OliverWyman

GLOBAL FLEET AND MRO MARKET FORECAST 2023–2033

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FOREWORD

Oliver Wyman's *Global Fleet and MRO Market Forecast 2023–2033* marks our firm's 23rd assessment of the 10-year outlook for the commercial airline transport fleet and the associated maintenance, repair, and overhaul (MRO) market. We're proud to say that this annually produced research, along with our *Airline Economic Analysis*, has become a staple resource of executives working in aerospace manufacturing, airlines, MRO, and financing of the sector through private equity firms and investment banks.

The year's research reveals how well aviation managed to perform in 2022, despite a litany of challenges. We've essentially moved beyond COVID-19, but if the industry expected 2022 to be a year of unfettered recovery, it was wrong. From Russia's invasion of Ukraine and rising inflation to ongoing supply chain irregularities and labor shortages that made the industry curtail capacity, 2022 tested aviation's resilience. In this year's report, we examine and measure the impact of the many mounting pressures facing the industry, insights that should lead to well-informed business decisions and better navigation of the complex economic landscape.

In conjunction with each year's *Global Fleet and MRO Market Forecast*, we conduct an annual survey of hot topics, critical issues, and new opportunities in MRO. To participate in the 2022 survey, please contact the research team at MROsurvey@oliverwyman.com.

A special note: Late last year, Oliver Wyman elevated the firm's commitment to the aerospace and defense sectors with our acquisition of Avascent, a leading management consulting firm and boutique private equity and M&A adviser for these sectors. With the acquisition, Oliver Wyman added 130 professionals, along with 10 seasoned partners. Please contact us to find out more about our new capabilities.

Meanwhile, we hope you find the data and insights in this year's *Global Fleet and MRO Market Forecast* valuable as you refine your business models and develop strategies moving forward. Oliver Wyman's Market Intelligence team, partners, and vice presidents are available to assist with any questions about this forecast, as well as with the *Airline Economic Analysis*, which is scheduled to be released in March.

Looking forward to working with you this year.

Best regards,

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Partner and study leader
Oliver Wyman

Anthony DiNota
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CAVOK Oliver Wyman

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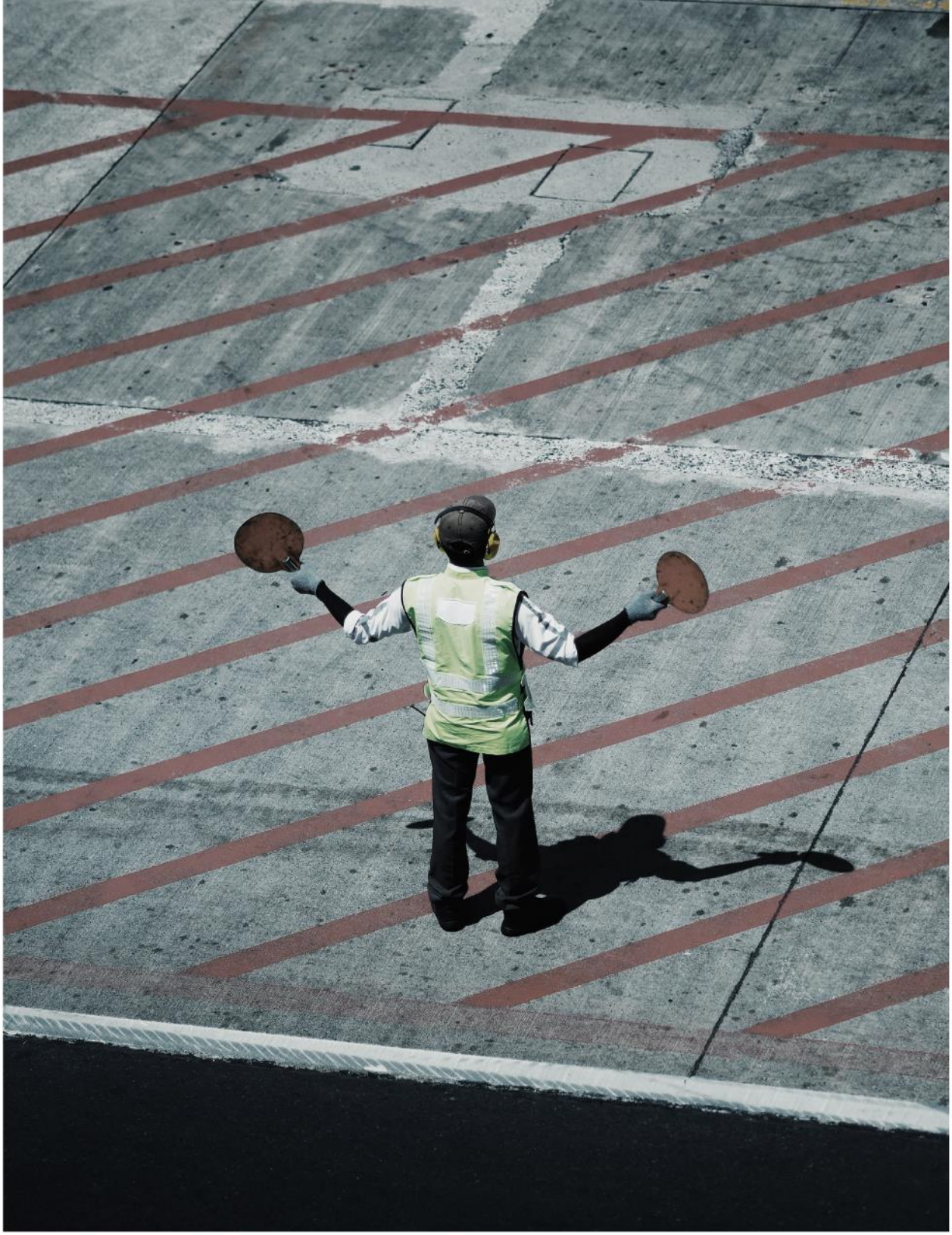


EXECUTIVE SUMMARY

AVIATION TAKES OFF AGAIN, BUT BUCKLE YOUR SEATBELT

By the beginning of this year, global aviation had recovered much of the territory it lost to the COVID-19 pandemic — despite 2022's widespread labor shortages, the Russian invasion of Ukraine, COVID-19 lockdowns in China, inflation, and dysfunctional supply chains. The global fleet is at 98% of where it was pre-pandemic, airlines are returning to profitability, and aerospace manufacturers are gearing up for their most productive years yet.

In Oliver Wyman's *Global Fleet and MRO Market Forecast 2023-2033*, we project the worldwide commercial fleet to expand 33% to over 36,000 aircraft by 2033 — a compound annual growth rate of 2.9%. Today it numbers almost 27,400, just short of its size in January 2020 — the last month before COVID changed the economy and everyday lives around the globe. And even with 2022's war, global inflation, and higher interest rates, the in-service fleet still managed to increase 7% between January 2022 and January 2023.

Aviation's global aftermarket, which provides the maintenance, repair, and overhaul (MRO) services to keep the fleet flying, expanded 18% in 2022. It's anticipated to grow 22% this year, topping $94 billion — a mere 2% below its 2019 peak. By 2033, it will reach $125 billion — a compound annual growth rate of 2.9%. Meanwhile, we expect a record number of aircraft deliveries over the next 10 years, despite current supply chain constraints that will make it hard to meet this year's targets.

And despite rising airfares and a year of delays and cancellations in many of the world's biggest markets, travelers seem undeterred. By December, global passenger traffic — domestic and international combined — reached 82% of the 2019 total. That's the highest level since the pandemic.

NOT ENOUGH AVIATION WORKERS

But while aviation is most assuredly on a growth trajectory after a devastating two years of losses, it's currently carrying a lot of baggage that can't be easily checked. With COVID-19 ostensibly behind us, the industry will be dealing with a series of new and old challenges over the next 10 years that will test its resilience and may temper how fast it continues to expand.

First, there are tight labor markets affecting all regions and all aspects of aviation. In North America, the industry is facing two potentially severe shortfalls in the ranks of commercial airline pilots and aircraft mechanics. By our analysis, the supply gaps will amount to 18% of the total pilot workforce in 2023 and 14% of aviation mechanics. The outlook is for those deficits to grow or at least linger through 2033. The gap between the number of pilots needed and those available has already led to reductions in service to less popular and more rural destinations and has hit regional airlines hardest.

But the shortfall of aviation workers is a global problem. European ground crew shortages were so ubiquitous and severe in 2022 they led to the imposition of capacity limits at some European airports, including London's Heathrow and Amsterdam's Schiphol. In India — the fastest-growing aviation market, according to our latest *Fleet and MRO Forecast* — the desperate need is for more air traffic controllers. But because so many aviation jobs are critical to operations, any ongoing shortage can eventually result in the industry's growth being limited not by a lack of demand but by supply constraints.

PRODUCTION DELAYS

Next, the industry faces hard-to-remedy supply chain snarls that have already led to longer lead times on parts — sometimes of more than a year. As the industry gradually recovered in 2021 and 2022, production and maintenance were both hindered by suppliers unable to fulfill orders and provide products or services in a timely manner. Not surprisingly, much of the breakdown was related to insufficient numbers of workers.

But supplier capacity problems are only likely to multiply once Airbus and Boeing, the globe's largest aircraft manufacturers, begin to implement planned higher production goals, which would be difficult to meet even if supply chains were functioning well. Some of their biggest suppliers have already suggested the elevated production may be beyond what they and the rest of the supply chain can handle.

Without doubt, the higher production reflects the growing demand for aircraft. In February, Air India placed the largest aircraft order in history — 470 aircraft, with a price tag around $70 billion, based on an Air India statement. Airbus will supply 250 aircraft, and Boeing 220. The order is primarily for narrowbody aircraft, but it also included 787 Dreamliners from Boeing and A350s from Airbus, both widebodies. The carrier reportedly has an option to buy an additional 370. Overall, Oliver Wyman forecasts 20,600 new production aircraft to be delivered over the next 10 years.

HIGHER OPERATING COSTS

As might be expected, the tight supply of many things has pushed prices and operating costs significantly higher. The price increases have touched everything from jet fuel and salaries to aircraft parts, putting pressure on airline earnings in 2022. Still, the International Air Transport Association (IATA) predicts the global airline sector will turn in profits for 2023.

Some price pressures may ease as the global economy begins to cool under the weight of a series of significant interest rate hikes, prompted by rising inflation. The slowdown is particularly pronounced in the advanced economies, among the biggest markets for air travel.

How the economic slowdown will affect aviation is unclear. While air travel demand has been historically linked to economic growth, it managed to outperform the economy during the decade before COVID. Given the expanding middle classes in so many nations, eager to travel, and a new supersize cohort of Generation Z workers with discretionary cash, our analysis assumes that trend will continue.

WHAT ABOUT EMISSIONS?

Longer term, a major issue facing the industry is climate change and the need to reduce greenhouse gas emissions. While it has been overshadowed by more immediate pressures like COVID-19, labor shortages, and the supply chain, it will likely become a more important issue for aviation to tackle as the decade progresses. Just recently, France enacted legislation that would prohibit air flights between destinations which are served by a train ride of 2.5 hours or less. Several other European countries are working on similar rules. While not onerous, the new prohibition may be a sign of more restrictions to come, particularly in Western Europe.

Despite improvements in engine efficiency and the anticipated switching out of older, less efficient aircraft for new ones, aviation still faces the likelihood of rising emissions, given strong demand for air travel — especially from growing markets like India. The problem for the industry is the lack of solutions to reduce emissions. For instance, Oliver Wyman has no electric-powered, hydrogen-powered, or other alternatively powered aircraft in its forecast. That's because no commercially viable replacement for internal combustion jet engines on commercial airliners is expected this decade and maybe not even the next.

Based on that, aviation will likely need to depend on solutions like sustainable aviation fuel (SAF). SAF, which emits 50% to 80% fewer greenhouse gases, is currently a pricey substitute to traditional jet fuel. Here, too, supply problems exist. Based on our calculations, the best-case scenario for a 2030 supply is 5.4 billion gallons when the industry would require 16 billion just to keep airline emissions at 2019 levels.

RUSSIA AND CHINA

Geopolitical tensions also had an inordinate impact on aviation last year. Russia's invasion of Ukraine resulted in sanctions that limited the amount of Russian raw materials like titanium and aluminum and oil and gas in the market. Sanctions have also blocked Russia's access to Western-manufactured aircraft and parts.

Ultimately, while only 3% of the global market now, the Russian commercial fleet is likely to be upended by these penalties. The sanctions also may thwart Russia's plans to produce its own narrowbody aircraft. By 2033, the Russian fleet is expected to shrink 25% because of the sanctions, based on our analysis. Russian carriers are already being forced to harvest parts from their current fleets to keep other planes flying.

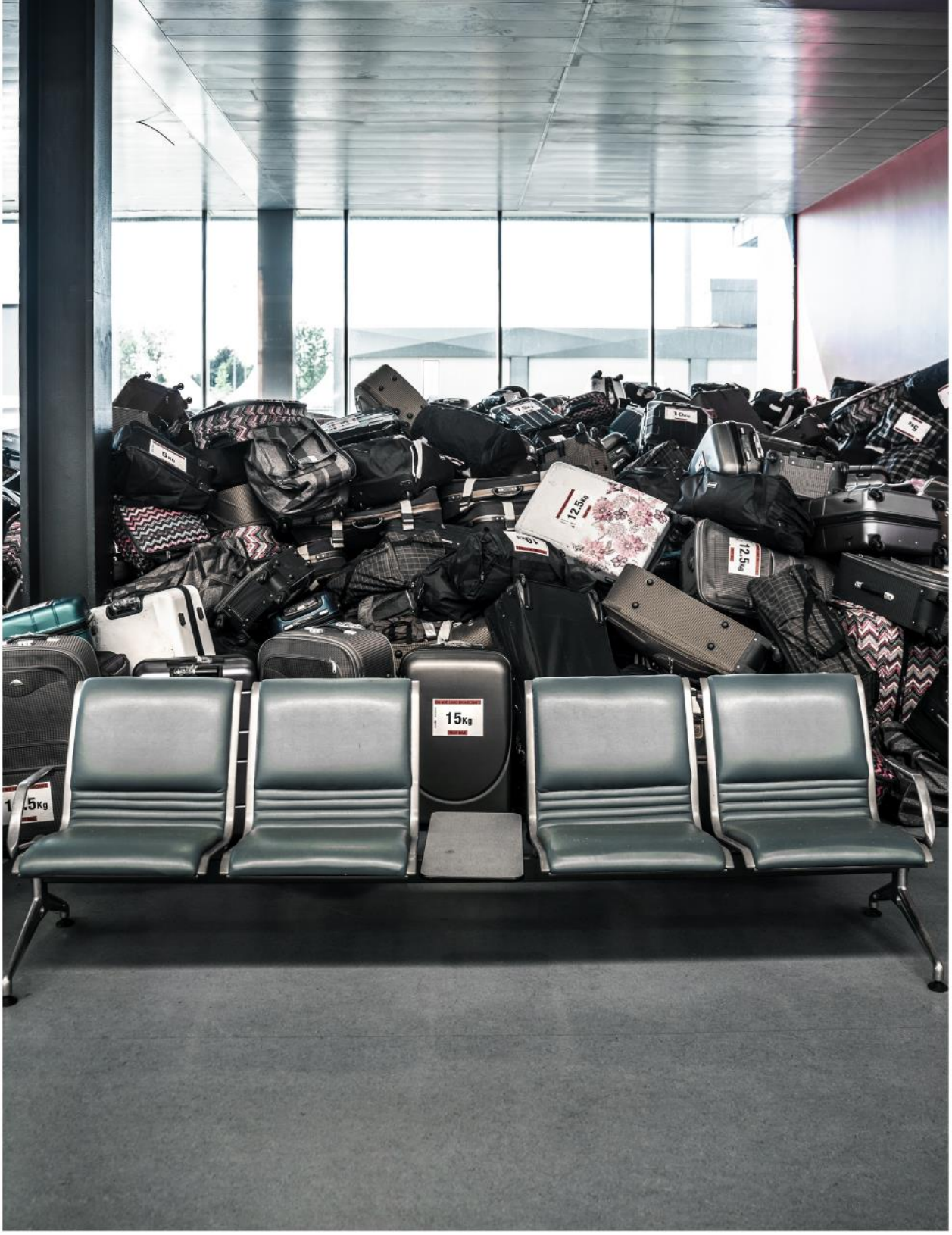
In addition, Russia is apt to find Western companies reluctant to do business with it after President Vladimir Putin prohibited leased Western planes from leaving Russia, essentially expropriating the aircraft. That led to Western countries suspending the airworthiness certificates of these aircraft, making them impossible to sell to non-Russian buyers. Many of them will end up being scraped for parts anyway, but those that aren't will probably never leave Russia again.

China also may have lost some of its luster as an aviation business partner after its strict zero-COVID policy led to lockdowns that closed off MRO capacity Western airlines depended on. Also, affecting aviation aircraft orders and the supply chain may be the increasing competition between the dominant Western aerospace manufacturers and China's still young aerospace industry.

Over the next decade, aviation's drive to expand is likely to bump up against various limitations from an overloaded supply chain, labor shortages, and new rules on emission reduction. For aviation, that will require developing innovative solutions if it is to avoid scaling back on growth. While the demand for air travel will be there, the capacity to meet it may not always be — a challenge the industry can't afford to ignore.

FLEET AND MRO FORECAST SUMMARY

Region	Africa	Middle East	Asia Pacific	China	India	Latin America	North America	Eastern Europe	Russia	Western Europe	World
2023 Fleet											
Narrowbody	463	521	2,114	3,206	502	1,134	4,369	455	427	3,178	16,369
Widebody	164	748	1,333	463	41	167	1,409	51	66	1,080	5,522
Regional jet	167	51	211	152	4	233	1,782	76	211	367	3,254
Turboprop	293	27	651	0	79	177	562	75	32	344	2,240
TOTAL	**1,087**	**1,347**	**4,309**	**3,821**	**626**	**1,711**	**8,122**	**657**	**736**	**4,969**	**27,385**
2033 Fleet											
Narrowbody	644	1,058	2,925	4,839	1,153	1,619	6,078	895	200	3,953	23,364
Widebody	223	1,070	1,564	682	53	225	1,666	105	39	1,257	6,884
Regional jet	234	58	270	618	19	240	1,359	114	313	313	3,538
Turboprop	368	24	782	182	125	148	554	96	2	238	2,519
TOTAL	**1,469**	**2,210**	**5,541**	**6,321**	**1,350**	**2,232**	**9,657**	**1,210**	**554**	**5,761**	**36,305**
Fleet growth rates											
2023–2028	3.6%	7.3%	2.8%	4.8%	9.9%	2.2%	1.6%	8.6%	-10.8%	1.7%	2.8%
2028–2033	2.6%	2.9%	2.3%	5.5%	6.1%	3.2%	1.9%	4.0%	5.9%	1.3%	2.9%
2023–2033	**3.1%**	**5.1%**	**2.5%**	**5.2%**	**8.0%**	**2.7%**	**1.7%**	**6.3%**	**-2.8%**	**1.5%**	**2.9%**
2023 MRO (US$ in billions)											
Airframe	$0.8	$1.4	$3.0	$2.6	$0.2	$0.9	$5.3	$0.5	$0.3	$4.1	$19.3
Engine	$1.2	$6.1	$10.1	$3.1	$0.6	$2.3	$9.6	$0.6	$0.5	$9.0	$43.0
Component	$0.6	$1.3	$3.1	$2.1	$0.3	$1.0	$5.5	$0.4	$0.5	$3.6	$18.5
Line	$0.3	$0.8	$2.0	$1.6	$0.3	$0.7	$3.4	$0.3	$0.4	$3.3	$13.1
TOTAL	**$3.0**	**$9.6**	**$18.2**	**$9.4**	**$1.4**	**$4.9**	**$23.8**	**$1.8**	**$1.7**	**$20.0**	**$93.9**
2033 MRO (US$ in billions)											
Airframe	$0.8	$1.8	$3.9	$3.1	$0.6	$1.1	$5.1	$0.7	$0.4	$4.1	$21.6
Engine	$2.4	$10.6	$11.5	$8.3	$2.5	$3.2	$13.4	$1.6	$0.9	$8.9	$63.4
Component	$0.8	$1.9	$3.7	$3.9	$0.8	$1.3	$5.8	$0.7	$0.3	$3.5	$22.8
Line	$0.4	$1.2	$2.6	$2.9	$0.5	$0.9	$4.3	$0.6	$0.3	$3.8	$17.5
TOTAL	**$4.4**	**$15.5**	**$21.7**	**$18.2**	**$4.5**	**$6.6**	**$28.6**	**$3.6**	**$1.9**	**$20.3**	**$125.3**
MRO growth rates											
2023–2028	3.2%	6.9%	2.8%	12.3%	16.4%	1.3%	1.3%	7.0%	-7.0%	1.8%	3.9%
2028–2033	4.6%	3.0%	0.7%	1.7%	8.6%	4.7%	2.4%	7.1%	9.9%	-1.5%	1.9%
2023–2033	**3.9%**	**4.9%**	**1.8%**	**6.9%**	**12.4%**	**3.0%**	**1.8%**	**7.1%**	**1.1%**	**0.2%**	**2.9%**



STATE OF THE INDUSTRY

A RECOVERY FACING HEADWINDS

In 2022, consumers continued returning to the skies in droves after a couple of years of quarantines and travel restrictions. Fleet sizes, passenger demand, and utilization began to approach the elevated levels from before the COVID pandemic. But the recovery was held back by external constraints, such as labor shortages, supply chain disruptions, travel restrictions, sporadic outbreaks of COVID-19, and Russia's invasion of Ukraine.

Global fleet growth made one of the largest rebounds. In 2022, airlines across the world brought aircraft out of storage and added new ones to meet burgeoning demand. By the beginning of 2023, the fleet reached 98% of its pre-pandemic January 2020 size.

By the end of 2022, IATA was predicting 2022 airline revenue at 87% of 2019's record high, thanks to fares trending higher, and a return to overall profitability in 2023 for the first time since the pandemic. Even so, demand had trouble getting much beyond 80% of 2019's traffic — mostly because of limits on capacity than because people didn't want to fly.

NO SLACK IN THE SYSTEM

The 2022 gains were marred by challenges and capacity constraints that created problems for both airlines and travelers. Among the biggest obstacles to a return to pre-pandemic operations were tight labor markets that affected all regions and aspects of aviation. In North America, pilot shortages prompted delays and cancellations as well as cutbacks in less popular routes and regional jet flights.

Globally, a shortage of air traffic controllers — from the United States to India — constrained airspace capacity and the ability of systems to recover from weather events and other irregular operations. Ground crew shortages, from security personnel to baggage handlers, were ubiquitous and so severe they led to the imposition of capacity limits at some European airports, including London's Heathrow and Amsterdam's Schiphol, during the peak of summer travel.

In June and July, a series of powerful storms across the US contributed to more than 55,000 canceled flights, 40% more than the normal number of cancellations for those months. There was no slack in the system to cope with the unexpected. While airlines, airports, and regulators have raised salaries and recruited actively for new candidates, categories like pilots and mechanics are expected to be plagued with shortfalls through the decade.

CHINA'S RELAPSE

COVID-19 also wouldn't go away and slowed recovery in certain regions. While North America and Europe kept the coronavirus relatively under control, China suffered several outbreaks in 2021 and 2022 that triggered the nation's zero-COVID policy and placed various parts of China, including several major cities, under lockdown.

Besides the impacts from COVID quarantines and a slower economy, China's aviation market was also hurt by government limitations on travel outside the country and visitors entering it, which were only lifted in January 2023. China's COVID-19 policy affected the rest of Asia Pacific as well, keeping passenger volumes down. In 2022, APAC's domestic volume reached 56% of 2019 levels, with China's domestic even lagging that at 54%.

The result was a setback in China's economic recovery. In 2022, China's gross domestic product (GDP) grew at only 3%, the lowest in a decade — except 2020 when COVID-19 cut growth to 2.2%. While China is expected to pick up in 2023, the rate will still be less than what it achieved in 2021 and in many of the years before COVID-19.

RUSSIAN ROULETTE

While most parts of the world were working their way back to pre-pandemic highs in 2022, Russian aviation went in the opposite direction. Following Russia's invasion of Ukraine on Feb. 24, 2022, the US and North Atlantic Treaty Organization (NATO) imposed sanctions that prohibited the sale of Western-manufactured aircraft and aerospace parts to Russian entities. Unable to buy Western equipment, Russian airlines — as early as July — were reported cannibalizing aircraft for replacement parts to support aircraft in service.

The sanctions also will set back Russian production of the Superjet and MC-21 aircraft, which were going to be reliant on a high proportion of Western-made engines and components. To produce the aircraft with sanctions in place, Russia now needs to develop its own components and engines. It faces years of delay before the aircraft are likely to enter service and earn certification to fly outside Russia — if they ever do. Still, Russia only represents about 3% of the global fleet and MRO demand, so the impact of the sanctions will be harder on Russia than the global industry.

Russia responded to the sanctions by closing its airspace to Western aircraft, forcing carriers to contend with sometimes significant rerouting to avoid violating the airspace. Russian President Vladimir Putin also prohibited foreign-made aircraft from flying outside Russia, essentially holding hostage hundreds of leased aircraft. Western lessors scrambled to recover their planes, but few were successful. It's likely most will hesitate to do business there for a while, if or when sanctions are lifted.

Meanwhile, the global aviation industry also felt the impact of the Ukraine conflict. The sanctions were particularly hard on the aerospace production's supply chain because they blocked the sale of Russian raw materials, such as titanium, nickel, aluminum, and oil and gas — which are critical to aircraft production and aerospace manufacturers that are already dealing with a constricted supply chain. The oil and gas disruption forced up jet fuel prices globally at a time when the aviation industry has been struggling with rising operating costs.

GLOBAL GROWTH

Following record increases in inflation globally and repeated and significant hikes in interest rates in many countries, economic growth around the world cooled in 2022, raising fears of recession. That trend might be ominous for air travel, given the discretionary nature of a large percentage of it. But while historically closely linked to GDP growth, air travel demand outpaced economic expansion for much of the decade before the pandemic, and there's reason to believe that pent-up demand will help it continue that trend in the future.

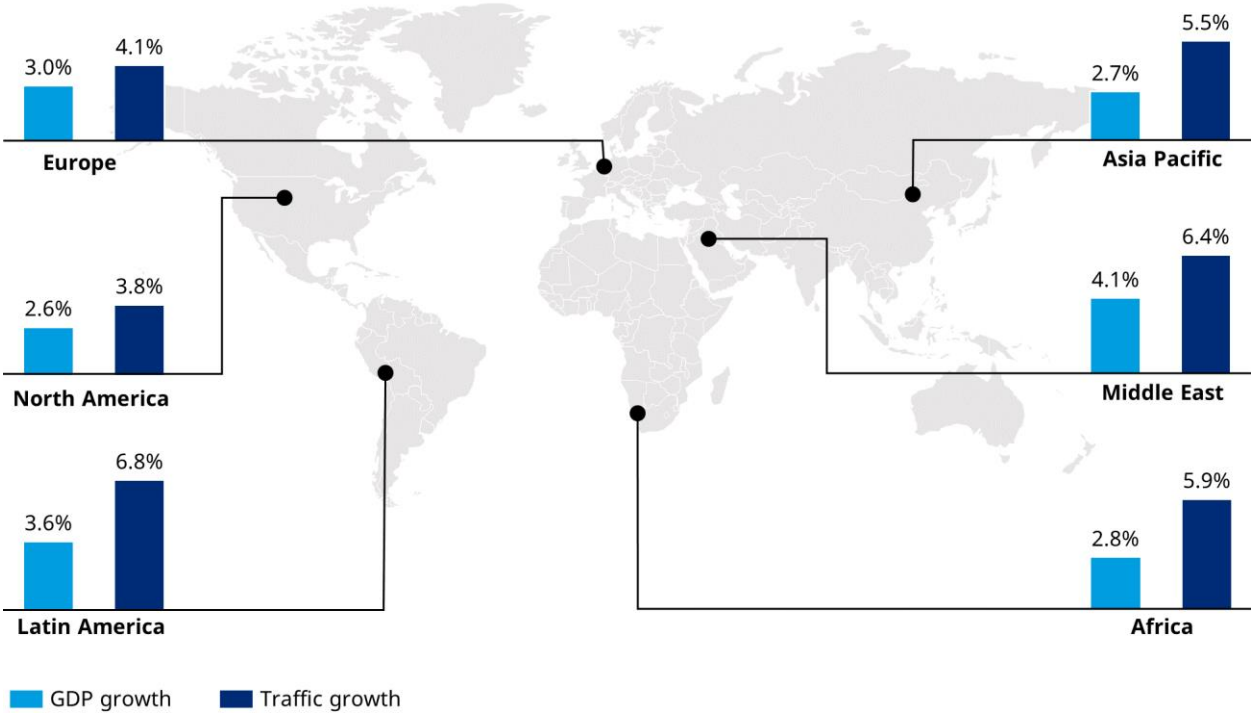
Travelers seemed relatively undeterred by travel disruptions, higher fares, and a cooling global economy. They also feared COVID-19 less, given the availability of vaccines and effective treatments. IATA is predicting total airline revenue in 2023 of $779 billion, the highest since 2019 when the global industry reported a record $838 billion.

Especially in domestic markets in North America, Europe, and Latin America, airline bookings in 2022 remained strong, pushing passenger traffic closer to 2019 peaks. The same cannot be said for the international segment, which has been markedly slower to improve. The segment's sluggishness has held back the recovery in markets like Asia Pacific, which depends on a large component of international traffic. It also has delayed the full recovery of the widebody fleet — used extensively for transoceanic routes.

One interesting exception: the Middle East, a market heavily dependent on international travelers. While it lagged other regions for a long time, the region's numbers benefited in recent months from the rerouting of traffic prompted by the war in Ukraine and even more so from the World Cup in Qatar in late November and early December 2022. It even managed to sustain recovery in the international sector, despite the slowdown in travel to the major Asian destinations popular with travelers to and from the region.

For the year 2022, the number of international passengers only recovered to 66% of 2019 levels versus domestic, which was at 83%. By the end of the year, that trend began to change. In December, international was at 80% of 2019, while domestic was still at 83%. Still, the recovery in both is less than many had thought at the beginning of 2022 would be the case as 2023 dawned.

Exhibit 1: 2023 to 2033 projections for traffic growth and gross domestic product



Source: Oliver Wyman analysis

HOW GLOBAL DEMAND GROWTH AFFECTS THE FLEET

Passenger traffic and demand, despite headwinds, continued to recover in 2022. Global revenue passenger kilometers were 69% of the total in 2019, according to IATA, up from 42% in 2021. Last year, the global total was held down by the international RPKs, which were 62% of the 2019 total. Domestic RPKs were 80% of 2019.

All regions' domestic segments, except China's, are expected to recover to pre-pandemic levels at some point in 2023. While most regions' international segments will recover in 2024, total global recovery of the segment is not expected until sometime in 2025.

Exhibit 2: Expected recoveries for fleets and demand by region, indexed to year-end 2019

	DOMESTIC RECOVERY		INTERNATIONAL RECOVERY	
Region	**Fleet**	**Demand**	**Fleet**	**Demand**
North America	Recovered	2023 Q3	Recovered	2023 Q4
Western Europe	2024 Q1	2023 Q2	Recovered	2024 Q1
Asia Pacific	2023 Q4	2023 Q4	2024 Q2	2025 Q1
China	Recovered	2024 Q4	2023 Q2	2025 Q1
Latin America	Recovered	2023 Q1	2025 Q1	2024 Q3
Eastern Europe	Recovered	2023 Q2	Recovered	2024 Q1
Middle East	Recovered	2023 Q4	2024 Q2	2024 Q1
Africa	Recovered	2023 Q2	2025 Q1	2024 Q1
India	Recovered	2023 Q4	2024 Q1	2025 Q1

Source: Oliver Wyman analysis

The different fates of the domestic and international markets have meant distinctly different recoveries for narrowbody and widebody aircraft. Narrowbodies dominate domestic markets, and with fewer restrictions on domestic travel, narrowbody fleets have largely recovered to 2019 levels — with the notable exception of narrowbody fleets in Asia Pacific and Western Europe.

Widebody recovery has trailed the narrowbody rebound because of the slow return of international traffic and travel restrictions between some countries and regions that lingered well into 2022. Even China, where the narrowbody fleet was at pre-pandemic size by the end of 2020, still has a widebody fleet 6% smaller than it was pre-COVID.

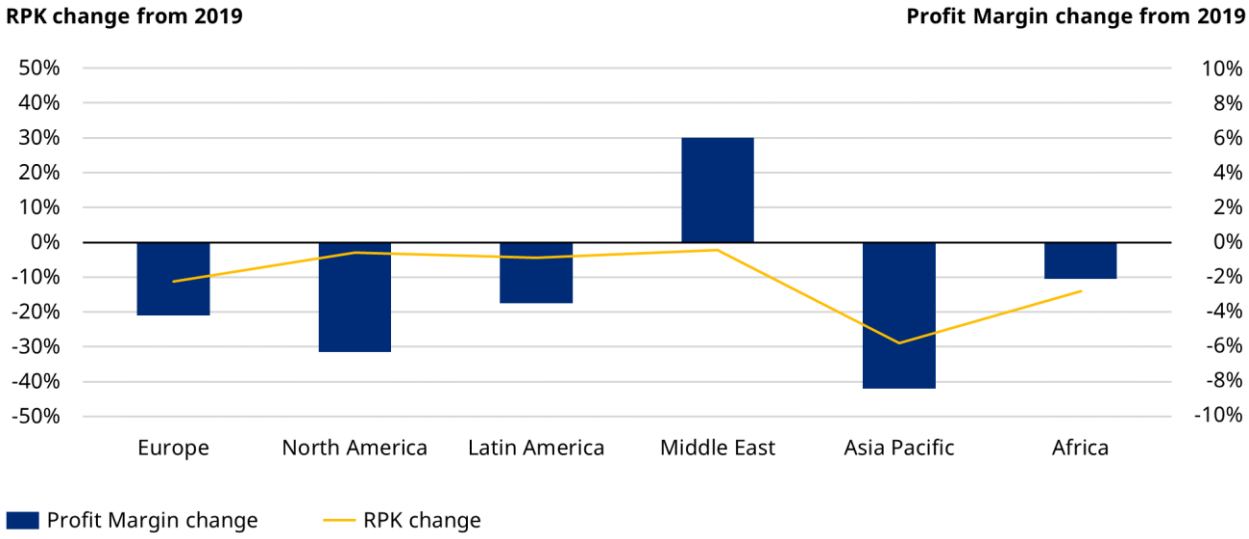
A RETURN TO PROFITABILITY

As the airline industry's recovery continued in 2022, financial performance improved accordingly. While globally the industry is expected to post a loss for the third straight year in 2022, the decline will be smaller than expected. In December 2022, IATA predicted a loss of $6.9 billion instead of the more than $11 billion forecast earlier that year. By 2023, IATA sees the industry posting net profits of $4.7 billion.

North America was the first region to return to profitability. Major carriers, including Delta, American, United, Southwest, and Alaska, reported record revenue in the last half of 2022, large enough to help them return to profitability for the year.

European carriers, including Lufthansa, AF-KLM, and IAG, also posted strong results in the last half of 2022 that approached 2019 levels. Similarly, other regions are making progress as losses narrow, driven by the easing of travel restrictions globally. Despite Japan Airlines, ANA, and Korean Air posting profits in 2022, the broader Asia Pacific region is expected to post losses because of the impact of China's COVID problems. With the lifting of China's travel restrictions in 2023, the region's pent-up demand is expected to help it rebound.

Exhibit 3: 2023 RPK and profit forecasts by region



Source: IATA

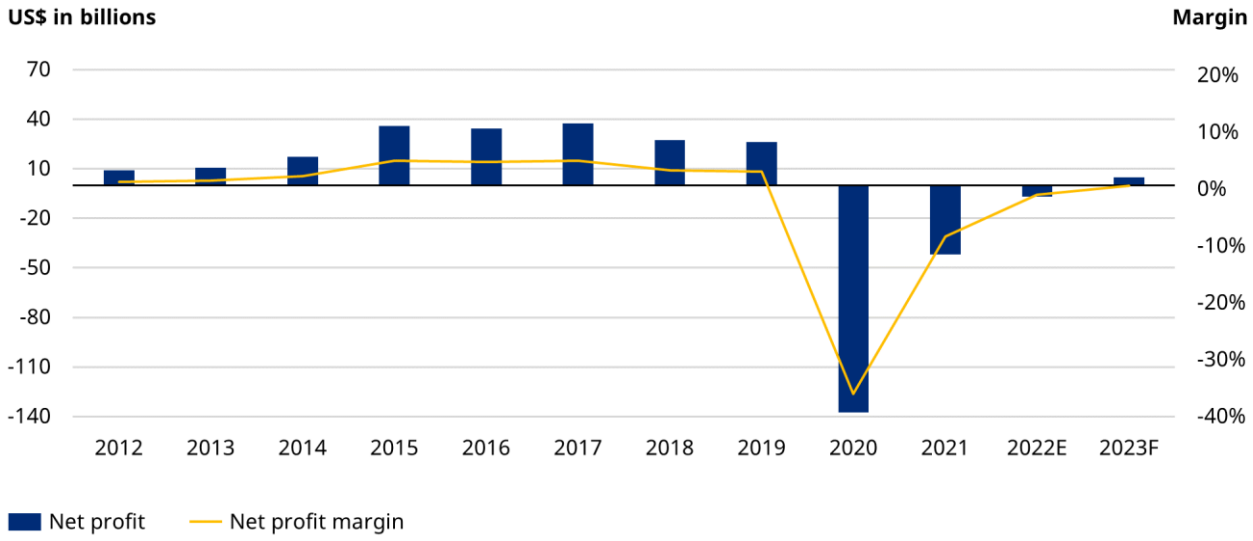
RISING OPERATING COSTS

A looming challenge to airlines' return to profitability is rising costs. Almost every carrier expense has risen over the past year — including their two biggest, fuel and labor. IATA reports total labor costs increasing 7% in 2022 year-over-year, and unit labor costs rising 12% since 2019. The jump for fuel was worse: Despite reducing fuel usage by 23%, fuel costs on a per unit basis increased 50% over 2019's, while overall spending on fuel was up 17%.

Meanwhile, supply chain disruptions and inflation have pushed up the cost of spare parts and materials. Catalog list prices of some parts have risen between 10% and 20%.

Longer lead times on parts, because of a strained and broken supply chain, also can increase costs if the solution is to hold extra inventory — including extra aircraft and spare parts — as a cushion. This has and will continue to push up operating costs for airlines.

Exhibit 4: Global Airline Industry Financial Performance, 2012–2023F



Notes: The net profit totals are rounded to the nearest whole number; E stands for estimate e, F for forecast
Source: IATA

LABOR AND FUEL

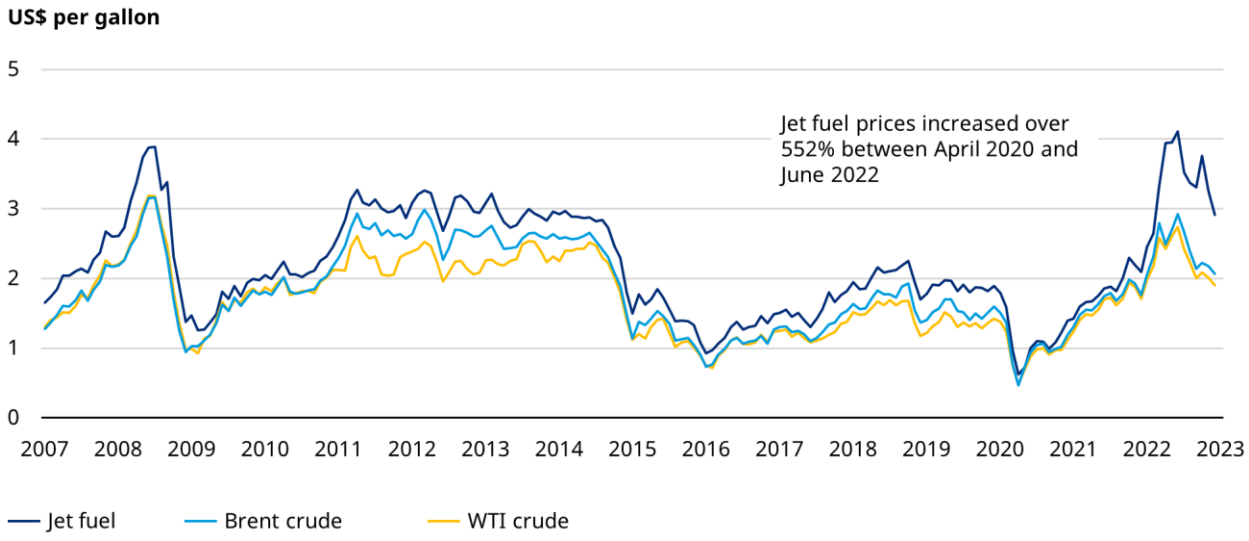
Fuel and labor costs, which together account for about half of operational expenses for airlines, were rising steadily in 2021 and 2022. While they trade off on which represents the biggest annual expense, 2022 saw substantial increases for both.

In both cases, this was not just a rise in absolute annual costs but also in the cost per available seat mile. That's because airlines couldn't add more capacity to spread the higher costs over more seats — mostly because of the tightness in supply of just about everything. Of course, some airlines hedge oil prices and may have been able to put off the impact on their bottom line for a time.

In 2022, the Russia-Ukraine conflict and resulting sanctions sent oil prices soaring above $100 per barrel for the first time since 2014. Capacity constraints at refineries also contributed to the jet fuel crack spread — the difference in price between crude oil and the refined product — reaching historically high levels.

The war and the rebound in demand pushed up the price of jet fuel more than 70% at times. With healthy demand for travel, airlines have been able to pass some of these costs along to consumers. Still, if prices remain high, some airlines may pursue fuel efficiency gains by switching out older, less efficient aircraft earlier than planned.

Exhibit 5: Spot prices of crude oil and jet fuel, 2007–2022



WTI = West Texas Intermediate
Note: Crude prices are calculated by dividing the price by the number of gallons in a barrel
Source: US Energy Information Administration

Labor markets were tight for aviation even before COVID-19 cut headcount through a combination of early retirements and layoffs. As a result, like elsewhere in the labor market, wages for almost all categories of workers have been raised to attract and retain employees.

But even that has not always closed the gap. For instance, the pilot shortage has pushed up salaries, especially at the entry level. Even so, airlines, especially regional carriers, were still forced to cut back flights to less popular and rural destinations. The MRO aftermarket will also see a shortage of mechanics starting this year, which is expected to push up labor rates in that sector.

THE AEROSPACE CHALLENGE

Supply chain challenges have hindered aerospace production lines, causing both Airbus and Boeing to fall short of production and delivery targets for 2022. 2023 is unlikely to be different for either, given that the two rely on many of the same suppliers and sources of raw materials, and the conditions remain about the same this year. Of course, many of the same parts are used on the A320 and Boeing 737, meaning that the pressure on some suppliers is multiplied.

With the limited global supplies of materials being quickly used up for new production, airlines and MROs have been left scrambling for aftermarket materials to support maintenance. The squeeze has pushed up the cost of materials at a time when maintenance demand is rising, with deferred maintenance over the last three years coming due.

To support fleets and the aftermarket, these businesses have been forced to get creative, with options such as optimizing maintenance programs, considering use of alternate parts and repairs, and taking full advantage of green time and used serviceable materials.

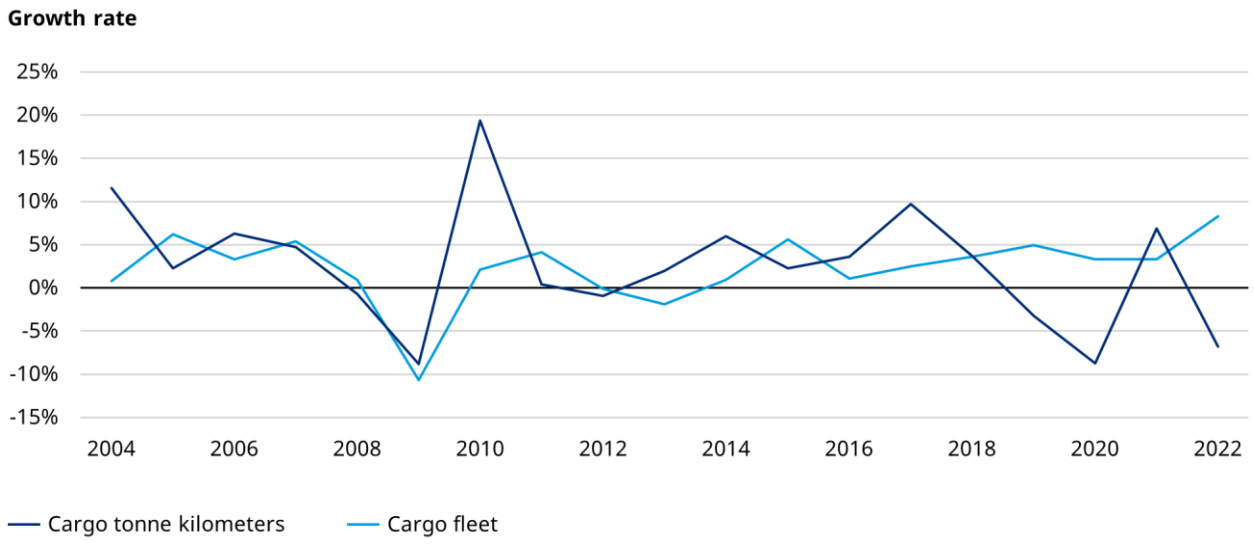
OUTLOOK FOR CARGO

In 2020 and 2021, the volume of ecommerce cargo exploded as people shifted to online shopping to avoid unnecessary exposure to COVID-19 while in-store shopping. Ecommerce and the hot cargo market it produced cooled off in 2022 as the economy slowed down, prices rose with inflation, and a strong US dollar made prices on imports higher. In addition, supply chain snarls in the maritime space abated, making that a shipping option again.

The 14-month growth streak in cargo demand, as measured by cargo tonne kilometers (CTKs), ended in second quarter 2022, when demand fell slightly below 2021 levels. Despite the slippage, cargo demand remains above pre-pandemic levels.

Air cargo capacity, as measured by available cargo tonne kilometers (ACTKs), also saw its first contraction since the rebound from COVID shutdowns. It has yet to recover to pre-pandemic levels as more than half of all cargo capacity is in the belly of passenger aircraft. The cargo fleet is also evolving, with the last delivery of the workhorse 747 and the impending end of 767F and 777F production because of new emissions and noise rules from the International Civil Aviation Organization (ICAO).

Exhibit 6: Cargo fleet and cargo tonne kilometer growth trends, 2004–2022



Note: The 2022 cargo tonne kilometer data is an estimated value
Source: Aviation Week Intelligence Network's Fleet Discovery, Oliver Wyman analysis, IATA

IN-SERVICE FLEET FORECAST

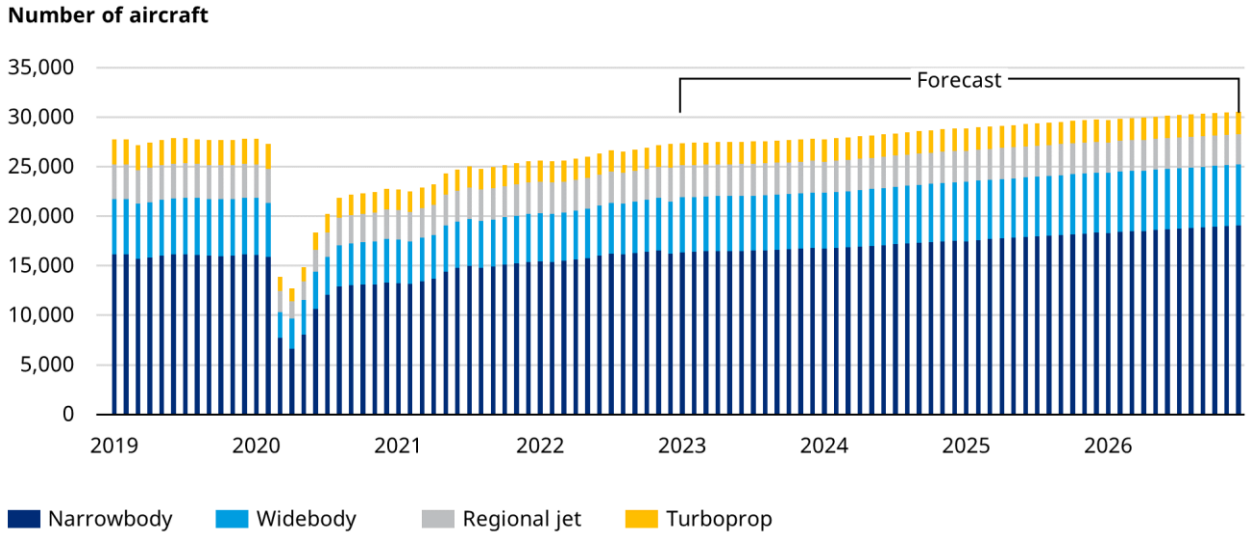
BACK ON COURSE FOR GROWTH

At the beginning of 2023, the global commercial fleet had about 27,400 aircraft in service, just shy of the January 2020 peak of almost 28,000 set before the outbreak of the COVID pandemic. Sometime this year, we expect the fleet to surpass its old record.

Based on our analysis, the fleet will grow 33% to 36,300 aircraft by January 2033, a compound annual growth rate of 2.9%. While that's impressive expansion, given the bite the pandemic took out of the industry, the total in 2033 will still be significantly less than the 39,000 projected for 2030 before COVID-19 reset expectations. Given current growth rates, the fleet will not reach 39,000 until 2034 at the earliest — representing a loss of four years of growth.

Besides growing more slowly, the global fleet will also look different in 2033. Just for starters, a larger percentage than ever will be based in Asia — 36% compared with a historical average of 30%. Narrowbody aircraft will make up 64% of the global total versus the current 60% share. It will also be slightly younger, with an average age of 11.5 years compared with previous average ages of around 12.

Exhibit 7: Monthly in service fleet, 2019–2026



Source: Curium Fleets Analyzer, Aviation Week Intelligence Network's Fleet Discovery, Oliver Wyman analysis

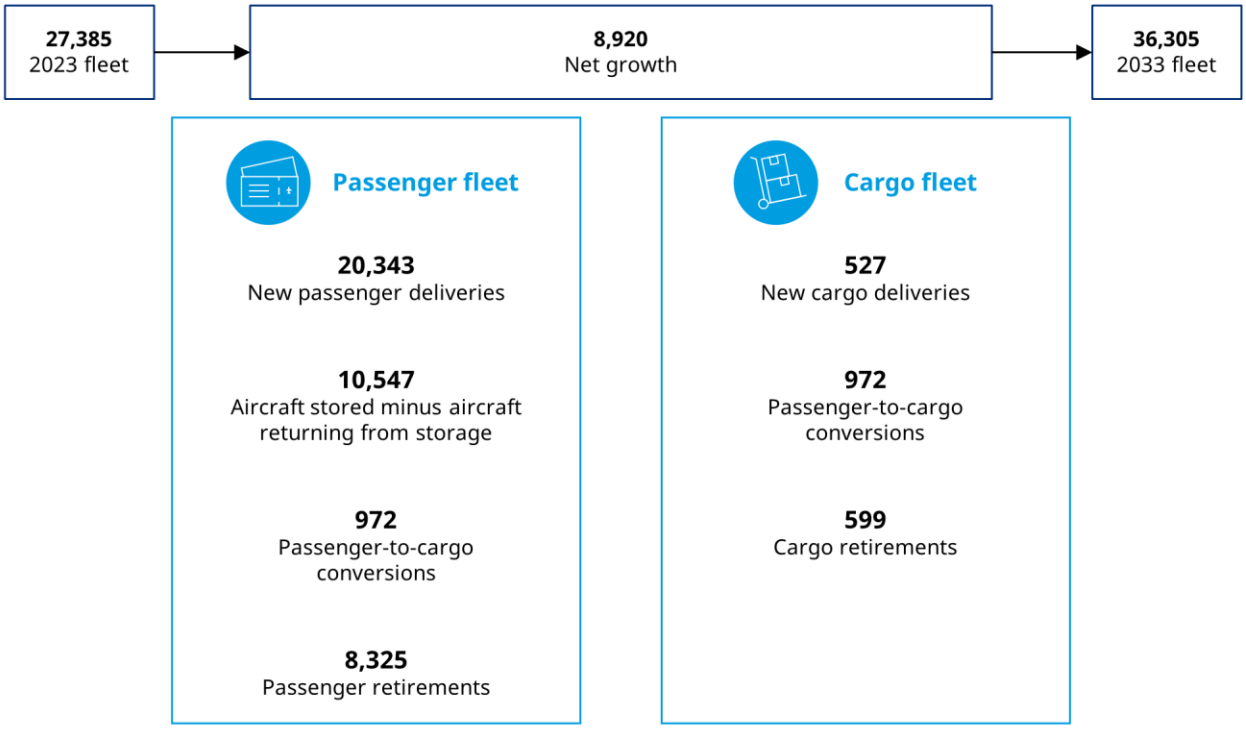
DOMESTIC STRENGTH

By the beginning of 2023, the domestic fleets of seven out of the nine regions analyzed in the *Fleet and MRO Forecast* had fully recovered by January 2020, with the notable exception of Western Europe and Asia Pacific. Three international fleets had returned to pre-pandemic levels, with staggered recoveries for the rest from now through the first part of 2025.

While there was much hope last year for a full recovery of the entire fleet by now, the Russian invasion of Ukraine, continuing COVID lockdowns in China, global inflation, and slower economic growth undermined that expansion. Still, 2023 opened about 7% higher than 2022 — 27,400 versus 25,552 in January 2022.

The increase included hundreds of aircraft returning to service from storage, where they had been sitting since the early days of the pandemic, as well as around 1,100 new aircraft. We estimate as many as 4,000 aircraft are still in storage, although some are considered retired. Because of the stronger domestic recovery, almost all aircraft entering the fleet last year were narrowbodies.

Exhibit 8: Projected global fleet changes, 2023–2033



Note: Fleet sizes as of beginning of 2023 and 2033, stored aircraft includes retirements
Source: Oliver Wyman analysis

WIDEBODIES, REGIONAL JETS, AND TURBOPROPS

Despite lingering cases of COVID-19 and some continuing cross-border travel restrictions, about 97% of the widebody fleet — primarily used for transoceanic travel — had recovered by the end of 2022. Given the expected 250 widebody deliveries in 2023, the global widebody fleet should be fully recovered by the end of 2024, in time for an anticipated return of more international travel.

Widebodies are less efficient than narrowbodies, and some airlines are turning to narrowbodies with longer ranges to replace the larger aircraft for some cross-border travel. By 2033, the share of widebodies in the fleet is expected to decrease slightly from 20% today to 19%. Narrowbodies are the only aircraft class expected to grow in share over the forecast.

The regional jet and turboprop fleets, used for shorter domestic routes, face the toughest outlook over the 10 years. It is likely regional jets will never again reach their January 2019 peak as the shortage of pilots prompted airlines to cut back service to less popular and more rural destinations where regional jets fly. Carriers also replaced regional jets, where possible, with narrowbody aircraft because of their superior fuel efficiency.

Additionally, there are limited options to replace aging regional jets and turboprops. That's because few platforms are currently in production, and many of those aren't options in North America because of certain pilot contract provisions. Finally, there are no new platforms announced from manufacturers for these classes through the forecast period.

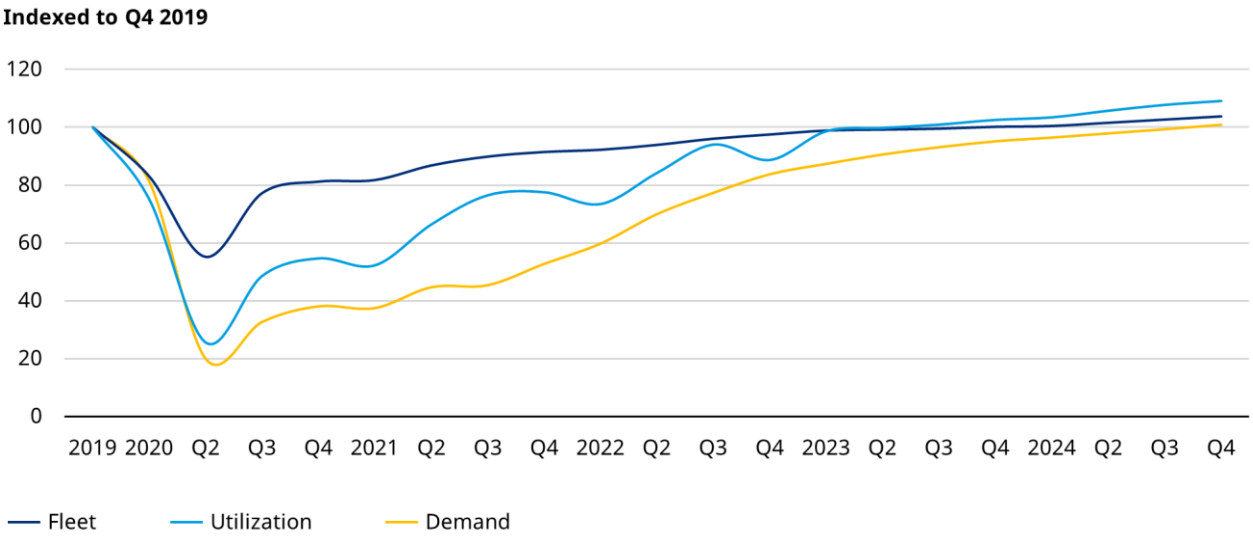
REGIONAL RECOVERY FROM COVID

Despite a strong rebound in demand for air travel in 2022, recovery in various regions was uneven as each faced different economic outlooks and conditions.

North America was close to fully recovered in 2022. In fact, the region was doing so well that many airlines had trouble handling the demand because of shortages of essential workers, such as pilots. The consequence was an inordinate number of delays and cancellations, tied to inadequate staffing. Any disruption — because of weather, for instance — was also difficult to offset because there were not enough pilots, fewer reserve aircraft, and restrictions on airspace because of a shortage of air traffic controllers.

Western Europe faced similar pressures, although its labor shortages were focused more on limited ground crew and airport workers and its recovery was less robust. Even so, the summer demand last year prompted some European airports, unable to accommodate the crowds, to impose capacity restrictions. This, of course, further delayed fleet recovery.

Exhibit 9: Quarterly fleet, utilization, and demand recoveries, 2019–2024



Source: Cirium Fleets Analyzer, Aviation Week Intelligence Network Fleet & Data Services, Oliver Wyman analysis

CHINA LAGS

After a quick rebound in both demand and fleet size after the initial wave of COVID-19, China faced new outbreaks of the virus in 2021 and 2022. The government continued its zero-COVID policy, which involved months-long citywide lockdowns of some of China's largest cities, including Shanghai.

The disruptions undid some of China's recovery and caused its aviation sector to behave differently than other regions. Where in other regions fleet sizes were slower to recover than utilization per aircraft, the reverse was the case in China. While China's domestic fleet had fully recovered as early as the second half of 2020, its utilization per individual aircraft is still lagging, in large part because of the zero-COVID policy, which discouraged both domestic and international travel.

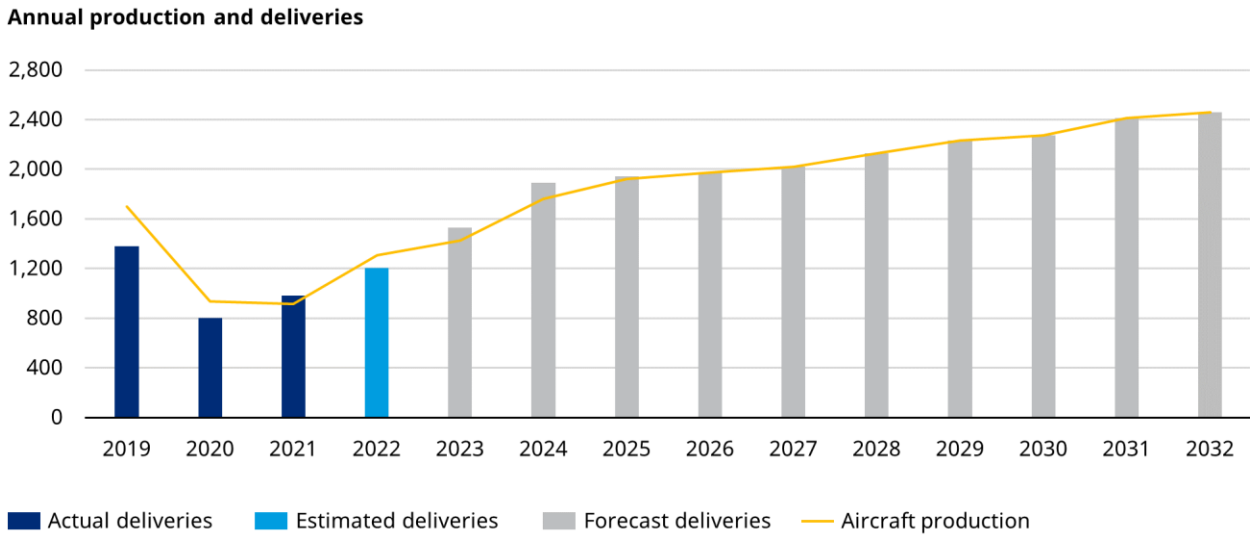
The lockdowns began to ease toward the end of 2022, and by January 2023, China had lifted both the lockdowns and restrictions on cross-border travel. This decision should help growth globally, particularly in international travel.

While China's aircraft utilization is still not fully recovered, the Chinese fleet has continued to see growth since the trough in the summer of 2020. China's 2023 starting fleet was made up of just over 3,800 aircraft, exceeding pre-pandemic levels. In January 2020, China's fleet stood at about 3,550. Year-over-year, the fleet grew 2.6% in 2020, 3.7% in 2021, and 1.2% in 2022.

GLOBAL INVENTORY

Many of the aircraft shipped in 2022 represent new planes that had been sitting in manufacturer inventories for months, even years, waiting for buyers to take delivery. Of the 1,100 deliveries in 2022, 287 were from manufacturer's undelivered backlog. Almost three-quarters were narrowbody aircraft, 16% widebody, and 11% regional jet and turboprop.

Exhibit 10: Aircraft production and delivery actuals and forecasts, 2019–2032



Source: Oliver Wyman analysis

In 2022, Boeing had a large inventory with which to contend, after regulators grounded its popular 737 MAX in 2019 and paused delivery of the 787 widebody Dreamliner in 2020. Boeing received the go-ahead from the US Federal Aviation Administration (FAA) to restart deliveries of the MAX in November 2021 and the 787 in July 2022.

We estimate that Boeing still has about 150 MAX aircraft in inventory, almost all of which are destined for China. Despite the Civil Aviation Administration of China approving the MAX for a return to service in December 2021, Chinese airlines have been slow to take delivery, perhaps because of COVID-19 lockdowns or geopolitical tensions. The first 737 MAX flights in China since the grounding didn't occur until early 2023. Additional 737s are expected to return to service with the easing of China's zero-COVID policy in January and the subsequent return in demand.

Boeing still has an inventory of about 75 787s, after delivering 26 in the third and fourth quarters of 2022. We expect it could take up to three years to clear the inventory, depending on global economic growth. That means Boeing could eliminate its backlog in 2025.

THE NARROWBODY RACE

Until the grounding of Boeing's 737 MAX, Boeing and Airbus had tended to split the narrowbody market. But moving forward, Airbus is expected to grab a bigger share of the market, increasing to 59% of production between 2023 and 2032.

Total narrowbody production is expected to increase to an average of 93 per month in 2023, 132 per month in 2027, and 149 per month in 2032, based on Oliver Wyman's analysis. Narrowbody production includes the flagships of both major manufacturers, the Boeing 737 and Airbus A320, along with Airbus' smaller A220, and the anticipated Chinese COMAC C919. While Russia is expected to produce a narrowbody, it is unlikely to get certified to fly outside of Russia.

Airbus has pledged to produce 75 A320 aircraft per month by the middle of the decade. Yet, historically, the highest rate of production achieved for the A320 was 53 per month in 2019, which then fell to 40 per month in 2022. Reaching its target would require massive support from suppliers and an easing of current supply-chain constraints and labor shortages. Airbus recently announced it was looking to add another 13,000 workers, the equivalent of 10% of its current workforce.

SUPPLY CHAIN ANXIETY

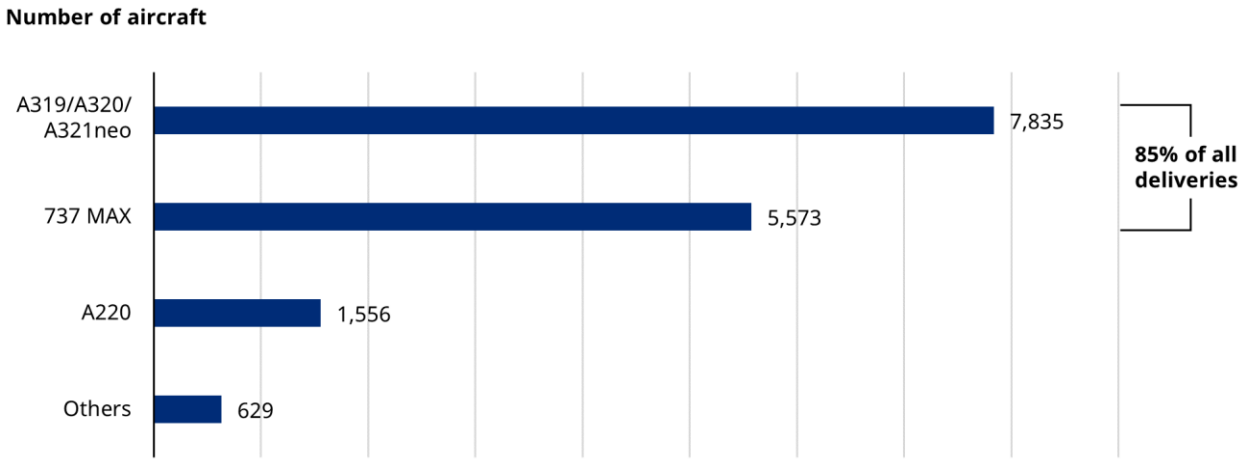
To exceed historical production levels, Airbus and its suppliers will have to undergo a significant upscaling of the manufacturer's supply chain. Some suppliers are openly challenging the feasibility of the ambitious production targets. Internally, the current assembly lines would require massive optimization to turn around the higher numbers of finalized planes in the given timeframes.

In addition, even at the current level of production, suppliers are facing difficulty obtaining the necessary resources. Finally, if supply and demand are to align given that aerospace builds only on order, the higher level of production suggests that airlines would begin to retire much younger aircraft later in our forecast to accommodate the new planes.

At the same time, Boeing is also looking to increase monthly production of its 737 flagship to 50 by the middle of the decade. Previously, the highest production rate Boeing achieved was 48.5 per month in 2018. To support the slightly augmented production, Boeing is preparing to open a fourth production line in its Everett, Washington, manufacturing facility by the end of 2024.

Because many suppliers support both Boeing and Airbus, sometimes selling each the same parts, Boeing would face the same supplier and supply chain constraints as Airbus. And with both ramping up simultaneously, that elevates what is being asked of the supply chain. We forecast narrowbody production to reach 1,550 by 2026 — the year we expect production and deliveries to be once again aligned and inventory backlogs cleared.

Exhibit 11: Projected deliveries of narrowbody aircraft by platform, 2023–2032



Note: Others include C919, E-Jet, and Russian NB
Source: Oliver Wyman analysis

OTHER PRODUCTION CHANGES

Another notable change in production involves Boeing's 767 and 777 lines, which will no longer be produced after 2027 because of new noise and emission limits set by the ICAO and adopted by the FAA. The 777 line will be replaced with the 777X line, which is expected to reach almost 400 deliveries during the forecast.

Unlike narrowbodies and widebodies, regional jets have limited replacement options that offer marginal benefits other than newness. This, along with the shortage of pilots, is constraining the future of regional jets.

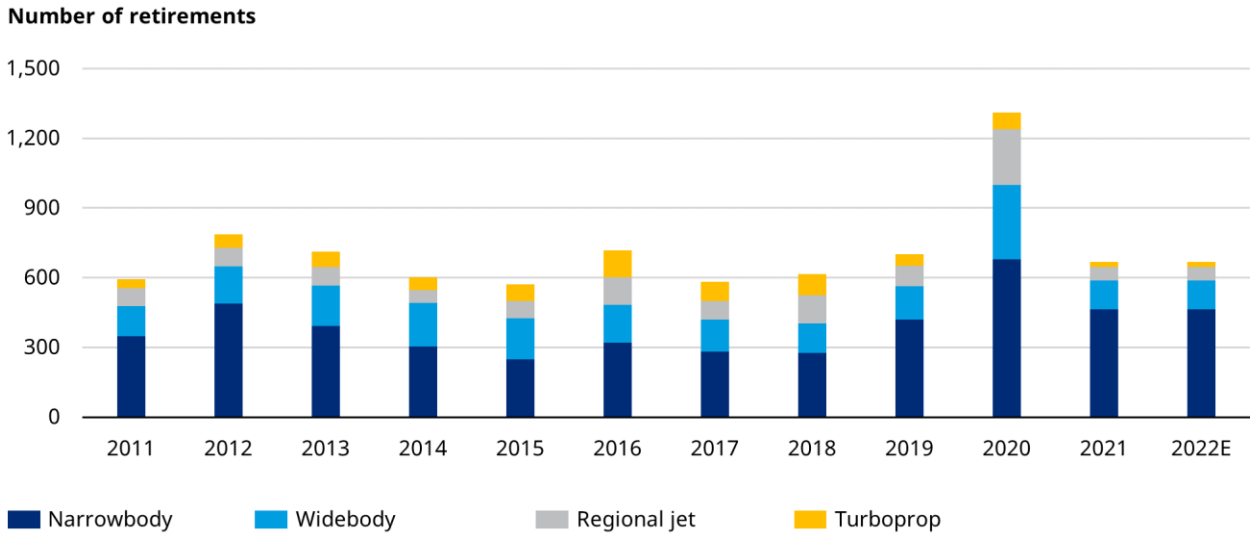
Turboprop production, on the other hand, will primarily be composed of ATR and Skycourier deliveries. ATR is expecting to reach production of 50 aircraft per year in 2023 and 80 in 2026. We are expecting over 600 ATR deliveries throughout the forecast period. Skycourier will see almost 200 deliveries over the same period.

RETIREMENT TRENDS

Retirements can be difficult to capture in real time, as many aircraft sit in storage for months or even years before they are officially retired. In 2022, we expect the number of retirements to decline to around its historical average, with about 670 retiring compared with an average of 650 prior to 2020. Through 2033, however, we expect an average of 760 retirements annually — a 17% increase over pre-pandemic.

Over the course of the forecast, the average age of the narrowbody fleet at retirement will drop to less than 25 by 2032 from 30 in the early 2000s. As Boeing and Airbus ramp up production of their narrowbody fleets, the availability of new-generation, more fuel-efficient aircraft will keep the narrowbody average age at retirement at historical lows.

Exhibit 12: Annual retirements, 2011–2022



Note: Retirements in 2022 are based on an estimate of aircraft that will not return to service and may not reflect current financial retirement status
Source: Oliver Wyman analysis

Fleet retirements spiked in 2020 at double the average amount but have since returned to their historical trend, with a little more than 500 in 2021 and about 670 last year. During these years, the impact on the widebody fleet was significant, with 300 retired in 2020 alone, double the historical average. Of those, the majority were aircraft with more than two engines.

In the last few years, North American and Western European shares of fleet retirements have increased to 58% from a historical average of 51% of all global retirements, mostly driven by COVID-19 and the age of their fleets. Still, with the worst of the pandemic behind us, North America and Western Europe will continue to have the largest shares of retirements moving forward as those regional fleets work to make room for new, more fuel-efficient aircraft. This trend will be driven by the two regions' large share of aging regional jets and turboprops. But with limited options for replacements, some operators may opt to hold onto these aircraft beyond normal retirement age, tempering the number of retirements.

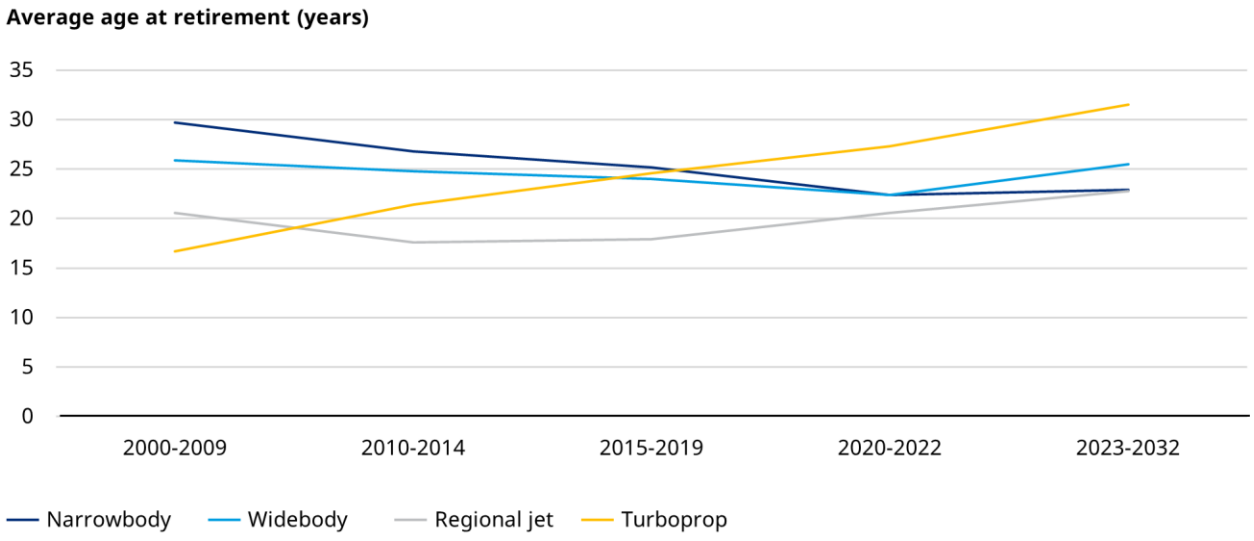
REGIONAL JETS

Regional jets were hit particularly hard by COVID and the pilot shortage in North America and Western Europe, where 66% of the regional jet fleet is based. The thousands of pilots who took early retirement during COVID-19 aggravated the pilot shortfall and prompted airlines to cut back on less popular and rural routes often flown by regional jets.

At the start of 2023, 2,100 regional jets were in service in North America and Western Europe, with more than 900 still in storage. The average age of these jets is 18. By the end of our forecast period, the number in service in the two regions will have fallen 22% to between 1,650 and 1,700 because of retirements.

Over the decade, global regional jet deliveries will total a little over 1,400 and retirements more than 1,200. But some regional jets will have a limited market: The Russian-produced Sukhoi Superjet is unlikely to operate outside of Russia in the foreseeable future because of sanctions, and the Chinese COMAC ARJ will be confined to China and Asia Pacific until it is certified by other parts of the world.

Exhibit 13: Aircraft Average age at Formal Retirement



Source: Oliver Wyman analysis

THE NEED FOR NEXT-GEN AIRCRAFT

Aside from age, an important factor that plays into aircraft retirements is fuel efficiency and sustainability. With an increasing number of airlines committing to reach net-zero emissions by 2050, more will be under pressure to achieve better fuel efficiency by replacing older planes with new.

The newest generation aircraft have already begun to replace legacy aircraft, but their fuel efficiencies won't cut emissions enough so airlines can meet global climate targets. These newer aircraft provide a 15% to 20% improvement in fuel efficiency.

The 737 MAX and A320neo will take over the narrowbody market, sending 737 NGs and A320ceos into retirement. Since 2019, 617 737s and 682 A320ceos have been retired globally. Over the course of our forecast, the 737 NG share of the narrowbody fleet will decline to 11% from 34%, while the 737 MAX grows to 27% from 6%. The A320ceo will experience a similar trend, dropping to 10% from 36%, while the A320neo family grows to 39% from 15% of the total global fleet.

MORE TO COME ON EMISSIONS

But more pressure over sustainability can be expected. Western Europe has already been much more aggressive on this front, actively promoting the use of trains over flying. In December, France passed the first legislation that prohibited flights between cities that can be reached by train in 2.5 hours or less. Several other countries are discussing such bans, including Spain and Germany. Austria has the beginnings of such a ban, but it was prompted by efforts to fight COVID-19 and not climate change.

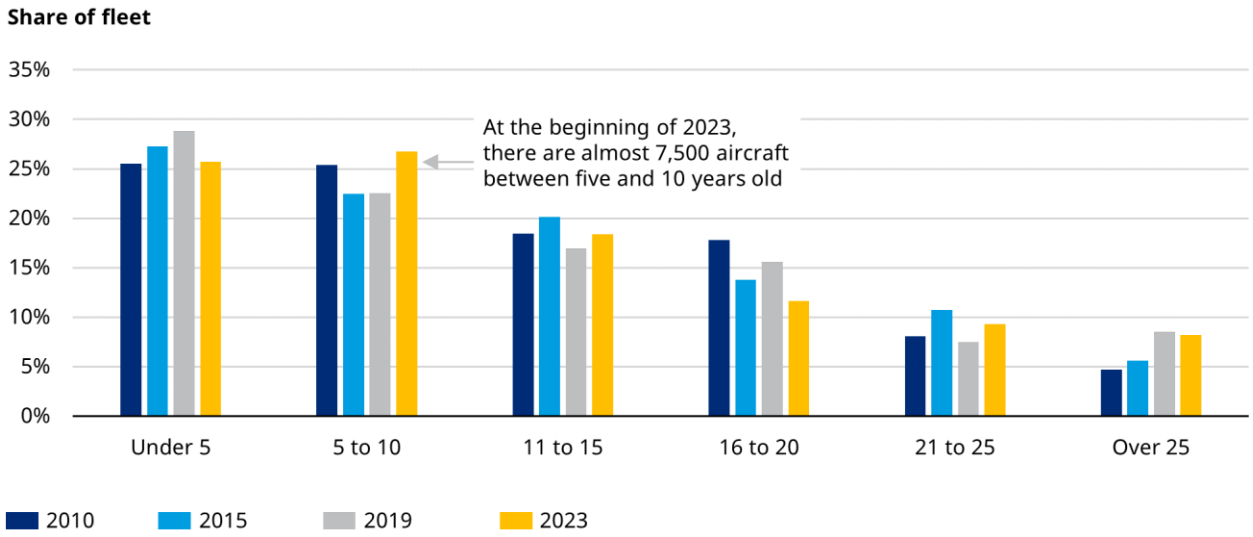
While next-gen aircraft represent important gains in efficiency, they will not by themselves reverse the rise in emissions expected over the next decade from air travel. Thus, manufacturers are actively exploring alternatives to fossil fuel propulsion, including electric-powered, hydrogen-powered, and hybrids with several energy sources.

Despite the need for these low-carbon aerospace propulsion systems and the non-conventional airframes they require, it is highly unlikely that they will be commercially viable for airliners within our forecast window or even before 2040. For that reason, we didn't include any potential impact from these alternative aircraft in our current forecast.

IN-SERVICE FLEET CHARACTERISTICS

The fleet has almost entirely recovered to its pre-pandemic size, but the current fleet has different characteristics than its predecessor. In early 2020, the average age of aircraft in the fleet was 11.5 years, with the oldest fleets in Africa at 15.4 years old, and North America at 14.4. The youngest fleets are based in India where the average age is 6.8 and China where it's 6.7.

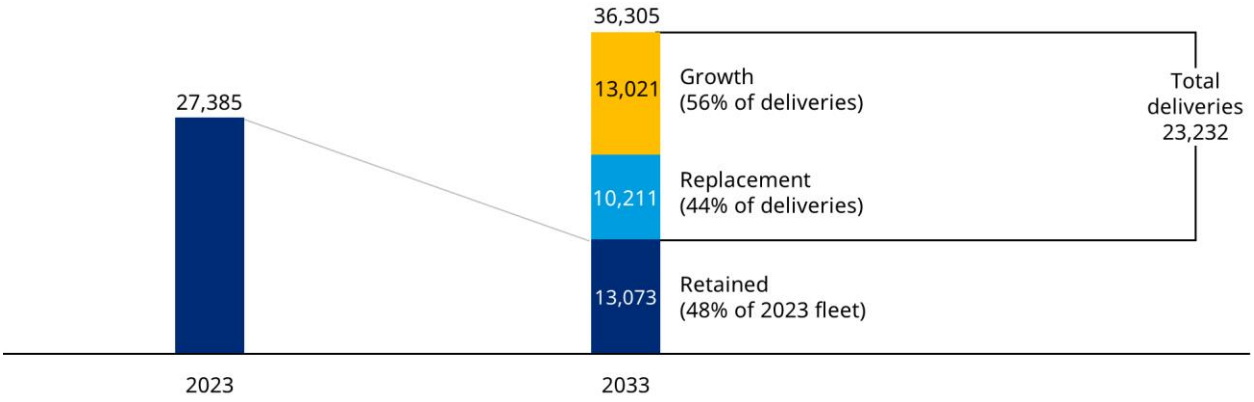
Exhibit 14: Global in service fleet segmented by age in years



Source: Cirium Fleets Analyzer, Aviation Week Intelligence Network's Fleet Discovery, Oliver Wyman analysis

Yet, even with 1,300 aircraft retirements in 2020 and 1,100 since, the average age of the global fleet did not decline. Instead, because of the lack of new deliveries, it increased to 11.9 years by the start of 2023. This will slowly reverse with more deliveries, as we are expecting the average age of the in-service fleet to be 11.5 again by 2033.

Exhibit 15: Fleet replacement versus growth, 2022–2033



Source: Oliver Wyman analysis

The narrowbody market will continue to dominate, soaring to a market share of 64% in 2033 versus 58% at the start of 2020. The distribution of the narrowbody fleet by region is expected to follow historical trends but will be overtaken by newest generation aircraft: the 737 MAX and A320neo.

These newest-generation aircraft provide 15% to 20% fuel savings compared with the legacy aircraft they are replacing. The need to save on fuel, as well as cut emissions, will propel these aircraft to 40% of the total fleet by 2033, up from 13% in 2023.

The cargo fleet will continue its impressive expansion, even though ecommerce has cooled a bit since it took off during COVID-19. Over the decade, we expect the cargo fleet to grow 3.7% annually — 32% faster than the passenger fleet at 2.8%. By 2033, we expect cargo to have slightly expanded its share of the global fleet to 9% from 8%.

AIRCRAFT CLASSES

Over the next decade, narrowbodies will lead annual growth at 3.6%, followed by widebodies at 2.2%, with regional jets and turboprops both growing at 1% annually. The newest narrowbodies offer a lot of flexibility: Narrowbodies can let airlines "up-gauge" and cover former regional jet routes or take the place of widebodies in some routes across the Atlantic. While operators are unlikely to rely solely on narrowbodies, their advantages in terms of efficiency and flexibility explain their rising share of the fleet. Also, on a purely practical level, there are not enough pilots to keep regional jets flying.

Exhibit 16: Fleet aircraft by seat capacity

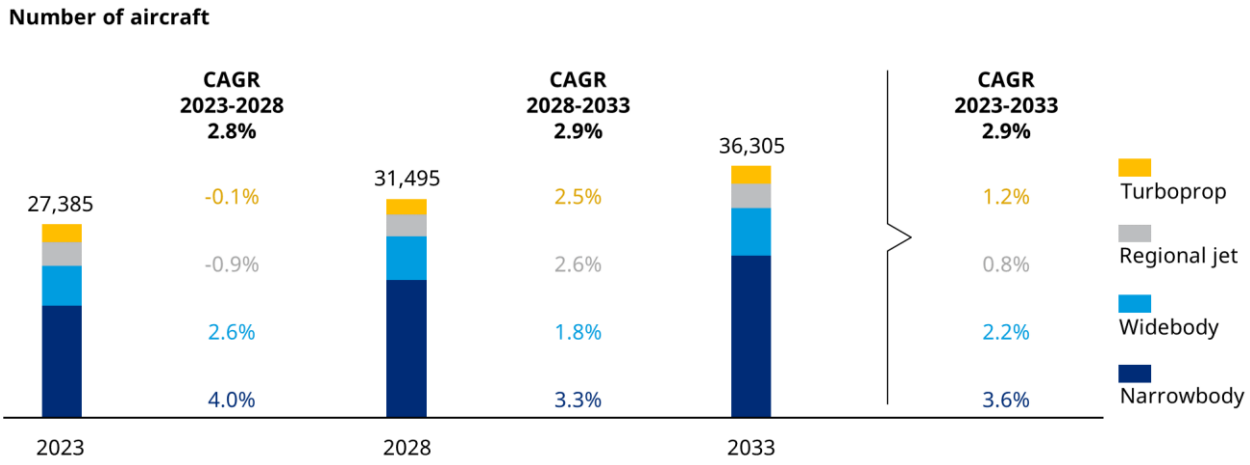
NARROWBODY		WIDEBODY		REGIONAL JET	TURBOPROP
Small <140 seats	**Medium ≥140 seats**	**Large <350 seats**	**Extra large ≥350 seats**	**N/A**	**N/A**
717	737-300/400/500	767	747	ARJ	ATR
727	737 NG	777/777X	A380	BAe 146/Avro RJ	BAe ATP
737-100/200	737 MAX	787		CRJ	Beech 1900
A220	757	A300/310		DO 328Jet	DO 328
A318	A319/A320/A321	A330		E-Jet/E2	EMB-120
DC-9	A319/A320/ A321neo	A330neo		ERJ	Jetstream 41
	DC-8	A340		Fokker	Q-Series
	MD-80/90	A350		Superjet 100	Saab
	C919	DC-10/MD-11			SkyCourier
					Modern Ark

Source: Oliver Wyman analysis

Narrowbody production has long been much higher than for other classes and will continue to grow throughout the decade. Taking Airbus, Boeing, and COMAC, a Chinese aerospace manufacturer anticipated to bring the C919 into service this year, we expect total monthly production to reach 149 by 2032. Although most C919 deliveries will be in China, we expect COMAC to grab 3% of global narrowbody deliveries from Boeing and Airbus in 2027.

The largest narrowbody markets are North America, China, and Western Europe, which are expected to take more than 600 deliveries of the almost 1,200 total deliveries for 2023.

Exhibit 17: Global fleet forecast by aircraft class, 2023–2033



Note: Fleet sizes as of beginning of year; CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

REGIONAL JETS AND WIDEBODIES

As narrowbody demand grows throughout the decade, much of the new production for regional jets will be to replace retiring aircraft instead of new growth. The average age of regional jets is expected to rise from 13.2 in 2023 to 14.9 in 2033. Historically, regional jets have retired at 18 years, but that average age may increase over the next decade as operators seek to prolong the life of these aircraft.

The other group seriously affected by COVID-19 is the four-engine widebodies. The majority of 2020 early retirements involved four-engine widebodies — a group unlikely to regain the numbers they had pre-pandemic. Aircraft such as the A380 and 747 posed too much of a financial burden even to keep in storage.

From 2010 to 2019, the widebody growth rate was 3.5% annually; from 2023 to 2033, only 2.2% growth is forecast for widebodies. The average age of the fleet is 12 and expected to rise to 14.5 as operators extend the life of their widebodies as they wait to see the extent of recovery in international demand and how production issues play out.

The newest widebodies include the Airbus 330neo and A350 and the Boeing 787. Deliveries of the 787 were halted in 2020 and again in 2021 because of production defects. They were restarted again in August 2022, but each aircraft is required to be inspected and retrofit to meet FAA certification standards before it can be delivered. Despite challenges with the 787, we expect Boeing to maintain dominance in widebodies, with the 777X entering service. Boeing's widebody share will decline to 58% in 2033 from 63% in 2023.

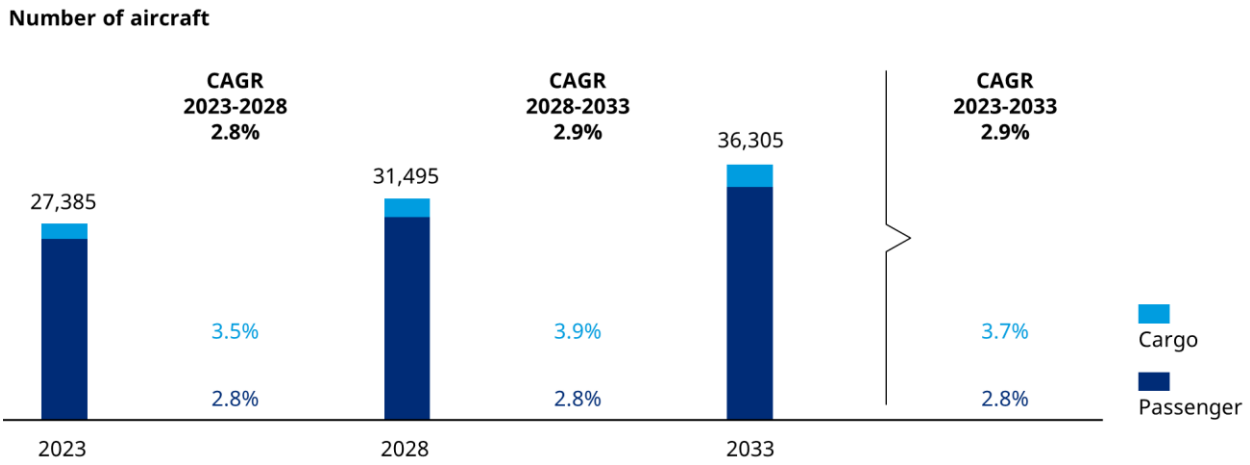
New entrants in the cargo widebody market as well as passenger-to-freighter conversions will also help widebody market growth. The size of the widebody cargo fleet remained relatively stable throughout the pandemic, declining only 2% from its size at the start of 2020 at its lowest point.

CARGO TRENDS

The cargo fleet has seen sustained growth over the last few years and is expected to continue to be a bright spot for the industry moving forward, albeit only 8% of the global fleet. Cargo aircraft deliveries remained steady through the pandemic and passenger-to-freighter conversions reached record highs with more than 100 aircraft converted in both 2021 and 2022, up from historical averages of 60 to 70 per year. Conversions are expected to fall slightly from the recent highs but will remain well above their historical levels.

Over the forecast, we expect roughly 1,000 conversions and almost 600 new cargo deliveries. These additions will drive cargo fleet growth of 3.7% annually, outpacing growth in the passenger fleet. As a result, cargo aircraft will see their share of the global fleet rise from 8% in 2023 to 9% in 2033.

Exhibit 18: Passenger and cargo fleet forecasts, 2023–2033



Note: Fleet sizes as of beginning of year; CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

In addition to a different growth outlook, the class composition of the cargo fleet differs from the passenger fleet. Widebodies, which are only 15% of the passenger fleet, represent more than half of all cargo aircraft. Narrowbodies are another 30% of the cargo fleet, with turboprops and regional jets making up the rest.

NEW CARGO ENTRANTS AND CONVERSIONS

Over the forecast, two major cargo widebody platforms — the 767 and 777 — will see production end. These aircraft are not compliant with ICAO noise and emission regulations and cannot be produced after 2027. With production of these aircraft set to end, Boeing and Airbus are both planning to produce cargo variants of their next generation widebodies, the 777XF and A350F. These next-generation cargo variants combined are expected to rack up more than 70 deliveries through 2033.

In addition to the next generation of direct-build freighters, a new conversion program for the 777-200LR/300ER is expected to enter the market in the next few years. Over the forecast period, Oliver Wyman expects there to be more than 120 777-200LR/300ER conversions, most of which will be the 777-300ER.

On the narrowbody side, growth is being fueled primarily by the explosion in ecommerce. The type of packages and volume produced by ecommerce is perfectly suited to passenger-to-freighter conversions of the 737, which has historically been the most popular cargo narrowbody and will continue to be as they are well-sized aircraft to move inventory in between regional distribution centers.

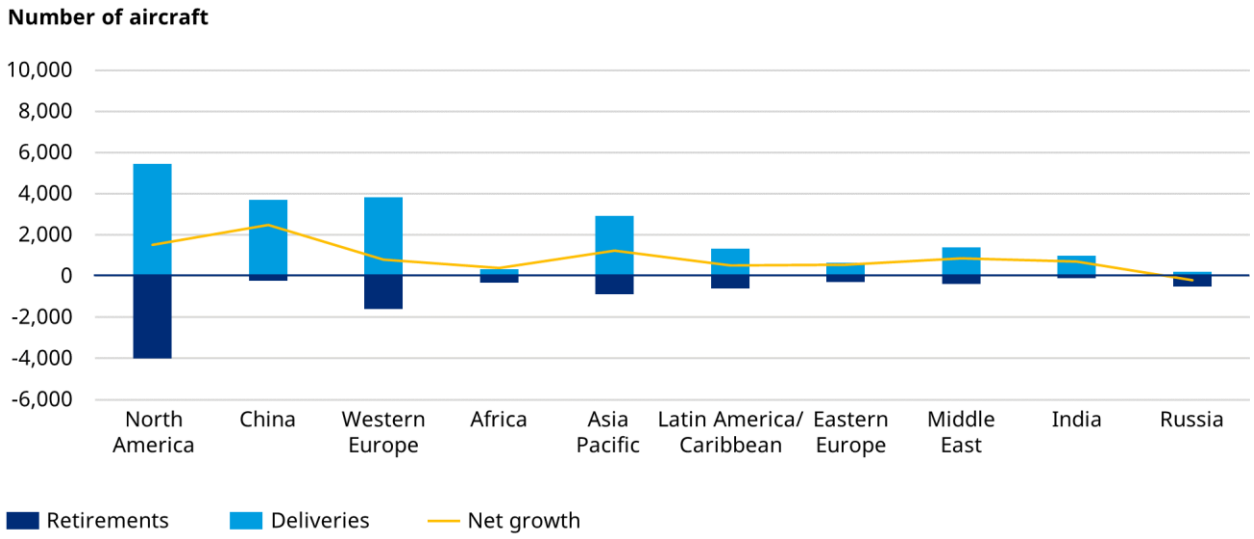
But competition in the narrowbody space has increased after the entry of Airbus with conversions of the A320 and A321ceo. Of the almost 500 narrowbody conversions expected over the forecast, 60% will be 737s, with another 35% A320ceos. No manufacturer makes a direct-build narrowbody freighter.

The regional jet and turboprop markets will also see new entrants over the next 10 years. The Cessna SkyCourier, a new cargo turboprop, had its first delivery in late 2022. FedEx is currently the largest SkyCourier customer having placed 50 firm orders for the aircraft. In 2022, Embraer announced that it would be developing an STC for an E190/E195. Nordic Aviation Capital was the first customer, placing an order for 10 aircraft with the first delivery expected in 2024.

REGIONAL FLEET TRENDS

The regional makeup of the global fleet is going to see a slight shift in favor of China and the Middle East over the next 10 years, growing from 19% to 24% of global market share. While global growth will be a steady 2.9% annually from 2023 to 2033, each region will see different growth depending on how mature the market is.

Exhibit 19: Projected fleet growth by region, 2023–2033



Note: Asia Pacific excludes China and India
Source: Oliver Wyman analysis

North America and Western Europe have mature fleets and will not experience the same type of growth that some emerging markets, such as China and India, are projected to see. North American and Western Europe are expected to maintain an annual compound growth rate of about 1.5% during our forecast period. Conversely, China and India are among the fastest growth regions, at 5.2% and 8% respectively.

The North American fleet has topped its pre-pandemic size by about 1%. It's expected to add 400 new aircraft in 2023. Although it's expected to add almost 5,500 newly delivered aircraft throughout the forecast, North America is expected to decrease its market share of the total global fleet from 30% in 2023 to 27% in 2033.

In North America, we are forecasting 1,300 regional jets at the end of the forecast period compared with nearly 2,000 in 2019, a 30% decline caused in part by the pilot shortage. Narrowbodies are expected to have the most growth in this region, accounting for 88% of the increase in fleet size from 2023 to 2033.

The Western European fleet is near full recovery, with small growth anticipated in its narrowbody fleet moving forward. Although Europe also has a pilot shortage, Western Europe will still see slight growth in the regional jet fleet as it receives 150 E195-E2 aircraft over the forecast period.

INDIA AND CHINA

We anticipate the highest growth region to be India, expanding at 8% annually, followed by China and Eastern Europe at 5.2% and 6.3% respectively. India, with currently one of the smallest fleets, is expected to more than double over the next 10 years. Recently, Air India put in one of the biggest purchase orders in history for 480 aircraft, which Airbus and Boeing essentially split.

China's fleet did not suffer as much as those elsewhere from the COVID-19 pandemic, bouncing back to pre-pandemic fleet sizes by mid-2020 and then growing beyond that. Its fleet jumped 8% from the start of 2020, before the pandemic's impact, to the start of 2023. Despite that, China's fleet utilization has not bounced back to pre-pandemic levels. This means that although more aircraft are in service, they are not being flown as often, or for as long, as previously. The available seat miles (ASMs) for schedules originating in China were down 27% for narrowbodies, 85% for widebodies, and 67% for regional jets in September 2022 compared with the same period of 2019.

Our outlook for China is still positive, with anticipated compound annual growth of 5.2% through 2033. We expect the nation to take delivery of 3,700 aircraft over that period, assuming the 737 MAX fully returns to service. China has been producing the ARJ, a regional jet, and plans to produce the C919 narrowbody and the Modern Ark turboprop.

OTHER GROWTH MARKETS

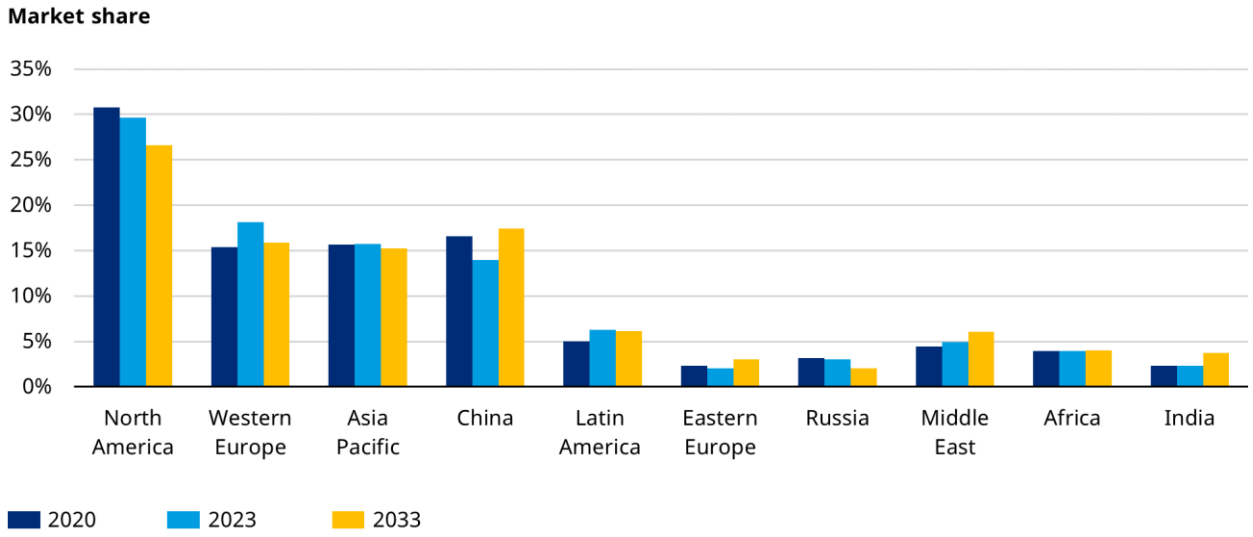
Eastern Europe, excluding Russia, is another high-growth region, expected to take more than 650 deliveries in the forecast period. The fleet will grow 84% by the end of the forecast compared with 2023, despite the current Ukraine war. Eastern Europe is home to Europe's fastest-expanding airline Wizz Air and other rapidly growing carriers, such as LOT Polish airlines, which has helped it to keep growing.

The Middle East fleet is forecast to grow 5.1% annually over the forecast period, primarily driven by narrowbodies. Historically, the Middle Eastern fleet has been primarily made up of widebodies. But moving forward, narrowbodies will increase from 39% of the fleet to 48%, while widebodies will decline to 48% from 56%.

Latin America's domestic travel bounced back quicker than expected, given the economic conditions before and after the pandemic. The domestic fleet, not including regional jets and turboprops, recovered in the summer 2022, one of the first domestic regions to recover. However, widebodies are only at 87% of pre-pandemic levels. We don't expect regional jet fleets to recover fully in Latin America, given the lack of replacement aircraft and the pilot shortage. Its total fleet is expected to grow 2.7% annually, with regional jets staying essentially flat and turboprops declining 2% annually, while narrowbodies and widebodies drive most growth at 3.6% and 3%, respectively.

Africa has historically had large migrations of aircraft from other regions, and, with its low number of firm orders for new aircraft, that will continue over the forecast. We expect over 400 aircraft to join the continent's fleet from other regions, representing the majority of its 3.1% annual growth over the decade. Although its total narrowbody fleet size has recovered, its turboprop fleet reached a peak of 90% recovery in summer 2021 and has since slipped to 87% recovery.

Exhibit 20: Fleet market share by region, 2020–2033



Source: Oliver Wyman analysis

THE RUSSIAN QUAGMIRE

Russia faces a multitude of problems of its own making. At the beginning of 2022, Russia had recovered fully to pre-pandemic levels. But after invading Ukraine on Feb. 24, it saw demand and fleet size plunge. The conflict also stifled travel to Eastern Europe in general.

Strict trade sanctions were imposed on Russia for its aggression by the United States and its North Atlantic Treaty Organization (NATO) allies, which included bans on the sale of aircraft and aircraft parts. Eventually, the bans were extended to oil and gas to limit Russia's biggest revenue stream.

The uniqueness and unprecedented nature of the situation makes creating an outlook for Russia challenging. We assumed sanctions would continue under most situations, except a Ukrainian victory or a retreat of the Russian army. And even if they are lifted, Western companies are unlikely to do business there for the foreseeable future because of the heightened geopolitical risk.

If that's the case, the Russian international fleet is not expected to return to pre-pandemic levels throughout our fleet forecast. The fleet can grow through the addition of Russian-made aircraft, if countries such as China or Iran provide support, or if Russia can acquire aircraft and parts through the gray market. We expect a pickup in international traffic between Russia and countries that have not imposed sanctions, such as China and Turkey.

RUSSIA'S FUTURE

Russia represents almost 3% of the total global fleet, although its role in geopolitics and energy politics elevates its importance as a market. Russia's fleet started 2023 with 700 aircraft, compared with 850 at the start of 2022 before the invasion of Ukraine. Six out of 10 are narrowbodies. The fleet is expected to dwindle to 554 aircraft by 2033, and the share of narrowbodies is expected to decrease to 36%.

Sanctions have made it nearly impossible to get aircraft parts legally in and out of Russia, forcing Russian airlines, aerospace manufacturers, and MRO providers to harvest parts from the aircraft to keep at least a portion of the Russian fleet flying.

The lack of parts not only affects the existing fleet, but also any new production. We anticipate that the Russian fleet will shrink 3% annually over the forecast period. However, we expect most of the decline to happen in the first half of the forecast, losing on average 20% annually from now to 2026. At that point, domestic production is expected to ramp up, leading to annual growth of 5.8% from 2026 to 2033.

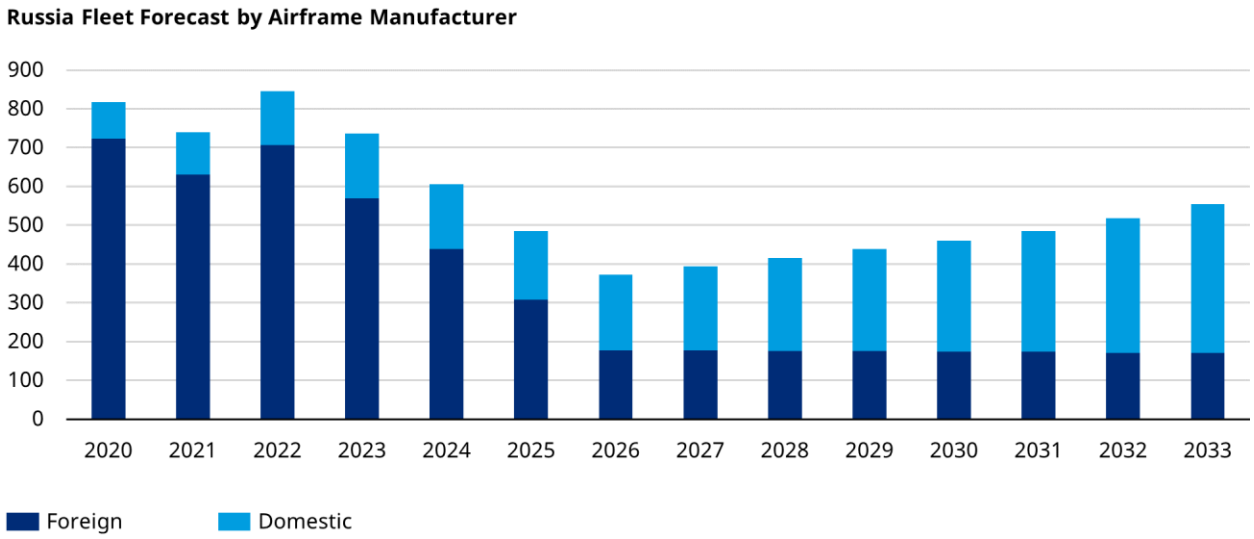
NEW PRODUCTION COMPLICATIONS

Russia is unlikely to receive any deliveries from Western aircraft and parts manufacturers during the decade even if sanctions ease. That leaves the anticipated Russian-made Irkut MC-21 and the existing Sukhoi Superjet without critical Western-made parts and dependent on Russian manufacturers.

Previously, the Superjet had an SaM146 engine, the product of PowerJet, a joint venture between aerospace manufacturer Safran and Russia. Now firm orders for the Superjet contain the PD-8 engine, made by the Russian manufacturer Aviadvigatel — which is also making the PD-14 for the MC-21. To lower the number of imported parts needed for new production, Russia has decided to revive the Tupolev TU-214, made entirely with domestic components.

Whether or not the MC-21 comes into service, Oliver Wyman forecasts that a Russian-made narrowbody will enter service in 2025, with expected deliveries of 12 aircraft per year into 2033. Superjet deliveries are expected to reach 24 per year by 2033; deliveries of the PD-8 are expected to resume in 2024.

Exhibit 21: 76% of foreign-made Russian aircraft will eventually be cannibalized for parts by 2033



Domestic includes Sukhoi & Russian NB; Foreign includes Airbus, ATR, Boeing, Bombardier, and Embraer
Source: Oliver Wyman analysis

A SHRINKING FLEET

Over half of the current Russian fleet will be retired by 2025 so they can be used for piece parts, according to leaked fleet plans from the Russian Ministry of Transport. Of these retirements, we expect all Western-made aircraft that are currently in storage to be retired, with older aircraft being the first to go.

Russia will continue producing a regional jet and a narrowbody, but there are no plans to manufacture a widebody domestically. Because of this and the reduced international routes Russia is currently able to serve because of sanctions, we expect the widebody fleet by 2033 to be 39% of its size at the start of the Ukraine war. The war is essentially transforming the Russian aviation market from one evenly split between domestic and international to one primarily serving the domestic market.

By 2033, we expect 69% of the fleet to be narrowbodies, regional jets, or turboprops, up from 23% before the Ukraine war. From the day sanctions are eased, it will still take years, even decades, to undo the changes.

MRO FORECAST

MORE PLANES, MORE FLYING EQUALS MORE MRO

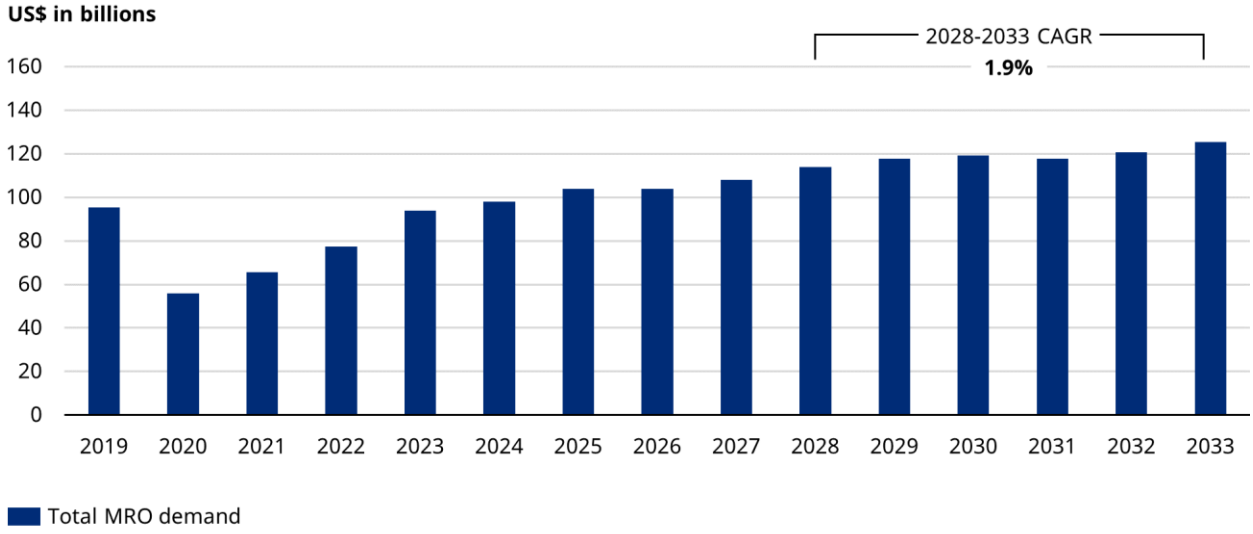
The global maintenance, repair, and overhaul (MRO) market grew 18% in 2022 to $77 billion as the fleet expanded, aircraft flew more, and air travel demand rose. In 2023, MRO spending will reach $94 billion, a mere 2% below the market's 2019 peak of $95 billion, according to our analysis.[1]

And, like the fleet, it will keep growing from there. Between 2023 and 2033, we expect the market to grow at an annual rate of 2.9%, reaching $125 billion in those 10 years. It's simple math, except for the variables that make the outlook much less straightforward.

While this represents a solid recovery, the MRO market faces challenges after three rocky years of pandemic, an overwhelmed supply chain, inflation, and Russian war against Ukraine. Like the rest of the global economy, the MRO sector struggles with labor shortages and supply chain disruptions — two major capacity constraints just as deferred maintenance comes due on fleets back in service.

Even before COVID-19, aerospace manufacturers had trouble meeting orders and MRO providers faced delays securing parts because suppliers couldn't always keep up with accelerating demand. But the hurdles that existed before have been amplified many times over by the litany of complications facing the global economy.

Exhibit 22: MRO market forecast, 2019–2033



Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

[1] Growth rates in this report are based on our assumptions on material and labor cost increases. All amounts are expressed in 2023 dollars.

STRAINS ON THE SECTOR

While labor shortages of pilots, airport ground crews, and air traffic controllers received the public's attention in 2021 and 2022, another labor supply imbalance — a shortfall in the number of aircraft mechanics — looms. Right now, it is primarily a North American problem, like the pilot shortage. But we expect other regions to feel the squeeze in both pilots and mechanics when the fleet and demand surpass previous peaks.

Our analysis of the supply of mechanics in North America finds a workforce on the cusp of a shortage that will manifest itself this year once the sector recovers beyond 2019 levels. In 2023, we expect to see a shortfall of more than 12,000, or 14% of the total mechanic workforce in North America. And the problem of too few mechanics will plague MRO through 2033. The peak of this regional shortfall is projected for 2027 when the gap could extend beyond 40,000 mechanics.

Meanwhile, on the other side of the planet, China's zero-COVID policy created ripple effects throughout the industry in 2022. Like Russia, although to a lesser degree, China supplies raw materials and parts for such aerospace systems as avionics. And, with the lockdowns, these have become scarcer.

China lockdowns also had a dampening effect on MRO and economic growth. First, operations at several large Chinese MRO providers were curtailed, putting pressure on regional capacity. China's economy was also crippled, with the growth rate essentially halved between 2021 and 2022. As a result, China's utilization per aircraft continues to significantly trail other regions, reducing the need for MRO — even as the Chinese fleet has essentially recovered to pre-pandemic size, save for a small percentage of widebodies

UKRAINE AND SUPPLY CHAIN

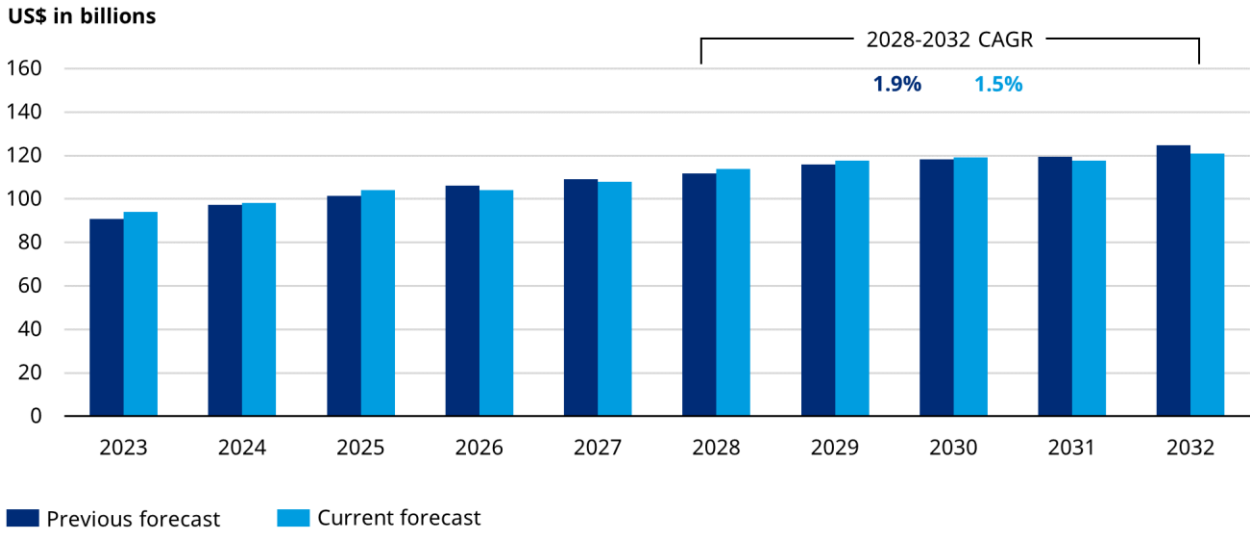
Russia's invasion of Ukraine further disrupted the MRO supply chain and global economy. Along with the financial disorder in commodities markets provoked by the conflict, sanctions slapped on Russia by the US and NATO allies interrupted Russian shipments of such raw materials as titanium, aluminum, nickel, and oil and gas. Aerospace manufacturers have had trouble obtaining metals, and the entire industry faced higher prices as global inflation and fuel prices reached levels not seen for years.

Globally, parts availability — both piece parts and full assemblies — continues to pose a challenge to the market. At the onset of the pandemic, airlines sought to defray costs by harvesting used serviceable materials (USM) from retired aircraft, burning through inventory, cannibalizing aircraft, and taking advantage of green time — extra weeks, months, or years of use left on equipment — on whatever parts they could.

As COVID-19 began to subside and demand returned, lead times on new and repaired components lengthened, sometimes by as much as a year, and workforce constraints became more conspicuous. With the tight supply, the cost of parts soared, putting additional financial pressure on shops that were already scrambling for workers.

The short supply also encouraged airlines and MROs to pursue alternate means to salvage parts and reduce costs. This included utilizing more PMA — parts manufacturer approval components, which are FAA-authorized replacement or modified parts produced by manufacturers other than the original producer. Repair stations are also incentivized to create and utilize repairs approved by DERs, which are designated engineering representatives authorized by a regulatory authority to oversee aircraft fixes on parts not from the original manufacturers.

Exhibit 23: MRO Market Forecast, 2023–2032



Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

MARKET DEMAND

In 2023, the MRO market will nearly return to its 2019 peak and will then surpass it in 2024. Behind the recovery has been two things: first, the increase in narrowbody fleets in response to demand in domestic markets across most regions, and second, the catch-up on deferred maintenance on aircraft being brought out of storage.

Over the 10-year forecast period, the same regions that have driven growth in recent years — China, India, and the Middle East — will continue to have the fastest-growing markets. That's despite a slow start for China because of COVID lockdowns. More mature markets like North America and Western Europe will grow slower. Western Europe's MRO spend growth, for example, will decrease significantly over the forecast, in part because its fleet will get younger.

In the outer years of the forecast, the annual rate of expansion of the MRO market will decline to 1.5% from the 1.9% forecast last year because the fleet will not be as big as expected. The dip in fleet size is directly connected to lower aircraft production rates over the past few years. With fewer new aircraft in the forecast, the overall MRO market demand naturally shrinks.

NORTH AMERICA AND WESTERN EUROPE

North America and Western Europe remain mature MRO markets with growth rates closely tied to fleet expansions. In 2023, the North American market, with its aging aircraft, will recover to its pre-pandemic size, and over the next 10 years, it will grow at a modest 1.8% annual rate.

MRO growth in North America will be suppressed as the region undergoes a significant re-fleeting — bringing in new aircraft that initially will require less maintenance, with major checks that fall outside the forecast. The average age of the fleet in North America is expected to drop from 14.9 in 2023 to 12.3 by 2033. While its regional jet fleet will shrink during the forecast period, the North American narrowbody fleet will grow.

Currently, the region's MRO spend on turboprops and regional jets combined is equal to that of the narrowbody fleet. While turboprops and regional jets will age and become a smaller share of the fleet through retirements, the MRO spend on narrowbodies will continue to grow. By the end of the forecast period, the narrowbody spend will represent 54% in the North American region, up from 43% in 2023.

In Western Europe, MRO recovery to pre-pandemic levels has been slow. While the region is also expected to reach full MRO recovery in 2023, it will see its annual growth rate slip to 0.2% over the next 10 years. Limited MRO growth in the region is the result of two major factors. First, there will be slow fleet growth of just over half a percent annually. And second, the average age of the fleet will decline significantly to 9.6 from 11.9 with the anticipated delivery of many new aircraft that require less maintenance during the forecast window — a similar situation to North America's.

With mature narrowbody and widebody fleets in Western Europe, MRO spend on these aircraft will peak mid-forecast before dropping back to near-2023 levels by 2033. In addition, with similar regional jet and turboprop fleet dynamics as North America, Western Europe's MRO spend on those aircraft will also decrease over the forecast, impacting the overall growth of the region.

ASIA PACIFIC AND THE LEADERS

For Asia Pacific, 2023 will mark a speedup in fleet recovery in a region heavily dependent on the international segment. Because of that fact, APAC has trailed other regions in both fleet and air travel demand growth. Asia Pacific is expected to see a rise in MRO demand in the early years of the forecast, as maintenance deferred over the last three years comes due.

The MRO demand in Asia Pacific in 2023 recovers beyond the 2019 peak of $17 billion to $18 billion. Between 2023 and 2033, demand for MRO is expected to grow at a compound annual growth rate of 1.8%.

India, China, and the Middle East represent some of MRO's fastest growing regions throughout the forecast, with India expanding the most at 12.4% annually. China, which will see its utilization numbers recover moving forward, will be next highest at 6.9%.

For the Middle East, the incorporation of more narrowbodies will drive fleet growth. But its dependence on international will limit its compound annual growth rate to 4.9%.

EASTERN EUROPE, LATIN AMERICA, AND AFRICA

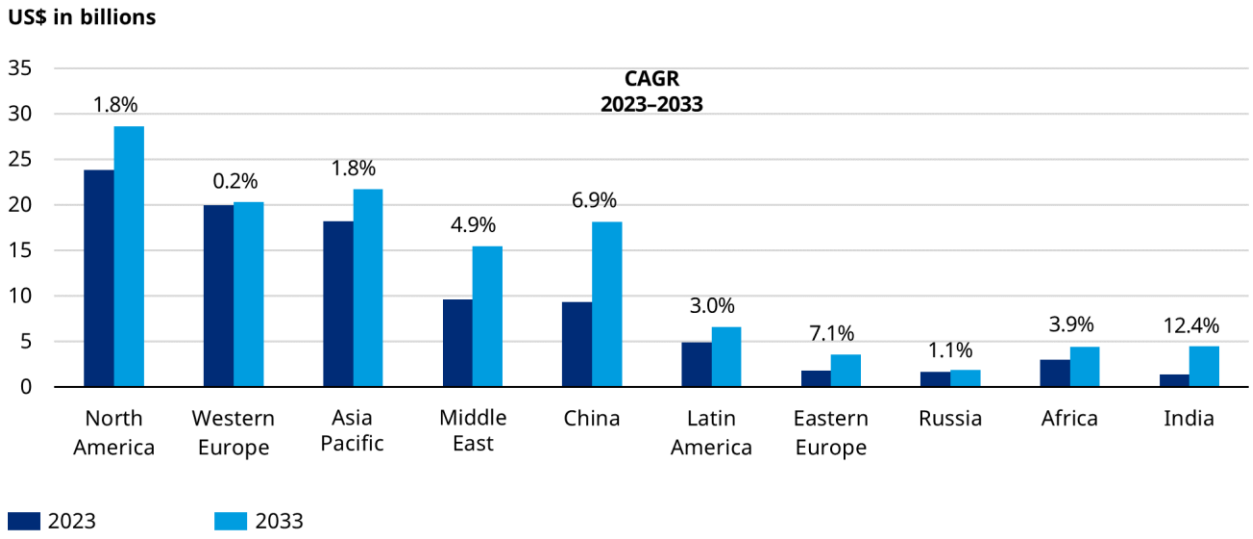
Eastern Europe, excluding Russia, will see a later recovery in MRO than other regions, taking until 2025 before returning to — and surpassing — 2019 levels. But in the later part of the forecast period, the region will also see robust growth in both its fleet and MRO market as it fills the gaps opened by sanctions on Russia. Through the end of the forecast in 2033, this region will see an annual growth rate of 7.1%, growing to $3.6 billion in size.

Over the forecast period, Latin America will be the last region to return to 2019 levels. While 2023 MRO demand will increase in the region to $4.9 billion from $3.8 billion in 2022, the spike will fall short of pre-pandemic levels. Narrowbody and widebody MRO in the region will fully recover in 2026, but regional jet and turboprop MRO will likely not reach its 2019 level in our forecast period. This region has some of the larger turboprop and regional jet fleets, making it sensitive to the changes and reductions in those aircraft over the next 10 years.

While most new entries to the Latin American fleet won't go through their first heavy, expensive maintenance visits until after the forecast period, the region's MRO market will grow to $6.6 billion by 2033. That represents an annual growth rate of 3%.

African MRO will grow at a rate of 3.9% annually over the forecast period. The outlook for rising MRO demand stems from fleet additions and the longstanding practice of migrating older aircraft into the region to meet fleet needs at a reduced cost.

Exhibit 24: Total MRO demand forecast by region, 2023 versus 2033



Source: Oliver Wyman analysis

UTILIZATION

Aircraft utilization is a primary driver of demand for MRO services — except for airframe maintenance that typically corresponds to calendar checkups. The engine, component, and line segments are tied to the hours flown and cycles aircraft operate.

That means that market size and growth largely depend not only on the number of aircraft in service, but also how these aircraft are being operated. But while utilization per individual aircraft has grown faster than the fleet, the recovery in total flight hours and cycles has still lagged fleet recovery and utilization, which translates into a slower MRO comeback.

Across most regions of the world, once fleets were around 90% of their pre-pandemic size, daily utilization per aircraft returned to its pre-COVID average. China was the notable exception, with its domestic fleet fully recovering relatively quickly and utilization continuing to lag because of COVID lockdowns and a slowdown in economic growth. In 2023, utilization and fleet size are expected to grow at the same pace, but in 2024 utilization will start to outpace fleet growth to keep up with rising demand for air travel.

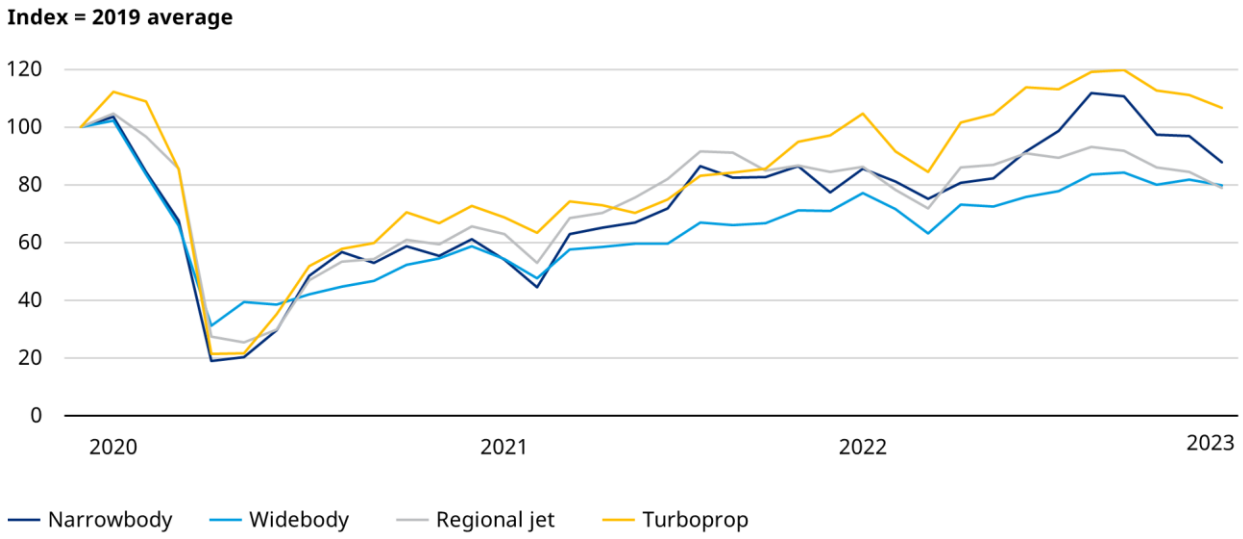
PLATFORM VARIATIONS

While average utilization of the fleet is on track to recover in 2023, numbers can vary greatly by platform. All platforms are catching up to their 2019 hours, but only turboprops and narrowbodies were back at their 2019 levels for utilization during 2022 because of the growth in domestic fleets.

Meanwhile, fleets of regional jets and widebodies are hovering at about 80% of 2019 average utilization levels. While individual regional jets are flying roughly the same hours per day as they were in 2019, the platform's total flight hours are still down from 2019 because of the lack of pilots to operate the full fleet.

For widebodies, the problem is a case of lingering COVID-19 with international traffic slower to recover because of travel restrictions in some regions and China's stricter limitations on cross-border travel. Through 2022, those rules kept recovery of the widebody flight hours at 80% or below 2019 hours. With the lifting of China's cross-border travel prohibitions in January 2023, total flight hours are expected to increase.

Exhibit 25: Flight hours per aircraft by class



Source: Aviation Week Intelligence Network Fleet & Data Services, Oliver Wyman analysis

RUSSIA'S SANCTIONS

For Russia in 2023, the MRO market will contract initially and then grow slowly over the remainder of the forecast period. Its war on Ukraine prompted NATO sanctions that will prevent delivery of any new parts and aircraft for the foreseeable future and ultimately limit growth of its fleet. The sanctions will also threaten the completion of Russian-produced platforms, such as the MC-21 and the Superjet. Because it can't buy Western-made engines and components for its new aircraft, as planned, Russian aerospace will be forced to develop its own or buy them from China or unauthorized channels on the gray market.

If Russian aerospace overcomes these challenges for its domestic production, it will also face other hurdles such as developing MRO capabilities for its current commercial fleet. With Western MROs and parts manufacturers no longer supplying the Russian fleet because of sanctions, Russian airlines have already been forced to cannibalize aircraft in the existing fleet for parts to keep aircraft in service flying.

MRO MARKET SEGMENTS

AIRFRAME MRO

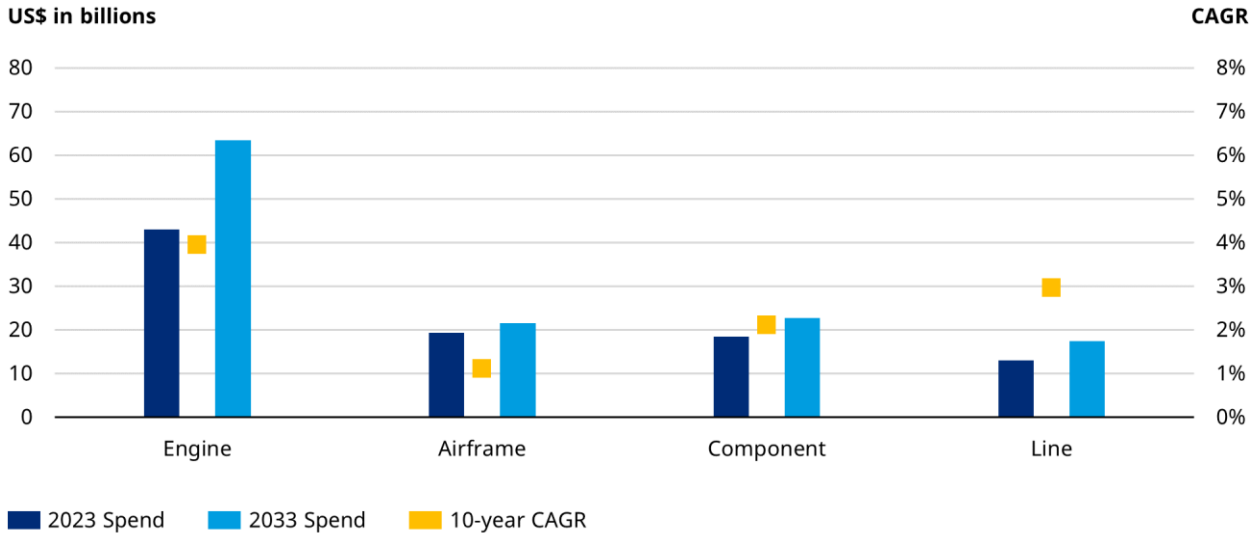
The demand for airframe MRO is usually resilient because of mandatory calendar-driven maintenance events. During COVID-19, so many aircraft were sent to approved storage programs, effectively pausing the calendar for maintenance task intervals and allowing airlines to defer most of the work until the aircraft was back in service again. 2022 saw these aircraft emerge from storage, which meant the airframe MRO market began to grow again — from $17 billion in 2021 to $20 billion in 2022.

In 2023, the market will dip slightly to $19 billion. This small decline is driven by fewer aircraft returning from storage in 2023 than 2022, which will reduce the number of service checks and maintenance needed. Over 10 years, the global airframe marked is expected to sustain a compound annual growth of 1.1% The relatively slow growth reflects the expected influx of new aircraft over the next decade, which will require less airframe MRO than older aircraft. These new planes entering the fleet will also have longer check intervals and are forecast to be less labor intensive than the aircraft they are replacing, which will reduce some of the labor market tightness. The labor hours per check on A320neos and 737 MAXs are expected to be 5% to 15% lower than they were on their predecessors.

Airframe modifications, a subsegment of airframe MRO that focuses on upgrades and changes to cabins, cockpits, and avionics, also don't rely as heavily on utilization. Instead, modifications may be aligned to coincide with other maintenance visits, such as heavy checks and lease returns, or when an operator deems a refresh cycle is needed. Thus, the modifications market can be variable, aligning more closely to the aircraft's age. We project the market to reach $9 billion this year and grow to $10 billion by 2033.

With narrowbody fleets growing, airframe capacity could become a factor within regions where they dominate, such as North America and Europe. While widebodies have historically been sent outside of their regions for MRO, narrowbodies tend to stay in-region because of their limited range. Additionally, geopolitical tensions in some areas may also cause a spike of airframe MRO demand in-region.

Exhibit 26: Total MRO demand forecast by segment, 2023 and 2033



Note: Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

ENGINE MRO

Engine MRO has historically represented the biggest piece of the MRO market and remains so today. But the pandemic wreaked havoc on the segment, with the parking of aircraft and harvesting of green-time engines. In 2022, as aircraft returned to service and utilization increased, the segment began to grow again, jumping to $31 billion in 2022 — 73% of the 2019 spend. It was up 15% from 2021's total of $27 billion.

In 2023, engine MRO is expected to exceed 2019 levels, helping the overall MRO market to rebound. This recovery comes a year earlier than previously forecast because of the rapid return of air travel demand and utilization. Over the forecast period, engine MRO is expected to hit $63 billion by 2033, representing compound annual growth of 4%.

Driving this market expansion is a bigger fleet and more technologically advanced next-generation engines that need more maintenance and are built with more expensive materials. By the end of the forecast, engine MRO will represent 50% of the market versus 45% in 2019.

A caveat: The LEAP and GTF, engines used on A320neo and 737 MAX aircraft, are new to the market and have largely untested maintenance profiles and spend. Projected spend for engines is highly sensitive to the operational profile and damage from operations and forecasts will be updated as these engines mature — particularly since they will represent over half of the fleet by 2033. In 2023, these engines represent less than 2% of the engine MRO market but will grow to 30% by 2033.

In contrast, the mature CFM56 market will largely stay flat until 2030, but will precipitously drop after that, decreasing from 19% in 2023 to 8% of engine MRO in 2033. As this engine type continues to mature, evolving maintenance strategies could significantly impact our forecast assumptions for shop visit costs, particularly as the availability of PMA and DER increase for this fleet and strategies like module swaps increase in popularity to defray maintenance costs.

The shortage of materials, stemming from supply chain disruptions, has weighed on the throughput of engine MROs worldwide, with turn times on certain engines at 180 days — two to four times more than normal— and anecdotal evidence of engines waiting on parts for months. This could limit capacity and market size going forward.

LINE AND COMPONENT MRO

Line maintenance is driven by utilization and calendar time and is comprised of check schedules that are recommended by manufacturers and required by regulators. In addition, it includes troubleshooting and work performed for defect rectification on aircraft in operation.

The market for line MRO expands and contracts with the fleet size and how aircraft accumulate hours and cycles. Given this relationship, line MRO plunged with the reduction in fleet size during the pandemic and recovered as aircraft entered or returned to the fleet.

In 2023, line MRO is expected to expand to $13 billion, up 16% from 2022. That would represent a full recovery to 2019 levels. Over the forecast period, we're projecting an annual compound growth

of 3%. Unlike airframe maintenance, newer aircraft don't require significantly less line maintenance, which should benefit line maintenance spend.

The component market is a hybrid: It depends to some degree on scheduled maintenance but is primarily driven by increases in fleet size and utilization. As airlines did with engine MRO, they deferred some component maintenance during the pandemic by harvesting more costly components from stored aircraft. Then, as aircraft returned to service, component maintenance started to rise again. Component MRO in 2023 is expected to return to its 2019 level. It will then grow 2.1% annually to $23 billion by 2033.

While the component MRO segment is comprised of parts from nose to tail of the aircraft, certain components represent a larger portion of the market, including auxiliary power units, avionics, landing gear, and wheels and brakes. These categories will account for nearly 50% of the component market over the forecast period.

BY PLATFORMS

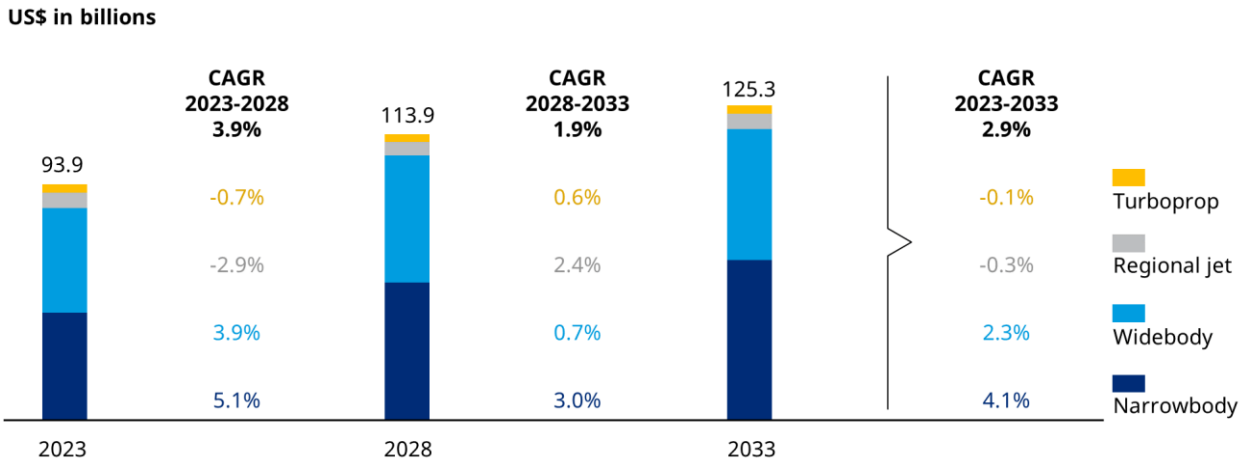
Future production rates, along with the pandemic, will have a lasting impact on the distribution of platforms within the MRO market. First, the turmoil of the past few years has delayed the certification dates for new fleets, from freighters to the new Chinese-produced C919 aircraft. Manufacturers across the board are also struggling — and so far, failing — to reach and surpass pre-pandemic production rates. Together, these trends are altering the mix of platforms in the forecast.

Still, more efficient aircraft will continue to enter the market and replace current models. The share of MRO spend on newer fleets will grow throughout the forecast period, with 2010 vintage aircraft representing 40% of the market by 2033.

Historically, narrowbodies account for the largest share of the MRO market, and, with fleet growth coming largely from this category, the trend will continue over the next 10 years. The impact of the 737 MAX groundings will be felt in the market for years to come; by 2033, the 737 MAX is expected to represent 27% of the narrowbody market while the A320neo will have a 38% share.

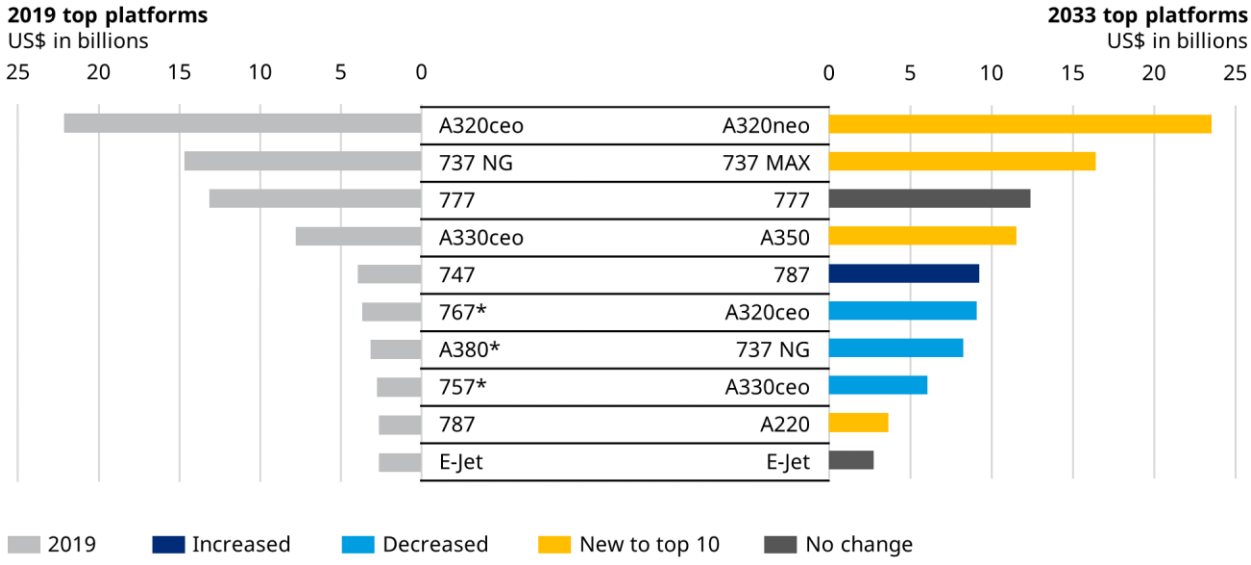
Newer entries in the market, such as the widebody freighters 777XF and A350F, won't begin their MRO visits until after the forecast period. With limited replacement options and pilot shortage issues, the contraction of the regional jet fleet will lead to a decrease in MRO spend on that class over the next 10 years. Turboprop spend is also essentially flat because of aging and retiring fleets.

Exhibit 27: MRO market forecast by aircraft class, 2023–2033



Note: CAGR stands for compound annual growth rate
Source: Oliver Wyman analysis

Exhibit 28: Top aircraft platforms by total MRO spend, 2019 actual versus 2033 projections



Note: * indicates not in 2033 top 10
Source: Oliver Wyman analysis

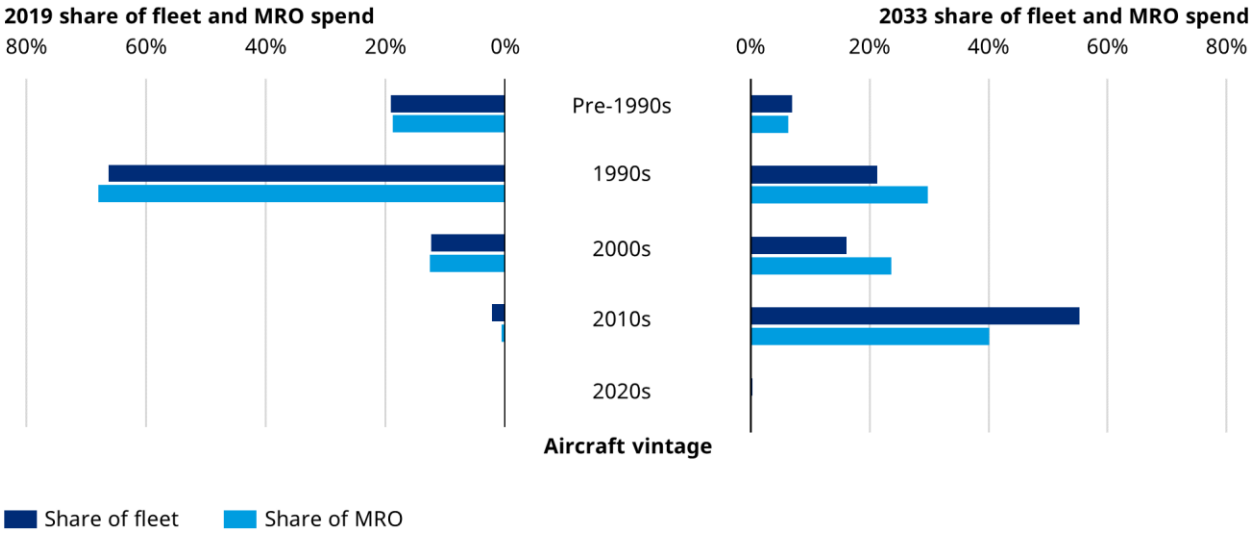
AIRCRAFT AGE

Along with fleet size and utilization, the average age of a fleet is a major driver of MRO demand. In 2019, aircraft developed in the 1990s accounted for 66% of the fleet and 68% of MRO spend, while new generation aircraft developed in the 2010s comprised 2% of the fleet and less than 1% of MRO.

As more 1990s vintage aircraft retire over the next 10 years, their share of the fleet will decline, but they will still have a disproportionately large share of MRO because of their advanced age. By 2033, 1990s vintage aircraft are expected to account for 22% of the fleet and 29% of MRO.

Aircraft developed from 2010 to 2019 are projected to increase to 55% of the fleet and 40% of MRO. Only a small portion of that vintage fleet will reach expensive heavy checks or engine shop visits by the forecast's end.

Exhibit 29: Total MRO spend by aircraft vintage, 2019 versus 2033



Source: Oliver Wyman analysis

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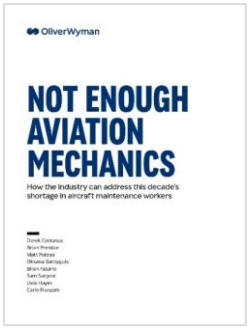

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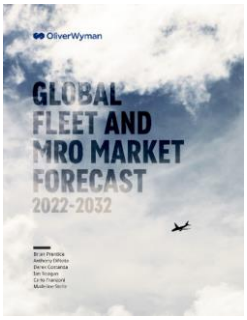

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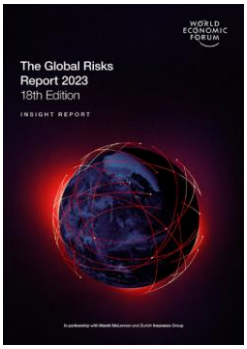

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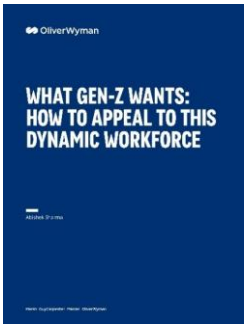

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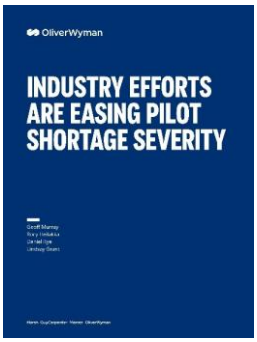

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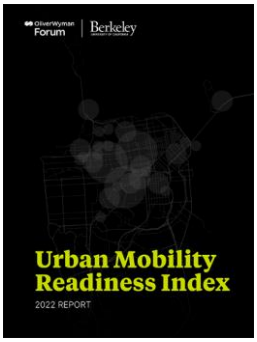

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