

Aerospace Market Outlook

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PREPARED FOR
SpeedNews Commercial Aviation Suppliers Conference
Beverly Hills, CA
2 March 2022



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Global air travel demand remains in the doldrums thanks to COVID-19

Air Travel Capacity Changes 2022 vs 2020

Capacity Percent Changes				
Asia	W-o-W	2-Week	M-o-M	v. 2020
Asia Total	-1%	-3%	-6%	-41%
China Total	-4%	-5%	-3%	-31%
China Domestic	-4%	-5%	-3%	-14%
China International	6%	-16%	-22%	-98%
South Korea	8%	0%	-1%	-62%
Japan	-8%	-14%	-16%	-50%
Taiwan	3%	-15%	-32%	-92%
Singapore	2%	26%	51%	-75%
India	2%	-4%	-15%	-38%
Indonesia	2%	8%	4%	-37%

Europe				
	W-o-W	2-Week	M-o-M	v. 2020
Europe Total	3%	2%	-15%	-41%
Italy	2%	1%	-17%	-52%
United Kingdom	6%	3%	-18%	-50%
Germany	3%	-1%	-15%	-45%
France	3%	-2%	-15%	-39%
Spain	4%	4%	-12%	-29%

Middle East				
	W-o-W	2-Week	M-o-M	v. 2020
Middle East Total	6%	4%	3%	-25%
Iran	3%	3%	10%	5%
Dubai	8%	3%	6%	-28%
Doha	5%	8%	4%	-24%

Americas				
	W-o-W	2-Week	M-o-M	v. 2020
North America Total	1%	0%	-2%	-16%
United States	1%	0%	-1%	-17%
Brazil	-3%	-5%	-2%	-37%

Total				
	W-o-W	2-Week	M-o-M	v. 2020
Global Total	1%	-2%	-5%	-33%
Domestic	0%	-2%	-5%	-19%
International	4%	1%	-7%	-59%

› Asia down 41%; China’s domestic recovery recently reversed due to Omicron lockdown

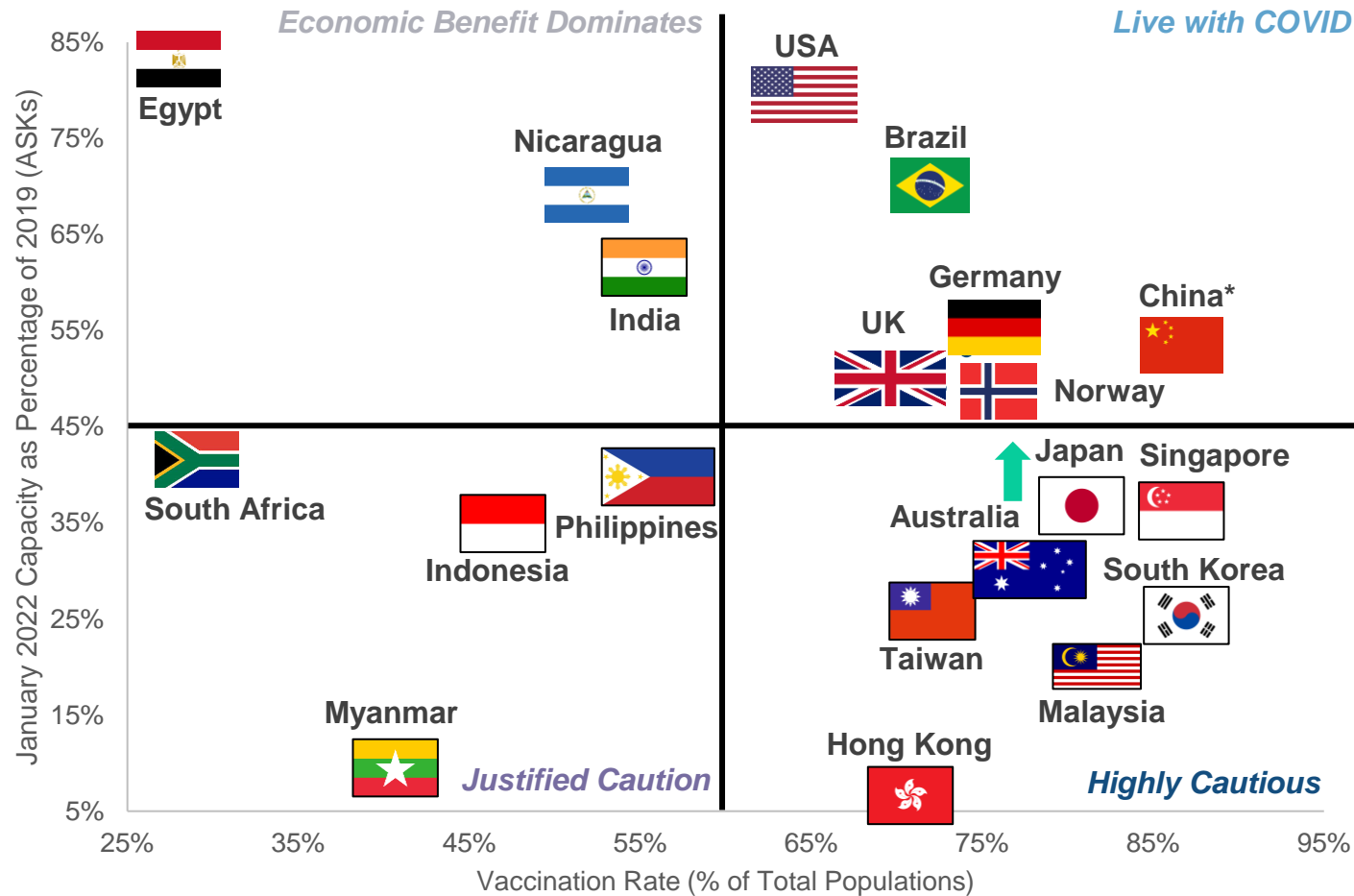
› Europe also down 41%; Middle East hubs are faring better

› North America the least impacted – 16% off 2020 ASKs

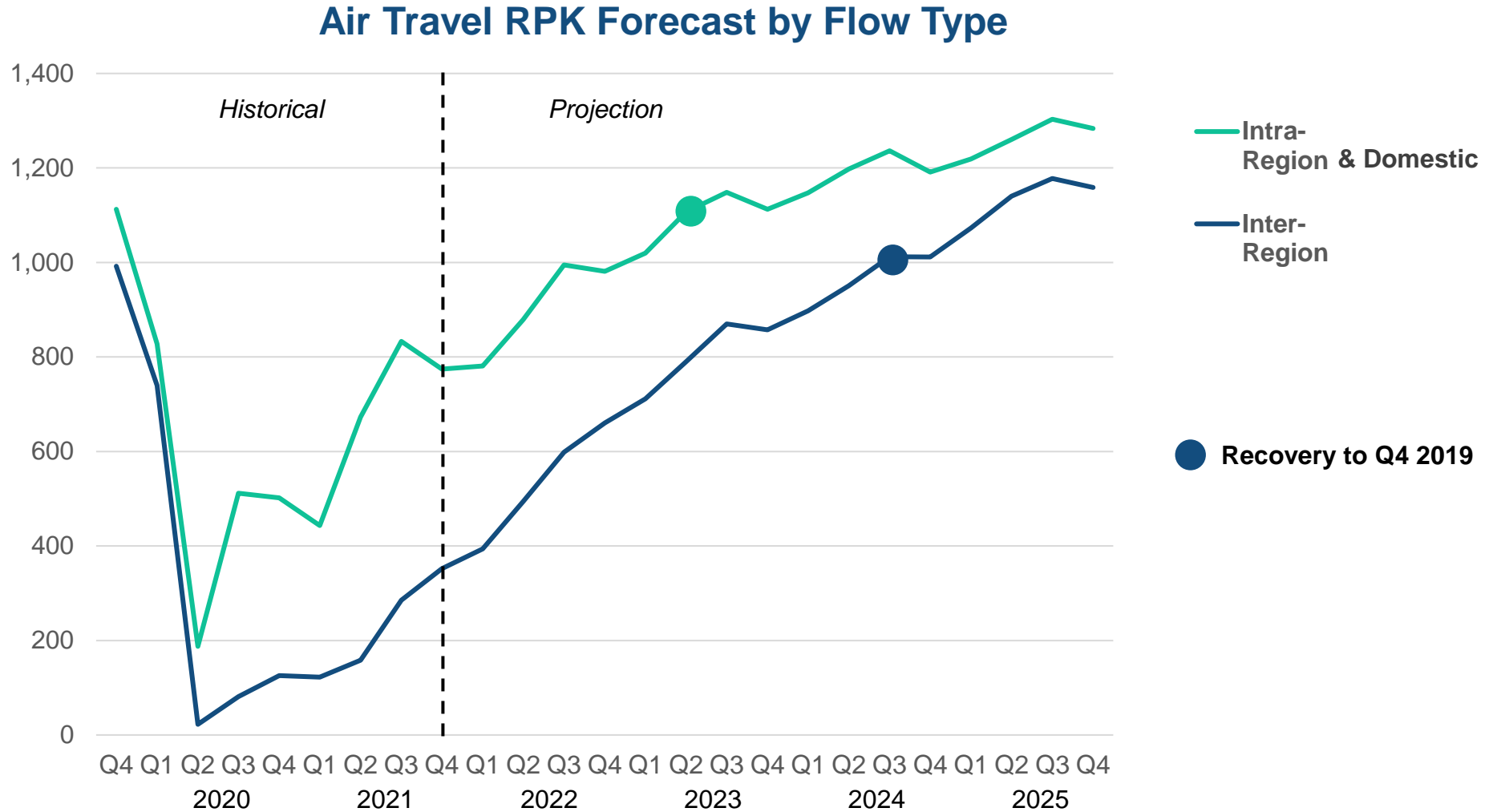
› International travel, which comprises 65% of global ASKs, is off 59%

However, the approaches to COVID-19 also depend on the necessity to be pragmatic

Air Travel Capacity vs Vaccination Rates for Sample Countries/Territories

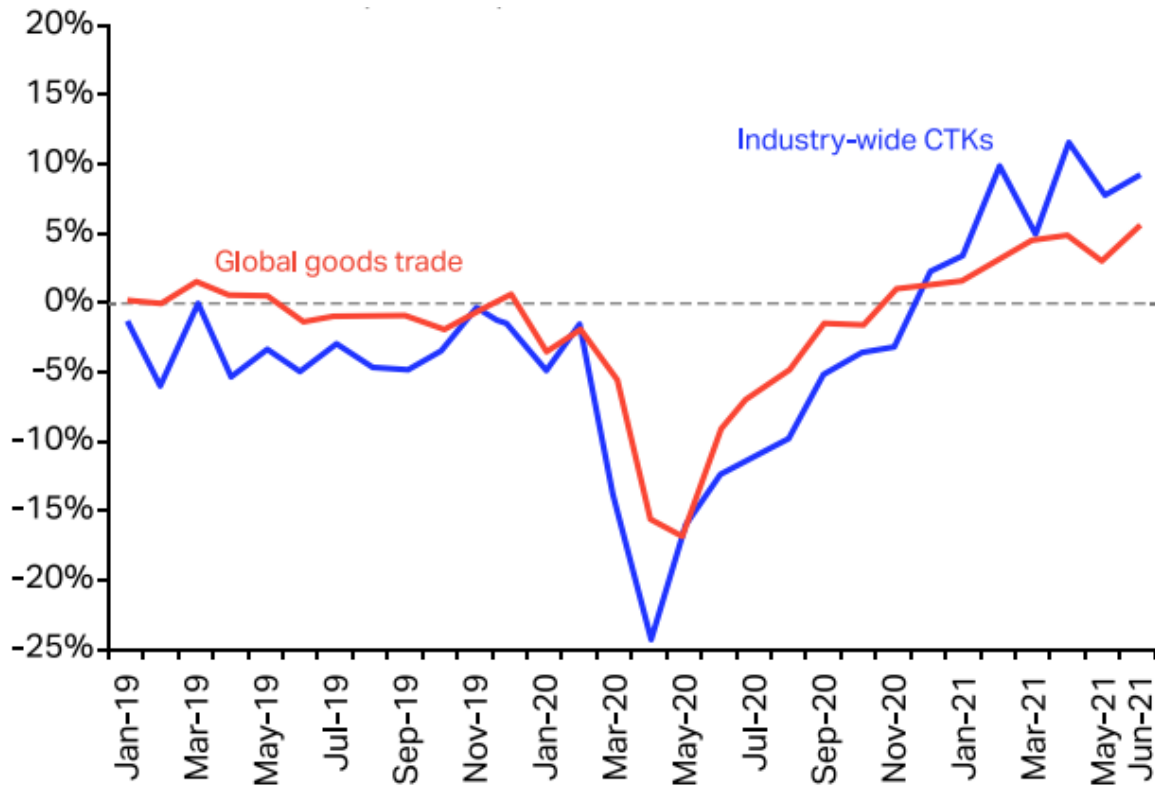


AeroDynamic expects inter-region travel to recover two years after intra-region and domestic travel



Air cargo is a bright spot in aviation and is poised to accelerate

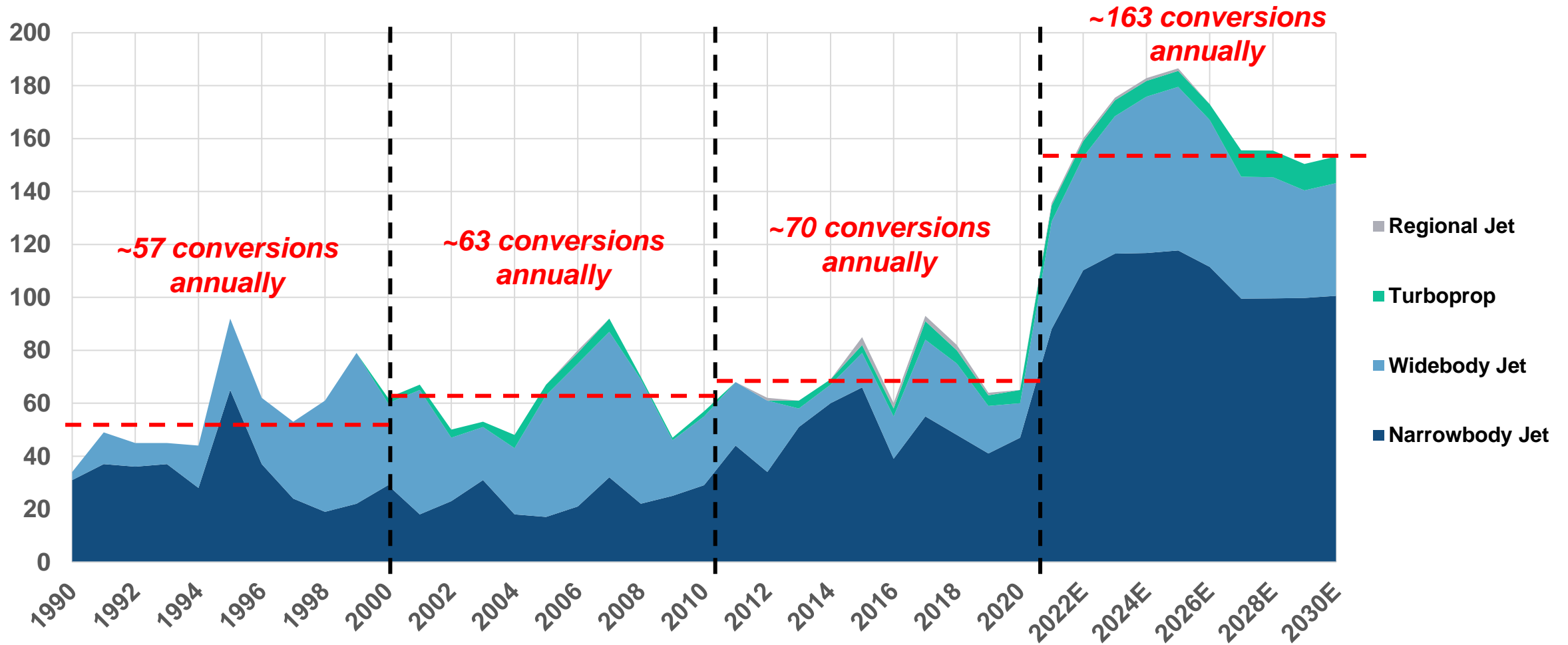
Global Cargo Ton-Kms (CTK): % YoY 2021 v 2019



- › Air cargo activity recovered to pre-COVID levels by late 2020
- › The 2,000+ freight aircraft fleet is operating at 10-20% higher levels of utilization than before the crisis
- › Air cargo accounted for ~30% of airline revenue in 2020...up from 12% in 2019
- › Supply chain restocking, maritime transportation bottlenecks, and shifting supply chains all contributed to the unexpected growth

...and freighter conversions will explode to keep up with demand...

1990A-2030E Pax - Freighter Conversions, by Aircraft Type



...while two new freighter programs were recently announced

Airbus A350F



Payload: 120 tons
Volume: 24,500 cubic feet
Range: 5400 miles

- › Air Lease became the A350F launch customer in November 2021, ordering seven
- › CMA CGM Group followed with an order for four; SIA signed a letter of intent for seven

Boeing 777-8F

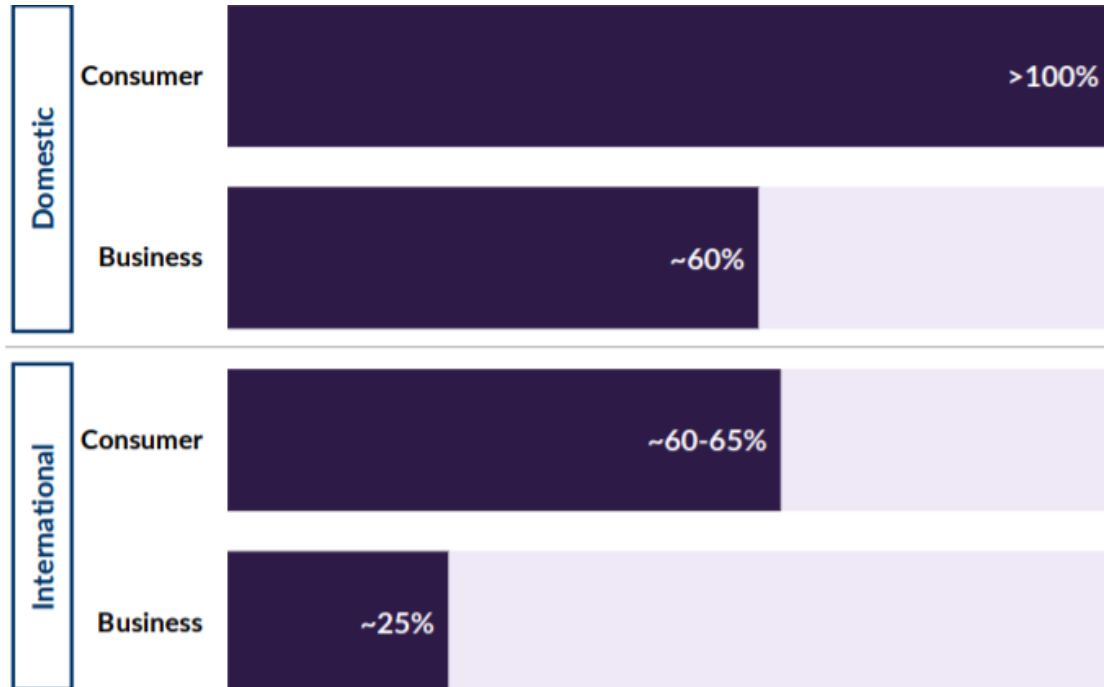


Payload: 130 tons
Volume: 27,000 cubic feet
Range: 5100 miles

- › Qatar Airlines launched the 777-8F last month with an order for 34 + 16 options
- › Responds to A350F helps to address the potential shutdown of Boeing's other twin-aisle cargo aircraft by 2027 (emissions)

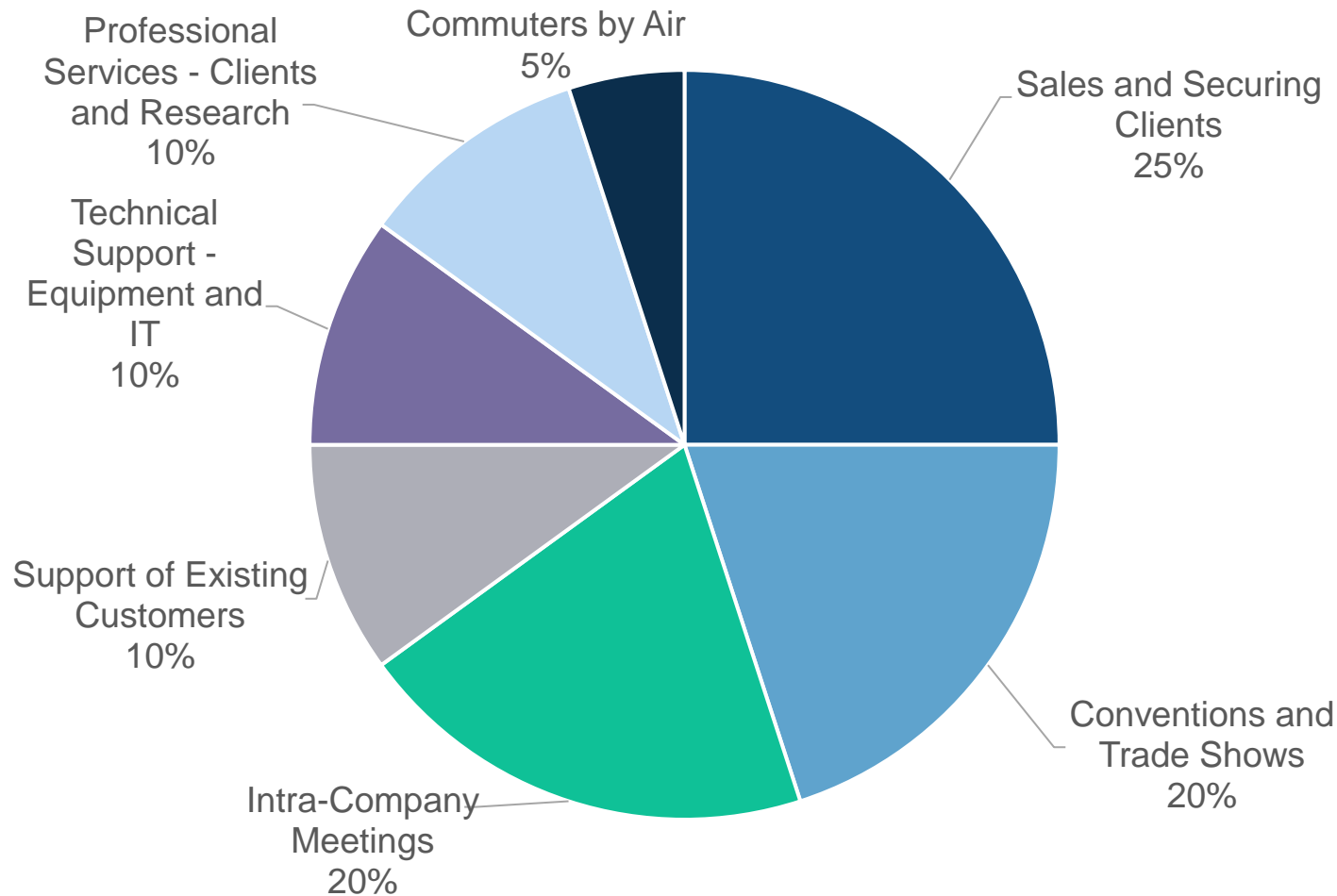
The COVID Crisis led to a dramatic reduction in business travel -- even in North America...

Delta Airlines Tickets Sold – 2021 vs 2019



Most business travel has an external or client facing purpose such as securing clients and trade shows

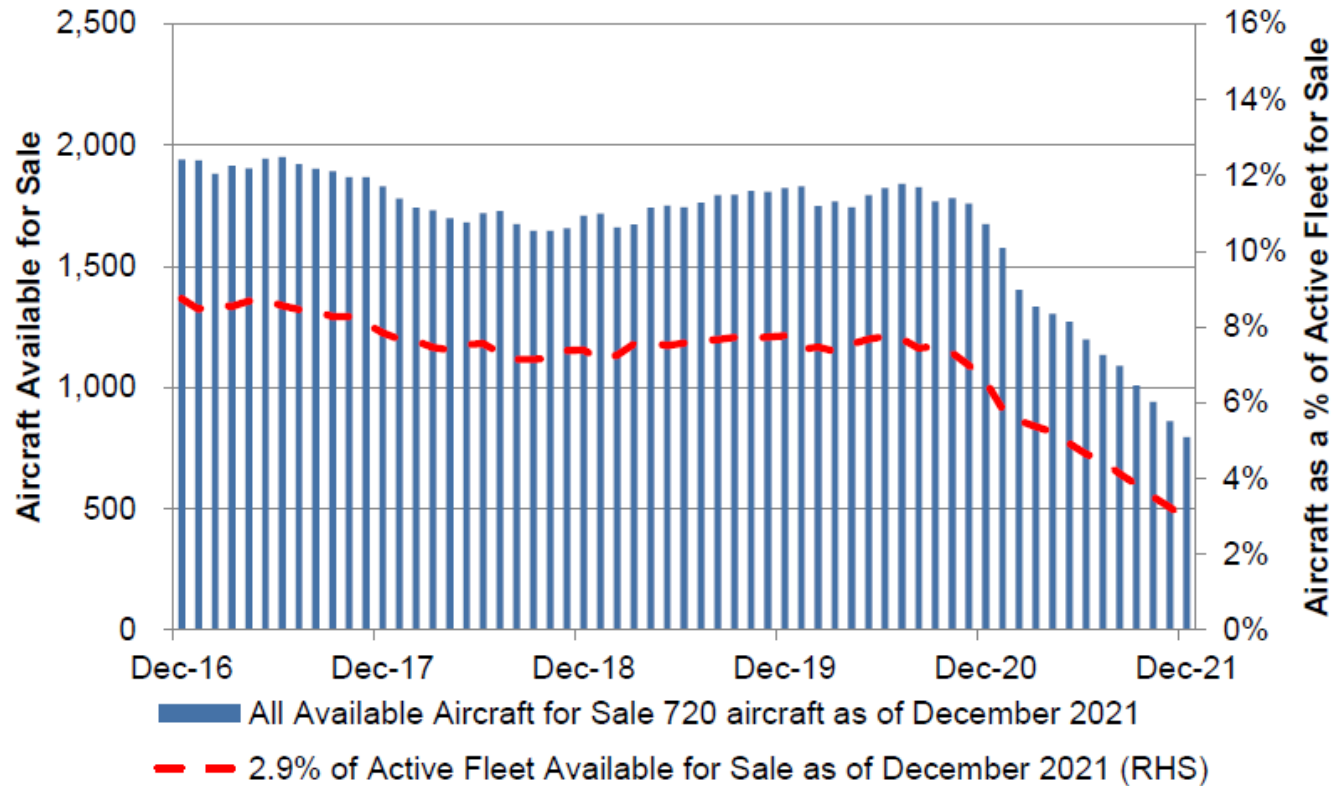
Airline Business Travel by Trip Purpose



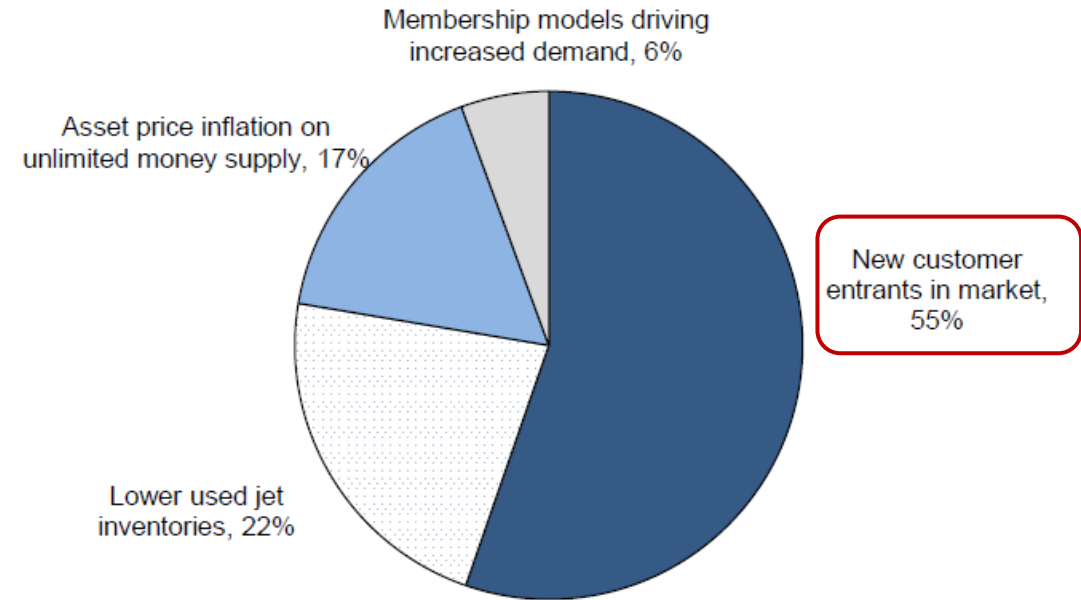
- › Business travel can largely be grouped into internal or external-facing
- › Connectivity technologies like Zoom and Teams will largely impact the internal company travel

Conversely, COVID-19 sparked higher interest in business aviation, with tens of thousand of new customers

Business Jets Available for Sale



“What is Driving The Improvement?”



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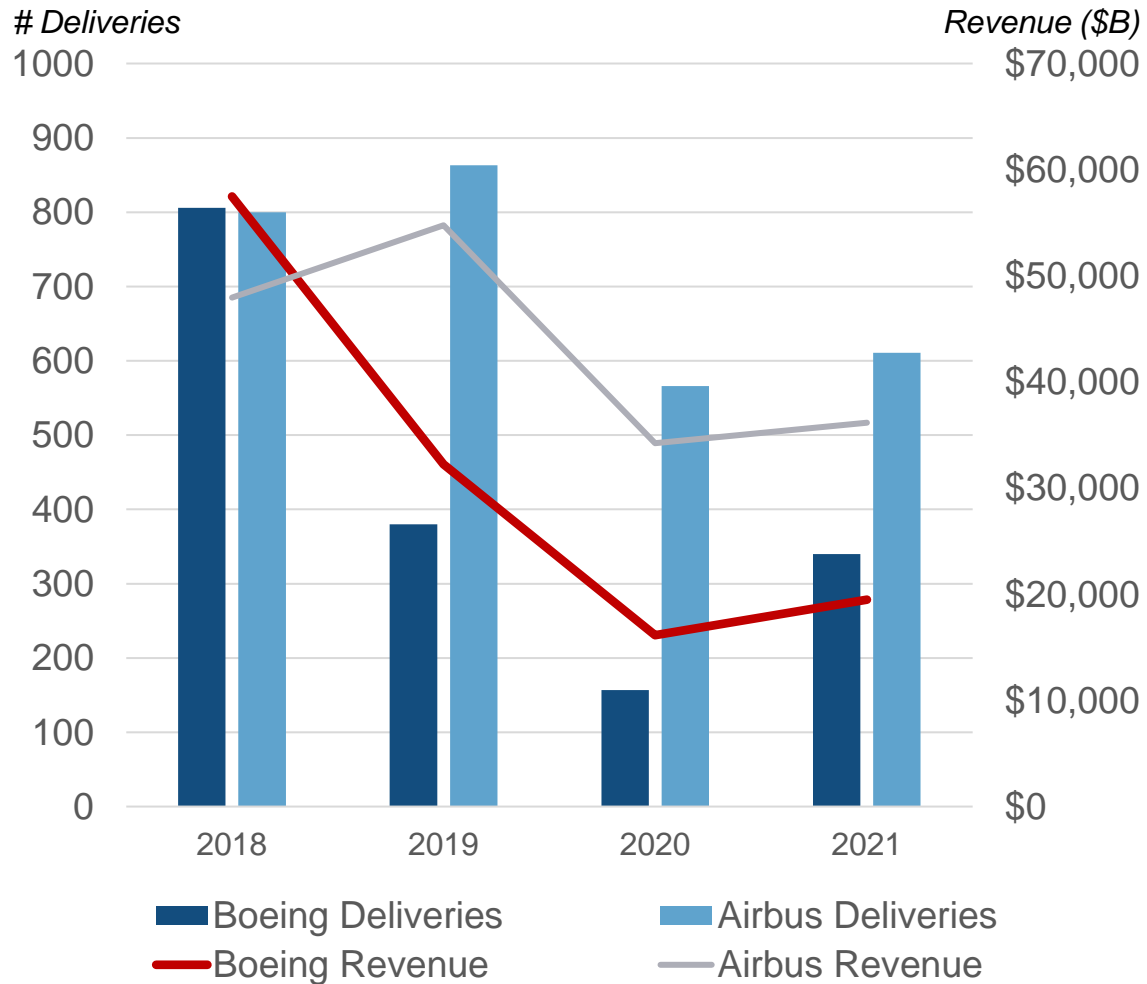
Production Outlook

Supply Chain Challenges



The fortunes of Boeing and Airbus have sharply diverged since the 737MAX grounding

Boeing Commercial & Airbus Commercial Deliveries and Revenue



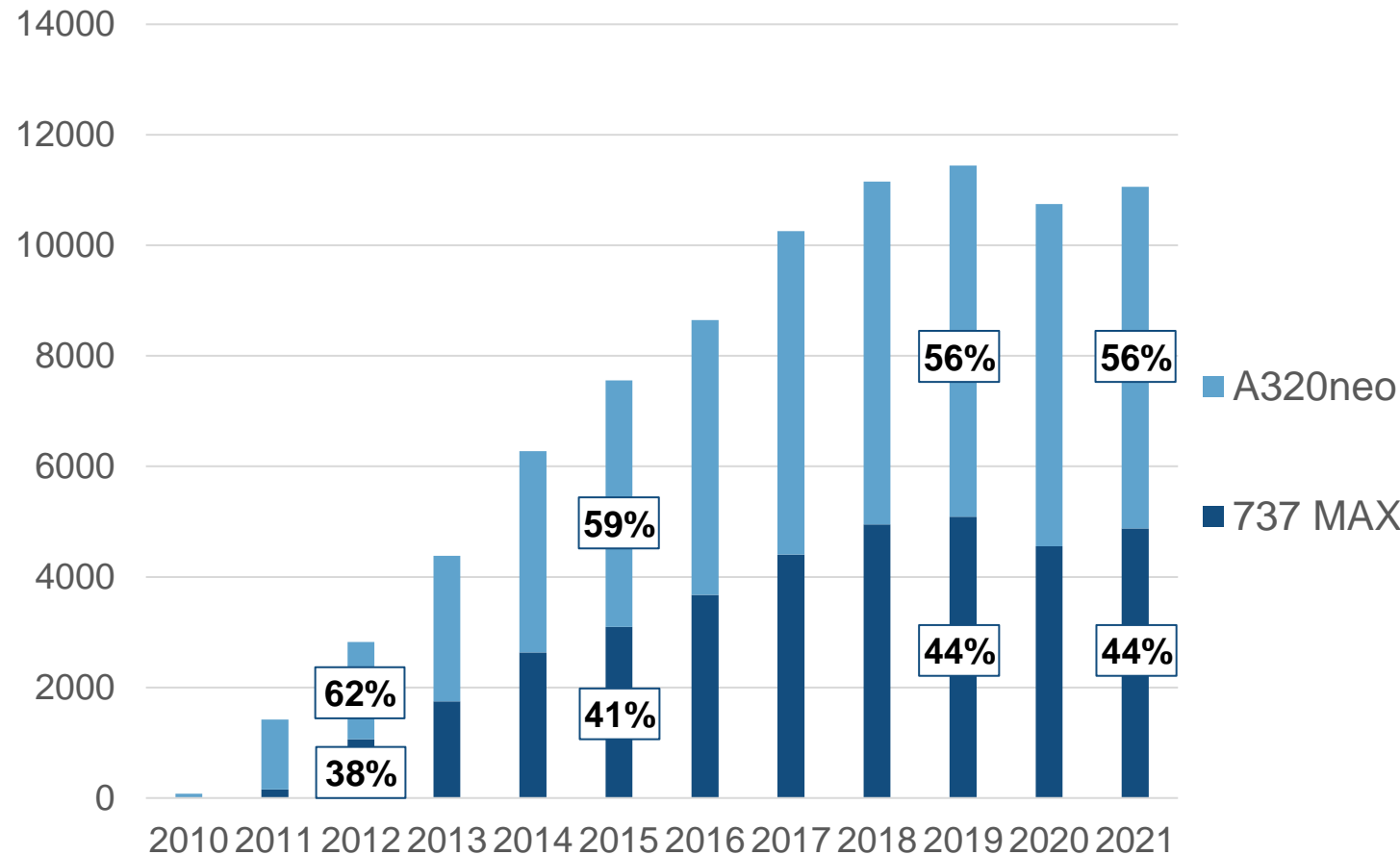
- › Continue steady ramp of MAX production
- › Solve certification and supplier quality issues on 787 – critical for cash flow
- › Certify 777X and focus on freighter orders
- › Make launch decision on new middle market program



- › Mitigate supply chain bottlenecks on A320neo to cement market share lead
- › Leverage leadership position to gain additional supply chain concessions
- › Make decision on A220-500 program launch
- › Bring A350F successfully to market

The A320neo has a significantly higher share of the backlog than the 737MAX, although the introduction of the 737-10 will narrow the gap

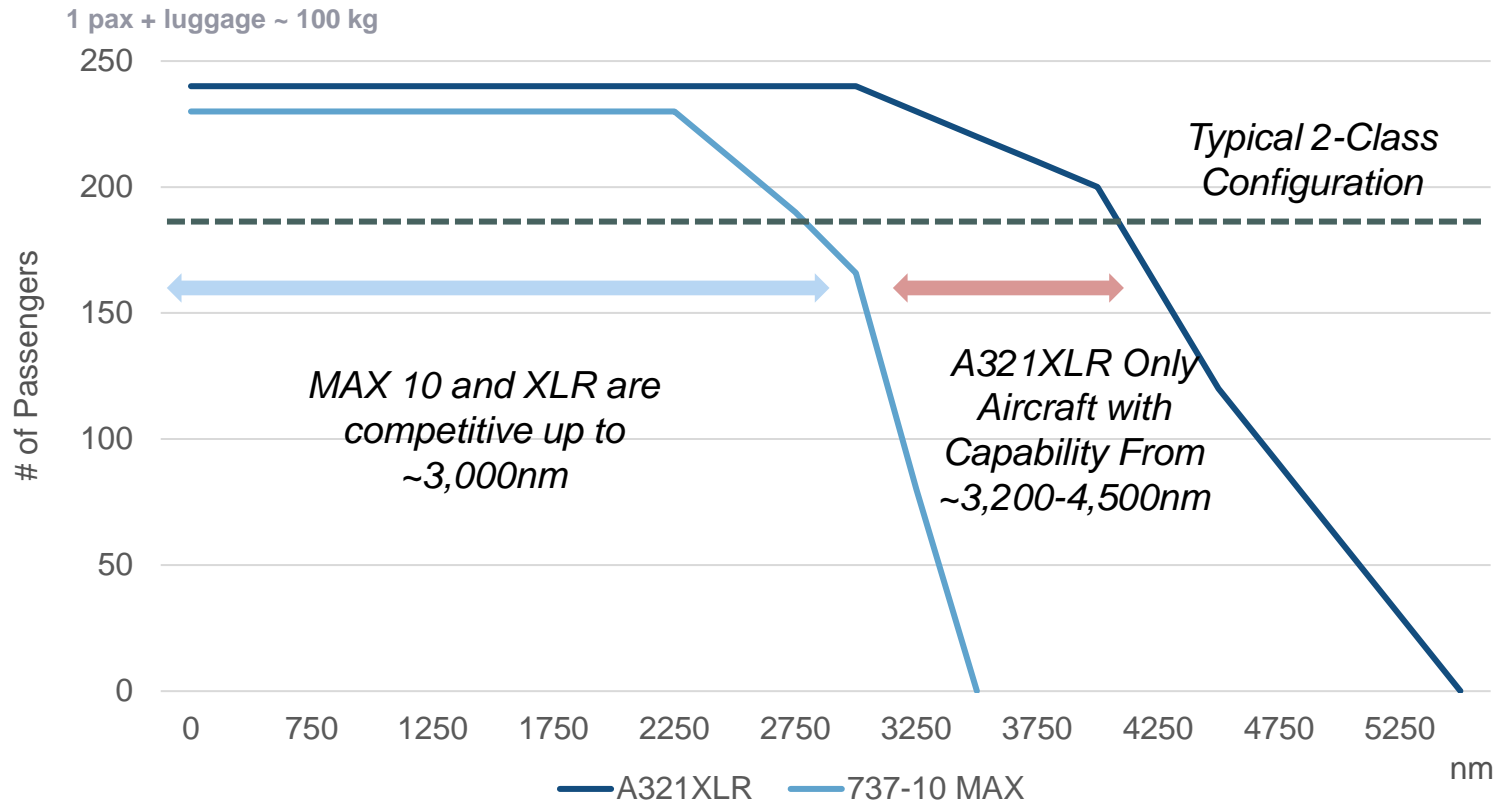
A320neo vs. 737 MAX Year-End Backlog Comparison



- › Despite the grounding, the 737 MAX is holding steady at 40-45% market share
- › The A321neo, including the LR and XLR, are driving much of this market share differential
- › The introduction of the 737 MAX 10 will partially slow the market share shift

The 737 MAX 10 and A321XLR are competitive up to ~3,000nm; the A321XLR is best positioned for thin medium-haul routes

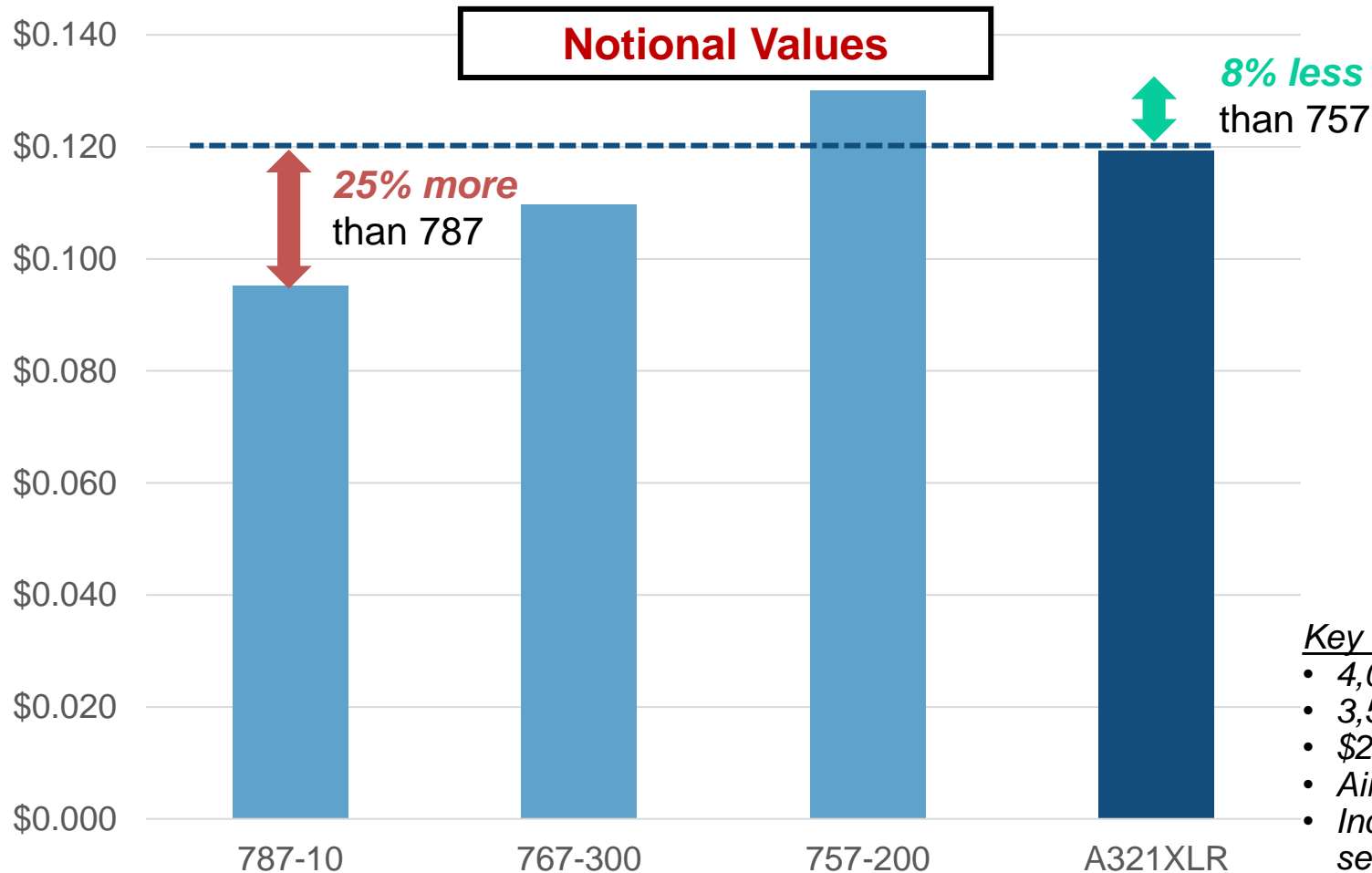
MAX 10 and A321XLR # of Passengers by Route Length



- › Narrowbodies will take share on thin medium-haul routes, but are unlikely to displace widebodies on existing routes
- › The A321neo has better takeoff performance and fewer operational restrictions
- › On shorter routes the 737 MAX's lighter weight and lower thrust lead to lower fuel burn and operating costs

Higher unit costs on long-haul routes will prevent single aisles from completely displacing twin aisles

A321XLR Unit Cost (\$/ASM) Comparison on 4,000nm Route



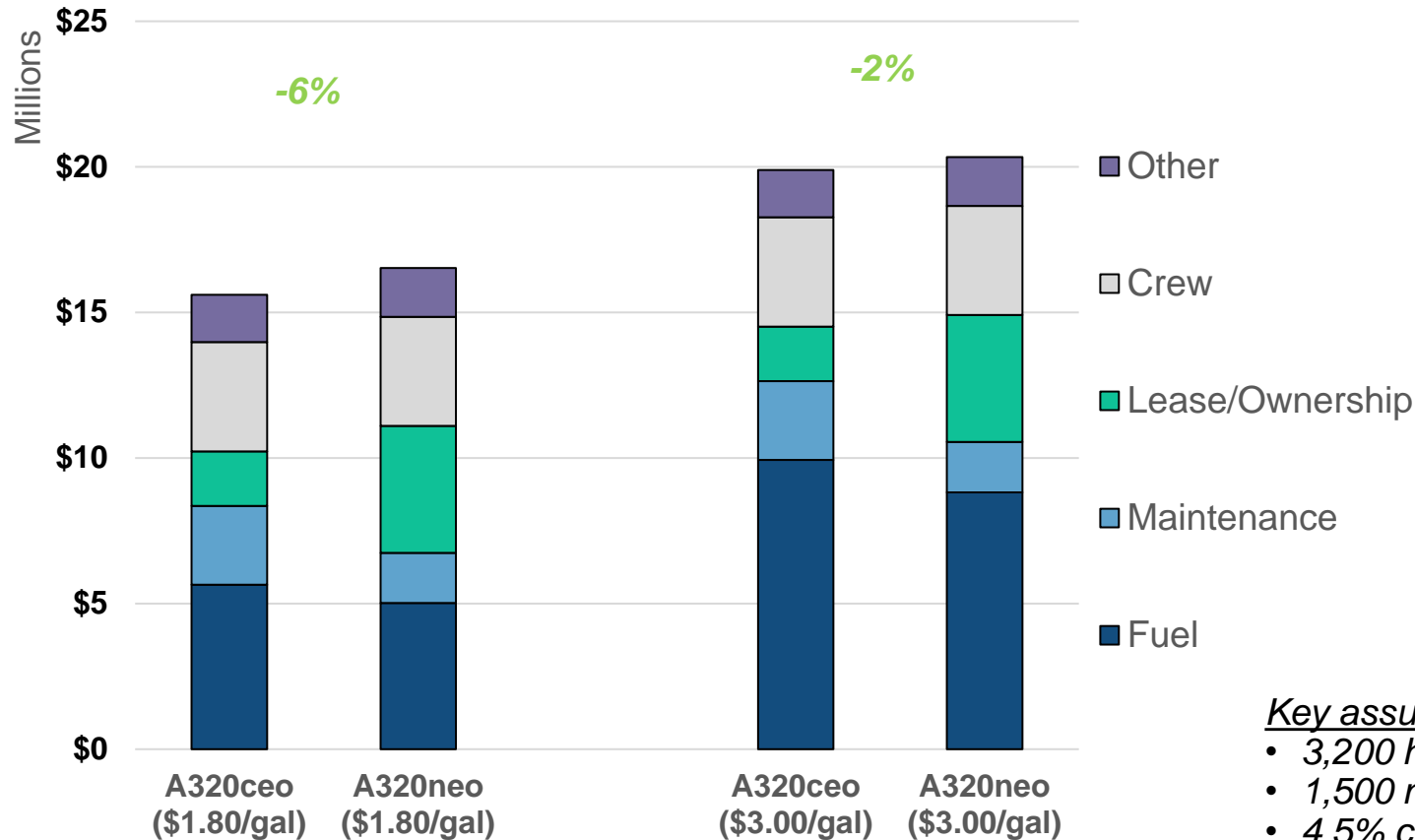
- › Narrowbody aircraft will primarily be used for thin medium-haul routes
- › Long-range narrowbodies can also provide supplemental frequencies on existing routes
- › They are great replacements for the 757 and smaller legacy widebodies like the 767

Key assumptions

- 4,000nm stage length
- 3,500 flight hours annual utilization
- \$2.50/gal fuel
- Aircraft leased (1 year old for 787 and A321XLR)
- Includes fuel, lease, crew, passenger servicing, traffic servicing / navigation, aircraft ground handling, insurance, and miscellaneous costs

Russia-Ukraine is driving higher fuels prices, which hastens the shift to newer more fuel-efficient models

Annual Aircraft Direct Operating Costs – 18-year-old A320ceo vs new A320neo (\$M)



- › Higher lease costs on newer A320neos largely outweigh the fuel savings vs. an existing A320ceo
- › Russia-Ukraine is driving higher fuel prices which marginally increase the case to switch to a new aircraft
- › Higher fuel prices are overall a negative for air travel demand, but positive for production

Key assumptions

- 3,200 hours annual utilization
- 1,500 mile stage length
- 4.5% cost of capital
- 894 annual flights

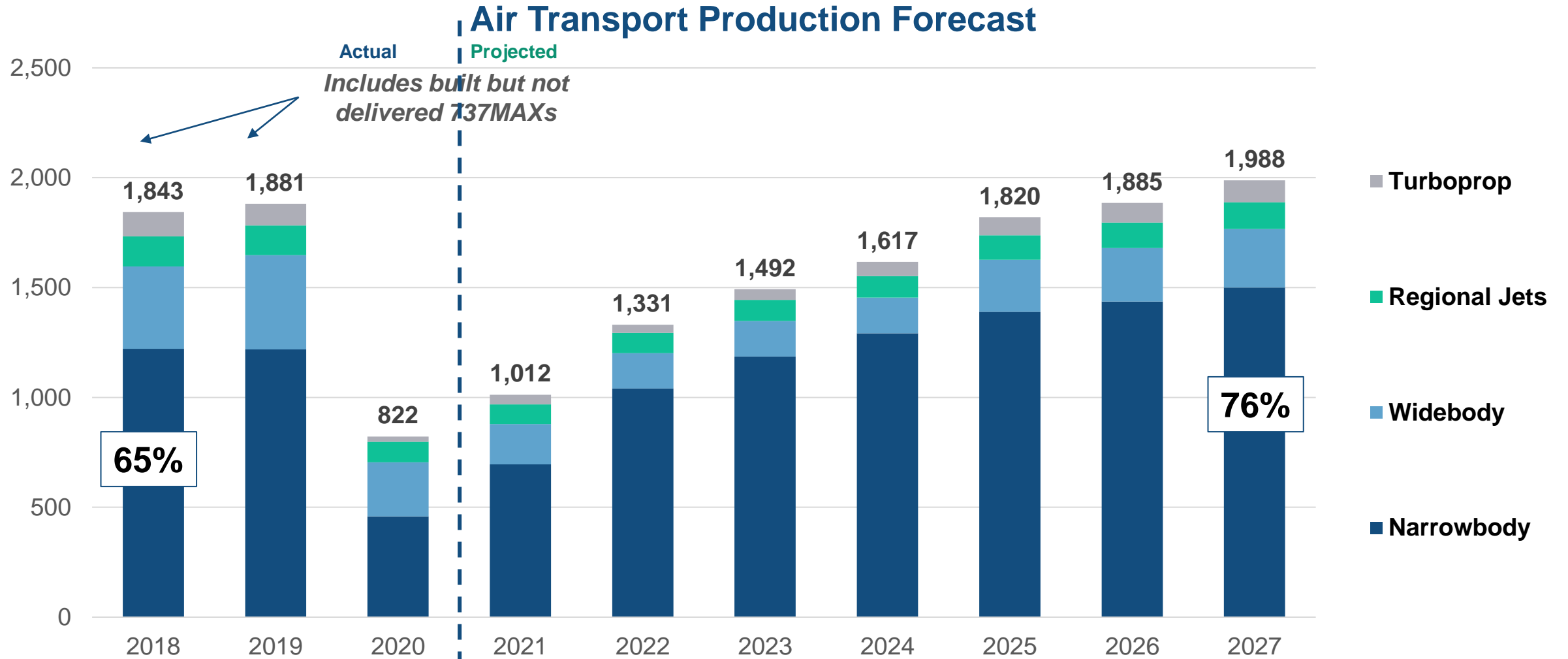
The A330neo and the 777X are the programs most at-risk



Program	Risk Rating	Comments
A220		<ul style="list-style-type: none"> • Good niche platform • Potential A220-500 launch decision
A320neo		<ul style="list-style-type: none"> • Large and growing backlog • Supply chain will be limiting factor
A330neo		<ul style="list-style-type: none"> • Low backlog • Significant overlap with A350 • Tanker could be savior
A350		<ul style="list-style-type: none"> • Freighter version will buoy production rates

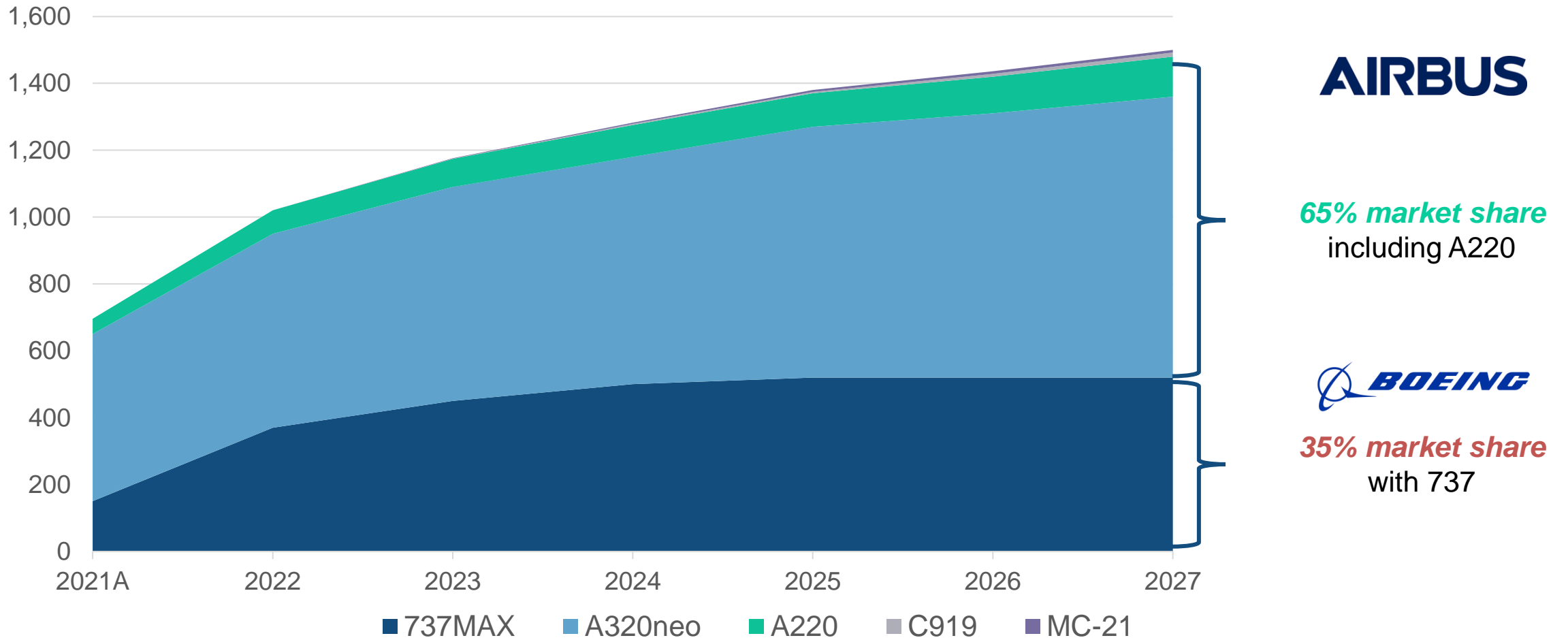
Program	Risk Rating	Comments
737MAX		<ul style="list-style-type: none"> • Still has large backlog despite lengthy grounding • Ramp up critical
767		<ul style="list-style-type: none"> • Strong position in freighter market until 2027 with ICAO mandate
787		<ul style="list-style-type: none"> • Strongest widebody program • Solving quality issues and resuming deliveries critical
777X		<ul style="list-style-type: none"> • Freighter launch is lifeline for program

A consistent and strong production increase from the 2020 nadir is in motion; single aisles will increase from 65% to 76% of production



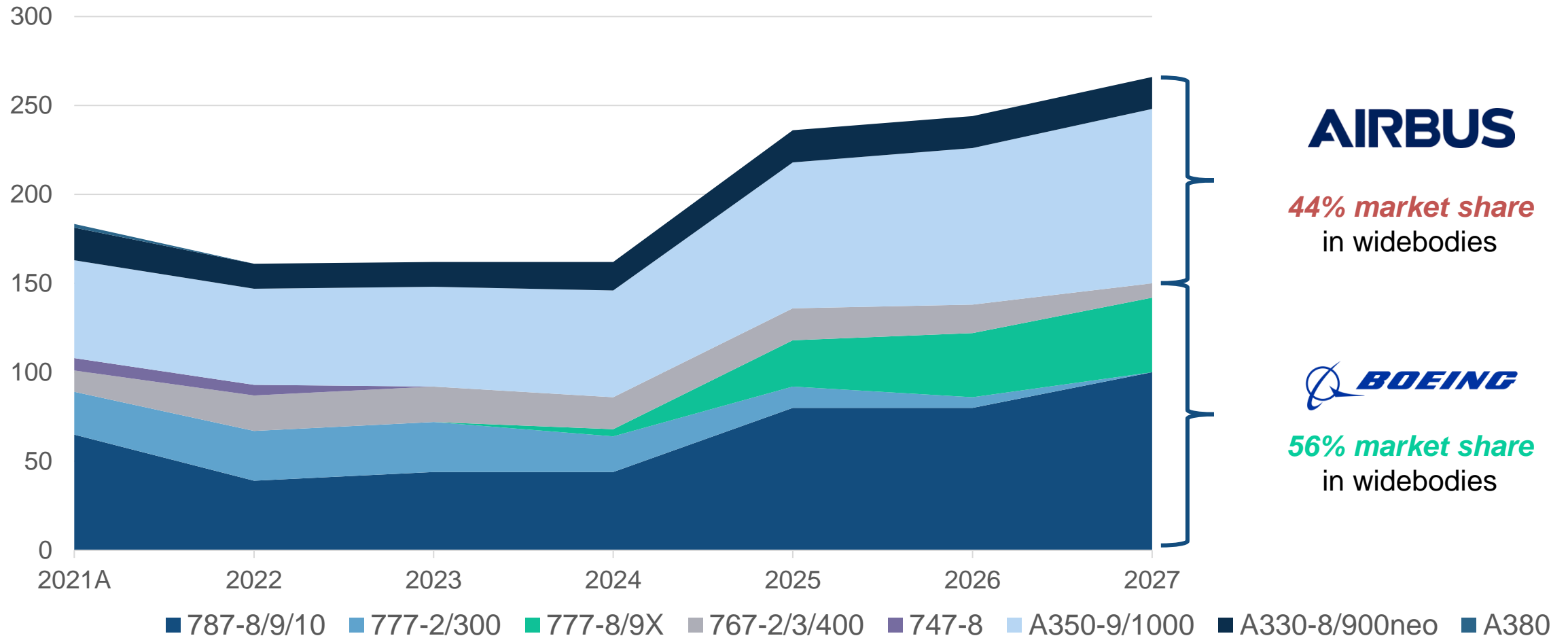
Airbus reaches a 65% single aisle market share in 2027 with the A220 and A320neo in AeroDynamic Advisory's latest forecast

Single Aisle Unit Production Forecast 2021-2027



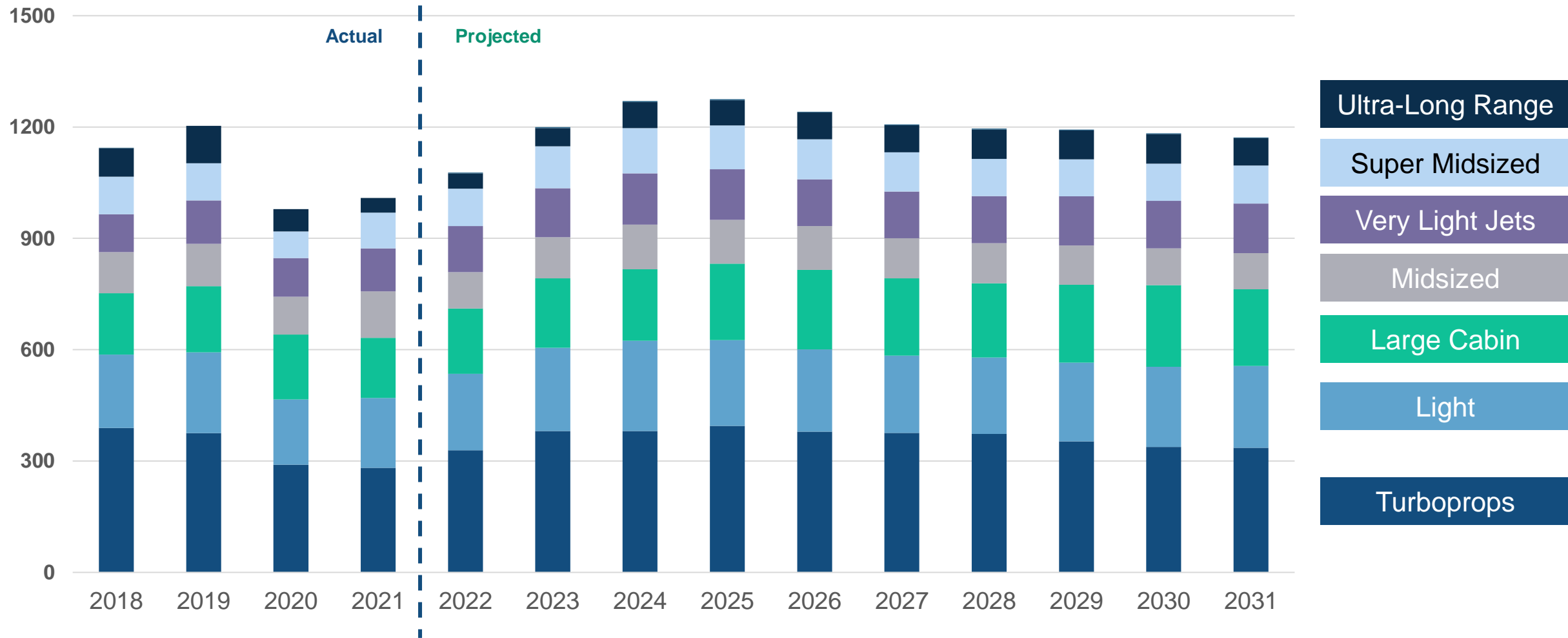
Boeing will maintain its lead in widebodies with a 56% market share in 2027

Twin Aisle Unit Production Forecast 2021-2027



Business aviation production is expected to reach pre-COVID levels in 2023, with sustained growth through 2025

Business Aviation Aircraft Production, 2018 – 2031



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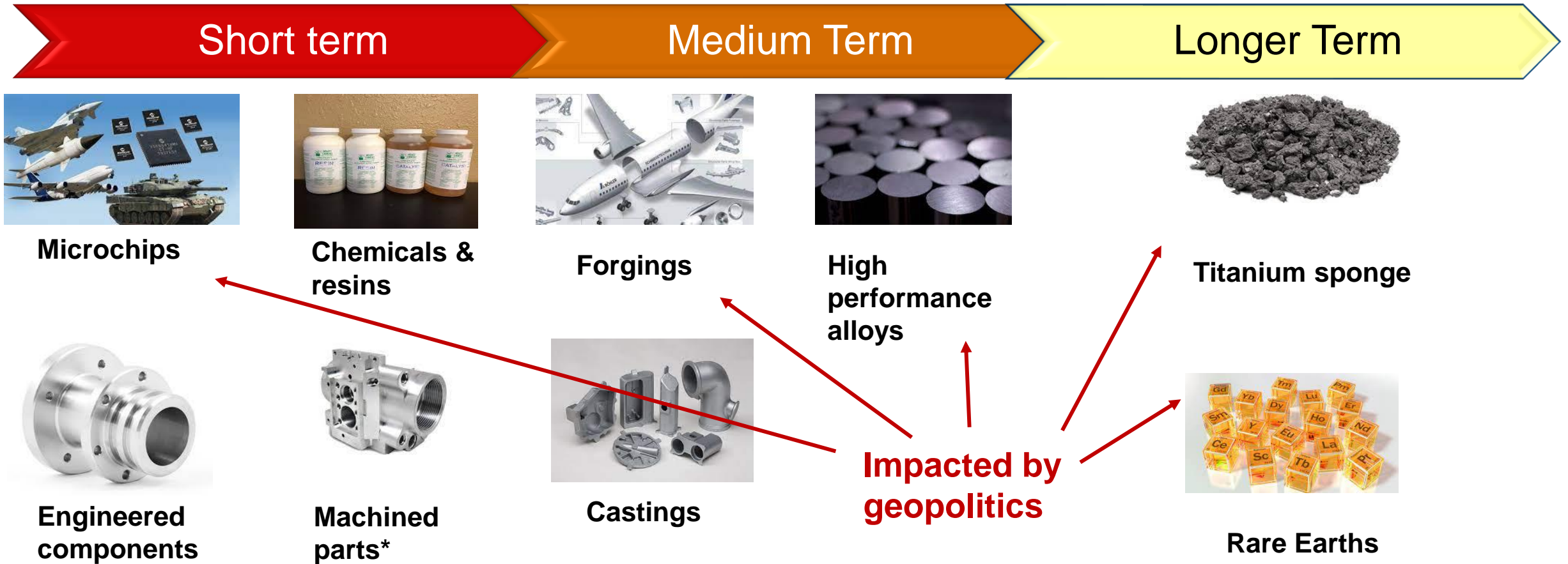
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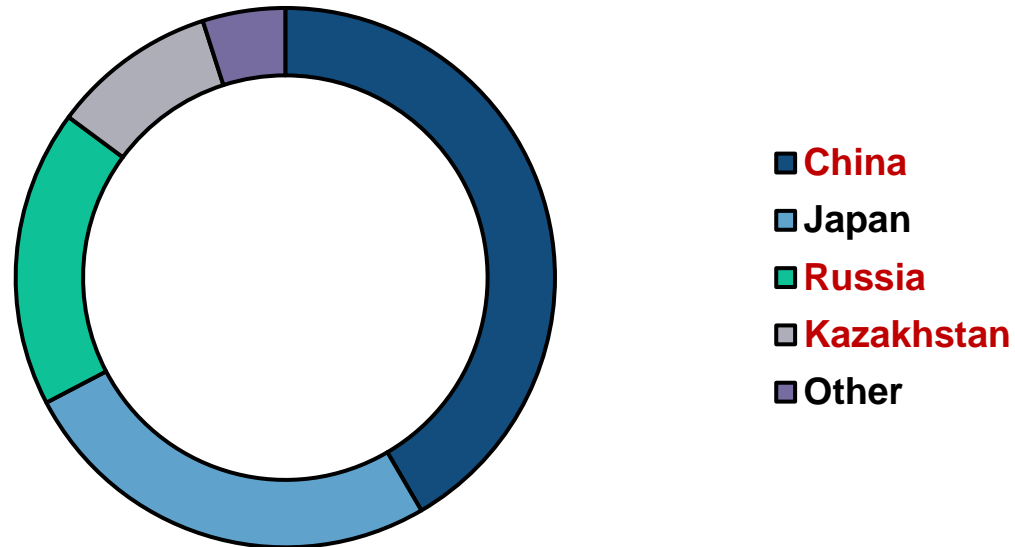
The aerospace supply chain faces near and long-term bottlenecks

Aerospace supply chain bottlenecks

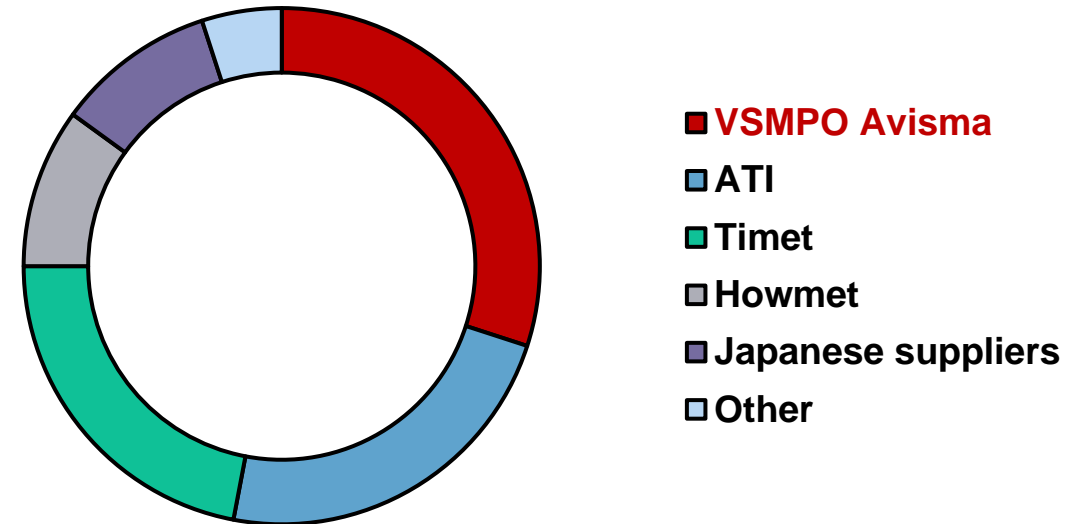


Aerospace titanium supply is heavily influenced by Russia...and geopolitics

Titanium Sponge Market Share 2022







Titanium Mill Product Market Share ~2010



- › The last US titanium sponge facility closed during the COVID Crisis; Japanese imports comprise the majority of US usage
- › Russia-based VSMPO Avisma is crucial to the supply chains of commercial aircraft OEMs, supplying 35% of Boeing's titanium and 50% of Airbus's titanium as of 2019
- › OEMs and suppliers are quietly stockpiling titanium to hedge against any escalation of the Russia-Ukraine situation

The Russia-Ukraine conflict will have potential impacts on air travel demand, aircraft deliveries, and the supply chain

Possible Russia-Ukraine Supply Chain Impacts

Risk	Impact	Timeframe		
	<p><i>Closure of Russian Airspace</i></p>	<p>Low-Med</p>	<p>Short-Term</p>	<ul style="list-style-type: none"> • Dozens of Europe-Asia routes impacted • Makes some routes uneconomical and further slows return of international travel
	<p><i>Cancellation of Russian Aircraft Leases</i></p>	<p>Med</p>	<p>Medium-Long Term</p>	<ul style="list-style-type: none"> • ~500 aircraft in Russia have Western lessors • Possible long-term damage to global aircraft leasing of aircraft assets
	<p><i>Forgings</i></p>	<p>High</p>	<p>Medium-Long Term</p>	<ul style="list-style-type: none"> • 787 landing gear forgings produced in Russia • Difficult to qualify other sources • <i>Not yet impacted by sanctions/Russia response</i>
	<p><i>Titanium Raw Material</i></p>	<p>Med</p>	<p>Medium Term</p>	<ul style="list-style-type: none"> • Have excess inventory in short term. In long term, U.S. sources can replace VSMPO capacity. • <i>Not yet impacted by sanctions/Russia response</i>

Thank You!



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