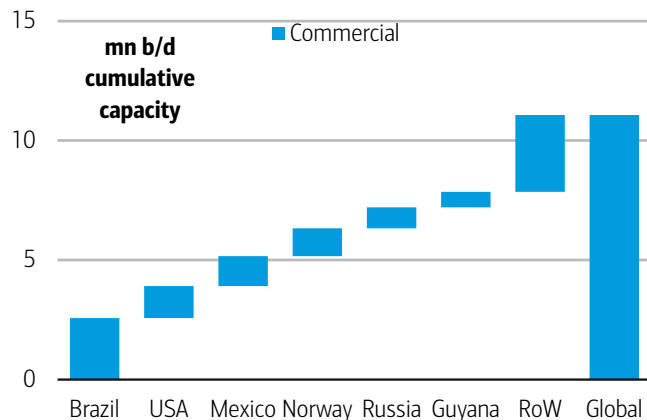
**...but the medium-term pipeline of projects still looks healthy...**

During the past six years, major non-OPEC oil projects with nearly 11.1mn b/d of peak production capacity commenced operations, driven by Brazil (2.6mn b/d of capacity additions), while the USA, Mexico, Norway and others delivered much smaller

contributions (Exhibit 115). Over the next six years (2024-29), there is potential for non-OPEC to deliver upwards of 12mn b/d of cumulative capacity additions (Exhibit 116), but geopolitical and technical challenges threaten to thin the project pipeline. In Brazil, capacity additions are expected to be higher than the 2018-23 timeframe at nearly 2.8mn b/d, followed by Russia, which is expected to see first oil from fields tied to its massive Vostok oil project late in the decade. Meanwhile, the US and Guyana are expected to deliver close to 1.4mn b/d and 1.2mn b/d of new project starts.

#### Exhibit 115: Realized non-OPEC capacity starts 2018-23

Over the past six years, major non-OPEC oil projects with nearly 11.1mn b/d of peak production capacity commenced operations

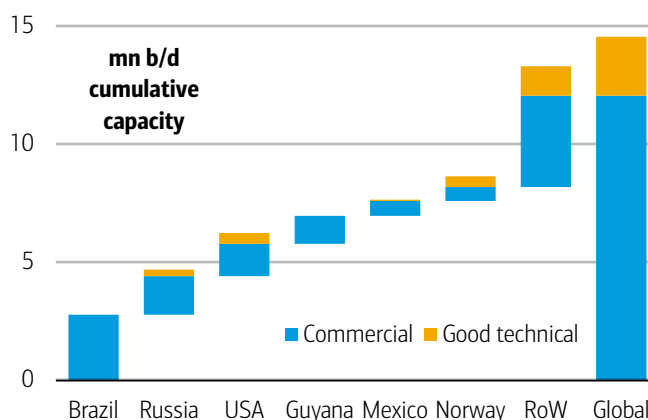


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 116: Potential non-OPEC capacity starts 2024-29

Over the next six years (2024-29), there is potential for non-OPEC to deliver upwards of 12 mn b/d of cumulative capacity additions



Source: Woodmac, BofA Global Research estimates

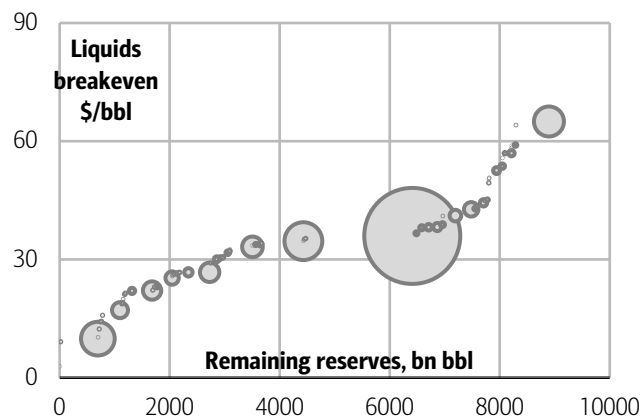
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#### ...partly because the economics for many projects are still attractive

Many projects to be commissioned during the 2024-29 have exceptionally low forward looking breakevens, and those that don't still appear to have positive economics at the current forward strip (Exhibit 117). Very strong forward-looking economics are partly a result of capital already sunk into the projects. Even if some of these projects don't breakeven on a full cycle basis at future oil prices, they still look attractive given the remaining capital required to bring production onstream. In the shale basins, the cost curve also looks very attractive due to efficiency and productivity gains achieved over the past decade (Exhibit 118).

#### Exhibit 117: Forward-looking breakeven economics for select non-OPEC projects (2024-29)

Many non-OPEC projects to be commissioned during the 2024-29 have exceptionally low forward-looking breakevens

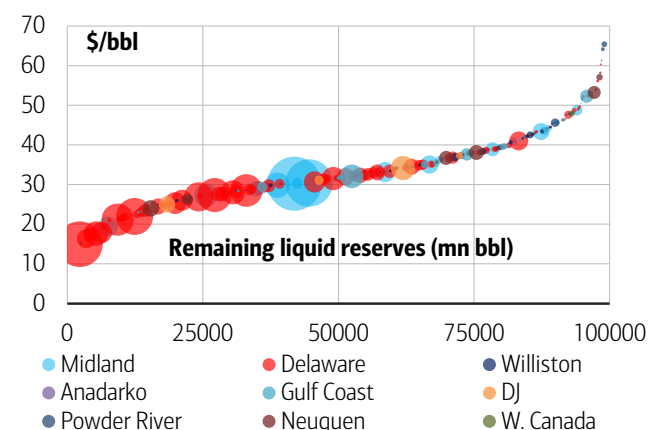


Note: 15% cost of capital. Source: Woodmac

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#### Exhibit 118: Shale oil breakeven cost curve

In the shale basins, the cost curve also looks very attractive due to efficiency and productivity gains achieved over the past decade



Note: 15% cost of capital. Source: Woodmac

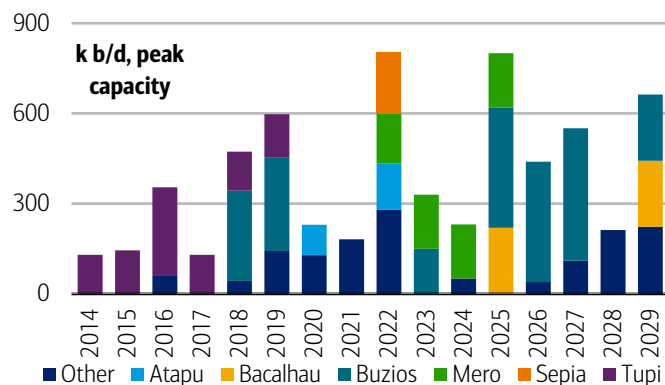
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### Significant pre-salt project startups drive Brazilian output higher...

In Brazil, development of pre-salt fields continues at a rapid pace, and we see more than 2.7mn b/d of new capacity starting up in the medium term, with Buzios FPSOs accounting for more than half of the total (Exhibit 119). Furthermore, the start-up of projects like Equinor and Exxon's Bacalhau and Bacalhau Norte FPSOs will add about 220k b/d of capacity each when they are commissioned in 2025 and 2029. The laundry list of large offshore projects planned over the medium term should drive Brazil's production comfortably above 4mn b/d during the second half of the decade (Exhibit 120), and more FPSO projects could extend growth into the early 2030s too.

#### Exhibit 119: Realized and potential Brazil upstream project starts

We see more than 2.7mn b/d of new capacity starting up in the medium term for Brazil, with Buzios FPSOs accounting for more than half of the total

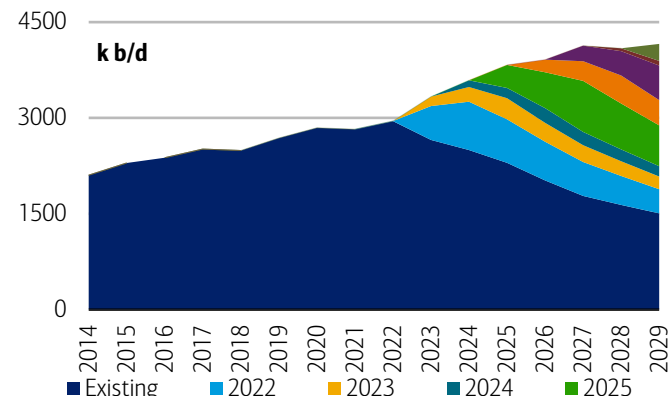


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 120: Brazil offshore oil production forecast

The laundry list of large offshore projects should drive Brazil's production comfortably above 4mn b/d during the second half of the decade



Source: IEA, BofA Global Research estimates

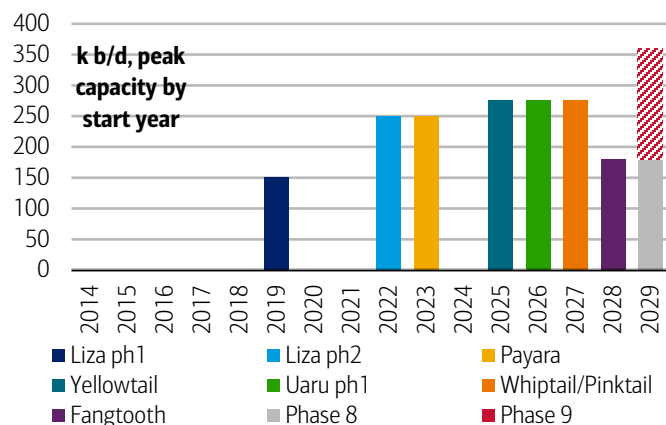
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### ...while Guyana's crude oil production ramp is just getting started

Guyana could be the largest source of non-OPEC (ex-US) growth in the medium term. Nearly 15bn boe of reserves have been discovered in Guyana's offshore since 2015, and projects have been fast tracked with first oil delivered in 2019 (Exhibit 121) (see [Budget 2024: Capex guide in line, momentum & asset visibility defensive](#)). Exxon and its partners already commissioned 3 FPSOs and could deliver upwards of 6 more by the end of 2029. Already, Guyanese oil production has soared to more than 500k b/d as of December, according to IEA estimates, but the country's project pipeline could push output toward 1.9mn b/d by the end of 2029 (Exhibit 122) if development stays on schedule.

**Exhibit 121: Realized and potential Guyana upstream project starts**

Guyana could be the largest source of non-OPEC (excluding US) growth in the medium term, with at least five new developments expected before 2030

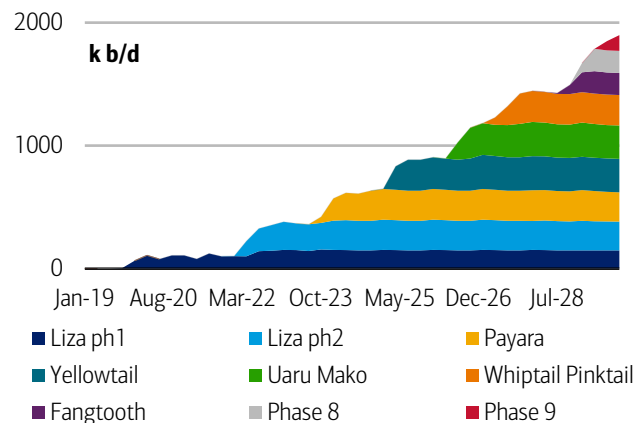


Source: BofA Global Research estimates

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**Exhibit 122: Guyana offshore oil production forecast**

Guyana's project pipeline could drive output toward 1.9mn b/d by the end of 2029 if development stays on schedule



Source: BofA Global Research estimates

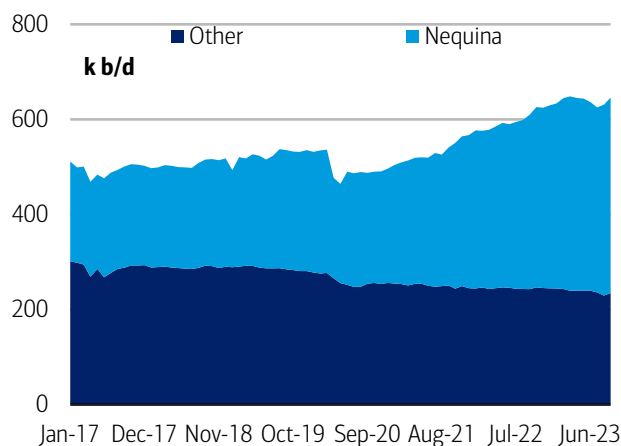
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**In Argentina, new pipelines should give Vaca Muerta room to run**

The Vaca Muerta shale formation has garnered significant attention in the past decade, but the pace of production growth there has lagged the American shales. At the end of 2023, production in the Neuquen basin (Vaca Muerta) was estimated at just 400k b/d (Exhibit 123). Vaca Muerta growth has more than offset declining output elsewhere in Argentina, leading to 50k b/d of production growth at a country level. Growth in the Vaca Muerta has been constrained at times by political/labor issues and pipeline bottlenecks. Fortunately, the political climate is favorable for growth, and incremental brownfield and greenfield pipeline capacity should allow Argentina's production to exceed 1mn b/d over the medium term. After all, Argentina's resource base is nearly 50% larger than the US DJ basin, but output is 33% less. Looked at differently, we note that the Vaca Muerta has ~45 years of inventory at current production levels, or more than double that of most major US and Canadian shale basins (Exhibit 124).

**Exhibit 123: Argentina onshore crude oil production**

At the end of 2023, production in the Neuquen basin (Vaca Muerta) was estimated at just 400k b/d, but output should continue to grow medium term

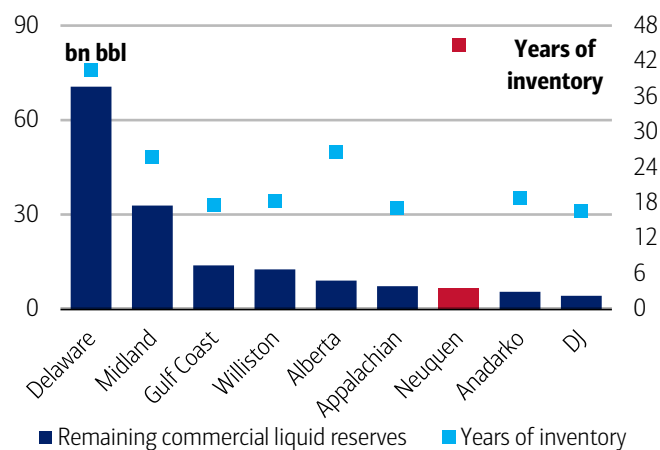


Source: Rystad Energy

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**Exhibit 124: Commercial liquid resource reserves and years of inventory for select shale basins**

The Vaca Muerta has ~45 years of inventory at current production levels, or more than double that of most major US and Canadian shale basins



Source: Woodmackenzie, BofA Global Research

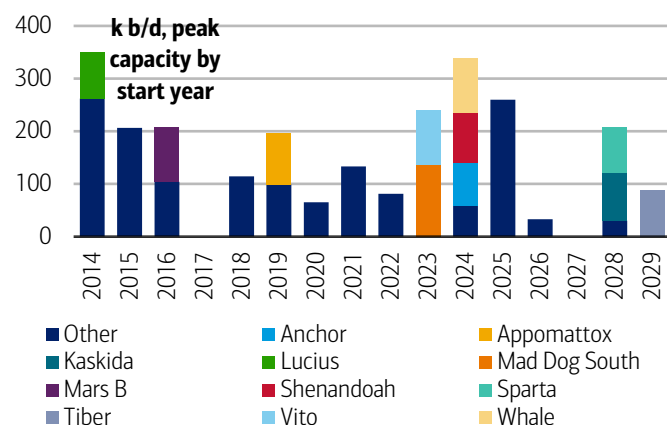
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## Deepwater to drive GoM growth, while Alaska's prospects mired by politics

In the US, we see opposite trends in the Gulf of Mexico and in Alaska. The former is set to grow into 2026 on the back of a slug of new capacity starts, including Mad Dog South and Vito, which started in 2023, and Appomattox, Anchor, Shenandoah, which start in 2024 (Exhibit 125). The project pipeline slows considerably from 2026 onward, with just a few notable projects, such as Sparta, Tiber, and Kaskida, seeing first oil in 2028-29. Alaska is only likely to see meaningful new project starts later in the decade, with the massive Willow project starting up by 2029 (Exhibit 126) and pushing up Alaska's production during the early 2030s. Given the political resistance to Willow's approval and the size of the project, it is possible that Willow's startup timeline slips into the 2030s.

### Exhibit 125: Realized and potential Gulf of Mexico upstream project starts

Gulf of Mexico capacity additions are weighted towards 2024-25...

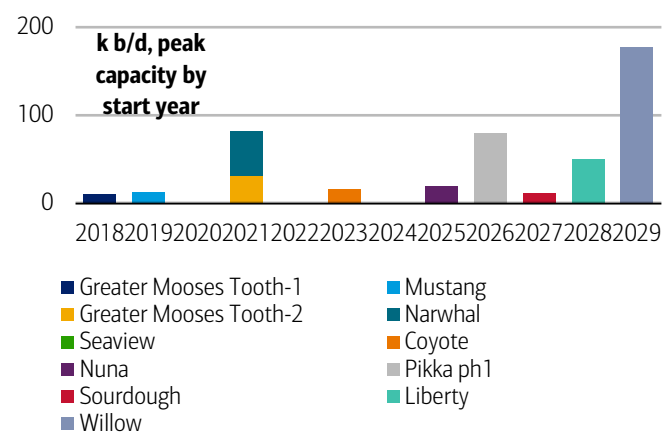


Source: Woodmac, BofA Global Research estimates

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### Exhibit 126: Realized and potential Alaska upstream project starts

...while Alaska's project pipeline is back half weighted and heavily dependent on the timing of Willow



Source: Woodmac, BofA Global Research estimates

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## Mexico benefitted from recent projects, but supply should fall further medium term

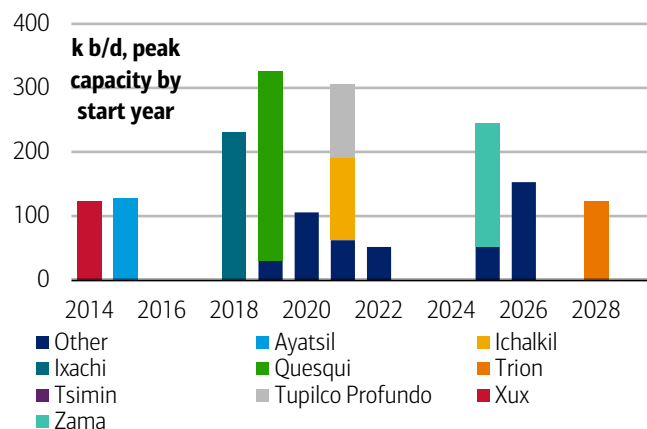
### term

Several large projects have ramped up over 2018-22 in Mexico (Exhibit 127), adding enough volume to halt production declines that persisted over the prior 15 years. Since 2020, Mexico's crude oil production has been rising (Exhibit 128), but with no major project starts expected in 2023-24, output seems poised to decline into 2025. Over the medium term, the project pipeline looks light, with just 500k b/d of capacity additions during 2024-29, down from more than 1mn b/d of additions during 2018-23.

Furthermore, two offshore fields, Zama and Trion, are likely to account for more than 60% of new capacity additions, creating concentration risk should either project get delayed. We believe that a limited project pipeline will cap Mexico's recent growth and should drive output lower in the medium term.

**Exhibit 127: Realized and potential Mexico upstream project starts**

Several large projects have ramped up over 2018-22, halting 15 years of production declines in Mexico...

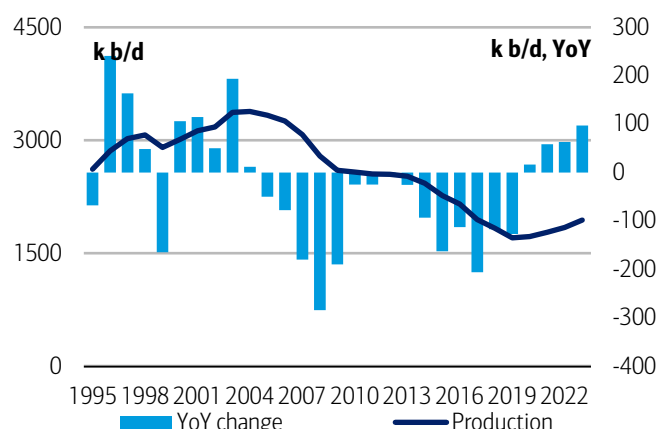


Source: Woodmac, BofA Global Research estimates

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**Exhibit 128: Mexico crude oil production**

...but a limited project pipeline should cap Mexico's recent growth and drive output lower in the medium term



Source: IEA

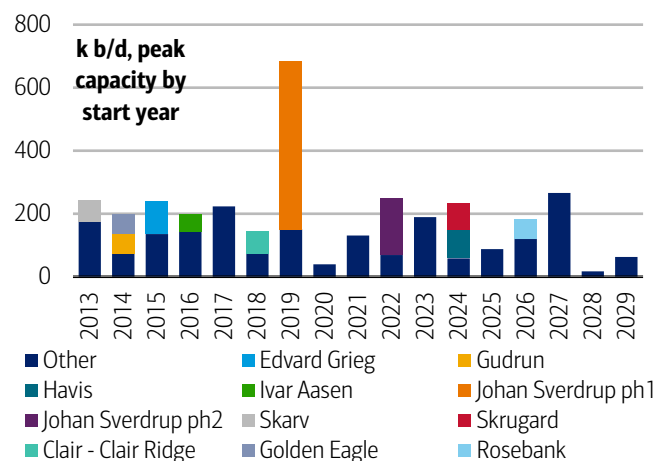
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**North Sea production should shift into reverse late this decade**

UK and Norway production has struggled to meet expectations in recent years as high decline rates at mature fields erased gains from new projects. In the UK, this led to a production decline of nearly 100k b/d YoY in 2023, and in Norway, production growth totaled 120k b/d. In the medium term, we see more limited capacity additions, with only one major project, Johan Castberg (190k b/d). This project, which includes Skarv, Skrugard, and other developments, should see first oil in 2024 (Exhibit 129). While we expect modest North Sea production growth through 2027, we think that production will roll over by 2028-29 (Exhibit 130).

**Exhibit 129: UK and Norway realized and potential project starts**

North Sea capacity additions appear limited over the medium term

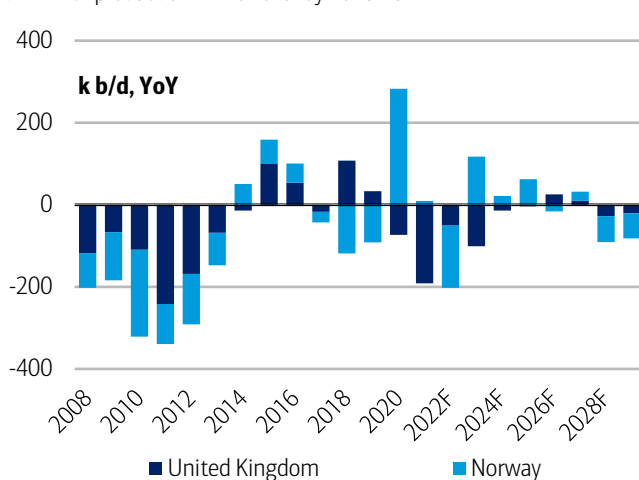


Source: Woodmac, BofA Global Research estimates

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**Exhibit 130: UK and Norway liquids production**

While we expect modest North Sea production growth through 2027, we think that production will roll over by 2028-29



Source: IEA, BofA Global Research estimates

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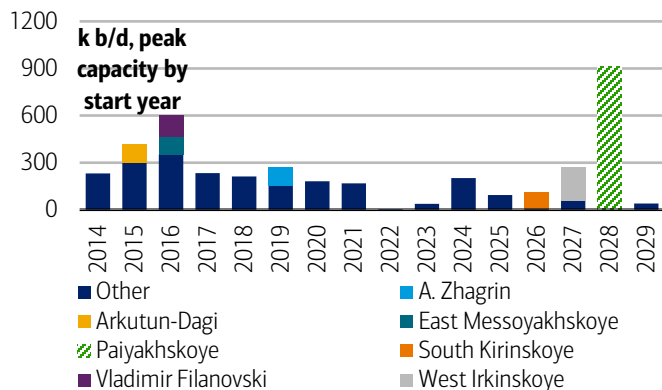
**Russian outlook hinges on Vostok, production exposed to conflict**

Historical capacity additions in Russia appear small relative to its production base (Exhibit 131), but output rose steadily through 2019 (Exhibit 132), helped by a steady ramp-up at fields already online. In the medium term, capacity additions are limited until 2028, when the Paiyakhskoye field, which ties into the 1+mn b/d Vostok oil project, is expected online. Yet we think that Russia has room to grow output from current levels if it wants to. Over the medium term, we expect output there to climb higher, accelerating in 2028-29, when Paiyakhskoye starts up. Russia's ongoing war with Ukraine has put its

upstream and energy infrastructure at risk. Recent attacks on refineries, processing facilities, and other infrastructure have so far not led to any material loss of output, but the risk of outages appears to only be rising. Thus, we see the potential for a wide range of outcomes for Russian oil supply in the medium term.

#### Exhibit 131: Russia realized and potential project starts

Russia's project pipeline looks light and depends heavily on the timing of the Paiyakhskoye field

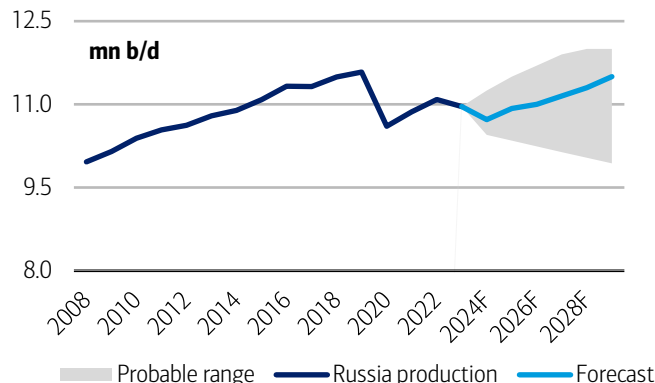


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 132: Russia total liquids production

The timing of the Vostok oil project and war with Ukraine create significant uncertainty for Russia's supply in the medium term



Source: EIA, BofA Global Research estimates

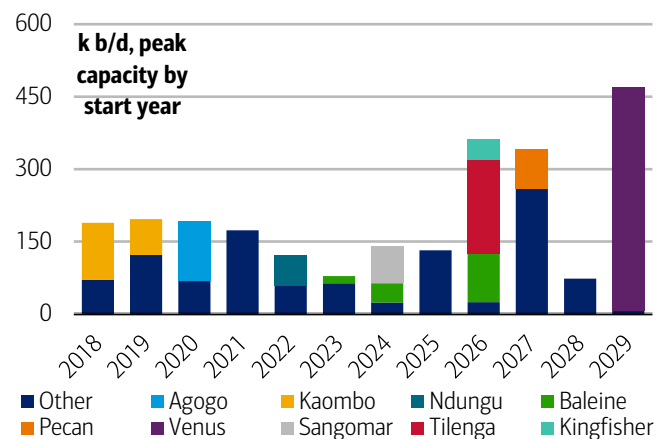
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#### Non-OPEC Africa projects to hit late in the 2020s, FIDs still needed

The project pipeline for non-OPEC Africa, which now includes Angola, slowed for three consecutive years into 2023 (Exhibit 133), which helped perpetuate production declines across the continent (Exhibit 134). Fortunately, the pace of new project starts should accelerate, particularly in 2026-27. Major fields expected online over the medium term include Cote d'Ivoire's Baleine field, Senegal's 75k b/d Sangomar project, Uganda's long-awaited 200k b/d Tilenga project, the 85k b/d Pecan project, and the prolific 470k b/d Venus project in Namibia. Venus still requires an FID and is technically challenging. It is possible that even if this project is sanctioned in 2025, first oil might not occur until after 2029. While a delay for Venus may alter the 2029+ outlook, we still see potential for the existing projects to stabilize and grow non-OPEC African output in 2026-28.

#### Exhibit 133: Non-OPEC Africa realized and potential project starts

The pace of non-OPEC Africa's new project starts should accelerate, particularly in 2026-27...

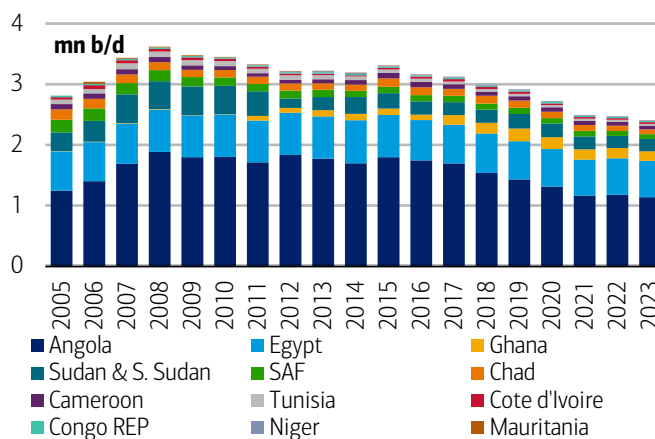


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 134: Non-OPEC Africa liquids production

...which should help push supply higher after underinvestment led to years of declines



Source: IEA, BofA Global Research estimates

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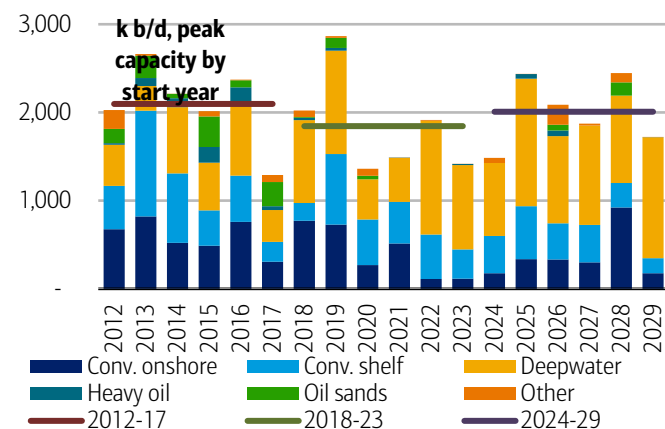


### Non-OPEC pipeline healthy, but we see major technical, geopolitical risk...

The pipeline of non-OPEC projects that started during the 2018-23 time horizon is estimated to be roughly 250k b/d lower annually than what was seen during 2012-17 (Exhibit 135). Over the next six years (2024-29), capacity additions could rise ~150k b/d annually versus 2018-23. On the surface, these figures are reassuring against a medium-term oil supply shortage, but the oil market will likely be even more dependent on complex deepwater projects to support global supply than during the last decade, which creates a higher risk of delays (Exhibit 136). Furthermore, the supply stack has significant capacity coming online in countries such as Guyana, whose borders are being disputed by its Venezuelan neighbor; Russia, which is fighting a war and has seen its infrastructure attacked; and Brazil, which just announced that it will join the OPEC+ cooperation charter (non-binding). Thus, we see plenty of risk to non-OPEC's project pipeline.

#### Exhibit 135: Realized and potential non-OPEC capacity additions by resource type

We see ~2mn b/d of new non-OPEC capacity additions (peak) annually in 2024-29, up from 1.84mn b/d during 2018-23...

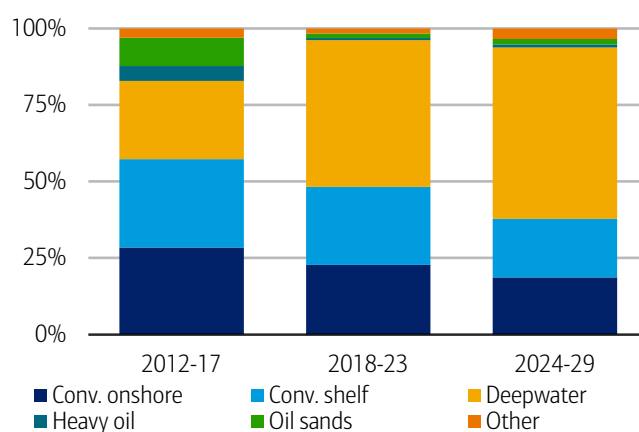


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 136: Composition of realized and potential Non-OPEC capacity additions by resource type

...but increased dependence on deepwater projects and rising geopolitical tensions create downside risks to supply



Source: Woodmac, BofA Global Research estimates

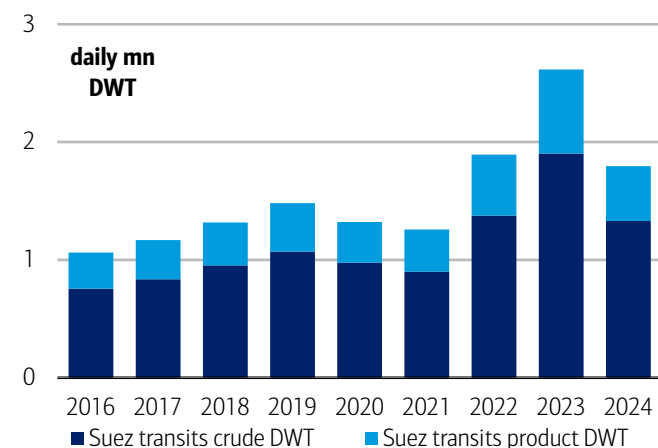
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### ...especially as Middle East tensions, Russia sanctions dislocate oil flows

Russia sanctions already triggered a major re-routing of oil flows away from the Mediterranean (Europe) into the Red Sea (Asia), expanding global supply chains (Exhibit 137). Plus, recent Houthi attacks on vessels have been tempered by spare shipping capacity, although we see growing upside risks in petroleum fuels, such as diesel. Should Middle East tensions persist throughout 2024, oil shipping routes may lengthen further. Oil output and developments could be disrupted altogether. If global balances shift from a projected surplus into a deficit, Brent crude prices would exceed our projected averages for \$80/bbl in 2024 and 2025.

**Exhibit 137: Daily Suez Canal oil and product transits**

Russia sanctions already triggered a major re-routing of oil flows away from the Mediterranean (Europe) into the Red Sea (Asia), expanding global supply chains

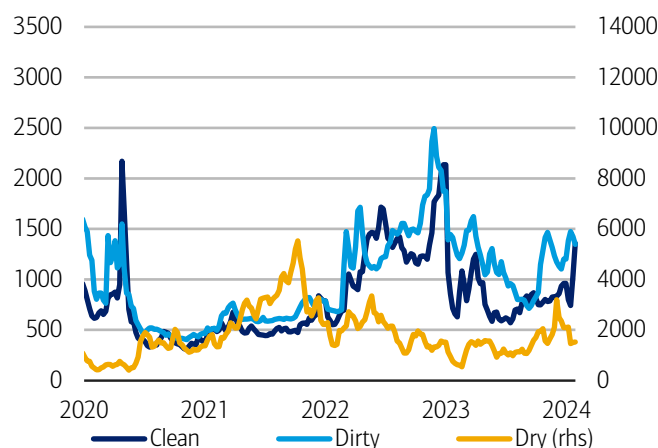


Source: Clarksons

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**Exhibit 138: Baltic freight indices**

Plus, recent Houthi attacks on vessels were tempered by spare shipping capacity, but we see growing upside risks in petroleum fuels, such as diesel



Source: Bloomberg

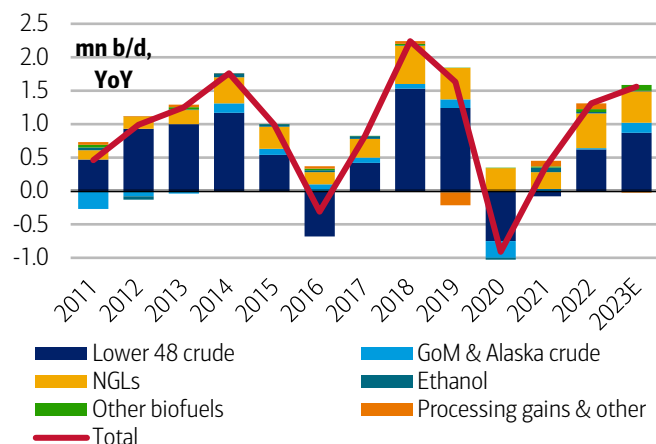
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**Meanwhile, robust US shale growth re-emerged in 2023**

US shale producers have worked hard to change their image in recent years, reining in ambitious capex and growth plans in favor of shareholder returns and moderate supply growth. 2022 appeared to confirm this trend, with crude oil supply growth registering around 600k b/d YoY (Exhibit 139). Lower prices in 2023 and a general slowdown in drilling activity allowed the market to maintain its assumption that US shale wouldn't destabilize the oil market like it had on multiple occasions during the 2010s. However, in recent months supply growth started to tick higher once again and crude oil growth is now likely to reach about 1mn b/d YoY in 2023, which combined with strong NGL and biofuel growth, likely boosted US petroleum and other liquid supply by roughly 1.5mn b/d last year. Soaring US supply, coupled with rising supply elsewhere and slowing demand caused balances to deteriorate and inventories to begin building in 4Q24 (Exhibit 140). The reversal of 3Q23 inventory draws during 4Q23 has weighed on prices even as geopolitical tensions flared.

**Exhibit 139: US petroleum and liquids supply growth**

US petroleum and other liquid supply likely grew by roughly 1.5mn b/d in 2023

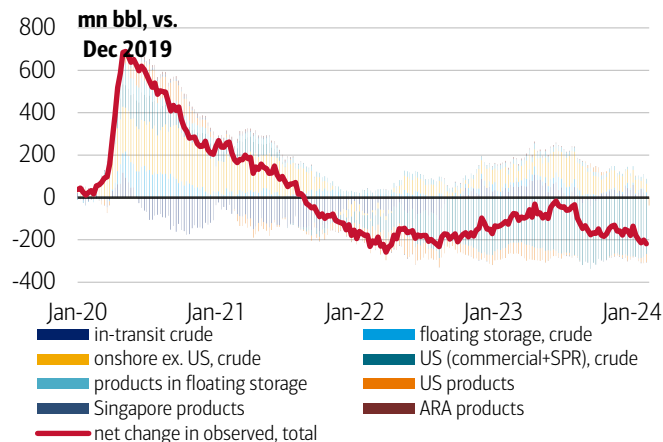


Source: EIA

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**Exhibit 140: Observed change in petroleum inventories**

Soaring US supply, coupled with rising supply elsewhere and slowing demand caused balances to deteriorate in 4Q24



Source: Kayros, Bloomberg, Clarkson's, BofA Global Research

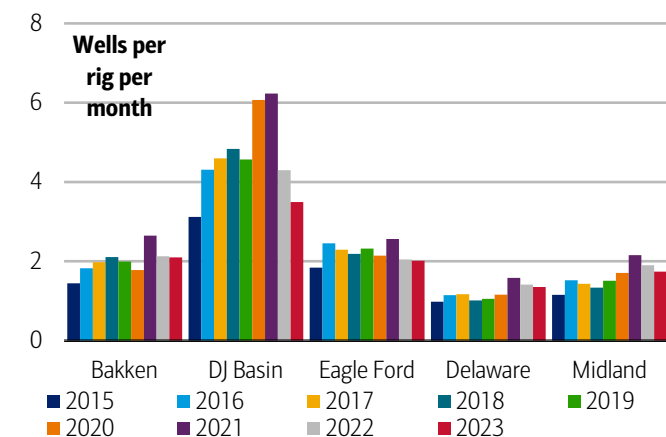
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**Some observers attribute recent shale growth to rising efficiency, ...**

One defining feature of shale wells is their accelerated decline rates, which can be upwards of 70%+ in the first year. To sustain and grow output in the shale basins, producers must constantly drill new wells, a dynamic that has allowed E&Ps and oil field service companies to iterate, modify, and optimize well design and become more efficient along the way. One of the most obvious signs of efficiency and technological innovation is the pace of drilling. The number of wells drilled per month per rig rose fairly steadily across the oil basins through 2021, but this trend has reversed in 2022 and 2023 (Exhibit 141). The slowdown is partly explained by the need to bring more inexperienced crews into the field in the past two years as drilling demand increased in response to rising oil prices. Less experienced crews typically contributed to slower drilling activity, which may explain the dip in feet drilled per day during 2022 and early 2023 (Exhibit 142).

**Exhibit 141: Horizontal wells drilled per month per rig**

The number of wells drilled per month per rig rose during 2015-21, but this trend has reversed in 2022 and 2023

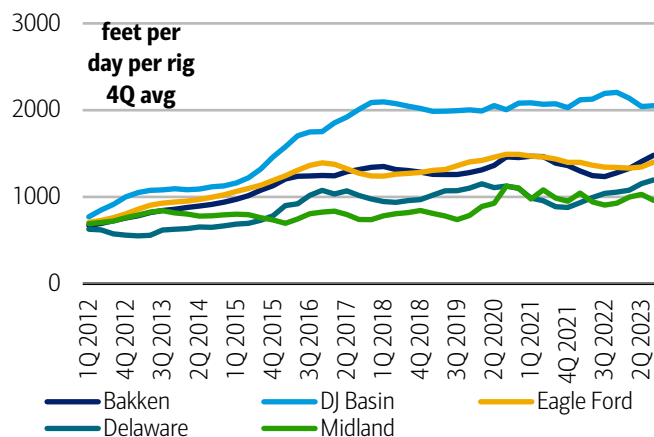


Source: Rystad Energy

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**Exhibit 142: Horizontal feet drilled per day per rig by basin**

Less experienced crews typically contributed to slower drilling activity, which may explain the dip in feet drilled per day during 2022 and early 2023



Source: Rystad Energy

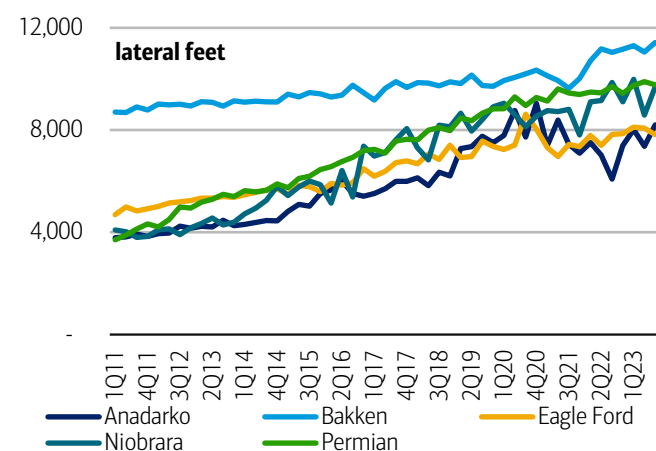
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### ...longer laterals, and increased well productivity

One of the easiest ways for producers to boost well productivity has been to increase the size of wells by drilling longer laterals. Wells in the Bakken have always been relatively long, but wells in other basins have caught up over the past decade (Exhibit 143). Since 2011, the lateral length of wells in the Permian has more than doubled from roughly 4,000 feet to nearly 10,000 feet in recent quarters. Other areas of focus for boosting well productivity included frac spacing and intensity and well spacing. Proppant usage per foot, an indicator of the intensity and number of fracs per well, rose across most basins through 2018, but the pace of growth has either slowed or flatlined since then (Exhibit 144), suggesting that proppant intensity has been more or less optimized.

#### Exhibit 143: Average US horizontal oil well lateral lengths by basin

Wells in the Bakken have always been relatively long, but wells in other basins have caught up over the past decade

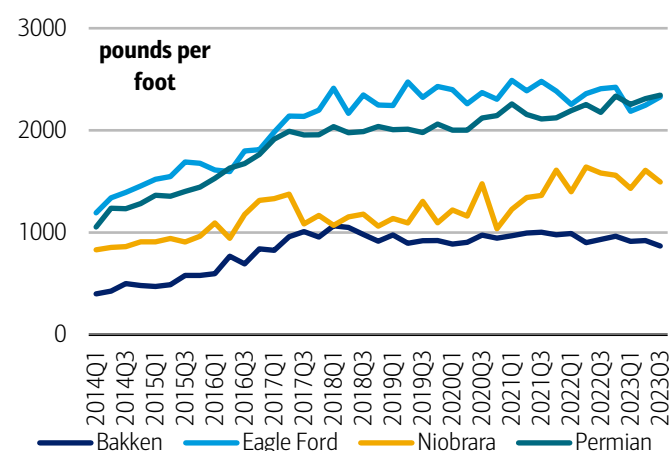


Source: Rystad Energy

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#### Exhibit 144: US horizontal shale well oil proppant usage

Proppant usage per foot, an indicator of the intensity and number of fracs per well, rose across most basins through 2018 but has slowed since



Source: Rystad Energy

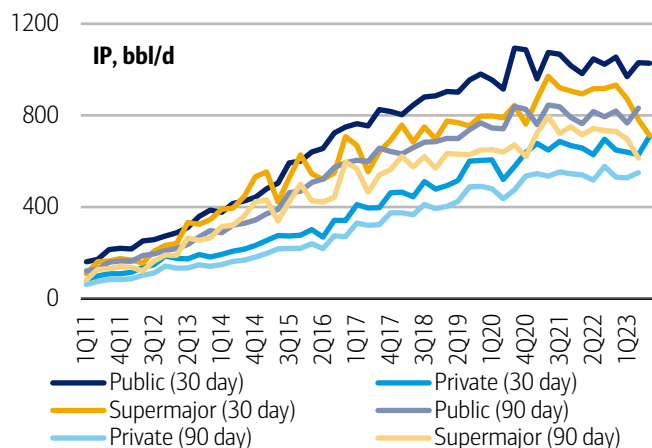
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### While these factors likely contributed to US growth...

Well productivity is measured in a variety of ways, and one of the most commonly recognized is the rate of initial production or IP, which can be measured over a variety of time horizons. The productivity of oil wells, measured using IP rates, shows a steady improvement from 2011 to 2020 across all producers (Exhibit 145), but the pace of improvement has either slowed significantly or stagnated since then, implying that well productivity likely did not play the main role in the recent surge. A look at performance across different basins suggests that only the Eagle Ford has seen material improvement recently, but this rise follows a steady decline during 2021-22 (Exhibit 146).

**Exhibit 145: US horizontal shale well oil IPs by company type**

The productivity of oil wells, measured using IP rates, shows a steady improvement from 2011 to 2020 but improvement has slowed since then

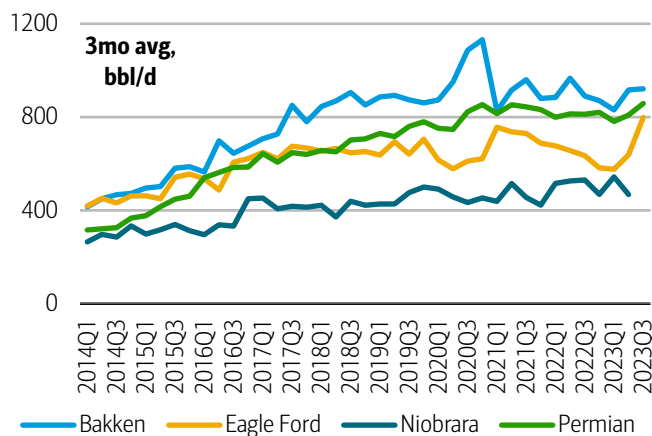


Note: includes horizontal wells in the Bakken, Eagle Ford, Niobrara, and Permian. Source: Rystad Energy

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**Exhibit 146: US horizontal shale well oil IPs (3mo avg)**

A look at performance across different basins suggests that only Eagle Ford 3 month IPs have seen material improvement recently



Source: Rystad Energy

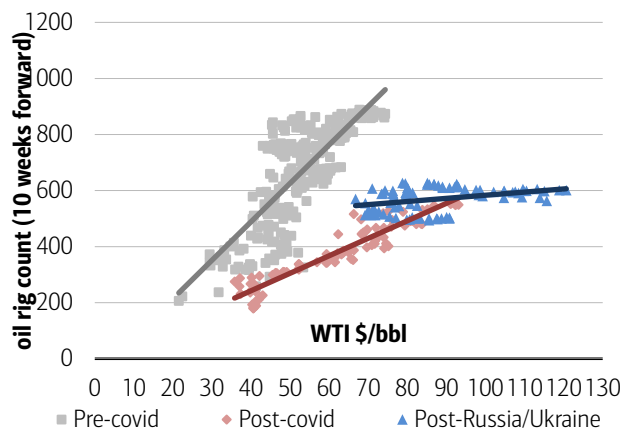
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**...another factor was shale's delayed response to high prices in 2022**

The pace of upstream activity is unsurprisingly crucial in determining oil production growth. Shale producers were slower to add rigs in the aftermath of the pandemic (Exhibit 147), a reflection of a more disciplined approach to growth but also a result of the drilled but uncompleted well backlog accumulated during the early days of the pandemic. Rig additions were even less sensitive to higher prices following the war in Ukraine, which suggested that producers were nearly unresponsive to rising prices. In fact, this was not the case as wells drilled rose steadily into 2H22 before slowing again in 2023, alongside the decline in rig counts. Typically, wells are completed and put-on-production several months after the well is drilled because most wells are part of a pad design. As a result, well starts peaked long after oil prices had crashed from their mid-2022 highs (Exhibit 148), leading to a production surge during 2023.

**Exhibit 147: US oil rig count and WTI oil prices**

Rig additions were less sensitive to prices following the Ukraine war, which superficially suggested that E&Ps were nearly unresponsive to rising prices...

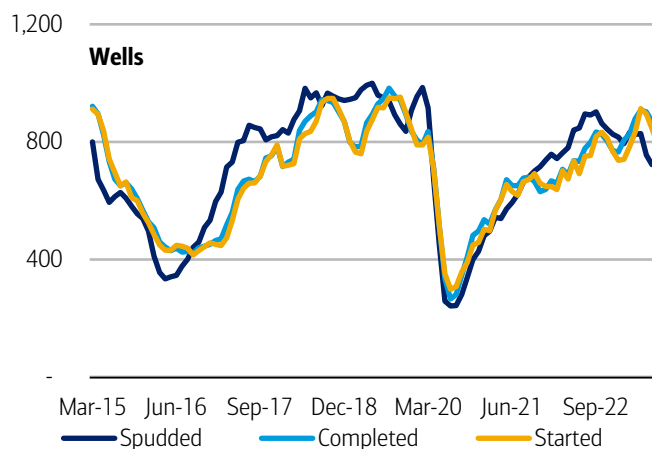


Source: Bloomberg

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**Exhibit 148: Wells spudded, completed, and started in major oil basins**

...as a result, well starts peaked long after oil prices had crashed from their mid-2022 highs, leading to a production surge during 2023



Note: includes horizontal wells in the Bakken, Eagle Ford, Niobrara, and Permian. Source: Rystad Energy

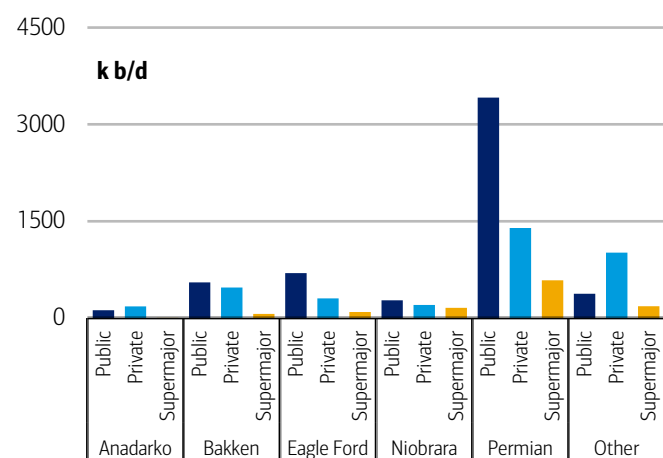
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### In 2023, private E&Ps disproportionately contributed to growth...

Splitting US producers into three buckets, private E&Ps, public E&Ps, and majors, helps explain activity in the shale patch. Majors view their shale assets as part of a broader portfolio and have in recent years grown their shale production to help offset declining output elsewhere in their portfolio. As a result, their drilling and completion activity is less sensitive to oil prices than public or private E&Ps. Different motives for public E&Ps (typically appeasing shareholders) and private E&Ps (typically growing and selling their company) leads to the former being less sensitive to oil prices than the latter. In 2022, public E&Ps, private E&Ps, and majors accounted for 54%, 35%, and 11% of total US onshore oil production. Public E&Ps account for a large majority of Permian output, while the split is more balanced across the rest of the US (Exhibit 149). August and September estimates suggest private E&Ps grew 400-450k b/d YoY, while public E&Ps rose 250-300k b/d (Exhibit 31) and majors grew at a slower pace.

#### Exhibit 149: US onshore oil production by basin (2022)

In 2022, public E&Ps, private E&Ps, and majors accounted for 54%, 35%, and 11% of total US onshore oil production

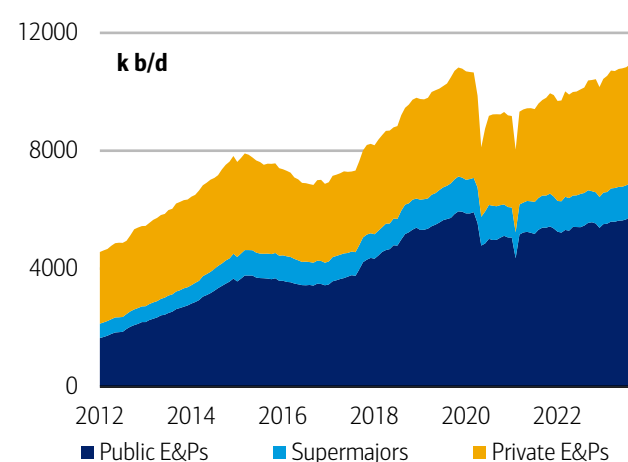


Source: Rystad Energy

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#### Exhibit 150: US onshore oil production

August and September estimates point to private E&Ps grew 400-450k b/d YoY, while public E&Ps rose 250-300k b/d and majors grew at a slower pace



Source: Rystad Energy

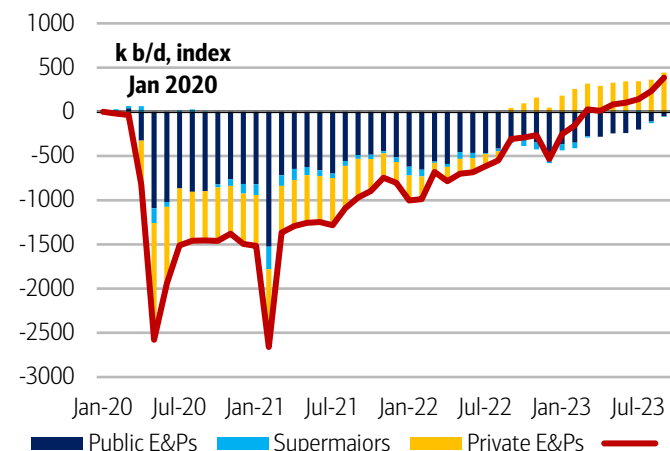
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### ...which has been driven by basins like the Permian and the Bakken

US oil production has recovered steadily since troughing in 1H20 (Exhibit 151), save for a temporary drop in supply related to winter storm Uri in 2021 (Exhibit 152). Public E&Ps and supermajors have been slowly bringing production back to pre-Covid levels, while private oil producers have grown output by nearly 400k b/d over the same period. Nearly all private E&P supply growth has been driven by the Permian, where the group's production is up more than 500k b/d. Elsewhere, the recovery in production is still ongoing.

### Exhibit 151: Cumulative US onshore crude oil supply growth since January 2020

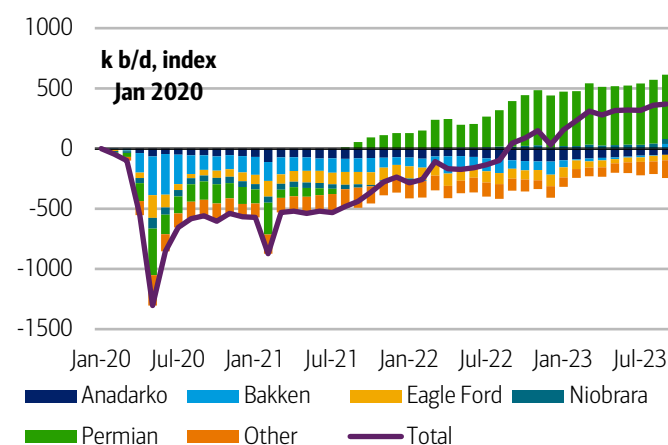
Private E&Ps are producing more oil than before the pandemic, while public companies are still recovering



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### Exhibit 152: Cumulative US onshore crude oil production growth by private E&Ps since January 2020

Private E&P production growth has been dominated by the Permian basin, while other basins have lagged behind



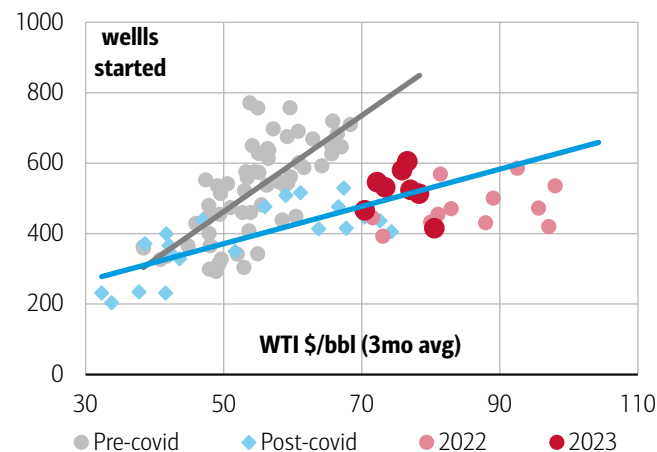
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### In 2023, private E&Ps exhibited activity similar to pre-Covid trends

All US oil producers became less sensitive to oil prices in the aftermath of the pandemic, but the degree of desensitization depended on the company. Public E&Ps and majors brought on fewer wells in 2022 than previous post-Covid trends (2020-21) would have suggested, but well starts re-aligned with these trends in 2023. Data on private E&Ps point to more noise in their activity during 2022 (Exhibit 153), but activity appeared more closely aligned with post-Covid trends on average. However, private E&Ps brought wells online in 2023 at a pace consistent with pre-Covid trends (Exhibit 154). We view this as a lagged response to the rapid rise in oil prices and a pace of activity that will be difficult to repeat in 2024, especially because drilling activity has declined substantially.

### Exhibit 153: Public E&P and supermajor oil well starts and oil prices

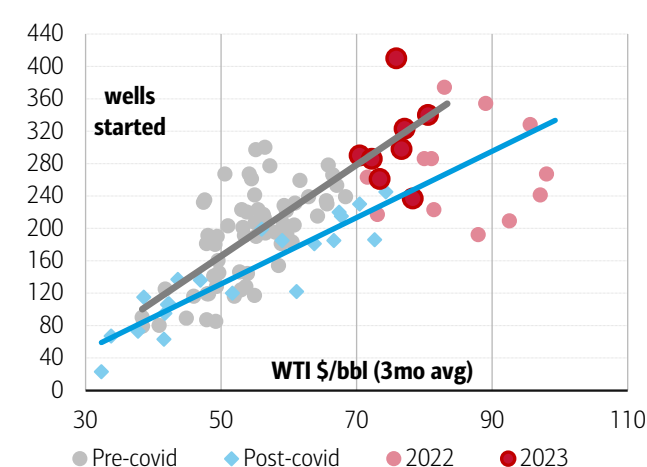
Data on private E&Ps point to more noise in their activity during 2022, but activity appeared more closely aligned with post-Covid trends on average



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### Exhibit 154: Private E&P oil well starts and oil prices

private E&Ps brought wells online in 2023 at a pace consistent with pre-Covid trends



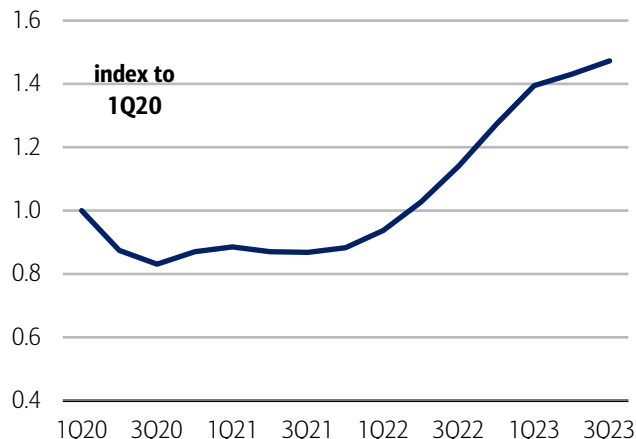
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### Although E&Ps could enjoy some service cost deflation in 2024...

Average rig dayrates have risen steadily since late 2021 as drilling demand increased and as OFS input costs rose. In 3Q23, the average rig dayrate was estimated to have been between 65-70% higher than 4Q21 levels, and although prices may ease due to falling demand, rising input costs are likely to keep rig cost deflation in check (Exhibit 155). Pressure pumping costs also increased since 2021, with costs rising closer to 50% in 3Q23 versus 4Q21 levels (Exhibit 156). Pressure pumping costs peaked in 2Q and have already started to roll over, but even here, price relief is likely constrained by rising input costs for pumping companies.

#### Exhibit 155: Estimated average rig dayrates

In 3Q23, the average rig dayrate was estimated to be 65-70% higher than 4Q21 levels

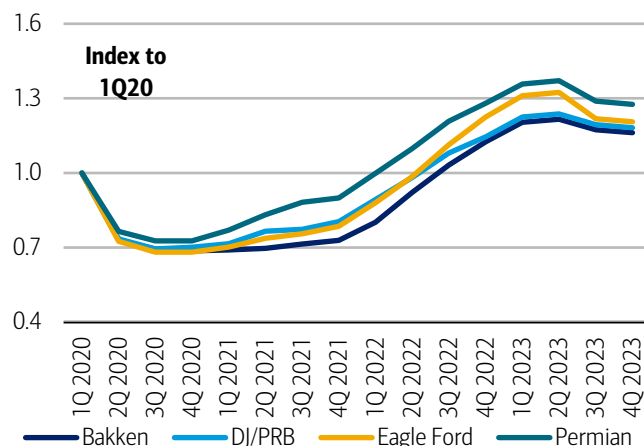


Source: HP, PTEN, BofA Global Research estimates

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#### Exhibit 156: Rystad pumping hour price index

Pressure pumping costs also increased since 2021, with costs rising closer to 50% in 3Q23 versus 4Q21 levels



Source: Rystad Energy

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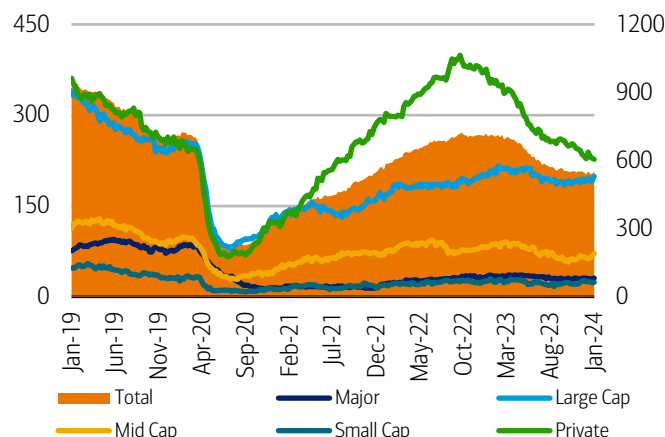
### ...they are likely to pull back on spending activity, led by privates

In response to the decline in prices since 2022, the US rig count has been steadily falling since early 2023, with private E&Ps driving most of the decline in rig demand (Exhibit 157). Indeed, the private E&P rig count has fallen roughly 40% from the highs of 2022, while publics and majors have seen their rig count decline between 10-20%. Completion activity has also slowed, with the number of frac spreads already 17% lower YoY for oil basins (Exhibit 158). The decline in frac spreads was led by public E&Ps and majors (-20% YoY), while private producers have only dropped 10%, suggesting there is room for private E&Ps to drop frac spreads in the future to catch up to rig activity.



### Exhibit 157: US Land Horizontal Rig Count by Operator Type, Jan '19 – Current

The private E&P rig count has dropped 40% from the peak of 2022

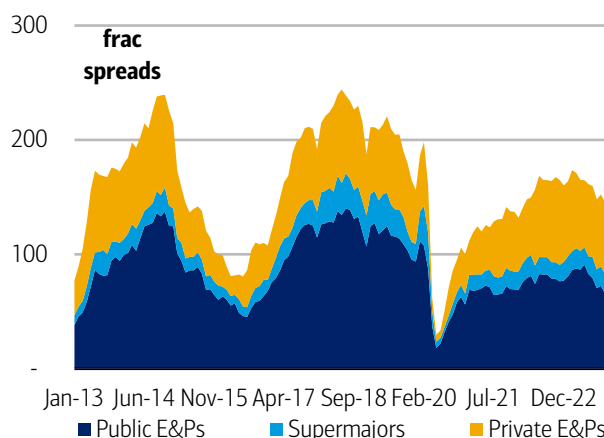


Source: Enverus, BofA Global Research

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### Exhibit 158: US frac spread count by company type

Completion activity has also slowed, with the number of frac spreads already 17% lower YoY for oil basins



Note: includes horizontal wells in the Bakken, Eagle Ford, Niobrara, and Permian. Source: Rystad Energy

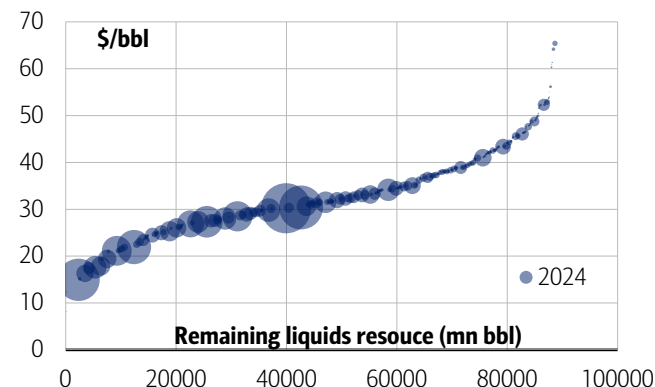
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### Afterall, private E&Ps have the worst economics on average

For most of the 2010s, the cost curve for tight oil has dropped as producers benefitted from efficiency and productivity improvements and a drop in OFS service costs (versus 2014 levels). Now, much of the tight oil resource base breaks even below \$40/bbl (Exhibit 159), according to Woodmac, creating very profitable half-cycle economics for nearly all US tight oil assets. That said, profitability varies by company type. Private E&Ps have the poorest economics on average in the oil patch, according to Rystad (Exhibit 160), which strengthens the argument that they will slow more in the current lower price environment.

### Exhibit 159: US tight oil cost curve

Much of the US tight oil resource base breaks even below \$40/bbl on a half-cycle basis, according to Woodmac data

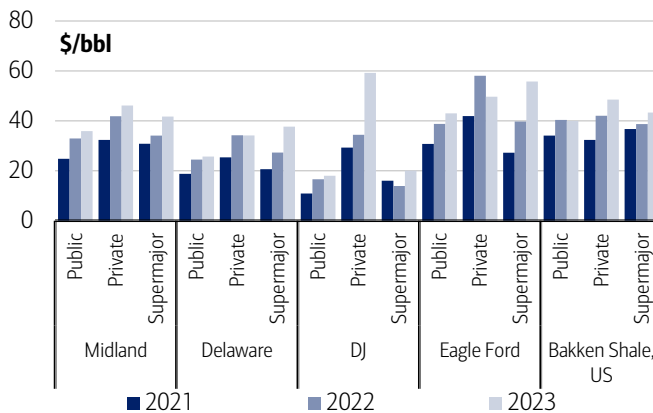


Note: assumed 15% cost of capital. Source: Rystad Energy

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### Exhibit 160: US horizontal wellhead oil breakevens

Private E&Ps have the poorest economics on average in the oil patch, which helps explain why they have pulled back more than other companies recently



Source: Rystad Energy

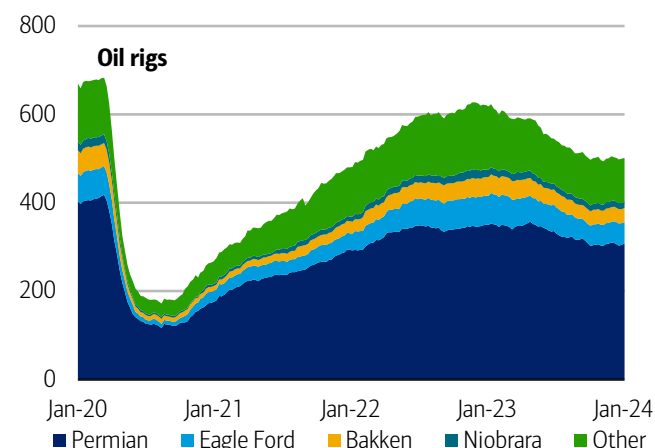
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### D&C activity is likely to fall most in the Bakken, Niobrara, and Eagle Ford...

The US upstream is clearly showing signs of slowing, but some basins are likely to feel the pain more than others. Rig counts in the Eagle Ford, Niobrara, and Bakken have already fallen 27%, 24%, and 18% YoY as of early January (Exhibit 161). Meanwhile, activity in the Permian has held up better, dropping just 12%. Outside the major oil basins, the rig count has fallen more than 30%, driven partly by the slowdown in gas activity. In aggregate, our oilfield service equity research team expects drilling and completion spending to fall roughly 9% YoY in 2024 (Exhibit 162) (see [2024 Outlook: INTL/Offshore OFS shines bright in a dark macro](#)).

**Exhibit 161: US oil rigs by basin**

Rig counts in the Eagle Ford, Niobrara, and Bakken have fallen 27%, 24%, and 18% YoY as of early January

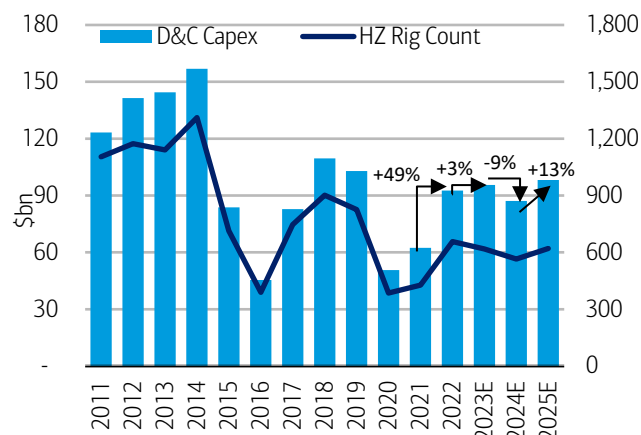


Source: Baker Hughes

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**Exhibit 162: US Land Drilling & Completion (D&C) capex, 2011-25E**

Our OFS equity research team see US Land D&C spending falling 9% YoY in 2024 and then growing 13% YoY in 2025



Source: Baker Hughes, Rystad, BofA Global Research estimates

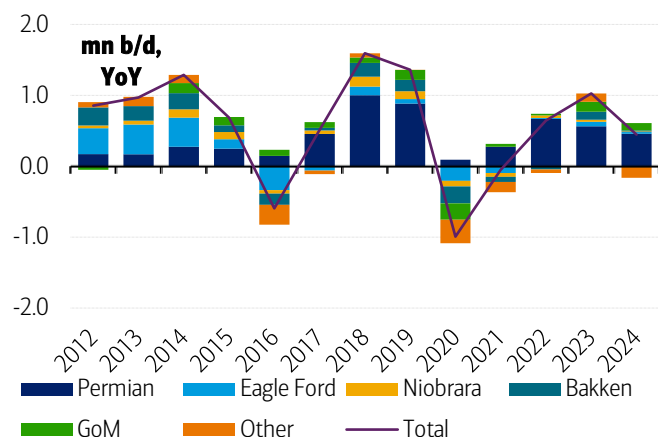
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**...which means slower production growth led primarily by the Permian**

After rising roughly 1mn b/d in 2023, slowing upstream activity should lead to lower growth in 2024. A high single digit decline in well starts YoY across the major oil basins should lead to total US crude oil production growth of just 440k b/d this year, driven primarily by the Permian (Exhibit 163). The annual average growth rate masks the actual slowdown in activity which should lead to exit-to-exit growth of just 310k b/d, with production topping out around 13.6mn b/d (Exhibit 164).

**Exhibit 163: US crude oil production growth**

A high single digit decline in well starts YoY across the major oil basins should lower total US crude oil supply growth to 440k b/d on average...

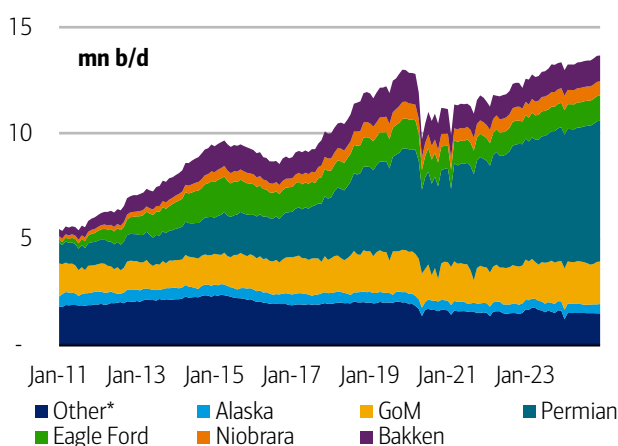


Source: EIA, Rystad Energy, BofA Global Research estimates

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**Exhibit 164: US crude oil production**

...this year, leading to an exit-to-exit growth rate of about 310k b/d, with production topping out around 13.6mn b/d



Source: EIA, Rystad Energy, BofA Global Research estimates

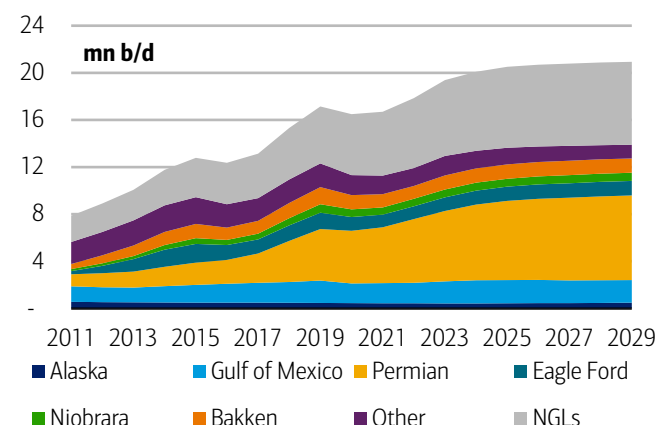
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**Consolidation, inventory exhaustion to slow MT US oil growth**

Over the medium term, we expect US production growth to slow but continue rising (Exhibit 165). Three main factors that we see dampening growth are the massive consolidation of shale assets in recent years, which has historically yielded slower growth, inventory exhaustion, which we expect will constrain some of the smaller players that have helped drive growth in recent years, and slowing oil demand growth, which leaves less room for new global supply. Even so, there is significant uncertainty around the path of shale supply in the medium term, driven by prices, technology, and shareholder demands, among other things (Exhibit 166).

**Exhibit 165: US crude oil and NGL supply growth**

Over the medium term, we expect US production growth to slow but continue rising

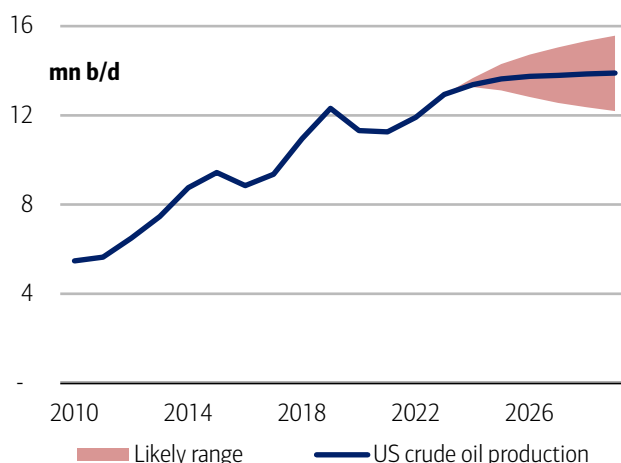


Source: EIA, Rystad Energy, BofA Global Research estimates

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**Exhibit 166: US crude oil production growth**

Shale supply faces significant uncertainty in the medium term, driven by oil prices, technology, and shareholder demands, among other things



Source: EIA, Rystad Energy, BofA Global Research estimates

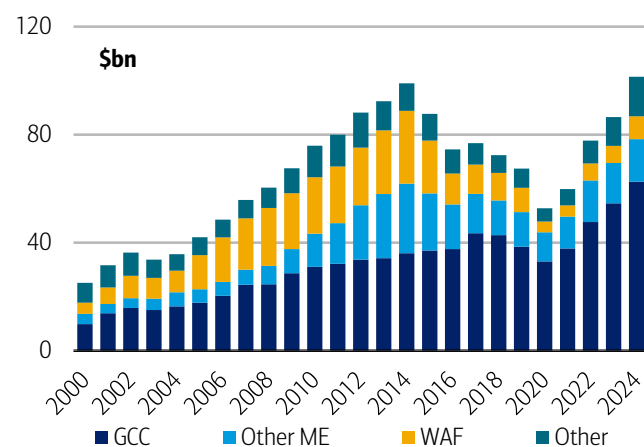
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**OPEC capex recovered from Covid lows and a new high likely in 2024...**

Global upstream capex typically swings in response to crude oil prices, and OPEC countries are no exception. Since troughing in 2020, OPEC upstream capex rebounded 39% through 2023 and capex is expected to soar higher in 2024. In nominal terms, 2024 OPEC capex could exceed the 2014 peak (Exhibit 167), but spending in real terms falls short of 2014 levels by more than 20%. Since the mid-2010s, spending in West Africa and Iraq and Iran has shrunk, while spending in GCC countries and other OPEC (Algeria, Libya, Venezuela) has grown (Exhibit 168). Indeed, 2023 GCC upstream spend was 50% higher than 2014 levels, while spending in Algeria, Libya, and Venezuela is estimated to have been 5% higher.

**Exhibit 167: OPEC capex (nominal)**

In nominal terms, 2024 OPEC capex could exceed the 2014 peak but spending in real terms falls short of 2014 levels by more than 20%

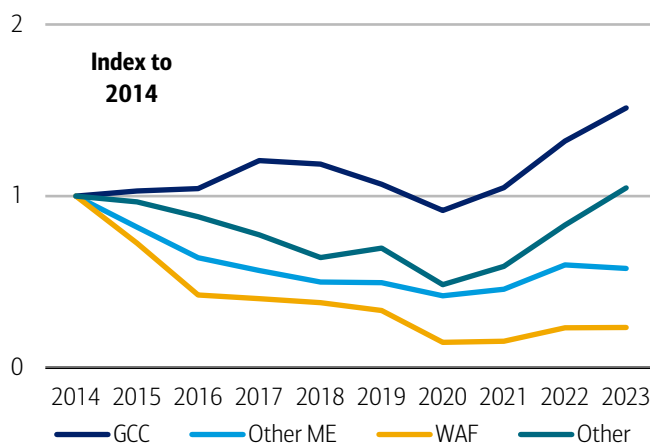


Source: Woodmac

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**Exhibit 168: OPEC capex (nominal)**

2023 GCC upstream spend was 50% higher than 2014 levels, while spending in Algeria, Libya, and Venezuela is estimated to have been 5% higher



Source: Woodmac

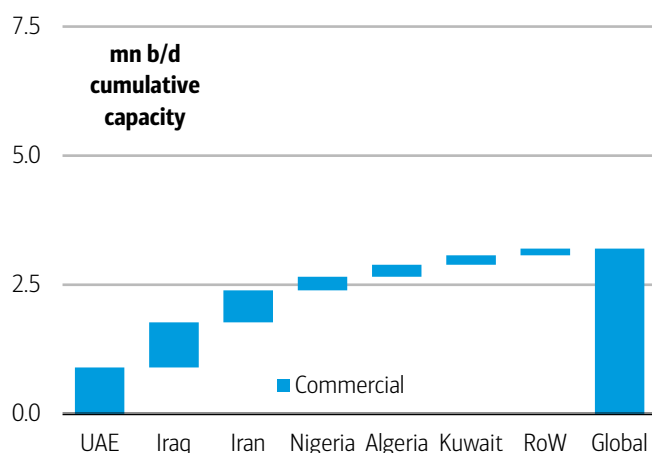
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**...as OPEC ramps up spend on new projects in the Middle East**

A look at the medium-term OPEC project pipeline shows an improved outlook versus recent history. During the 2018-23 timeframe, roughly 3.2mn b/d of new capacity was delivered into the market, led by the UAE, Iraq, and Iran (Exhibit 169). Over the next six years, potential capacity starts could approach 4mn b/d, led by Saudi Arabia and Iraq (Exhibit 170). The pace of starts will depend heavily on oil prices and appetite for national oil companies like Aramco to raise production capacity.

**Exhibit 169: Realized OPEC capacity starts 2018-23**

During the 2018-23 timeframe, roughly 3.2mn b/d of new capacity was delivered into the market, led by the UAE, Iraq, and Iran

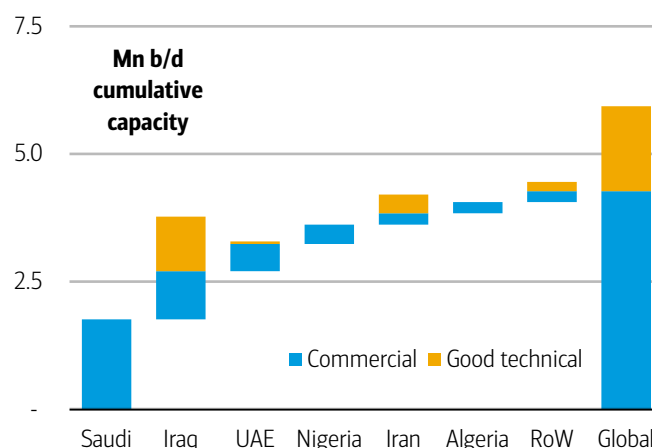


Source: Woodmac, BofA Global Research estimates

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**Exhibit 170: Potential OPEC capacity starts 2024-29**

Over the next six years, potential capacity starts could approach 4mn b/d, led by Saudi Arabia, Iraq, and the UAE



Source: Woodmac, BofA Global Research estimates

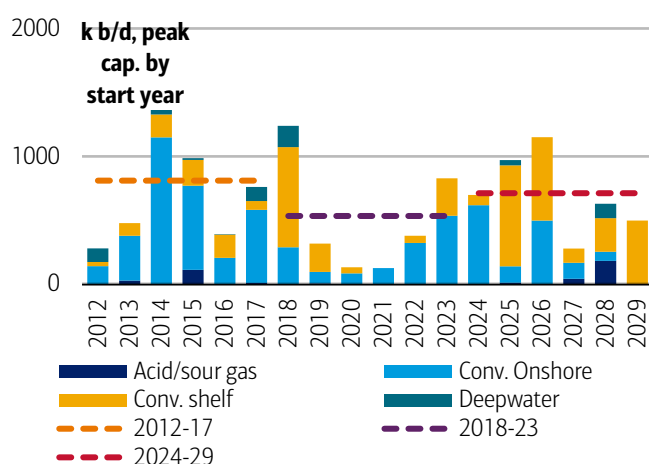
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**OPEC projects are concentrated in offshore shelf and in the Middle East**

OPEC capacity additions have slowed dramatically from 2012-17, when conventional onshore projects in Iraq, Saudi Arabia, UAE, and Iran came online. OPEC capacity additions dropped to roughly 530k b/d annually during 2018-23, from more than 800k b/d in 2012-17 (Exhibit 171). New project starts during 2024-29 should add more than 700k b/d of capacity annually, driven primarily by shallow water offshore fields in Saudi Arabia and the UAE (Exhibit 172). In Africa, capacity additions are set to rise over the medium term but remain lower relative to early 2010s activity.

**Exhibit 171: Realized and potential OPEC capacity additions by resource type**

New project starts during 2024-29 should add more than 650k b/d of capacity annually...

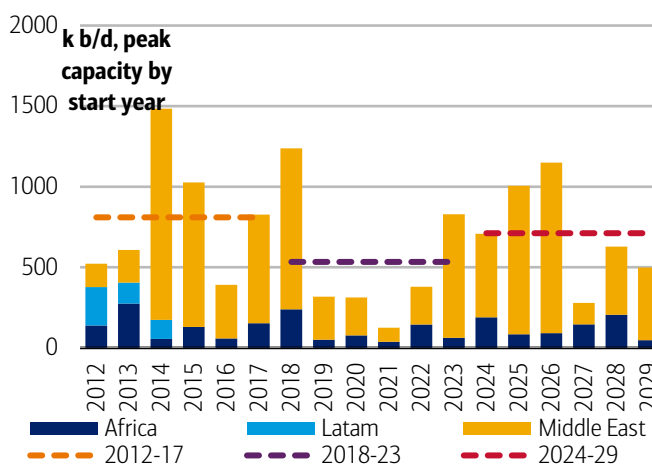


Source: Woodmac, BofA Global Research estimates

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**Exhibit 172: Realized and potential OPEC capacity additions by region**

...driven primarily by shallow water offshore fields in Saudi Arabia and the UAE



Source: Woodmac, BofA Global Research estimates

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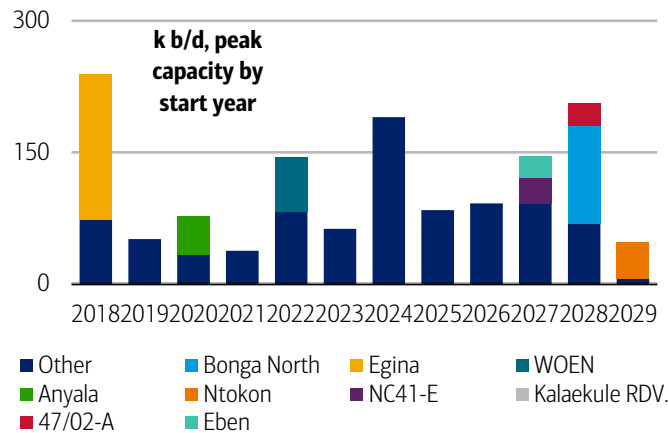
**In Africa, project starts pick up, but production trajectory still lower**

Major oil project starts in Africa are set to pick up slightly over the medium term, including a few notable projects like Nigeria's Bonga North, but we do not view these as sufficient to support aggregate production over the medium term (Exhibit 173). We see some room for growth in OPEC Africa (ex-Libya) supply through 2025, with production rising more than 150k b/d versus 2023 levels, driven by a recovery in Nigerian and

Algerian output, but a thin project pipeline should lead to more stable production declines throughout the remainder of the medium term (Exhibit 174). In total, we expect output to fall more than 150k b/d from 2023 levels by the end of the forecast period.

#### Exhibit 173: OPEC Africa (ex-Libya) project starts

Major African OPEC project starts should rise slightly during 2024-29, but we don't not view these as sufficient to support output in the medium term

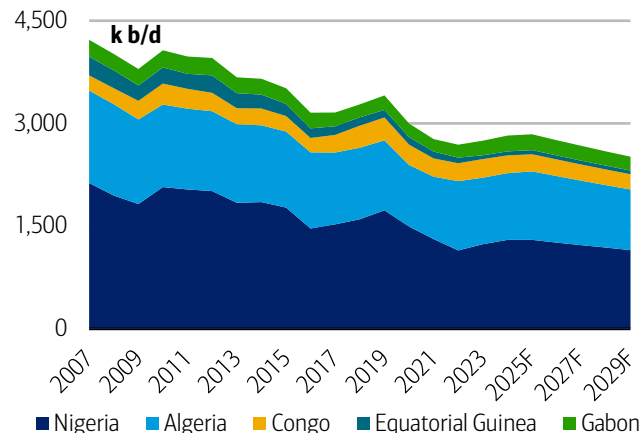


Source: Woodmac, BofA Global Research estimates

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#### Exhibit 174: OPEC Africa oil production (ex-Libya)

OPEC Africa (ex-Libya) output should fall more than 150k b/d from 2023 levels by the end of the forecast period



Source: IEA, BofA Global Research estimates

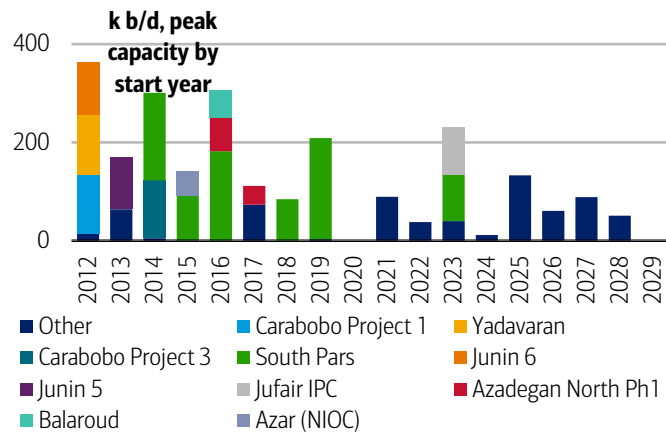
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#### Geopolitics create uncertainty for Iran, Venezuela and Libya production

Above ground issues have plagued several OPEC countries in the past two decades, including Iran, Venezuela, and Libya. In the early 2010s, Iran and Venezuela brought online a significant amount of production capacity (Exhibit 175). In Iran, these volumes came primarily in the form of condensate from the South Pars gas field, while Venezuela brought online several Orinoco Belt heavy oil projects. Yet, the project pipeline has lightened up recently and most new projects coming online in the medium term are smaller and subject to delays. Over the medium term, we expect Iranian crude oil production to recover to 3.6mn b/d as the country becomes more creative in its marketing efforts (Exhibit 176). Meanwhile, bellicose and anti-democratic actions in Venezuela may deter development there and lead to the re-imposition of US trade restrictions. Given this risk, we forecast Venezuelan output to average 850k b/d over the medium term and acknowledge upside risk to this view. In Libya, we assume continued instability keeps output from rising meaningfully and forecast output will average 1.15mn b/d through 2029.

**Exhibit 175: Iran, Libya, and Venezuela realized and potential project starts**

The project pipeline for Iran, Libya, and Venezuela has dried up in recent years...

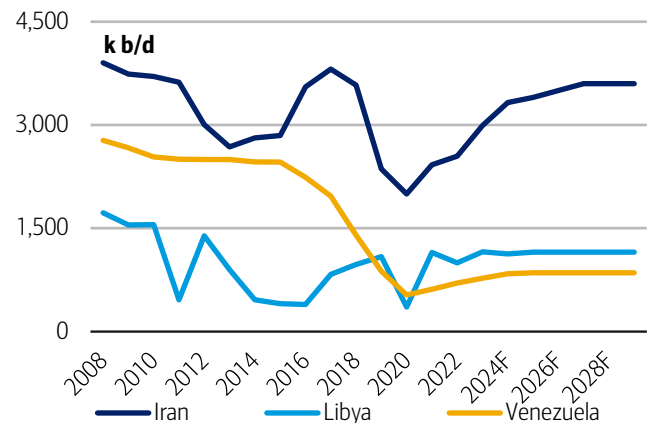


Source: Woodmac, BofA Global Research estimates

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**Exhibit 176: Iran, Libya, and Venezuela crude oil production**

...and production is likely to be driven by above ground issues rather than new project starts.



Source: IEA, BofA Global Research estimates

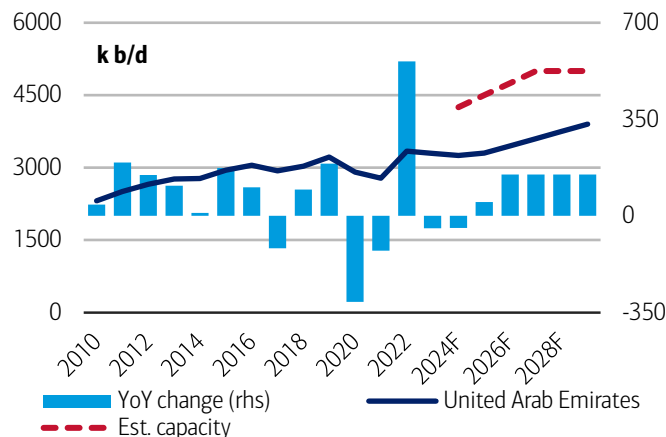
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**The UAE and Kuwait medium term capacity targets remain in-tact...**

GCC OPEC members are the primary holders of spare production capacity globally and two of those members, the UAE and Kuwait, have maintained their plans to expand capacity this decade. The UAE is targeting 5mn b/d of production capacity by 2027, helped by expansions at its Upper Zakum field (Exhibit 177). Ultimately, UAE seems likely to raise output over the medium term even if prices are lower, in our view. Afterall, their economy is less levered to oil prices than other GCC countries. Kuwait is also pushing forward with efforts to boost its oil production capacity to 3.2mb b/d by 2025-26 by further developing its prolific Burgan field, among others. However, we see Kuwait following Saudi's lead and holding production flat near 2.6mn b/d over the medium term. (Exhibit 178).

**Exhibit 177: UAE crude oil production**

UAE is likely to raise output toward 4mn b/d over the medium term even if prices are lower

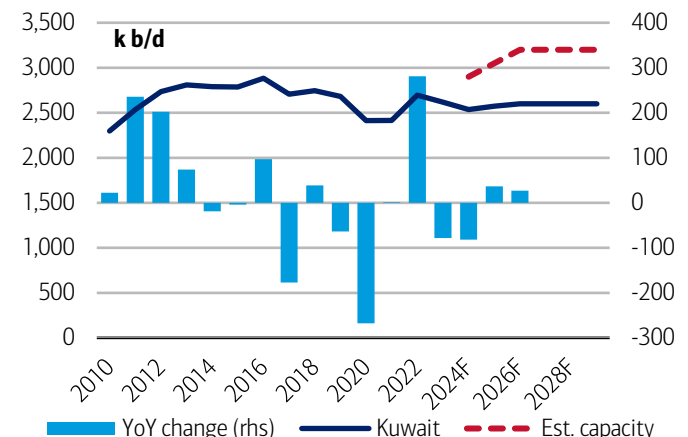


Source: IEA, BofA Global Research estimates

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**Exhibit 178: Kuwait crude oil production**

Kuwait should follow Saudi's lead and holding production flat near 2.6mn b/d over the medium term, despite spending to increase production capacity



Source: IEA, BofA Global Research estimates

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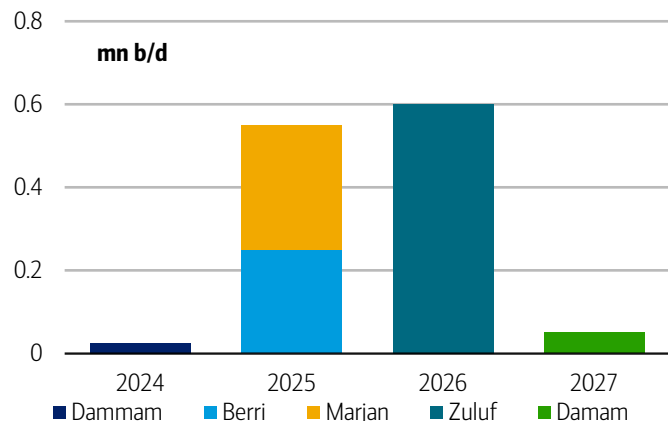
**...while Saudi is set to maintain its current capacity of 12mn b/d**

Saudi Arabia recently scrapped efforts to expand its production capacity to 13mn b/d and instead will maintain its current capacity of 12mn b/d. In doing so, Aramco has put its Safaniyah project on pause and will likely spend less at existing fields leading to higher decline rates there. The Berri, Marjan, and Zuluf fields, which are set to start up

during 2025-26, will help make up for accelerated declines elsewhere and keep total capacity near 12mn b/d (Exhibit 179). The decision to pull back on development was in part a response to the energy transition, which threatens future oil demand growth and thus the need to expand capacity. In our view, there is limited room for Saudi Arabia to expand output over the medium term without pushing prices lower and we forecast output will remain flat at 9mn b/d for the foreseeable future (Exhibit 180).

#### Exhibit 179: Saudi Arabia upstream projects by start year

The Berri, Marjan, and Zuluf fields will help make up for accelerated declines elsewhere and keep total capacity near 12mn b/d

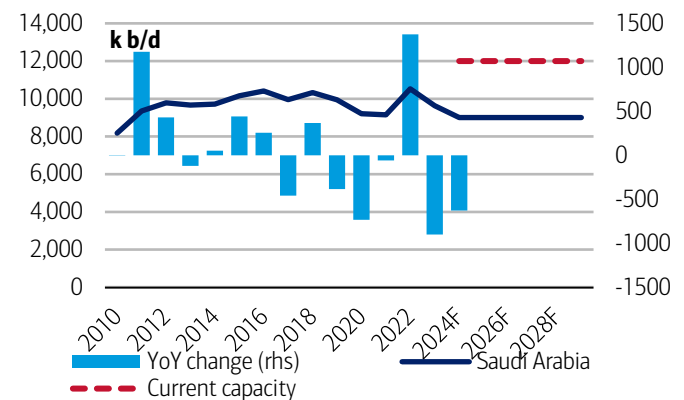


Source: Saudi Aramco

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#### Exhibit 180: Saudi Arabia crude oil production

There is limited room for Saudi Arabia to expand output over the medium term



Source: IEA, BofA Global Research estimates

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#### Spare capacity is ample and will be underutilized in the medium term

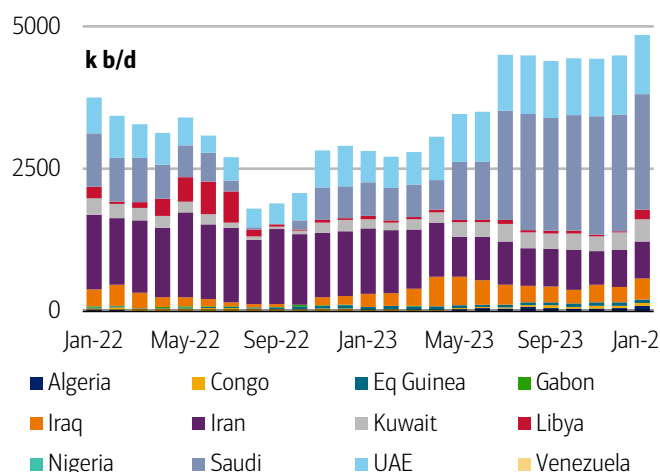
Spare production capacity can play an important role in actively stabilizing the oil market. In a market where production exceeds demand, OPEC has historically responded by curtailing output, which raises spare capacity. Conversely, OPEC often taps spare production capacity in undersupplied markets to keep prices from overheating and damaging the economy and oil demand. OPEC spare capacity troughed in August 2022 and has more than doubled since then, nearly reaching 5mn b/d in January (Exhibit 181). Slowing demand growth and rising non-OPEC supply (ex US) leave little room for GCC OPEC countries to raise output in the next two years, but new projects starting in 2025-27 should boost capacity further in the medium term.

#### For Saudi, a price war may be tempting, but outcome highly uncertain

Saudi Arabia's decision to shelve capacity growth plans seems prudent, but the Kingdom is continuing to fund the current 12mn b/d of capacity even as output sits at 9mn b/d. The current oil outlook suggests Saudi Arabian output may be stuck at 9m b/d or forced to cut further, leading some market participants to draw parallels between today and 2014, when Saudi Arabia launched a price war to squeeze out higher cost producers like shale. If the Saudis launched another price war, oil prices would most certainly crater near term, hurting Aramco and the country's financial position (see [Year Ahead 2024: Uncertainty to continue; stay defensive](#)) (Exhibit 182), but may recover to \$80+/bbl in 2-3 years with Saudi producing near full capacity. On paper, the strategy may look appealing, but it is important to consider the difference between 2024 and 2014. Today, Saudi Arabia has lower fiscal reserves and more ambitious economic growth plans, which are heavily dependent on capital market funding. A collapse in oil prices could make future debt and equity capital raises challenging, and a deteriorating fiscal position could damage credit ratings too. Furthermore, while the shale industry has matured, it is much stronger financially and can withstand lower oil prices without materially shifting D&C plans. In aggregate, we view the supply stack as much less elastic than during the 2010s. Chasing market share would hurt Saudi Arabia's financial position and potentially delay or curtail its economic transformation plans and prices could stay depressed for longer than originally anticipated. These uncertainties should dissuade Saudi Arabia from pursuing this strategy, but it remains a risk in our view.

**Exhibit 181: OPEC spare capacity estimates**

OPEC spare capacity peaked in August 2022 and has more than doubled, nearly reaching 5mn b/d in January

**Exhibit 182: Aramco's 2024E EBITDA (US\$bn) estimate at different levels of production (mb/d) and oil prices (US\$/bbl)**

Raising output could dent Aramco's near-term earnings prospects

2024E EBITDA (US\$bn)		Oil production (mn b/d)						
		7.5	8	8.5	9.2	10	10.5	11
Oil price (US\$/bbl)	50	140	147	154	164	176	184	191
	60	166	173	184	196	210	221	228
	70	192	200	213	228	245	258	265
	80	210	218	233	249	268	283	291
	90	228	236	253	270	289	308	316
	100	246	254	273	292	311	333	341
	110	255	262	283	302	320	344	352

Source: BofA Global Research estimates.

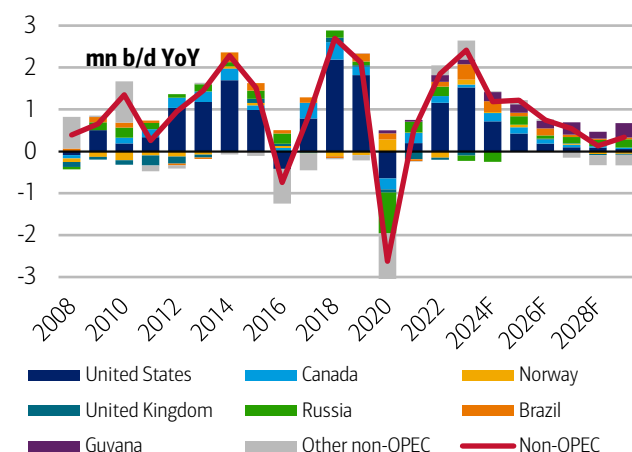
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**Global oil supply to rise 845k b/d on average during 2024-29**

Over the medium term, non-OPEC supply is set to rise about 700k b/d YoY on average (2024-29), with the US accounting for just 260k b/d of growth annually (Exhibit 183). Latin America accounts for roughly half of medium-term non-OPEC supply growth at around 360k b/d YoY on average, with Guyana rising roughly 230k b/d annually. OPEC crude oil growth should average 110k b/d through 2029, led by the UAE and Iran, which each add about 100k b/d of output annually. Total OPEC supply (including NGLs, condensates, and non-conventional volumes) should rise 150k b/d annually, with total volumes recovering toward 34mn b/d by 2029 (Exhibit 184). Global oil supply is set to expand at a pace of roughly 850k b/d annually over the medium term.

**Exhibit 183: Non-OPEC production growth**

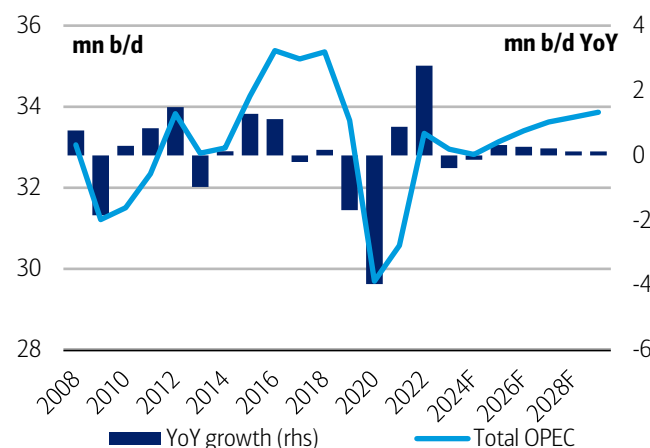
Non-OPEC supply is set to rise nearly 700k b/d YoY on average during 2024-29



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**Exhibit 184: OPEC oil production**

Total OPEC supply should rise 150k b/d annually, with total volumes recovering toward 34mn b/d by 2029



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# Appendix: Medium-term oil balances

## Exhibit 185: BofA global oil supply forecast (in thousand b/d)

Annual balances

	2017	2018	2019	2020	2021	2022	2023	2024F	2025F	2026F	2027F	2028F	2029F
<b>OECD Americas</b>	<b>20,440</b>	<b>22,890</b>	<b>24,770</b>	<b>23,860</b>	<b>24,320</b>	<b>25,690</b>	<b>27,380</b>	<b>28,260</b>	<b>28,730</b>	<b>28,950</b>	<b>29,050</b>	<b>29,120</b>	<b>29,150</b>
United States	13,210	15,400	17,220	16,570	16,770	17,920	19,450	20,160	20,580	20,770	20,870	20,960	21,010
-Crude	9,360	10,950	12,310	11,320	11,270	11,910	12,940	13,370	13,630	13,750	13,800	13,860	13,900
-NGL	3,780	4,370	4,820	5,170	5,420	5,930	6,430	6,710	6,870	6,940	6,990	7,020	7,040
Canada	4,990	5,410	5,610	5,350	5,590	5,750	5,820	6,030	6,180	6,270	6,330	6,360	6,390
Mexico	2,230	2,070	1,930	1,930	1,950	2,010	2,100	2,060	1,960	1,900	1,850	1,790	1,740
<b>OECD Asia Oceania</b>	<b>390</b>	<b>410</b>	<b>530</b>	<b>530</b>	<b>510</b>	<b>480</b>	<b>460</b>	<b>460</b>	<b>440</b>	<b>410</b>	<b>400</b>	<b>380</b>	<b>360</b>
Australia	310	340	460	460	440	410	380	390	380	360	350	340	330
<b>OECD Europe</b>	<b>3,490</b>	<b>3,470</b>	<b>3,370</b>	<b>3,580</b>	<b>3,390</b>	<b>3,160</b>	<b>3,210</b>	<b>3,210</b>	<b>3,240</b>	<b>3,220</b>	<b>3,220</b>	<b>3,090</b>	<b>2,970</b>
Norway	1,970	1,850	1,760	2,040	2,050	1,900	2,020	2,040	2,100	2,080	2,110	2,040	1,980
United Kingdom	1,010	1,120	1,150	1,080	880	830	730	720	720	740	750	720	700
<b>Non-OECD Europe</b>	<b>130</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>110</b>	<b>110</b>	<b>100</b>	<b>100</b>	<b>90</b>	<b>90</b>	<b>90</b>	<b>90</b>	<b>90</b>
<b>Former Soviet Union</b>	<b>14,320</b>	<b>14,580</b>	<b>14,650</b>	<b>13,500</b>	<b>13,770</b>	<b>13,900</b>	<b>13,830</b>	<b>13,590</b>	<b>13,950</b>	<b>14,100</b>	<b>14,240</b>	<b>14,280</b>	<b>14,380</b>
Russia	11,320	11,490	11,580	10,610	10,870	11,090	10,960	10,730	10,930	11,000	11,150	11,300	11,500
Azerbaijan	780	790	770	700	700	670	620	600	620	600	580	570	550
Kazakhstan	1,850	1,940	1,940	1,840	1,850	1,820	1,940	1,950	2,100	2,220	2,250	2,180	2,110
<b>Non-OPEC Africa</b>	<b>3,130</b>	<b>2,990</b>	<b>2,880</b>	<b>2,720</b>	<b>2,490</b>	<b>2,470</b>	<b>2,410</b>	<b>2,420</b>	<b>2,390</b>	<b>2,320</b>	<b>2,280</b>	<b>2,240</b>	<b>2,160</b>
Egypt	640	650	630	620	590	600	600	600	610	590	570	550	540
Sudan and South Sudan	210	220	200	220	210	200	200	210	200	190	180	170	160
Ghana	160	180	210	200	170	170	160	190	200	210	230	240	260
<b>Non-OPEC Asia</b>	<b>7,390</b>	<b>7,240</b>	<b>7,170</b>	<b>6,990</b>	<b>6,910</b>	<b>6,880</b>	<b>6,940</b>	<b>6,880</b>	<b>6,840</b>	<b>6,710</b>	<b>6,560</b>	<b>6,420</b>	<b>6,280</b>
India	860	840	800	750	730	700	690	670	640	610	580	560	540
Malaysia	730	720	670	600	570	560	560	560	540	530	500	480	460
China	3,890	3,850	3,920	3,970	4,060	4,180	4,280	4,290	4,330	4,300	4,250	4,200	4,150
<b>Non-OPEC Latin America*</b>	<b>5,130</b>	<b>5,100</b>	<b>5,330</b>	<b>5,330</b>	<b>5,300</b>	<b>5,640</b>	<b>6,180</b>	<b>6,660</b>	<b>6,960</b>	<b>7,320</b>	<b>7,670</b>	<b>7,900</b>	<b>8,320</b>
Argentina	590	620	650	610	640	710	770	810	850	900	950	1,000	1,040
Brazil	2,750	2,710	2,900	3,040	3,000	3,120	3,490	3,740	3,830	4,000	4,050	4,080	4,130
Colombia	860	870	890	790	740	760	790	770	750	730	700	680	660
Guyana	0	0	0	70	120	270	390	610	810	990	1,290	1,450	1,790
<b>Non-OPEC Middle East</b>	<b>3,020</b>	<b>3,060</b>	<b>3,000</b>	<b>3,000</b>	<b>3,060</b>	<b>3,160</b>	<b>3,120</b>	<b>3,110</b>	<b>3,120</b>	<b>3,170</b>	<b>3,220</b>	<b>3,240</b>	<b>3,250</b>
Oman	980	990	980	960	980	1,070	1,060	1,050	1,060	1,050	1,040	1,030	1,020
Qatar	1,770	1,780	1,710	1,760	1,800	1,800	1,810	1,810	1,810	1,880	1,950	2,000	2,030
Processing Gains	2,340	2,390	2,370	2,130	2,240	2,310	2,350	2,390	2,430	2,550	2,560	2,560	2,570
Global Biofuels	2,450	2,670	2,840	2,650	2,790	2,950	3,200	3,280	3,380	3,480	3,580	3,680	3,790
<b>Non-OPEC (incl. processing gains)</b>	<b>62,220</b>	<b>64,910</b>	<b>67,030</b>	<b>64,400</b>	<b>64,910</b>	<b>66,760</b>	<b>69,170</b>	<b>70,350</b>	<b>71,570</b>	<b>72,320</b>	<b>72,860</b>	<b>72,990</b>	<b>73,330</b>
<b>OPEC crude</b>	<b>29,830</b>	<b>29,890</b>	<b>28,280</b>	<b>24,460</b>	<b>25,330</b>	<b>27,940</b>	<b>27,480</b>	<b>27,270</b>	<b>27,590</b>	<b>27,810</b>	<b>27,970</b>	<b>28,040</b>	<b>28,120</b>
Saudi Arabia crude	9,960	10,330	9,940	9,210	9,150	10,530	9,630	9,000	9,000	9,000	9,000	9,000	9,000
Kuwait crude	2,710	2,750	2,680	2,410	2,420	2,700	2,620	2,540	2,570	2,600	2,600	2,600	2,600
UAE crude	2,930	3,030	3,220	2,910	2,780	3,340	3,290	3,250	3,300	3,450	3,600	3,750	3,900
Iraq crude	4,470	4,570	4,710	4,050	4,030	4,450	4,270	4,380	4,480	4,500	4,500	4,500	4,500
Iran crude	3,810	3,580	2,360	2,000	2,420	2,550	2,990	3,330	3,400	3,500	3,600	3,600	3,600
Libya crude	830	970	1,090	350	1,150	990	1,160	1,130	1,150	1,150	1,150	1,150	1,150
Nigeria crude	1,530	1,600	1,730	1,490	1,310	1,150	1,240	1,300	1,300	1,260	1,220	1,190	1,150
Venezuela crude	1,970	1,400	870	530	610	700	770	840	850	850	850	850	850
other OPEC crude	1,630	1,680	1,680	1,500	1,460	1,540	1,510	1,520	1,540	1,490	1,450	1,410	1,360
OPEC crude less Iraq	25,360	25,330	23,570	20,410	21,290	23,500	23,210	23,210	23,210	23,310	23,470	23,540	23,620
Total OPEC NGLs + Non-conventional	5,340	5,460	5,380	5,240	5,250	5,400	5,470	5,550	5,550	5,600	5,650	5,700	5,750
<b>Total OPEC</b>	<b>35,180</b>	<b>35,350</b>	<b>33,660</b>	<b>29,700</b>	<b>30,580</b>	<b>33,340</b>	<b>32,950</b>	<b>32,820</b>	<b>33,140</b>	<b>33,410</b>	<b>33,620</b>	<b>33,740</b>	<b>33,870</b>
<b>Total World Supply</b>	<b>97,390</b>	<b>100,260</b>	<b>100,690</b>	<b>94,100</b>	<b>95,490</b>	<b>100,100</b>	<b>102,120</b>	<b>103,170</b>	<b>104,710</b>	<b>105,720</b>	<b>106,480</b>	<b>106,730</b>	<b>107,190</b>

Source: IEA, BofA Global Research estimates

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**Exhibit 186: BofA global oil demand forecast (in thousand b/d)**

Annual balances

	2017	2018	2019	2020	2021	2022	2023	2024F	2025F	2026F	2027F	2028F	2029F
<b>TOTAL OECD Demand</b>	<b>47,450</b>	<b>47,680</b>	<b>47,700</b>	<b>42,090</b>	<b>44,810</b>	<b>45,680</b>	<b>45,770</b>	<b>45,660</b>	<b>45,580</b>	<b>45,350</b>	<b>45,070</b>	<b>44,690</b>	<b>44,210</b>
OECD Americas Demand	24,880	25,360	25,460	22,520	24,280	24,790	25,040	24,980	24,880	24,770	24,630	24,460	24,250
United States	20,040	20,600	20,580	18,350	20,030	20,160	20,360	20,310	20,260	20,150	20,020	19,870	19,690
Canada	2,460	2,510	2,550	2,210	2,260	2,410	2,460	2,470	2,480	2,500	2,510	2,500	2,490
Mexico	2,020	1,890	1,970	1,630	1,630	1,860	1,850	1,820	1,750	1,730	1,710	1,690	1,670
Chile	360	360	360	330	360	370	370	380	380	390	390	390	400
OECD Europe Demand	14,420	14,320	14,310	12,410	13,190	13,510	13,390	13,270	13,250	13,150	13,030	12,850	12,620
OECD Pacific Demand	8,150	8,000	7,930	7,160	7,340	7,380	7,340	7,410	7,450	7,430	7,410	7,380	7,330
<b>TOTAL NON-OECD Demand</b>	<b>51,260</b>	<b>52,470</b>	<b>53,070</b>	<b>49,810</b>	<b>52,700</b>	<b>53,800</b>	<b>55,990</b>	<b>57,400</b>	<b>58,700</b>	<b>59,910</b>	<b>60,980</b>	<b>61,980</b>	<b>62,910</b>
China	12,570	13,620	14,150	14,280	15,090	14,660	16,390	16,920	17,380	17,760	18,040	18,250	18,420
India	4,760	4,930	4,960	4,590	4,900	5,280	5,500	5,750	5,960	6,160	6,360	6,560	6,740
Other Asia (ex. China & India)	9,110	9,250	9,200	8,380	8,630	8,780	8,900	9,100	9,300	9,470	9,640	9,810	9,970
Middle East	8,880	8,810	8,760	8,060	8,350	8,850	8,890	9,110	9,210	9,340	9,460	9,570	9,680
Latin America	6,380	6,260	6,310	5,410	6,010	6,210	6,350	6,410	6,540	6,630	6,720	6,820	6,920
FSU	4,650	4,690	4,730	4,590	4,890	4,950	4,930	4,960	5,000	5,050	5,100	5,150	5,200
Africa	4,140	4,160	4,170	3,770	4,060	4,290	4,260	4,350	4,510	4,680	4,840	4,990	5,140
Non-OECD Europe	760	760	780	720	770	790	790	810	810	820	830	830	830
<b>TOTAL Demand</b>	<b>98,710</b>	<b>100,150</b>	<b>100,770</b>	<b>91,900</b>	<b>97,510</b>	<b>99,480</b>	<b>101,760</b>	<b>103,060</b>	<b>104,280</b>	<b>105,270</b>	<b>106,050</b>	<b>106,670</b>	<b>107,110</b>

Source: IEA, BofA Global Research estimates

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**Exhibit 187: Acronym list**

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Acronym	Definition
\$/bbl	dollars per barrel
2H	Second half of the year
avg	average
b/d	barrels per day
bbl	barrel
bn	billion
boe	barrel of oil equivalent
Btu	British thermal unit
CB	central bank
CPI	consumer price index
D&C	Drilling and completion
DM	developed market
E&P	Exploration and production
ECB	European Central Bank
EM	European market
EM	emerging market
EUAs	European Union Allowances
EUR	Euro
EV	electric vehicle
FID	Final Investment Decision
FPSO	Floating production storage and offloading
GoM	Gulf of Mexico
GWh	gigawatt hours
Hz	Horizonntal
IEA	International Energy Agency
IMO	International Maritime Organization
JKM	Japan Korea Marker
JPY	Japanese Yen
LNG	liquified natural gas
MA	moving average
mcm	million cubic meters
ME	Middle East
Mfg	manufacturing
MMBtu	million British thermal units
mn	million
mt	metric ton
MWh	Megawatt hours
NBS	National Bureau of Statistics of China
NEV	New Electric Vehicle
ngl	natural gas liquids
NWE	North west Europe
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OPEC+	OPEC countries plus ten additional countries
PMI	purchasing managers index
rhs	righthand side
SPR	Strategic Petroleum Reserve
TMX	Trans Mountain Expansion
TTF	Dutch TTF
TWh	terawatt hours
VLSFO	very low sulfur fuel oil
WCS	Western Canadian Select
WTI	West Texas Intermediate
YoY	year over year
yr	year

Source: BofA Global Research

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