FAA AEROSPACE FORECAST

Fiscal Years 2022-2042

Federal Aviation Administration

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Forecast Highlights (2022–2042)

The Russian invasion of Ukraine and ensuing war in 2022 occurred after this forecast was prepared and therefore it does not reflect impacts from those events. However, those impacts are already being felt and may worsen significantly depending on the extent, severity and duration of the war. Already, flights that normally traverse Russian and Ukrainian airspace are rerouting, resulting in longer flight times and higher fuel and crew costs. Next, fuel prices spiked as some countries halted imports of oil from Russia, a major global supplier. Higher energy costs for American consumers may combine with higher food costs as other exports such as for wheat and fertilizer from the region are also curtailed. Higher fuel costs can be passed on to consumers in the form of higher ticket prices, thus directly restraining air travel demand, but higher prices for both food and fuel also stretch consumer wallets, leaving less for discretionary travel. Finally, depending on the progression of the war, consumer confidence may weaken, increasing caution and financial conservatism.

Since its deregulation in 1978, the U.S. commercial air carrier industry has been characterized by boom-to-bust cycles. The volatility that was associated with these cycles was thought by many to be a structural feature of an industry that was capital intensive but cash poor. However, the great recession of 2007-09 marked a fundamental change in the operations and finances of U.S Airlines. Since the end of the recession in 2009, U.S. airlines revamped their business models to minimize losses by lowering operating costs, eliminating unprofitable routes, and grounding older, less fuel-efficient aircraft. To increase operating revenues, carriers initiated new services that customers were willing to purchase and started charging separately for services that were historically bundled in the price of a ticket. The industry experienced an unprecedented period of consolidation with three major mergers in five years. The results of these efforts were impressive: 2019 marked the eleventh consecutive year of profitability for the U.S. airline industry.

The outbreak of the COVID-19 pandemic in 2020, however, brought a rapid and cataclysmic end to those boom years. Airline activity and profitability tumbled almost overnight and without the financial and competitive strength built up during the boom, airlines would have faced even greater challenges. As it was, they were able to slash capacity and costs, and then, relying on their balance sheets, credit ratings and value inherent in their brands, to raise capital through borrowing and restructuring fleets allowing them to withstand the period of losses. Although several small regional carriers ceased operations in 2020, no mainline carriers did. Cargo activity was one of few bright spots as it surged, boosted by consumers purchasing goods to enhance time spent at home as necessitated by the pandemic, and by surface transportation disruptions caused by worker shortages due to COVID-19 illnesses.

By the middle of 2021, conditions and the outlook had brightened considerably. With the arrival of spring, the introduction of vaccines, and the lifting of some local restrictions, leisure travel began rebounding. Favored destinations remained concentrated in outdoor recreation spots, whether beach or mountain, and some recorded traffic levels higher than in 2019. The emergence of the

COVID-19 variants in the second half of the year paused the recovery but generally didn't reverse it. Two new low-cost carriers were formed and one regional carrier that ceased operations in 2020 was reborn. By the third quarter, industry profitability was nearing the breakeven point.

The business modifications necessitated by the downturn will shape the industry for years to come, long after the recovery is complete. Primarily, airlines will be smaller having retired aircraft and encouraged voluntary employee separations. Fleets, however, become younger and more fuel-efficient as retirements targeted the oldest and the least efficient aircraft. As airlines carry high levels of debt, capital spending and investment will be restrained which in turn holds back future growth. And even the unbundling of services took a small step backwards as carriers eliminated change fees for all but Basic Economy tickets.

In the medium-term, airlines will be focused on trying to foretell the recovery in demand and position themselves to meet it. To date, that demand recovery has been extremely uneven across markets and population segments, driven by COVID-19 case counts, vaccinations, governmental restrictions and the degree of pent-up demand experienced by consumers and businesses. While domestic leisure traffic has led the recovery, domestic business travel is expected to gain momentum in 2022. International activity generally lags domestic as individual country experience with the pandemic is varying and shifting so widely.

Long-term, the strengths and capabilities developed over the past decade will become evident again. There is confidence that U.S. airlines have finally transformed from a capital intensive, highly cyclical industry to an industry that can generate solid returns on capital and sustained profits.

Fundamentally, over the long-term, aviation demand is driven by economic activity, and a growing U.S. and world economy provides the basis for aviation to grow. The 2022 FAA forecast calls for U.S. carrier domestic passenger growth over the next 20 years to average 4.7 percent per year. This average, however, includes double-digit growth years in 2022 and 2023, as activity climbs out from a very low base. Following the recovery period, trend rates resume with average growth through the end of the forecast of 2.6 percent. Domestic passengers are forecast to return, on an annual basis, to 2019 levels in 2023. Oil prices averaged $55 per barrel over the five years ending in 2021 but are forecast to rise to $75 per barrel in 2022 (again, as forecast prior to the war in Ukraine) before rising steadily to $87 by the end of the forecast period.

Just as U.S. economic activity drives domestic demand for air transport, foreign economic activity affects international travel demand. And as virtually all countries took actions to contain COVID-19, those same actions resulted in economic patterns that are similar to those in the U.S. with sharp declines in 2020 followed by strong rebounds that began in 2021. The variation of economic performance across countries depends on their relative strength as the pandemic began but is also dependent on the severity of their experience with COVID-19 as well as the stringency of their responses. Europe saw sharp economic declines in 2020, consistent with its relatively high level of infections and numerous lockdowns that overwhelmed a tepid level of baseline economic growth. Many Asian countries, on the other hand, saw only mild downturns as they took swift and strong actions to control the virus early in the pandemic but also began the year with relatively strong economic growth. For most countries, economic growth rates settle back to their long-run trends in about 2023.

System traffic in revenue passenger miles (RPMs) is projected to increase by 5.7 percent a year between 2022 and 2042. Domestic RPMs are forecast to grow 4.8 percent a year while International RPMs are forecast to grow significantly faster at 8.8 percent a year, largely due to the steep declines in 2020 and 2021 that brought RPM to just 31 percent of 2019's level – about half that of domestic RPM. Thus, these figures are boosted by several years of high growth rates during the recovery after which the annual rates return to more moderate long-term trends. The strong growth rates return system RPM, on an annual basis, to 2019 levels in 2024, with domestic RPM returning a year earlier and international RPM also recovering in 2024. System capacity as measured by available seat miles (ASMs) is forecast to grow somewhat slower than RPM during the recovery period as airlines seek to restore load factors but, subsequently, ASM grow in line with the increases in demand.

The FAA expects U.S. carrier profitability to remain under pressure for several years due to lower demand and competitive fare pressures. As carriers return to levels of capacity consistent with their fixed costs, shed excess debt, and yields stabilize, consistent profitability should return. Over the long term, we see a competitive and profitable aviation industry characterized by increasing demand for air travel and airfares growing more slowly than overall inflation, reflecting growing U.S. and global economies.

The general aviation (GA) sector was less affected by the COVID-19 crisis than the airlines. Private aviation continues to attract those who can afford while the pandemic continues. At the lower end of the industry, new comers to private flying included student, private and commercial pilots, joining the existing GA pilot population. The long-term outlook for general aviation thus is promising, as growth at the higher-end offsets continuing retirements at the traditional low end, mostly piston-powered part of the sector. The active GA fleet is forecast to increase by just 0.1 percent between 2022 and 2042, after recording a slight increase of 0.1 percent in 2021 from the year before, and is essentially unchanged from its 2019 level. The turbine aircraft fleet, including rotorcraft, did not experience a decline between 2019 and 2020, and is estimated to have increased slightly between 2020 and 2021; while the total of piston fleet (single and multi-engine pistons, light-sport aircraft, and piston rotorcraft) declined by 3.8 percent between 2019 and 2020 and is estimated to have fallen by 0.6 percent in 2021 from the previous year. While steady growth in both GDP and corporate profits results in continued growth of the turbine and rotorcraft fleets, the largest segment of the fleet – fixed wing piston aircraft will continue to shrink over the forecast period, just to be offset by the growing turbine fleet. Despite the marginal growth of the active GA fleet between 2020 and 2042, the number of GA hours flown is projected to increase by 31.4 percent from 2020 to 2042 (an average of 1.2 percent per year), as growth in turbine, rotorcraft, and experimental hours more than offset a decline in fixed wing piston hours. When the period of 2022 to 2042 is compared, the total hours flown by the GA aircraft is forecast to increase by an average of 1.0 percent per year, after declining by 12.0 percent between

2019 and 2020, and recovering partially, with a growth of 4.0 percent in 2021 from the previous year.

With the expected robust air travel demand growth between 2022 and 2026 due to the U.S. economy recovering from the impact of COVID, we expect increased activity growth that has the potential to increase controller workload. Operations at FAA and contract towers are forecast to grow 1.5 percent a year over the forecast period (FY2022-42) with commercial activity growing at approximately five times the rate of non-commercial (general aviation and military) activity. The recovery in U.S. airline activity from the COVID downturn is the primary driver. The U.S. commercial aviation sector has been hit by the pandemic much harder than the non-commercial sector. The pent-up demand is expected to drive the commercial operations back to the pre-COVID level by 2023, hence leading to the stronger growth in the commercial sector. In particular, large and medium hubs will see much faster increases than small and non-hub airports, largely due to the commercial nature of their operations.

Review of 2021

Although conditions in 2021 remained bleak, there was definite improvement from the previous year as the turmoil and uncertainty from COVID-19 began to diminish. Businesses began to reopen, employment growth stabilized, and consumer spending rebounded, supported by fiscal and monetary stimulus. Air passenger travel picked up, air cargo surged, and tower operations rose for both the air carrier and general aviation segments. UAS activity grew solidly and commercial space launches surged in 2021, both of which had expanded in 2020.

U.S. commercial aviation began the year on the back foot but saw solid movement along the path of recovery as the year progressed, while COVID-19 remained the limiting factor. TSA checkpoint throughput had come off the bottom by the end of the previous year but only improved to about 40 percent of 2019's level at the start of 2021. With the rollout of vaccinations in the spring, however, throughput rose steadily to about 80 percent of 2019's level by mid-summer. Then, the emergence of COVID-19 variants (Delta in late summer and Omicron in the final weeks of the year) hampered further recovery and throughput ended the year about where it was in the summer. The main source of strength throughout the year was from leisure travelers, both to domestic and short-haul international destinations, primarily in the Latin region. In the business segment, activity picked up although not to the same extent as in the leisure segment as many employees remained on work-from-home status and meetings, conferences and trainings were either conducted virtually or forgone.

Airlines responded aggressively to these shifts in demand, seeking to match capacity with changes in timing, markets and segments. According to the Bureau of Transportation Statistics (BTS), airline employment rose in ten months of the year to average an increase of 3,000 jobs per month. At year end, employment was 40,000 higher than in 2020 even though it remained 19,000 lower than in 2019. Airlines increased staffing to enable them to offer more flights to more, and generally smaller, destinations as leisure travelers were eager to escape pandemic restrictions. Airlines assisted by adding capacity to outdoor locales, particularly to beaches in the south and mountains in the west. International destinations in the Latin region also saw especially heavy activity with available seat miles (ASM) in the fourth quarter exceeding those in 2019.

As reflected by the TSA throughput figures, demand for air travel in 2021 began to recover. In FY2021, system traffic as measured by revenue passenger miles (RPMs) grew 3.3 percent from the previous year while system enplanements rose 9.0 percent. Domestic RPMs were 13.1 percent higher while enplanements were up 9.7 percent. International RPMs, however, fell 28.8 percent although enplanements rose by 1.4 percent, a consequence of busy short-haul Latin markets. The system-wide load factor was 68.5 percent, down a percentage point from the FY2020 level.

System nominal yields fell again in 2021. In domestic markets, all carriers, whether they normally targeted the leisure segment or not, focused on that price-sensitive segment, adding capacity and lowering fares to attract revenue. The result was a 12.9 percent drop in nominal yields. International yield, however, declined just 4.5 percent as demand was constrained more by travel restrictions than by price.

With the pickup in activity during the year, financial results improved as well. Data for FY2021 shows that the reporting passenger carriers[1] had a combined operating loss of $26.1 billion compared to an average profit over the five years ending in FY2019 of $22.1 billion. However, this obscures improvement over the course of the year that shows quarterly losses gradually declining and ending the fiscal year with a loss of under $200 million – far better than the $10 billion average loss of the previous six quarters.

The general aviation industry partially recovered from its decline in 2020 with an increase of 7.4 percent in deliveries of U.S. manufactured aircraft in 2021, with pistons slightly up by 0.5 percent (in fact, fixed-wing single engine piston aircraft deliveries were up by 2.3 percent) and turbines up by 16.6 percent. Global billings increased by 7.7 percent to $21.6 billion (still down by 8.2 percent from its 2019 level (Statistics for the U.S. billings were not available as of the publication date of this report).

Total operations in 2021 at FAA and contract towers increased by 7.4 percent compared to 2020 (down by 10.5 percent from 2019). Air carrier activity increased by 4.1 percent, while air taxi operations were up 7.1 percent. General aviation activity increased by 9.1 percent and military activity was up by 6.8 percent. Activity at large and medium hubs rose by 2.3 percent and 5.0 percent, respectively, while small and non-hub airport activity rose by 8.8 percent in 2021 compared to the prior year.

[1] Includes network carriers (Alaska Airlines, American Airlines, Delta Air Lines, and United Air Lines) and low cost carriers (Allegiant Air, Frontier Airlines, JetBlue Airways, Southwest Airlines, Spirit Air Lines, and Sun Country Airlines).

Glossary of Acronyms

Acronym	Term
ANG	FAA Office of NextGen
ARP	FAA Office of Airports
ASMs	Available Seat Miles
AST	FAA Office of Commercial Space Transportation
ATO	FAA Air Traffic Organization
ATP	Air Transport Pilot
AUVSI	Association for Unmanned Vehicle Systems International
BVLOS	Beyond Visual Line of Sight
CAPS	COA Application Processing System
CBP	Customs and Border Patrol
CFR	Code of Federal Regulations
COAs	Certification of Authorizations
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRS	Commercial Resupply Services
CY	Calendar Year
DARPA	Defense Advanced Research Projects Agency
DHS	Department of Homeland Security
DoD	Department of Defense
DoE	Department of Energy
DoI	Department of Interior
FAA	Federal Aviation Administration
FY	Fiscal Year
GA	General Aviation
GAMA	General Aviation Manufacturers Association
GC	Grand Challenge
GDP	Gross Domestic Product
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMF	International Monetary Fund
ISS	International Space Station
LAANC	Low Altitude Authorization and Notification Capability
LCC	Low Cost Carriers
LSA	Light Sport Aircraft
lUAS	Large Unmanned Aircraft System(s)
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NDAA	National Defense Authorization Act
NOTAM	Notices to Airmen
NPRM	Notice of Public Proposed Rulemaking
PCE	Personal Consumption Expenditure
PDARS	Performance Data Analysis and Reporting Systems
RAC	Refiners' Acquisition Cost
RLV	Reusable Launch Vehicle
RP	Remote Pilot
RPA	Remote Pilot Authorization
RPMs	Revenue Passenger Miles

RTMs	Revenue Ton Miles
sUAS	Small Unmanned Aircraft System(s)
SpaceX	Space Exploration Technologies Corp.
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
TSA	Transportation Security Administration
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System(s)
UASFM	UAS facility maps
USD	United States Dollar
VFR	Visual Flight Rules

Acknowledgements

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APO Websites

- Forecasts and Statistical publications — http://www.faa.gov/data_research/aviation_data_statistics/
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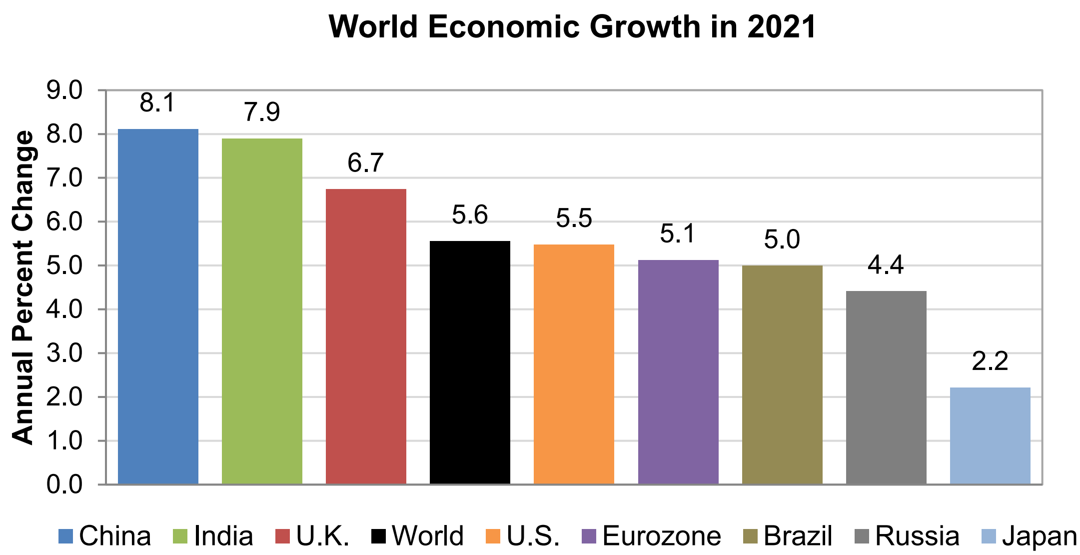
FAA Aerospace Forecasts Fiscal Years 2022-2042

Economic Environment

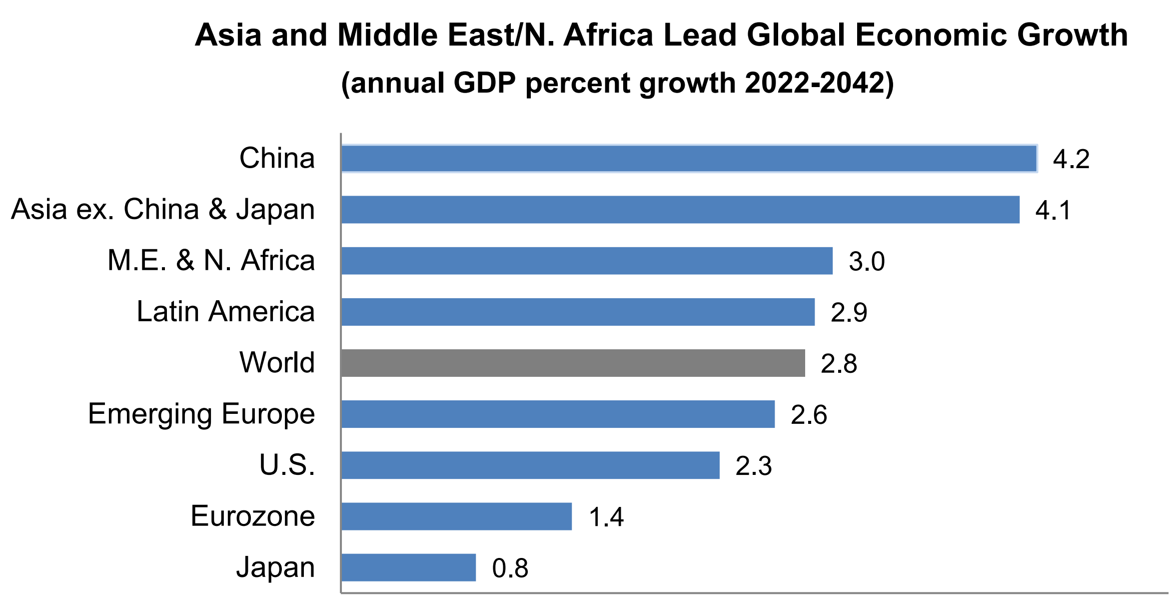
In 2021, global real GDP expanded sharply as countries began to recover from the worst of the economic effects of COVID-19. After falling 3.5 percent in 2020, GDP surged by 5.6 percent in 2021, a rate not seen since the early 1970s. Despite this high rate of growth, the level of GDP is not expected to return to its pre-pandemic path until about the middle of the decade. The recovery was supported by widespread fiscal stimulus, the availability of COVID-19 vaccines and the revival of consumer spending that had been curtailed in 2020. Moving into 2022 and 2023, countries are expected to shift their foci to dealing with COVID-19 as an endemic disease, to fiscal restraint, to rising interest rates and to reducing inflation, all of which contribute to moderating GDP growth in the coming years.

In the U.S., real GDP growth slows from 5.5 percent in 2021 to 4.3 percent in 2022 and 2.9 percent in 2023 as the effects of COVID-19 relief measures wear off, consumer spending normalizes and interest rates rise. Compared to the U.S., real GDP growth in the Eurozone will be somewhat slower in the near- and medium-term at 3.7 percent in 2022 and 2.2 percent in 2023. Aggressive deficit reduction efforts, high energy costs and supply chain disruptions all dampen growth in the near-term followed by continued slowing toward the area's trend rate. In Japan, the recovery was somewhat delayed by stringent COVID-19 control measures and increased cases in the second half of 2021, resulting in real GDP growth rates that rise in 2022 before receding in 2023. Some of the near-term strength will be due to increased exports, particularly autos, as supply chain disruptions fade. Although China's growth remained positive in 2020 and jumped to 8.1 percent in 2021, the country's zero-COVID policy tamps down growth in 2022 and 2023 to 5.5 percent, or slightly below its trend rate. Additionally, exports slow as global consumer spending shifts out of goods and back to services. In efforts to support growth, the government is easing monetary policy and boosting infrastructure investment. In other large emerging markets, Brazil provided large fiscal stimulus causing growth to surge in 2021 but then fall back sharply in 2022 as that stimulus was withdrawn. Further constraining growth, Brazil's central bank hiked interest rates sharply in an effort to rein in the country's high inflation. Russia, like Brazil, began raising interest rates in 2021 to counter inflation, thus restraining GDP growth. On the other hand, the energy sector, consumer spending and investment activity are expected to counterbalance that restraint.. While India's pandemic stimulus spending has been relatively modest, in the medium-term its growth will be supported by favorable demographics including strong consumer spending from growing middle-income households.



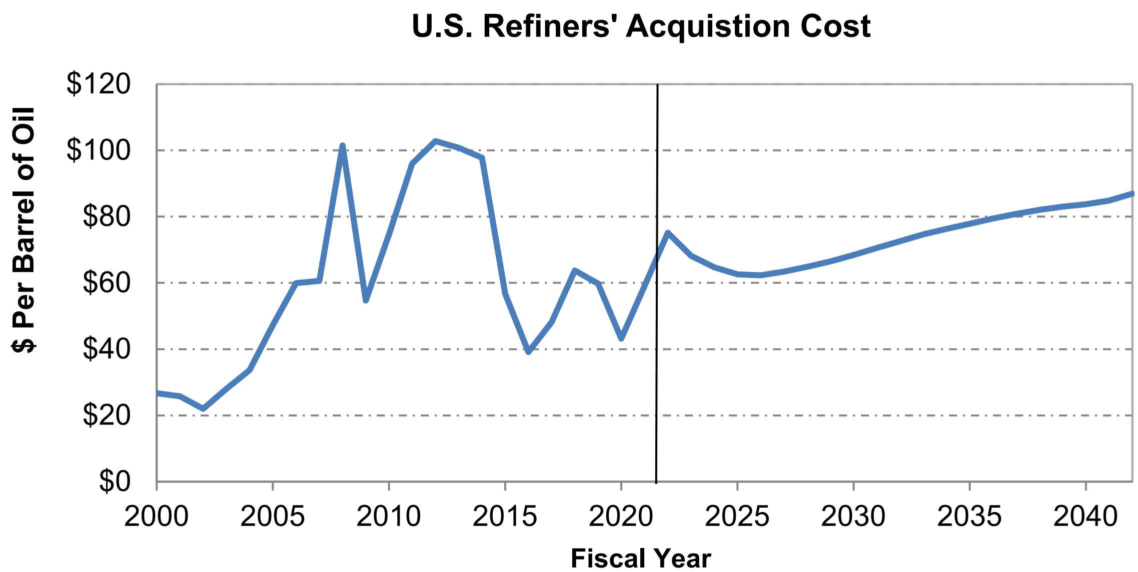
Source: IHS Markit

IHS Markit forecasts world real GDP to grow at 2.8 percent a year between 2022 and 2042. Emerging markets, at 3.9 percent a year, are forecast to grow above the global average but at lower rates than in the early 2000's. Asia (excluding Japan), led by India and China, is projected to have the fastest growth followed by Africa and Middle East, Latin America, and Eastern Europe. Growth in the more mature economies (1.8 percent a year) will be lower than the global trend with the fastest rates in the U.S. followed by Europe. Growth in Japan is forecast to be very slow at 0.8 percent a year reflecting deep structural issues associated with a shrinking and aging population.



Source: IHS Markit, Dec 2021 World Forecast

Accompanied by the rebound in global economic activity was increased demand for oil in 2021, pushing prices up. After dropping from about $60 per barrel to $43 in 2020, the price returned to $60 and is projected to continue up to $75 in 2022. Again, however, this forecast does not include the impacts of the Russian invasion of Ukraine, which will likely push prices even higher in 2022 and beyond. Over the long-run, IHS Markit expects the price of oil to increase due to growing global demand and higher costs of extraction. IHS Markit forecasts U.S. refiner's acquisition cost of crude to rise to $87 per barrel at the end of the forecast horizon.



Source: IHS Markit

U.S. Airlines

Domestic Market

Mainline and regional carriers[2] offer domestic and international passenger service between the U.S. and foreign destinations, although regional carrier international service is confined to the border markets in Canada, Mexico, and the Caribbean.

Over the coming years, the commercial air carrier industry will be focused on recovering from the devastating consequences of the COVID-19 pandemic. First, carriers will work to identify and assess demand as it returns fitfully from the lows reached in 2020. Next, and as load factors rise, the focus will shift to adding capacity back into networks in a cautious and deliberate manner. With demand beginning to approach 2019 levels, balance sheets strengthen allowing carriers to adopt the more customary longer-term strategies.

[2] Mainline carriers are defined as those providing service primarily via aircraft with 90 or more seats. Regionals are defined as those providing service primarily via aircraft with 89 or fewer seats and whose routes serve mainly as feeders to the mainline carriers.

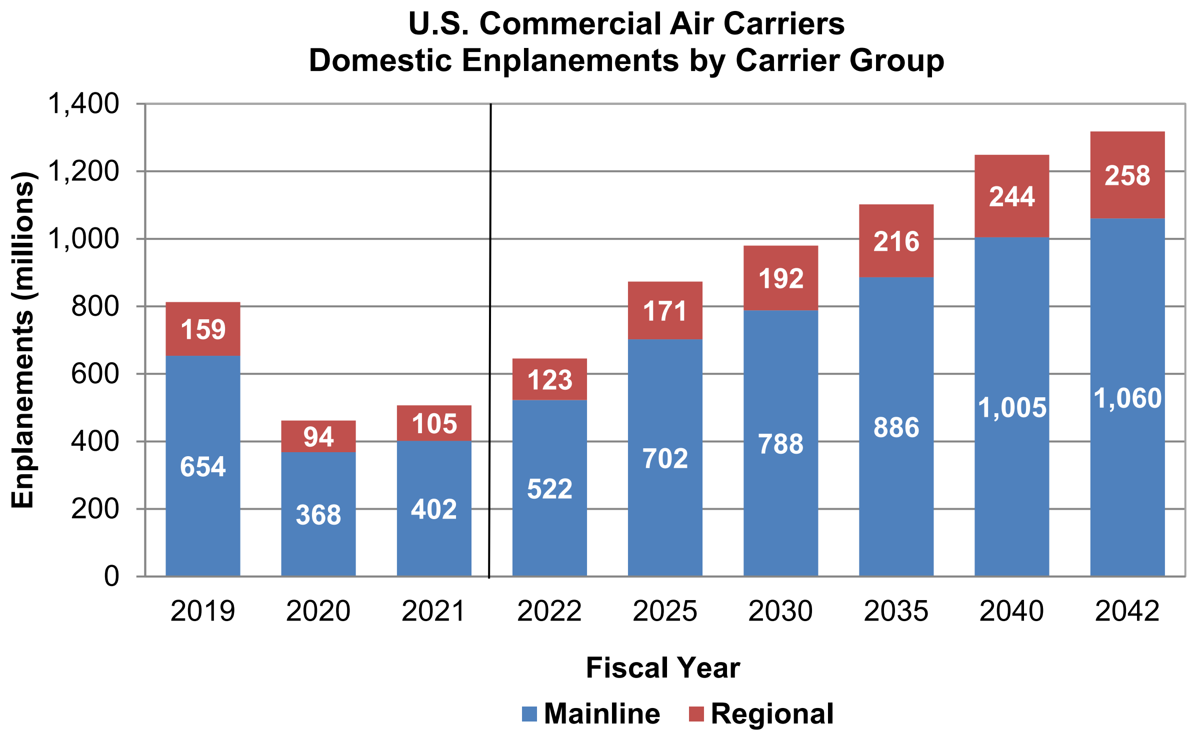
The unpredictable demand environment carriers faced in the previous two years will improve in 2022. Driving the predictability will be the continued lifting of COVID-19 precautions, the working off of pent-up demand, and employees returning to offices as they become more comfortable with travelling again and employers find ways to satisfy duty-of-care requirements. Increasingly predictable activity allows carriers to return capacity to typical markets, and reduce reliance on purely recreational destinations. Load factors and utilization rates will rise and so will fares.

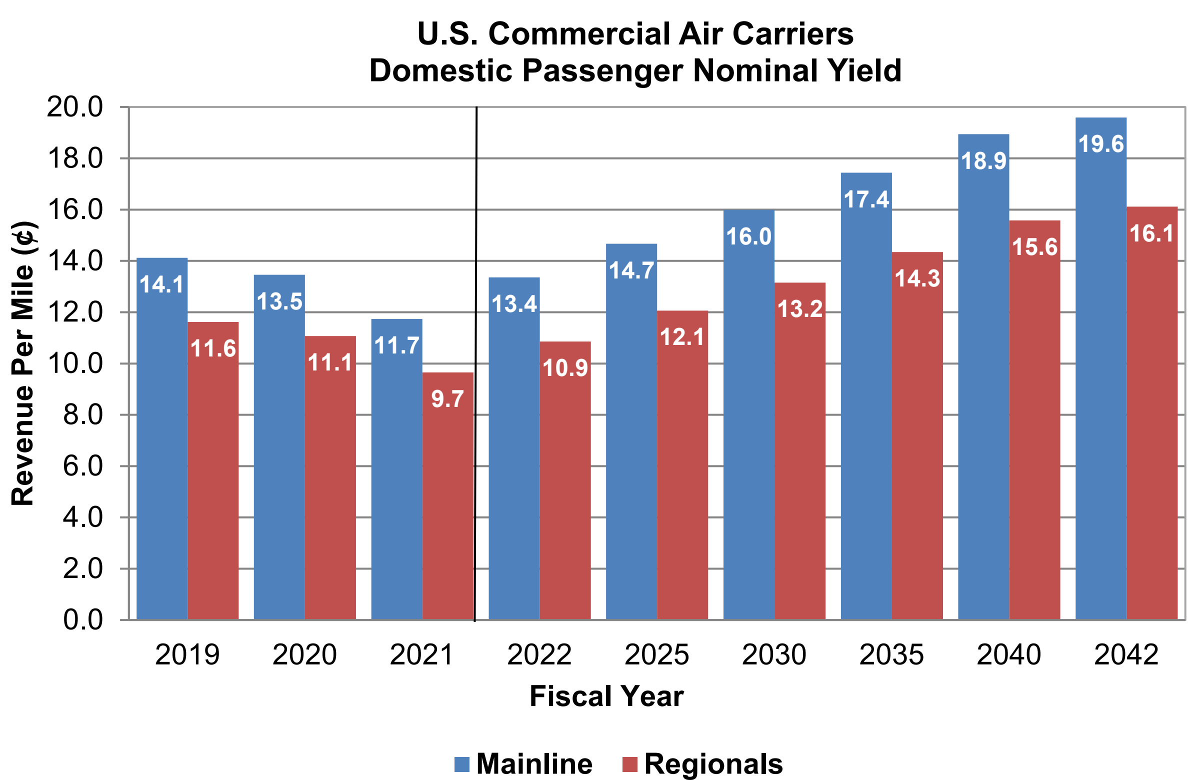
In the final recovery phase, activity approaches 2019 levels and industry conditions begin to normalize. Leisure travel has largely returned to pre-pandemic levels and business travel is steadily catching up. Carriers remain somewhat constrained by debt incurred to survive the crisis and forgo some capital investments in favor of strengthening their balance sheets.

Throughout the recovery from the pandemic, several trends emerged that subsequently will, to greater or lesser extent, be reversed. Low-cost carriers targeting leisure travelers benefitted from relative strength in this segment. The sharp curtailment of business travel, on the other hand, impacted legacy carriers and those serving key business markets. And all carriers received a boost from low fuel prices that were due in part to reduced energy demand worldwide.

Regional carriers suffered very similar consequences of COVID-19 as did the mainline group. In 2021, regionals provided 11.6 percent of domestic capacity, up just slightly from 11.1 percent in 2019. In terms of traffic, regionals saw marginally better performance than their mainline counterparts, claiming 11.3 percent of RPM in 2021 compared to 10.4 percent in 2019. The deviations in 2020 are expected to be temporary as travel patterns and airline operations begin their recovery to more normal conditions.

The regional market continues to face pressure as the regionals compete for even fewer contracts with the remaining dominant carriers; this implies paltry growth in enplanements and yields.


U.S. Commercial Air Carriers
Domestic Enplanements by Carrier Group
Enplanements (millions)
1,400
1,200
1,000
800
600
400
200
0
159
94
105
123
171
192
216
244
258
654
368
402
522
702
788
886
1,005
1,060
2019
2020
2021
2022
2025
2030
2035
2040
2042
Fiscal Year
Mainline
Regional


U.S. Commercial Air Carriers
Domestic Passenger Nominal Yield
Revenue Per Mile (¢)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
14.1
11.6
13.5
11.1
11.7
9.7
13.4
10.9
14.7
12.1
16.0
13.2
17.4
14.3
18.9
15.6
19.6
16.1
2019
2020
2021
2022
2025
2030
2035
2040
2042
Fiscal Year
Mainline
Regionals

The regionals have less leverage with the mainline carriers than they have had in the past as the mainline carriers have negotiated contracts that are more favorable for their operational and financial bottom lines. And as mainline carriers cut service to smaller cities over the past two years, it was the regional partners that were most affected. Furthermore, mainline carriers successfully reduced costs by offering voluntary retirements to flight crews but as activity picked up they drew replacements from the ranks of the regionals, exacerbating their pre-pandemic pilot shortages. As regional carriers recover and activity returns to 2019 levels, service to smaller cities is expected to return. Regional pilot shortages, however, are likely to persist through next year due to the time required for training and recruitment.

A trend for regionals that was largely unaffected by the pandemic is the longstanding increase in the number of seats per aircraft. This measure rose by more than 55 percent over the decade from 1997 to 2007 and although it slowed more recently to an increase of 17 percent in the ten years ending in 2019, that same pace generally continued in 2021. A consequence of this drive to replace 50 seat regional jets with more fuel-efficient 70 seat jets is that capital costs have increased. The move to the larger aircraft will prove beneficial in the future, however, since their unit costs are lower.

Mainline carriers have also been increasing the seats per aircraft flown although, unlike that for the regionals, the trend had been accelerating. From 1997-2007, mainline seats per aircraft expanded just one-half of one percent but from 2009-2019, the measure grew 10 percent. In 2021, mainline seats per aircraft bumped up to almost 13 percent over the decade as carriers flew some of their idle long-haul international aircraft on domestic routes.

Another continuing trend is that of ancillary revenues. Carriers generate ancillary revenues by selling products and services beyond that of an airplane ticket to customers. This includes the un-bundling of services previously included in the ticket price such as checked bags, on-board meals and seat selection, and by adding new services such as boarding priority and internet access. After posting record net profits in 2015, U.S. passenger carrier profits declined subsequently on rising fuel and labor costs, and flat yields, but were supported by ancillary revenues. Even in 2020 when profits turned to staggering losses, this remained a meaningful source of revenue for carriers.

On the other hand, revenue management systems that have grown increasingly sophisticated in recent years became almost worthless in 2020. These systems enable carriers to price fares optimally for each day and time of flight, and to minimize foregone revenue. But, because they rely on historical data to make price and schedule predictions, the unprecedented nature of the collapse in 2020 meant they could provide little guidance and carriers were forced to assess market conditions without the benefit or precision of that quantitative analysis.

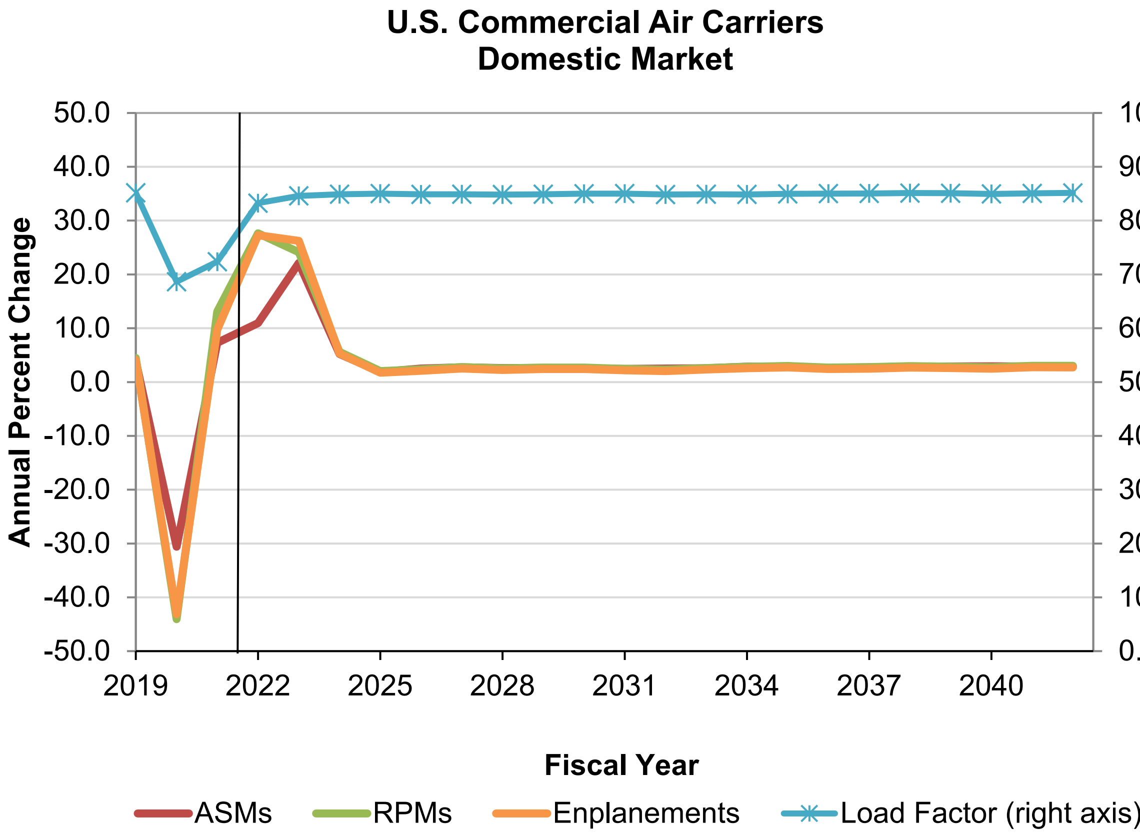
While revenue management systems will regain their important role once travel demand returns to more normal rhythms, one source of ancillary revenue, change fees, was broadly scrapped in 2020. As traveler plans were forced to change due to COVID-19-related restrictions, airlines began dropping fees for itinerary changes in many ticket classes. As a share of total passenger revenue, cancellation fees dropped from about 2 percent in FY2019 and the years prior to under

1 percent in FY2021. Some airlines have stated that the elimination of change fees is a permanent move and won't be reversed with the end of the pandemic. In contrast, baggage fees seem unlikely to be rescinded as their share rose from 4.0 percent to 6.7 percent in FY2021. And in the third quarter of 2021, revenue from baggage fees exceeded that in the same quarter of 2019 even though total passenger revenue remained down nearly a third.

Other methods of segmenting passengers into more discreet cost categories based on comfort amenities like seat pitch, leg room, and access to social media and power outlets were unaffected by the pandemic. The offering of Basic Economy fares has been part of an effort by network carriers to protect market share in response to the rapid growth low cost carriers (LCC) have achieved in recent years. In 2019, mainline enplanements had increased almost 23 percent since 2007 but low cost carrier enplanements grew by 39 percent. RPM over the same period show a similar pattern with mainline RPMs up almost 27 percent and LCC RPM fully 48 percent higher. These longer term trends were interrupted in 2020 with both enplanements and RPM dropping across both mainline and LCC carriers to about 55 percent of 2019's levels. However, by 2021 the strength of LCC's became apparent again as their enplanements and RPM had recovered to about 70 percent of 2019 levels while mainline traffic edged up to about 60 percent. In fact, 2021 saw the inaugural operations of three new small LCCs, Aha!, Avelo and Breeze, all of which are targeting smaller, underserved cities with point-to-point flights independent of mainline contracts.

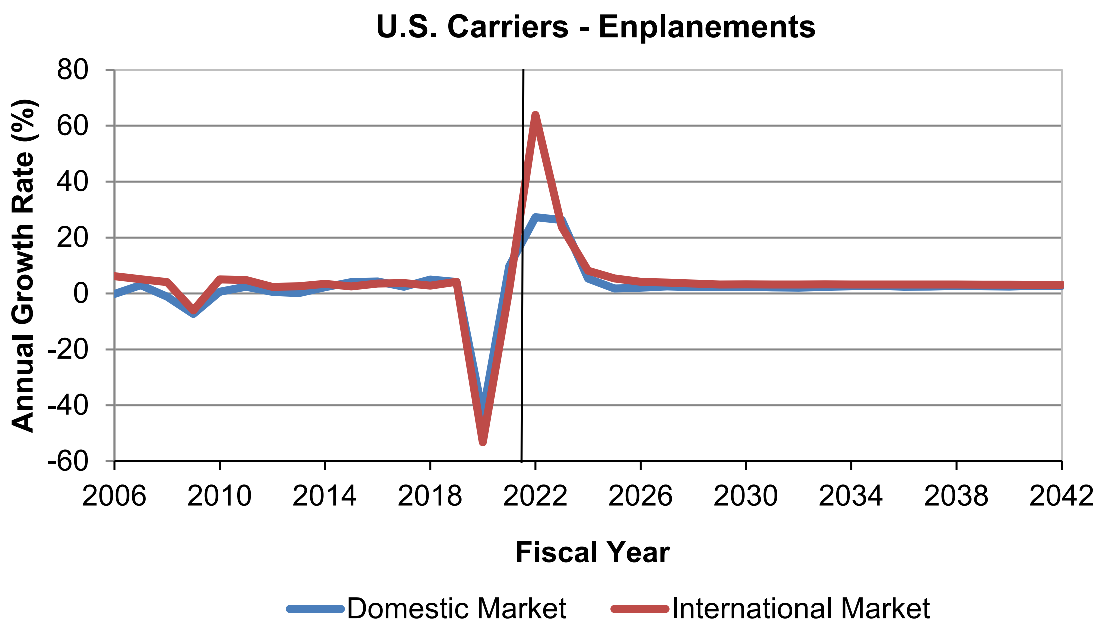
The outbreak of the pandemic in 2020 interrupted other domestic trends as well. U.S. commercial air carriers'[3] total number of domestic departures had risen for the second year in a row in 2019, and ASM had risen each of the previous nine years. But then in 2020, departures and ASM declined sharply, falling 30 percent from the prior year. On the demand side, RPM and enplanements, which had grown for ten consecutive years, saw even steeper declines of 40 percent in 2020. Because of the faster demand-side growth, load factors rose in ten of the eleven years leading up to 2020, reaching 85.2 percent, before dropping sharply in that year to 68.6 percent, as passengers stopped flying to a greater extent than carriers could match. As leisure travelers returned in 2021, load factors began to recover and reached 72.4 percent.

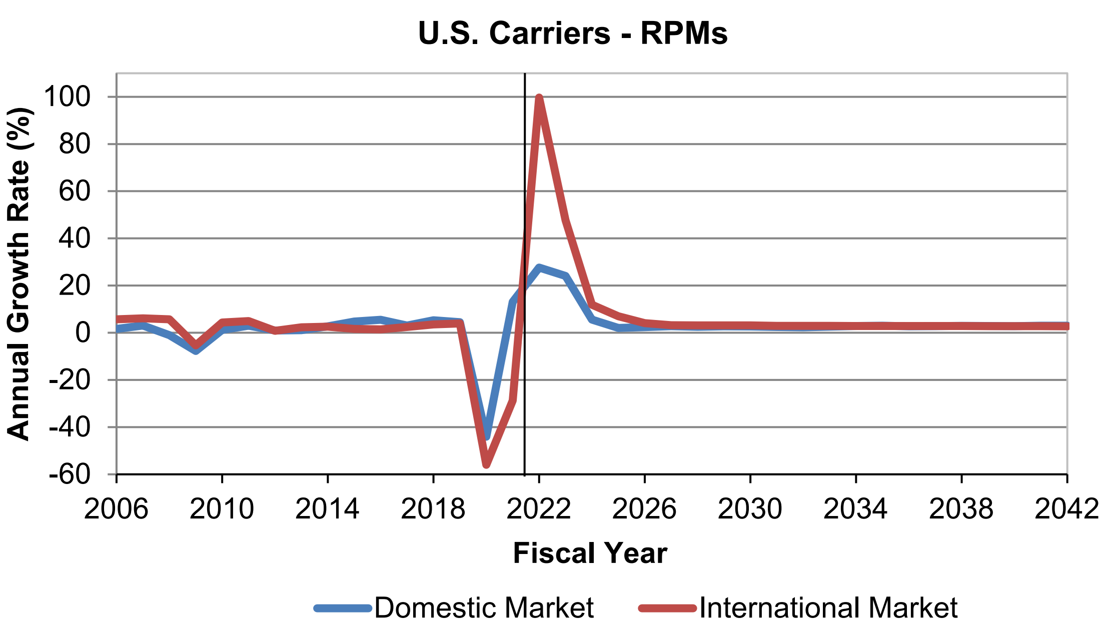
[3] Commercial air carriers encompass both mainline and regional carriers.

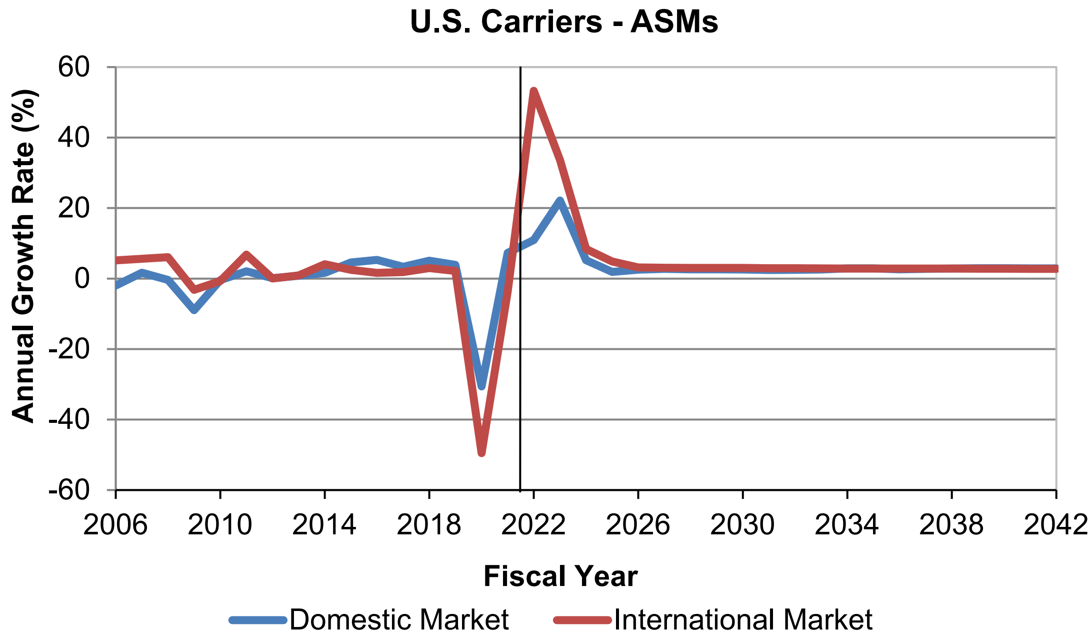


International Market

Over most of the past decade, the international market has been the growth segment for U.S. carriers when compared to the mature U.S. domestic market. In 2015 and 2016, growth in the domestic market surged, outpacing international markets. However, in 2017 enplanement growth in international markets exceeded that in domestic markets, only to be reversed again in 2018 and 2019. That relative strength of domestic activity compared to international continued during the downturn in 2020 and the start of the recovery in 2021. In 2021, domestic enplanements rose to 62 percent of 2019's level after being at 57 percent a year earlier, but international enplanements were flat at 47 percent, increasing less than a percentage point from 2020. International travel continues to be particularly impacted by border closings, quarantine requirements and other travel restrictions, as well as the uncertainty of when requirements might change. The fall off of business travel also contributed to the decline, even as leisure travel supports domestic markets. International travel is expected to continue to be constrained over the next two years by varying levels of COVID-19 infections and governmental responses across countries. Individuals will also be making personal assessments of the risks of travel and will likely be less comfortable travelling internationally than domestically due to uncertainties surrounding border closures and other restrictions.



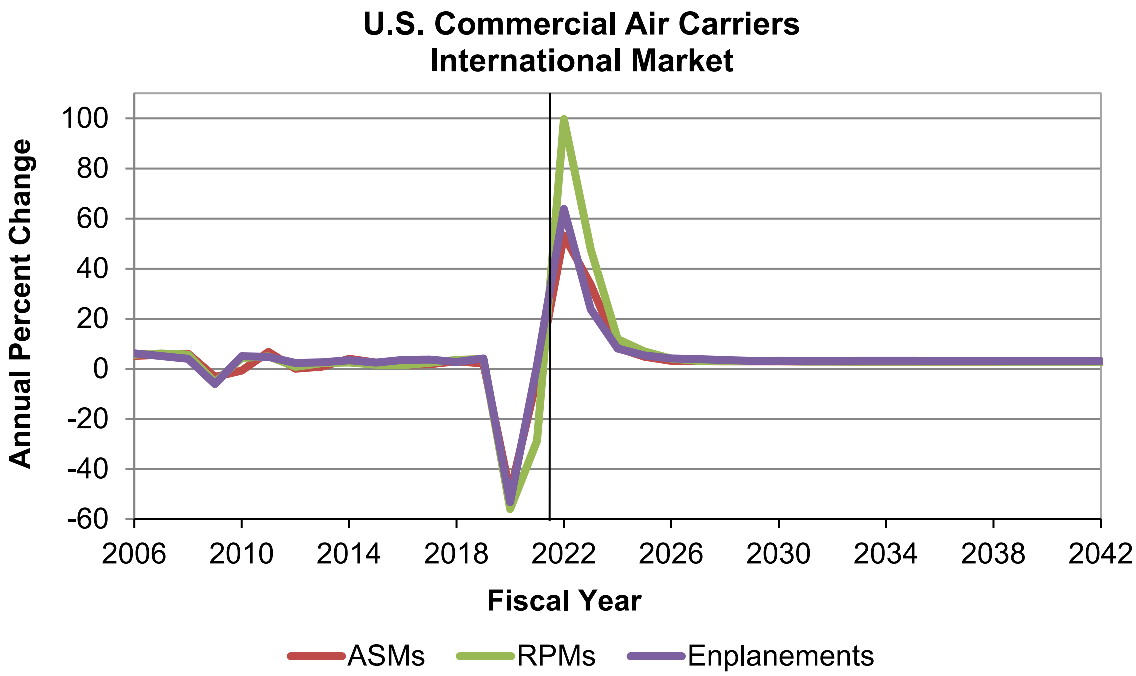




The early years of the international recovery will see some strong growth rates as activity levels come off a low base but these will return to more typical rates once levels approach 2019 values expected in 2024. From FY2022-2024, average annual growth rates for international ASM and enplanements are projected at 30 percent while RPM are forecast to grow at an annual rate of 49 percent as aggregate trip lengths grow due to increasing Atlantic and Pacific activity. From FY2024-2042, annual growth for ASM and enplanements are forecast to grow at 3.0 and 3.4 percent, respectively, while RPM will grow at a rate of 3.2 percent. Taking these two periods as a whole gives annual growth rates from FY 2022-2042 for ASM, RPM and enplanements of 6.5, 8.8, and 6.9 percent, respectively.

In the long-run, growth of major global economies will slow from the above-trend rates of recent, pre-pandemic years. Several moderating factors are at work, including dampened credit growth, reduced global trade, and political stresses. The European and Japanese economies are generally seeing slow but positive growth, in part due to weak trade with Asia. In turn, this has been driven by trade disputes as well as China's continuing gradual slowdown which has been managed by the government and is unlikely to decline sharply. Overall, global conditions appear set to return to a stable path once the pandemic has been brought under control but with growth rates that are closer to long-term trends than the higher rates of the recent pre-pandemic years. Rising oil prices, however, will create some drag on this otherwise supportive environment for air travel demand.

The past two years have been particularly difficult for carriers serving international markets because no amount of marketing, low fares or other strategizing could overcome the border closures and other restrictions related to COVID-19 that were constraining demand. For countries with few restrictions or that have lifted restrictions, activity has already been strong and, in some cases, at or above 2019 levels. As other countries lift restrictions this year and next and uncertainties surrounding travel diminishes, activity is expected to resume smartly. In 2022, ASM are forecast to grow 53 percent. RPM will double from its low level in 2021 (just 30 percent of 2019's level) and enplanements will grow 64 percent. Load factors fell further in 2021, reaching 54 percent, almost 30 percentage points below where they were in 2019 because carriers retained some capacity to protect market share. As RPM recovers in 2022, load factors also rise sharply, to 70 percent and are nearly fully recovered by 2024.



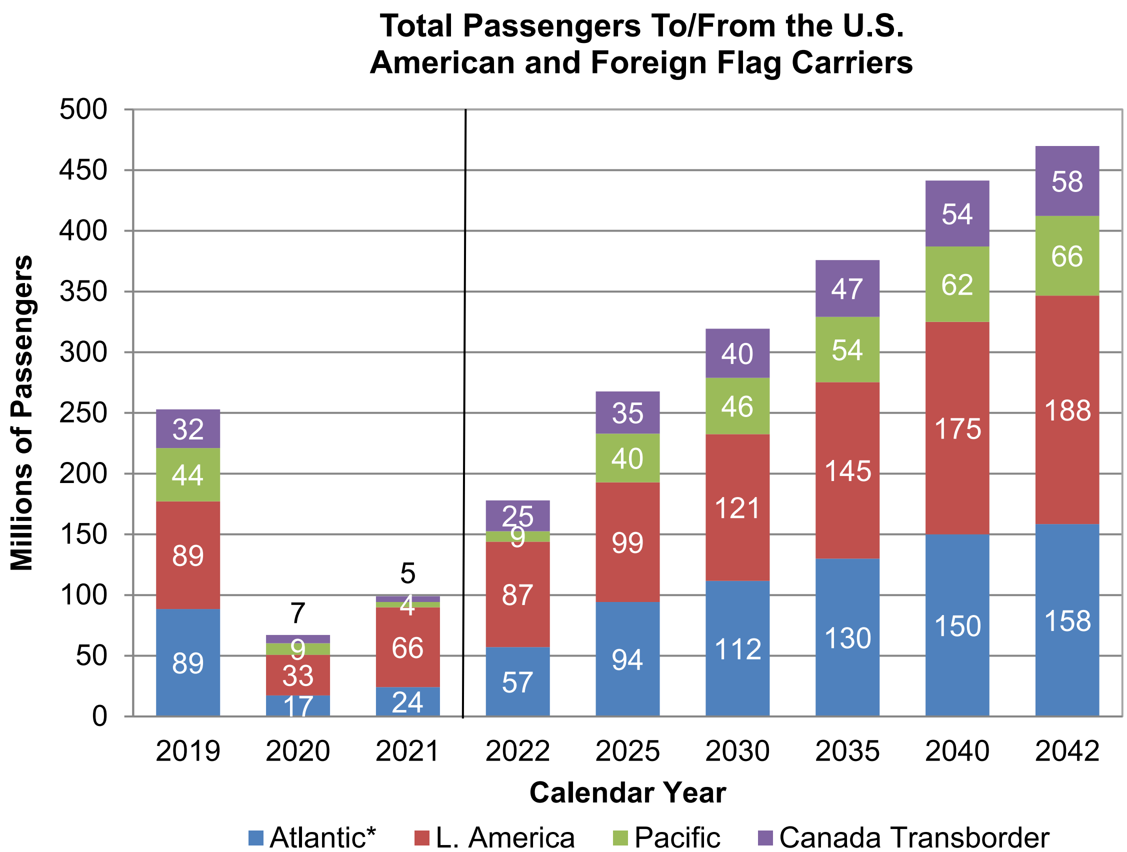
The impact of COVID-19 on travel by region has varied considerably, as will the recovery paths. Factors affecting the responses by market are similar to those affecting travel as a whole: COVID-19 case counts, governmental restrictions, predominant traveler segments, and macroeconomic conditions. As a result, by 2021, enplanements to Latin America had recovered the most followed by the Atlantic region and, in a distant third, the Pacific region.

For U.S. carriers, Latin America remains the largest international destination with more than twice the enplanements of Atlantic, the next largest in a typical year, due to its proximity to the U.S., strong trade ties, and popular visitor destinations. In contrast to the other two regions that saw declines in 2021, Latin enplanements rose by 34.9 percent while RPMs rose 22.6 percent. Much of the strength was fueled by leisure traffic heading to warm weather destinations and by the relatively low number of COVID-19 cases and travel restrictions in some countries. Enplanements and RPMs are forecast to increase 41.6 and 46.3 percent, respectively, in 2022, before resuming single-digit growth and gradually slowing to a long-term trend rate of around 4 percent. Both enplanements and RPM are expected to recover to

2019 levels in 2023. Over the twenty-year period 2022-2042, Latin America enplanements are forecast to increase at an average rate of 5.8 percent a year while RPMs grow 6.2 percent a year.

Switching to the Pacific region, it is the smallest in terms of enplanements despite the economic growth and potential of air travel to the region's emerging markets. After falling in 2020 to 42.1 percent of 2019's level, enplanements fell further in 2021 to just 5.8 percent as many countries enforced stringent travel restrictions, especially China, a very large market in the region. RPM also collapsed by similar amounts. In 2022, enplanements and RPM are expected to come off the bottom and recover to about 20 percent of 2019 levels. Because many countries in the Pacific region have had relative success in controlling COVID-19 transmission, travel restrictions have been slow to lift, leading to the slow recovery in 2022 and in the medium term. Although initial growth is strong in percentage terms due to the low base, trend growth is comparatively slow. Consequently, enplanements take 7 years to fully recover to 2019's level and RPM reach that milestone in 2025. From FY2022-2025, Pacific enplanements and RPM are forecast to double each year on average, and in the long-term from FY2025-2042, grow at rates of 2.4 percent and 2.8 percent, respectively. Although the region is forecast to have the strongest economic growth of any region over the next 20 years, led by China and India, enplanements and RPMs over the period are restrained in part because U.S. carriers continue to provide a majority of their service in the region to Japan as opposed to faster growing countries.

The Atlantic region ranks in the middle between the other two, with pre-pandemic enplanements roughly twice those in the Pacific region and half those in the Latin region. After contracting in 2015 and 2016, Atlantic enplanements began rising to reach 7.0 percent growth in 2019. This growth was supported by U.S. demand as well as growth of Middle East and African markets, even as the European economies slowed in 2019. In 2020, like the other regions, Atlantic enplanements tumbled by 61.1 percent and then a further 47.1 percent in 2021 to bottom out at 21 percent of 2019's level. Subsequent percentage gains are large, returning enplanements to 2019 levels in 2024. The historical and forecast path for RPM is quite similar and for the medium-term from FY2022-2024, RPM grows at an average annual rate of 67 percent while enplanements grow at a rate of 71 percent. Although Western Europe is a mature area with moderate economic growth, the economically smaller Middle East and Africa areas are expanding rapidly with GDP growth rates more than twice that of Europe. As a result, a larger share of the forecast aviation demand in the Atlantic region is linked to those two areas, particularly in the second half of the forecast period. Over the forecast horizon from 2022 to 2042, enplanements and RPM in the Atlantic region are forecast to grow at an average annual rate of 10 percent.



Source: US Customs & Border Protection data processed and released by Department of Commerce; data also received from Transport Canada
* Per past practice, the Mid-East region and Africa are included in the Atlantic category.

Total passengers (including Foreign Flag carriers) between the United States and the rest of the world fell even more in 2020, and recovered less in 2021, than did U.S. carriers alone. Foreign carriers, without the relative strength of domestic markets for support, were forced to reduce capacity more and thereby sacrificed passenger traffic. Total passengers collapsed by an estimated 73.4 percent to 67 million in 2020 as all regions posted losses led by an 80.4 percent reduction in the Atlantic region. In 2021, the Latin American and Atlantic regions saw sizable growth from the previous year, while the Pacific and Canada Transborder regions saw further declines, and all regions remained well below 2019 levels.

FAA projects total international passenger growth of 79.7 percent in 2022 as global economic growth stabilizes and COVID-19 restrictions abate. The strongest passenger growth is expected in the Latin region and the slowest in the Pacific. Similar to growth rates of enplanements on U.S. carriers, total passenger growth rates in the early years of the forecast are high, returning passenger numbers to 2019 levels in 2024. Moderate global economic growth averaging 2.8 percent a year over the next 20 years (2022-2042) is the foundation for the forecast growth of international passengers of 7.7 percent a year, as levels increase almost five fold from 99 million in 2021 to 470 million in 2042.

The Atlantic and Latin American regions were of comparable size in 2019 but by the end of the forecast period the Latin American region counts about 20 percent more passengers and their growth paths differ. Atlantic growth is faster early on and slows relative to Latin American in later years, consistent with GDP forecasts. Over the 20-year forecast period (2022-2042), the Atlantic region grows at an average annual rate of 9.4 percent while Latin America grows at a rate of 5.1 percent. Although European markets in the Atlantic region are mature and relatively slow growing, other markets such as the Middle East and Africa boost overall growth in the region.

In the Pacific region, passenger levels in 2021 were just 10 percent of those in 2019 and combined with stringent COVID-19 travel restrictions and sluggish Japanese GDP growth that offsets some of the strong economic growth and rising incomes in China, India and South Korea, the outcome is a relatively slow return to 2019 passenger levels in 2028. From 2022 to 2042, passengers between the United States and the Pacific region are forecast to grow 13.8 percent a year.

Like the Atlantic region, Canada transborder is another mature market but is considerably smaller. It is projected to grow at an average rate of 12.6 percent over the forecast period, slightly faster than the Atlantic region. Total passenger counts return to 2019 levels in 2023, about the same as in the Latin America region.

System

System (the sum of domestic plus international) capacity contracted 35.9 percent to 791 billion ASMs in 2020 while RPMs plummeted 47.4 percent to 549 billion. During the same period, system-wide enplanements fell 44.3 percent to 511 million. Supported by domestic and Latin markets, activity began to recover in 2021 as ASM, RPM and enplanements expanded by 4.8 percent, 3.3 percent and 9.0 percent, respectively. In prior years, U.S. carriers had prioritized the domestic over the international market in terms of allocating capacity as the U.S. saw stronger economic growth than many regions around the world. And in 2020 and 2021, travel restrictions associated with COVID-19 caused this split to largely continue as domestic capacity was curtailed less than international: down 25.5 percent in 2021 from 2019 for domestic compared to down 51.4 percent for international. However, as U.S. carriers shift their focus to recovery, international capacity growth will outpace domestic, mainly because the international reductions in 2020 and 2021 were much more severe. Subsequent years through 2042 see carriers continue to expand capacity in international markets faster than domestic as the international markets see stronger income growth and the corresponding demand for travel.

U.S. mainline carrier enplanement growth in the combined domestic and international market was 8.2 percent in 2021 while regional carriers carried 12.1 percent more passengers – a difference explained by the greater reliance of mainline carriers on lagging international markets.

In the domestic market in 2019, mainline enplanements marked their ninth consecutive year of increases, a trend that was abruptly halted in 2020 with a decline of 43.7 percent, but followed by a 9.1 percent increase in

2021. Similarly, international mainline passengers had posted a tenth consecutive year of growth in 2019, a trend that was broken in 2020 with a 53.4 percent decline but, in contrast to the domestic side, was followed by a small 1.4 percent increase. Domestic mainline enplanement growth is forecast to accelerate in 2022, rising 30.0 percent as the recovery proceeds. Another year of strong growth in 2023 returns domestic enplanements to 2019 levels in that year. With the recovery complete, domestic enplanements resume growth driven by economic fundamentals and average 2.5 percent over the remainder of the forecast. International mainline enplanements follow a similar path with strong growth early in the recovery that slows as enplanements return to 2019 levels in 2024. From then through the end of the forecast in 2042, international enplanements are expected to grow at an average of 3.5 percent.

Although carriers cut capacity aggressively in 2020, the drop in traffic was even greater and system load factor fell from 84.5 percent in 2019 to 69.5 in 2020 and further to 68.5 in 2021 – a combined drop that far exceeded those following both 9/11 and the Great Recession. Load factor gradually recovers, returning close to its 2019 level in 2025.

Cargo

Air cargo traffic includes both domestic and international freight/express and mail. The demand for air cargo is a derived demand resulting from economic activity. Cargo moves in the bellies of passenger aircraft and in dedicated all-cargo aircraft on both scheduled and nonscheduled service. Cargo carriers face price competition from alternative shipping modes such as trucks, container ships, and rail cars, as well as from other air carriers.

U.S. air carriers flew 51.3 billion revenue ton miles (RTMs) in 2021, a large 16.9 percent increase from the previous year that raised RTM 19.7 above 2019's level. Domestic cargo RTMs increased 11.7 percent to 19.9 billion in 2021 while international RTMs expanded 20.4 percent to 31.4 billion. In comparison, for the decade ending in 2019, domestic RTM increased at an average rate of 3.2 percent and international grew at a 3.8 percent rate. The surge in 2020 and 2021 RTM was supported by consumers purchasing goods to enhance time spent at home as necessitated by the pandemic, and by surface transportation disruptions caused by worker shortages due to COVID-19 illnesses. Air cargo RTMs flown by all-cargo carriers averaged 78.7 percent of the total in the years leading up to 2020 but then spiked to 88.0 percent of total RTMs in 2020 and 2021, with passenger carriers flying the remainder. Total RTMs flown by the all-cargo carriers increased 12.3 percent in 2020 while total RTMs flown by passenger carriers fell by 37.8 percent but in 2021, both all-cargo and passenger carriers saw increases of about 17 percent. Although many passenger carriers reconfigured aircraft to accommodate more cargo, the sheer drop in passenger flights in 2020 outweighed that increase, resulting in the steep drop of passenger carrier RTM. As passenger flights return, the share of cargo on all-cargo carriers will ease, dropping from 88 percent in 2021 to about 82 percent in 2025.

U.S. carrier international air cargo traffic spans four regions consisting of Atlantic, Latin, Pacific, and 'Other International.'

Historically, air cargo activity tracks with GDP. Other factors that affect air cargo growth are fuel price volatility, movement of real yields, globalization and trade.

The forecasts of revenue ton miles rely on several assumptions specific to the cargo industry. First, security restrictions on air cargo transportation will remain in place. Second, most of the shift from air to ground transportation has occurred. Finally, long-term cargo activity depends heavily on economic growth.

The forecasts of RTMs derive from models that link cargo activity to GDP. Forecasts of domestic cargo RTMs use real U.S. GDP as the primary driver of activity. Projections of international cargo RTMs depend on growth in world and regional GDP, adjusted for inflation. FAA forecasts the distribution of RTMs between passenger and all-cargo carriers based on an analysis of historic trends in shares, changes in industry structure, and market assumptions.

After increasing by 16.9 percent in 2021, total RTMs are expected to grow 2.5 percent in 2022. Because of steady U.S. and world economic growth in the long term, FAA projects total RTMs to increase at an average annual rate of 3.2 percent over the forecast period (from 2022 to 2042).

Following the surge in 2021, domestic cargo RTMs are projected to moderate in subsequent years as the boost from the pandemic fades. Between 2022 and 2042, domestic cargo RTMs are forecast to increase at an average annual rate of 2.6 percent. In 2021, all-cargo carriers carried 93.4 percent of domestic cargo RTMs. The all-cargo share is forecast to decline modestly to about 92 percent in the medium-term as passenger flights return to the system. In the long-term, the all-cargo share rises only slightly to 92.7 percent by 2042 based on increases in capacity for all-cargo carriers.

International cargo RTMs 20.4 percent surge in 2021 dissipates in 2022 as surface transportation snarls are resolved. As with domestic markets, RTM carried by all-cargo carriers grew strongly in 2020 while that transported by passenger carriers fell even more sharply, but by 2021 both types grew again. With the post-pandemic return of passenger flights, RTM on passenger aircraft is expected to grow rapidly, increasing about 18 percent per year from 2022 to 2024. Over the same period, all-cargo RTM is roughly flat as some tonnage is lost to passenger carriers in 2022. Following the period of recovery, growth for both types of carriers returns to long-run trend rates. For the forecast period (2022-2042), international cargo RTMs are expected to increase an average of 3.6 percent a year based on projected growth in world GDP with the Pacific International region having the fastest RTM growth (4.0 percent), followed by Other (3.5 percent), Atlantic (3.3 percent), and Latin America region (2.1 percent).

The share of international cargo RTMs flown by all-cargo carriers was 84.6 percent in 2021 and is forecast to decline steadily during the recovery period before gradually increasing in line with historical trends and ending at 80.3 percent in 2042.

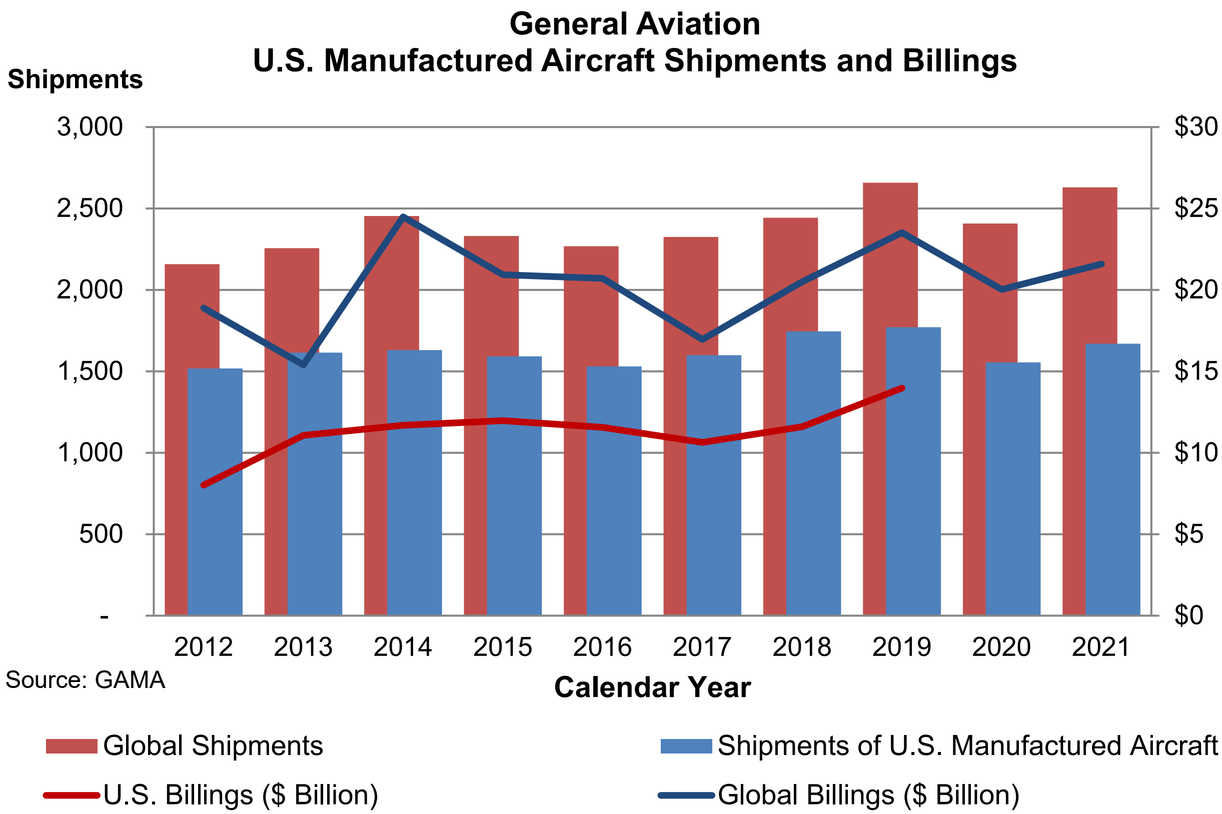
General Aviation

The FAA uses estimates of fleet size, hours flown, and utilization rates from the General Aviation and Part 135 Activity Survey (GA Survey) as baseline figures to forecast the GA fleet and activity. Since the survey is conducted on a calendar year (CY) base and the records are collected by CY, the GA forecast is done by CY. Forecasts of new aircraft deliveries, which use the data from General Aviation Manufacturers Association (GAMA), together with assumptions of retirement rates, generate growth rates of the fleet by aircraft categories, which are applied to the GA Survey fleet estimates. The forecasts are carried out for "active aircraft,"[4] not total aircraft. The FAA's general aviation forecasts also rely on discussions with the industry experts conducted at industry meetings, including Transportation Research Board (TRB) meetings of Business Aviation and Civil Helicopter Subcommittees conducted twice a year in January and June.

The results of the 2020 GA Survey, the latest available, were consistent with the results of surveys conducted since 2004 improvements to the survey methodology. The active GA fleet was estimated to be 204,140 aircraft in 2020 (3.2 percent decline from 2019), as increases in fixed wing turbine were more than offset by decreases in pistons, rotorcraft, lighter-than-air and light sport aircraft (LSA), and experimental aircraft. Total hours flown were estimated to be 22.5 million in 2020, down 12.0 percent from 2019. Decreases were across the board, with the highest absolute decline in fixed wing piston hours (10.3 percent), and highest percentage decline in lighter than air aircraft (44.6 percent) and glider activity (28.7 percent), followed by rotorcraft hours (19.6 percent).

In 2021, deliveries of the general aviation aircraft manufactured in the U.S. increased to 1,670, 7.4 percent higher than in CY 2020 (still 5.7 percent lower than the 2019 level, but has been improving). Deliveries of single-engine piston aircraft were up 2.3 percent, while the much smaller segment of multi-engine piston deliveries were down by 51.6 percent (summing to a 0.5 percent increase in the fixed engine piston deliveries). Business jet deliveries increased by 14.7 percent and turboprop deliveries were up 18.6 percent, amounting for a 16.6 percent increase in fixed wing turbine shipments. While the GAMA statistics for factory net billings were not available yet for the U.S. manufactured GA aircraft, global billings increased in 2021 by 7.7 percent to $21.6 billion.

[4] An active aircraft is one that flies at least one hour during the year.



GAMA also reported the rotorcraft deliveries increased at a global level in 2021 in both piston and turbine segments by 27.5 percent and 13.8 percent, respectively.

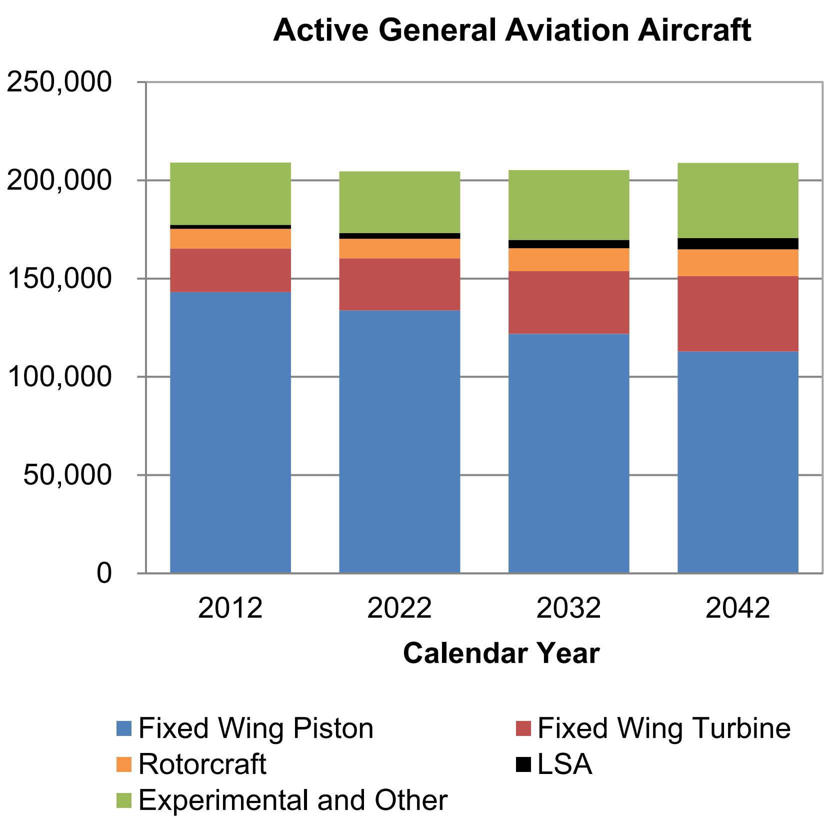
Against these current conditions, we expect the GA sector, which was not as severely affected by the pandemic as the airlines, to recover sooner to its 2019 levels by aircraft type than the other sectors. Then, the long-term outlook for general aviation, driven by turbine aircraft activity, remains stable. The active general aviation fleet, which showed a decline of 3.2 percent between 2019 and 2020, is projected to increase from its 2021 level of 204,405 aircraft to 208,905 by 2042, as the declines in the fixed-wing piston fleet were offset by increases in turbine, rotorcraft, experimental, and light sport fleets. The total active general aviation fleet grows by a small increase of 0.1 percent annually. When measured from pre-COVID-19 levels in 2019, the active GA fleet of 210,981 experiences an annual decline of 0.04 percent on average.

The more expensive and sophisticated turbine-powered fleet (including rotorcraft) is projected to grow by 15,750 aircraft between 2021 and 2042 to total 46,060 in 2042, an average rate of 1.9 percent a year during this period, with the turbojet fleet increasing 2.6 percent a year. When measured from the 2019 levels, the growth rate for the turbine-powered fleet is 1.8 percent. The growth in U.S. GDP and corporate profits are catalysts for the growth in the turbine fleet.

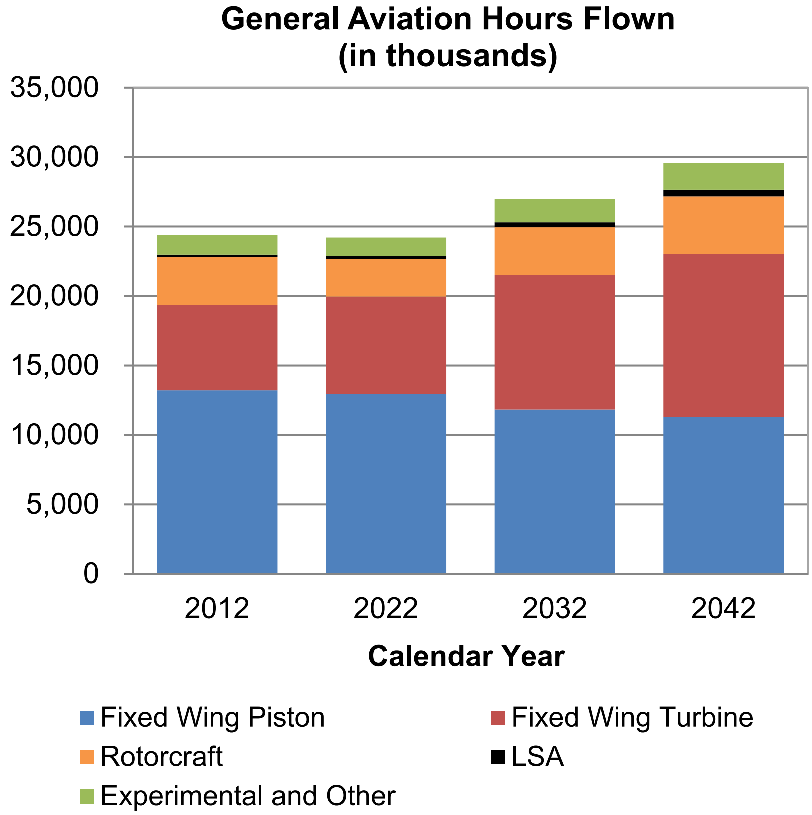
The largest segment of the fleet, fixed wing piston aircraft, is predicted to shrink over the by 22,055 aircraft between 2021 and 2042, an average annual rate of -0.8 percent.

When measured from the 2019 fleet of 141,396 in 2019, the annual decline averages 1.0 percent. Unfavorable pilot demographics, overall increasing cost of aircraft ownership, availability of much lower cost alternatives for recreational usage, coupled with new aircraft deliveries not keeping pace with retirements of the aging fleet are the drivers of the decline.

On the other hand, the smallest category, light-sport-aircraft (created in 2005), is forecast to grow by 3.5 percent annually, adding about 2,890 new aircraft by 2042, doubling its 2019 fleet size of 2,675.



Although the total active general aviation fleet is projected to marginally increase, the number of general aviation hours flown is forecast to increase an average of 1.1 percent per year through 2042, from 22.5 million in 2020 to 29.6 million, as the newer aircraft fly more hours each year. Fixed wing piston hours are forecast to decrease by 0.6 percent, at a slightly lower rate than that of the fleet decline. Countering this trend, hours flown by turbine aircraft (including rotorcraft) are forecast to increase 3.2 percent yearly between 2020 and 2042. Jet aircraft are expected to account for most of the increase, with hours flown increasing at an average annual rate of 3.8 percent between 2021 and 2042. The large increases in jet hours result mainly from the increasing size of the business jet fleet.



Rotorcraft activity, which was not as heavily impacted by the pandemic conditions as most of the other aircraft categories, had been facing the challenges brought by lower oil prices, a trend currently moving in the opposing direction. By the time this forecast was completed, it was too early to include the most recent changes. The low oil prices impacted utilization rates and new aircraft orders both directly through decreasing activity in oil exploration, and also through a slowdown in related economic activity. The active fleet of rotorcraft is projected to grow at a faster rate than the previous year's forecast, driven by higher growth in the turbine segment, going from a total of (piston and turbine together) 9,746 in 2020 to 13,530 in 2042. Rotorcraft hours are projected to grow by 2.2 percent annually between 2021 and 2042.

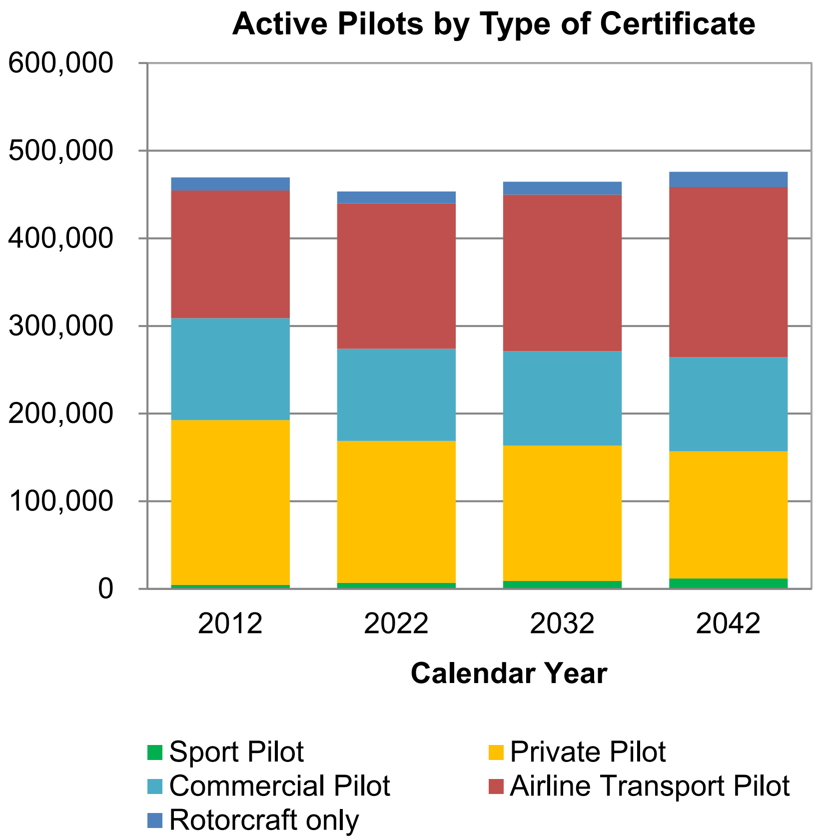
Lastly, the light sport aircraft category is forecasted to see an increase of 3.9 percent a year in hours flown, primarily driven by growth in the fleet.

The FAA also conducts a forecast of pilots by certification categories, using the data compiled by the Administration's Mike Monroney Aeronautical Center. There were 720,605 active pilots certificated by FAA at the end of 2021. The number of certificates in some pilot categories continued to increase, while there were different rates of declines in the rotorcraft only, ATP, and recreational certificates. The FAA suspended the student pilot forecast since 2018. The number of student pilot certificates has been affected by a regulatory change that went into effect in April 2016 and removed the expiration date on the new student pilot certificates. The number of student pilots jumped from 128,501 at the end of 2016 to 149,121 by the end of 2017, and to 250,197 at the end of 2021. The 2016 rule change generates a cumulative increase in the certificate numbers and breaks the link between student pilot and advanced certificate levels of private pilot or higher. There is no sufficient data yet to perform a reliable forecast for the student pilots.

Commercial and air transport pilot (ATP) certificates have been impacted by a legislative change as well. The Airline Safety and Federal Aviation Administration Extension Act of 2010 mandated that all part 121 (scheduled airline) flight crew members would hold an ATP certificate by August 2013. Airline pilots holding a commercial pilot certificate and mostly serving at Second in Command positions at the regional airlines could no longer operate with only a commercial pilot certificate after that date, and the FAA data initially showed a faster decline in commercial pilot numbers, accompanied by a higher rate of increase in ATP certificates. The number of both commercial pilot and ATP certificates had increased until 2012 for three years. Commercial pilot certificate holders continued to increase in 2021 to 104,610. Significantly reduced number of flights and a large number of parked aircraft due to the pandemic generated an overcapacity for the ATPs employed by the airlines, despite government support to the aviation sector. Consequently, the number of pilots holding an ATP certificate declined in 2021 for the second year in a row, to 163,934 (still higher than the 2018 level), after growing every year since 2011.

Private pilots increased in 2021, from 160,860 to 161,459, to a level higher than where they were in 2019, after a slight decline in 2020. Sport pilot certificates, created in 2005, kept their steady increase since their inception to reach 6,801 by December 31, 2021. Rotorcraft pilots continued their decline since 2016 to end up with 13,191 by the end of 2021.

The number of active general aviation pilots (excluding students and ATPs) is projected to remain flat between 2021 and 2042 at around 306,400. The ATP category is forecast to increase by 30,360 (up 0.8 percent annually). The much smaller category of sport pilots are predicted to increase by 2.7 percent annually over the forecast period. Commercial pilot certificates, which has been on an increase for five consecutive years, are projected to increase at an average annual rate of 0.1 percent between 2021 and 2042. On the other hand, private pilot certificates are projected to decrease at an average annual rate of 0.6 percent over the forecast horizon.


Active Pilots by Type of Certificate
600,000
500,000
400,000
300,000
200,000
100,000
0
2012
2022
2032
2042
Calendar Year
Sport Pilot
Private Pilot
Commercial Pilot
Airline Transport Pilot
Rotorcraft only

FAA Operations

The traffic at FAA facilities underwent drastic changes during the period of 2019 and 2020 from the COVID-19 impact. Activity recovered a modest 7.4percent from 44.4 million in 2020 to 47.7 million in 2021, following the 16.7 percent decline from 53.3 million in 2019 to 44.4 million in 2020. The limited recovery was partially due to the fact that FY 2020 includes 5 months of pre-pandemic data. Going forward, the pace of recovery accelerated starting in early spring of CY 2021, and continued in the winter months of CY 2021 and CY 2022 despite the fourth wave of COVID-19 driven by the Delta variant. Elevated growth is predicted to last until around 2023 and 2024 as the unemployment rate is forecast to reach the pre-pandemic level around that time.

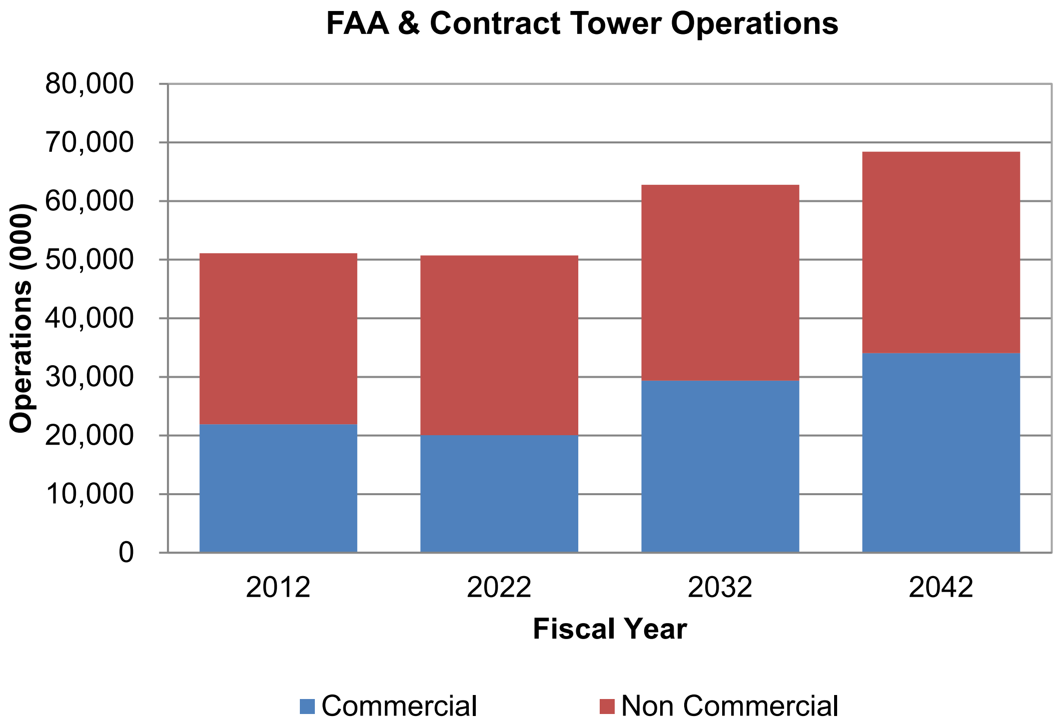
After operations return to pre-pandemic levels, the longer term economic health along with the growth in air travel demand and the business aviation fleet will drive the long term growth in operations at FAA facilities over the rest of the forecast period. Activity at FAA towers and contract towers is forecast to increase at an average rate of 1.5 percent a year through 2042 from 50.7 million in 2022 to close to 68.4 million in 2042. The 1.5 percent annual growth forecast is lower than the 1.9 percent forecast for 2021-2041 last year mainly due to the shorter recovery time from COVID-19. Commercial operations[5] at these facilities are forecast to increase 2.7 percent a year, approximately five times faster than non-commercial operations. The growth in commercial operations is less than the growth in U.S. airline passengers (2.7 percent versus 3.8 percent) over the forecast period due primarily to larger aircraft (seats per aircraft mile) and higher load factors. Both of these trends allow U.S. airlines to accommodate more passengers without increasing the number of flights.

General aviation operations are forecast to increase an average of 0.6 percent a year as increases in turbine powered activity more than offset declines in piston activity. General aviation operations accounted for 57 percent of operations in 2021. The share has been increasing since the pandemic, from 51 percent in 2019 to 56 percent in 2020, and 57 percent in 2021. This occurs because the decline of general aviation traffic was relatively mild during the pandemic and the recovery speed has been very swift.

The growth in operations at towered airports is not uniform. Most of the activity at large and medium hubs[6] is commercial in nature, given that these are the airports where most of the passenger enplanements in the U.S., about 87 percent in 2021, are reported.

[5] Commercial operations include air carrier and commuter/air taxi operations.

[6] A large hub is defined to have 1 percent or more of total U.S. revenue passenger enplanements in FY 2021. A medium hub is defined to have at least 0.25 percent but less than 1 percent of total U.S. revenue passenger enplanements. In the 2021 TAF there were 29 large hub airports and 34 medium hub airports.



Given the growth in airline demand and most of that demand is at large and medium hubs, activity at the large and medium hubs is forecast to grow substantially faster than small towered airports including small FAA towers[7] and FAA contract towers[8]. The forecasted annual growth is 3.0 percent at large hubs, 2.4 percent at medium hubs, 0.9 percent at small FAA towers, and 0.7 percent at FAA contract towers between 2022 and 2042.

Among the 29 large hubs, the airports with the fastest long term annual growth forecast are those located along the coastal sections of the country where most large cities are located. Large cities have historically shown to generate robust economic activity, which in turn drives up the airline demand. On the other hand, the airports forecast to have slower long term annual growth tend to be located in the middle of the country. In terms of COVID-19 recovery, the airports with mostly domestic traffic and the ones located at popular leisure destinations are forecast to have shorter recovery timeline.

FAA Tracon (Terminal Radar Approach Control) Operations[9] are forecast to grow slightly

[7] Small FAA towers are defined as towered airports that are neither large or medium hubs nor FAA contract towers.
[8] FAA contract towers are air traffic control towers providing air traffic control services under contract with FAA, staffed by contracted air traffic control specialists.

[9] Tracon operations consist of itinerant Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) arrivals and departures at all airports in the domain of the Tracon as well as IFR and VFR overflights.

faster than at towered facilities. This is in part a reflection of the different mix of activity at Tracons. Tracon operations are forecast to increase an average of 1.9 percent a year between 2022 and 2042. Commercial operations accounted for approximately 52 percent of Tracon operations in 2021 and are projected to grow 2.6 percent a year over the forecast period. General aviation activity at these facilities is projected to grow only 0.5 percent a year over the forecast.

The number of IFR aircraft handled is the measure of FAA En-Route Center activity. Growth in airline traffic and domestic leisure aviation is expected to lead to increases in activity at En-Route centers until the business aviation sector recovers. Over the forecast period, aircraft handled at En-Route centers are forecast to increase at an average rate of 2.7 percent a year from 2022 to 2042, with commercial activity growing at the rate of 3.1 percent annually. Activity at En-Route centers is forecast to grow faster than activity at towered airports and FAA Tracons because more of the activity at En-Route centers is from the faster growing commercial sector and high-end (mainly turbine) general aviation flying.[10] In 2021, the share of commercial IFR aircraft handled at FAA En-Route centers is about 78 percent, which is greater than the 52 percent share at Tracons or the 38 percent share at FAA and Contract Towers.

[10] Much of the general aviation activity at towered airports, which is growing more slowly, is local in nature, and does not impact the centers.

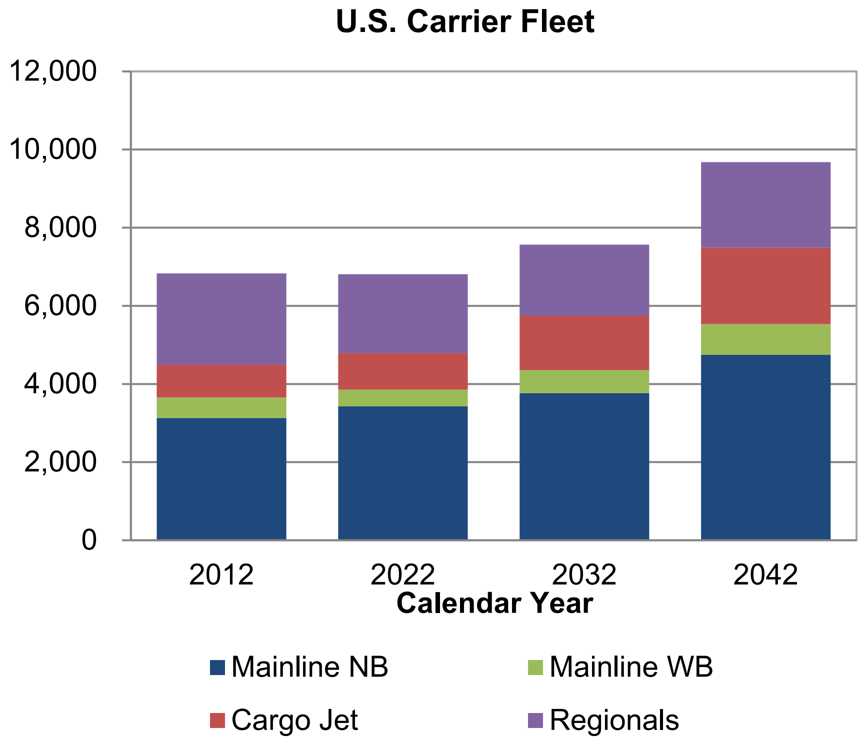
U.S. Commercial Aircraft Fleet

After arresting the Pandemic shrinkage and posting a very moderate -1.2% in 2020-21 (a decrease of 69 aircraft), the number of aircraft in the U.S. commercial fleet is forecast to increase from 5,815 in 2021 to 8,894 in 2042, an average annual growth rate of 2.0 percent a year. The continued recovery in demand from the COVID-19 downturn along with long-term post-COVID increases in demand for air travel and growth in air cargo is expected to fuel increases in both the passenger and cargo fleets.

Between 2021 and 2042 the number of jets in the U.S. mainline carrier fleet is forecast to grow from 3,132 to 5,532, a net average of 114 aircraft a year as carriers continue to remove older, less fuel efficient narrow body aircraft. As the industry recovers from the COVID-19 downturn, many aircraft that were temporarily parked are returning to the fleet, resulting in a large increase in the fleet (approximately 152 aircraft per year) out to 2026 and then slower rates thereafter. The narrow-body fleet (including E-series aircraft as well as A220-series at JetBlue and A220-series at Delta) is projected to grow 91 aircraft a year as carriers replace current technology 737 and A320 family aircraft with the next generation MAX and Neo families. The wide-body fleet grows by an average of 24 aircraft a year as carriers add 777-8/9, 787's, A350's to the fleet while retiring 767-300/400 and 777-200 aircraft. In total the U.S. passenger carrier wide-body fleet increases by 5.0 percent a year over the forecast period.

The regional carrier fleet is forecast to increase from 1,807 aircraft in 2021 to 2,187 in 2042 as the fleet expands by 0.9 percent a year (18 aircraft) between 2021 and 2042. Carriers remove 50 seat regional jets and retire older small turboprop and piston aircraft, while adding 70-90 seat jets, especially the E-2 family after 2021. By 2030 only a handful of 50 seat regional jets remain in the fleet. By 2042, the number of jets in the regional carrier fleet totals 1,979, up from 1,406 in 2021. The turboprop/piston fleet is forecast to shrink by 48% from 401 in 2021 to 208 by 2042. These aircraft account for 9.5 percent of the fleet in 2042, down from 22.2 percent in 2021.

The cargo carrier large jet aircraft fleet is forecast to increase from 876 aircraft in 2021 to 1,959 aircraft in 2042 driven by the growth in freight RTMs. The narrow-body cargo jet fleet is projected to increase by 19 aircraft a year as 737-800/900MAX's are converted from passenger use to cargo service. The wide body cargo fleet is forecast to increase 32 aircraft a year as new 777-8/10 and converted 767-300 aircraft are added to the fleet, replacing older MD-11, A300/310, and 767-200 freighters.


U.S. Carrier Fleet
12,000
10,000
8,000
6,000
4,000
2,000
0
2012
2022
2032
2042
Calendar Year
Mainline NB
Mainline WB
Cargo Jet
Regionals

Commercial Space

The FAA's Office of Commercial Space Transportation (AST) licenses and regulates U.S. commercial space launch activities including launch and reentry of vehicles and operation of non-federal launch and reentry sites authorized by Executive Order 12465 and Title 51 U.S. Code, Subtitle V, Chapter 509 (formerly the Commercial Space Launch Act). Title 51 and the Executive Order also direct the U.S. Department of Transportation to encourage, facilitate, and promote U.S. commercial launches. The FAA's mission is to license and regulate commercial launch and reentry operations and non-federal launch sites to protect public health and safety, the safety of property, and the national security and foreign policy interests of the United States.

The FAA licenses launches or reentries carried out inside the U.S. and by U.S. persons (which includes U.S. corporations) inside or outside the United States. The FAA does not license launches or reentries the U.S. Government carries out for the Government (such as those owned and operated by National Aeronautics and Space Administration (NASA) or the Department of Defense). Amateur-class rockets do not require a FAA license or permit[11].

To accomplish its mission, the FAA performs the following major functions:

- Maintains an effective regulatory framework for commercial space transportation activities,
- Provides guidance to prospective commercial operators on how to comply with regulatory requirements for obtaining an authorization and operating safely,
- Evaluates applications for licenses, experimental permits, and safety approvals for launch and reentry operations and related commercial space transportation activities,
- Evaluates applications for licenses for launch and reentry site operations,
- Monitors and enforces regulatory compliance through safety inspections of launches, reentries, sites, and other regulated commercial space activities,
- Provides U.S. Government oversight of investigations associated with the mishap of an FAA authorized launch or reentry,
- Facilitates the integration of commercial space launch and reentry operations into other modes of transportation including the National Airspace System (NAS) by establishing appropriate hazard areas and limits to ensure the protection of the public,
- Coordinates research into the safety, environmental, and operational implications of new technologies and the evolving commercial space transportation industry,

[11] Per 14 CFR Chapter 1, Part 1, section 1.1: Amateur rocket means an unmanned rocket that is propelled by a motor or motors having a combined total impulse of 889,600 Newton-seconds (200,000 pound-seconds) or less; and cannot reach an altitude greater than 150 kilometers above the earth's surface.

- Conducts outreach to the commercial space industry by hosting working groups and conferences,
- Collaborates with Government partners, such as the Department of Defense and NASA to assure consistent approaches to regulations, policy, and standards, and
- Conducts outreach to international counterparts to promote the U.S. regulatory framework across the world.

In addition to AST headquarters offices in Washington, D.C., AST maintains staff with assigned duty locations near active launch ranges to facilitate communication with space launch operators and to implement FAA's regulatory responsibilities more efficiently. AST personnel are currently assigned to duty locations in close proximity to: Kennedy Space Center and Cape Canaveral Space Force Station in Florida; Johnson Space Center in Texas; and, Vandenberg Air Force Base and the Mojave Air and Space Port in California. FAA also directly supports NASA's commercial space initiatives by providing on-site staff at both the Johnson Space Center and Kennedy Space Center to coordinate the FAA's regulatory and compliance activities with NASA's development and operational requirements for commercial space.

Regulatory Safety Oversight Activities of FAA

The business cycle from the time a firm first contacts FAA until the last launch of a licensed operation can be several years. There are many activities performed by FAA during this cycle. The most notable activities are described here.

Pre-Application Consultation for Licenses, Experimental Permits, and Safety Element Approvals

Prospective applicants seeking commercial space transportation licenses, experimental permits, or safety approvals are required by regulation to consult with FAA before submitting their applications. During this period, FAA assists them in identifying potential obstacles to authorization issuance and determining potential approaches to regulatory compliance. In addition, many new operators are seeking to incorporate new technologies, vehicle types, or operational models creating opportunities for FAA to assist in determining the applicable regulations or approach to regulatory compliance.

Licenses, Permits, and Safety Element Approvals

FAA authorizes commercial space transportation activities via the issuance of licenses, permits, and safety element approval. Though many licenses authorize multiple launches (for mature launch systems), the need remains for FAA to also issue individual launch licenses for systems that are still maturing towards a high level of reliability. Furthermore, with the dynamic commercial space industry, FAA often evaluates launch and reentry systems and operations that are evolving and changing, which may ultimately require license modifications or issuance of new licenses.

Inherent in the review process is the requirement to conduct policy reviews and payload reviews. When conducting a policy review, FAA determines whether the proposed launch, reentry, or site operation presents any issues that would jeopardize public health and safety or the safety of property, adversely affect U.S. national security or foreign policy interests, or be inconsistent with international obligations of the United States. If not otherwise exempt from review, FAA reviews a payload proposed for launch or reentry to determine whether the payload would jeopardize public health and safety, the safety of property, U.S. national security or foreign policy interests, or the international obligations of the United States. The policy and/or payload determination becomes part of the licensing record on which FAA's licensing determination is based.

FAA reviews and issues launch and reentry site operator licenses and license renewals. FAA also reviews and evaluates launch site license applications for launch sites located in foreign countries but operating with U.S.-licensed launch or reentry systems. FAA coordinates planning among Federal, state, and local governments and with the commercial range operators or users. As part of the evaluation of applications for launch licenses, reentry licenses, and site operator licenses, FAA also conducts environmental reviews consistent with its responsibilities under the National Environmental Policy Act.

FAA anticipates issuing a growing number of safety element approvals for space launch systems equipment, processes, technicians, training and other supporting activities. FAA reviews, evaluates, and issues safety approvals to support the continued introduction of new safety systems, safety operations applications, and safety approval renewal applications.

Safety Analyses

FAA conducts flight safety, system safety, maximum probable loss, and explosive safety analyses to support the evaluation and issuance of licenses and permits. FAA also evaluates and analyzes the performance of safety-critical space flight personnel to determine how they affect public safety risk. In the near future, as commercial firms become more involved with human space flight activity, AST and the FAA's Office of Aerospace Medicine may evaluate, analyze, and determine the health risks to the space flight participants (crew and space flight participants) due to natural and flight-induced launch and reentry environments, as well as any hazardous ground operations directly associated with the flight.

Inspections and Enforcement

FAA currently conducts as many as 330 preflight/ reentry, flight/ reentry, and post-flight/ reentry safety inspections per year. Inspections often occur simultaneously at any of the 12 licensed U.S. and international commercial space launch sites, as well as at 4 Federal launch ranges and 3 exclusive-use launch sites. The establishment of non-federal launch sites requires additional inspections in areas such as ground safety that have traditionally been overseen by the U.S. Air Force (now the U.S. Space Force) at Federal ranges. At spaceports and launch sites with high launch rates (e.g., Cape Canaveral Space Force Station, Vandenberg Air Force Base, the Mid-Atlantic Regional Spaceport, and Spaceport America), at least 80 percent of inspections are typically conducted by locally-based field inspectors. Additionally, as a result of the COVID-19 pandemic, many inspections in fiscal year (FY) 2020 were handled remotely. FAA will leverage this approach in the upcoming years in order to respond to a dynamic operational tempo, minimize cost, and increase efficiency.

Mishap Investigations

Mishap events have demonstrated that FAA needs to have the capacity to oversee the investigation of at least two space launch or reentry mishaps or accidents simultaneously anywhere in the world, and to lead/oversee as many as nine investigations during a single year. FAA anticipates an increase in mishaps with new operators coming online. FAA reviews all applicant mishap plans and accident investigation procedures as part of the license and permit evaluation process.

NAS Integration

AST works in partnership with all FAA lines-of-business, notably the Air Traffic Organization (ATO) and Office of Airports (ARP) to support the safe and efficient integration of commercial launch and reentry operations through the NAS and its system of airports and air traffic managed by the ATO. AST expects an increased level of interaction with the ATO, ARP, and the FAA Office of NextGen (ANG). Further, AST works with the ATO as FAA develops technologies to facilitate safe and efficient integration of commercial launch and reentry operations through the NAS, including technologies to improve the integration of launch and reentry data into FAA air traffic control systems and technologies to improve the timely and accurate development and distribution of notices of aircraft hazard areas.

FAA's Launch and Reentry Operations Forecast

FAA's 5-year launch and reentry operations forecast relies on data collected from operators and prospective applicants as the starting point for its launch and reentry forecasts, tying launch and reentry forecasts directly to anticipated operations by commercial space transportation firms known to FAA. As commercial space activity is still a highly dynamic and rapidly evolving industry, FAA's forecasting methodology continues to take a conservative view of industry growth by using historical launch activity data to establish better forecasting parameters for both new applicants and existing operators.

There are several factors that magnify the challenges associated with predicting the number of launches and reentries to expect in a given year. They include:

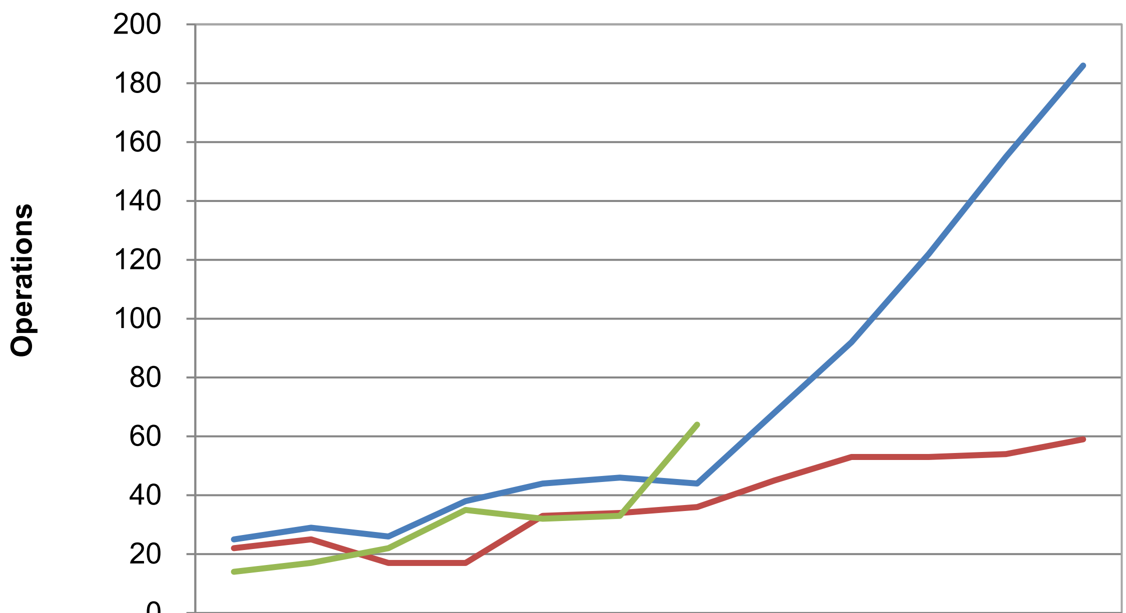
- list of firms intending to launch or actually launch is dynamic,
- continued development of new technologies,
- launch rates for reusable launch vehicles,
- commercial human spaceflight by both government astronauts and private citizens,
- dynamic nature of flight test programs, and
- mishaps.

New technologies [e.g., reusable launch vehicles (RLVs)] allow a faster operational tempo, and at the same time, early use of these technologies can increase the probability of a mishap. A mishap can drastically impact launch plans for one or more firms. Investigations and subsequent "return to flight" for firms impacted by a mishap can take months. FY2022 forecast data was collected in January 2022 and finalized in March 2022. The forecast can be considered a first quarter correction to previous forecast numbers.

However, there are reasons for optimism around the future of space activity moving forward. Space data, products, and services provide tangible benefits and economic opportunity to the American people as well as people all over the world. Firms are motivated towards new technology that is expected to increase launch cadences year over year. Interest and demand for space tourism as well as demands for placement of satellites and other equipment is anticipated to grow with each successful space mission. Likewise, as launch/reentry activities increase investment opportunities are also expected to grow. FAA has licensed approximately 525 launch/reentries since 1989, with 24% or 127 launch/reentries occurring in just the past three years (FY2018-2021). FY2021 actuals were the highest in U.S. history at 64, accounting for 12% of the activity since 1989.

FAA is forecasting launch and re-entry activity to increase from a low-high range of 45-68 in FY2022 to a low-high range of 59-186 by FY2026. Much of this increase is attributable to the lineup of reusable vehicles and the expectation for increased human space exploration. Taking these factors into account, the following table and graph provide FAA's forecasts through 2026, as well as historical activity.

Number of FAA Licensed and Permitted Operations by Fiscal Year, World-wide



	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026
Forecast High	25	29	26	38	44	46	44	68	92	122	155	186
Forecast Low	22	25	17	17	33	34	36	45	53	53	54	59
Actual	14	17	22	35	32	33	64					

It is important to note all FAA-authorized commercial space operations are included in this forecast, regardless of where they occurred in the world. That is, not all launch and reentry activity occurs at one location, for example, at Cape Canaveral, Florida. In the past year, FAA licensed launches and reentries throughout the world, including multiple reentries in the Pacific and Atlantic Oceans and six licensed launches from New Zealand. This forecast, however, does not include launch activity not authorized by the FAA (e.g. U.S. Department of Defense or non-commercial NASA launches), launch activity for other nations, and this forecast is not tied exclusively to satellite demand.

Additional Factors Affecting Forecast Accuracy

Commercial space transportation is a rapidly evolving industry. The industry's growth through technological innovation and the development of new markets increases the challenges associated with forecasting commercial space transportation operations.

New Commercial Launch Technologies and Operations are Emerging Rapidly

The commercial space transportation industry is exploring a variety of new technologies and new approaches to space launch and reentry. In late 2015, both Blue Origin and Space Exploration Technologies Corp. (SpaceX) successfully demonstrated the reusability of their vertically launched rockets. Both companies are now developing a new generation of much larger orbital vehicles that will launch and land in a vertical configuration. By May 2021, SpaceX had successfully recovered 10 flown boosters, and planned to continue this trend in 2022. While these new orbital-class vehicles are expected to lead to increases in the number of annual launch and reentry operations over the next four years, if the trend is realized, greater increases may continue in the future, as the upper end of the forecast shows in fiscal years 2023 through 2026. Other U.S. commercial entities are also pursuing the development of reusable launch vehicles (RLVs). At the same time, state and local governments are joining with commercial firms to promote additional launch and reentry sites, and some firms are seeking to establish launch sites for their exclusive use. This added launch capacity sets the stage for simultaneous operations and an increase in the number operations per year.

New Markets for Commercial Space Transportation Continue to Emerge

The continuing development of commercial space transportation technology has spurred new markets for commercial space transportation services. As the commercialization of space flight demand increases on suborbital and orbital launches, new and reusable vehicles are emerging. With SpaceX and Blue Origin leading the way for reusable rocket development, there are a number of other private companies following suit. The introduction of reusable rockets is a significant cost reducer and thereby encourages more exploration into space.

States and municipalities have sought to open new spaceports to attract commercial space transportation and associated high-tech firms and create technology hubs for research and development. In 2021, Blue Origin flew its first crewed mission into space. Since 2008, NASA has managed the Commercial Resupply Services (CRS) program, which acquires transportation services from commercial providers to deliver cargo to and from the International Space Station (ISS). In 2020 and 2021, SpaceX successfully transported NASA astronauts to the International Space Station. Boeing continues to work on its vehicle for NASA's crewed mission. The commercial vehicles used by NASA for cargo and crew transportation will have other commercial applications that increase the capabilities of the commercial space transportation industry as a whole.

Looking further afield, there are several companies in the regulatory pipeline seeking authority to land commercial vehicles on the Moon, establish private-sector space stations, service satellites on-orbit, and establish launch sites using non-traditional technologies like railguns and tube launchers. Additional FAA resources may be needed to determine how these unprecedented commercial space ventures will impact public safety and U.S. national interests.

Unmanned Aircraft System

Unmanned Aircraft Systems or Drones

Drones have been experiencing healthy growth in the United States and around the world over the past few years. The last two years have been no exception, despite the profound impact of COVID-19 on the overall economy.[12] A drone consists of a remotely-piloted aircraft and its associated elements—including the control station and the associated communication links—that are required for safe and efficient operation in the national airspace system (NAS). The introduction of drones in the NAS has opened up numerous possibilities, especially from a commercial perspective. That introduction has also brought operational challenges including drones' safe and secure integration into the NAS. Despite these challenges, the drone sector holds enormous promise; potential uses range from individuals flying solely for recreational purposes to large companies delivering commercial packages and delivering medical supplies. Public service uses, such as conducting search and rescue support missions following natural disasters, are proving promising as well.

This section provides a broad overview covering recreational and commercial (or part 107) unmanned aircraft and their recent trends, as gathered from trends in registration, surveys, overall market, and operational information.[13] Using these trends and insights from industry, the FAA produces a number of forecasts. Forecasts reported in the following sections are driven primarily by the assumptions of the continuing evolution of the regulatory environment, the commercial ingenuity of manufacturers and operators, persistent recreational uses, and underlying demand for drone services.

Trends in Recreational/Model Aircraft New Registration

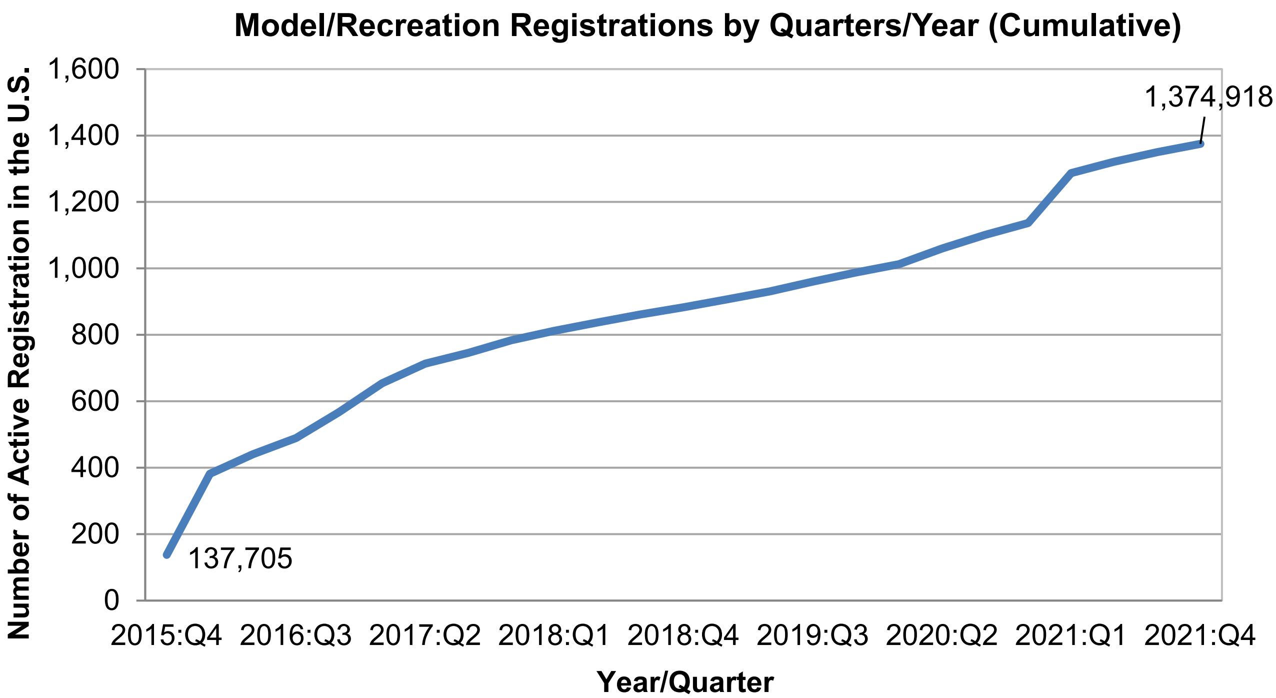
The FAA's online registration system for recreational/model small drones went into effect on December 21, 2015. This required all drones weighing more than 0.55 pounds (or 250 grams) and fewer than 55 pounds (or 25 kilograms) to be registered using the on-line system [www.faa.gov/uas/getting_started/register_drone/] or the existing

[12] Drone, model aircraft, and unmanned aircraft systems are often used interchangeably, both in common and legal terms. Although some communities differentiate between these terms, the three terms are used interchangeably in this document.

[13] Recreational and commercial drones are also called, interchangeably, hobby and non-hobby UAS, respectively. On October 5, 2018, the President signed the FAA Reauthorization Act of 2018 (Pub. L. 115-254). Section 349 of that Act repealed the Special Rule for Model Aircraft (section 336 of Pub. L. 112-95; Feb. 14, 2012) and replaced it with new conditions to operate recreational sUAS without requirements for FAA certification or operating authority. The Exception for Limited Recreational Operations of Unmanned Aircraft established by section 349 is codified at 49 U.S.C. 44809 [see www.federalregister.gov/documents/2019/05/17/2019-10169/exception-for-limited-recreational-operations-of-unmanned-aircraft for more details]. Recreational fliers, under Section 349, are referred to as "recreational fliers or modeler community-based organizations" [see www.faa.gov/uas/recreational_fliers/]. In previous notes including other documents of the Agency, these terms are often interchanged.

(paper-driven) aircraft registry. Registration was free for the first 30 days, and $5 thereafter. Following a temporary halt in registration due to an order from the US Appeals Court in Washington, DC in May, 2017 (*Taylor v. Huerta*), the registration requirement for all model aircraft was reinstated in December, 2017 with the National Defense Authorization Act (NDAA) [Pub. L. 115-91, Sec. 1092]. The NDAA extended the registration for three years for those registered prior to December, 2017. New registration resumed after the temporary halt was removed. On October 5, 2018, the President signed the FAA Reauthorization Act of 2018, which formalized new conditions for recreational use of drones. [See www.faa.gov/news/updates/?newsId=91844 for more details].

With the continuing registration, over 1.37 million (new) recreational drone owners had already registered with the FAA by end of December, 2021.[14] On average, new owner registration stood at around 10,300 per month during January – December 2021 with some expected peaks during the holiday seasons and summer.



The current pace of new registration has decreased compared to last year in the same period; average new monthly owner registration during 2021 stood at 2,500 less than the level observed in 2020.

[14] For our estimate and projections using the registration database, applying to recreational, commercial/part 107 and remote pilots, we use only those who are registered in the US and the territories for the period January – December, 2021. Furthermore, we draw a clear distinction between new registrations, cancellations, and renewals in this document.

Forecasts Using New Registrations vs. Effective/Active Fleet

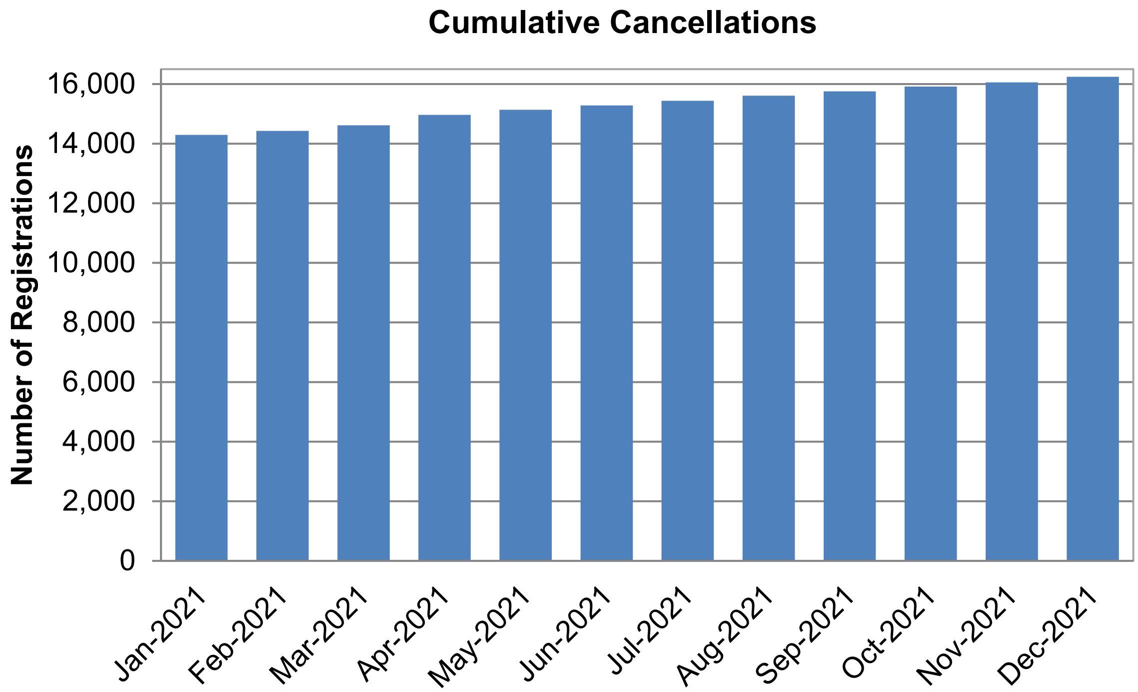
As noted in last year's Aerospace Forecast, small drones are registered for 3 years while remote pilot (RP) certifications are valid for 2 years. [See www.faa.gov/uas/getting_started/register_drone/ and

www.faa.gov/uas/commercial_operators/become_a_drone_pilot/.] Following the *Taylor vs. Huerta* ruling and the FAA's authority over registration via NDAA, the Agency elected to extend the registration period, for all drones registered prior to December 12, 2017, for three years. Thus, December 12, 2020 marked the first effective renewal date. As a result of this sequence of events, as noted in last year's report, approximately 800,000 small drone registrations were due for renewal in December 2020.

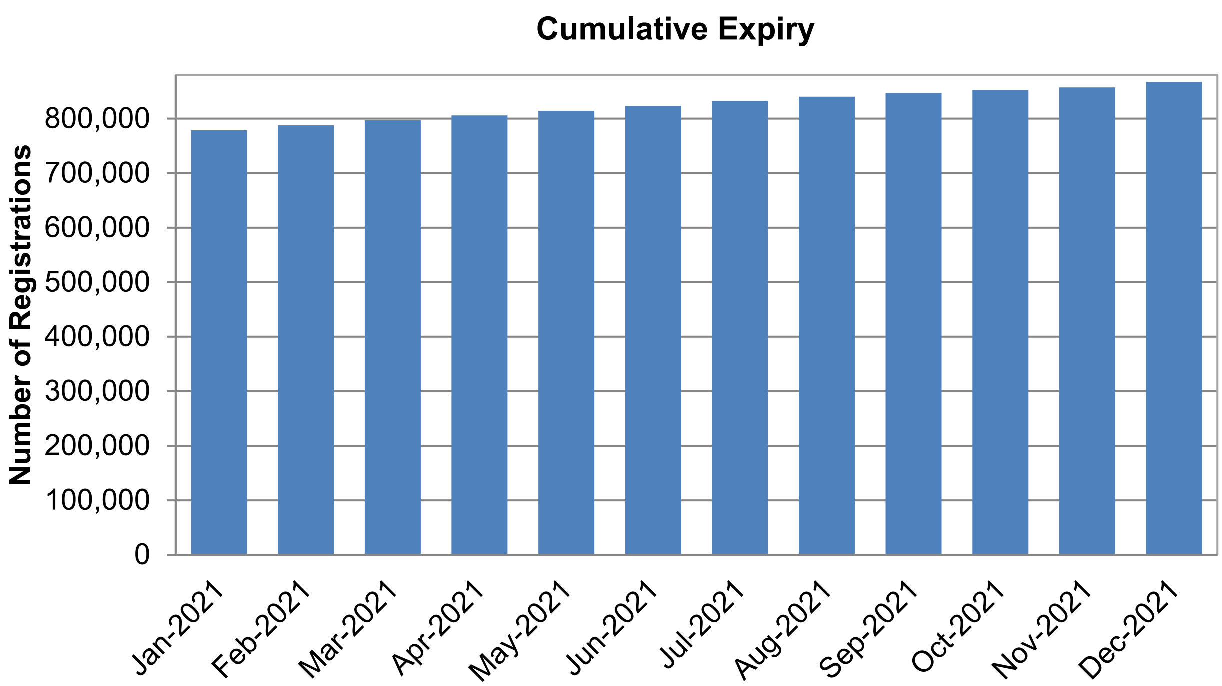
The beginning of the registration renewal afforded the FAA an opportunity to analyze the data, including duplicate and spurious registrations. Following this process, an examination of the data provided an opportunity for the FAA to discern the effective/active fleet more succinctly using the following five elements: *Cancellations*, defined as number of registrations canceled by user; *Expiry,* defined as the number of registrations expired; *New*, defined as the number of brand new registrations (i.e. new registration number) that are reported in the preceding section; *Renew*, defined as the number of registrations renewed prior to expiration; and *Renew+,* defined as the number of registrations renewed after expiration.

Cumulative cancellations were, on average, 15,313/month for the time period of January 2021 – December 2021 (or averaging around 179 new cancellations, or the average gaps between the two bars, for each month during the January – December 2021 timeframe):[15]

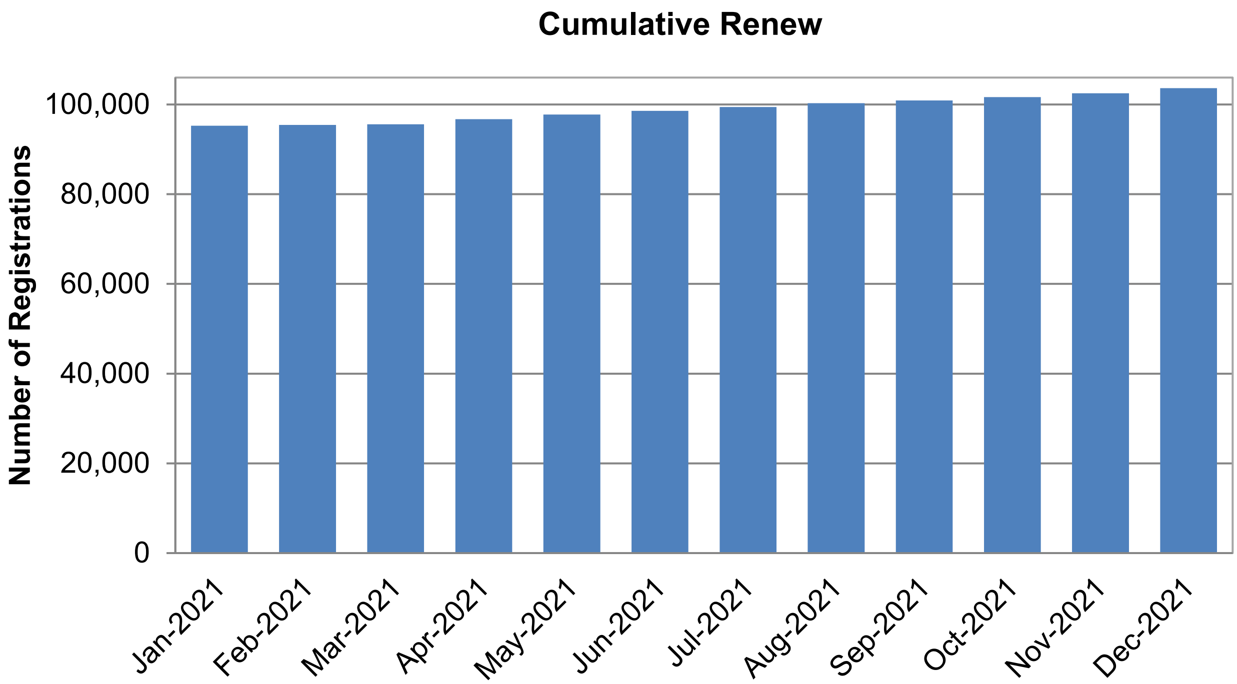
[15] We report cumulative numbers throughout this document for two reasons: first, cumulative numbers reflect the stability of the trend over time, taking into account past changes; and second, differences between the two numbers (i.e., bars) capture the changes between two particular time periods.



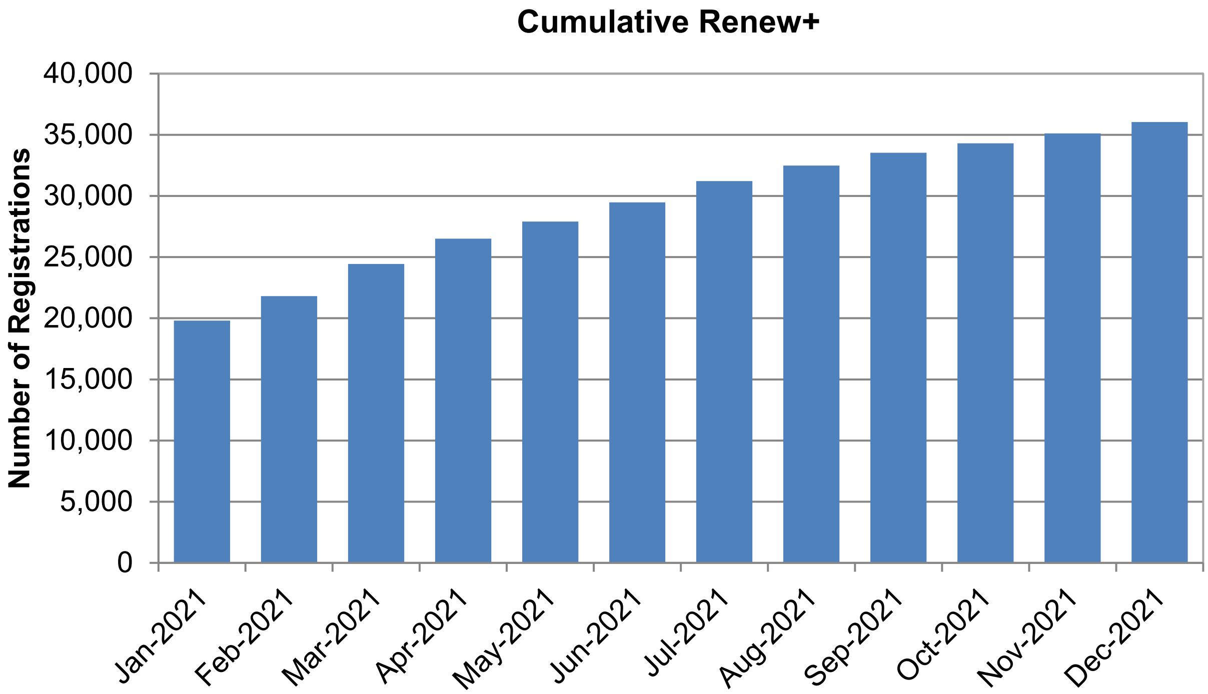
On average, cumulative registrations expired at a rate of more than 825,000/month following the substantial adjustment in December 2020, as noted above and as shown below. (This is equal to slightly more than 8,480 new average expiries for each month during January – December 2021):



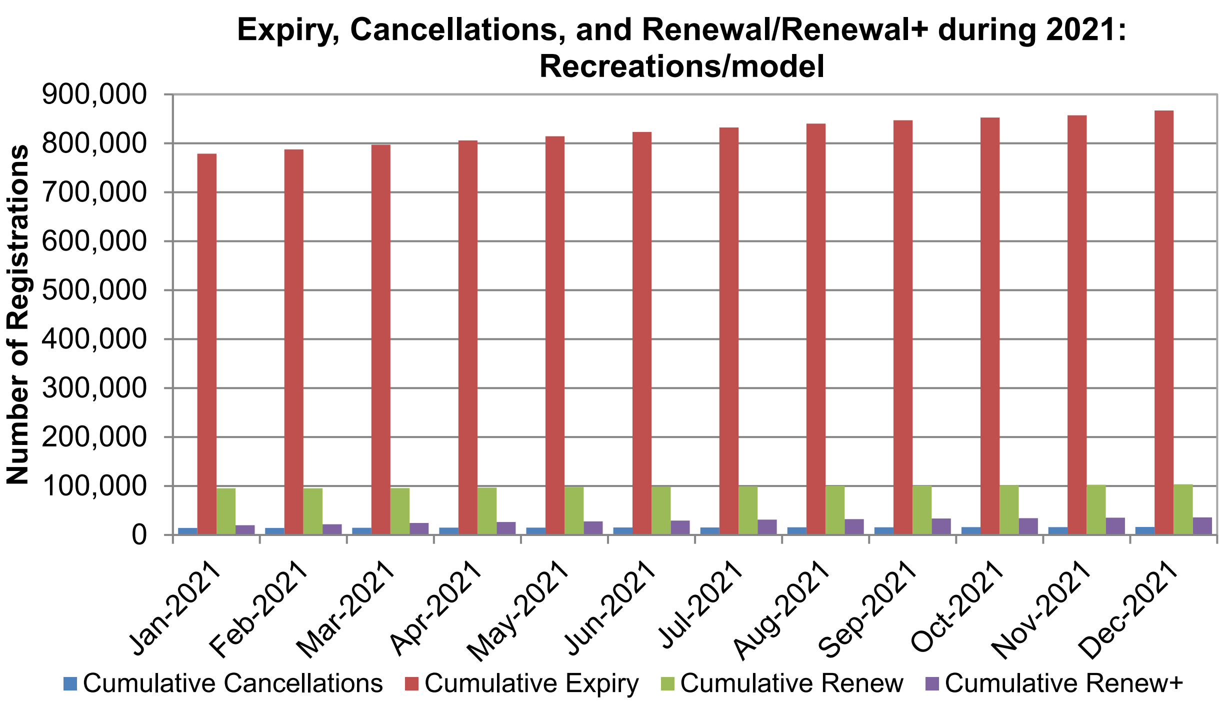
Renew or re-registrations prior to expiry date logged, on average, more than 98,984/month on a cumulative basis (or 712 new average renewals for each month during January – December 2021). This was almost four times higher than Renew+ on a cumulative basis, as reported below:



Renew+ are re-registrations after expiry date logged, on cumulative average, at 28,254/month. This is equivalent to approximately 1,780 new average Renew+ registrations for each month during January – December 2021 and are reported in below:



A summary of the above 4 charts is provided in below to narrate the relative contributions of cancellations, expiry, renew and renew+:



Calculating active/effective registrations for a particular day requires calculating the "net gain/loss" of registrations for each preceding day and adding them together with the particular day (i.e. calculating the running sum).

The following are the contributions of each element to the day's net gain/loss:[16]

- Cancel: (-1 for each registration);
- Expire: (-1 for each registration);
- New: (+1 for each registration)
- Renew: (0); and
- Renew+: (+1 for each registration)[17]

An example of this calculation may be constructed as follows: calculating the net gain/loss for recreational registration for August 9, 2021, where Cancel = 11; Expiry = 263; New = 276; Renew = 20; and Renew+ = 46 had been reported for recreational operators/modelers.

Thus, Net Gain/Loss for August 9, 2021 =

11 X (-1) + 263 X (-1) +

276 X (1) + 20 X (0) +

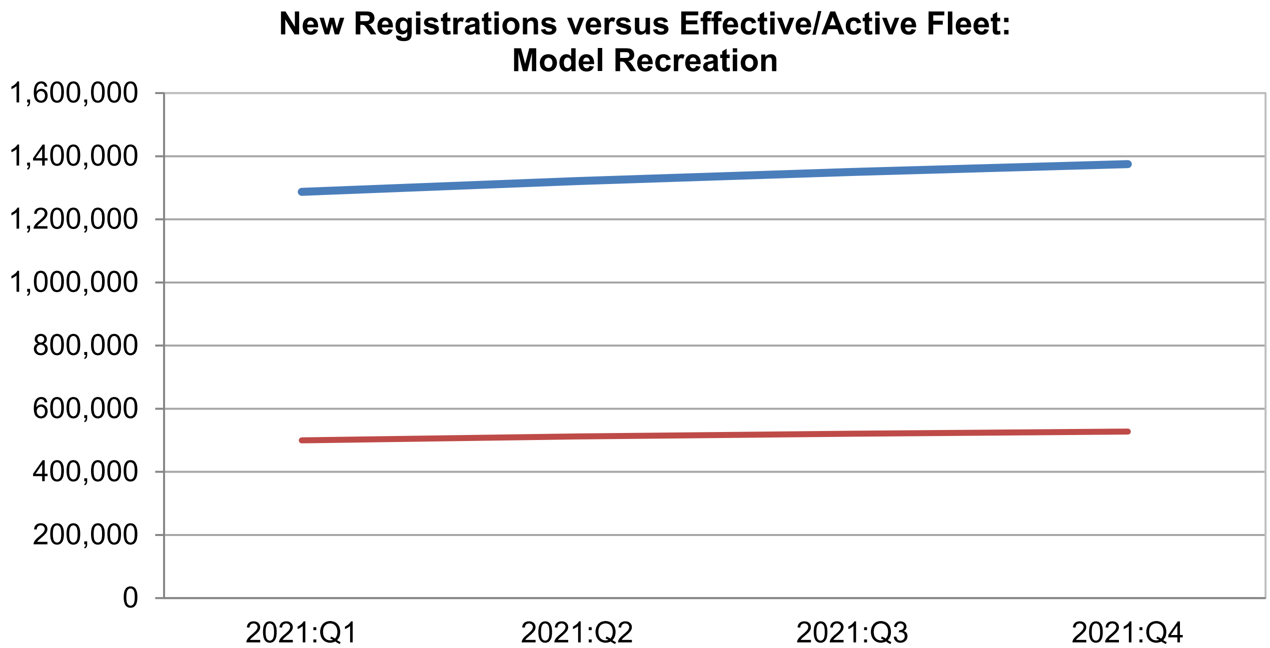
46 X (+1) = 48

Finally, a comparison chart capturing the difference between cumulative new registrations and. effective/active registrations, using cumulative net gain/loss for recreational registrations, is provided below:[18]

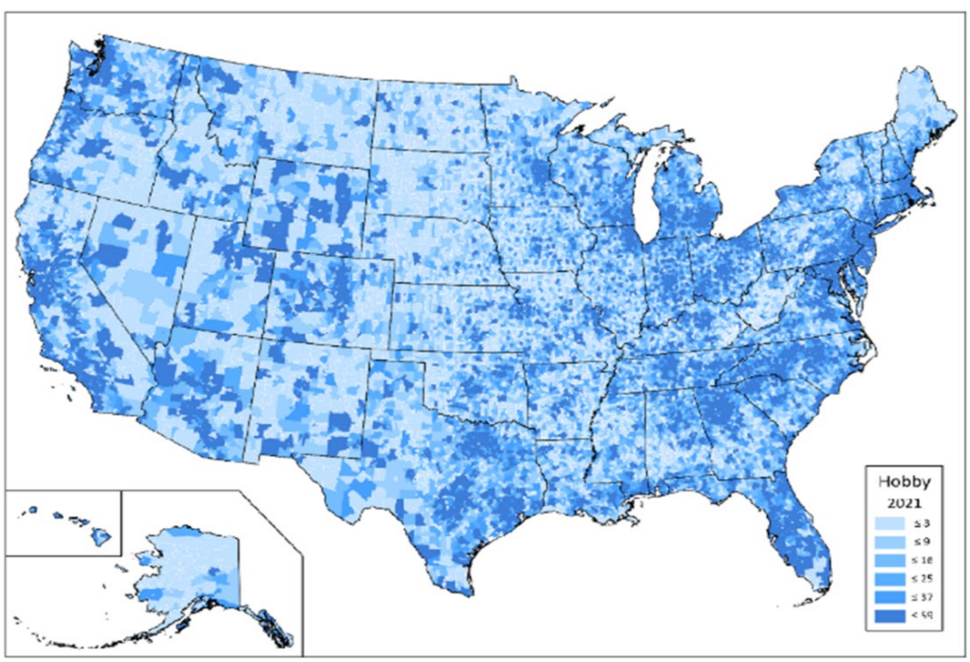
[16] We attribute this methodology of calculations to the UAS Integration Office (AUS), provided internally to facilitate this year's forecasts. For cumulative new registration trends, see the final graph preceding this section.

[17] It is important to note here that renew+ is a replacement for cancellation on a one-on-one basis.

[18] There are two important aspects making the difference: (a) the base; and (b) the rate of change in two lines. For cumulative net gain/loss, the base is highly influenced by substantial expiry and cancellations implemented in December 2020, as discussed above; the rates of change (or slope) of the cumulative net gain/loss line is influenced by these two elements plus new registrations and Renew+ re-registrations. In comparison, new registration counted cumulatively has a substantial base thus making the difference between the two lines while new monthly registrations is the primary factor driving the rate of change for cumulative new registrations line.



Recreational registration, and thus ownership of small drones, is distributed throughout the country. Using the data available in December 2021, the spatial distribution of ownership by zip codes (shown below) demonstrates that small drones continue to be distributed throughout the US, with denser ownership mapping closely to the population centers of the zip codes, as expected.



At present, recreational ownership registration does not correspond one-to-one with aircraft. Unlike their commercial non-model counterparts, the registration rules for recreational operators do not require owners of recreational small drones to register each individual aircraft; only operators are registered. For each registration, therefore, one or more aircraft may be owned. In some instances, there is no equipment associated with registration. Free registration at the initial phase may have incentivized some to create a registration without any equipment to report. Notwithstanding these challenges, there is information available, both from industry and academia, allowing us to understand aircraft ownership. Furthermore, as a result of robust strategic drone research planning, the FAA has launched various research activities to understand the possible magnitude of the sector as well as implications for likely aircraft that may be used for recreational flying, as well as the safety impacts on the small drone fleet from gradual integration into the NAS. Finally, the Agency has incorporated outside analysis to aid forecasting efforts.

As noted in earlier annual reports, forecasts of small drones were based primarily on new registrations without considering the effective/active fleet for reasons described in the beginning of the section (e.g., lack of renewals required). However, now that data on elements for net gain/loss are available, more granular forecasts can be made, particularly the lower bound, using the effective or active fleet. With over 1.37 million new recreational operators cumulatively registered as of December 2021, the FAA estimates that there are approximately 1.58 million sUAS in the fleet distinctly identified as recreational aircraft. Comparing with industry sales and other data noted earlier, we conclude that the number of recreational aircraft is almost 15% higher than ownership registration.[19] Applying cumulative net gain/loss calculations from above, the effective/active fleet is estimated to be around 607,177 as of December 2021. This provides us the lower bound of effective/active fleet of recreational small drones in the NAS.

A comparison of last year's data (2020) with this year's (2021) shows the annual growth rate for new registration to be approximately 10.2%. This was possible due to the continuation of drones playing a dominant role in recreation, a continuation facilitated by decreasing equipment prices (e.g., average price of $750 or less), improved technology such as built-in cameras and higher capability sensors, and relatively easy maneuvering. Furthermore, it appears that COVID-19 had a positive impact on recreational registration during 2020, but a negative impact during 2021. (See below for more details.) Nevertheless, similar to all technologies fueling growth of hobby items, (e.g., cell phone and video game consoles, and prior to that, video cameras and video players), the trend in recreational small drone ownership registration has been slowing. It is likely to slow down further as the pace of falling prices diminishes

[19] This calculation involves taking into account retirement, redundancy, and loss of aircraft corresponding to ownership registration. As aircraft become sturdier and operators more situationally aware, this rate has been changing and we expect it to change dynamically over time. Assumptions tying ownership to aircraft holding and issues related to compliance have been discussed elsewhere. [See napawash.org/academy-studies/federal-aviation-administration-assessment-of-compliance-with-and-effective for a recent study by the National Academy of Public Administration on these issues.]

and the early adopters begin to experience limits in their experiments, or simply because recreational eagerness plateaus.

Given trends in registration and market developments, the FAA forecasts that the recreational small drone market will saturate at around 1.81 million units over the next five years.[20] However, there is still some upside uncertainty due to further changes in technology, including battery life, faster integration from a regulatory standpoint, and the likely event of continued decreasing prices. This leads to upside possibilities in the forecast of as many as 1.84 million units by 2026. In contrast, there are some low-side uncertainties; the primary among them is the lack of renewal (i.e., before and after expiry dates), followed by expiry and cancellations. The inertia, loss of interests, or lack of recreational opportunities may be key factors leading to the observed trends in renewal. Nevertheless, if renewals were kept up over time, effective/active fleet would likely converge to base forecasts, i.e., derived from cumulative new registrations combined with multiplicity of craft ownership. In the presence of slower renewal tendency, as data presently indicates, it is likely that the effective/active fleet will be lower than that derived from base forecasts. This provides the FAA with an opportunity to derive low-side forecasts using effective/active fleet calculations. Nevertheless, low-side uncertainty growth trajectory (i.e., annual growth rates) tracks closer to the base forecast. A forecast base (i.e., likely), together with high and low scenarios, is provided in the table below:[21]

Total Recreation/Model Fleet (Million sUAS Units)

Fiscal Year	Low*	Base**	High**
Historical			
2021	0.6072	1.5822	1.5822
Forecast			
2022	0.6509	1.6965	1.6981
2023	0.6848	1.7576	1.7645
2024	0.7096	1.7965	1.8182
2025	0.7262	1.8039	1.8272
2026	0.7378	1.8075	1.8360

*: Effective/Active fleet counts combined with multiplicity of craft ownership.

**: New registration counts combined with multiplicity of craft ownership.

[20] These forecasts have two dimensions worth emphasizing. When looked at from the cumulative base, "total" captures the number of drones that *are reported* to be in the system (i.e., base and high); while "effective/active fleet" refers to how many aircraft are *presently operating* in the system (i.e., low).

[21] As noted earlier, low scenario reports effective/active fleet using a net gain/loss calculation. By definition, low scenario differs from base and high scenarios, which are based on new registrations. Hence, a low scenario for the year 2021 is markedly different than the baseline and high scenario for the same year.

Last year, the FAA forecasted that the recreational small drone sector would have slightly more than 1.50 million drones in 2021, a growth rate exceeding 4.6% from the year before (2020). Actual data using new registration overshot the projection by a little over 80,000 registrations, with over 1.58 million small drones already accounted for by the end of 2021. Thus, our forecast of recreational small drones last year undershot by 5.06% for 2021, (or 1.5822 million actual aircraft vs 1.5022 million aircraft that were projected last year).

The FAA uses the trends observed in registrations, particularly over the past year; calculation of net gain/loss (described above) this year; information from the survey conducted in 2018; expert opinions distilled from Transportation Research Board annual workshops; review of available industry forecasts; market/industry research; and time-series models fitted on monthly data. These apply to all three elements reported above: low, base, and high forecasts. Using these, the FAA forecasts that the recreational small drone fleet will likely (i.e., base scenario) attain its peak over the next 5 years, from the present 1.58 million units to approximately 1.81 million units by 2026.

Following a similar growth trajectory as the base, there will be approximately 738,000 active/effective small drones over the next five years in 2026, which is now the low forecast for recreational/model small drones. Active/effective fleet count is derived and projected based on the net gain/loss calculation discussed above. The high scenario, on the other hand, may reach as high as 1.84 million units. High scenario projection is based on the base forecast.

Notice that eventual saturation at somewhat higher levels, in comparison to last year's projections, reflects relatively higher new registration by recreational flyers observed during 2021. The increased new registration trend, in part driven by COVID-19, may or may not continue in the longer run.[22] In comparison, low side forecasts assume the present trend in renewals followed by similar expiry and cancellations. Nevertheless, the growth rates underlying these numbers are fairly steady in the initial years, but fade faster in the last two to three years. The gradual saturation that is projected in five years and beyond in the recreational small drone fleet parallels other consumer technology products and the Agency's projections from last year, particularly with respect to base and high forecasts. However, both the numbers and the growth trajectory for the low scenario (i.e., effective/active fleet) are fundamentally different than the last year for reasons described above. Nevertheless, it provides a lower bound that is likely to be closer to reality in terms of small drones that are in use and effective in the NAS.

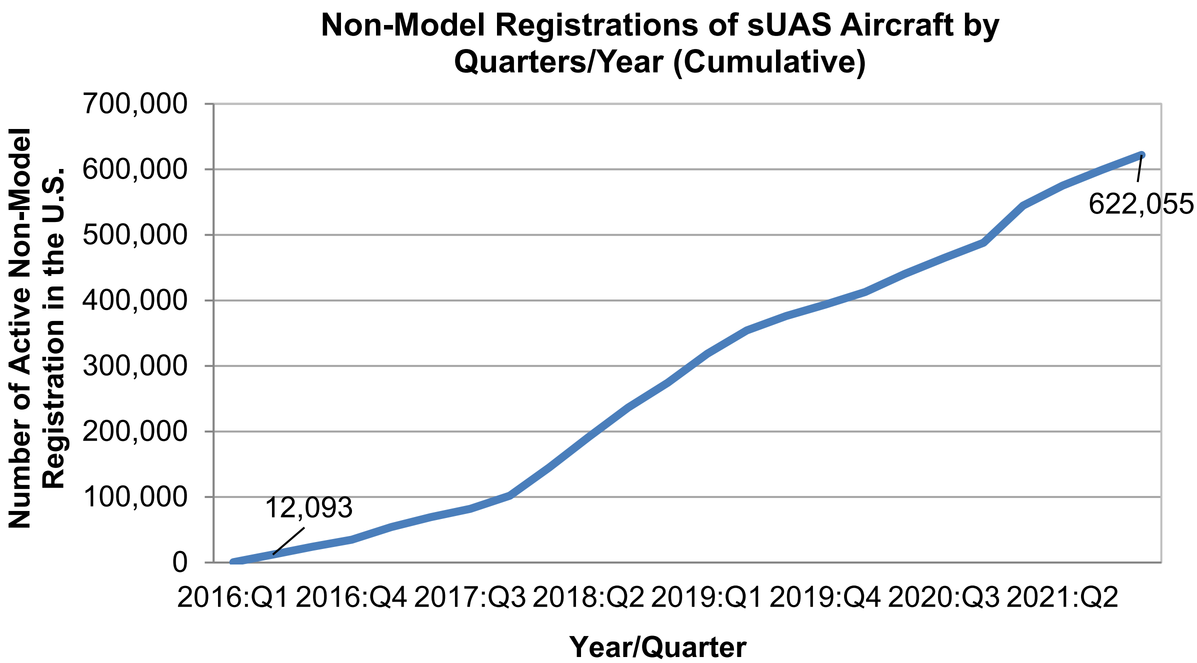
[22] It is quite likely that many users are buying and experimenting with recreational small drones given the COVID-19 public health emergency and the substantial portion of the workers presently working from home. This trend may or may not continue once regular work patterns are resumed.

The Recreational UAS Safety Test (TRUST)

Under the most recent (2018) reauthorization bill [see www.congress.gov/115/bills/hr302/BILLS-115hr302enr.pdf], new requirements for recreational pilots have been introduced. (See P.L. 115-254 – exception for limited recreational operations of unmanned aircraft.). TRUST is the safety test for recreational/model small drones. It provides education and testing for recreational flyers on important safety and regulatory information. All recreational flyers must pass an aeronautical knowledge and safety test and provide proof of test passage – the TRUST completion certificate — to the FAA or law enforcement upon request. [See www.faa.gov/uas/recreational_fliers/knowledge_test_updates/ for more details.] By December 2021, more than 175,000 recreational flyers completed TRUST certification subsequent to its inception in June 2021.

Trends in Commercial/Non-Model Aircraft and Forecasts Using Registrations vs. Effective/Active Fleet

Online registration for commercial/non-model small drones went into effect on April 1, 2016. Unlike recreational/model ownership, rules for commercial registration require owners to register each small drone, thus creating a one-to-one correspondence between registration and aircraft. During the period of January – December 2021, more than 100,000 commercial operators registered their new equipment. The pace of monthly registration, around 8,500, is higher than the same period in 2020, which was approximately 7,870. It appears that the pace of new registrations is picking up speed slightly in comparison with 2020 and prior years. (From April 2016 – December 2020 there were roughly 9,100 new registrations per month.) As the pace of recreational registration has increased somewhat, particularly last year, the pace of new registration for the commercial counterparts has followed suit, with more than 620,000 commercial drones registered since April 2016.



For each month the registration has been available, over 4,600 new aircraft per month were registered until December 2017. This pace accelerated to 14,600 new registrations per month during 2018. During 2019, average monthly new registrations stood at approximately 10,100. In the past year, 2020, average monthly registration dropped to 7,850, while during 2021, average monthly registrations jumped by 650 to around 8,500. The commercial small drone sector is dynamic and appears to be at an inflection point, demonstrating powerful stages of growth. Unlike the recreational small drone sector, the FAA anticipates that the growth rate in this sector will remain high over the next few years. This is primarily driven by the regulatory clarity that part 107 continues to provide to industry. In particular, the Operations Over People final rule, published on December 28, 2020, is the latest incremental step towards further integration of small drones into the NAS. This final rule allows routine operations over people and routine operations at night under certain circumstances, and eliminates the need for individual part 107 waivers. [See www.faa.gov/news/media/attachments/OOP_Executive_Summary.pdf for more details.]

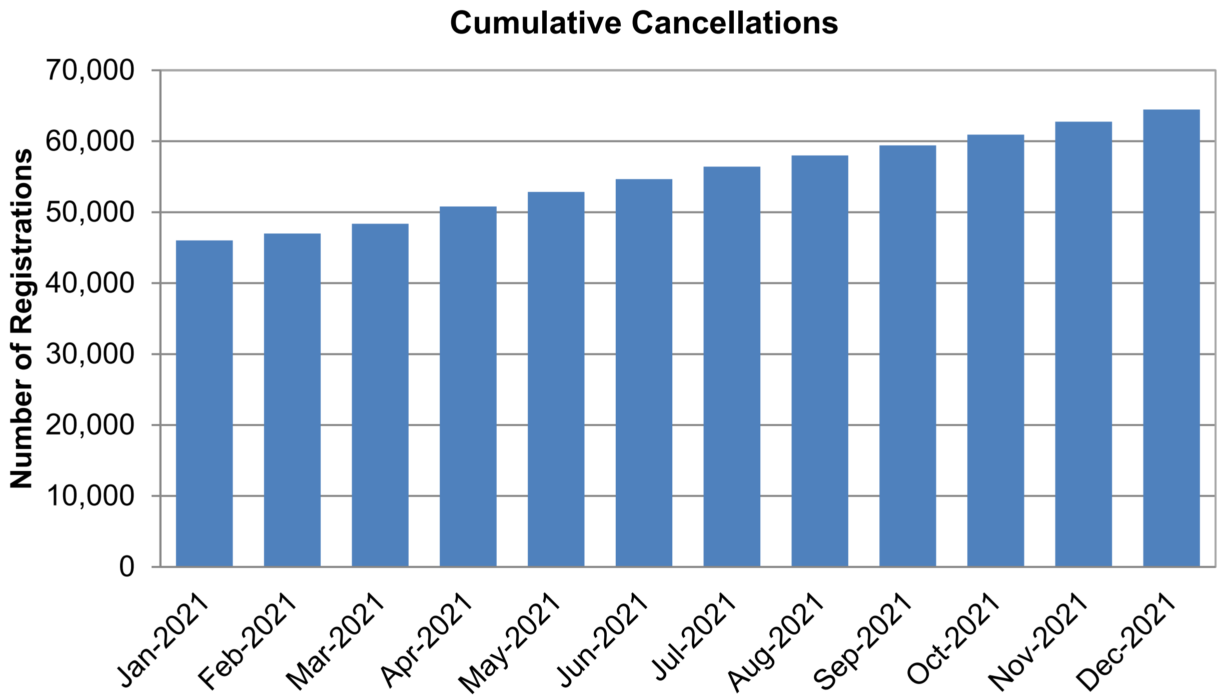
The Remote ID rule was announced on December 28, 2020 as well. [See www.faa.gov/news/media/attachments/RemoteID_Final_Rule.pdf] Upon adjudicating numerous comments from stakeholders, the final rule [See www.faa.gov/sites/faa.gov/files/2021-08/RemoteID_Final_Rule.pdf for more details] was published in the Federal Register on January 15, 2021 with an original effective date of March 16, 2021. Corrections made to the rule and published in the Federal Register on March 10, 2021 delayed the effective date to April 21, 2021. Remote ID (i.e., digital license-plate) of remotely piloted aircraft is necessary to ensure public safety and efficiency of US airspace. The rule applies to all operators of small drones that require FAA registration (i.e., both recreational and part 107). Remote ID provides airspace awareness to the FAA, national security agencies, law enforcement entities, and other government officials. In accordance with the requirements of the present rule, remotely piloted aircraft in flight are to provide, via broadcast, certain identification, location, and performance information that can be received by interested parties on the ground and by other airspace users.

There are three ways to comply with the remote ID rule: (a) operate a standard remote ID small drone broadcasting identification and location information of both the aircraft and control station; (b) operate a small drone with a remote ID broadcast module attached to it that broadcasts identification, location and take-off information; and (c) operate a small drone without remote ID at specific FAA-recognized identification areas (or FRIAs). As noted, almost all of the final rule on remote ID became effective on April 21, 2021. The subpart covering the process for FRIA applications from community-based organizations and educational institutions becomes effective September 16, 2022. Drone manufacturer compliance with the final rule's requirements becomes effective on September 16, 2022 as well. Finally, operator compliance with the remote ID rule and/or in an FAA designated FRIA is required by September 16, 2023. [See www.faa.gov/uas/getting_started/remote_id/ for more details]

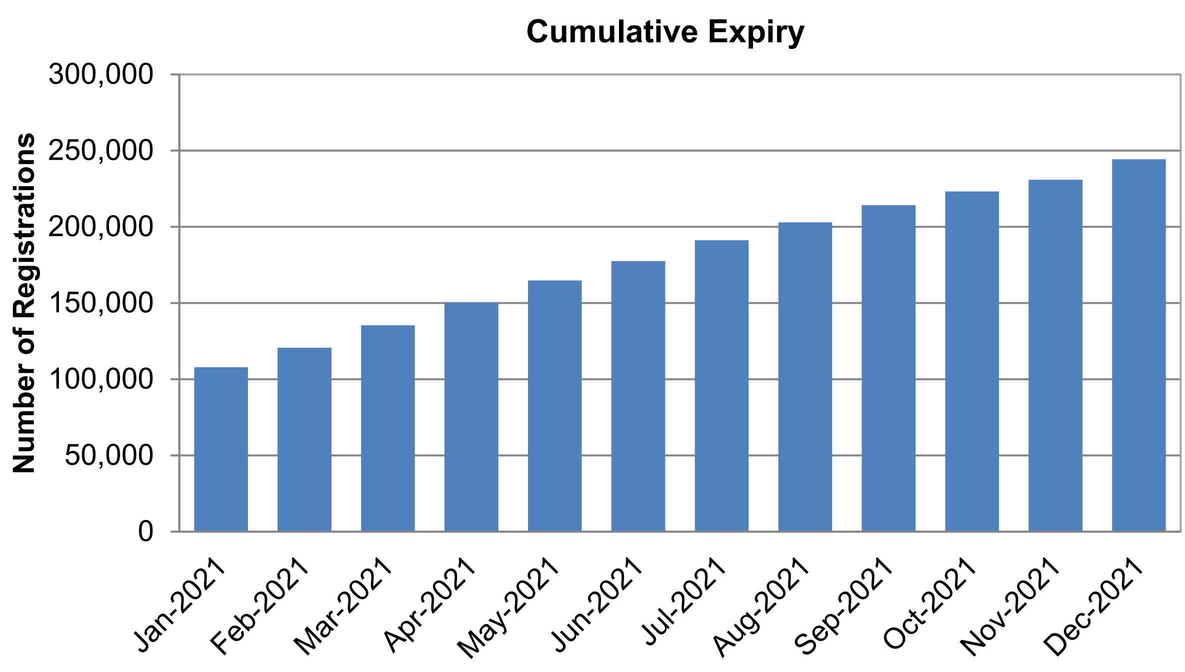
These two rules together provide much-needed regulatory clarity and reduce the need for waivers under part 107. With enhancement of operational efficiencies under increasingly well-defined concepts of operations (CONOPS)—which ensures safety and transparent information flow across the community—more and more commercial uses will become likely, fueling even further growth. Notably, as a central location for receiving all operational information, including registration, authorization, and accident report logs the DroneZone has helped further facilitate this growth. [faadronezone.faa.gov/#/].

As noted in the preceding section, the beginning of the registration renewal afforded the FAA an opportunity to review part 107 data; duplicates and unnecessary registrations were removed, and the registration database was made cleaner and more compact. As in the case of recreational/model aircraft, an examination of the data provides an opportunity to discern the effective/active fleet more accurately using the following five elements introduced earlier: Cancellations; Expiry; New; Renew; and Renew+. It is worth mentioning here that, prior to having access to these five elements, forecasts in the past were based only on new registration trends.

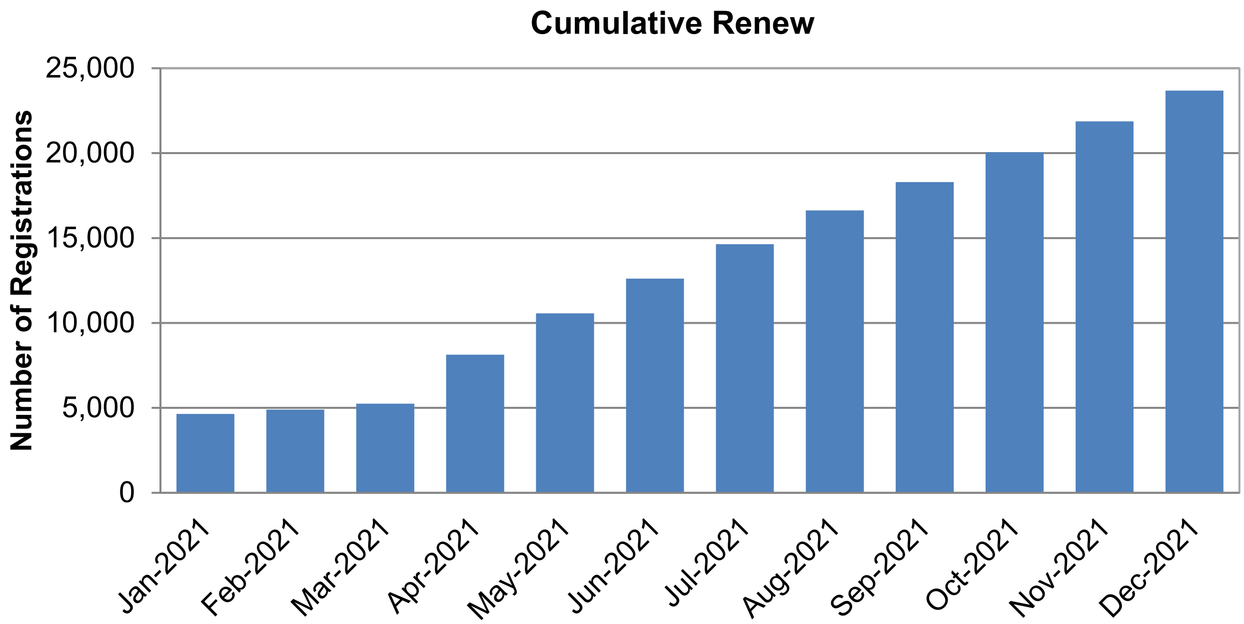
An average of 55,140 cancellations per month, on a cumulative basis, were reported between January – December 2021, as shown below. This is an average of approximately 1,650 new cancellations for each month of 2021.



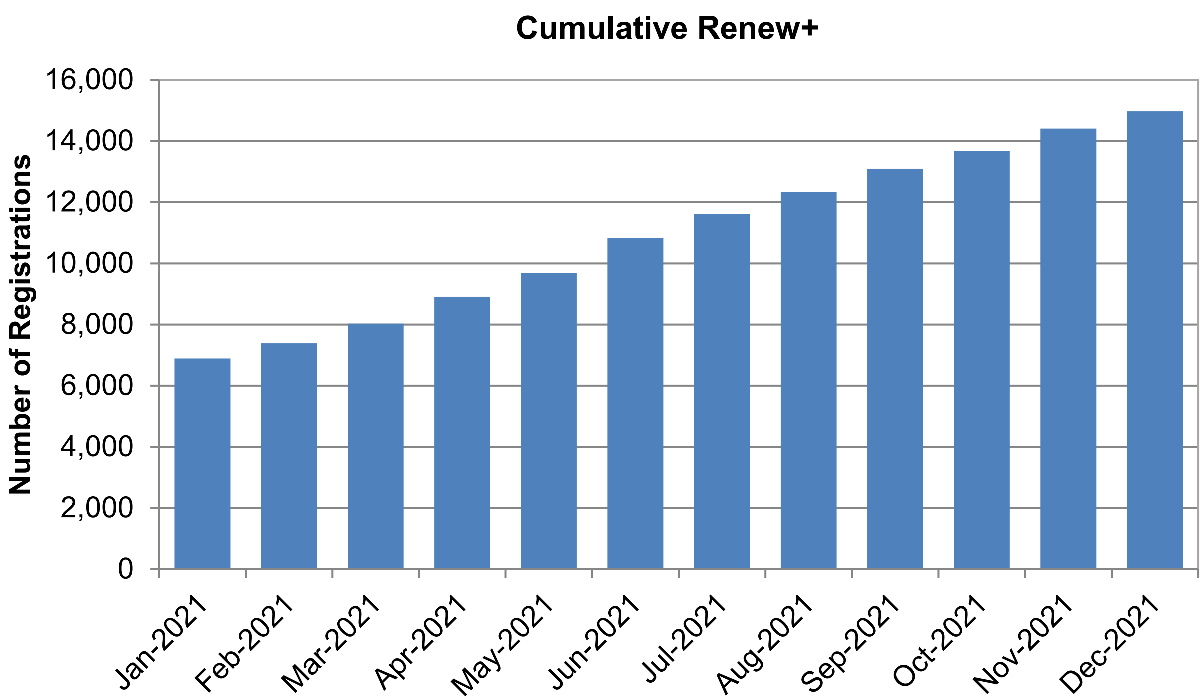
An average of 180,306 expirations per month was reported on a cumulative basis between January 2021 – December 2021 following the substantial adjustment noted above and as shown below. (This equals approximately 12,610 new average expiries for each month during January 2021 – December 2021):



Renew or re-registration prior to expiry date logged, on average, more than 13,440/month on a cumulative basis during January 2021 – December 2021 (or 1,610 new average renewals for each month during January – December 2021):



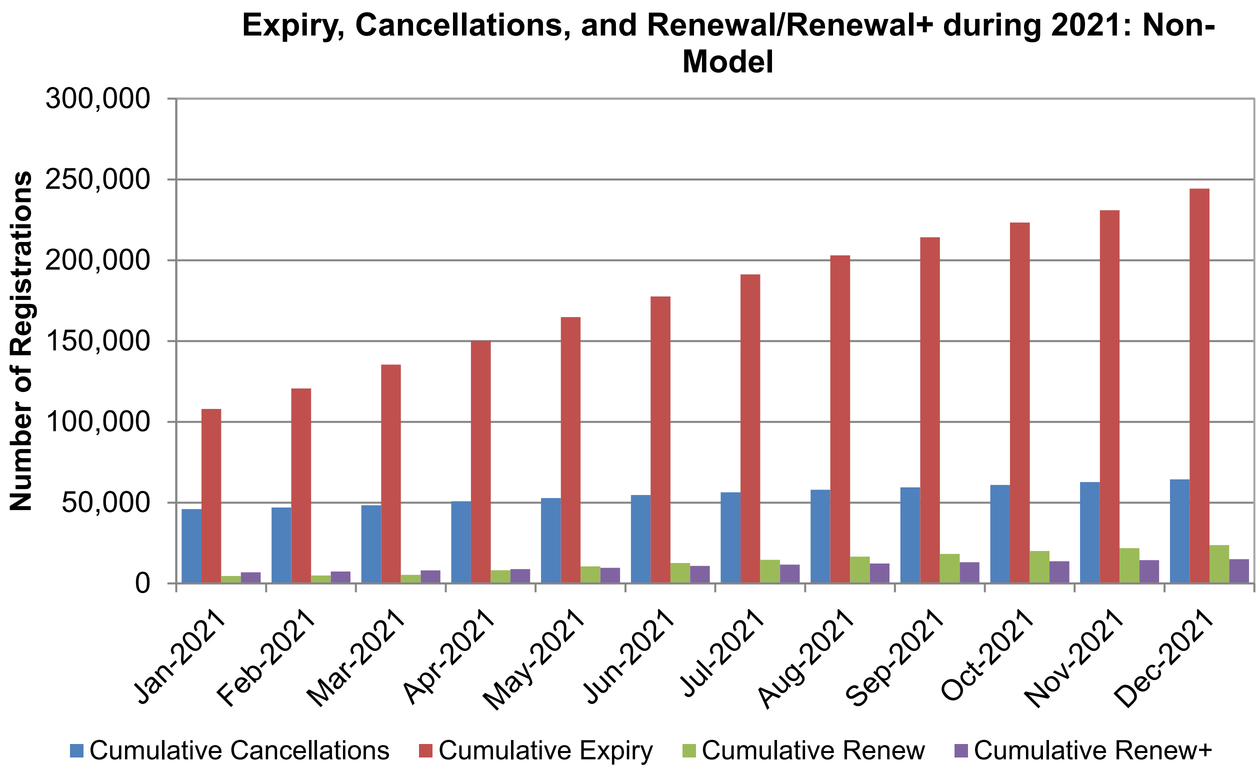
"Renew+" are re-registrations after expiry, and logged, on average, 10,986/month on a cumulative basis. This is an average of 718 new Renew+ each month between January 2021 – December 2021, as reported below:



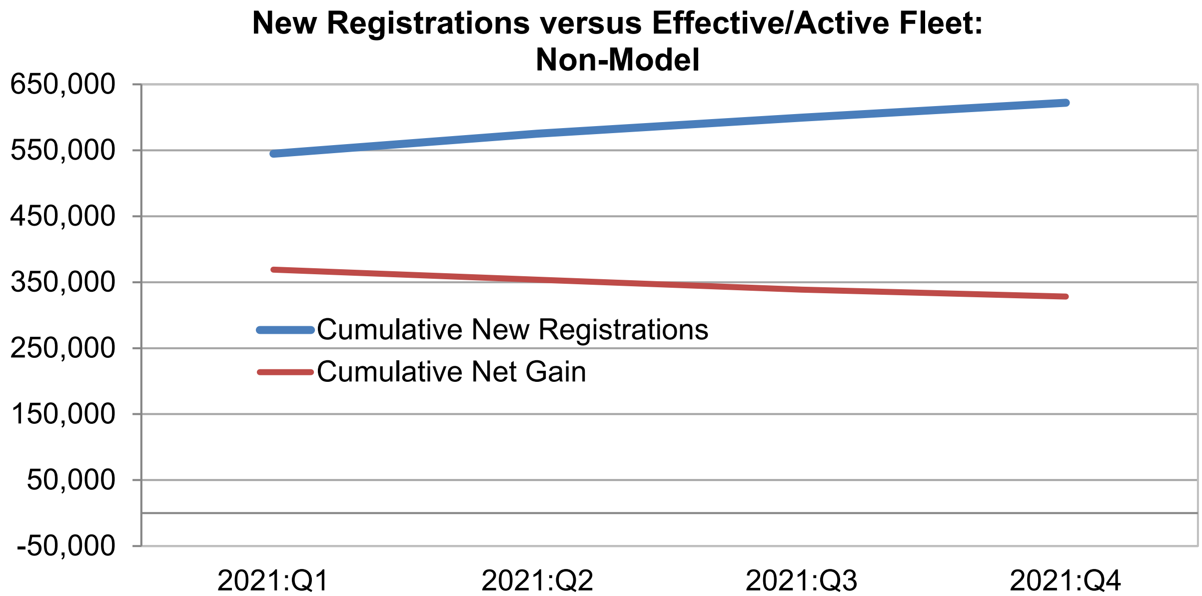
As in the case of recreational/model registrations, calculating active/effective registrations for a particular day requires calculating the "net gain/loss" of registrations for each preceding day and adding them with the particular day (i.e. calculating the running sum).

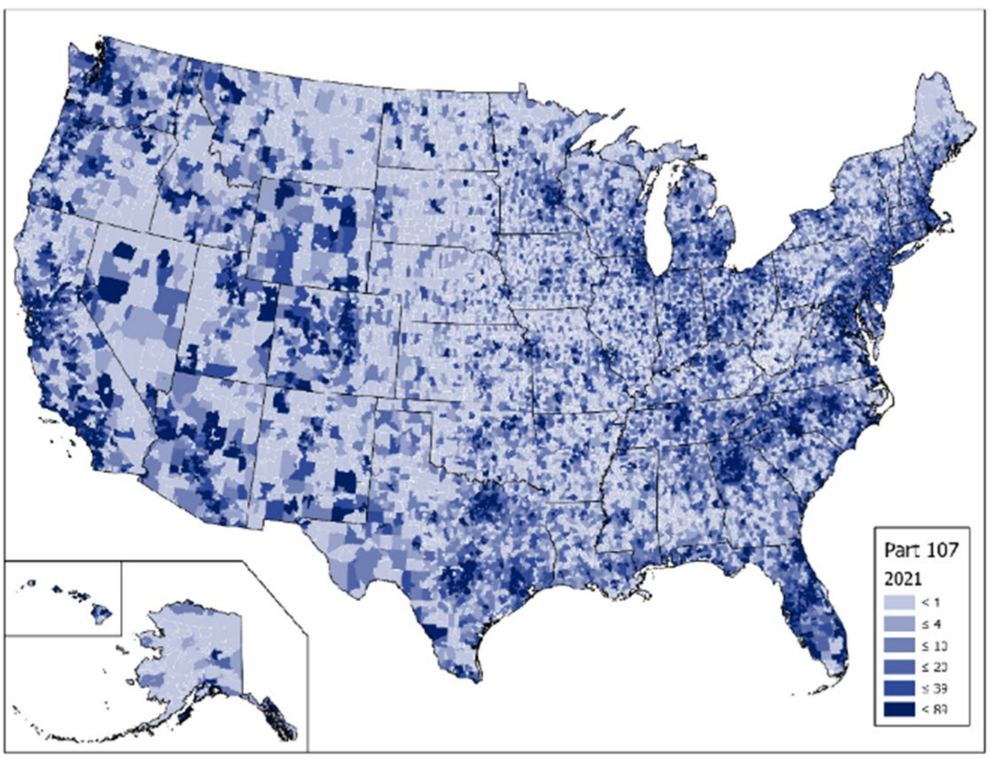
Using the formulation described in the example in the preceding section, we can derive the net gain/loss for part 107 data as well.

A summary of the above 4 charts is provided in below to relate the relative contributions of cancellations, expiry, renew and renew+:



A comparison chart capturing the difference between cumulative new registrations vs. effective/active registrations using net gain/loss for part 107 registration is provided below:





As in the case of recreational drone ownership, commercial small drones are distributed across the country. A spatial distribution of equipment registration by zip codes (using data for December 2021) demonstrates that commercial small drones are distributed throughout the country, with denser activity mapping closely against the economic or commercial activities of the geographical areas.

Last year, the FAA forecasted that the commercial drone sector would include approximately 589,000 small drones in 2021, a growth rate exceeding 21% over the year before (2020). Actual data came in slightly over 622,000 aircraft by the end of 2021. Our forecast of commercial small drones last year thus undershot by 5% for 2021 (or 622,055 actual aircraft vs 589,463 projected aircraft).

Forecasting in a time of tremendous uncertainty is indeed challenging, especially given the economic slowdown during COVID-19 and its impact on the drone sector. The commercial small drone sector's fast growth and adjustments during the pandemic demonstrate that fact. Nevertheless, our forecast errors for both recreation and commercial small drones appear to be within the bounds of reasonableness.

Total Commercial/Non-Model Fleet (Thousand sUAS Units)

Fiscal Year	Low*	Base**	High**
Historical			
2021	328	622	622
Forecast			
2022	292	699	729
2023	301	757	809
2024	320	801	869
2025	339	834	918
2026	355	858	968

*: Effective/Active fleet counts;

**: New registration counts based on fleet counts;

The FAA uses the trends observed in registration during previous years, calculation of net gain/loss, information from the survey conducted in 2018, a review of available industry forecasts/workshops and past FAA Drone Symposiums, and internal research together with market/industry research. Using these, the FAA forecasts that the commercial drone fleet will likely (i.e., base scenario) be at around 858,000 by 2026. This is 1.38 times larger than the current number of new commercial small drones.[23]

Using low or effective/active fleet, the FAA forecasts an expansion of the small drone fleet by 26,000, 1.08 times larger than the currently calculated effective/active fleet of

[23] Last year, the ratio of end-year forecast to base-year forecast was 1.7-times. (That is the FAA forecasted end-year to be 1.7 time base year's (2020) numbers in 5-year (2025)). Higher forecasts are often the result of improved regulatory environments, as noted below, and environments that are in the process of rule-making evaluation (See fn. #17-19).

328,000 units.[24] As the present base (i.e., the cumulative total) increases, the FAA anticipates the growth rate of the sector will slow down over time, and the effective/active fleet will likely catch up with the growth trajectory of new registrations. Nevertheless, the sector will be much larger than what was understood only a few years earlier.

In order to understand the growth trajectory of the sector better, this report divides the commercial drone sector into two types of small drone aircraft: consumer grade and professional grade. Consumer-grade, commercial drones have a wide range of prices, below US $10,000 with an average unit price of approximately $2,500. The professional grade, on the other hand, is typically priced above US $10,000 with an average unit price assumed to be around $25,000.[25] For both consumer-grade and professional-grade drones, the average price has fallen over time, particularly over the last few years. Currently, the consumer grade dominates the commercial drone sector, with a market share approaching 91%. However, as the sector matures and the industry begins to consolidate, the share of consumer grade commercial drones is likely to decline, though it will still be dominant. By 2026, the FAA projects this sub-sector will have approximately 86% of the overall commercial small drone sector.

Starting from a lower base of approximately 59,000 aircraft registered in 2021, the professional-grade commercial small drone subsector stands to expand rapidly over time, reaching 115,000 in 2026—especially as newer and more sophisticated uses are identified, designed, and operationally planned and flown. If, for example, professional-grade small drones meet criteria of operations, safety, and regulations, and if they satisfy economic and business principles and enter into the logistics chain via small package delivery, the growth in this sector will likely be phenomenal. On the other hand, starting from a registration base (and not active/effective fleet) of 563,000 in 2021, consumer grade small drones are likely to grow over 744,000 by 2026. These numbers will be somewhat smaller if we use the effective/active number of drones as the basis for calculation instead of new registration.

These growth trajectories could be even further enhanced by expanding operations in controlled airspaces, e.g., the LAANC system, which began authorization in May 2017.[26] LAANC is designed to facilitate small drone use of controlled airspace (i.e., Class B terminal airspace) in the NAS. While most of the near-term growth in commercial small drones will continue to come from consumer-grade units (over 90%), the FAA anticipates a significant part will come from professional-grade small drones as well.

[24] This is driven completely by the combined effects of projected underlying growth rates of cancellations, expiry, new registrations, and renewals.

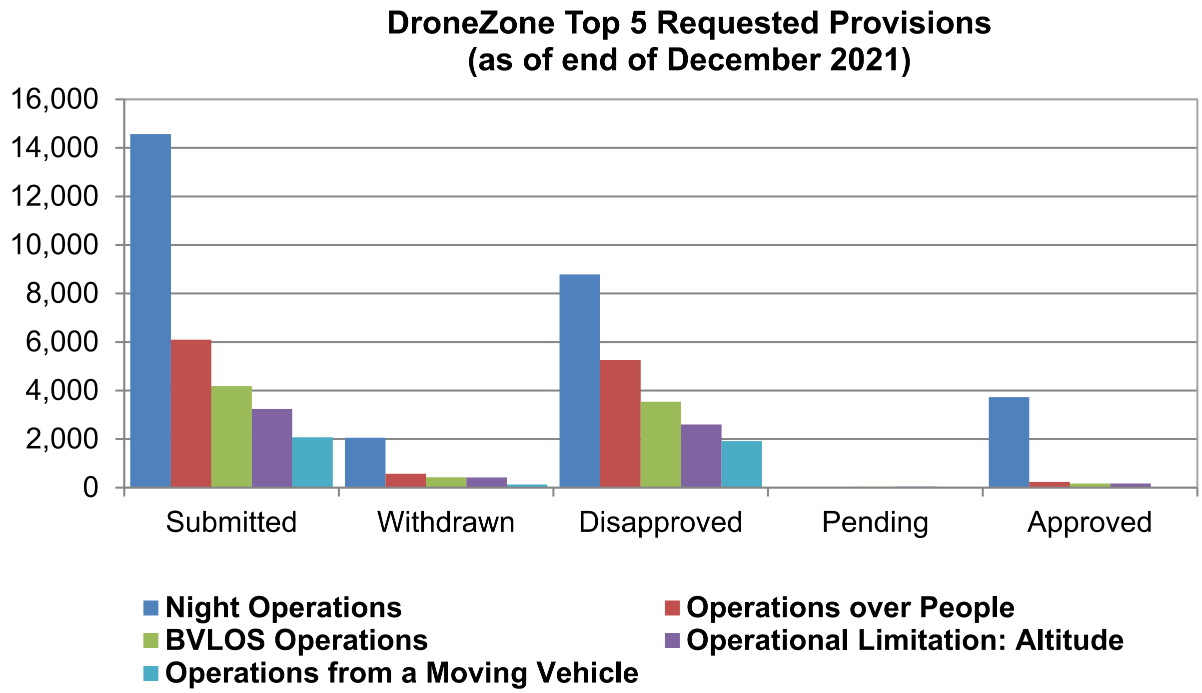
[25] Because of this wide range in prices between types of small drones in commercial activities, start-up costs for a business may vary between $2,500 and $25,000.

[26] Low Altitude Authorization and Notification Capability (LAANC) [https://www.faa.gov/uas/programs_partnerships/uas_data_exchange/] automated the application/approval process for airspace authorizations. Requests submitted via FAA-approved UAS Service Suppliers (USS) are checked against airspace data in the FAA UAS Data Exchange, such as temporary flight restrictions (TFRs), Notice to Airmen (NOTAMS), and the UAS Facility Maps (UASFM). Approved requests thus provide the FAA/ATO visibility into where and when planned drone operations will take place.

Unlike its recreational small drone counterpart, it is extremely difficult to put a floor on the growth of the commercial small drone sector due to its composition (i.e., consumer vs. professional grades) and the varying business opportunities and growth paths. As commercial small drones become operationally more efficient and safe, battery life expands, and integration continues (e.g., recent final rule involving operations over people; and remote ID), new business models will begin to develop, thus enhancing robust supply-side responses. These responses, in turn, will pull demand forces (e.g., consumer responses to receiving commercial packages, routine blood delivery to hospitals, and search-and-rescue operations) that are somewhat latent and in the experimental stage at present. Unlike a developed sector such as passenger air transportation, it is impossible to put a marker on "intrinsic demand" (or core demand) primarily driven by economic and demographic factors underlying this sector. Nevertheless, in this year's forecast the FAA makes a provisional attempt to provide a "low" side for now, essentially capturing the intrinsic demand and making use of the calculation of effective/active fleet. In addition, we provide the likely or base scenario, together with the enormous potential embodied in the "high" scenarios, representing cumulative annual growth rates of 7% and 9%, respectively. As noted earlier, low scenarios are driven by two positive factors (i.e., new registration and renew+) and two negative factors (i.e., cancellations and expiry). Average annual growth rate corresponding to the low scenario is determined by the combined effect of both positive and negative factors, and at present is calculated to be approximately 1.6%. This is much smaller than both base and high scenarios and this is because effective/active count is driven to catch up with the new registrations trend. [See fn. #7 for further explanation pertaining to effective/active count for recreational registration].

Commercial small drones are currently used for numerous purposes. As the sector grows, the FAA anticipates there will be many more uses for, and much more use of, commercial small drones. This is increasingly evident, for example, from the successful implementation of the UAS Integration Pilot Program (IPP). [See www.faa.gov/uas/programs_partnerships/integration_pilot_program/ for more details] and continuation in BEYOND [see Section later on].

One way of identifying early trends in commercial small drone use is to analyze the waiver applications granted to small drone operators. Both the magnitude and relative composition of waiver types may indicate the direction of the commercial small drone sector as a whole. A breakdown of the waiver requests granted in December 2021 is shown in the chart below:



Beyond the daytime operation that is presently allowed under existing part 107 rules, expanding applications further requires waivers, to a large extent, for night operations as distinct from daylight operations (around 9 of every 10 granted waivers), and operations over people (around 1 of every 20 granted waivers). As noted earlier, approved rules will now allow night operations and some operations over people as part of routine operations no longer requiring waivers. There are also beyond visual line-of-sight (BVLOS) waiver requests (around 14% of total requests) and limitations on altitude (around 11% of total requests), for which waiver approvals are granted at a rate of 3.9% in both cases. Many of these waivers are combined, and thus total waiver approvals (i.e., full + partial) granted (over 4,321 by December, 2021) exceed 100%.

Waivers are issued to facilitate business activities by small drones while preparing for the next round of regulations that will enable routine, more complex drone operations. Now that night operations and operations over people have been finalized,[27] amending Title 14 of the Code of Federal Regulations part 107 (14 CFR part 107) by permitting the routine operation of small drones at night[28] or over people under certain conditions,[29] the

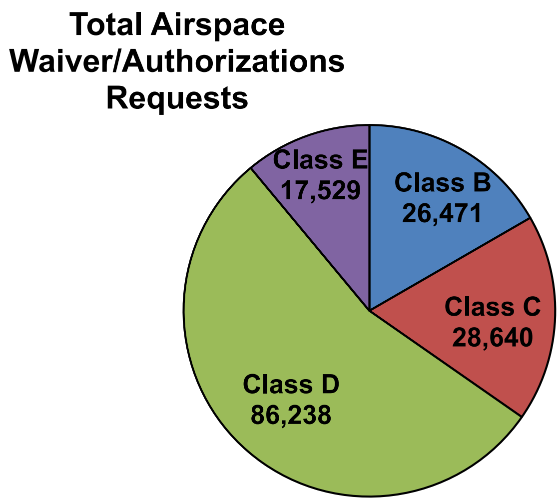
[27] The rule was published in the Federal Register on January 15, 2021. Corrections to the final rule were published in the Federal Register on March 10, 2021, delaying the effective date from March 16, 2021 to April 21, 2021 [See: www.faa.gov/uas/commercial_operators/operations_over_people/.].

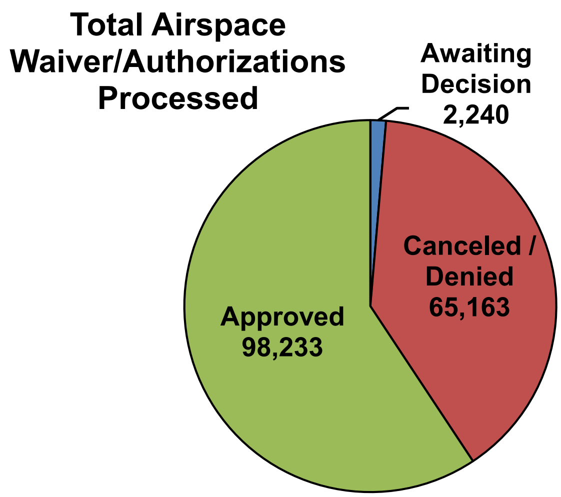
[28] *See* § 107.29. An operation at night was defined as an operation conducted between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time (*ibid*).

[29] *See* § 107.39. An operation over people was established as one in which a small remotely piloted aircraft passes over any part of any person

Agency is turning its focus to long term solutions that will eventually enable routine BVLOS fights without waivers.[30] Analysis of the waiver applications allows the FAA to understand industry trends, one of many metrics essential for understanding and projecting the growth trajectory, course corrections, and growth trends of the sector.

Nearly 60% of airspace authorizations and waiver requests were approved for controlled airspace at the end of December 2021. While over half were for Class D airspace (i.e., smaller airports with control towers), other classes were also requested and regularly flown.





Finally, LAANC has been routinely providing auto-approval since its inception in May 2017, and now covers 732 airports. It has provided over 1 million approvals: 545,074 auto-approvals for airspace access requests from part 107 users, and 352,775 requests from recreational operators as defined by 49 U.S.C. §44809[31] and sending 102,837 for further coordination. Approvals thus total more than 1 million, 570,000 more since this time last year. (See below.) LAANC authorizations are facilitated by the use of UAS Facility Maps (UASFM) that provide maximum allowed altitudes around airports where the FAA may authorize Part 107 UAS operations without additional safety analysis. [See faa.maps.arcgis.com/apps/webappviewer/index.html?id=9c2e4406710048e19806ebf6a06754ad.] The UAS facility maps are used to

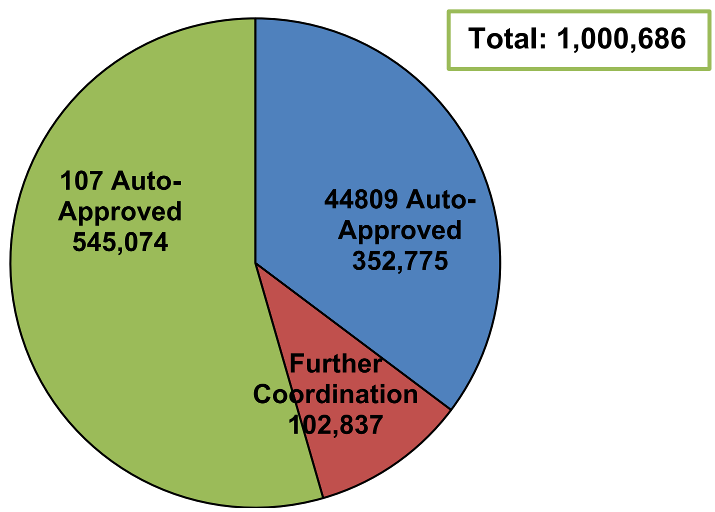
who is not directly participating in the operation and who is not located under a covered structure or inside a stationary vehicle.

[30] On June 9, 2021, the FAA initiated an Aviation Rulemaking Committee (ARC) to facilitate BVLOS in the NAS. [See www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/committee/browse/committeeID/837 for details.] Recently, UAS BVLOS ARC has provided recommendations to the FAA for performance-based regulatory requirements to normalize safe, scalable, economically viable, and environmentally advantageous BVLOS drone operations that are not under positive air traffic control (ATC) [see www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS_BVLOS_ARC_FINAL_REPORT_03102022.pdf for the final report]

[31] §44809 is strictly for recreational uses. [See www.faa.gov/uas/recreational_fliers/new_changes_recreational_uas/media/44809_authorization.pdf.]

inform requests for part 107 airspace authorizations and waivers in controlled airspace.

LAANC Airspace Requests



Status of Survey

The FAA has initiated a comprehensive survey of drones, the "Survey of UAS Operators."[32] The survey targets commercial, public safety, and recreational small drone operators within the United States.[33] Recreational, commercial, and public safety UAS operators are identified via the aircraft registry and are randomly sent invitations to complete a questionnaire specific to their geographic location and operating type. Utilizing the part 107 (commercial and public safety) and section 44809 (recreational) registries, Survey of UAS Operators invites small UAS operator to participate in the survey by completing a questionnaire.[34] These invitation are randomly sent to operators within the two registries controlling for the U.S. County or the equivalent in which the registrant is registered and the type of operating: recreational, commercial, and public safety.[35] This

[32] The FAA has received OMB approval for a new information collection (OMB# 2120-0797). For additional information, see www.reginfo.gov/public/do/PRAViewDocument?ref_nbr=202008-2120-005.

[33] Survey respondents are all individuals or organizations who own and operate small drones within the United States. This does not include licensed remote pilots who pilot drones for other individuals or organizations.

[34] The section 44807 registry is used as the sample frame for sampling recreational operators. The part 107 (or Section 44809) registry is divided into two sample frames, commercial and public safety operators, by applying an algorithm to a registrant's data within the part 107 registry. These three frames serve as the bases for random sampling stratified by operator type. See following footnote for additional details in the survey design.

[35] The survey is designed as a stratified random sample with two strata: operator type and US county or the equivalent (such as parish or borough). Each cell, operator, and county pair is randomly sampled 30 times. If the cell has 30 or fewer registrants within it, the entire cell is sampled. See Supporting Statement B in the Information Collection Request (ICR) supporting doc-

survey method ensures a geographical representation of the operators and their behavior.

The survey aims to collect drone flight behavior, fleet characteristics, commercial activities, and features of public safety programs. To accomplish this, the questionnaire asks all operator types about typical flight activity such as average time of flight, operation over a week, and activity in specific months; and the composition of their fleet, such as number of aircraft, propulsion type, and operability.[36] Commercial and public safety operators who operate under part 107 are asked additional questions. Commercial operators are asked where they are operating, the industries in which they operate, and whether they intend to apply for a part 107 waiver. Public safety operators are asked about their drone program, if they share their program with other agencies or hire a commercial operator, and types of missions conducted.

The FAA is currently conducting pilot studies for the Survey of UAS Operators, and anticipates completion by summer 2022. These pilot studies are used to improve the survey design, clarify the questionnaire, and increase statistical validity.[37] The pilot studies are designed to reveal respondent activities during 2021. In late summer of 2022, the FAA plans to conduct a standardized survey regarding 2022 behavior. The FAA plans to publish the results of the 2022 standardized survey in the following year's Aerospace Forecast.[38] The Survey of UAS Operators is expected to be conducted annually, with the results published in the following year's Aerospace Forecast.

The FAA plans to use the information from the survey to paint a comprehensive picture of small drone activity throughout the NAS and how this activity is expected to change over time. This includes developing a geographical density estimate of small drone activity across the United States, and the change in activity over the course of a year. The annual survey is expected to become an additional data source for developing the small drone forecasts after multiple years of

uments at www.reginfo.gov/public/do/PRAViewDocument?ref_nbr=202008-2120-005 for additional information regarding the survey design.

[36] The survey questionnaire is administered through Survey Monkey, and invitations are sent to selected participants through an FAA email. Questionnaire completion time ranged from 5 to 10 minutes, depending on operator type. All three types were asked identical questions regarding flight behavior and fleet. Only commercial and public safety operators have additional question following the flight behavior and fleet questions.

[37] Pilot studies include several studies of sampling and nonresponse bias as well as testing several aspects of the questionnaire.

[38] The data from the 2022 Survey of UAS Operators is expected to appear in a supplement to the Aerospace Forecast 2023-2043.

survey data have been collected.[39] Moreover, the fleet data collected from the survey should support forecasting at the county level and thus increase the granularity of the small drone forecast. Overall, the Survey of UAS Operators is expected to increase the data available to FAA forecasters and the drone industry as it becomes a standard product of the FAA.

Remote Pilot Forecast

An important final metric in commercial small drones is the trend in remote pilot (RP) certifications. RPs are used primarily to facilitate commercial and public use small drone flights. As of December 2021, 254,850 RP certifications had been issued, an increase of approximately 52,000 from the same time last year (2020) and slightly higher than the year before (2019).[40]

Part 107 certifications require completing a multi-step process, beginning with obtaining an FAA tracking number via the creation of an Integrated Airman Certification and Rating Application (IACRA) profile prior to registering for a knowledge test. Following this initial step, scheduling and passing the initial aeronautical knowledge test at a Knowledge Testing Center is required. Provided that one has passed this test, the applicant is required to fill out FAA Form 8710-13 in IACRA. A confirmation email is sent when an applicant has completed the necessary Transportation Security Administration (TSA) security background check. This email contains instructions for printing a copy of the temporary remote pilot certificate from IACRA. A permanent remote pilot certificate is sent via mail once all other FAA-internal processing is complete. An RP certificate is valid for two years, and certificate holders must pass a recurrent knowledge test every two years at a Knowledge Testing Center. It is required that RPs carry their certificate whenever flying a small drone.

Certifications for part 61 operators, on the other hand, require an applicant to hold a pilot certificate issued under 14 CFR part 61, and to have completed a flight review within the previous 24 months. Since part 61 operators already have IACRA profiles established, they are required to complete, like part 107 operators, FAA Form 8710-13 in IACRA. Upon completion of this form, submission of proof of current flight review, and submission of proof of online course completion, part 61 operators are required to meet with FAA representatives at the FAA Flight Standards District Office (FSDO), or with an FAA-designated pilot examiner (DPE), or an airman certification representative (ACR) or an FAA-certificated flight instructor (CFI), who issues the RP certificate to the part 61 operator. Like their part 107 counterparts, certificates for part 61 operators are valid for 2 years and require renewal. [See

[39] The FAA has authorization to conduct the Survey of UAS Operators through 2023 under the current information collection authorization from OMB. The FAA anticipates the renewal of the survey in 2024 and to continue the survey annually in perpetuity.

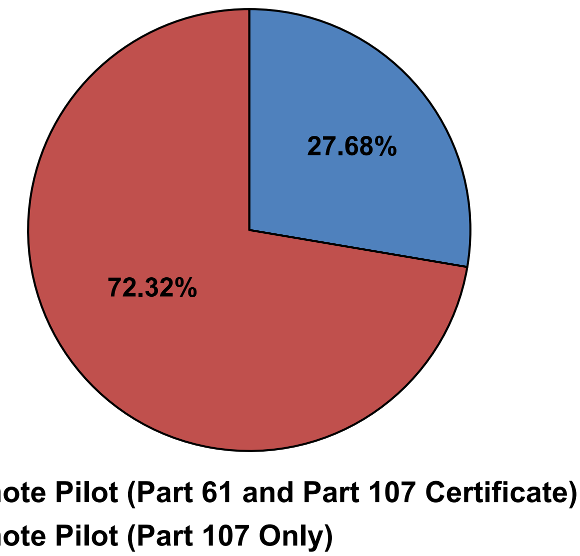
[40] In our accounting of RPs, we take pilots who passed the initial knowledge test (or part 107), plus current traditional pilots who took online training in lieu of the knowledge test (or part 61).

www.faa.gov/uas/commercial_operators/become_a_drone_pilot/ for more details.]

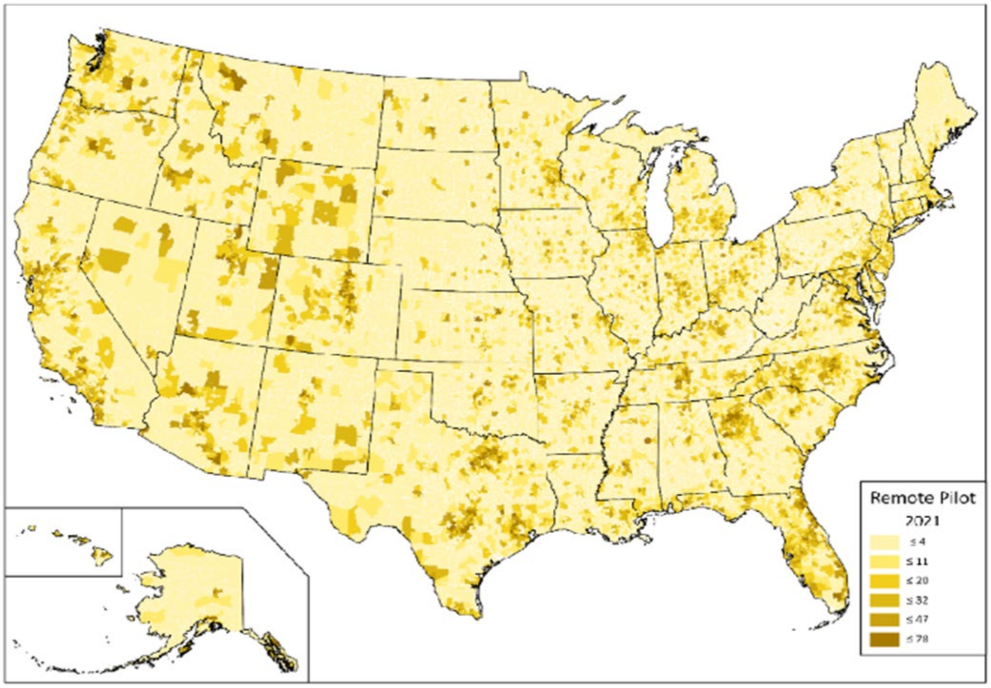
Following the process above, the FAA classifies RPs into two categories:

- those who do not hold any pilot certificate other than the part 107, or Remote Pilot Only; and
- those who hold a part 61 certificate and a part 107 certificate, or Part 61 and Remote Pilot.

Distribution of Remote Pilots

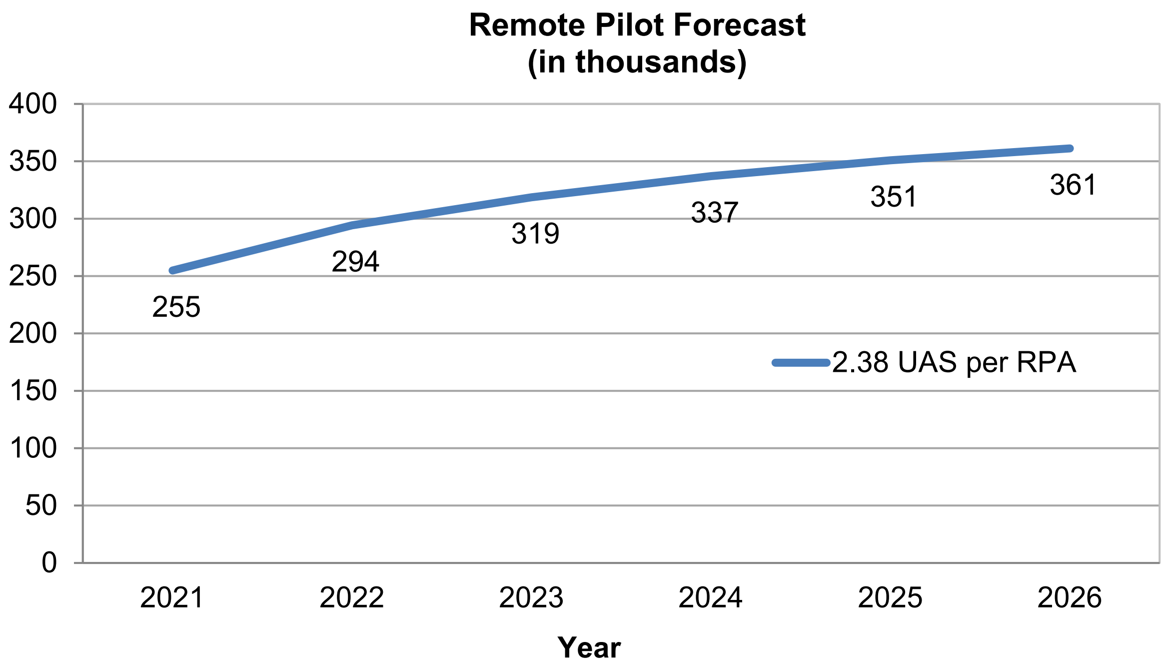


Over 70% of the RPs are part 107 RPs only. Over 90% of those who took the exam passed and obtained RP certification. A cumulative density distribution of remote pilots by zip codes in 2021 is provided in the map below.



The RP forecasts presented below are based on three primary data sources: (a) trends in total RPs; (b) renewal trends; and (c) trends in commercial small drone registration and forecasts of fleet. In this context, it is important to note that the empirical relationship between trends in RP and commercial/part 107 small drone registration, particularly new registration, appear to hold despite expiry, cancellations and renewal. Given the trends in registration and our forecast of the commercial small drone fleet (i.e., base forecasts), the FAA assumes that one pilot is likely to handle 2.38 units of commercial small drone aircraft, the same as the previous two years.

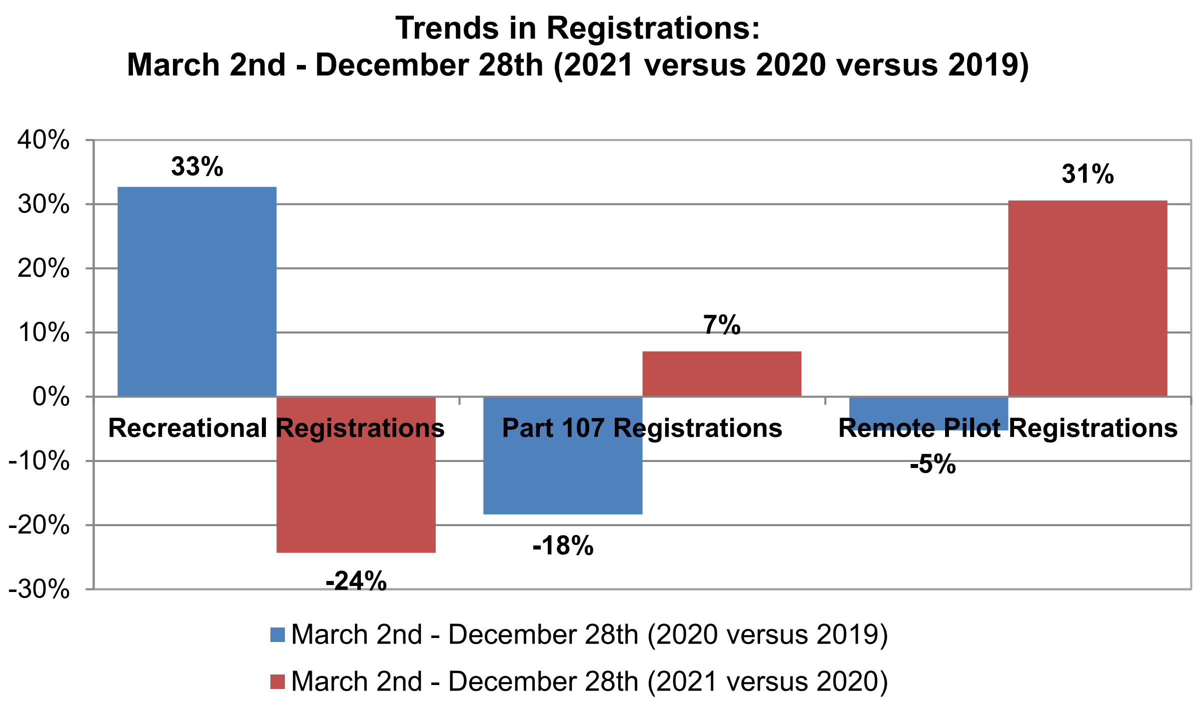
Using these assumptions and combined with the base scenario of the commercial small drone forecast, we project RPs in the graph below. Last year, the FAA projected RPs to be approximately 248,200 by the end of 2021. Actual registrations by the end of 2021 totaled 254,850 (or more than 6,800 from last year's projection) thus actual exceeding last year's projection by 2.68%.



Given the actual numbers at the end of 2021, RPs are set to experience tremendous growth following the growth trends of the commercial small drone sector. Starting from the base of 254,850 RPs in 2021, commercial activities may require over 361,000 RPs in five years, a 1.4-fold increase that may provide tremendous opportunities for growth in employment—over 100,000 new RP opportunities—associated with commercial and public use activities of small drones. Potential for RPs may enhance even more if larger drones are used in commercial activities and advanced air mobility (AAM) becomes a reality in the near future.

COVID-19 and Its Impact on sUAS

The chart below summarizes how COVID-19 may have impacted three areas of registration. During the prolonged and partial economic shut-downs during March – December 2020 and January – December 2021, respectively, it is clear that commercial facets of small drone operations, i.e., part 107 and RP registrations, were impacted negatively during 2020.



Part 107 registrations dropped by over 18% in 2020 compared to the prior year, but recovered in 2021 with an increase of 7%. RP registrations dropped by 5% in 2020, followed by a 31% increase in 2021. Interestingly, the registration of recreational users increased by almost 33% during the past year (2020) in comparison to the year before; however, recreational user registration went down by 24% in the second year of the pandemic, in comparison with the first year. While it is quite possible that these drops/increases were led by developments within the Part 107 community, we believe that at least some of the observed drops/increases were caused primarily by COVID-19. As the economy slowed down considerably, the use of commercial small drones (and, correspondingly, the use of RPs), may have decreased in the first year, followed by economic adjustments in the following year that allowed for increased commercial use. On the other hand, the economic slowdown may have afforded more time to people working from home to experiment with recreational use of small drones; this may have caused higher recreational registration in the first year of the pandemic in comparison to the prior year. The situation seems to have reversed during 2021, where recreational registrations dropped by 24%, while part 107 and RP registrations bounced back by 7% and 31%, respectively, in comparison to the prior year. The changing nature of registrations, and subsequently forecasts, offers challenges and opportunities for integration of small drones into the NAS.

IPP to BEYOND and PSP

One such integration challenge was addressed under the UAS Integration Pilot Program (IPP). Beginning in 2017, the IPP brought state, local, and tribal governments together with private sector entities, such as UAS operators or manufacturers, to test and evaluate the integration of civil and public drone operations into the NAS. The IPP program concluded on October 25, 2020 [See www.faa.gov/uas/programs_partnerships/integration_pilot_program/ for more details.] The FAA launched a new program called BEYOND to continue working on specific challenges of drone integration by:

- identifying ways to balance local and national interests related to drone integration;
- improving communications with local, state and tribal jurisdictions;
- addressing security and privacy risks; and
- accelerating the approval of operations that currently require special authorizations.

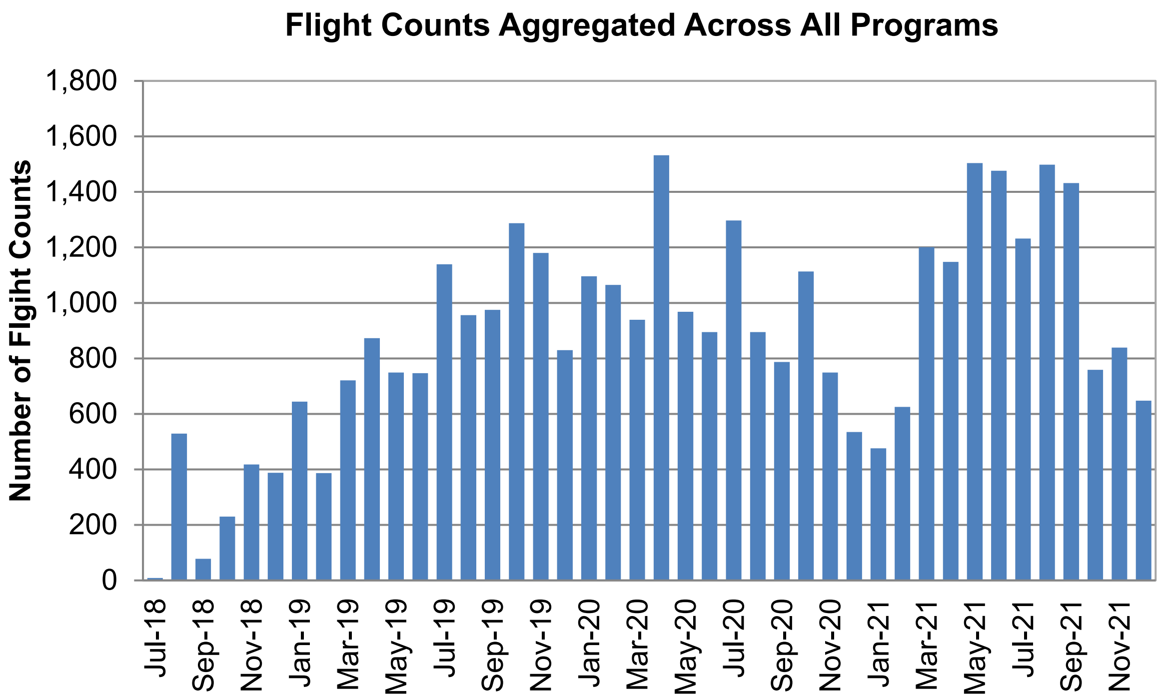
BEYOND started on October 26, 2020 to continue the partnership activities with eight of the nine IPP participants. [See www.faa.gov/uas/programs_partnerships/beyond/.]

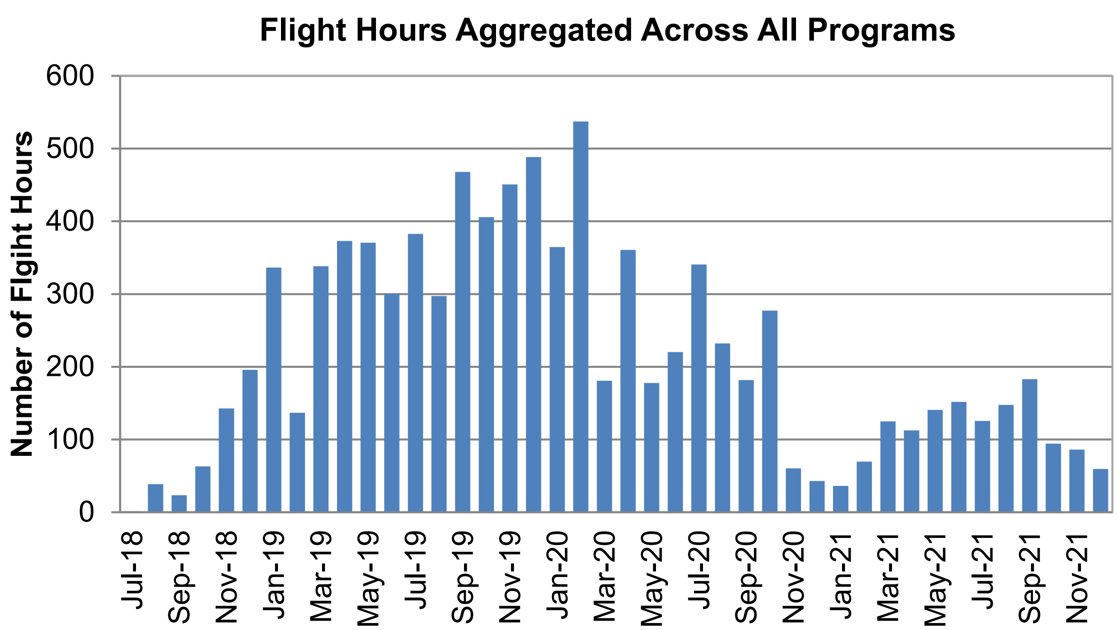
In addition to these programs, the FAA launched the UAS Partnership for Safety Plan (PSP) initiative in December 2016 to address and advance complex drone operational capabilities. The program establishes a working relationship between the FAA and industry to help facilitate the full integration of drones into the NAS. [See www.faa.gov/uas/programs_partnerships/psp/ for more details.][41]

Since their beginning, these programs have facilitated numerous activities by the participants. For example, under the programs, participants have logged over 36,800 flights using over 2,300 small drones, accumulating over 9,100 hours of flight time. Activities under both BEYOND and the PSP continue.

Distribution of the combined flight counts and corresponding total flight hours over time are given, respectively, in the following charts:

[41] In order to assist and accommodate other members outside these programs, the FAA has created a category called "voluntary reporting." Under this program, members outside BEYOND and PSP can volunteer their information which is then aggregated with IPP, BEYOND, and PSP information and presented in this section.

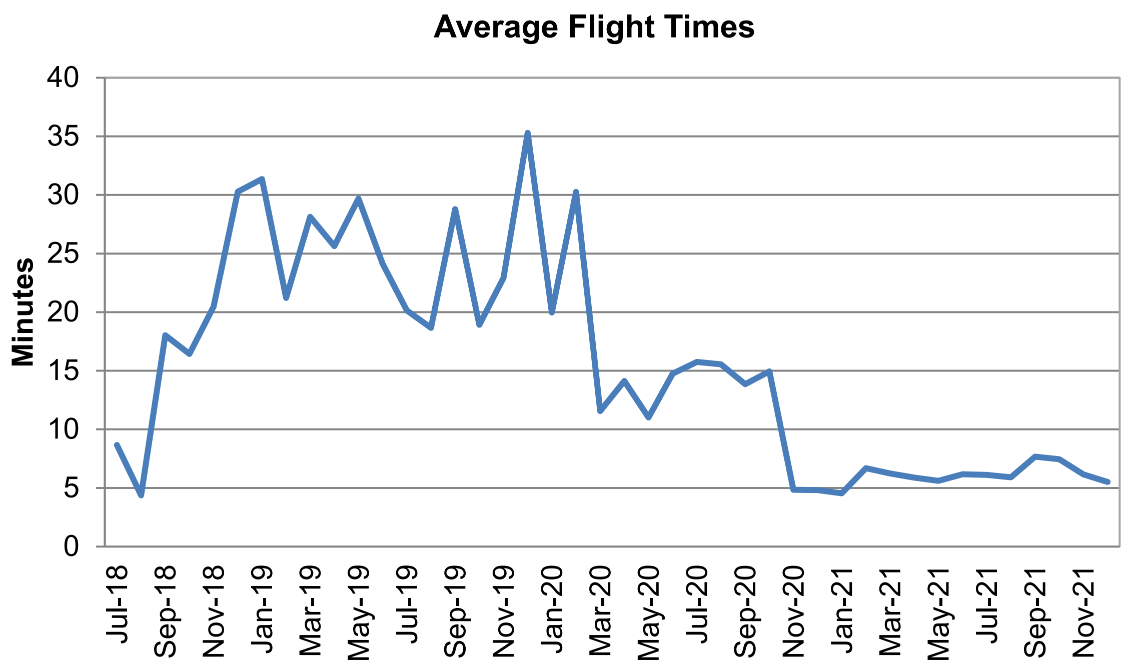




Based on the above information, average flight time over the years across all programs has stood at approximately 15 minutes.[42] Distribution of flight times during the period is provided in the graph below. Given that BE-

[42] This is an important metric to understand the scope of operational activities of drones across the NAS. When widely operational, i.e., outside BEYOND and PSP, this will have implications in terms of capital investment in infrastructure, planning for personnel, and unmanned traffic management (or UTM) in the future.

YOND and PSP programs are presently operational and active, average flight times are expected to increase over time.



Of around 36,850 total flights over the lives of these programs, a large majority of the flights have been geared towards package delivery (73%), thus signifying the commercial importance of this mission. Package delivery flights are followed by infrastructure inspection, both linear and non-linear, accounting together for over 14%; and other activities such as public safety (7.7%) and research/testing (4.4%). This composition provides some guidance in terms of likely forecasts and growth trajectory of the drone sector in the near future. The table below summarizes the types of missions and corresponding flight counts aggregated under all three programs.

Flight Counts by Mission Type

Mission Type	Flight Count
Agricultural Operations	125
Infrastructure Inspection (Linear)	2,047
Infrastructure Inspection (Non-Linear)	3,176
Media	11
Package Delivery	26,859
Public Safety	2,835
Research/Testing	1,613
Surveillance	183
Grand Total	**36,849**

All these activities take place in different types of airspace classes, thus signifying the importance of drone integration into the NAS. Furthermore, these classes of airspace intersect with different types of geographic locations, broadly captured under assembly, rural, suburban and urban.[43] The table below summarizes airspace usage by aggregated location within the NAS.

Total Flight Counts by Geographic Locations and Use of Airspaces

Airspace Classes	Assembly	Rural	Suburban	Urban	Grand Total
Class B	50	65		1,233	1,348
Class B, Class G		50			50
Class C, Class G		1		1	2
Class D	3	534	1,816	2	2,355
Class D, Class G				486	486
Class G	28	11,618	10,102	5,463	27,211
Class G, SUA				1	1
NA		1,867	3,529		5,396
Grand Total	**81**	**14,135**	**15,447**	**7,186**	**36,849**

*NA: Not Available or Reported

Clearly, the most used airspace is Class G (74%), and it is distributed primarily in rural (43%) and suburban (37%) areas, followed by urban areas (20%). Class D and B are increasingly used while intersections of other classes, (e.g., Class D/G, and Class B/G), are also observed.

Finally, participants under all three programs undertake the above activities using different operating rules. The table below summarizes flight counts under these rules:

[43] "Assembly" is short for "open-air assembly". An open-air assembly is generally understood as a dense gathering of people in the open, usually associated with concert venues, sporting events, parks, and beaches during certain events. Such assemblies are usually associated with public spaces. [See www.faa.gov/documentLibrary/media/Advisory_Circular/AC_107-2A.pdf for more details.]

Flight Counts by Operating Rules

Operating Rules	Flight Count
Airspace	931
BVLOS w/o VO	110
BVLOS w/VO	25,373
Multiple UA	57
Night Operations	101
OOP	3,365
OOP; OOMV	187
VLOS	2,223
UNK*	4,502
Grand Total	**36,849**

*UNK: Not documented/Not reported

As noted earlier, one of the primary focuses of the BEYOND program is to accelerate the approval of operations that currently require special authorizations (or waivers). On the other hand, advancing complex operations has been the key focus of the PSP program. Given these, it is quite natural that BVLOS is the predominant operating rule under all three programs, accounting for almost 70% of total flight counts. The previous table shows that the majority of flights are conducted with a visual observer (VO), while only 0.2% of flights are conducted without a VO. [44] For operations requiring waivers, i.e., multiple UA, night operations, operations over people (OOP), operations over moving vehicles (OOMV)), airspace and altitude are facilitated and observed across programs. Thus the table above demonstrates the underlying focus of these programs in facilitating different operating rules proposed and performed by the participating members. Finally, "UNK" (unknown) stands for flights that had not reported and/or where there was very little documentation to report.

Large UAS

Drones weighing 55 pounds or greater cannot be operated under part 107 or as recreational remotely piloted aircraft. These large drones must be registered using the existing aircraft registration process and operated under a section 49 U.S.C. § 44807 exemption or public aircraft operator (PAO) certification. [See www.faa.gov/uas/advanced_operations/certification/section_44807/ for more

[44] BVLOS with VO has numerous classifications within it; e.g., BVLOS w/VO for airspace; BVLOS for operating multiple drones; BVLOS w/VO for night operations; BVLOS w/VO for operations over people, moving vehicles, and visibility. These are combined under the broad category of "BVLOS w/VO" in the table. Following on BVLOS Final Report (see fn. #19) from the ARC, it is anticipated that regulatory environment will evolve in the near future.

details.][45] At present, many of these large drones are flown within the NAS by government entities, but commercial operators have steadily increased in 2021, with the majority of new large drone operators active in agricultural spraying markets. In order to calculate active large drones in the NAS, we employ a multitude of data from various sources:

- COA Online system and its successor CAPS or COA Application Processing System [see www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/coa];
- MITRE's Threaded Track infusing data from different sources [see www.mitre.org/publications/technical-papers/threaded-track-geospatial-data-fusion-for-aircraft-flight-trajectories];
- FAA's Performance Data Analysis and Reporting Systems (PDARS) [see www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/perf_analysis/perf_tools];
- FAA's Aircraft Registry [see www.faa.gov/licenses_certificates/aircraft_certification/aircraft_registry/];
- Published decisions on 44807 exemption applications; and
- Notices to Airmen (NOTAM).

Combining these data sources, the FAA estimates that 285 IUAS or large drones were operating in 2021. However, these estimates are likely the lower bound since a growing number of agricultural large drones are operating in close proximity to the ground (i.e., likely below 400 feet above ground level (AGL)) and are not captured by this data. The exemptions and registration of these agricultural spraying large drones have increased significantly in 2021 and are likely to grow rapidly over the next five years. However, these agricultural spraying large drones will have little effect on air traffic in the NAS given their location away from busy traditionally-piloted air traffic and low altitude traffic.

Large drones operated by military and civilian agencies in the NAS are expected to grow at a steady pace over the next five years. Currently, military aircraft and military contractors constitute the majority of large drone activity in airspace above 400 feet AGL and are likely to remain the predominant operators over the forecast time horizon.

In 2021, 51 companies were granted FAA 49 U.S.C. § 44807 exemptions for commercial drones with weights above 55lbs, more than double the exemptions granted in 2020. Some of these companies were granted multiple exemptions. Over 92 percent of the new 44807 exemptions for large drones were granted for use in agricultural spraying.[46] This sharp increase in the number of new exemptions granted in 2021, as well as the vast majority granted to agricultural spraying

[45] Large drones operated by the military or a military contractor are operated under authority of the Department of Defense. Military large drones are not required to be registered in the public aircraft registry.

[46] Although 92 percent of the 44807 exemptions are for agricultural spraying, only 9 percent of the public aircraft registrations were linked to agricultural large drones in 2021. However, registered agricultural large drones more than doubled between 2020 and 2021, a trend that started in 2019. This suggests that registration of large drones could lag behind grants of 44807 exemptions.

companies, signals regulatory standardization around the use of large drones operating close to ground level and outside of populated areas, such as in the case of agricultural spraying.

The registration, in the public aircraft registry, of heavier-than-air, remotely piloted aircraft over 55lbs has increased by 56 percent, from 510 at the end of 2020 to 784 at the end of 2021. Three hundred and twenty-one (321) large drones were registered or renewed in 2021, up 52 percent from 2020, while the delisted and expired registrations fell by 39 percent from 128 in 2020 to 78 in 2021. This has led to a 50 percent increase in large drones registered in the public aircraft registry.

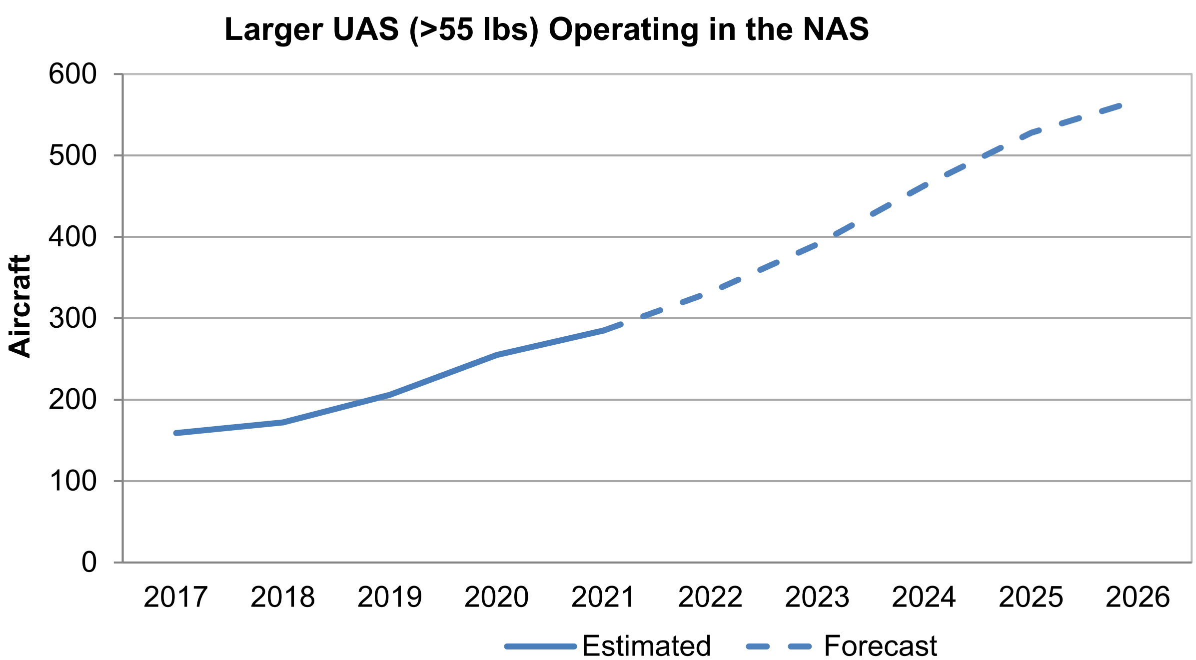
Although 784 large drones are registered in the public aircraft registry, only 12 percent of those registered large drones have been observed in flight.[47] As such, a sizable portion of large drone operators are not active in the NAS due to safety or regulatory concerns or because they only operate close to the ground or in private airfields. Thus, the vast majority of registered large drones are unlikely to come in contact with air traffic control (ATC). For the purposes of this forecast, the FAA limits the projected large drone activity to aircraft operating in airspace where contact with other large drones or traditionally-piloted aircraft is likely.

Larger UAS (>55 lbs) Forecast - 5 Years

Year	Active L-UAS	Number of Flights
Historical		
2017	159	7,066
2018	172	7,223
2019	206	7,360
2020	255	7,144
2021	285	7,519
Forecast		
2022	332	8,757
2023	391	10,325
2024	463	12,223
2025	528	13,930
2026	568	14,981

[47] The statistic is based on tail numbers from MITRE's thread tracking data and manufacturer/model characteristics from the public aircraft registry.

Combining the baseline from military and civilian agencies and projections of commercial exemptions from the FAA, large drones are estimated to have increased from 255 in 2020 to 285 in 2021; they are expected to continue increasing at a steady pace, through 2026, to 568 aircraft. This is due to an increase in the commercial and research applications of large drones. However, the sunset of drone exemptions under section 44807 in September of 2023 could create headwinds for further deployment of large drones. Operators are likely to scale back investment in new large drones as their ability to operate these aircraft beyond 2025, assuming they receive renewals in 2023, becomes uncertain. Extending or replacing the 44807 exemptions before 2025 would likely remove these obstacles to continued fleet expansion.

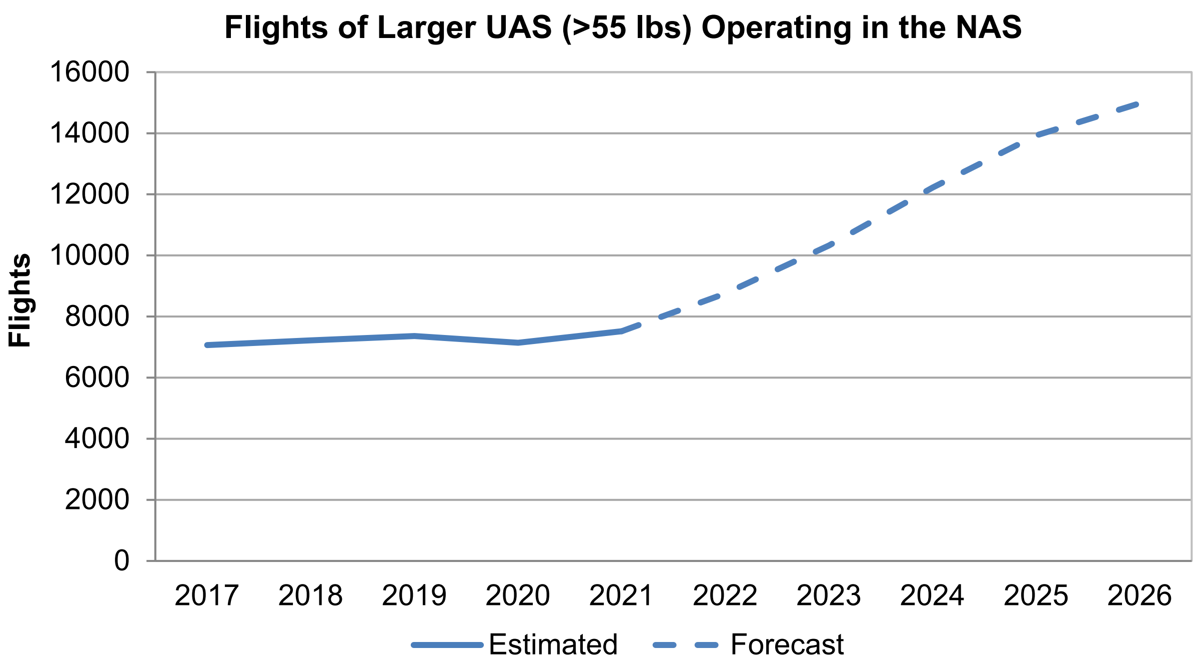


Corresponding to the active large drone fleet, the number of large drone flights increased from an estimated 7,144 in 2020 to 7,519 in 2021.[48] This indicates that the utilization of large drones is falling compared to previous years.[49] The increase in lUAS or the large drone fleet and decreasing aircraft utilization suggests that lUAS or large drones are still at an early stage of development. However, the sharp increase in 44807 exemptions granted, and the healthy increase in registered large drones in the public aircraft registry suggest that large drone operators have shrugged off the uncertainty of the 2020 – 2021 recession, which should increase investment in new aircraft over the next five years. As such, the forecast has been adjusted upward to reflect the growth

[48] Estimates of 2021 large drone flights are based on new methodology. The new algorithm decreases the misidentification of traditionally-piloted aviation as large drones. . Over 70% of the observed flights are conducted by registered large drones operating under a variety of authorities: 44807 exemptions, public aircraft operators (PAO), or the Department of Defense.

[49] Utilization is calculated as lUAS flights divided by active lUAS or large drones.

path from before the pandemic-related recession, which is likely a more accurate reflection of future outcomes, barring an economic downturn in the near future.



Advanced Air Mobility

In September 2017, NASA launched a market study for a segment crossing over some functions of drones discussed above. This segment of piloted and autonomous vehicles, broadly called AAM, is defined as "a safe and efficient system for air passenger and cargo transportation, inclusive of small package delivery and other urban drone services, which supports a mix of onboard/ground-piloted and increasingly-autonomous operations."[50] [See www.nasa.gov/aero/nasa-embraces-urban-air-mobility.] Building on the UAM concept by incorporating use cases not specific to operations in an urban environment, the FAA defines the scope of AAM as follows [See www.faa.gov/uas/advanced_operations/urban_air_mobility/):

- Commercial Inter-city (Longer Range/Thin Haul);
- Cargo Delivery;
- Public Services; and
- Private / Recreational Vehicles

[50] The community is in the process of establishing nomenclature. Only recently, the community-at-large has moved on to coining earlier-used "urban air mobility" (UAM) as "advanced air mobility" (AAM) to broaden its operational scope, technical characteristics, economic opportunities, and regulatory framework. Under this broad characterization, UAM is considered a subset of AAM.

AAM technology presents considerable opportunities for economic growth over the coming decades. Markets for AAM services, such as package delivery by drone or larger autonomous or remotely piloted cargo delivery, airport shuttling (or services along the fixed routes between urban routes to airports), or traditionally-piloted, remotely-piloted, or autonomous passenger shuttles or air taxis (i.e., on-demand point-to-point services) have significant potential both in the United States and globally. For example, package or larger cargo delivery is the AAM service that is most likely to experience economic growth in the next decade. By 2030, package delivery is likely to be profitable at a price point of $4.20 per delivery, with a fleet of 40,000 vehicles completing 500 million deliveries per year.[51]

Passenger services, on the other hand, promise larger markets for AAM services, but safety challenges, infrastructure, public acceptance, and evolving technology leading to market uncertainties may slow the pace of AAM's penetration into this segment of the market. Nevertheless, flight testing continues to elucidate the performance dynamics of electric vertical take-off and landing (eVTOL). For example, Joby Aviation announced in July 2021 that it has completed a test flight which surpassed 150 miles on a single charge with its eVTOL aircraft. The flight was remotely piloted and completed 11 laps of a predefined circuit, covering a total distance of 154.6 statute miles with a total air time of 1 hour and 17 minutes.[52] Additionally, in fall 2021, under NASA's AAM National Campaign, Joby Aviation conducted further flight tests which produced data on its eVTOL aircraft performance and acoustic characteristics.[53] The data was shared with NASA to support its modeling and simulation and AAM research efforts. The flight tests also helped evaluate NASA's flight safety and airworthiness processes to approve flight testing participants and establish a baseline and protocols for future testing.

The increasing number of flight tests and data collection are paving the way for type certification of eVTOL aircraft. In 2020, Joby became the first eVTOL company to sign a G-1 issue paper to define a certification basis with the FAA, and in February 2022 Joby announced it started certification testing observed by an on-site FAA Designated Engineering Representative (DER). The test will evaluate the material strength of its eVTOL components, and is an important step in obtaining FAA aircraft type certification.[54] It is also worth noting that Joby has begun the process to obtain an FAA part 135 air carrier certificate, which it expects to receive in 2022, to formalize its status as an eVTOL airline.

There is also eVTOL type certification progress globally. In February 2022, Eve Urban Air Mobility, which plans to operate eVTOL flights in Brazil and in Latin America, formalized the process for obtaining type certification from the National Civil Aviation Agency – Brazil for its eVTOL aircraft (with deliveries

[51] Urban Air Mobility (UAM) Market Study, Nov. 2018, NASA. (See www.nasa.gov/uamgc)

[52] www.jobyaviation.com/news/joby-completes-flight-of-more-than-150-miles/

[53] NASA launched a National Campaign in March 2020 to promote public confidence and accelerate the realization of emerging aviation markets for passenger and cargo transportation in urban, suburban, rural, and regional environments. [See www.nasa.gov/aamnationalcampaign for more details.]

[54] www.jobyaviation.com/news/joby-begins-first-conformity-testing-enters-next-phase-certification-process/

expected to start in 2026).[55] German air taxi manufacturer, Volocopter, obtained a production organization approval (POA) from the European Union Aviation Safety Agency (EASA).[56] Recently, Volocopter laid out an urban transportation and mobility roadmap enabling tourist routes within the Marina Bay area and to nearby regional economic centers from Singapore in just 30 minutes.[57] In a similar vein, Joby Aviation, in collaboration with ST Telecom, signed a partnership on February 6, 2022 to introduce aerial ridesharing services to cities and communities in South Korea.[58] Airbus expects its UAM aircraft to meet EASA certification standards (EASA SC-VTOL Enhanced Category) and receive type certification around 2025.[59]

One of the major challenges of eVTOL entering into the marketplace is infrastructure. In order to increase accessibility of vertiports for AAM services, air taxi operators have been evaluating different approaches to expand the potential network of vertiports or takeoff and landing areas (TOLAs). In 2021, both Joby and Archer entered into partnerships with parking garage operator REEF Technology with the goal of running air taxi operations from the rooftops of redesigned parking garages.[60]

The infrastructure constraint—the availability of desirable TOLAs—will be a challenge for scaling AAM operations, as they require community acceptance and affect issues relating to social equity and noise and environmental impacts. NASA is leading research in these areas, and in 2021 it released a report with NUAIR (Northeast UAS Airspace Integration Research Alliance, Inc.) and industry describing a concept of operations for high density vertiport operations.[61] Recently, the FAA issued an engineering brief providing interim guidance to airport owner/operators and their support staff for the design of vertiports for vertical takeoff and landing operations [see www.faa.gov/airports/engineering/engineering_briefs/drafts/ for more details].

Other than eVTOL operators, some companies are focusing on developing the infrastructure needs which require partnering with local governments and property owners to locate and acquire sites for future vertiports. For example, Urban-Air Port, a UK-based startup, announced in January 2022 that it plans to develop 200 vertiports for eVTOL flights in 65 cities to accommodate the anticipated AAM demand.[62]

Due to uncertainties associated with numerous issues such as type certification and infrastructure, market estimation for the overall sector has been quite wide. The total available market for passenger services is estimated to be $500 billion in the United States, but AAM is unlikely to garner more than $2.5

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[55] Eve Urban Air Mobility is an Embraer company planning to become public through a merger with a special purpose acquisition company (SPAC), as predecessors Joby, Archer, Lilium, and Vertical Aerospace have.

[56] www.aerospace-technology.com/news/volocopter-poa-easa-evtol/

[57] volocopter-statics.azureedge.net/content/uploads/220209_Volocopter_Singapore-Roadmap.pdf for more details.

[58] See ransportup.com/category/headlines-breaking-news/vehicles-manufactures/

[59] www.airbus.com/en/newsroom/press-releases/2021-09-airbus-reveals-the-next-generation-of-cityairbus

[60] www.jobyaviation.com/news/joby-aviation-announces-infrastructure-partnership/

[61] ntrs.nasa.gov/api/citations/20210016168/downloads/20210016168_MJohnson_VertiportAtmtnConOpsRprt_final_corrected.pdf

[62] dronedj.com/2022/01/26/urban-air-ports-to-create-200-evtol-vertiports-for-aam-service/

billion of this market in the near term, as one study estimates.[63] On the upside of the estimation, a recent study conducted by Deloitte and the Aerospace Industries Association (AIA) estimates the AAM market in the US to reach approximately US $115 billion by 2035, equivalent to 30% of the present US commercial air transportation market.[64] Of that total, US $57 billion is expected to originate in passenger air mobility, while an equivalent amount is expected to come from the cargo market.

Market dynamics underlying AAM are complex, numerous, and quickly evolving. Although COVID-19 has led to an increased adoption of virtual work versus commuting and business travel, persistence of this trend in the long-run is mired in uncertainty.[65] Socioeconomic changes such as population shifts from urban to suburban or rural areas (i.e., de-urbanization) could also affect the various AAM use cases differently. AAM services, both cargo and passenger, may appear to be unprofitable in the near future, like many other services in the beginning. The AAM passenger industry is likely to expand due to an inflow of venture capital and experimental services exploring market opportunities. For example, following the numerous SPAC mergers for AAM companies last year, which injected significant capital to further their development and commercialization efforts, Wisk Aero secured an additional $450 million investment from Boeing in January 2022. Volocopter has also recently entered into an agreement that may provide up to $1 billion in financing.[66] Furthermore, eVTOL operators like Joby are expanding partnerships to operate air taxis in international markets[67] and many companies are experiencing rising interest and increased orders of their eVTOL aircraft, both in the US and globally.[68]

Airport shuttles and other fixed-route passenger services are the AAM passenger services most likely to gain economic traction in the coming decade. Optimistic reports project the AAM passenger industry to have 23,000 aircraft with 740 million enplanements per year at a price of around $30 per trip by 2030.[69] However, several other studies have reported more conservative estimates, arguing that market penetration is likely to be limited to a handful of major metropolitan areas where geography and economic conditions are conducive to AAM market development. As such, estimates by KMPG predict 60.4 million enplanements by

[63] UAM Market Study – Technical Out Brief, Oct. 2018, Booz-Allen-Hamilton and NASA. [See ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190001472.pdf.]

[64] www2.deloitte.com/us/en/insights/industry/aerospace-defense/advanced-air mobility.html?id=us:2el:3pr:4diER6839:5awa:012621:&pkid=1007244

[65] Road congestion and associated opportunity cost in commuting around metro areas provided the most powerful boon for economic and financial justifications for AAM passenger services. However, changed working pattern and working from home (WFH) location due to COVID19 put a damper on that earlier economic trade-off, at least in the near-term.

[66] www.flyingmag.com/volocopter-partners-with-acg-to-provide-1-billion-in-financing-solutions/

[67] www.forbes.com/sites/catherinewang/2022/02/09/heads-up-sk-telecom-joins-forces-with-joby-aviation-to-launch-flying-taxis-in-south-korea/?sh=41b6642615c8

[68] dronedj.com/2022/01/20/japanese-helicopter-service-provider-orders-50-air-taxis-from-ehang/ and https://eveairmobility.com/eve-and-bristow-enter-partnership-to-develop-uam-capabilities-with-an-order-of-up-to-100-evtols/

[69] Urban Air Mobility (UAM) Market Study, Nov. 2018, NASA. [See www.nasa.gov/uamgc.]

2030 and a much smaller industry size.[70] Similarly, Roland Berger estimates a fleet of only 12,000 passenger drones by 2030.[71] However, given the current safety and technology challenges, even these projections may be optimistic. Using airport shuttle and air taxi as the scope, a recent study concluded that AAM passenger services could have a daily demand of 82,000 passengers served by approximately 4,000 four to five-seater aircraft in the US. Baselining in the most conservative scenario, these services may yield an annual market valuation of $2.5 billion[72].

Given the enormous economic potential underlying the AAM sector, coordination led by the FAA, including collaborations with NASA and industry, is allowing numerous integration activities to take place presently. For example, under NASA's National Campaign (NC), working groups drawn from the FAA, NASA, and numerous stakeholders are focusing on understanding the four areas of AAM integration: aircraft, airspace, community integration, and cross-cutting areas. Complimenting this effort, the FAA created an internal AAM Integration Executive Council, and is actively working with internal and external stakeholders to understand the nature, scope, and likely evolutions of AAM. [See www.faa.gov/uas/advanced_operations/urban_air_mobility/.] The FAA also issued a concept of operations (CONOPS) in June 2020, and is likely to publish a strategic implementation framework in the near future.

All these activities are facilitating an operational framework for gradual integration of AAM into the NAS; e.g., flight testing of AAM vehicles [see www.nasa.gov/centers/armstrong/features/nasa-begins-air-mobility-campaign.html], regulatory coordination for safety, traffic management, and international harmonization with other agencies, e.g., European Union Aviation Safety Agency (EASA) leading to type certifications [e.g.,www.faa.gov/uas/advanced_operations/certification/].

These proactive steps are positioning the AAM industry positively towards realizing market opportunities. In December 2020, for example, Joby Aviation received the first airworthiness approval by the US Air Force (USAF) for an eVTOL aircraft under Agility Prime, and it recently reached an agreement with the FAA to certify its aircraft using the FAA's part 23 requirements along with special conditions for eVTOL aircraft.[73] Joby Aviation plans to launch air taxi services in the US by 2023. Lilium GMBH, a German company, is developing an eVTOL transport network centered on Lake Nona in Orlando, Florida. It has partnered with the City of Or-

[70] Getting Mobility Off the Ground, 2019, KPMG (see institutes.kpmg.us/manufacturing-institute/articles/2019/getting-mobility-off-the-ground.html).

[71] Urban Air Mobility: The rise of a new mode of transportation, Nov. 2018, Roland Berger. (See www.rolandberger.com/en/Publications/Passenger-drones-ready-for-take-off.html.)

[72] Advanced Air Mobility: Demand Analysis and Market Potential of the Airport Shuttle and Air Taxi Markets. [See escholarship.org/uc/item/4b3998tw for more details.]

[73] www.aviationtoday.com/2021/02/09/joby-agrees-evtol-certification-requirements-faa/

lando and a real estate development company to establish a vertiport hub in Lake Nona by 2025. It will be used for regional, inter-city air mobility services, with travel distances of up to 186 miles in 60 minutes by Lilium Jet aircraft currently under development.[74]

The trend is somewhat similar at the international level as well. For example, EHang, a Chinese manufacturer of autonomous aerial vehicles (AAVs), established a strategic partnership with UAM pilot cities in Spain, Austria, and China in 2020.[75] It also conducted demonstration flights in South Korea with its two-passenger autonomous aerial vehicle, the EHang 216. German AAM companies, Lilium and Volocopter, are also working to launch passenger air transport services within the next few years. Volocopter completed demonstration air taxi flights in Singapore in 2019 and began to sell tickets for commercial service, expected to start in Singapore by 2023.[76] Volocopter has also announced plans to introduce air taxi services in the US.

AAM services are likely to face stiff competition from technological advances in industries with close substitutes, such as ground transportation (i.e., emerging automated solutions on increasingly electric-powered vehicles). Furthermore, economic and financial tradeoffs underlying the emergence of AAM may have changed following COVID-19, changing travel patterns and perhaps long-term living arrangements. Finally, the high costs of urban infrastructure and potential community concerns pose challenges for AAM adoption. Future AAM operators must also prepare to comply with new operating requirements and other regulations yet to come.

Despite these challenges, state, local, and regional governments are aligning themselves with the manufacturers and likely operators. For example, the city of Los Angeles announced the creation of its Urban Air Mobility Partnership in December 2020. It is a public-private partnership, called Urban Movement Labs that will evaluate barriers and solutions now towards facilitating air taxi services in Los Angeles by 2023.[77] Other entities, including the Canadian AAM Consortium (CAAM,) have also studied the impacts of AAM on regional economies.[78]

In order to facilitate AAM entry into local transportation networks, numerous local and state entities have begun the process of preparing and self-identifying as early adopters. [See www.nasa.gov/aeroresearch/programs/iasp/aam/nasa-to-help-local-governments-plan-for-advanced-air-mobility.] Furthermore, targeting investments in regional air mobility (RAM) by utilizing the country's vast underutilized airport infrastructure may compliment and accelerate local and state initiatives on emerging markets, including those targeted by AAM, likely transforming the entire NAS in the future. [See sacd.larc.nasa.gov/ram/ for more details.]

As the sector grows and new initiatives are undertaken, the FAA, together with numerous stakeholders including NASA, is keeping

[74] lilium.com/newsroom-detail/lilium-partners-with-tavistock-and-orlando

[75] www.ehang.com/news/617.html

[76] www.bloomberg.com/news/articles/2020-12-09/first-electric-air-taxis-set-to-fly-in-singapore-by-2023

[77] www.lamayor.org/mayor-garcetti-announces-first-nation-urban-air-mobility-partnership; see also https://www.urbanmovementlabs.com/programs-projects/

[78] www.pnwer.org/uploads/2/3/2/9/23295822/economic_impact_assesment_-_caam_-_v1.0.pdf

a keen eye on understanding overall trends in AAM. It is likely that AAM services will become a reality in the US by 2025-2026 and will initially become incrementally available in certain urban and suburban areas. As more information becomes available, the FAA will likely provide emerging trends and forecasts for AAM in the near future.

Forecast Uncertainties

The forecasts in this document are forecasts of aviation demand, driven by models built on forecasts of economic activity. There are many assumptions in both the economic forecasts and in the FAA models that could affect the degree to which these forecasts are realized. This year's forecast is driven, at least in the near-term, by the pace of recovery from the impacts to the U.S. and global economies and the aviation industry resulting from the novel coronavirus (COVID-19). It does go without saying that terrorism remains among the greatest world-wide risks to aviation growth. Any terrorist incident aimed at aviation could have an immediate and significant impact on the demand for aviation services that could be greater than its impact on overall economic activity.

In addition, changes in the geo-political landscape could lead to outcomes very different than the forecasts provided in this document. The crisis in Ukraine represents a very large uncertainty to this year's forecast. The impacts as of the writing of this document are still evolving and dependent in large part on the outcome of the armed conflict in Ukraine. Already we have seen negative impacts on airline bookings to areas close to the fighting as well as a surge in oil prices. The impact of the economic sanctions on Russia is unknown with any specificity at this time but it is clear that the Russian economy (the world's 12th largest as of 2021) will suffer a sharp recession that may have broad spillover effects to the global economy. Many forecasters have lowered their expectations for European economic growth in 2022 as well due to the impacts of the conflict. In the longer run, most analysts are seeing a return to higher tensions between Russia and the West resulting in higher expenditures on defense that may push taxes higher, and leave consumers with less money to spend on items like air travel.

The rapid spread of the novel coronavirus (COVID-19) that began in early 2020 resulted in the largest decline in aviation activity since the jet era began in the late 1950's. Although the FAA forecast is a long-term trend forecast and it has been almost two years since a global pandemic was declared, there is still a good deal of uncertainty about the path of aviation's recovery from the 2020 downturn. This uncertainty arises from a variety of factors including the willingness of consumers to resume air travel as infection rates are reduced, the success of the strategies U.S. and foreign carriers are employing to recover from the downturn in demand, the stability of consumer attitudes and behaviors towards aviation in a post-COVID environment, as well as the breadth and depth of the and the speed and nature of the economic recovery, all of which apply both domestically and globally.

The future direction of oil prices presents another considerable uncertainty in producing the forecast. At the end of 2020, the average price of West Texas Intermediate crude (WTI) for 2021 was projected to be $44 per barrel but the actual price was 57 percent higher at $69 per barrel. Similarly, the FAA's baseline forecast (derived from economic assumptions in IHS Global Insight's November 2021 U.S. macro forecast and 30-Year Focus released during August 2021) called for oil prices to rise slightly to $74 per barrel in 2022. Instead, according to the March 2022 forecast and with the war in Ukraine only days old, the projected average for 2022 had spiked to $101 per barrel. Longer term, the forecasts are generally aligned, projecting a price of about $72 per barrel in 2030 and about $88 per barrel by the end of the forecast period in 2042. However, there are other oil price forecasts that are considerably more aggressive than the FAA base forecast such as the latest Energy Information Administration (EIA) Annual Energy Outlook released in March 2022. By 2030, it anticipates the spot price of oil will reach $88 per barrel and by 2042, $132 per barrel, considerably above the FAA base forecast of $88. Over the long run, lower oil prices give consumers an impetus for additional spending, including air travel, and should enhance industry profitability. In the case where oil prices turn out to be higher than the FAA forecast, we would expect lower spending on air travel by consumers, higher costs for fuel to airlines and reduced industry profitability.

The baseline forecast incorporates additional infrastructure spending in 2021 and beyond. However, there is considerable uncertainty as to the magnitude, timing, and nature of these programs that ultimately determines the impact on the future growth of the U.S. economy. In addition, how the U.S. will engage with the rest of the global economy over the next several years continues to evolve. Under the right conditions, a period of sustained high and more inclusive growth along with increased financial stability could occur. However, in light of the recent Russia-Ukraine conflict there is an increased possibility of an outcome that leads to greater global economic fragmentation due to rising tensions resulting in slower growth, and increased financial instability.

The baseline forecast assumes that the global economic recovery that began at the end of 2020 will continue with global GDP back to pre-COVID (2019) levels led by China and the United States by the end of 2021. Thereafter, the baseline forecast assumes that China and India will be growth engines for emerging economies as China successfully transitions the economy from heavy reliance on manufacturing and resource industries to one more oriented towards the services and technology sectors and India continues to implement reforms to make its economy more competitive. Many analysts are concerned that in light of the Russia-Ukraine conflict, China moves closer to Russia, limiting opportunities to further transition its economy away from manufacturing and resource intensive industries. In the case of India, the impact of the Russia-Ukraine conflict on energy prices and food prices may put pressure on trade and fiscal deficits resulting in a slowdown of reforms.

In the United States, economic growth will slow from the strong growth observed in 2021 as the impacts from the latest round of COVID-19 stimulus finish flowing through the economy. The combination of direct payments, extension of unemployment benefits, and direct federal spending provided money into consumer's wallets and boosted their spending in 2021. However later on in the decade, the forecast assumes some measure of fiscal restraint will be implemented as the impact of the huge increase in federal spending to combat the economic impacts of COVID-19 has pushed the government debt as percent of GDP to levels that were last seen at the end of World War 2. In Japan, the United Kingdom, and the European Union economic growth over the next few years will be well above rates seen over the past decade as these regions recover from the COVID-19 recession. However, over the forecast horizon, demand growth will remain slow in these regions as they continue to be constrained by structural economic problems (high debt, slow population growth, weak public finances, for example) and political instability. In most of the major advanced economies, governments need to shore up their finances after the increases in government spending to offset the impacts of COVID-19. There exists a non-trivial possibility that authorities will either act prematurely or be excessively timid and late in taking necessary steps to maintain a healthy global economy. The current forecasts call for strong passenger growth for travel between the United States and other world regions, especially over the next five years. An unexpected slowing of worldwide economic activity could push the return of international passenger demand to pre-COVID levels beyond our current forecast of 2024.

Although U.S. airline finances have been decimated as a result of COVID-19 and the fall in demand, the outlook for further consolidation either through mergers and acquisitions (M&A) or bankruptcy appears to be rather limited, with one exception: a planned merger between Frontier Airlines and Spirit Airlines, pending regulatory approval. Ultra low-cost carriers which focus on domestic leisure traffic have been fastest to recover during the pandemic, putting them in relatively strong positions in recent quarters, and creating the opportunity for a merger. Based on FY 2021 data, the top 6 (American, Delta, United, Southwest, Alaska and JetBlue) accounted for about 78 percent of the U.S. airline industry capacity and traffic, and a combined Frontier and Spirit would make up about 8 percent. For the large network carriers, the steps they have taken to increase their liquidity have reduced the risk of bankruptcy in the next few years. However, if the demand recovery is slower than expected, the increase in debt that these carriers are servicing may be a burden and increase the possibility of a bankruptcy or liquidation. While the announced merger of Frontier and Spirit shows that in the right circumstances, consolidation among ultra-low cost carriers can happen, in general, the risk associated with a merger today compared to pre-COVID has increased due to the poorer financial condition of carriers.

The forecast assumes the addition of sizable numbers of large regional jets (70 to 90 seats) into the fleets of regional carriers. While the recovery in air travel demand from the COVID downturn is projected to be robust, we are not projecting a uniform recovery across all segments. As network carriers continue to adjust the size and breadth of their networks in anticipation of the post-COVID environment, they are continuing to move forward with plans to significantly reduce the numbers of small regional jets they will need. Prior to the COVID downturn in 2020, strong air travel demand has not ensured financial stability for regional carriers, as the bankruptcy filings of Republic Airways in 2016, Great Lakes Airlines in 2018 and Trans States Airlines in 2020 have shown. Financially strong and well positioned regional carriers may see increased opportunities for regional flying as a result of the network carrier actions, but the overall impact will most likely reduce opportunities for many regional carriers. In addition to managing changing relationships with network carriers, regional carriers have struggled with pilot shortages that were exacerbated during the pandemic recovery. The downturn prompted mainline carriers to reduce costs by, among other measures, offering voluntary retirements to flight crews but, as activity picked up, they drew replacements from the ranks of regionals, causing additional shortages for those carriers. To attract and recruit crews, some carriers have raised salaries and offered bonuses, further increasing financial pressures and possibly leading to new consolidation in the regional airline industry.

The general aviation sector did suffer a downturn in activity in 2020 due to the impacts of COVID-19, but the magnitude of the decline was much less than the decline in commercial aviation. By the end of 2021 most sectors, including corporate and business aviation, were at or exceeding pre-COVID activity levels. We project a return to pre-COVID levels of activity in the GA segment by 2022. Once returning to pre-COVID levels of activity, future growth in business and corporate aviation is based largely upon the prospects for economic growth and corporate profits. Uncertainty in these leading indicators poses a risk to the forecast, but the risk is not limited to these factors. Other influences, such as potential environmental regulations and taxes do not seem to be as much of a concern in the short term, but over the long term, uncertainties about the direction of these influences may place downward pressure on the forecast.

Overall activity at FAA and contract towers rose 7.1 percent in 2021, while activity at large and medium hub airports (62 in total) increased 2.3 percent and 5.0 percent, respectively, in 2021. While FAA's baseline forecast calls for operations at FAA and contract towers to return to pre-COVID levels of activity by 2023, in the long run, operations at large and medium hub airports grow faster than the overall national trend and congestion and delays could become critical limits to growth over the forecast period. FAA's forecasts of both demand and operations are unconstrained in that they assume that there will be sufficient infrastructure to handle the projected levels of activity. Should the infrastructure be inadequate and result in even more congestion and delays, it is likely that the forecasts of both demand and operations would not be achieved.

Not only is the volume of aircraft operating at most large hubs expected to increase over the next 20 years, but the mix of aircraft is changing for this same period. The expected increases in the numbers of larger regional jets and business jets as well as the anticipated widespread deployment of UAS and Advanced Air Mobility (AAM) vehicles into the national airspace system will make the FAA's job more challenging. For example, in adding these new vehicles to the system, they could replace existing traditional aircraft. This change in the mix of aircraft will most likely add to workload above and beyond the increasing demand for aviation services resulting from the growth in operations over the forecast period.

Increasing concerns about aviation's environmental impacts could potentially limit or delay the ability of the aviation sector to grow to meet national economic and mobility needs. Airspace modernization and airport expansion or new construction are often contentious because of concerns over noise, air quality, and water quality. Climate change is also of concern and could limit aviation growth. In Europe, concerns about climate change are leading to restrictions on airport expansion activities and proposals to limit short-haul domestic flights. Community concerns across the U.S. about aviation noise have led to increasing levels of public debate, political interest, and even litigation. Without effective measures to mitigate and abate aviation noise, the infrastructure projects and airspace redesign efforts needed to achieve aviation growth may be delayed. Similarly, community concerns about environmental and/or other considerations (e.g., privacy concerns) associated with UAS, AAM, and commercial space launch activity could impact growth in these aviation areas.

In addition to providing economic benefits, technologies to improve aircraft fuel efficiency and reduce fuel consumption provide benefits in terms of reduced emissions that impact air quality and climate change; many technologies that improve fuel efficiency also result in reduced noise. Airlines are increasing their use of sustainable aviation fuels, which provides benefits in terms of reduced impacts of aviation on climate change and air quality. The implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), a global market-based measure for international carbon dioxide emissions, will help ensure an approach that is economically preferable to a patchwork of State or Regional-level regulations around the world is used, and will help to further address the impacts of aviation on climate change. Continued advancements and fleetwide uptake of sustainable aviation fuels and new aircraft and engine technologies that result in improved fuel efficiency, reduced fuel consumption, noise reduction and reduced emissions are required to ensure that access restrictions or operating limitations are not imposed on the in-service fleet, which in turn may depress growth.

Widespread deployment of UAS and AAM vehicles is another potential tool for reducing aviation emissions if they replace traditional aircraft in the movement of people and goods. However, if they do not replace existing air vehicles, then they would result in a net life-cycle increase in environmental impacts. The expansion of commercial space launch activity could also change the mix of aircraft in service, with associated impacts on aviation emissions. The emissions from commercial space operations could have a negative impact on both climate change and the ozone layer; however, the magnitude of the impacts is unknown with the fuel type in particular having considerable impact on this magnitude.

Appendix A: Alternative Forecast Scenarios

Uncertainty exists in all industries, but especially in the commercial air travel industry. As volatility in the global environment has increased, the importance of scenarios for planning purposes has increased. In order to help stakeholders better prepare for the future, the FAA provides alternative scenarios to our baseline forecasts of airline traffic and capacity.

To create the baseline domestic forecast, economic assumptions from IHS Markit's 10-year and 30-year U.S. Macro Baselines were used. To develop the alternative scenarios, assumptions from IHS Markit's 30-year optimistic and pessimistic forecasts from their August 2021 *US Economy: The 30-Year Focus* were utilized. Inputs from these alternative scenarios were used to create "high" and "low" traffic, capacity, and yield forecasts.

International passengers and traffic are primarily driven by country specific Gross Domestic Product (GDP) forecasts provided by IHS Markit. Thus, the alternative scenarios use inputs based on ratios derived from IHS Markit's Major Trading Partner and Other Important Trading Partners optimistic and pessimistic forecasts in order to create high and low cases.

Scenario Assumptions

The FAA's domestic baseline forecast assumes that economic growth rebounds solidly in 2022 and then remains slightly above trend through the remainder of the decade, supported by consumer and government spending. The unemployment rate continues its retreat, falling below its pre-pandemic rate in 2023. Oil prices surge in 2022 but, as previously mentioned, the forecast now appears conservative due to the war in Ukraine. No external shocks are assumed in the forecast.

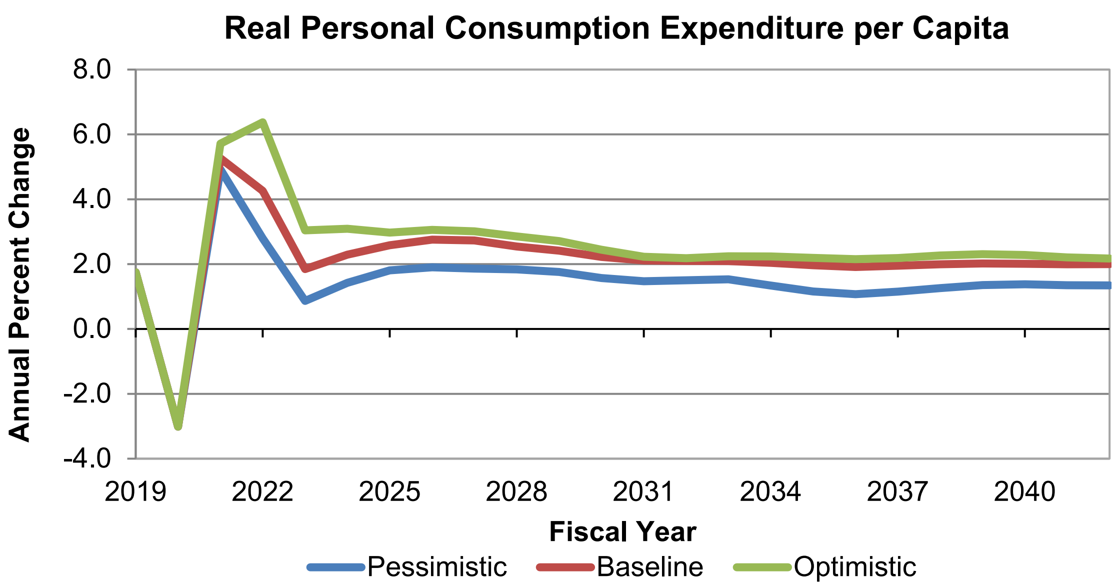
The FAA's high case forecast uses IHS Markit's optimistic forecast. The optimistic scenario is characterized by a quicker recovery in the near term than in the baseline followed by slightly stronger growth over the balance of the forecast. Near-term differences include surging GDP growth of 7.0 percent in 2022 compared to 4.5 percent in the baseline, driven mainly by stronger consumer spending. This spending results from a more robust response by consumers to the Infrastructure Investment and Jobs Act and a willingness to tap into some of their excess savings, buttressed by stronger confidence from declining COVID-19 cases. The unemployment rate falls a bit more sharply than in the baseline though it also reaches the pre-pandemic rate in 2023. And the price of oil is about 10 percent below the baseline as OPEC+ raises output quotas and US inventories rise faster than normal.

In this scenario, real personal consumption expenditure (PCE) per capita growth is about 3 tenths of a percentage point stronger than the baseline in the medium- and long-term. Unemployment averages 0.25 percentage points lower on a fiscal year basis than the baseline.[79]

Conversely, FAA's low case forecast uses IHS Markit's pessimistic scenario. In this forecast, an upturn in new COVID-19 cases, hospitalizations, and deaths, lead to more caution on the part of consumers, slowing their spending which falls below the baseline path. The economy sees a recovery in 2022 that is more modest than in the baseline and optimistic scenarios, and medium- and long-term growth is also slower. GDP growth averages 0.5 percentage points lower than in the baseline over the forecast horizon.

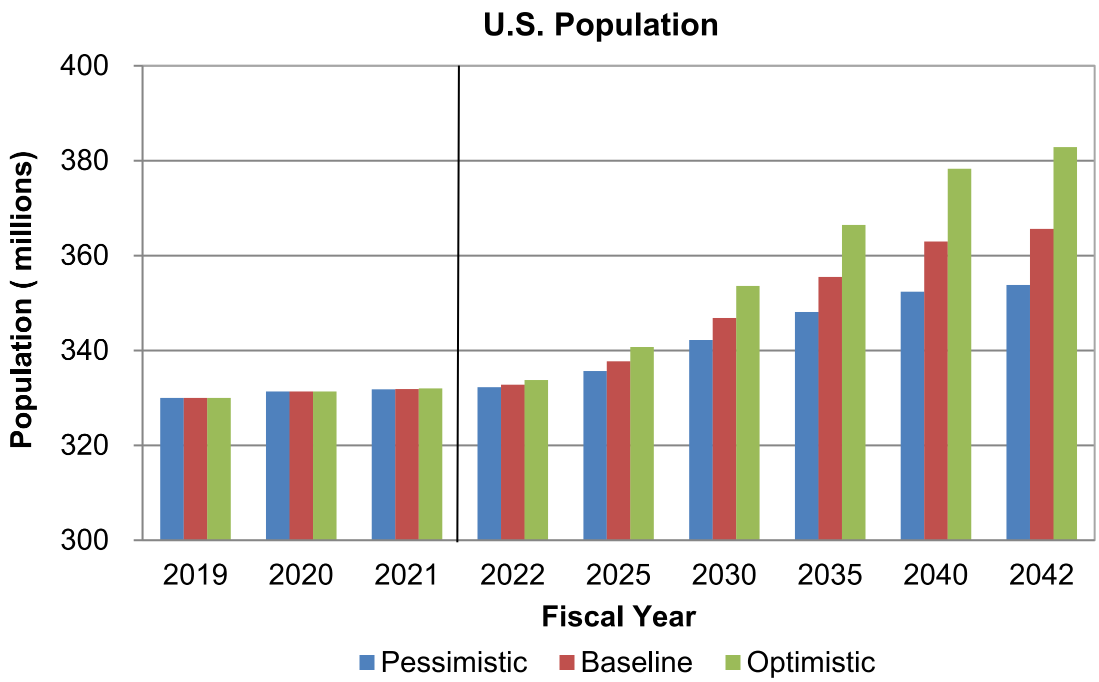
Contributing to slower GDP growth in this scenario, business capital investments and residential housing investments both grow more slowly than in the baseline, resulting in lower overall productivity growth. Supply chain issues continue and consumer hesitancy combine, causing businesses to scale back investments. Financial conditions are tight and household wealth is impacted by declining stock markets.

Oil prices rise faster than the baseline throughout the forecast and are $52 per barrel higher by 2042. Real PCE per capita in this scenario grows 0.8 percentage points slower per year than in the baseline; and unemployment, on average, is 0.6 points higher on an annual basis than in the baseline.

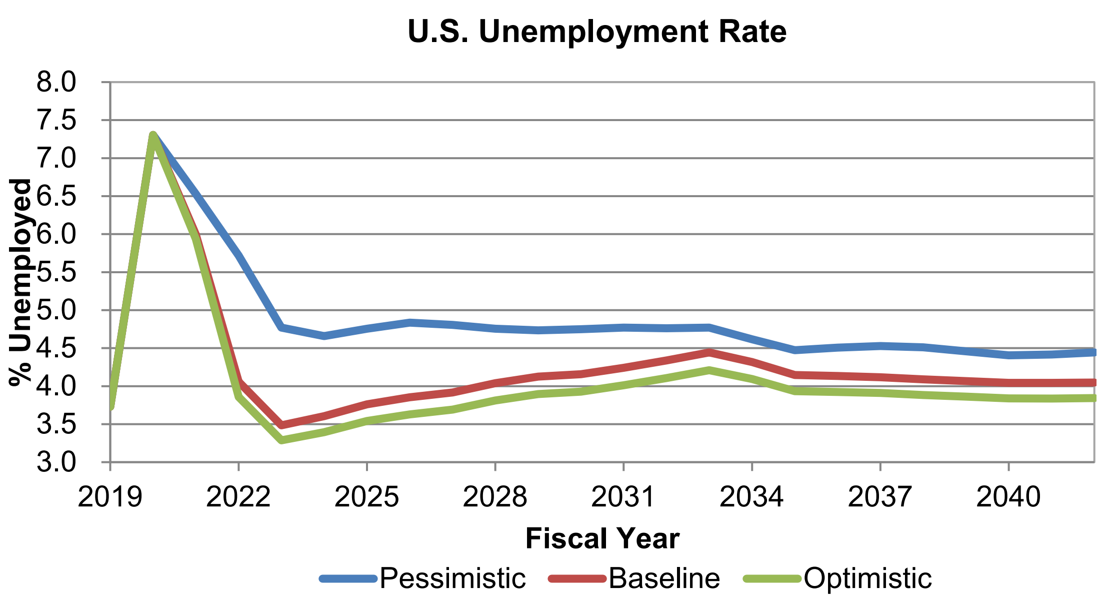


Source: IHS Markit

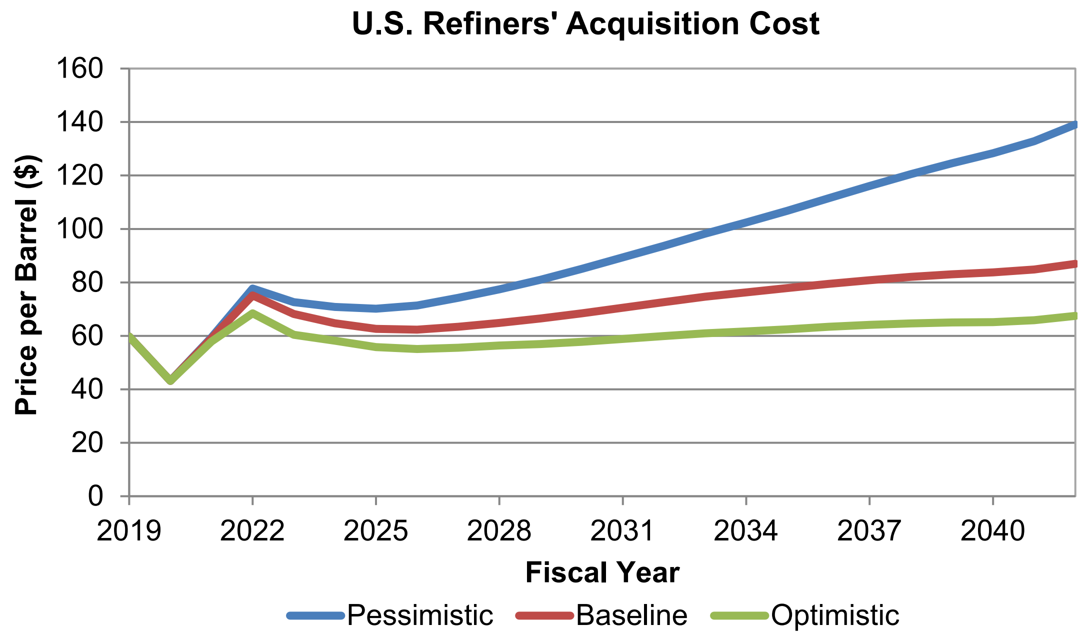
[79] Real personal consumption expenditure per capita and unemployment are used as input variables to the FAA's base, high and low forecasts of enplanements.



Source: IHS Markit

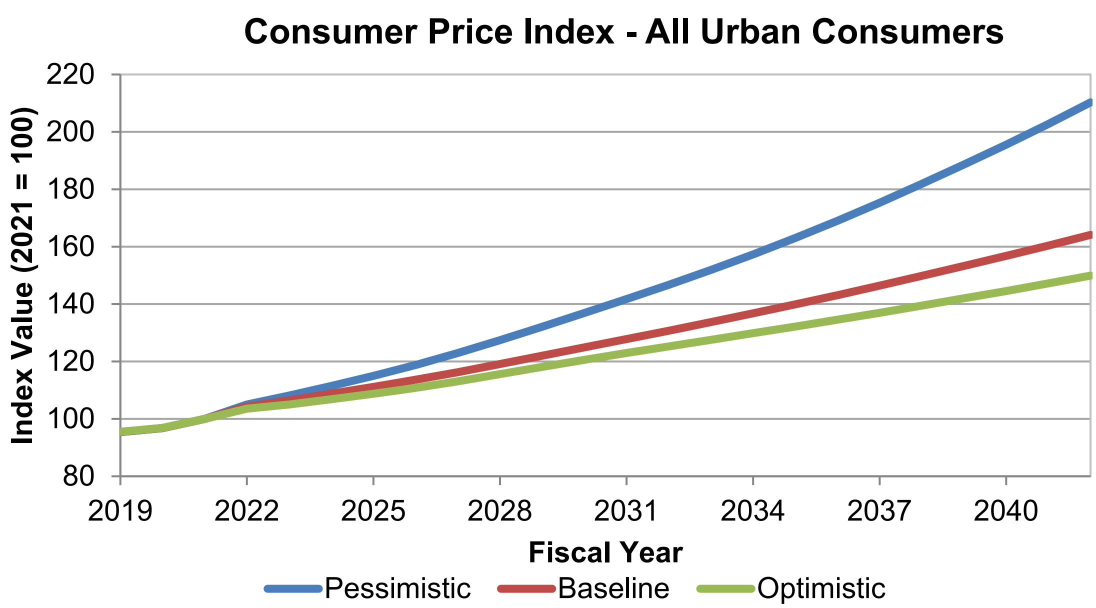


Source: IHS Markit



Source: IHS Markit

The price of energy is one of the drivers in the growth of consumer prices over the forecast period. In the optimistic case, slow growth of energy prices and import prices counteracts faster growth of other consumer goods prices causing the optimistic CPI to rise somewhat slower than the baseline. In the pessimistic case, energy prices, wages and import prices all rise more rapidly compared to the baseline.



Source: IHS Markit

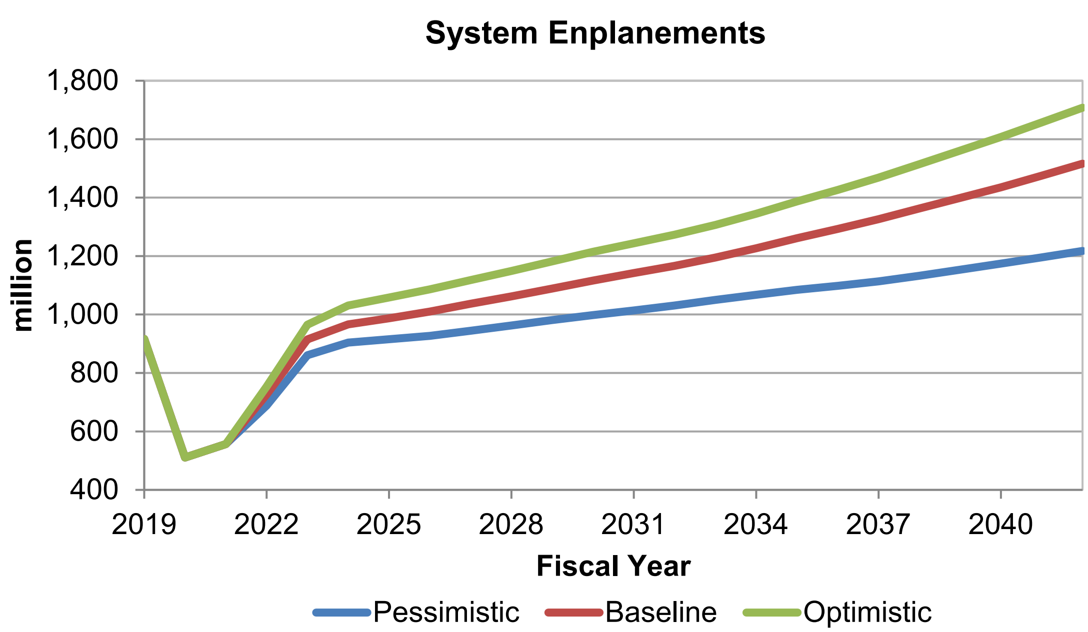
Alternative Forecasts

Enplanements

In the baseline forecast, system enplanements are forecast to grow at an average annual rate of 4.9 percent a year over the forecast horizon of 2022-2042 (with domestic and international passengers increasing at rates of 4.7 and 6.9 percent, respectively).

In the optimistic case, enplanements grow at a slightly quicker pace, averaging 5.5 percent per year (up 5.3 percent domestically and 7.1 percent internationally). This scenario is marked by a more favorable business environment and lower fuel prices which make the price of flying more affordable to business and leisure travelers. By the end of the forecast period in 2042, system passengers in the optimistic case are 12.6 percent above the baseline, totaling 1.7 billion, 191 million greater than in the baseline.

The pessimistic case is characterized by a period of weakened personal income growth and consumer confidence combined with a contraction in financial asset markets, leading to higher interest rates, and curtailed investment and consumer spending. In this scenario, enplanements grow an average of 3.8 percent per year (domestic up 3.5 percent and international up 6.3 percent). In the pessimistic case, system passengers in 2042 are 19.7 percent below the baseline case, totaling 1.2 billion, or 299 million fewer than in the baseline.

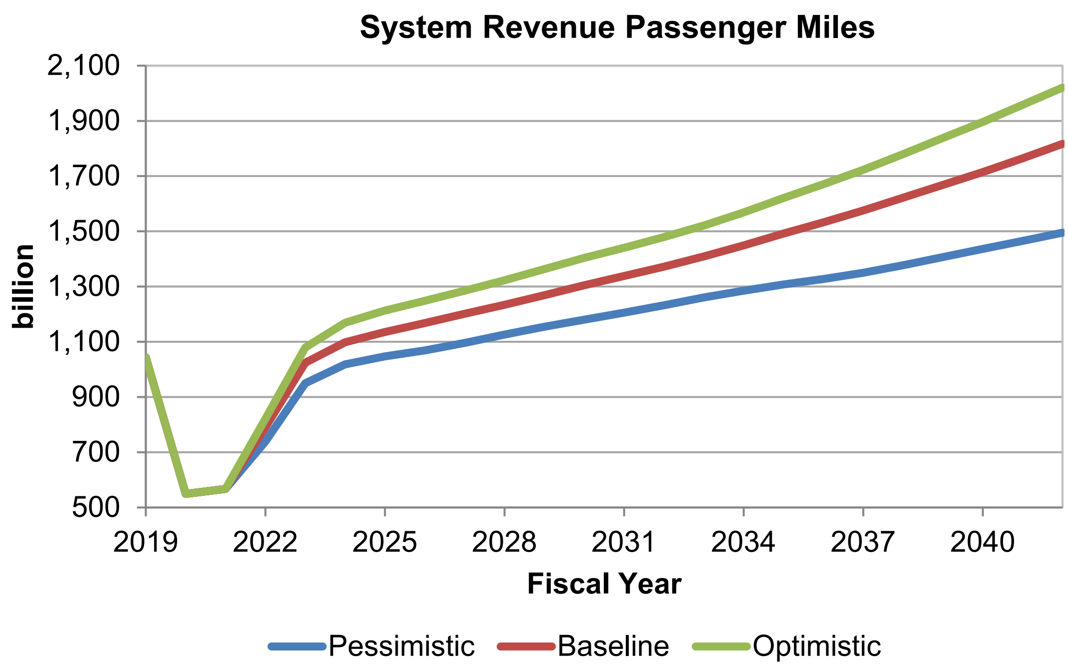


Revenue Passenger Miles

In the baseline forecast, system RPMs grow at an average annual rate of 5.7 percent a year over the forecast horizon (2022-2042), with domestic RPMs increasing 4.8 percent annually and international RPMs growing 8.8 percent annually.

In the optimistic case, the faster growing economy coupled with lower energy prices drives RPMs higher than the baseline, with growth averaging 6.2 percent per year (domestic and international RPMs up 5.5 and 9.0 percent, respectively).

In the pessimistic case, the combination of a slower growing economy and higher energy prices result in RPM growth averaging 4.7 percent annually with domestic markets growing 3.7 percent a year while international traffic grows 8.2 percent annually.

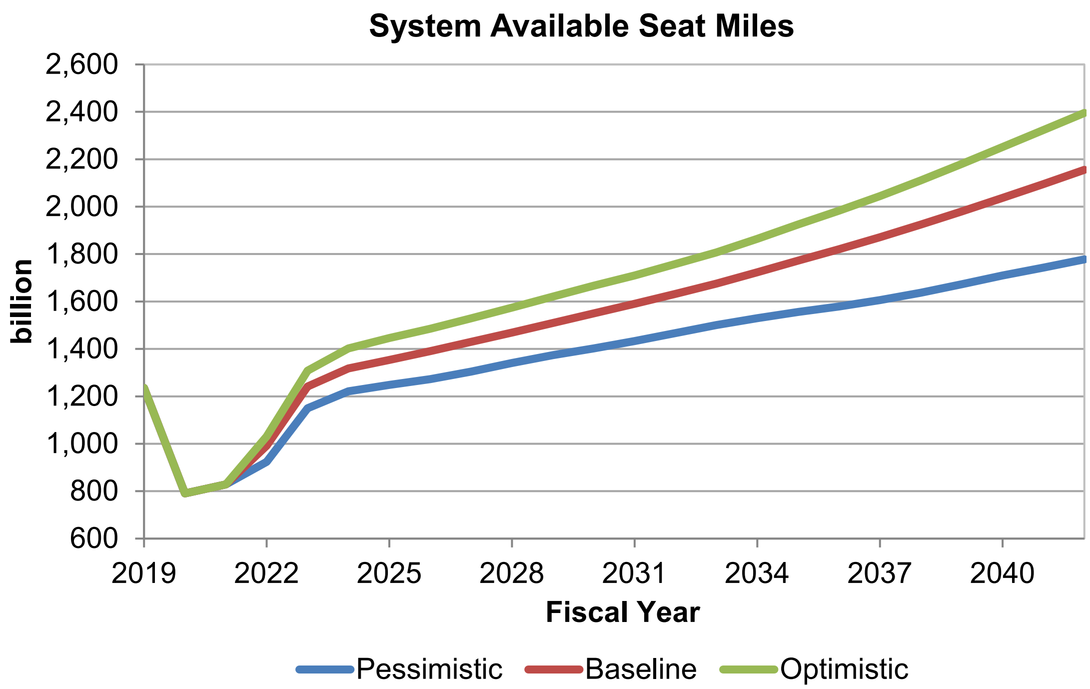


Available Seat Miles

In the base case, system capacity is forecast to increase an average of 4.7 percent annually over the forecast horizon with growth averaging 4.0 percent annually in domestic markets and 6.5 percent a year in international markets.

In the optimistic case, capacity grows somewhat faster than in the baseline forecast, averaging 5.2 percent annually system-wide (4.7 and 6.8 percent for domestic and international markets, respectively). Carriers increase capacity compared to the baseline forecast to accommodate increased travel demand brought about by a more favorable economic environment.

In the pessimistic case, demand for air travel is lower than in the baseline, thus system capacity grows at a slower pace of 3.7 percent annually (domestic growth of 2.9 percent annually and international up 6.1 percent annually).



Load Factor

System load factors over the 20-year forecast period are similar for all three forecast scenarios. System load factor rises from 68.5 percent in 2021 to 84.4 (optimistic), 84.1 (pessimistic), and 84.3 (baseline) percent in 2042.

In all three scenarios it is assumed that carriers will keep load factors on the high side by actively managing capacity (seats) to more precisely meet demand (passengers).

The domestic load factor increases over the forecast horizon from 72.4 percent to 85.1 percent in the baseline, and to 85.2 percent in the optimistic and pessimistic scenarios.

The international load factor rises in the baseline from 53.5 percent to 82.3 percent; in the optimistic to 82.3 percent; and in the pessimistic to 82.0 percent. This reflects in part the relative growth in demand and capacity in the three (Atlantic, Latin, and Pacific) international regions under each scenario.

Yield

In the baseline forecast, nominal system yield increases 2.3 percent annually, rising from 11.71 cents in 2021 to 18.89 cents in 2042. In domestic markets, yield in the baseline forecast rises from 11.50 cents in 2021 to 19.23 cents in 2042. International yield rises from 12.80 cents in 2021 to 18.09 cents in 2042.

System yield rises in the optimistic case at a slower rate than in the baseline, up 1.9 percent annually to 17.35 cents in 2042. Domestic yield increases to 17.33 cents while international yield increases to 17.40 cents. The moderate growth in yield in both cases is due to advancements in technology, gains in productivity, and modestly rising fuel prices.

In the pessimistic case, nominal yields rise more rapidly than in the baseline, growing an average of 3.4 percent annually, reaching 23.49 cents by 2042 (25.10 cents domestically and 20.11 cents internationally). This scenario reflects higher general domestic inflation and markedly higher energy prices than in the baseline, forcing carriers to increase fares in order to cover the higher costs of fuel, labor, and capital.

TABLE A-1

FAA FORECAST ECONOMIC ASSUMPTIONS

FISCAL YEARS 2021-2042

		Historical	FORECAST					PERCENT AVERAGE ANNUAL GROWTH				
Variable	Scenario	2021E	2022	2027	2032	2037	2042	2021-22	2022-27	2022-32	2022-37	2022-42
Economic Assumptions												
Real Personal Consumption	Pessimistic	40,244	41,368	44,722	48,484	51,591	55,134	2.8%	1.6%	1.6%	1.5%	1.4%
Expenditure per Capita	Baseline	40,376	42,095	47,491	53,157	58,666	64,785	4.3%	2.4%	2.4%	2.2%	2.2%
(2012 $)	Optimistic	40,550	43,134	50,089	56,626	63,140	70,562	6.4%	3.0%	2.8%	2.6%	2.5%
Refiners Acquisition Cost -	Pessimistic	59.4	77.7	74.2	93.7	116.1	139.0	30.8%	-0.9%	1.9%	2.7%	3.0%
Average - $ Per Barrel	Baseline	59.1	75.1	63.4	72.6	80.8	86.9	27.2%	-3.3%	-0.3%	0.5%	0.7%
	Optimistic	57.9	68.4	55.6	59.9	64.1	67.5	18.2%	-4.1%	-1.3%	-0.4%	-0.1%
Consumer Price Index	Pessimistic	2.67	2.80	3.28	3.91	4.67	5.61	5.0%	3.2%	3.4%	3.5%	3.5%
All Urban, 1982-84 = 1.0	Baseline	2.67	2.78	3.10	3.48	3.90	4.37	4.3%	2.2%	2.3%	2.3%	2.3%
	Optimistic	2.67	2.76	3.01	3.34	3.65	4.00	3.5%	1.8%	1.9%	1.9%	1.9%
Civilian Unemployment Rate	Pessimistic	6.5	5.7	4.8	4.8	4.5	4.4	-12.4%	-3.4%	-1.8%	-1.5%	-1.3%
(%)	Baseline	6.0	4.1	3.9	4.3	4.1	4.0	-32.3%	-0.7%	0.7%	0.1%	0.0%
	Optimistic	5.9	3.9	3.7	4.1	3.9	3.8	-35.0%	-0.9%	0.6%	0.1%	0.0%

Source: IHS Markit

TABLE A-2

FAA FORECAST OF AVIATION ACTIVITY*

FISCAL YEARS 2021-2042

		Historical	FORECAST					PERCENT AVERAGE ANNUAL GROWTH				
Variable	Scenario	2021E	2022	2027	2032	2037	2042	2021-22	2022-27	2022-32	2022-37	2022-42
System Aviation Activity												
Available Seat Miles	Pessimistic	828.7	923.4	1,304.5	1,467.1	1,605.7	1,777.7	11.4%	7.2%	4.7%	3.8%	3.3%
(BIL)	Baseline	828.7	991.9	1,430.1	1,632.0	1,871.3	2,155.5	19.7%	7.6%	5.1%	4.3%	4.0%
	Optimistic	828.7	1,031.2	1,528.8	1,758.6	2,044.9	2,395.5	24.4%	8.2%	5.5%	4.7%	4.3%
Revenue Passenger Miles	Pessimistic	567.4	738.6	1,096.2	1,232.5	1,350.1	1,495.2	30.2%	8.2%	5.3%	4.1%	3.6%
(BIL)	Baseline	567.4	790.2	1,201.7	1,372.1	1,575.7	1,816.8	39.3%	8.7%	5.7%	4.7%	4.3%
	Optimistic	567.4	821.1	1,285.3	1,479.4	1,723.2	2,020.7	44.7%	9.4%	6.1%	5.1%	4.6%
Enplanements	Pessimistic	556.4	688.6	944.3	1,030.7	1,113.5	1,217.5	23.8%	6.5%	4.1%	3.3%	2.9%
(MIL)	Baseline	556.4	726.2	1,037.0	1,166.7	1,326.3	1,516.2	30.5%	7.4%	4.9%	4.1%	3.7%
	Optimistic	556.4	753.4	1,118.0	1,273.0	1,468.3	1,707.7	35.4%	8.2%	5.4%	4.5%	4.2%
Psgr Carrier Miles Flown	Pessimistic	5,391.1	5,830.1	7,993.3	8,784.3	9,456.2	10,300.9	8.1%	6.5%	4.2%	3.3%	2.9%
(MIL)	Baseline	5,391.1	6,216.0	8,772.4	9,851.3	11,133.5	12,646.6	15.3%	7.1%	4.7%	4.0%	3.6%
	Optimistic	5,391.1	6,457.2	9,415.4	10,677.6	12,240.5	14,142.9	19.8%	7.8%	5.2%	4.4%	4.0%
Psgr Carrier Departures	Pessimistic	6,553.0	6,919.2	9,124.4	9,695.7	10,195.6	10,844.6	5.6%	5.7%	3.4%	2.6%	2.3%
(000s)	Baseline	6,553.0	7,274.8	10,006.0	10,983.8	12,154.8	13,518.4	11.0%	6.6%	4.2%	3.5%	3.1%
	Optimistic	6,553.0	7,534.2	10,786.1	11,981.7	13,450.4	15,222.8	15.0%	7.4%	4.7%	3.9%	3.6%
Nominal Passenger Yield	Pessimistic	11.71	13.28	15.19	17.36	20.18	23.49	13.5%	2.7%	2.7%	2.8%	2.9%
(cents)	Baseline	11.71	13.19	14.63	15.99	17.39	18.89	12.7%	2.1%	1.9%	1.9%	1.8%
	Optimistic	11.71	13.06	14.28	15.41	16.36	17.35	11.6%	1.8%	1.7%	1.5%	1.4%

* Includes domestic and international activity.

TABLE A-3

FAA FORECAST OF DOMESTIC AVIATION ACTIVITY

FISCAL YEARS 2021-2042

		Historical	FORECAST					PERCENT AVERAGE ANNUAL GROWTH				
Variable	Scenario	2021E	2022	2027	2032	2037	2042	2021-22	2022-27	2022-32	2022-37	2022-42
Domestic Aviation Activity												
Available Seat Miles	Pessimistic	657.5	700.9	915.3	996.5	1,080.8	1,188.0	6.6%	5.5%	3.6%	2.9%	2.7%
(BIL)	Baseline	657.5	729.6	1,006.5	1,141.3	1,306.3	1,507.0	11.0%	6.6%	4.6%	4.0%	3.7%
	Optimistic	657.5	755.7	1,090.7	1,255.8	1,459.5	1,714.2	14.9%	7.6%	5.2%	4.5%	4.2%
Revenue Passenger Miles	Pessimistic	475.8	583.5	777.0	845.7	919.2	1,011.6	22.6%	5.9%	3.8%	3.1%	2.8%
(BIL)	Baseline	475.8	607.3	854.5	968.5	1,111.0	1,283.1	27.6%	7.1%	4.8%	4.1%	3.8%
	Optimistic	475.8	629.1	926.1	1,065.7	1,241.3	1,459.7	32.2%	8.0%	5.4%	4.6%	4.3%
Enplanements	Pessimistic	507.1	620.1	831.0	892.3	957.0	1,039.2	22.3%	6.0%	3.7%	2.9%	2.6%
(MIL)	Baseline	507.1	645.5	913.9	1,021.9	1,156.7	1,318.2	27.3%	7.2%	4.7%	4.0%	3.6%
	Optimistic	507.1	668.7	990.4	1,124.5	1292.4	1,499.5	31.9%	8.2%	5.3%	4.5%	4.1%
Psgr Carrier Miles Flown	Pessimistic	4,529.3	4,765.6	6,245.3	6,685.9	7,131.8	7,707.8	5.2%	5.6%	3.4%	2.7%	2.4%
(MIL)	Baseline	4,529.3	4,961.1	6,870.2	7,661.4	8,626.5	9,785.7	9.5%	6.7%	4.4%	3.8%	3.5%
	Optimistic	4,529.3	5,139.8	7,447.4	8,432.6	9,641.5	11,136.4	13.5%	7.7%	5.1%	4.3%	3.9%
Psgr Carrier Departures	Pessimistic	6,081.2	6,373.1	8,346.1	8,757.6	9,146.1	9,661.7	4.8%	5.5%	3.2%	2.4%	2.1%
(000s)	Baseline	6,081.2	6,631.0	9,160.0	10,002.7	11,015.8	12,201.9	9.0%	6.7%	4.2%	3.4%	3.1%
	Optimistic	6,081.2	6,858.4	9,909.3	10,974.9	12,268.4	13,838.0	12.8%	7.6%	4.8%	4.0%	3.6%
Nominal Passenger Yield	Pessimistic	11.50	13.25	15.87	18.49	21.53	25.10	15.2%	3.7%	3.4%	3.3%	3.2%
(cents)	Baseline	11.50	13.11	14.86	16.26	17.70	19.23	14.0%	2.5%	2.2%	2.0%	1.9%
	Optimistic	11.50	12.93	14.32	15.39	16.34	17.33	12.5%	2.1%	1.8%	1.6%	1.5%

TABLE A-4

FAA FORECAST OF INTERNATIONAL AVIATION ACTIVITY*

FISCAL YEARS 2021-2042

		Historical	FORECAST					PERCENT AVERAGE ANNUAL GROWTH				
Variable	Scenario	2021E	2022	2027	2032	2037	2042	2021-22	2022-27	2022-32	2022-37	2022-42
International Aviation Activity												
Available Seat Miles (BIL)	Pessimistic	171.2	222.5	389.2	470.5	525.0	589.7	30.0%	11.8%	7.8%	5.9%	5.0%
	Baseline	171.2	262.3	423.7	490.7	564.9	648.5	53.3%	10.1%	6.5%	5.2%	4.6%
	Optimistic	171.2	275.4	438.0	502.8	585.5	681.3	60.9%	9.7%	6.2%	5.2%	4.6%
Revenue Passenger Miles (BIL)	Pessimistic	91.6	155.1	319.2	386.8	430.9	483.5	69.4%	15.5%	9.6%	7.0%	5.8%
	Baseline	91.6	182.9	347.3	403.6	464.8	533.6	99.7%	13.7%	8.2%	6.4%	5.5%
	Optimistic	91.6	192.0	359.3	413.7	481.9	561.0	109.7%	13.3%	8.0%	6.3%	5.5%
Enplanements (MIL)	Pessimistic	49.2	68.5	113.3	138.4	156.5	178.3	39.0%	10.6%	7.3%	5.7%	4.9%
	Baseline	49.2	80.7	123.1	144.7	169.6	198.0	63.9%	8.8%	6.0%	5.1%	4.6%
	Optimistic	49.2	84.7	127.6	148.5	176.0	208.1	72.0%	8.5%	5.8%	5.0%	4.6%
Psgr Carrier Miles Flown (MIL)	Pessimistic	861.8	1,064.5	1,748.0	2,098.3	2,324.4	2,593.1	23.5%	10.4%	7.0%	5.3%	4.6%
	Baseline	861.8	1,254.9	1,902.2	2,189.9	2,507.0	2,860.9	45.6%	8.7%	5.7%	4.7%	4.2%
	Optimistic	861.8	1,317.5	1,968.0	2,244.9	2,599.0	3,006.6	52.9%	8.4%	5.5%	4.6%	4.2%
Psgr Carrier Departures (000s)	Pessimistic	471.8	546.0	778.2	938.1	1,049.5	1,183.0	15.7%	7.3%	5.6%	4.5%	3.9%
	Baseline	471.8	643.7	846.0	981.1	1,139.0	1,316.6	36.4%	5.6%	4.3%	3.9%	3.6%
	Optimistic	471.8	675.8	876.8	1,006.8	1,182.0	1,384.8	43.2%	5.3%	4.1%	3.8%	3.7%
Nominal Passenger Yield (cents)	Pessimistic	12.80	13.43	13.53	14.90	17.30	20.11	4.9%	0.2%	1.1%	1.7%	2.0%
	Baseline	12.80	13.47	14.05	15.32	16.65	18.09	5.3%	0.8%	1.3%	1.4%	1.5%
	Optimistic	12.80	13.50	14.17	15.45	16.41	17.40	5.5%	1.0%	1.4%	1.3%	1.3%

*Includes mainline and regional carriers.

Appendix B: Forecast Tables

TABLE 1

U.S. SHORT-TERM ECONOMIC FORECASTS

	FISCAL YEAR 2021				FISCAL YEAR 2022				FISCAL YEAR 2023			
ECONOMIC VARIABLE	1ST. QTR.	2ND. QTR.	3RD QTR.	4TH. QTR.	1ST. QTR.	2ND. QTR.	3RD QTR.	4TH. QTR.	1ST. QTR.	2ND. QTR.	3RD QTR.	4TH. QTR.
Real Personal Consumption												
Expenditure per Capita												
(2012 $)	38,973	40,035	41,177	41,316	41,738	41,998	42,218	42,425	42,581	42,758	42,962	43,192
Year over year change	-2.6%	1.9%	16.1%	6.9%	7.1%	4.9%	2.5%	2.7%	2.0%	1.8%	1.8%	1.8%
Refiners' Acquisition Cost - Average												
(Dollars per barrel)	42.03	57.24	66.03	71.04	80.35	74.61	71.95	73.59	71.86	66.91	68.23	65.77
Year over year change	-27.5%	21.1%	148.6%	74.2%	91.2%	30.4%	9.0%	3.6%	-10.6%	-10.3%	-5.2%	-10.6%
Consumer Price Index												
(1982-84 equals 1)	2.61	2.63	2.69	2.73	2.76	2.77	2.79	2.80	2.82	2.83	2.85	2.86
Year over year change	1.2%	1.9%	4.8%	5.3%	5.8%	5.2%	3.7%	2.6%	1.9%	2.1%	2.1%	2.1%

Source: IHS Markit

TABLE 2

U.S. LONG-TERM ECONOMIC FORECASTS

FISCAL YEAR	REAL GROSS DOMESTIC PRODUCT (Billions 2012 $)	REAL PERSONAL CONSUMPTION EXPENDITURE PER CAPITA (2012 $)	CONSUMER PRICE INDEX (1982-84=1.00)	REFINERS' ACQUISITION COST AVERAGE (Dollars per barrel)
Historical				
2010	15,542	34,429	2.17	74.61
2015	17,310	36,750	2.37	56.69
2018	18,501	38,869	2.50	63.72
2019	18,912	39,548	2.54	59.77
2020	18,493	38,357	2.58	43.15
2021E	19,164	40,376	2.67	59.08
Forecast				
2022	20,024	42,095	2.78	75.13
2027	22,881	47,491	3.10	63.42
2032	25,475	53,157	3.48	72.60
2037	28,032	58,666	3.90	80.84
2042	30,919	64,785	4.37	86.94
Avg Annual Growth				
2010-21	1.9%	1.5%	1.9%	-2.1%
2021-22	4.5%	4.3%	4.3%	27.2%
2022-32	2.4%	2.4%	2.3%	-0.3%
2022-42	2.2%	2.2%	2.3%	0.7%

Source: IHS Markit

TABLE 3

INTERNATIONAL GDP FORECASTS BY TRAVEL REGION

	GROSS DOMESTIC PRODUCT (In Billions of 2015 U.S. Dollars)				
CALENDAR YEAR	CANADA	EUROPE / AFRICA / MIDDLE EAST	LATIN AMERICA / CARIBBEAN / MEXICO	JAPAN / PACIFIC BASIN / CHINA / OTHER ASIA / AUSTRALIA / NEW ZEALAND	WORLD
Historical					
2010	1,400	22,197	5,126	19,240	64,618
2015	1,557	23,992	5,691	24,785	74,550
2018	1,659	25,634	5,638	28,710	81,810
2019	1,690	26,122	5,584	29,862	84,007
2020	1,600	24,635	5,144	29,577	81,146
2021E	1,677	25,843	5,444	31,346	85,643
Forecast					
2022	1,747	26,849	5,563	32,880	89,280
2027	1,942	29,795	6,386	40,503	104,206
2032	2,112	32,636	7,367	48,802	119,651
2037	2,299	35,588	8,484	57,705	136,041
2042	2,503	38,661	9,758	67,262	153,843
Avg Annual Growth					
2010-21	1.7%	1.4%	0.5%	4.5%	2.6%
2021-22	4.2%	3.9%	2.2%	4.9%	4.2%
2022-32	1.9%	2.0%	2.8%	4.0%	3.0%
2022-42	1.8%	1.8%	2.8%	3.6%	2.8%

Source: IHS Markit website, GDP Components Tables (Interim Forecast, Monthly)

TABLE 4

INTERNATIONAL GDP FORECASTS – SELECTED AREAS/COUNTRIES

	GROSS DOMESTIC PRODUCT (In Billions of 2015 U.S. Dollars)				
CALENDAR YEAR	NORTH AMERICA (USMCA)	EUROZONE	UNITED KINGDOM	JAPAN	CHINA
Historical					
2010	18,794	11,192	2,668	4,220	7,490
2015	20,933	11,665	2,958	4,446	10,961
2018	22,392	12,429	3,140	4,580	13,366
2019	22,867	12,624	3,193	4,581	14,166
2020	21,992	11,803	2,883	4,367	14,493
2021E	23,192	12,407	3,078	4,464	15,669
Forecast					
2022	24,166	12,866	3,197	4,584	16,531
2027	27,445	13,880	3,442	4,788	21,239
2032	30,533	14,759	3,709	4,952	26,306
2037	33,750	15,663	3,981	5,124	31,702
2042	37,196	16,599	4,266	5,295	37,229
Avg Annual Growth					
2010-21	1.9%	0.9%	1.3%	0.5%	6.9%
2021-22	4.2%	3.7%	3.9%	2.7%	5.5%
2022-32	2.4%	1.4%	1.5%	0.8%	4.8%
2022-42	2.2%	1.3%	1.5%	0.7%	4.1%

Source: IHS Markit website, GDP Components Tables (Interim Forecast, Monthly)

TABLE 5

U.S. COMMERCIAL AIR CARRIERS[1]

TOTAL SCHEDULED U.S. PASSENGER TRAFFIC

	REVENUE PASSENGER ENPLANEMENTS (Millions)			REVENUE PASSENGER MILES (Billions)		
FISCAL YEAR	DOMESTIC	INTERNATIONAL	TOTAL	DOMESTIC	INTERNATIONAL	TOTAL
Historical						
2010	635	77	712	555	231	786
2015	696	90	786	629	261	889
2018	781	100	880	720	281	1,001
2019	813	104	917	752	292	1,044
2020	462	49	511	421	129	549
2021E	507	49	556	476	92	567
Forecast						
2022	645	81	726	607	183	790
2027	914	123	1,037	854	347	1,202
2032	1,022	145	1,167	969	404	1,372
2037	1,157	170	1,326	1,111	465	1,576
2042	1,318	198	1,516	1,283	534	1,817
Avg Annual Growth						
2010-21	-2.0%	-4.0%	-2.2%	-1.4%	-8.1%	-2.9%
2021-22	27.3%	63.9%	30.5%	27.6%	99.7%	39.3%
2022-32	4.7%	6.0%	4.9%	4.8%	8.2%	5.7%
2022-42	3.6%	4.6%	3.7%	3.8%	5.5%	4.3%

Source: Forms 41 and 298-C, U.S. Department of Transportation.

[1]Sum of U.S. Mainline and Regional Air Carriers.

TABLE 6

U.S. COMMERCIAL AIR CARRIERS[1]

SCHEDULED PASSENGER CAPACITY, TRAFFIC, AND LOAD FACTORS

FISCAL YEAR	DOMESTIC ASMs (BIL)	DOMESTIC RPMs (BIL)	DOMESTIC % LOAD FACTOR	INTERNATIONAL ASMs (BIL)	INTERNATIONAL RPMs (BIL)	INTERNATIONAL % LOAD FACTOR	SYSTEM ASMs (BIL)	SYSTEM RPMs (BIL)	SYSTEM % LOAD FACTOR
Historical									
2010	679	555	81.7	281	231	82.1	961	786	81.8
2015	744	629	84.5	323	261	80.7	1,067	889	83.4
2018	850	720	84.7	345	281	81.5	1,195	1,001	83.8
2019	883	752	85.2	352	292	82.9	1,235	1,044	84.5
2020	613	421	68.6	178	129	72.3	791	549	69.5
2021E	658	476	72.4	171	92	53.5	829	567	68.5
Forecast									
2022	730	607	83.2	262	183	69.7	992	790	79.7
2027	1,006	854	84.9	424	347	82.0	1,430	1,202	84.0
2032	1,141	969	84.9	491	404	82.3	1,632	1,372	84.1
2037	1,306	1,111	85.0	565	465	82.3	1,871	1,576	84.2
2042	1,507	1,283	85.1	648	534	82.3	2,155	1,817	84.3
Avg Annual Growth									
2010-21	-0.3%	-1.4%		-4.4%	-8.1%		-1.3%	-2.9%	
2021-22	11.0%	27.6%		53.3%	99.7%		19.7%	39.3%	
2022-32	4.6%	4.8%		6.5%	8.2%		5.1%	5.7%	
2022-42	3.7%	3.8%		4.6%	5.5%		4.0%	4.3%	

Source: Forms 41 and 298-C, U.S. Department of Transportation.

[1]Sum of U.S. Mainline and Regional Air Carriers.

TABLE 7

U.S. COMMERCIAL AIR CARRIERS[1]

TOTAL SCHEDULED U.S. INTERNATIONAL PASSENGER TRAFFIC

	REVENUE PASSENGER ENPLANEMENTS				REVENUE PASSENGER MILES			
FISCAL YEAR	ATLANTIC (Mil)	LATIN AMERICA (Mil)	PACIFIC (Mil)	TOTAL INTERNATIONAL (Mil)	ATLANTIC (Bil)	LATIN AMERICA (Bil)	PACIFIC (Bil)	TOTAL INTERNATIONAL (Bil)
Historical								
2010	25	40	13	77	109	63	59	231
2015	25	52	14	90	107	83	71	261
2018	26	60	13	100	112	94	75	281
2019	28	63	13	104	121	96	75	292
2020	11	32	6	49	48	49	31	129
2021E	6	43	1	49	27	60	4	92
Forecast								
2022	18	60	3	81	80	87	16	183
2027	32	79	13	123	144	119	84	347
2032	35	95	14	145	162	145	97	404
2037	39	115	16	170	180	176	109	465
2042	43	137	18	198	200	211	122	534
Avg Annual Growth								
2010-21	-12.4%	0.6%	-22.7%	-4.0%	-11.8%	-0.5%	-21.0%	-8.1%
2021-22	213.7%	40.7%	236.4%	63.9%	193.4%	45.7%	251.2%	99.7%
2022-32	6.9%	4.7%	18.8%	6.0%	7.3%	5.2%	20.0%	8.2%
2022-42	4.5%	4.2%	10.2%	4.6%	4.7%	4.5%	10.8%	5.5%

Source: Forms 41 and 298-C, U.S. Department of Transportation.

[1]Sum of U.S. Mainline and Regional Air Carriers.

TABLE 8

U.S. AND FOREIGN FLAG CARRIERS

TOTAL PASSENGER TRAFFIC TO/FROM THE UNITED STATES

	TOTAL PASSENGERS BY WORLD TRAVEL AREA (Millions)				
CALENDAR YEAR	ATLANTIC	LATIN AMERICA	PACIFIC	U.S./CANADA TRANSBORDER	TOTAL
Historical					
2010	56	53	27	22	158
2015	70	75	36	27	207
2018	85	86	42	31	244
2019	89	89	44	32	253
2020	17	33	9	7	67
2021E	24	66	4	5	99
Forecast					
2022	57	87	9	25	178
2027	101	107	42	37	288
2032	119	130	49	43	341
2037	138	156	57	50	401
2042	158	188	66	58	470
Avg Annual Growth					
2010-21	-7.4%	2.0%	-15.3%	-12.9%	-4.1%
2021-22	137.0%	32.1%	95.5%	430.3%	79.7%
2022-32	7.6%	4.1%	19.1%	5.4%	6.7%
2022-42	5.2%	3.9%	10.7%	4.2%	5.0%

Source: US Customs & Border Protection data processed and released by Department of Commerce; data also received from Transport Canada.

TABLE 9

U.S. COMMERCIAL AIR CARRIERS' FORECAST ASSUMPTIONS[1]

SEATS PER AIRCRAFT MILE AND PASSENGER TRIP LENGTH

	AVERAGE SEATS PER AIRCRAFT MILE			AVERAGE PASSENGER TRIP LENGTH		
FISCAL YEAR	DOMESTIC (Seats/Mile)	INTERNATIONAL (Seats/Mile)	SYSTEM (Seats/Mile)	DOMESTIC (Miles)	INTERNATIONAL (Miles)	SYSTEM (Miles)
Historical						
2010	121.9	216.4	139.7	874.8	2,988.0	1,104.2
2015	131.6	214.8	149.1	902.8	2,892.6	1,131.1
2018	140.0	219.1	156.3	922.1	2,820.1	1,136.9
2019	141.3	221.3	157.6	925.2	2,813.9	1,139.0
2020	141.4	216.8	153.4	910.4	2,648.1	1,075.6
2021E	145.2	198.6	153.7	938.3	1,859.6	1,019.8
Forecast						
2022	147.1	209.1	159.6	940.9	2,266.2	1,088.2
2027	146.5	222.7	163.0	935.0	2,820.1	1,158.9
2032	149.0	224.1	165.7	947.7	2,789.0	1,176.1
2037	151.4	225.3	168.1	960.5	2,739.6	1,188.0
2042	154.0	226.7	170.4	973.4	2,695.0	1,198.3
Avg Annual Growth						
2010-21	1.6%	-0.8%	0.9%	0.6%	-4.2%	-0.7%
2021-22	1.3%	5.3%	3.8%	0.3%	21.9%	6.7%
2022-32	0.1%	0.7%	0.4%	0.1%	2.1%	0.8%
2022-42	0.2%	0.4%	0.3%	0.2%	0.9%	0.5%

Source: Forms 41 and 298-C, U.S. Department of Transportation.

[1]Sum of U.S. Mainline and Regional Air Carriers.

TABLE 10

U. S. MAINLINE AIR CARRIERS

SCHEDULED PASSENGER TRAFFIC

	REVENUE PASSENGER ENPLANEMENTS (Millions)			REVENUE PASSENGER MILES (Billions)		
FISCAL YEAR	DOMESTIC	INTERNATIONAL	SYSTEM	DOMESTIC	INTERNATIONAL	SYSTEM
Historical						
2010	473	75	548	480	230	710
2015	543	87	630	556	259	815
2018	627	96	723	645	279	924
2019	654	100	754	674	290	963
2020	368	47	415	374	127	502
2021E	402	47	449	422	90	512
Forecast						
2022	522	78	601	547	181	729
2027	735	120	855	766	345	1,111
2032	822	141	963	868	401	1,269
2037	930	166	1,096	995	462	1,457
2042	1,060	193	1,254	1,150	531	1,680
Avg Annual Growth						
2010-21	-1.5%	-4.0%	-1.8%	-1.2%	-8.1%	-2.9%
2021-22	30.0%	65.6%	33.7%	29.7%	100.8%	42.2%
2022-32	4.6%	6.0%	4.8%	4.7%	8.3%	5.7%
2022-42	3.6%	4.6%	3.7%	3.8%	5.5%	4.3%

Source: Form 41, U.S. Department of Transportation.

TABLE 11

U.S. MAINLINE AIR CARRIERS

SCHEDULED PASSENGER CAPACITY, TRAFFIC, AND LOAD FACTORS

	DOMESTIC			INTERNATIONAL			SYSTEM		
FISCAL YEAR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR
Historical									
2010	581	480	82.7	279	230	82.2	860	710	82.5
2015	653	556	85.1	321	259	80.8	973	815	83.7
2018	756	645	85.3	342	279	81.6	1,098	924	84.1
2019	785	674	85.8	349	290	83.0	1,134	963	85.0
2020	542	374	69.0	176	127	72.4	718	502	69.8
2021E	582	422	72.6	169	90	53.4	751	512	68.2
Forecast									
2022	652	547	83.9	260	181	69.7	913	729	79.8
2027	895	766	85.6	421	345	82.0	1,316	1,111	84.4
2032	1,015	868	85.5	488	401	82.3	1,502	1,269	84.5
2037	1,161	995	85.7	561	462	82.3	1,723	1,457	84.6
2042	1,340	1,150	85.8	644	531	82.3	1,984	1,680	84.7
Avg Annual Growth									
2010-21	0.0%	-1.2%		-4.5%	-8.1%		-1.2%	-2.9%	
2021-22	12.2%	29.7%		53.8%	100.8%		21.6%	42.2%	
2022-32	4.5%	4.7%		6.5%	8.3%		5.1%	5.7%	
2022-42	3.7%	3.8%		4.6%	5.5%		4.0%	4.3%	

Source: Form 41, U.S. Department of Transportation.

TABLE 12

U.S. MAINLINE AIR CARRIERS

SCHEDULED INTERNATIONAL PASSENGER ENPLANEMENTS

	REVENUE PASSENGER ENPLANEMENTS (MIL)			
FISCAL YEAR	ATLANTIC	LATIN AMERICA	PACIFIC	TOTAL
Historical				
2010	24.5	37.2	12.9	74.6
2015	24.6	48.6	14.0	87.2
2018	26.0	56.9	13.3	96.2
2019	27.9	59.2	13.2	100.2
2020	10.8	30.3	5.6	46.7
2021E	5.7	40.9	0.8	47.4
Forecast				
2022	18.0	57.9	2.6	78.5
2027	31.7	75.5	12.8	120.0
2032	35.1	91.7	14.4	141.2
2037	38.9	110.7	16.1	165.7
2042	43.0	132.4	18.1	193.5
Avg Annual Growth				
2010-21	-12.4%	0.9%	-22.7%	-4.0%
2021-22	213.7%	41.6%	236.4%	65.6%
2022-32	6.9%	4.7%	18.8%	6.0%
2022-42	4.5%	4.2%	10.2%	4.6%

Source: Form 41, U.S. Department of Transportation.

TABLE 13

U.S. MAINLINE AIR CARRIERS

SCHEDULED PASSENGER CAPACITY, TRAFFIC, AND LOAD FACTORS BY INTERNATIONAL TRAVEL REGIONS

	ATLANTIC			LATIN AMERICA			PACIFIC			INTERNATIONAL		
FISCAL YEAR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR	ASMs (BIL)	RPMs (BIL)	% LOAD FACTOR
Historical												
2010	131	109	82.9	78	62	79.2	70	59	84.1	279	230	82.2
2015	133	107	80.0	101	81	80.3	86	71	82.5	321	259	80.8
2018	138	112	81.0	111	92	82.2	92	75	81.7	342	279	81.6
2019	146	121	82.9	112	94	83.5	91	75	82.6	349	290	83.0
2020	69	48	69.3	63	48	76.2	44	31	71.8	176	127	72.4
2021E	57	27	47.8	92	59	63.5	20	4	22.4	169	90	53.4
Forecast												
2022	108	80	74.0	118	86	73.0	35	16	45.0	260	181	69.7
2027	176	144	81.8	141	117	82.8	104	84	81.3	421	345	82.0
2032	198	162	81.8	172	143	82.8	118	97	82.4	488	401	82.3
2037	220	180	81.8	209	173	82.8	133	109	82.4	561	462	82.3
2042	245	200	81.8	251	208	82.8	149	122	82.4	644	531	82.3
Avg Annual Growth												
2010-21	-7.3%	-11.8%		1.5%	-0.5%		-10.9%	-21.0%		-4.5%	-8.1%	
2021-22	89.6%	193.4%		27.2%	46.3%		74.5%	251.2%		53.8%	100.8%	
2022-32	6.2%	7.3%		3.9%	5.2%		13.0%	20.0%		6.5%	8.3%	
2022-42	4.2%	4.7%		3.9%	4.5%		7.5%	10.8%		4.6%	5.5%	

Source: Form 41, U.S. Department of Transportation.

TABLE 14

U.S. MAINLINE AIR CARRIER FORECAST ASSUMPTIONS

SEATS PER AIRCRAFT MILE

FISCAL YEAR	DOMESTIC (Seats/Mile)	INTERNATIONAL ATLANTIC (Seats/Mile)	INTERNATIONAL LATIN AMERICA (Seats/Mile)	INTERNATIONAL PACIFIC (Seats/Mile)	INTERNATIONAL TOTAL (Seats/Mile)	SYSTEM (Seats/Mile)
Historical						
2010	152.0	231.7	171.7	287.2	220.9	169.2
2015	157.7	237.0	173.9	272.1	219.5	173.8
2018	164.2	247.5	178.1	265.2	223.2	178.9
2019	166.0	251.6	177.9	269.9	225.6	180.7
2020	166.7	256.2	178.5	255.0	221.5	177.5
2021E	171.7	255.4	178.8	205.8	202.4	177.8
Forecast						
2022	172.7	250.1	175.7	251.9	212.0	182.4
2027	172.1	250.6	178.1	279.3	225.6	186.2
2032	175.0	253.0	180.6	284.0	226.8	189.0
2037	177.9	255.4	183.0	288.8	228.0	191.6
2042	180.9	257.8	185.5	293.6	229.4	194.2
Avg Annual Growth						
2010-21	1.1%	0.9%	0.4%	-3.0%	-0.8%	0.5%
2021-22	0.6%	-2.1%	-1.8%	22.4%	4.7%	2.6%
2022-32	0.1%	0.1%	0.3%	1.2%	0.7%	0.4%
2022-42	0.2%	0.2%	0.3%	0.8%	0.4%	0.3%

Source: Form 41, U.S. Department of Transportation.

TABLE 15

U.S. MAINLINE AIR CARRIER FORECAST ASSUMPTIONS

AVERAGE PASSENGER TRIP LENGTH

		INTERNATIONAL				
FISCAL YEAR	DOMESTIC (Miles)	ATLANTIC (Miles)	LATIN AMERICA (Miles)	PACIFIC (Miles)	TOTAL (Miles)	SYSTEM (Miles)
Historical						
2010	1,015	4,433	1,660	4,587	3,077	1,296
2015	1,023	4,336	1,669	5,080	2,969	1,292
2018	1,029	4,299	1,610	5,638	2,895	1,277
2019	1,030	4,330	1,582	5,709	2,890	1,278
2020	1,016	4,442	1,577	5,634	2,725	1,209
2021E	1,050	4,756	1,434	5,809	1,906	1,141
Forecast						
2022	1,048	4,449	1,481	6,064	2,312	1,213
2027	1,041	4,544	1,545	6,617	2,877	1,299
2032	1,056	4,599	1,556	6,747	2,842	1,317
2037	1,070	4,626	1,564	6,770	2,789	1,330
2042	1,084	4,650	1,572	6,779	2,742	1,340
Avg Annual Growth						
2010-21	0.3%	0.6%	-1.3%	2.2%	-4.3%	-1.2%
2021-22	-0.2%	-6.4%	3.3%	4.4%	21.3%	6.4%
2022-32	0.1%	0.3%	0.5%	1.1%	2.1%	0.8%
2022-42	0.2%	0.2%	0.3%	0.6%	0.9%	0.5%

Source: Form 41, U.S. Department of Transportation.

TABLE 16

U.S. MAINLINE AIR CARRIER FORECAST ASSUMPTIONS

PASSENGER YIELDS

	REVENUE PER PASSENGER MILE					
	DOMESTIC		INTERNATIONAL		SYSTEM	
FISCAL YEAR	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)
Historical						
2010	12.62	15.47	12.84	15.74	12.69	15.56
2015	14.79	16.65	14.16	15.94	14.59	16.42
2018	13.92	14.85	13.58	14.50	13.81	14.75
2019	14.12	14.80	13.47	14.11	13.92	14.59
2020	13.46	13.90	13.45	13.89	13.45	13.90
2021E	11.73	11.73	12.85	12.85	11.93	11.93
Forecast						
2022	13.36	12.81	13.51	12.83	13.39	12.84
2027	15.14	13.02	14.08	12.01	14.81	12.73
2032	16.57	12.67	15.35	11.68	16.18	12.38
2037	18.03	12.32	16.68	11.33	17.61	12.02
2042	19.59	11.94	18.13	10.98	19.13	11.66
Avg Annual Growth						
2010-21	-0.7%	-2.5%	0.0%	-1.8%	-0.6%	-2.4%
2021-22	13.8%	9.1%	5.1%	-0.2%	12.3%	7.6%
2022-32	2.2%	-0.1%	1.3%	-0.9%	1.9%	-0.4%
2022-42	1.9%	-0.4%	1.5%	-0.8%	1.8%	-0.5%

Source: Form 41, U.S. Department of Transportation.

TABLE 17

U.S. MAINLINE AIR CARRIER FORECAST ASSUMPTIONS

INTERNATIONAL PASSENGER YIELDS BY REGION

	REVENUE PER PASSENGER MILE							
	ATLANTIC		LATIN AMERICA		PACIFIC		TOTAL INTERNATIONAL	
FISCAL YEAR	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)
Historical								
2010	12.73	15.61	13.33	16.35	12.50	15.33	12.84	15.74
2015	14.64	16.48	14.37	16.18	13.20	14.86	14.16	15.94
2018	14.38	15.35	14.12	15.07	11.73	12.52	13.58	14.50
2019	14.04	14.71	14.20	14.88	11.63	12.19	13.47	14.11
2020	13.49	13.93	14.51	14.99	11.76	12.15	13.45	13.89
2021E	11.84	11.84	12.59	12.59	22.48	22.48	12.85	12.85
Forecast								
2022	12.79	12.14	13.98	13.28	14.61	13.88	13.51	12.83
2027	14.32	12.22	14.94	12.74	12.46	10.63	14.08	12.01
2032	15.67	11.92	16.15	12.28	13.66	10.39	15.35	11.68
2037	17.12	11.62	17.33	11.77	14.95	10.15	16.68	11.33
2042	18.71	11.33	18.61	11.27	16.37	9.92	18.13	10.98
Avg Annual Growth								
2010-21	-0.7%	-2.5%	-0.5%	-2.3%	5.5%	3.5%	0.0%	-1.8%
2021-22	8.0%	2.6%	11.0%	5.4%	-35.0%	-38.3%	5.1%	-0.2%
2022-32	2.1%	-0.2%	1.5%	-0.8%	-0.7%	-2.9%	1.3%	-0.9%
2022-42	1.9%	-0.3%	1.4%	-0.8%	0.6%	-1.7%	1.5%	-0.8%

Source: Form 41, U.S. Department of Transportation.

TABLE 18

U.S. MAINLINE AIR CARRIER FORECAST ASSUMPTIONS

JET FUEL PRICES

	DOMESTIC		INTERNATIONAL		SYSTEM	
FISCAL YEAR	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)	CURRENT $ (Cents)	FY 2021 $ (Cents)
Historical						
2010	219.16	268.72	220.12	269.90	219.49	269.13
2015	207.29	233.39	211.77	238.44	208.96	235.27
2018	206.47	220.40	208.42	222.47	207.16	221.13
2019	205.67	215.54	207.82	217.79	206.42	216.32
2020	166.65	172.15	167.21	172.72	166.84	172.34
2021E	177.22	177.22	171.86	171.86	175.49	175.49
Forecast						
2022	224.23	214.99	217.45	208.49	222.04	212.89
2027	204.61	175.94	198.42	170.62	202.61	174.22
2032	232.54	177.88	225.51	172.50	230.27	176.14
2037	259.69	177.35	251.84	171.99	257.16	175.62
2042	278.88	169.93	270.45	164.80	276.16	168.28
Avg Annual Growth						
2010-21	-1.9%	-3.7%	-2.2%	-4.0%	-2.0%	-3.8%
2021-22	26.5%	21.3%	26.5%	21.3%	26.5%	21.3%
2022-32	0.4%	-1.9%	0.4%	-1.9%	0.4%	-1.9%
2022-42	1.1%	-1.2%	1.1%	-1.2%	1.1%	-1.2%

Source: Form 41, U.S. Department of Transportation

TABLE 19

U.S. COMMERCIAL AIR CARRIERS

AIR CARGO REVENUE TON MILES[1, 2, 3]

	ALL-CARGO CARRIER RTMS (Millions)			PASSENGER CARRIER RTMS (Millions)			TOTAL RTMS (Millions)		
FISCAL YEAR	DOMESTIC	INT'L.	TOTAL	DOMESTIC	INT'L.	TOTAL	DOMESTIC	INT'L.	TOTAL
Historical									
2010	11,306	15,971	27,276	1,495	6,246	7,742	12,801	22,217	35,018
2015	11,636	16,359	27,995	1,455	6,277	7,733	13,091	22,636	35,727
2018	14,182	19,465	33,647	1,580	7,532	9,112	15,761	26,997	42,759
2019	14,737	19,668	34,405	1,468	6,984	8,452	16,205	26,652	42,856
2020	16,663	21,964	38,627	1,124	4,130	5,255	17,787	26,094	43,882
2021E	18,555	26,580	45,135	1,320	4,850	6,169	19,875	31,430	51,304
Forecast									
2022	19,176	26,064	45,240	1,654	5,694	7,348	20,830	31,759	52,589
2027	22,040	30,365	52,405	1,969	9,291	11,260	24,009	39,656	63,666
2032	24,912	37,163	62,075	2,137	10,592	12,729	27,049	47,755	74,804
2037	27,964	44,584	72,548	2,300	11,801	14,102	30,265	56,386	86,650
2042	31,288	52,989	84,277	2,464	12,983	15,448	33,752	65,973	99,725
Avg Annual Growth									
2010-21	4.6%	4.7%	4.7%	-1.1%	-2.3%	-2.0%	4.1%	3.2%	3.5%
2021-22	3.3%	-1.9%	0.2%	25.3%	17.4%	19.1%	4.8%	1.0%	2.5%
2022-32	2.7%	3.6%	3.2%	2.6%	6.4%	5.6%	2.6%	4.2%	3.6%
2022-42	2.5%	3.6%	3.2%	2.0%	4.2%	3.8%	2.4%	3.7%	3.3%

Source: Form 41, U.S. Department of Transportation

[1]Includes freight/express and mail revenue ton miles on mainline air carriers and regionals/commuters.

[2]Domestic figures from 2000 through 2002 exclude Airborne Express, Inc.; international figures for 2003 and beyond include new reporting of contract service by U.S. carriers for foreign flag carriers.

[3]Domestic figures from 2003 and beyond include Airborne Express. Inc.

TABLE 20

U.S. COMMERCIAL AIR CARRIERS

INTERNATIONAL AIR CARGO REVENUE TON MILES BY REGION[1, 2]

FISCAL YEAR	ATLANTIC (MILLIONS)	LATIN AMERICA (MILLIONS)	PACIFIC (MILLIONS)	OTHER INTERNATIONAL (MILLIONS)	TOTAL (MILLIONS)
Historical					
2010	6,786	1,990	7,897	5,545	22,217
2015	6,627	1,639	9,018	5,352	22,636
2018	7,554	1,846	10,422	7,176	26,997
2019	7,426	1,661	10,429	7,135	26,652
2020	6,669	1,296	10,198	7,931	26,094
2021E	7,626	1,623	11,531	10,650	31,430
Forecast					
2022	8,136	1,716	12,407	9,500	31,759
2027	10,297	1,970	15,752	11,636	39,656
2032	11,976	2,182	19,019	14,579	47,755
2037	13,523	2,351	22,538	17,974	56,386
2042	15,058	2,497	26,452	21,966	65,973
Avg Annual Growth					
2010-21	1.1%	-1.8%	3.5%	6.1%	3.2%
2021-22	6.7%	5.7%	7.6%	-10.8%	1.0%
2022-32	3.9%	2.4%	4.4%	4.4%	4.2%
2022-42	3.1%	1.9%	3.9%	4.3%	3.7%

Source: Form 41, U.S. Department of Transportation

[1]Includes freight/express and mail revenue ton miles on mainline air carriers and regionals/commuters.

[2]Figures for 2003 and beyond include new reporting of contract service by U.S. carriers for foreign flag carriers.

TABLE 21

U.S. MAINLINE AIR CARRIERS

PASSENGER JET AIRCRAFT

Passenger	LARGE NARROWBODY				LARGE WIDEBODY						
CALENDAR YEAR	2 ENGINE	3 ENGINE	4 ENGINE	TOTAL	2 ENGINE	3 ENGINE	4 ENGINE	TOTAL	LARGE JETS	REGIONAL JETS	TOTAL JETS
Historical											
2010	3,120	8	1	3,129	470	9	43	522	3,651	71	3,722
2015	3,319	2	0	3,321	492	0	31	523	3,844	99	3,943
2018	3,678	0	0	3,678	541	0	0	541	4,219	98	4,317
2019	3,775	0	0	3,775	553	0	0	553	4,328	60	4,388
2020	2,860	0	0	2,860	298	0	0	298	3,158	23	3,181
2021E	2,828	0	0	2,828	281	0	0	281	3,109	23	3,132
Forecast											
2022	3,429	0	0	3,429	426	0	0	426	3,855	60	3,915
2027	3,463	0	0	3,463	503	0	0	503	3,966	0	3,966
2032	3,765	0	0	3,765	589	0	0	589	4,354	0	4,354
2037	4,203	0	0	4,203	676	0	0	676	4,879	0	4,879
2042	4,748	0	0	4,748	784	0	0	784	5,532	0	5,532
Avg Annual Growth											
2010-21	-0.9%	N.A.	N.A.	-0.9%	-4.6%	N.A.	N.A.	-5.5%	-1.5%	-9.7%	-1.6%
2021-22	21.3%	N.A.	N.A.	21.3%	51.6%	N.A.	N.A.	51.6%	24.0%	N.A.	25.0%
2022-32	0.9%	N.A.	N.A.	0.9%	3.3%	N.A.	N.A.	3.3%	1.2%	N.A.	1.1%
2022-42	1.6%	N.A.	N.A.	1.6%	3.1%	N.A.	N.A.	3.1%	1.8%	N.A.	1.7%

Note: N.A. - Not Applicable

TABLE 22

U.S. MAINLINE AIR CARRIERS

CARGO JET AIRCRAFT

	LARGE NARROWBODY				LARGE WIDEBODY				
CALENDAR YEAR	2 ENGINE	3 ENGINE	4 ENGINE	TOTAL	2 ENGINE	3 ENGINE	4 ENGINE	TOTAL	TOTAL
Historical									
2010	153	104	31	288	265	200	97	562	850
2015	228	22	2	252	309	156	72	537	789
2018	213	11	2	226	392	120	100	612	838
2019	216	10	2	228	419	120	112	651	879
2020	200	10	0	210	414	115	109	638	848
2021E	213	8	0	221	434	111	110	655	876
Forecast									
2022	219	7	0	226	469	118	122	709	935
2027	301	2	0	303	618	113	128	859	1,162
2032	408	0	0	408	744	110	128	982	1,390
2037	486	0	0	486	987	56	111	1,154	1,640
2042	622	0	0	622	1,235	8	94	1,337	1,959
Avg Annual Growth									
2010-21	3.1%	-20.8%	N.A.	-2.4%	4.6%	-5.2%	1.1%	1.4%	0.3%
2021-22	2.8%	-12.5%	N.A.	2.3%	8.1%	6.3%	10.9%	8.2%	6.7%
2022-32	6.4%	N.A.	N.A.	6.1%	4.7%	-0.7%	0.5%	3.3%	4.0%
2022-42	5.4%	N.A.	N.A.	5.2%	5.0%	-12.6%	-1.3%	3.2%	3.8%

Note: N.A. - Not Applicable

TABLE 23

TOTAL JET FUEL AND AVIATION GASOLINE FUEL CONSUMPTION

U.S. CIVIL AVIATION AIRCRAFT

(Millions of Gallons)

	JET FUEL					AVIATION GASOLINE			
	U.S. AIR CARRIERS[1, 2]								
FISCAL YEAR	DOMESTIC	INT'L.	TOTAL	GENERAL AVIATION	TOTAL	AIR CARRIER	GENERAL AVIATION	TOTAL	TOTAL FUEL CONSUMED
Historical									
2010	12,036	6,315	18,351	1,435	19,786	2	221	223	20,009
2015	12,834	6,541	19,374	1,383	20,757	2	196	198	20,955
2018	14,580	7,121	21,701	1,820	23,521	2	232	234	23,755
2019	14,648	7,043	21,691	1,510	23,202	2	200	202	23,404
2020	10,527	4,723	15,249	1,342	16,592	2	204	206	16,797
2021E	11,548	4,813	16,361	1,519	17,880	2	205	207	18,087
Forecast									
2022	12,686	6,087	18,773	1,680	20,453	2	206	208	20,661
2027	16,652	8,326	24,979	2,058	27,037	2	203	205	27,242
2032	17,967	9,176	27,143	2,292	29,435	2	197	199	29,634
2037	19,566	10,051	29,617	2,505	32,122	2	194	196	32,318
2042	21,476	10,978	32,454	2,707	35,161	2	194	196	35,357
Avg Annual Growth									
2010-21	-0.4%	-2.4%	-1.0%	0.5%	-0.9%	0.0%	-0.7%	-0.7%	-0.9%
2021-22	9.9%	26.5%	14.7%	10.6%	14.4%	0.0%	0.6%	0.6%	14.2%
2022-32	3.5%	4.2%	3.8%	3.2%	3.7%	0.0%	-0.5%	-0.4%	3.7%
2022-42	2.7%	3.0%	2.8%	2.4%	2.7%	0.0%	-0.3%	-0.3%	2.7%

Source: Air carrier jet fuel, Form 41, U.S. Department of Transportation; all others, FAA APO estimates.

[1]Includes both passenger (mainline and regional air carrier) and cargo carriers.

[2]Forecast assumes 1.0% annual improvement in available seat miles per gallon for U.S. Commercial Air Carrier

TABLE 24

U.S. REGIONAL CARRIER FORECAST ASSUMPTIONS

FISCAL YEAR	AVERAGE SEATS PER AIRCRAFT MILE			AVERAGE PASSENGER TRIP LENGTH			REVENUE PER PASSENGER MILE**	
	DOMESTIC (Seats/Mile)	INT'L (Seats/Mile)	TOTAL (Seats/Mile)	DOMESTIC (Miles)	INT'L. (Miles)	TOTAL (Miles)	CURRENT $ (Cents)	2021 $ (Cents)
Historical								
2010	56.1	53.2	56.1	464	503	465	15.74	19.30
2015	60.0	62.6	60.1	476	695	480	10.93	12.31
2018	64.1	70.8	64.3	487	680	491	11.32	12.09
2019	64.5	70.9	64.7	492	670	496	11.48	12.03
2020	65.1	70.7	65.3	495	675	498	11.01	11.38
2021E	66.5	72.9	66.7	511	662	514	9.63	9.63
Forecast								
2022	65.1	73.2	65.3	487	648	490	10.82	10.37
2027	66.9	74.7	67.0	498	644	500	12.39	10.66
2032	68.0	76.2	68.2	504	653	507	13.55	10.37
2037	69.1	77.7	69.3	511	662	514	14.75	10.07
2042	70.3	79.2	70.5	518	671	521	16.01	9.76
Avg Annual Growth								
2010-21	1.6%	2.9%	1.6%	0.9%	2.5%	0.9%	-4.4%	-6.1%
2021-22	-2.1%	0.4%	-2.1%	-4.7%	-2.0%	-4.6%	12.3%	7.7%
2022-32	0.4%	0.4%	0.4%	0.4%	0.1%	0.3%	2.3%	0.0%
2022-42	0.4%	0.4%	0.4%	0.3%	0.2%	0.3%	2.0%	-0.3%

Source: Form 41 and 298C, U.S. Department of Transportation.

** Reporting carriers.

TABLE 25

U.S. REGIONAL CARRIERS

SCHEDULED PASSENGER TRAFFIC

(In Millions)

	REVENUE PASSENGERS			REVENUE PASSENGER MILES		
FISCAL YEAR	DOMESTIC	INTERNATIONAL	TOTAL	DOMESTIC	INTERNATIONAL	TOTAL
Historical						
2010	162	3	164	75,029	1,347	76,376
2015	153	3	156	72,737	2,116	74,853
2018	154	3	157	74,852	2,295	77,147
2019	159	4	163	78,302	2,376	80,679
2020	94	2	96	46,385	1,229	47,614
2021E	105	2	107	53,798	1,221	55,020
Forecast						
2022	123	2	125	59,976	1,436	61,411
2027	179	3	182	88,975	2,020	90,995
2032	200	4	203	100,849	2,290	103,139
2037	226	4	230	115,680	2,626	118,306
2042	258	5	262	133,609	3,034	136,643
Avg Annual Growth						
2010-21	-3.8%	-3.3%	-3.8%	-3.0%	-0.9%	-2.9%
2021-22	17.0%	19.9%	17.0%	11.5%	17.6%	11.6%
2022-32	5.0%	4.7%	5.0%	5.3%	4.8%	5.3%
2022-42	3.8%	3.6%	3.8%	4.1%	3.8%	4.1%

Source: Form 41 and 298C, U.S. Department of Transportation.

TABLE 26

U.S. REGIONAL CARRIERS

SCHEDULED PASSENGER CAPACITY, TRAFFIC, AND LOAD FACTORS

	DOMESTIC			INTERNATIONAL			TOTAL		
YEAR	ASMs (MIL)	RPMs (MIL)	% LOAD FACTOR	ASMs (MIL)	RPMs (MIL)	% LOAD FACTOR	ASMs (MIL)	RPMs (MIL)	% LOAD FACTOR
Historical									
2010	98,455	75,029	76.2	1,857	1,347	72.5	100,312	76,376	76.1
2015	90,647	72,737	80.2	2,819	2,116	75.0	93,467	74,853	80.1
2018	93,860	74,852	79.7	3,023	2,295	75.9	96,883	77,147	79.6
2019	98,019	78,302	79.9	3,116	2,376	76.3	101,135	80,679	79.8
2020	70,554	46,385	65.7	1,811	1,229	67.9	72,364	47,614	65.8
2021E	76,017	53,798	70.8	1,836	1,221	66.5	77,853	55,020	70.7
Forecast									
2022	77,092	59,976	77.8	1,956	1,436	73.4	79,048	61,411	77.7
2027	111,724	88,975	79.6	2,699	2,020	74.9	114,423	90,995	79.5
2032	126,693	100,849	79.6	3,060	2,290	74.8	129,754	103,139	79.5
2037	145,009	115,680	79.8	3,503	2,626	75.0	148,512	118,306	79.7
2042	167,279	133,609	79.9	4,041	3,034	75.1	171,319	136,643	79.8
Avg Annual Growth									
2010-21	-2.3%	-3.0%		-0.1%	-0.9%		-2.3%	-2.9%	
2021-22	1.4%	11.5%		6.5%	17.6%		1.5%	11.6%	
2022-32	5.1%	5.3%		4.6%	4.8%		5.1%	5.3%	
2022-42	3.9%	4.1%		3.7%	3.8%		3.9%	4.1%	

Source: Form 41 and 298C, U.S. Department of Transportation.

TABLE 27

U.S. REGIONAL CARRIERS

PASSENGER AIRCRAFT

	REGIONAL AIRCRAFT											
				31 TO 40 SEATS			OVER 40 SEATS			TOTAL FLEET		
AS OF JANUARY 1	LESS THAN 9 SEATS	10 TO 19 SEATS	20 TO 30 SEATS	PROP	JET	TOTAL	PROP	JET	TOTAL	NON JET	JET	TOTAL
Historical												
2010	440	92	82	144	28	172	99	1,728	1,827	857	1,756	2,613
2015	346	68	13	32	0	32	57	1,628	1,685	516	1,628	2,144
2018	360	77	20	11	3	14	54	1,795	1,849	522	1,798	2,320
2019	374	72	19	11	0	11	39	1,846	1,885	515	1,846	2,361
2020	276	74	20	11	0	11	40	1,434	1,474	421	1,434	1,855
2021E	268	69	16	10	0	10	38	1,406	1,444	401	1,406	1,807
Forecast												
2022	259	67	15	3	3	6	49	1,623	1,672	394	1,626	2,020
2027	218	56	13	0	2	2	53	1,550	1,603	341	1,552	1,893
2032	177	46	11	0	0	0	60	1,530	1,590	293	1,530	1,823
2037	139	36	8	0	0	0	66	1,759	1,825	249	1,759	2,008
2042	101	26	6	0	0	0	75	1,979	2,054	208	1,979	2,187
Avg Annual Growth												
2010-21	-4.4%	-2.6%	-13.8%	-21.5%	N.A.	-22.8%	-8.3%	-1.9%	-2.1%	-6.7%	-2.0%	-3.3%
2021-22	-3.2%	-3.2%	-3.2%	-70.0%	N.A.	-40.0%	28.9%	15.4%	15.8%	-1.8%	15.6%	11.8%
2022-32	-3.7%	-3.7%	-3.7%	N.A.	N.A.	N.A.	2.0%	-0.6%	-0.5%	-2.9%	-0.6%	-1.0%
2022-42	-4.6%	-4.6%	-4.6%	N.A.	N.A.	N.A.	2.2%	1.0%	1.0%	-3.1%	1.0%	0.4%

Note: N.A. - Not Applicable

TABLE 28

ACTIVE GENERAL AVIATION AND AIR TAXI AIRCRAFT

	FIXED WING						ROTORCRAFT						TOTAL GENERAL AVIATION		
	PISTON			TURBINE											
AS OF DEC. 31	SINGLE ENGINE	MULTI-ENGINE	TOTAL	TURBO PROP	TURBO JET	TOTAL	PISTON	TURBINE	TOTAL	EXPERI-MENTAL**	LIGHT SPORT AIRCRAFT**	OTHER	FLEET	TOTAL PISTONS	TOTAL TURBINES
Historical*															
2010	139,519	15,900	155,419	9,369	11,484	20,853	3,588	6,514	10,102	24,784	6,528	5,684	223,370	159,007	27,367
2015	127,887	13,254	141,141	9,712	13,440	23,152	3,286	7,220	10,506	27,922	2,369	4,941	210,031	144,427	30,372
2018	130,179	12,861	143,040	9,925	14,596	24,521	3,082	6,907	9,989	27,531	2,554	4,114	211,749	146,122	31,428
2019	128,926	12,470	141,396	10,242	14,888	25,130	3,089	7,109	10,198	27,449	2,675	4,133	210,981	144,485	32,239
2020	124,059	11,947	136,006	10,317	15,316	25,633	2,930	6,816	9,746	26,367	2,570	3,818	204,140	138,936	32,449
2021E	123,105	11,865	134,970	10,275	15,755	26,030	2,920	6,900	9,820	27,000	2,765	3,820	204,405	137,890	32,930
Forecast															
2022	122,020	11,795	133,815	10,250	16,230	26,480	2,925	7,030	9,955	27,495	2,905	3,940	204,590	136,740	33,510
2027	116,225	11,490	127,715	10,245	18,830	29,075	2,970	7,705	10,675	29,455	3,600	4,405	204,925	130,685	36,780
2032	110,560	11,285	121,845	10,460	21,535	31,995	3,070	8,515	11,585	30,985	4,295	4,490	205,195	124,915	40,510
2037	105,565	11,135	116,700	10,780	24,290	35,070	3,180	9,360	12,540	32,460	4,985	4,525	206,280	119,880	44,430
2042	101,860	11,055	112,915	11,455	27,000	38,455	3,305	10,225	13,530	33,785	5,655	4,565	208,905	116,220	48,680
Avg Annual Growth															
2010-21	-1.1%	-2.6%	-1.3%	0.8%	2.9%	2.0%	-1.9%	0.5%	-0.3%	0.8%	-7.5%	-3.5%	-0.8%	-1.3%	1.7%
2021-22	-0.9%	-0.6%	-0.9%	-0.2%	3.0%	1.7%	0.2%	1.9%	1.4%	1.8%	5.1%	3.1%	0.1%	-0.8%	1.8%
2022-32	-1.0%	-0.4%	-0.9%	0.2%	2.9%	1.9%	0.5%	1.9%	1.5%	1.2%	4.0%	1.3%	0.0%	-0.9%	1.9%
2022-42	-0.9%	-0.3%	-0.8%	0.6%	2.6%	1.9%	0.6%	1.9%	1.5%	1.0%	3.4%	0.7%	0.1%	-0.8%	1.9%

* Source: 2001-2010, 2012-2018, FAA General Aviation and Air Taxi Activity (and Avionics) Surveys.

**Experimental Light-sport category that was previously shown under Sport Aircraft is moved under Experimental Aircraft category, starting in 2012.

Note: An active aircraft is one that has a current registration and was flown at least one hour during the calendar year.

TABLE 29

ACTIVE GENERAL AVIATION AND AIR TAXI HOURS FLOWN

(In Thousands)

	FIXED WING						ROTORCRAFT						TOTAL		
	PISTON			TURBINE									GENERAL		
AS OF DEC. 31	SINGLE ENGINE	MULTI-ENGINE	TOTAL	TURBO PROP	TURBO JET	TOTAL	PISTON	TURBINE	TOTAL	EXPERI-MENTAL**	LIGHT SPORT AIRCRAFT**	OTHER	AVIATION FLEET	TOTAL PISTONS	TOTAL TURBINES
Historical*															
2010	12,161	1,818	13,979	2,325	3,375	5,700	794	2,611	3,405	1,226	311	181	24,802	14,773	8,311
2015	11,217	1,608	12,825	2,538	3,837	6,375	798	2,496	3,294	1,295	191	162	24,142	13,623	8,871
2018	12,092	1,694	13,785	2,736	4,592	7,328	601	2,322	2,922	1,153	187	131	25,506	14,386	9,650
2019	12,700	1,731	14,431	2,619	3,926	6,546	628	2,369	2,997	1,269	189	135	25,566	15,059	8,914
2020	11,603	1,336	12,939	2,344	3,336	5,681	537	1,871	2,408	1,176	202	86	22,492	13,477	7,552
2021E	11,546	1,421	12,967	2,493	3,879	6,372	568	2,036	2,604	1,115	219	104	23,380	13,535	8,408
Forecast															
2022	11,478	1,464	12,942	2,618	4,403	7,022	586	2,116	2,702	1,198	232	116	24,211	13,528	9,137
2027	10,903	1,502	12,405	2,880	5,809	8,689	647	2,425	3,072	1,416	298	144	26,024	13,052	11,114
2032	10,328	1,496	11,824	2,946	6,739	9,685	703	2,731	3,434	1,543	362	145	26,994	12,527	12,417
2037	9,921	1,513	11,433	3,038	7,628	10,666	748	3,027	3,775	1,660	427	147	28,108	12,182	13,692
2042	9,742	1,552	11,294	3,229	8,513	11,743	797	3,331	4,129	1,758	491	149	29,563	12,091	15,074
Avg Annual Growth															
2010-21	-0.5%	-2.2%	-0.7%	0.6%	1.3%	1.0%	-3.0%	-2.2%	-2.4%	-0.9%	-3.1%	-4.9%	-0.5%	-0.8%	0.1%
2021-22	-0.6%	3.0%	-0.2%	5.0%	13.5%	10.2%	3.2%	3.9%	3.8%	7.4%	6.0%	11.2%	3.6%	-0.1%	8.7%
2022-32	-1.1%	0.2%	-0.9%	1.2%	4.3%	3.3%	1.8%	2.6%	2.4%	2.6%	4.6%	2.3%	1.1%	-0.8%	3.1%
2022-42	-0.8%	0.3%	-0.7%	1.1%	3.4%	2.6%	1.6%	2.3%	2.1%	1.9%	3.8%	1.3%	1.0%	-0.6%	2.5%

* Source: 2001-2010, 2012-2018, FAA General Aviation and Air Taxi Activity (and Avionics) Surveys.

**Experimental Light-sport category that was previously shown under Sport Aircraft is moved under Experimental Aircraft category, starting in 2012.

Note: An active aircraft is one that has a current registration and was flown at least one hour during the calendar year.

TABLE 30

ACTIVE PILOTS BY TYPE OF CERTIFICATE, EXCLUDING STUDENT PILOTS*

AS OF DEC. 31	RECREA-TIONAL	SPORT PILOT	PRIVATE	COMMERCIAL	AIRLINE TRANSPORT	ROTOR-CRAFT ONLY	GLIDER ONLY	TOTAL LESS STUDENT PILOTS	INSTRUMENT RATED PILOTS[1]
Historical**									
2010	212	3,682	202,020	123,705	142,198	15,377	21,275	508,469	318,001
2015	190	5,482	170,718	101,164	154,730	15,566	19,460	467,310	304,329
2018	144	6,246	163,695	99,880	162,145	15,033	18,370	465,513	311,017
2019	127	6,467	161,105	100,863	164,947	14,248	19,143	466,900	314,168
2020	105	6,643	160,860	103,879	164,193	13,629	19,753	469,062	316,651
2021	85	6,801	161,459	104,610	163,934	13,191	20,328	470,408	317,169
Forecast									
2022	80	6,970	161,800	105,250	166,000	13,350	21,000	474,450	318,100
2027	70	7,915	159,800	107,050	171,550	13,850	23,300	483,535	325,700
2032	55	9,115	154,500	107,600	178,550	14,850	24,200	488,870	333,800
2037	45	10,570	149,000	107,550	186,600	16,100	24,600	494,465	341,600
2042	20	11,850	145,150	107,350	194,300	17,350	24,700	500,720	349,450
Avg Annual Growth									
2010-21	-8.0%	5.7%	-2.0%	-1.5%	1.3%	-1.4%	-0.4%	-0.7%	0.0%
2021-22	-5.9%	2.5%	0.2%	0.6%	1.3%	1.2%	3.3%	0.9%	0.3%
2022-32	-3.7%	2.7%	-0.5%	0.2%	0.7%	1.1%	1.4%	0.3%	0.5%
2022-42	-6.7%	2.7%	-0.5%	0.1%	0.8%	1.3%	0.8%	0.3%	0.5%

** Source: FAA U.S. Civil Airmen Statistics.

*Starting with April 2016, there is no expiration date on the new student pilot certificates. This generates a cumulative increase in the student pilot numbers and breaks the link between student pilot and private pilot or higher level certificates. Since there is no sufficient data yet to forecast the student certificates unter the new rule, student pilot forecast is suspended and excluded from this table.

[1]Instrument rated pilots should not be added to other categories in deriving total.

Note: An active pilot is a person with a pilot certificate and a valid medical certificate.

TABLE 31

GENERAL AVIATION AIRCRAFT FUEL CONSUMPTION

(In Millions of Gallons)

	FIXED WING										
	PISTON		TURBINE		ROTORCRAFT				TOTAL FUEL CONSUMED		
CALENDAR YEAR	SINGLE ENGINE	MULTI-ENGINE	TURBO PROP	TURBO JET	PISTON	TURBINE	EXPERI-MENTAL** / OTHER	LIGHT SPORT**	AVGAS	JET FUEL	TOTAL
Historical*											
2010	133	54	187	1,123	11	125	22	1	221	1,435	1,656
2015	128	40	191	1,063	10	128	15	1	196	1,383	1,578
2018	152	50	234	1,455	9	132	20	1	232	1,820	2,052
2019	131	45	213	1,170	8	127	16	1	200	1,510	1,711
2020	146	35	201	1,036	8	105	14	1	204	1,342	1,546
2021E	145	37	214	1,192	8	113	14	1	205	1,519	1,724
Forecast											
2022	144	38	224	1,340	8	116	15	1	206	1,680	1,886
2027	136	39	243	1,685	9	130	17	2	203	2,058	2,261
2032	128	38	244	1,908	10	141	19	2	197	2,292	2,489
2037	123	38	245	2,106	11	154	20	2	194	2,505	2,699
2042	120	39	254	2,292	11	161	21	2	194	2,707	2,902
Avg Annual Growth											
2010-21	0.8%	-3.3%	1.2%	0.5%	-2.4%	-0.9%	-4.1%	-2.1%	-0.7%	0.5%	0.4%
2021-22	-0.6%	2.6%	4.8%	12.4%	2.7%	2.9%	6.7%	5.0%	0.6%	10.6%	9.4%
2022-32	-1.1%	0.1%	0.9%	3.6%	1.8%	1.9%	2.4%	4.1%	-0.5%	3.2%	2.8%
2022-42	-0.9%	0.2%	0.6%	2.7%	1.5%	1.6%	1.9%	3.5%	-0.3%	2.4%	2.2%

*Source: FAA APO Estimates.

**Experimental Light-sport category that was previously shown under Sport Aircraft is moved under Experimental Aircraft category, starting in 2012.

Note: Detail may not add to total because of independent rounding.

TABLE 32

TOTAL COMBINED AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA AND CONTRACT TRAFFIC CONTROL SERVICE

(In Thousands)

			GENERAL AVIATION			MILITARY				NUMBER OF TOWERS	
FISCAL YEAR	AIR CARRIER	AIR TAXI/ COMMUTER	ITINERANT	LOCAL	TOTAL	ITINERANT	LOCAL	TOTAL	TOTAL	FAA	CONTRACT
Historical											
2010	12,658	9,410	14,864	11,716	26,580	1,309	1,298	2,607	51,255	264	244
2015	13,755	7,895	13,887	11,691	25,579	1,292	1,203	2,495	49,724	264	252
2018	15,686	7,126	14,130	12,354	26,485	1,319	1,155	2,474	51,770	264	254
2019	16,192	7,234	14,245	13,109	27,354	1,349	1,134	2,483	53,264	264	256
2020	11,737	5,472	12,608	12,333	24,941	1,192	1,020	2,212	44,362	264	256
2021	12,214	5,882	13,759	13,441	27,200	1,288	1,075	2,362	47,659	264	258
Forecast											
2022	13,782	6,285	14,569	13,731	28,300	1,288	1,075	2,362	50,729	264	258
2027	20,928	5,963	15,636	14,951	30,587	1,288	1,075	2,362	59,840	264	258
2032	23,074	6,286	15,839	15,214	31,053	1,288	1,075	2,362	62,775	264	258
2037	25,112	6,617	16,046	15,486	31,533	1,288	1,075	2,362	65,624	264	258
2042	27,081	6,967	16,260	15,768	32,027	1,288	1,075	2,362	68,437	264	258
Avg Annual Growth											
2010-21	-0.3%	-4.2%	-0.7%	1.3%	0.2%	-0.1%	-1.7%	-0.9%	-0.7%		
2021-22	12.8%	6.8%	5.9%	2.2%	4.0%	0.0%	0.0%	0.0%	6.4%		
2022-32	5.3%	0.0%	0.8%	1.0%	0.9%	0.0%	0.0%	0.0%	2.2%		
2022-42	3.4%	0.5%	0.6%	0.7%	0.6%	0.0%	0.0%	0.0%	1.5%		

Source: FAA Air Traffic Activity.

TABLE 33

TOTAL TRACON OPERATIONS

(In Thousands)

FISCAL YEAR	AIR CARRIER	AIR TAXI/ COMMUTER	GENERAL AVIATION	MILITARY	OVERFLIGHT	TOTAL
Historical						
2010	12,575	8,512	10,761	2,050	4,840	38,738
2015	13,610	6,999	10,350	1,961	4,116	37,036
2018	15,519	6,475	10,795	1,953	4,113	38,856
2019	16,014	6,600	10,960	1,946	3,706	39,227
2020	11,617	5,153	9,691	1,763	3,050	31,274
2021	12,045	5,462	10,742	1,894	3,393	33,536
Forecast						
2022	13,608	5,803	11,417	1,896	3,686	36,410
2027	20,698	5,019	12,240	1,896	4,486	44,339
2032	22,831	5,309	12,380	1,896	4,775	47,189
2037	24,856	5,609	12,523	1,895	5,052	49,936
2042	26,813	5,924	12,670	1,895	5,324	52,627
Avg Annual Growth						
2010-21	-0.4%	-4.0%	0.0%	-0.7%	-3.2%	-1.3%
2021-22	13.0%	6.2%	6.3%	0.1%	8.7%	8.6%
2022-32	5.3%	-0.9%	0.8%	0.0%	2.6%	2.6%
2022-42	3.4%	0.1%	0.5%	0.0%	1.9%	1.9%

Source: FAA Air Traffic Activity.

TABLE 34

IFR AIRCRAFT HANDLED
AT FAA EN ROUTE TRAFFIC CONTROL CENTERS
(In Thousands)

	IFR AIRCRAFT HANDLED			
FISCAL YEAR	COMMERCIAL	GENERAL AVIATION	MILITARY	TOTAL
Historical				
2010	30,965	6,550	2,982	40,498
2015	33,116	7,007	1,795	41,918
2018	35,713	7,403	1,724	44,840
2019	35,682	6,275	1,525	43,483
2020	25,537	5,071	1,297	31,905
2021	26,386	6,094	1,430	33,910
Forecast				
2022	29,634	6,463	1,430	37,527
2027	42,013	6,966	1,430	50,409
2032	46,410	7,151	1,430	54,991
2037	50,632	7,346	1,430	59,408
2042	54,733	7,552	1,430	63,714
Avg Annual Growth				
2010-21	-1.4%	-0.7%	-6.5%	-1.6%
2021-22	12.3%	6.1%	0.0%	10.7%
2022-32	4.6%	1.0%	0.0%	3.9%
2022-42	3.1%	0.8%	0.0%	2.7%

Source: FAA Air Traffic Activity