Embraer E-Jets E2

A Program Review

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Conclusions

Embraer's re-engined E2 aircraft should prove very successful, given the well-established[1] E-Jet customer base, its strong operating economics, and improved performance. We expect Embraer and Mitsubishi to lead the market for regional jets under 100 seats, with the E-175 E2 continuing the popularity of the existing E-175 in North America and other markets. The E2 program has seen orders grow twice as fast as the E-Jets, and tellingly, twice as fast as its direct competition. The E2 program has 272 firm orders and 670 commitments.

In the 100-150 seats market, Embraer and Bombardier will lead the market, as their E-190 E2, E-195 E2, CS100 and CS300 aircraft are more efficient than "shrink" models including the Airbus A319neo and Boeing 737 MAX 7. With a leadership position in both segments of the 70 to 130 seats market, Embraer is well positioned to capture a strong share of both regional and mainline airline growth.

History

The Embraer E2 program represents a second generation of the popular E-Jet series introduced in 2004. The E-Jets, offered in four variants, quickly became best sellers in their respective classes, and to date Embraer has delivered some 1,200 of these aircraft to both regional and major airlines around the world.

The E-Jets were designed a decade ago, before a generation of new technology aircraft engines became available. With more efficient engines available and a period of high fuel costs fueling demanding more efficiency, Embraer embarked upon a redesign of its successful products after only seven years in service to ensure that they remained competitive with emerging new technology airplanes.

The company recognized emerging technologies, combined with new competition, posed a threat to the E-Jet program, and took decisive action to ensure that the aircraft would remain not only competitive, but also a market leader in economics, for the next two decades.

Market Outlook

Overall, we expect Embraer to sell more than 2,771 E2 aircraft over the next 20 years, and to continue its market success as a leader in the regional and small narrow-body segment.

[1] The E190/E195 fleet has reached a Schedule Reliability of 99.52% - all flights departed without a delay or cancellation - the highest ever recorded

II. E-JETS HISTORY

E-Jet Program

The E-Jet program was launched at the Paris Air Show in 1999, with the first aircraft entering service in March 2004 with LOT Polish Airlines. Since then the E-Jet program has taken off in popularity, with more than 1,700 orders and 1,200 deliveries through September, 2016.

There are two main families in the E-Jet program, the E-170/E-175 that primarily serves the regional market, and the E-190/195 that serves both regional and mainline carriers. The E-170/190 models are the baseline aircraft (with an optimized wing, landing gear, horizontal stabilizer and engine for each baseline model), while the E-175/195 models have a stretched fuselage.

The E-Jets are commonly viewed as the most comfortable regional/mainline jets, primarily due to their preferred 2x2 seating arrangement and a wide and tall stand-up cabin. The aircraft feels much more spacious than first generation regional jets and is significantly more comfortable than the competing Canadair Regional Jets (CRJ) from Bombardier. The E-Jet offers a cabin experience comparable to mainline narrow-body jets, enabling airlines to maintain a consistent cabin service and product standard. The absence of a middle-seat contributes greatly to passenger preference.

The following chart summarizes the key characteristics of the E-Jet family, and the E2 models that will replace the earlier variants.

Figure 1 E-Jets Specifications

EMBRAER E-ETS						
Model	**E-175AR**	**E2-175**	**E-190AR**	**E2-190**	**E-195AR**	**E2-195**
Seating						
Maximum	88	90	114	114	122	146
Single Class	86	88	106	106	118	132
Two Class	78	80	94	97	106	120
Length	103 ft. 11 in.	106 ft. 2 in.	118 ft. 10 in.	118 ft. 10 in.	126 ft. 10 in.	136 ft. 6 in.
Wingspan	94 ft. 2 in.	106.7 ft.	94 ft. 3 in.	110.6 ft.	94 ft. 3 in.	115 ft.
Height	32 ft. 4 in.	32.7 ft.	34 ft. 7 in.	36.1 ft.	34 ft. 7 in.	35.8 ft.
MTOW (lbs.)	89,000	98,767	114,200	124,341	115,280	133,821
Max Payload (lbs.)	22,840	23,369	28,840	28,836	30,090	35,605
Engine	CF-34-8E	PW1715G	CF34-10E	PW1919G	CF34-10E	PW1923G
Thrust (lbs.)	13,800	15,000	18,500	19,000	18,500	23,000
Range (nm)	1,920	2,060	2,350	2,850	2,000	2,450

In 2011, seven years after entry into service, Embraer decided to re-engine its E-Jets, and in 2013 selected the Pratt & Whitney PW1000G Geared Turbofan to power the new aircraft. That engine formed the centerpiece for the redesign of the E-Jet family into the E2 models that are the subject of this report.

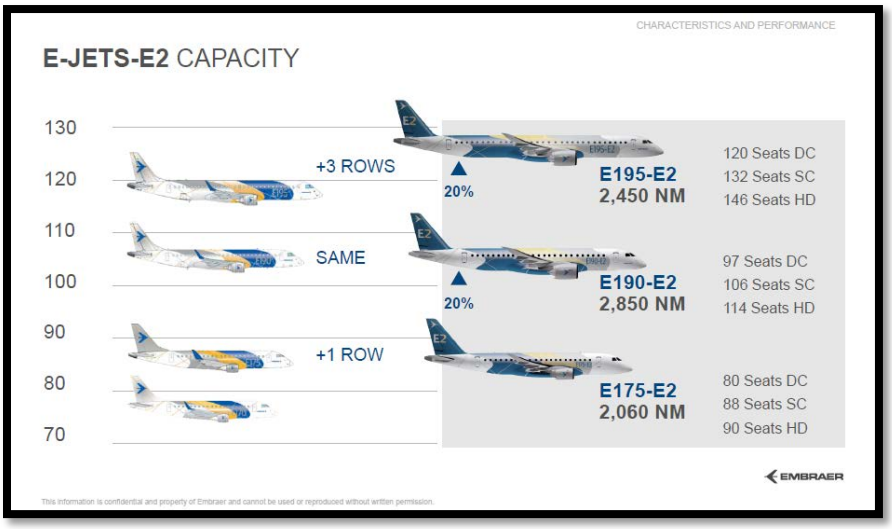
The Decision to Re-Engine

In 2011, fuel prices were approaching a peak, with oil prices at more than $110 US per barrel. This resulted in a rush by airlines to order new technology aircraft from Airbus and Boeing that incorporated new and more fuel-efficient engines. Airbus and Boeing experienced record order levels for their new models at the Paris and Farnborough shows in 2011 and 2012 respectively, primarily for larger aircraft models.

At the smaller end of the market, Mitsubishi had selected the new Pratt & Whitney geared turbofan for its competing Mitsubishi Regional Jet ("MRJ") that it planned to offer in two sizes, the MRJ70 and MRJ90. Bombardier launched its C Series with 110 and 135 seat variants that compete with the E190 and E195. With the industry moving to new technology engines, that offered a 15-16% improvement in fuel efficiency, it became an economic necessity for Embraer to match the propulsion technology level offered by its competitors. Fortunately, it already had a modern platform from which to launch the program.

In 2011, Embraer selected the Pratt & Whitney GTF engine, that had already been selected by Mitsubishi, Bombardier, Airbus and Irkut. Embraer would gain the benefit of their initial experiences and offer a competitive aircraft shortly after market entry of the competitors, incorporating any improvements in the engine after its entry into service. With competitor delays at Mitsubishi, Bombardier and Airbus, the time frame between competitor and Embraer offerings has shrunk, as Embraer continues to be "on-time" and "on-budget" with its development program.

The E2 Models



While one of the most notable changes in the aircraft is the Pratt & Whitney geared turbofan engine, the E2s are much more than just a "re-engine". The E2 also received additional changes to the design,

increasing the efficiency, comfort and performance of each new model. Embraer claims that the E-Jets E2 is the most efficient aircraft family in its segment.

The E-175 E2 is slightly larger than the existing E-175, with an additional row resulting from a fuselage stretch. In addition, a new wing has been designed specifically for this airframe and engine combination to optimize performance of the aircraft.

The E-190 E2 is the same size as the E-190. Embraer polled it airline customers, and the feedback was that the aircraft was the right size for the market. Taking that feedback, Embraer kept this aircraft the same size, true 100-seater. The E-190 E2 also has its own optimized wing that is different from the other E2 wings.

The E-195 E2 is the largest of the new models and significantly larger than its predecessor, the E-195. With three additional seat rows, an additional 12 seats make this the largest passenger aircraft Embraer has produced, accommodating 132 in single class configuration. The E-195 E2 also has its own optimized wing design. The E-195 E2 has the same empty weight as the Bombardier CS100, but has 10% more seats, providing the E2 a 10% advantage in seat mile based operating economics.

Technology in the E2 series goes far beyond the engines, which offer a substantial benefit in improved fuel economy and low maintenance costs. From an advanced aircraft health management system (AHEAD Pro) and new wing aerodynamics that eliminate the need for winglets to redesigned cabins with improved seating, lighting, and bins.

Competitiveness of New Aircraft

With a modern design, Embraer's E-Jets were leaders in their segment. The threat of new aircraft with next generation engines required a response for Embraer to maintain their competitiveness in operating economics.

In particular, the MRJ represents a threat to the E170/175 family, and the Bombardier C Series a threat to the E190/E195 family. Embraer's customer base of 100 operators and 1,140[2] E-Jet aircraft in service (with 15 million flight hours) would be threatened in a high fuel cost environment, given the game-changing technology of the Pratt & Whitney GTF engine. By selecting that engine for the E2, Embraer leveled the playing field while maintaining the advantage of a strong customer base for the E-Jet program.

While Embraer could have simply re-engined its existing models, the company also chose to upgrade the aircraft, including new wings, improved aerodynamics, enhanced aircraft health management, and new interiors, along with next generation engine technology, to ensure the competitiveness of the aircraft for the next two decades.

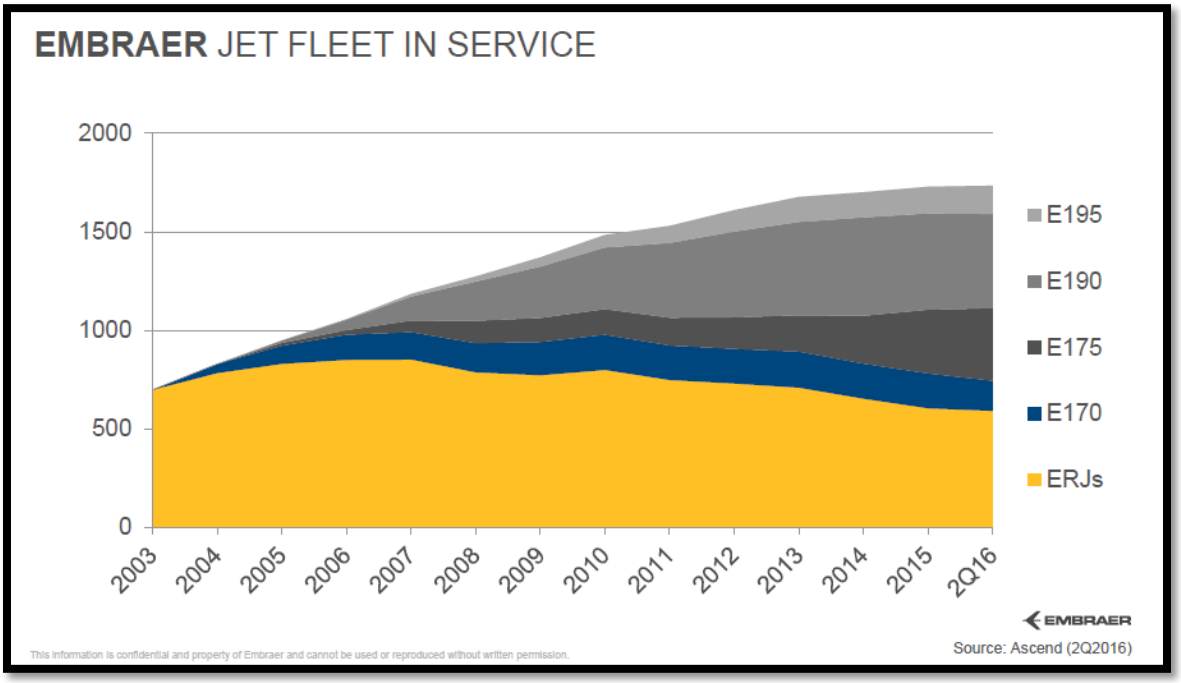
[2] ASCEND 2Q16

III. MARKET DRIVERS AND MARKET SIZE

The Embraer E-Jets, was first introduced to the market at the Paris Air Show in 1999. The program immediately attracted attention with a launch order from Régional Compagnie Aérienne Européenne, a subsidiary of Air France/KLM. Then came an order from Crossair in Switzerland. These two orders gave Embraer 30 firm orders for the E-170 and 30 for the E-190. Production started in 2002, and despite some delays, the E-170 was awarded certification (FAA, EASA, Brazil) in early 2004.

The E-Jets program went to achieve market success. The following chart shows the global Embraer jet fleet from 2003 to 2Q16.

Figure 2 Global Embraer Jet Fleet



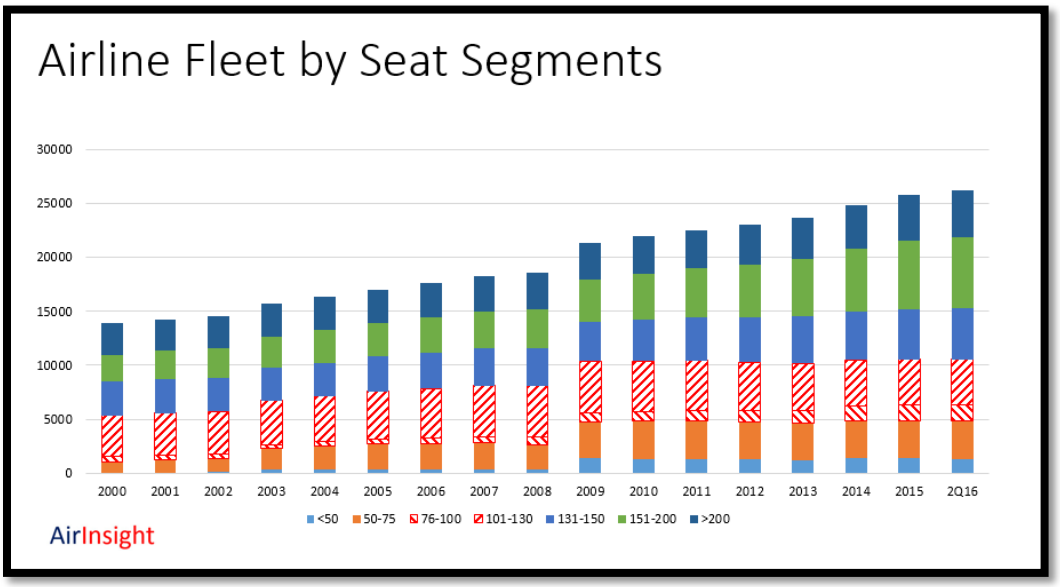
Embraer's E-Jets were well received because the company had developed a good reputation with its smaller regional jets. As the E-jets started to enter service, the regional jet fleet went from 100% of the in-service Embraer jet fleet to less than half by 2Q16. As the chart illustrates, the market quickly started to focus on the larger models of the E-Jet. Of the E-Jets, the larger E-190 and E-195 accounted for over half the global E-Jet fleet in 2Q16.

The key drivers were a correct evaluation by Embraer that existing aircraft in the segment were aging, increasingly fuel inefficient and expensive to maintain. Moreover, a number of the OEMs were leaving the industry. Airlines and lessors needed something else in the segment that offered low risk but was state of the art technologically.

The chart above also demonstrates why Embraer decided to focus on the E-190 as its first iteration of the E2. The E-190 model has typically is by far the most popular model.

The E-Jet operates in the seat segment that was typically the market where the traditional OEMs were market leaders. In the following chart we show how the global airline fleet breaks down by seat segments.

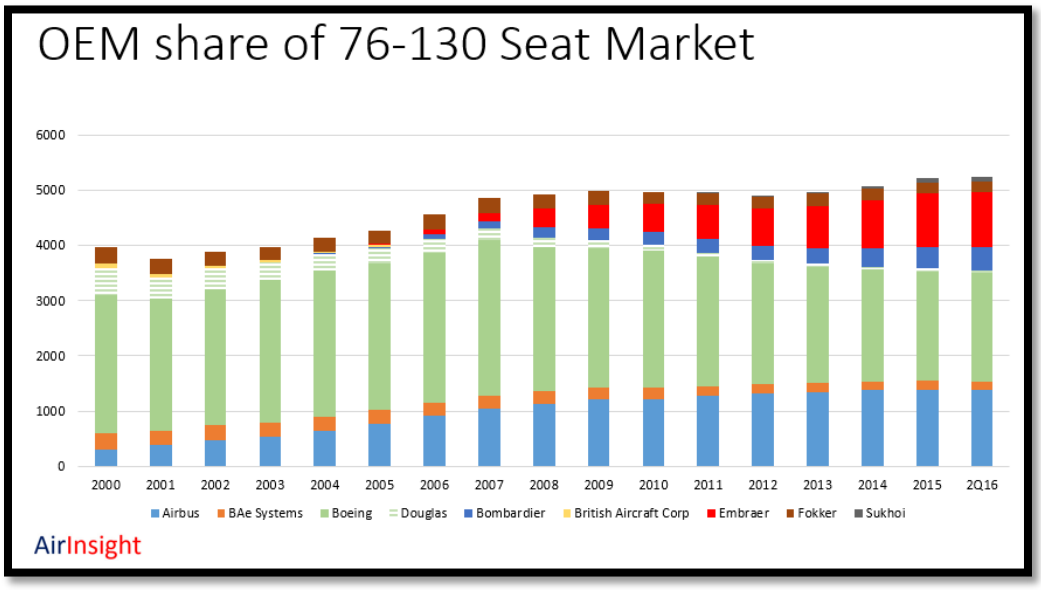
Figure 3 Airline Fleet by Seat Segments



As the chart illustrates, the market Embraer focused on with the E-Jets is substantial. It was also a market where existing aircraft were no longer in production or using shrinks of larger aircraft. It was a segment that was seeking an aircraft tailored for this size using modern technologies. The E-Jet met this requirement.

The following chart illustrates this point well. We see that Embraer entered this market in 2006 and quickly established itself as the third largest OEM, after Airbus and Boeing. Bear in mind that Embraer's E-Jets were competing with A318 and A319s as well as 737-500s, -600s and -700s.

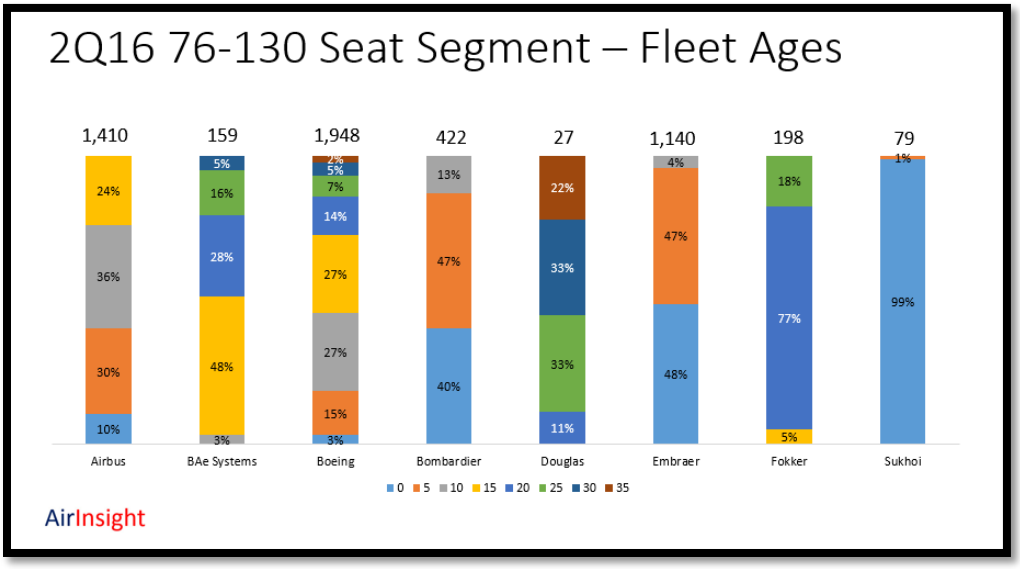
Figure 4 OEM Share of the 76-130 Seat Market



Although the E-Jet may not initially have been seen as a direct competitor, it was clear that Embraer had a mainline option in the E-190 and E-195. By 2Q16, the market leaders in the segment were Boeing (38%), Airbus (24%) and Embraer (18%). These three OEMs accounted for 80% of the market.

However, to get a sense of the market's size the following chart lays out the fleet of each OEM and the relative ages of the fleet.

Figure 5 2Q16 76-100 Seat Segment - Fleet Ages



As of 2Q16 there were 835 aircraft in this market that were 20 or more years old. Since these aircraft are short range, they have high cycles which age aircraft. These 835 account for 16% of the market.

Among the fleet at 2Q16, there were 3,425 aircraft under ten years old. There were 945 between 11 and nineteen years old. Among these two age groups, Embraer only features in the under ten-year sub-segment, where it has a 29% share which compares favorably with Airbus (30%) and Boeing (26%).

It is plausible that Embraer will continue to benefit as the fleet ages because within the segment it is an established brand with nearly 1,150 aircraft in service. As the Airbus and Boeing fleet ages, Embraer is well placed to be the replacement. The only threat to this dominance would be the success of the Bombardier C Series. However, we can confidently state that Embraer and Bombardier are likely to dominate this segment within the next decade.

The success of the E-Jet fleet was not ignored by other OEMs. Airbus and Boeing re-engined their aircraft to better compete. This was a successful strategy and both racked up big orders. Airlines are risk averse, which meant airlines and the lessors who supply them, took the low risk option and ordered these new Airbus and Boeing models. Whereas Bombardier took the risky approach with a clean-sheet design, Embraer took a more balanced risk-reward option, upgrading some major systems, including a new optimized wing for each E2 family member. It was a novel approach: conceiving a new design within a proven platform. It was a similar formula to Airbus and Boeing, but not limited to re-engining.

New Competition

The passenger aircraft market between 76 and 130 seats is rapidly becoming the most competitive in the business. It started when Mitsubishi became the first customer to order the innovative Pratt & Whitney geared turbofan engine (GTF) for its forthcoming MRJ that would compete directly with the E-170/175 series. Offering a 15% improvement in fuel burn over existing engines, the GTF became imperative in a rising fuel cost environment for Embraer to adopt a more efficient engine for the E-Jets.

Bombardier, whose CRJ models compete against the E-170/175, and in its largest size nearly matched the E-190, decided to develop the C Series to compete directly with the E-190 and E-195, as well as the Airbus A319 and Boeing 737-700.

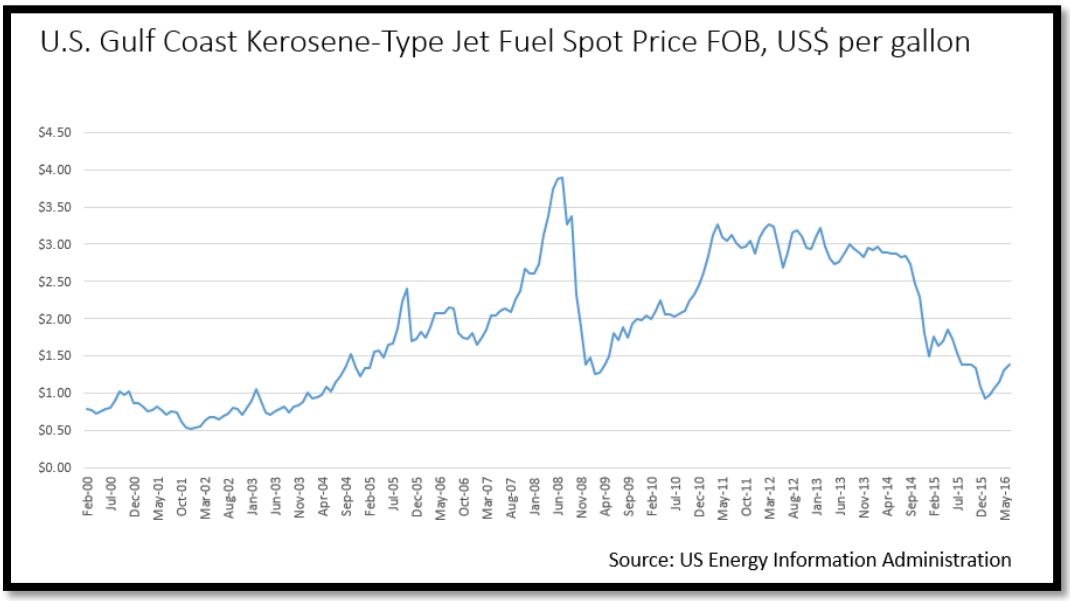
With new technology GTF engines from Pratt & Whitney offering a 15% better fuel burn than contemporary engines, the C Series would have an economic advantage against the E-Jets.

Meanwhile other competitors also entered the market. From Europe came the SuperJet, a Russian Sukhoi design seating 98 with French engines and Western flight controls. The aircraft is marketed by Venice, Italy-based SuperJet International. As the market lost legendary names like British Aerospace, Fokker and Douglas, along came new OEMs to join the market. Airbus and Boeing were seeing new competitors coming online with new aircraft that offered better economics than their smallest models.

Need for Fuel Efficiency

At the time these programs were being introduced, fuel prices were rising. The following chart shows the period these aircraft were undergoing consideration and development. The pressure to cut fuel burn was dramatic from the early 2001-timeframe.

Figure 6 US Gulf Coast Kerosene Spot Price



For Embraer the choices were clear. New competitors were emerging. Plus, Airbus and Boeing were not going to walk away from a market worth around 5,000 aircraft. For Embraer, the success of its E-Jets had to be supported and protected.

Although the price if Jet A had spiked and come down again, it was another price rise that no doubt helped spur the decision to refresh the E-Jets. In late 2011 Embraer announced that it would revise its E-Jets. The decision was complex, as there were good arguments for a clean sheet design. But this carried unacceptable risks. Besides, Embraer determined it did not want to compete directly with Airbus and Boeing. It was comfortable with the sub-130 seat market.

As we have seen above, the market favored Embraer as airlines and lessors retired their older aircraft in this segment. Moreover, Embraer had developed a global customer base with a near 1,150 fleet in service. It was clear that this entire customer base would be favorably disposed to the E2. The E2 would be designed in a way that existing customers would have minimal conversion costs.

Besides the new generation engines, Embraer could also deploy lighter materials and exploit its updated and improved fly-by-wire system. The development process proceeded and early in 2013 Embraer selected the GTF engine for the E2. This selection was the cause of annoyance at GE, the longtime supplier of engines for the E-Jets. GE was losing a market worth some 2,000 engines and spares.

Even with the attraction of having GECAS, GE's finance arm, to help market the E2, Embraer had determined they needed the GTF. The only GE solution would have been a shrink of the CFM LEAP. CFM was focused on the 737 MAX and Airbus A320neo family program. These two programs are worth tens of thousands of engines.

Availability of Next Generation Engines

As Figure 5 demonstrates, OEMs and their airline customers were under pressure to find ways to save fuel costs which had become the largest input cost. Moreover, as the chart also illustrates, fuel prices were volatile. This volatility played havoc with airline planning. Many airlines did not have the financial wherewithal to hedge against spike fuel prices.

In the US, Southwest Airlines did have the resources and speculated correctly about fuel prices. Consequently, the airline kept its fare lower than it might have. This caused its domestic competitors to bleed; Southwest's strategy was to hobble the competition and it worked. The only way US domestic airlines could emerge from the crisis was to consolidate and this happened.

However, all airlines were clamoring for major engine improvements to reduce fuel burn. At the time there was only one engine OEM that had something close to being ready and that was Pratt & Whitney with its pioneering geared turbofan.

Pratt & Whitney had been developing this engine for a long time. The GTF, as it became known, was an outcome of an engine Pratt & Whitney had in mind to power the Airbus A340 in the mid-eighties. While the engine for the A340 was cancelled, a few engineers kept at it. In the end Pratt & Whitney spent over one billion dollars to develop the GTF. Meanwhile Airbus selected the CFM56 for the A340 launch.

The GTF uses a gear between the large fan and the core, to optimize each part of the engine. Fuel burn is reduced by 15%. The engine also offers much improved noise and pollution. The first company to select the engine was Japan's Mitsubishi for its regional jet. Sometime later, Bombardier, which was also developing a clean sheet design also selected the engine. The Bombardier choice was important. Their new design was going to bump against Airbus and Boeing's smallest aircraft. The two big OEMs had to react. One of Airbus' most influential customers, Lufthansa, encouraged them to re-engine the A320 with the GTF. Airbus decided to look into this.

As this was happening, CFM International, the world's largest aero engine maker saw it needed to respond. CFM had been delivering engines since 1982. Airbus and Boeing were big customers and anything that was a threat to them was also a threat to CFM. CFM's CFM56 had become the best-selling engine ever. The company is a joint venture between France's Safran Aircraft Engines (formerly Snecma and GE in the US.

The CFM56 was the engine that powered the re-engined DC-8 and ensured a second life for the aircraft. Then, building on that success, CFM made another crucial win. The USAF selected the CFM56 to re-engine its tanker fleet of Boeing KC-135s in 1979. The USAF remains the largest CFM customer. Then in 1981 CFM was selected as the sole supplier to Boeing for its 737 program, winning the business from Pratt & Whitney. This is seen by most industry observers as possibly the biggest mistake Pratt & Whitney has ever

made. In 1984 Airbus selected the CFM56 to power its A320. CFM had built itself a solid bedrock of customers to ensure its success. In 1993 Boeing revised its 737 again and CFM became exclusive engine supplier for the 737 NG. By 1999, CFM had delivered 10,000 engines. By 2005, the company delivered its 15,000 engine and launched the LEAP56 (Leading Edge Aviation Propulsion) technology development and maturation program to eventually build a successor to the CFM56 family.

With this background it is no surprise that CFM was going to react to the Pratt & Whitney threat. In 2008, CFM launched the LEAP-X engine, even before an application had been identified. By 2009, CFM delivered its 20,000 CFM56. Borrowing from the GE GEnx and GE90 programs, the LEAP engine promised as much as 16% better fuel efficiency than current engines, along with lower noise, lower emissions, and the CFM level of industry-leading reliability and low maintenance costs. But whereas the GTF had the gear in order to achieve its numbers, the LEAP took an existing design and squeezed more out by using new materials and other IP from GE's larger engines.

The two engine OEMs promised the fuel efficiencies airlines needed and the aircraft OEMs figured out how to deploy these engines. While CFM won exclusivity on the next generation Boeing 737 MAX and the brand new COMAC C919, it also kept its slot on the A320 family. Meanwhile Pratt & Whitney was selected for the A320 family, after extensive tests, and then won slots on new designs from Bombardier CSeries and IRKUT MC-21 and finally the Embraer E2. Pratt & Whitney secured slots on five programs to three for CFM. The three airplanes that the CFM LEAP engine is offered on make up 90 percent of the orders for this market space.

The next generation engines are so good, and confidence in them so high, that the aircraft OEMs (particularly Airbus and Boeing) built up record backlogs that pushed deliveries to 2019.

The only wrinkle has been the precipitous decline in fuel prices. As oil costs dropped, so did the urgency for the new aircraft with new engines. European airlines are still eager for the new aircraft because they face high taxation on fuel use along with pollution and noise. Even as oil and fuel prices declined, EU requirements on noise and pollution have not abated. But for other aircraft operators, the lower fuel costs have enabled them to keep older aircraft in service for longer.

But it is clear the new generation engines have had a seminal impact on the industry. The new engines gave existing models extended life and saved Airbus and Boeing large amounts of R&D. While Bombardier went with its clean sheet approach, Embraer was able to tack between these two approaches. Embraer also did a re-engine but also significantly updated its E-Jets to get to the E2.

Selecting the E2's engine

The E2 engine procurement process involved all the main engine manufacturers (GE, Rolls-Royce and Pratt & Whitney), with engine options at the thrust level required for the E2 to reach its performance targets.

Embraer's engineering team and the engine OEMs worked closely for more than a year to evaluate and understand the pros and cons of each proposed combination of engine and airframe. Embraer's main drivers for engine selection were clear from the start: "*The E2 shall be the most efficient aircraft in the segment*."

When the E2 was still known as G2, the GTF was considered an outsider as a solution. GE was believed to be in pole-position as the incumbent on the E-Jets. GE proposed a next-generation NG34 (the CF34 is on the E-Jet). There was a suggestion that even a de-rated CFM LEAP might have been suggested. CFM claims they did not offer an engine because the thrust requirements for the E2 were below the scope of the CFM agreement by its two owners. The NG34 was going to be based on the common 'eCore' design used in the CFM LEAP engine and earmarked as a successor to the CF34.

Rolls-Royce, which hoped to build on its relationship established with Embraer over the earlier AE3007-powered ERJ-145 regional airliner family, also competed with a new two-shaft engine design.

Pratt & Whitney offered the most competitive package, considering performance (fuel consumption, emissions, noise, competitive life cycle costs), reliability and commercial offerings, with two engines powering the family (PW1700G for the E175-E2 and PW1900G for the E190-E2/E195-E2). Having an engine well into the development process was a big plus for Pratt & Whitney due to fact that it would lower overall E2 program risk and would help to achieve the target of having a high product maturity at EIS.

IV. Technology and Capabilities

Description of E2 Family

The E2 from Embraer consists of three models, the E-175 E2, E-190 E2, and E-195 E2. The E-190 E2 is equivalent in size to the current E-190, while the E-195 E2 adds 3 rows or 12 seats over the current E-195 and the E-175 E2 adds 1 row, or 4 seats over the current E-175. These re-engined models will replace the current E-Jets with entry into service for the E-190 E2 in 2018, E-195 E2 in 2019, and E-175 E2 in 2020. The models are shown in the illustration below.

The E2 jets are based on the design of the E-Jets, with improved engines and different wings, and for two models, larger fuselages, being the major visible differences from the outside. Inside, a new cockpit layout, new overhead bins and improved seating configurations further modernize the new models.

Basic specifications for the E2 Jets are shown in the table.

Figure 7 E2-Jet Specifications

E-Jet Specifications	E175-E2	E190-E2	E195-E2
MTOW (lbs.)	98,767	124,341	133,821
MLW (lbs.)	88,185	108,137	119,050
Payload (lbs.)	23,369	28,836	35,605
Range (max pax @LRC)	2,060	2,850	2,450
Takeoff length (ft.)	5,906	5,479	6,463
Landing length (ft.)	4,429	4,314	4,659

Engines

Embraer has chosen the Pratt & Whitney Geared Turbofan to power its new aircraft. The E-175 E2 will utilize the PW1700G, while the E-190 E2 and E-195 E2 will utilize the PW1900G in 19,000 and 23,000 thrust ratings. The GTF engines are a game-changing technology, as their innovative gearbox enables the fan to run slower than the core of the engine. This enables both elements of the engine to operate at optimal speeds, producing more power while reducing the complexity of the engine.

The GTF engine has fewer stages than its competitors, which in turn leads to fewer parts and lower maintenance costs. There is an “elegant simplicity” in its design that enables it to deliver superior fuel efficiency than the engines it is replacing, and led Mitsubishi, Bombardier, Airbus, Irkut, and now Embraer to select it for their new aircraft programs.

The GTF engine utilizes larger fans than the engines it replaces, which also provides additional drag. However, the efficiency of the engine is such that it still delivers a 11% improvement in fuel burn. When combined with aerodynamic improvements and improvements in the fourth generation fly-by-wire

system, the E2 models deliver 16% better fuel economy on the E-190 E2, which is the same size as the E-190.

Aerodynamics

Each E2 model will have its own wing, optimized for performance with the particular engine and fuselage size. It is quite unusual for three models in an aircraft family to have three different wing designs, and is a variation from the E-190 and E-195, which shared an identical wing. The optimization of wing aerodynamics, with a higher aspect ratio, provides additional efficiency and lower drag for each model, with the wing optimized for the size and weight of each engine. Winglets have been removed from the wing, which is designed to be more efficient without them. Instead, much like the Boeing 787, the wing cants back near the wing-tip in what amounts to a flat winglet incorporated into the shape of the wing. This is the most advanced and efficient wing in the segment today, with the highest aspect ratio in the single aisle market.

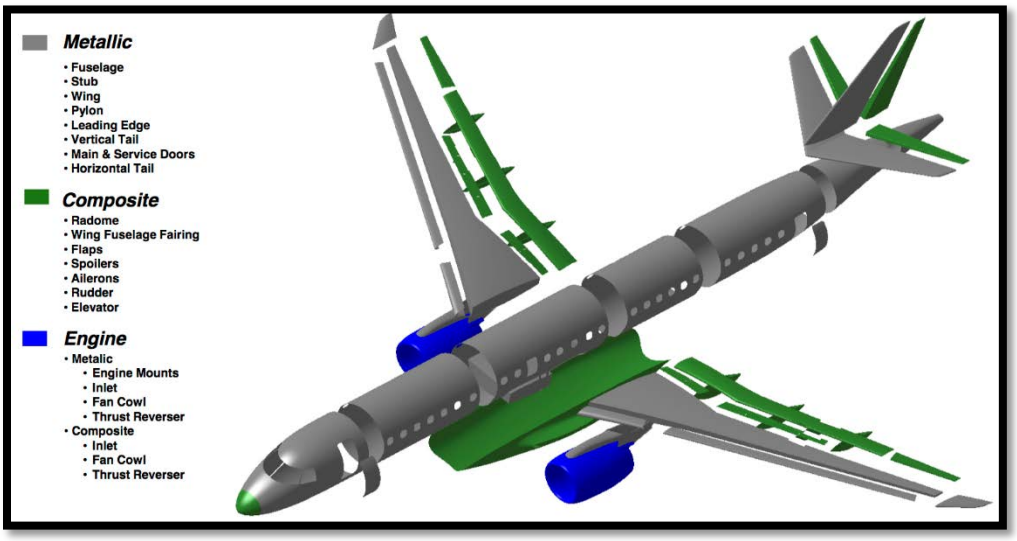
Advanced Materials

Embraer continues to utilize composites in its aircraft, but has not utilized composites for major structural elements, introduced in the Boeing 787 or Airbus A350. The size of regional aircraft subjects them to ramp impacts and "hangar rash" which would result in being difficult to repair. Given the high cycle nature of narrow-body and regional aircraft, Embraer chose to remain with metal for many of the components.

Embraer chose to remain with metal wings for the E2 to retain the proven reliability of their wing to fuselage mating system and wing box. After analyzing the advantages and disadvantages of a composite wing, Embraer chose to minimize program risk and maintain metal wings.

Composites are used for the radome, wing fuselage fairing, flaps, spoilers, ailerons, rudder and elevator, providing weight savings in these areas. The following illustration shows materials utilization for the E-190 E2 and E-195 E2 aircraft.

Figure 8 E2-Jet Materials



Maintenance Technology

A major reduction in maintenance cost is expected for the E2 when compared with today's E- Jets. This results from both reductions in engine maintenance, and from longer maintenance intervals for the airframe, improved reliability and lower prices for replacement components.

Maintenance intervals will increase to 850 hours and 8,500 hours for minor and major checks, with lower check costs. Increased systems reliability and reduction of component costs will also contribute to lower maintenance.

The use of aircraft health monitoring, in which Embraer is among the industry leaders, will also help airlines reduce maintenance costs as well as aircraft downtime. Embraer's Ahead Pro health monitoring system, which provides real-time transmission of exceptions to normal conditions, can provide an airline warning of potential component failures, enabling faster responses and precluding flight delays and cancellations.

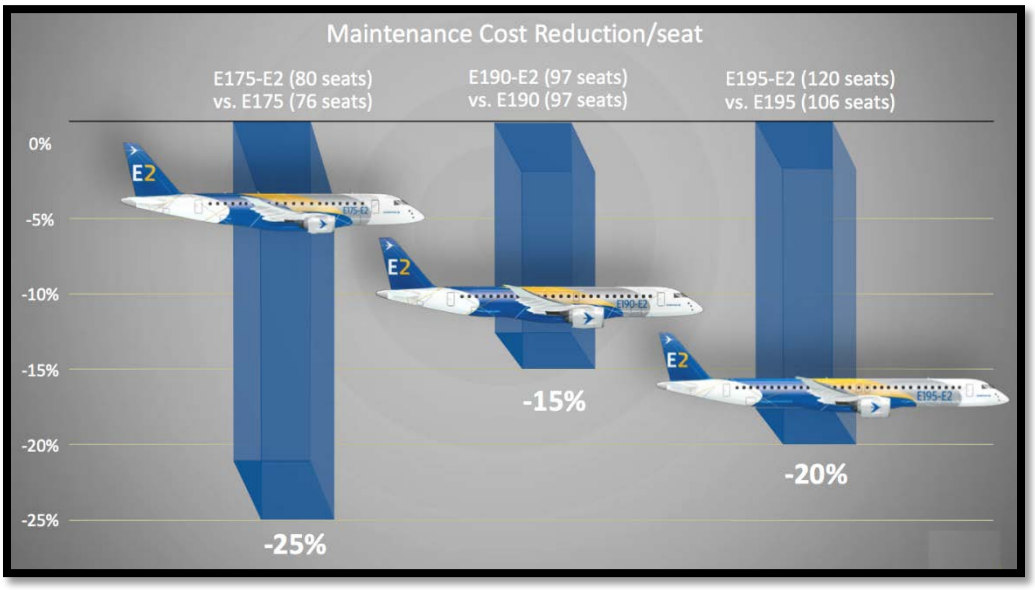
The system receives messages in flight from the aircraft, and references those message to Embraer's Digital Technical Publications, making troubleshooting easier for mechanics. Ahead Pro also contains advanced trend analysis monitoring that examines a variety of parameters, from cabin temperature controls, bleed manifold temperatures, avionics flow sensors, and hydraulic quantities. The system watches trends, and provides alerts for preventive maintenance activities.

In additional the system monitors loads, such as hard landing, severe turbulence, overspeed, and other parameters to ensure that maintenance is aware of abnormal operational conditions.

The result of analyzing terabytes of data (5,500 parameters for 200 flights per aircraft) will be the ability to predict failures, identify common failure modes, and to work with component suppliers to improve on-wing reliability.

All of these factors combine to generate substantial maintenance cost reductions for E2, as illustrated in the following chart

Figure 9 E2 Maintenance Cost Reduction



Avionics

The cockpit of the E2 incorporates the latest in advanced technology from Honeywell, including their Primus Epic 2 suite of touch-screen displays. Features such as synthetic vision, cockpit traffic displays, and Honeywell's SmartRunway™ and SmartLanding™ Runway Awareness and Advisory System. These elements combined to provide a state-of-the-art cockpit for the E2.

Embraer has also introduced a fourth generation fly-by-wire system, developed in-house, that provide both state of the art optimization for fuel savings as well as performance limits for improved safety. An illustration of the E2 cockpit is shown in the following graphic.

Figure 10 E2 Flight Deck image[3]

e-Enablement

The E2 models are e-Enabled by design, and ready for a digital future. Connectivity is provided, both on the ground and in the air, to provide data to support airline operations, aircraft health and maintenance, and internet access for a robust passenger experience. Embraer has designed their e-Enablement systems and processes in a modular way that allows for future bandwidth growth as technologies continue to improve in the future.

Performance

The E2 increase runway performance, range, and economics over predecessors. Fuel burn per seat is 16% lower for the E-175 E2 and E-190 E2 over their predecessors, and the larger E-195 E2 has a 24% lower fuel burn per seat than the E-195. This is a substantial improvement, and should keep the E2 Jets in a leadership position in each of their segments from an economic standpoint.

The 2,000 plus nautical mile range for the E2 Jets expands the operational radius of the aircraft when compared with their predecessors, enabling "right sized" operations for both short- and long-haul routes. The following charts depict range circles from Dallas and Paris that illustrate the flexibility of the aircraft.

[3] Source: Embraer

Figure 11 E2 Range Chart from DFW

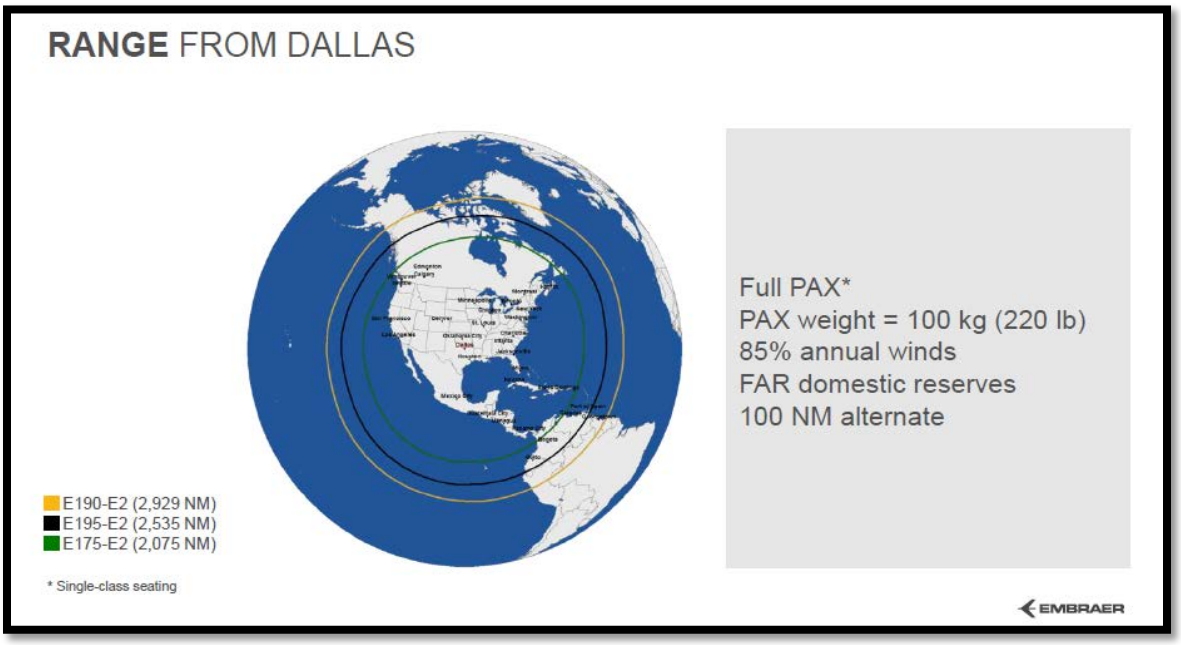
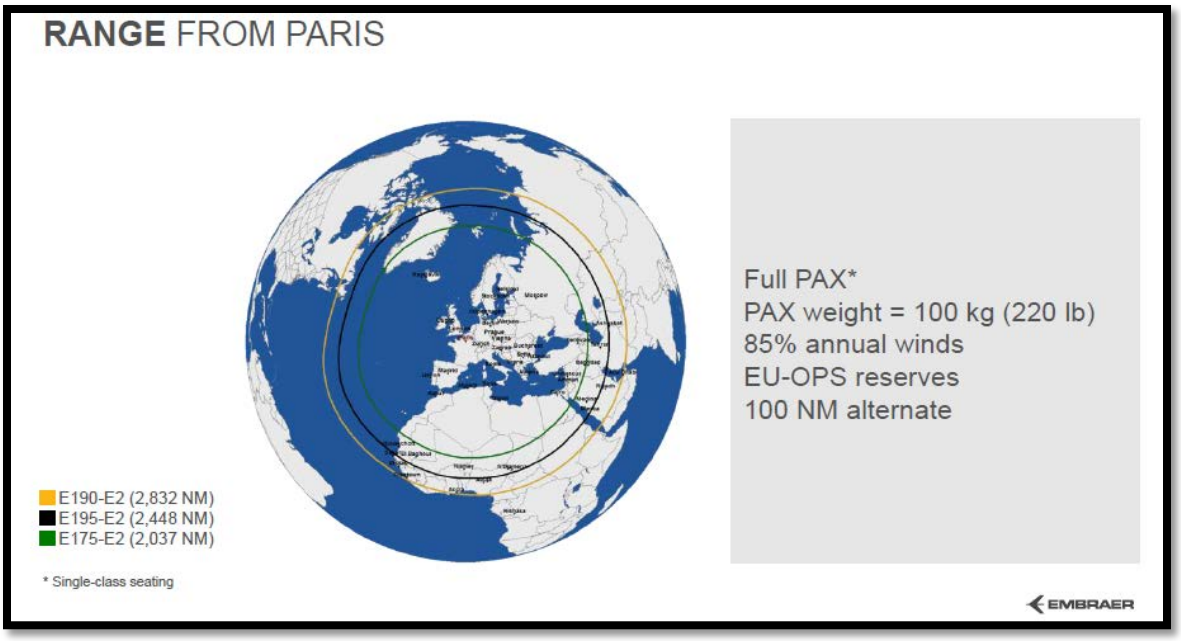


Figure 12 E2 Range Chart from Paris



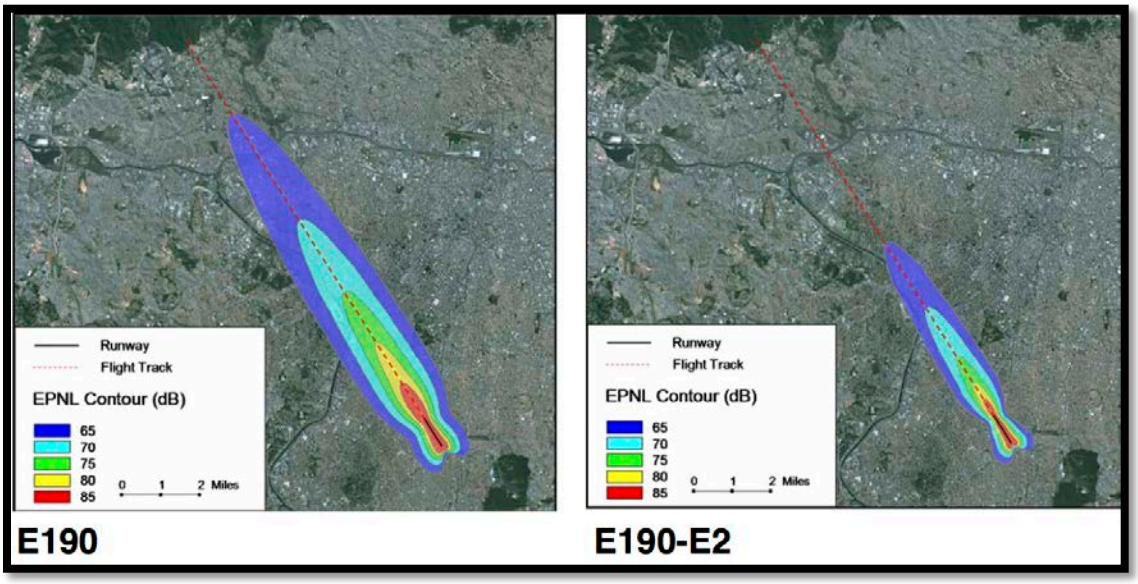
Environment

The E2 Jets provide environmental benefits over their predecessors in several areas. First, fuel burn improvements provide a 16%-24% reduction in carbon emissions per seat, depending on model. But

perhaps the most significant benefit from the E2 Jets is the noise reduction near airports, and how quiet the aircraft is compared with existing models. The following chart illustrates the massive 65% reduction in the noise footprint of the E-190 E2 when compared with the already relatively quiet E-190. The improvements in technology have made a strong environmental performer even better.

Embraer utilizes environmentally friendly REACH-compliant materials in the construction of the E2 Jets, and it the first aircraft manufacturer to be ISO1400 certified.

Figure 13 E2 Noise Contours[4]



Competitive Comparison

The E2 Jets compete favorably with existing competitors, re-engined models from Airbus and Boeing, and new technology competitors from Mitsubishi and Bombardier.

E-175 E2 Competitors

The Canadair Regional Jet series offers three existing models that compete against the E175-E2, the CRJ-700, CRJ-900, and CRJ-1000. While each of these aircraft represent a major improvement over the CRJ-200, they are constrained by a narrow cabin that, from a passenger preference standpoint, does not stack-up well against either the current E-Jets or the improved E2. The CRJ advantages are that they are small and light, and therefore relatively efficient. However, the fuel economy improvements of the E2-Jets that result in lower seat-mile costs, when combined with passenger preference, indicate that the CRJ series is approaching economic obsolescence.

[4] Source: Embraer

The MRJ is an all-new design in a similar seat range, also using the Pratt & Whitney GTF engines. The economics of this all new design should be highly competitive. However, the program has endured several delays, and it is likely that entry into service will continue to slide to the right, as evidenced by the latest delay in their flight test program. With a mature airframe and systems, we believe the E-175 E2 will offer airlines higher initial reliability that its all-new competitor, which has not sold commercial aircraft and needs to establish a global service and support network. Embraer has a significant advantage in that regard.

In the 100-130 seat segment, Embraer faces competition from the recently introduced Superjet 100, as well as the Bombardier C Series with two models, the 110 seat CS100 that competes with the E-190 E2, and the CS300 that competes with the E-195 E2. At the top end of this segment, Airbus and Boeing also offer the smallest models of their narrow-body families, the A319ceo and A319neo, and the Boeing 737-700 and 737 MAX 7.

The Superjet 100 is a Russian-built aircraft that incorporates many Western suppliers and components, including a joint-venture engine between Snecma (Safran) and NPO Saturn, avionics from Thales, electrical system from Hamilton Sundstrand, hydraulics from Parker-Hannifin, and APU from Honeywell, among others. The aircraft is competitive with the An-148 and E-190, and is attractively priced when compared to Western built aircraft. However, the Powejet engine is modeled after the CFM-56, and is now one generation behind the GTF powering the E2. Unfortunately, while a sound aircraft, the Superjet suffers from the reputation of earlier Russian aircraft, and Sukhoi and its western partner, Alenia, have had to overcome this in selling the aircraft.

The Bombardier C Series recently entered service with Swiss, and has gained market momentum after major orders from Air Canada and Delta. While the C Series program was delayed, the aircraft is modern, attractive, and has excellent operating economics that are competitive with the E2. The C Series is the major competitor for the E-190 E2 and E-195 E2 series. We expect Embraer and Bombardier to be the dominant players in the 100-130 seats segment over the next two decades.

Airbus has re-engined its A320 family and offers an A319neo in the 130 seats class. The A319ceo and A319neo are smaller versions of larger aircraft, and were not optimized for this segment. As a result, they carry excess weight and are not as efficient as aircraft from Bombardier and Embraer, which were specifically designed for this category. While Airbus does have an advantage in cockpit compatibility for operators of its larger aircraft, sales of the A319neo have been weak.

Similarly, Boeing has re-engined its 737 family, and offers a revised 737 MAX 7 model in the 150 seat class. The current 737-700NG model, like the A319, is too heavy for its size and not as efficient as aircraft from Embraer and Bombardier. Recently, Boeing stretched the original MAX 7 design by two rows, providing 12 additional seats to improve its competitiveness with the A320neo. Nonetheless, this model has not sold well.

In summary, the E-190 E2 and E-195 E2 compare favorably against the models from Sukhoi, Airbus, and Boeing, and are equivalent in economic performance to the new C Series from Bombardier, which also utilizes the Pratt & Whitney GTF engine.

V. DEVELOPMENT AND PRODUCTION

Development Plan and Timing

Embraer decided to move from a family of four models in the E-Jet family to three for the E2. The smallest model, the E-170 was dropped. The E-170 fleet peaked in 2008 at 16% of the Embraer E-Jet fleet. Airlines and lessors ordered the larger models. In the US, a key market for the E-Jets, the E-175 became the most ordered regional jet.

The E-Jet offers large windows and a comfortable cabin – items not associated with regional jet service. Improving on this was not going to be easy and Embraer focused on the flight deck and aircraft design for the E2. The cabin was improved[5] but not as much as the flight deck and airframe.

A major concern for airlines and lessors has been adjusting development timelines. Experience from the Airbus A380 and Boeing 787 taught that even the biggest and best could get it wrong. Then came delays at Bombardier, which served to reinforce this view. Most recently we have seen delays in the A320neo from engine troubles. It is not clear at this writing that Boeing won't also have engine challenges.

The concern is driven by how airline planning works – the business is schedule driven. Airline sell schedules and anything that negatively impacts the schedule causes expensive disruption. Flights may have to be cancelled. Fleet managers may need to refurbish an aircraft they planned to retire, or worse, hire in a wet lease to cover the flight. Reactions from airline managers in the press demonstrate the stress disrupted schedules create. Even if OEMs have to, very quietly, compensate for the delays, the schedule disruption is annoying. Especially when airlines have been advertising their new aircraft.

Which leads us to the surprising success at Embraer. The E2 program has been announced repeatedly as "on time and on budget". These are words people do not associate with new aircraft programs. This especially the case for Embraer which is doing so much more than a re-engine. Each of its E2 models has its own wing. The development and testing of a wing is significant. A delay would be normal.

Initial Results Ahead of Schedule

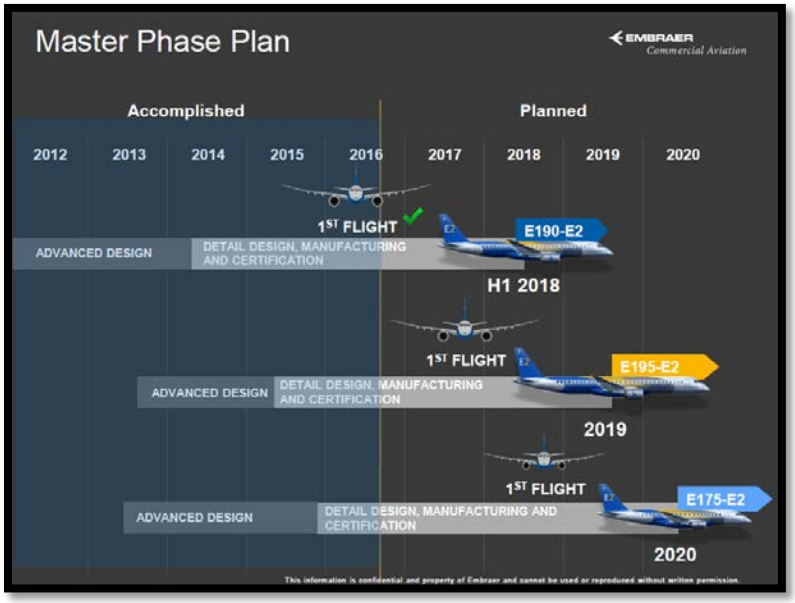
Embraer appears to be on time and on budget. The Brazilian economy means the company cannot turn to banks or the state for help. It must make do with it has. As if to prove, without any doubt, that the E2 program is doing better than anyone expected, Embraer brought their E2 to the 2016 Farnborough show. Indeed, not only the E2 test aircraft, but also its KC-390 military freighter was in attendance. It was a *tour de force*.

The E2 test aircraft at the show achieved a remarkable milestone. The final inbound leg from Sal Island was only its 26th flight! Were the test crew not 100% confident, they would never had embarked on an Atlantic crossing.

[5] The E2 features the Crystal Cabin award winner interior, with wheels-first capable oversized bins

Figure 14 E190 E2 Farnborough Trip

Figure 15 E2 Master Phase Plan[6]



The E2 was launched in 2013 and took its first flight in 2016, almost three years later. The first generation E-Jets took five years from launch to EIS. The E2 is not only beating this timeline, it is also a much more complex aircraft. This improvement demonstrates an important Embraer issue - the company continues to learn and apply that learning. This successful application of IP is not an accident.

[6] Source: Embraer, used with permission

One of the company's key advantages is its stable workforce, particularly at the senior management levels. To illustrate this, look at Airbus, Boeing and Bombardier. Every time there is a crisis, heads at the top roll. At Embraer mistakes must be happening; these are people and they are not divine. Yet the mistakes are dealt with and learned from. This learning has enabled people to learn faster – the "fail fast" approach knowing that your head is not guaranteed to roll helps people to take a chance, try something, fail and then try again and so make progress[7].

Internal Development of Fly-by-Wire Software

Embraer has a deliberate culture of internalizing IP. It starts off partnering with outside vendors, learns and then brings the knowledge in house. While this happened with the first E-Jet wing that was meant to come from Kawasaki in Japan, the fly by wire system is an even better example.

Embraer has been a firm that manages risk deliberately. Its history of moving from a state-owned company to a private company was a near death experience. The management in place today remember those days.

The original E-Jet fly by wire solution was to be developed by Parker Hannefin. The system was basic replacing the control cables. But as Embraer developed each new program, across business jets and military programs, it added to its fly by wire knowledge and technology. Each new aircraft had a more advanced fly by wire in place. Embraer now writes all its fly by wire software code. By the time the KC-390 took to the skies it had a third generation system in place, having integrated lessons from the Legacy 500's system.

The E2 has the most advanced system Embraer has ever flown and is full fly by wire. Embraer integrated the software code into fly by wire hardware made by Moog, which is responsible for the primary controls and spoilers. Full fly by wire is one of the E2 program's advances over the E-Jets which uses traditional controls for its ailerons. Embraer's engineers reduced the size of the E2 empennages, cutting drag.

Embraer's competitors question how the company can offer fly by wire in its smallest business jets. Embraer simply says that it can do this because with each program, whatever knowledge it has acquired, this is put into the next generation. It is actually not radical at all.

Indeed, the E-190 E2 promises 16% better fuel burn than the E-190 and this comes from the new wing's improved aerodynamics (3.5%), the GTF (11%) and the latest fly by wire (1.5%).

While we mentioned the wing before, Embraer is also now making the landing gear for the E2. Yet another piece of IP that was learned, acquired and now internally developed. Embraer has 6,000 engineers that are rotated through the company's programs to ensuring as broad an experience base as possible. This is another example of how the company de-risks its programs. Embraer has developed a school system next to its San Jose dos Campos plant to ensure a steady stream of talent.

[7] http://www.ainonline.com/aviation-news/aviation-international-news/2010-12-23/embraer-flight-testing-fbw-legacy-flies

Most recently Embraer announced the opening of a premium seat manufacturing facility in Florida. With each of these deliberate steps, Embraer de-risks future programs. It is ensuring a more vertical supply chain over which it has control. This control allows better visibility over the development of a program, but most crucially the ability to move quickly to fix things that need fixing. Outside vendors will not allow this visibility because of a fear of failure – but if failure comes, it occurs too late to fix and is consequently far worse.

"*Having spent nearly 50 years designing and developing aircraft for various markets, Embraer recognizes the distinct importance of the aircraft seat, the ultimate customer touch point. That's why we made the strategic decision to bring this expertise in-house*," said Paulo Cesar de Souza e Silva, Embraer President & CEO. This is an important clue as to how Embraer management thinks.

Supply Chain

For any aircraft program these days it is almost a certainty that if there are any delays, there is better than 75% chance the supply chain has failed. In the case of the E2, Embraer proudly announced the E2's first flight on May 23rd 2016 – this came ahead of schedule. The first flight was planned for the second half of 2016. The first flight was at least two months early. Which was a tremendous accomplishment.

Embraer provided the following chart to show its major vendors in the supply chain. In addition to those shown in the image, there are another ten for the cabin.

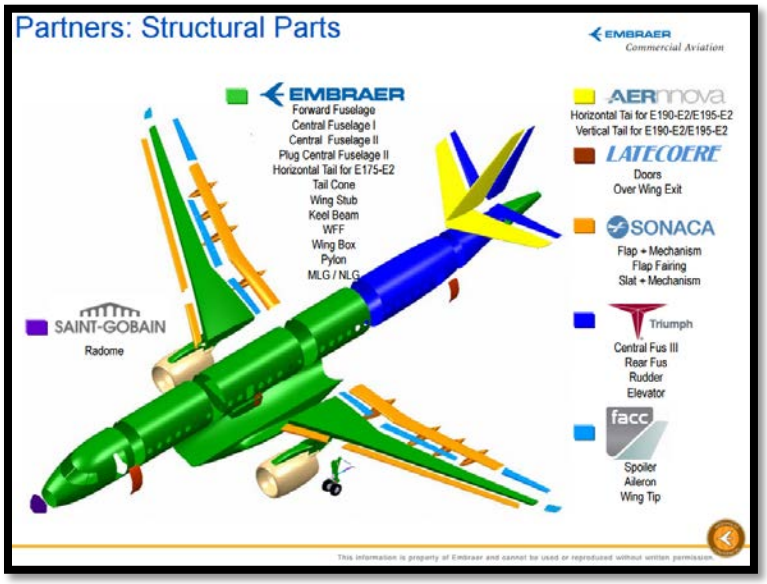
Figure 16 E2 Supply Chain - E-190/195 E2[8]

[8] Source: Embraer. Used with permission

Figure 17 E2 Supply Chain - E-175 E2[9]

Then in addition to these firms, Embraer also has more vendors in the supply chain for structural parts as this chart illustrates.

Figure 18 E2 Structural Parts Vendors[10]



[9] Source: Embraer. Used with permission.
[10] Source: Embraer. Used with permission.

Embraer has managed the E2 program well because the company has been doing a number of new aircraft programs. Starting with the E-Jets, Embraer followed up with the Phenom then the Legacy, followed by the KC-390 and then the E2.

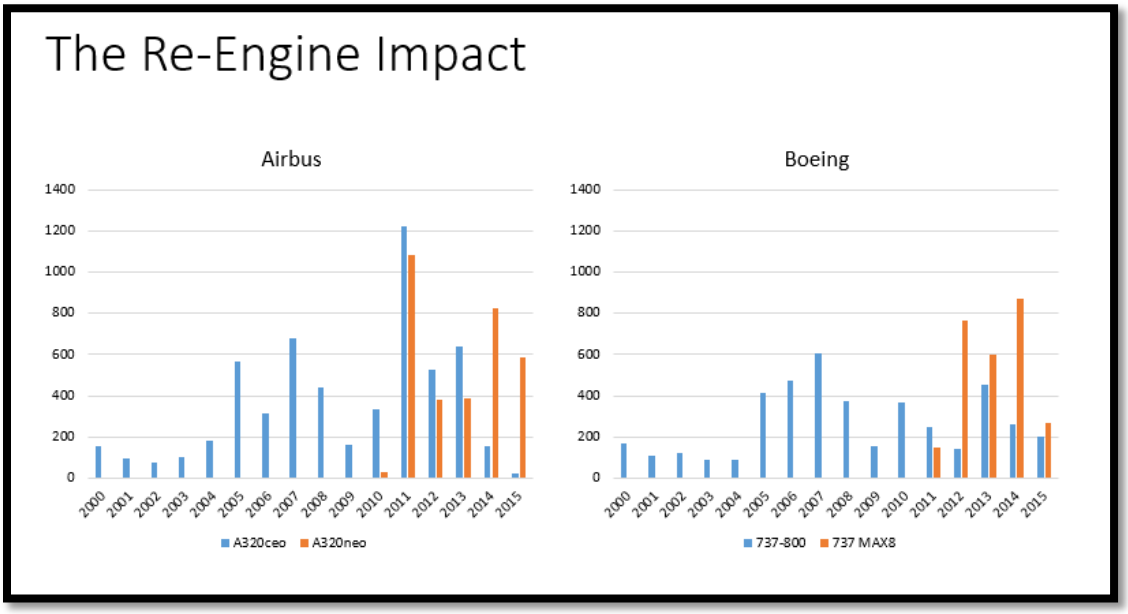
The company's development programs ensured fresh memories from each program. This means that the teams involved were continually in a "lessons learned" mode. With each program more technology was deployed. The fly by wire mentioned is an example of this. Embraer makes a big deal of the ability for its teams to de-risk and get programs matured quickly. The outcome has been an E2 program that applied all the lessons from the previous programs, building on technologies and engaging with suppliers from the start. The proof of the approach and its success is the early first flight.

VI. THE SUCCESS OF RE-ENGINING PROGRAMS

Airbus neo and Boeing MAX Successful

The re-engine programs started by Airbus and Boeing had a spectacular impact on orders. The following chart shows how Airbus and Boeing were selling their primary single aisle models.

Figure 19 The Re-Engine Impact



The orange columns are for the re-engined models. Airbus saw interest in the A320ceo quickly eclipsed by the A320neo. Boeing did not have quite the same sales volume as Airbus, and its 737-800NG kept selling relatively well even as 737 MAX8 orders started.

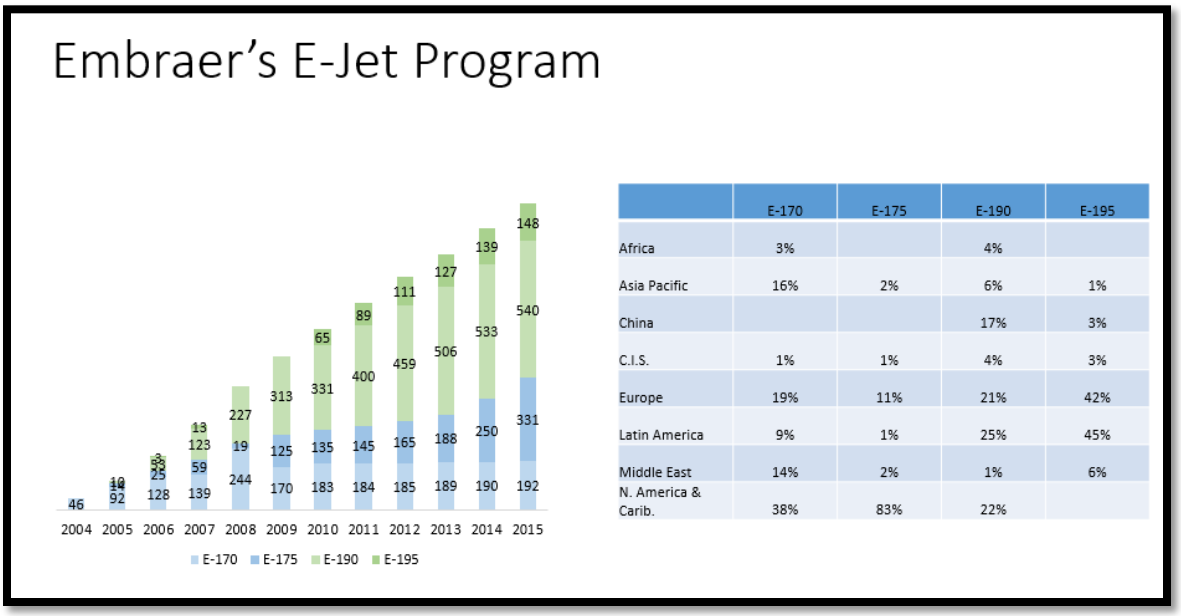
Both the models shown are one third of the families for each OEM. These two models shown though account for 4,912 aircraft. At production rates of approximately 60 per month, just these two models account for nearly seven years of production. It is not hubris to describe the launch of the re-engined aircraft by Airbus and Boeing as successful.

These aircraft were launched to both assist customers with cutting fuel costs and also to hold off threats from Bombardier. Embraer was still pondering its options on the E2. By waiting to make its decision, Embraer accomplished two important things: it saw that re-engining was a valid solution and it also saw what its E2 would need to offer to be a winner. In this case there was a second mover advantage for Embraer.

E2 Should Prove Successful

The E2 program is likely to be successful. The reason for this are simply because Embraer has built a large customer base for its E-Jets. If we break down the E-Jets program as of the end of 2015, the market looked like this.

Figure 20 E-Jet Program 2015



	E-170	E-175	E-190	E-195
Africa	3%		4%	
Asia Pacific	16%	2%	6%	1%
China			17%	3%
C.I.S.	1%	1%	4%	3%
Europe	19%	11%	21%	42%
Latin America	9%	1%	25%	45%
Middle East	14%	2%	1%	6%
N. America & Carib.	38%	83%	22%	

From the left chart we can see market bias quickly moved to the E-190 followed by the E-175. From table on the right we can see the E-Jet program has a wide spread of customers. The E-175 market is clearly the US, where three-quarters of the fleet is based. We noted earlier that the E-175 is a US regional airline favorite. The smaller E-170 is also popular in the US.

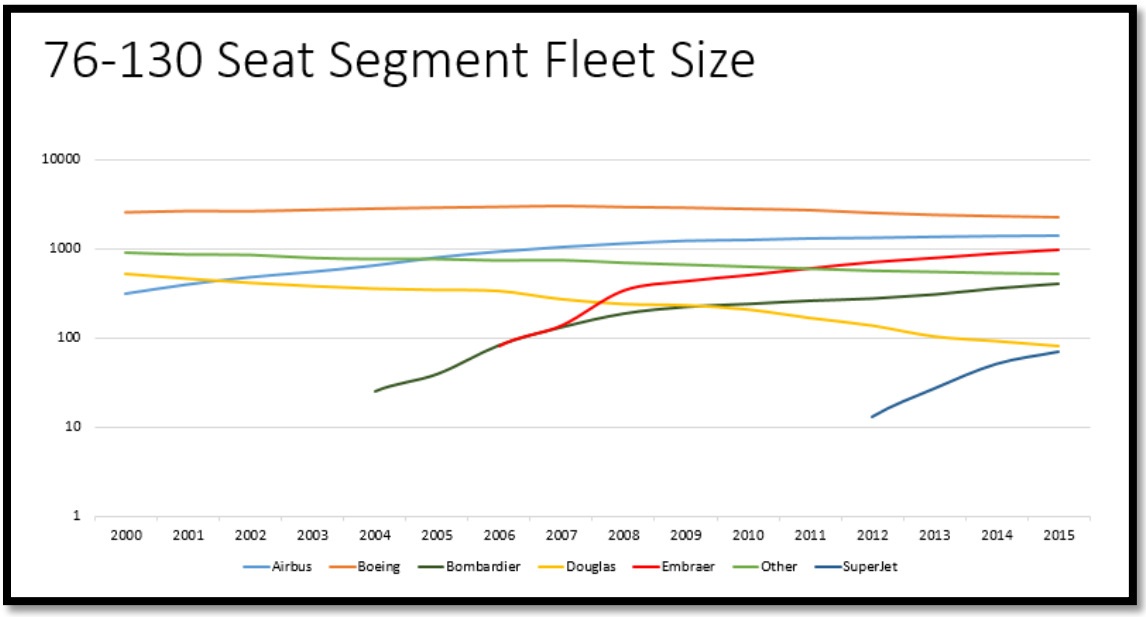
Looking at the E-190, we note that the primary market Latin America (Brazil and Azul being the leader) and Asia/Pacific accounting for nearly half the fleet (46%). The E-190 is also popular in Europe (19%) and the US (18%). The E-195 is most popular in Europe and Latin America which account for 92% of the market.

In the key markets of Europe, North America and Asia the E-Jet program has achieved a strong footprint. Given the penchant of airlines to be swayed by common flight deck arguments, as put forward by Airbus, Embraer's E2 should be a natural for most of these customers. Moreover, as we have seen with the Airbus and Boeing success with their new models, airlines are risk averse. The likelihood that E-Jet customers stick with Embraer and its E2 are high.

Popular platform with strong base

Embraer has acquired a strong customer base for the E-Jet program. One way to illustrate the impact Embraer has had on the market is shown in the next chart. The company entered the 76-130 seat market later than its main competitors. Yet, as we see, the company's products quickly attracted market attention. For example, although Embraer's primary competitor Bombardier had entered the market sooner, Embraer immediately matched them. Within two years Embraer passed Bombardier and has not looked back.

Figure 21 76-130 Seat Fleet Size



By 2011 Embraer had become the third biggest OEM in the segment. We used a logarithmic chart to illustrate that the growth in the Embraer fleet has been impressive. Airbus and Boeing are way ahead in fleet volume. But Airbus and Boeing are not offering competitive products.

The 76-130 seat segment is going to be dominated by Embraer and Bombardier. Since Embraer has the E-175 E2 which starts at 76 seats and offers the E-195 E2 at 130 seats, it offers market bookends. While Bombardier's CSeries will provide Embraer with strong competition, this will be between 100 and 130 seats.

Below 100 seats the E-175 E2 is likely to outsell the Bombardier CRJ which, in its current form, is dating. The biggest hurdle for the E-175 E2 is the US scope clause[11]. Should the scope clause weight limit be expanded, as we expect, to include the E2 and the Mitsubishi MRJ, the CRJ will face a daunting market. We therefore project Embraer to have a dominant position in this segment as the E2 program starts to deliver.

[11] The scope clause limits regional jets to under 86,000 pounds MTOW

VII. THREATS

Competition

Embraer faces some old foes and new competitors in the market. We will address these in order of aircraft size. This is a complicated issue. OEMs probably prefer to compare platforms rather than one aircraft against another. After all seating capacities vary. In the United states, for example, The E195-E2 would be regarded as comparable to the CS100 at Delta Air Lines and United Airlines. We decided to compare one aircraft against another regardless, because it is easier than dealing with each airline's unique requirements.

Mitsubishi MRJ

Competitor to: E-175 E2

Mitsubishi is a company with a long aviation heritage. The most famous aircraft Mitsubishi has built is the Zero, from the World War Two era. Since then Mitsubishi has been working on Boeing programs as a sub-contractor. Mitsubishi also built Hawker-Siddley HS748's under license.

Embraer faces off against a clean sheet design in the MRJ, Mitsubishi's first aircraft in over fifty years. The MRJ seats between 70 and 90. Like the E2, the MRJ is powered by the Pratt & Whitney GTF. The MRJ was the first program to select this engine.

However, Mitsubishi has discovered that a modern aircraft is a complex machine. The program has run into frequent delays. The company presented its cabin mockup at the Paris Air Show in 2007. First flight was planned for 2012, but it only occurred in 2015. First delivery was set for 2012, and that has slipped too. The ferry flight for flight testing in Moses Lake, Washington suffered faults two days in a row and had to return to Nagoya.

The MRJ is not a major threat to the E2[12]. Moreover, a lack of a comprehensive customer support usually impacts the direct maintenance costs (DMC) by 1% to 5%. It is expected that MRJ will be affected by such conditions and its airframe DMC could be at least 2% higher than E175-E2, and account for an 11% airframe DMC difference. Whereas Embraer has a fleet of E-170s and E-175s numbering 225 aircraft, Mitsubishi has no customers with aircraft yet. Embraer has a natural base for replacement. Embraer has a record of excellent service and product support dating back to 2004. Mitsubishi has none of this. It has a good looking aircraft. It has very strong financial backing. Of the advantages the MRJ has compared to the E2, only the Mitsubishi financial muscle is an issue. The market will not be won over by the MRJ easily. The MRJ program has struggled with few orders, reflecting the program risk.

[12] The MRJ compared to the E175 E2 has a fuselage with 8% more wetted area; the wing has more 7% wetted area and the empennage has more 5% wetted area and the E175-E2 has an 8% higher aspect ratio wing. Embraer has 15 million flight hours on the E-Jet design. Mitsubishi is at the start of this journey.

Sukhoi Superjet

Competitor to: E-175 E2

The Superjet (SSJ) is it scaled in the industry offers an interesting option for the segment it serves. The SSJ seats 98 in a two class layout. This makes it slightly larger than the E-175 E2 and close to the E-190 E2.

But we suspect the E-175 E2 customers are the principal targets for the SSJ sales team. The SSJ consists of an airframe from Sukhoi Design Bureau in Russia. Sukhoi is also the source for the superb Sukhoi fighter range. The SSJ heritage is therefore credible. The avionics comes from Esterline (Canada) and Thales (France). Engines come from a partnership between Safran (France) and NPO Saturn (Russia). The cabin is installed at SuperJet International in Venice, Italy and comes from Italian design house, Pinifarina.

This makes the SSJ essentially an option with the excellent inputs and offered at a compelling price point. Airlines and lessors are bottom fishers, and price is a major issue. We understand that the SSJ pricing ranges from $30m to $35m. This is aggressive. The SSJ has had some success with western airlines. The western launch customer was Mexico's InterJet. Recently Ireland based CityJet took delivery of its first aircraft. SSJ improvements are coming in the form of steep approach landing capabilities for London City (needed by CityJet) as well as fuel burn saving winglets (from Sukhoi).

Western airlines have typically avoided Russian aircraft. Even though sanctions on Russia now do not apply to aerospace, the SSJ is a tough sell. That said, SJJ has had some success. A recent series of orders in Asia and Egypt have helped. There is talk of strong interest from Iran. Embraer has to watch the SSJ as a threat – but it is not a major threat. The E2 is a generation newer, with a better wing and better engines. In addition, the E2 fly by wire system will be more advanced as well.

One final note, Sukhoi and SuperJet have announced their intent to stretch the current aircraft to 120 seats. Since this aircraft has no announced details, we have not taken it into account. However, it will clearly be a threat to Embraer if and when it emerges.

Bombardier

Competitor to: E-175 E2; E-190 E2 and E-195 E2

Clearly the biggest threats to the E2 program from Bombardier, which has competing products across the full E-Jet range. We will deal with each model.

E-175 E2 vs CRJ – here the competitor is the CRJ900. The E-175 has gotten most attention from US-based airlines. The E-Jet has outsold the CRJ. The Embraer has a substantially more attractive cabin. The E-175 and CRJ900 fall within the US scope clause. But the E2 version does not. (nor does the MRJ) our conversations with US pilot unions suggest they will not entertain any growth in scope clause for the next few years. This suits Embraer as they plan entry into service of the E-175 E2 in 2020. Embraer has stated they will continue to offer and build the E-175 as long as customers order it. Fortunately for Embraer, Bombardier has a product that is dating fast and Bombardier does not have the resources to develop a replacement. Time is on Embraer's side and the threat from the CRJ is limited.

E-190 E2 vs CS100 – this segment is much tougher as the CS100 is a clean sheet design. Air Canada sold its E-190s to Boeing, which then had a deal with Delta Air Lines to resell them. Delta selected the CS100 and refused to take the E-190s. The E-190 is the most popular E-Jet and is so well defined that Embraer's customers asked that the E2 version not be changed dimensionally. The E-190 is simply exactly the size customers want. Of the E2 orders, the E-190 and E-195 versions have the most orders (172 out of 272). The E-190 E2 has six[13] customer orders as of 2Q16, including Farnborough announcements. Embraer has a large customer base (540) that offer natural replacements. The CS100 is a manifest threat, and Embraer takes it seriously, the E-190 E2 is a compelling offering. As the economics show, Embraer can largely match the CS100. The CS100, being larger, has more range. For some airlines this is a deciding point. The CS100 is the greatest threat to the E-190 E2. But Embraer has the better history in this segment (the CRJ1000 has not done well) and should at least win 50% if not more of this segment. The 2Q16 segment (100-130 seats) accounts for 3,283 aircraft – plenty for both Embraer and Bombardier to fight over.

E-195 E2 vs CS300 – this segment is the top end for Embraer. The company is at pains to point out that it does not intend to compete with Airbus and Boeing. Bombardier, on the other hand, is out to attract A319 and 737-700 customers. This is helpful to Embraer as it is more focused on the segment. Bombardier is also eager for any wins in this segment, but it views this segment (~130 seats) as a stepping stone to 150 seats. For Bombardier the recent win at Delta Air Lines exactly fits this strategy. As mentioned, the segment is large and we see enough business for both Embraer and Bombardier to do profitable business as Airbus and Boeing exit this segment. Embraer clearly has to see the CS100/300 as the greatest threats. But Embraer has a distinct advantage – it has 1,150 aircraft in the segment in service. This is new turf for Bombardier which has to buy its way in. Even though Bombardier is the threat, Embraer's E2s match the essential economics of the C Series. It has less to prove and has to focus on delivering on spec and on time to keep its hold on its customer base. Given the E2 flight test program to date, Embraer understands this issue and is delivering exactly what its customers want.

Airbus A319neo

Competitor to: E-195 E2

Airbus' A310 is a shrink from the baseline A320. The A320 family has been a roaring success for Airbus. But this success has clearly been A320 focused so far, and in the neo versions, the A321neo is rapidly catching up. But the A319neo is floundering.

The A319neo is going to be built, according to Airbus' Kiran Rao[14], because it is the airframe for the Airbus ACJ. It also offers current Airbus customers special performance needed for Himalaya service. While this sounds plausible, it is also a rather weak response. Airbus' A319 customers have not flocked to the A319neo as A320 customers flocked to the A320neo. That is all that really one needs to know. The A319neo, for example, is 12,000 pounds heavier than the CS300. The CS300 offers better core economics than the A319neo. Similarly, the E-195 E2 is going to a better aircraft in the sub-130 seat segment.

The E-195 E2 is able to watch the fight between Airbus and Bombardier and avoid the blows. Airbus does not see the E-Jets program growing beyond 130 seats and is therefore not a manifest threat. The E-195

[13] Plus, one more undisclosed customer

[14] In answer to our question at the Airbus Innovation Days 2016 in Hamburg, Germany

program has a 2Q16 fleet of 148. This is dwarfed by the 540 E-190s in service. But the E-195 E2 offers customers a natural replacement with considerably better performance. It is, in short, an ideal growth aircraft for E-190 customers who want more capabilities. Embraer is essentially offering its E-190 customers the optimal growth aircraft.

Boeing 737 MAX 7

Competitor to: E-195 E2

Like Airbus' neo, Boeing's MAX program is an attempt to maintain its single aisle product line with a re-engine option to keep development costs low and stay current. The MAX line has attracted many orders, and there is a similarity to the Airbus experience.

Customers for the smaller 737-700 have not flocked to the 737 MAX 7. But 737-800 customers have jumped on the 737 MAX 8. Like Airbus, Boeing is leaving the sub-130 seat segment. Indeed, one could argue that Boeing has even left the sub-150 seat markets as they 737 MAX 8 seats 162.

Boeing has fumbled the MAX program at the low end. The MAX 7 now has grown to 150 seats to match the A320neo. This decision was endorsed by its most critical 737-customer, Southwest Airlines. But the mere fact that Boeing is still trying to define the MAX 7 this late in the program shows internal struggles trying to catch the Airbus neo program. Boeing is also struggling with the MAX 9 and discussing a MAX 10. Boeing has fallen behind Airbus, and its focus is clearly on Airbus.

Anything it does to match and beat Boeing that also happens to stymie Bombardier is a happy accident. Note, we do not see Embraer even appearing on Boeing's threat radar. Embraer can successfully hide in Bombardier's shadow. The E-190/195 E2 program is no threat to Boeing's MAX program. Embraer can go about its business and pitch its E2 program without any fear from Boeing.

VIII. COMPARATIVE ECONOMICS

The E-2 Jets compete in two different market segments, with the E2-175 competing primarily against the Canadair Regional Jet, Sukhoi Superjet and Mitsubishi Regional Jet under 100 seats, while the larger E2-190 and E2-195 compete primarily with the Bombardier CSeries, the Airbus A319ceo and A319neo, and Boeing 737-700 and MAX7 between 100-150 seats. We have also included models from COMAC, Irkut and Antonov to provide a complete marketplace comparison.

Economics: Embraer Maintains Competitiveness

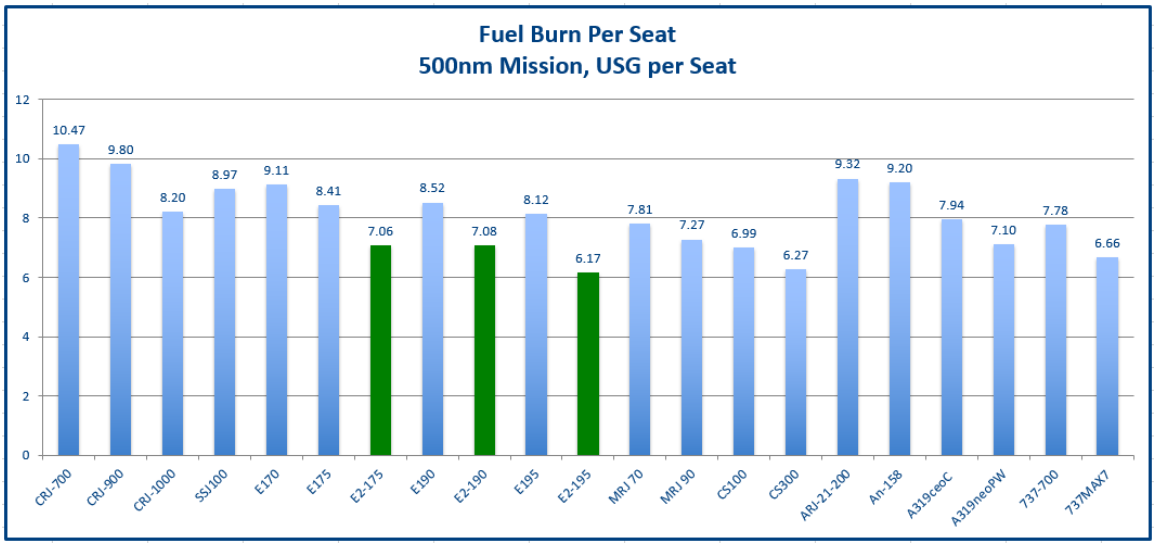
Embraer faces both new design and re-engined competition across its product line. The E2-175 faces older technology CRJ models from Bombardier as well as newly designed aircraft from Mitsubishi and Sukhoi. The E2-190 and 195 compete against the new technology Bombardier C Series, as well as against re-engined models from Airbus and Boeing. Even against new competition, the E2Jets maintain low costs per seat mile in each of their segments, matching both the new technology competitors from MRJ and C Series and the re-engined models of similar size from Airbus and Boeing, while offering lower aircraft mile costs.

The Bombardier CSeries, Mitsubishi Regional Jet, and Sukhoi Superjet are all new aircraft competitors that have either been recently introduced or, in the case of the MRJ, is still under development. These aircraft, designed specifically and optimized for their size, are more competitive than the larger models from Boeing and Airbus that are not optimized for this market and are too heavy to effectively compete.

Airbus and Boeing have each re-engined legacy aircraft of older design, with the 737 dating back to 1967 and the A320 to 1989. The E-Jets were introduced in 2004, and remain a modern design. Embraer has an advantage in that it has taken a well proven recent design, optimized its wing and aerodynamics to accommodate the new-technology GTF engine, and produced an aircraft that is equal to its new technology competition in terms of economics and fuel efficiency. Embraer combines the benefit of a more mature airframe and systems from day one with new technology engines and aerodynamics.

The following chart illustrates how the E2Jets compare against new technology aircraft in that regard on a 500nm trip using European rules for navigation and landing fees. The E2 jets, shown in green, are favorably positioned against their competition, with only the larger Bombardier CS300 having a lower fuel burn per seat. Even the larger 737MAX7, with 12 additional seats, cannot match the E2-195 in this measure of efficiency.

Figure 22 Fuel Burn per Seat 500NM



The Pratt & Whitney GTF engine is utilized by the E2Jets, MRJ, C Series, and A320neo. As a result, we would expect fuel burn for each of these aircraft to be nearly equivalent, with differences stemming from weight and aerodynamic efficiency. The A320 and C Series were designed to be transcontinental aircraft, and carry the associated structural weight to handle the additional fuel loads required. The E2 and MRJ are medium range aircraft, and their lighter weight improves fuel burn.

The E2 series features different wing designs for each model, each optimizing aerodynamic performance for the airframe/engine combination. While it is somewhat unusual for an aircraft family to have three different wings, the individual wing designs enhance performance and provide optimized fuel efficiency.

Comparative Economics

The E2-jets perform quite favorably against both re-engined and new technology competitors. In this section, we will detail the economic differences between aircraft in a head to head comparison based on data using the same set of assumptions provided by each manufacturer.

Operating economics are one of the most compelling features of the E2, which incorporates new technology engines and new wings with a proven airframe and systems. The result is an aircraft that is competitive with all-new aircraft while offering low maintenance costs through proven systems and components.

The E2 features an advanced aircraft health management system, expanding on the system from the E-Jet with additional data and functionality. This system will enable airlines to monitor components in real-time and dispatch components for maintenance while the aircraft is still enroute to a destination to reduce delays and cancellations, a major expense for airlines. Embraer's AHEAD-PRO system and technology is quite advanced and an industry leader in its sophistication.

The result of blending a proven airframe and systems with new technology engines and an optimized wing delivers performance comparable to all new aircraft with the reliability of a mature aircraft.

New technology engines, including the Pratt & Whitney PW1000G geared turbofan and CFM International LEAP are providing a significant improvement in fuel consumption over the last generation of engines. These engines have improved performance while keeping maintenance costs at or below levels for the engines they replaced.

For the E2 jets, the net gain from new technology engines is about 11%, with an additional 3.5% from wing and aerodynamic improvements and an additional 1.5% from a 4th generation fly-by-wire system.

Operating economics for the E2 jets are substantially better on a per seat basis than the E-jets they replace. The E2-175 and E2-190 have a 16% improvement in fuel burn per seat, while the E2-195, with its three row stretch, has a 24% improvement over the E-195.

Overall Economics

The E2-Jets compare quite favorably with both existing and new technology aircraft. In the under 100 seat class, the E2-175 has economics that are nearly equal to the all-new Mitsubishi Regional Jet while providing the reliability of a proven airframe and systems.

The table below compares cost per aircraft and seat-mile for a 500nm mission for aircraft under 100 seats.

Figure 23 Comparative Economics Aircraft Under 100 Seats

Comparative Operating Economics		
Aircraft Under 100 Seats		
500 nm mission		
Aircraft Model	**Cost per Aircraft Mile**	**Cost per Seat Mile**
CRJ-700	$6.74	$0.10208
CRJ-900	$7.34	$0.09658
CRJ-1000	$7.84	$0.08162
E170	$7.01	$0.10016
E175	$7.31	$0.09373
E2-175	$6.84	$0.08546
MRJ 70	$6.45	$0.09349
MRJ 90	$6.96	$0.08598
SSJ 100	$8.08	$0.09287
ARJ-21	$7.71	$0.09880
An-158	$8.03	$0.09340

The table below compares cost per aircraft mile and cost per seat mile for aircraft between 100-162 seats for a 500nm mission. Once again, the E2 jets are competitive not only with new technology aircraft from Bombardier, but also with much larger models from Boeing and Airbus on a cost-per-seat-mile basis, while being much lower on a cost per aircraft mile basis. The economics enable an airline to "right-size" aircraft to routes with new models from Embraer offering similar seat-mile costs, enabling them to reduce risks without penalty.

Figure 24 Comparative Economics Aircraft Over 100 Seats

Comparative Operating Economics		
Aircraft over 100 Seats		
500 nm mission		
Aircraft Model	**Cost per Aircraft Mile**	**Cost per Seat Mile**
E190	$8.74	$0.08914
E2-190	$8.14	$0.08308
E195	$8.86	$0.08362
E2-195	$8.35	$0.06962
CS100	$8.53	$0.07901
CS300	$9.05	$0.06963
A319CFM	$10.72	$0.08643
A319neoPW	$10.03	$0.08085
737-700	$10.71	$0.08500
737MAX7	$10.65	$0.07721
A320CFM	$11.57	$0.07711
A320neoPW	$10.78	$0.07188
737-800	$11.90	$0.07343
737MAX8	$11.52	$0.07111

The E2 models are highly competitive economically with the all new Bombardier CSeries while bringing the benefits of a proven airframe, proven systems, and the experience of more than 1,200 E-Jets delivered.

Fuel Consumption

While fuel consumption is not the driving force it once was when fuel prices were in excess of $100 per barrel, fuel use remains a key consideration in the economics of a new aircraft. The following table estimates fuel usage for the E2-Jets and competing aircraft for 500, 1,000, and 1,500 nautical mile missions as shown in the table below.

Figure 25 Fuel Consumption

Fuel Consumption Comparison			
US Gallons per Mission			
Aircraft	**500nm**	**1,000nm**	**1,500nm**
CRJ-700	691	1,219	NA
CRJ-900	745	1,319	NA
CRJ-1000	787	1,394	NA
SSJ100	781	1,422	1,955
E170	638	1,159	1,678
E175	656	1,192	1,727
E175-E2	565	1,077	1,589
E190	834	1,467	2,133
E190-E2	694	1,227	1,788
E195	861	1,519	2,218
E195-E2	740	1,328	1,929
MRJ 70	539	1,070	1,575
MRJ 90	589	1,122	1,633
CS100	754	1,399	2,017
CS300	815	1,492	2,161
ARJ-21-200	727	1,263	1,864
An-158	791	1,445	1,970
A319ceoC	985	1,747	2,543
A319neoPW	880	1,560	2,263
737-700	980	1,733	2,521
737MAX7	920	1,612	2,346
A320ceo C	1,048	1,859	2,707
A320neoPW	898	1,593	2,310
737-800	1,106	1,955	2,845
737MAX8	975	1,732	2,450

The E2-195 and CS300 models have a substantial lead over the comparably sized A319ceo, A319neo and 737-700 and MAX7 models from Airbus and Boeing, and as one would expect. They are more fuel efficient than the larger A320 and 737 models. On a fuel per seat basis, the aircraft from Embraer and Bombardier are competitive with larger models from Airbus and Boeing.

Embraer's successful evolution of the E-Jet to the E2 variant provides superior competition to the Airbus A319 in the sub-130 seat segment, and was one of the factors causing Boeing to increase the seating capacity of the 737MAX7 to improve seat-mile economics and better compete with the E2-195 and CS300.

Maintenance Cost

The E2-Jets will enter service with mature airframe and component costs that are already down the learning curve from the E-Jets, and combine them with the lower maintenance costs expected from new technology engines and an advanced aircraft health monitoring system.

The following table shows estimated maintenance costs per mission for competing aircraft.

Figure 26 Maintenance Cost

Maintenance Cost			
US Dollars per Mission			
Aircraft	**500nm**	**1,000nm**	**1,500nm**
CRJ-700	$607.29	$832.34	NA
CRJ-900	$637.65	$873.96	NA
CRJ-1000	$747.09	$1,081.83	NA
SSJ100	$769.10	$1,207.70	$1,620.30
E170	$764.01	$1,128.01	$1,494.18
E175	$772.23	$1,128.01	$1,494.18
E175-E2	$656.40	$958.81	$1,270.05
E190	$808.00	$1,188.00	$1,586.00
E190-E2	$727.20	$1,069.20	$1,427.40
E195	$812.00	$1,188.00	$1,586.00
E195-E2	$730.80	$1,069.20	$1,431.00
MRJ 70	$649.14	$898.99	$1,415.66
MRJ 90	$683.16	$958.92	$1,389.16
CS100	$758.65	$1,135.70	$1,521.09
CS300	$791.74	$1,185.24	$1,587.44
ARJ-21-200	$770.22	$1,405.00	$1,675.00
An-158	$808.15	$1,485.00	$1,725.33
A319ceoC	$1,147.10	$1,504.39	$1,880.49
A319neoPW	$1,009.00	$1,357.97	$1,696.12
737-700	$1,227.00	$1,622.00	$2,038.00
737MAX7	$1,289.00	$1,674.33	$2,055.58
A320ceo C	$1,220.00	$1,599.88	$1,998.56
A320neoPW	$1,115.87	$1,501.97	$1,875.99
737-800	$1,254.76	$1,658.67	$2,083.90
737MAX8	$1,285.39	$1,684.00	$2,067.46

Crew Cost

Our crew cost analyses are based upon block times for each aircraft on routes of 500, 1,000 and 1,500 nautical miles. Our cost assumptions vary by aircraft size, with costs for a Captain and First Officer estimated at $325 per block hour for aircraft under 85 seats, $375 per block hour for aircraft between 85-105 seats, $425 per hour for aircraft between 106-140 seats, and $500 per block hour for aircraft greater than $140 seats.

Costs for flight attendants were computed using $45 per block hour and were calculated using the FAA rules of one flight attendant per 50 passengers or fraction thereof. While costs vary by airline, utilizing the same assumptions provides an "apples to apples" comparison for our purposes. The following table summarizes our crew costs for 500, 1,000, and 1,500nm missions:

Figure 27 Crew Costs

Crew Cost			
US Dollars per Mission			
Aircraft	**500nm**	**1,000nm**	**1,500nm**
CRJ-900	$716.10	$1,104.59	NA
CRJ-1000	$719.20	$1,243.10	NA
SSJ100	$712.23	$1,241.55	$1,759.25
E170	$636.33	$1,099.75	$1,570.08
E175	$713.00	$1,099.75	$1,570.08
E175-E2	$713.00	$1,099.75	$1,570.08
E190	$858.67	$1,351.50	$1,929.50
E190-E2	$858.67	$1,351.50	$1,929.50
E195	$858.67	$1,493.33	$2,118.67
E195-E2	$868.00	$1,493.33	$2,118.67
MRJ 70	$643.25	$1,106.67	$1,570.08
MRJ 90	$725.55	$1,106.67	$1,570.08
CS100	$868.00	$1,493.33	$2,118.67
CS300	$873.60	$1,495.20	$2,122.40
ARJ-21-200	$722.30	$1,240.00	$1,577.00
A319ceoCFM	$869.87	$1,485.87	$2,118.67
A319neoPW	$869.87	$1,485.87	$2,118.67
737-700	$869.87	$1,485.87	$2,118.67
737MAX7	$869.87	$1,485.87	$2,118.67
A320ceo C	$1,056.27	$1,684.87	$2,402.42
A320neoPW	$1,056.27	$1,804.27	$2,572.67
737-800	$1,056.27	$1,804.27	$2,572.67
737MAX8	$1,056.27	$1,804.27	$2,572.67

Landing and Navigation Fees

The US and Europe differ substantially in terms of fees. European airlines pay additional fees for navigation and environmental compliance, in addition to the landing and terminal fees typically paid in the US, where navigation fees are not charged.

For landing and terminal fees, we utilized an average rate of $4.50 per thousand pounds of Maximum Take Off Weight for both US and European airports. For navigation fees, we utilized the standard Eurocontrol formula, using a rate of €50. Our estimates for landing fees and navigation fees are shown in the table below.

Figure 28 Landing & Navigation Fees by Aircraft

Landing Fees	
US Dollars per Mission	
Aircraft	Fee
CRJ-700	$ 327.38
CRJ-900	$ 380.25
CRJ-1000	$ 413.10
SSJ100	$ 490.59
E170	$ 382.95
E175	$ 400.50
E175-E2	$ 439.79
E190	$ 513.90
E190-E2	$ 557.54
E195	$ 518.76
E195-E2	$ 557.54
MRJ 70	$ 398.82
MRJ 90	$ 424.61
CS100	$ 580.50
CS300	$ 648.00
ARJ-21-200	$ 431.55
A319ceoC	$ 747.00
A319neoPW	$ 748.80
737-700	$ 695.25
737MAX7	$ 717.30
A320ceo C	$ 774.00
A320neoPW	$ 783.00
737-800	$ 783.90
737MAX8	$ 815.40

Navigation Fees			
US Dollars per Mission - Eurocontrol Formula			
Aircraft	500nm	1,000nm	1,500nm
CRJ-700	$413.56	$845.78	NA
CRJ-900	$445.70	$911.53	NA
CRJ-1000	$464.56	$950.09	NA
SSJ100	$506.25	$1,035.36	$1,564.47
E170	$447.28	$914.76	$1,382.23
E175	$457.42	$935.48	$1,413.55
E175-E2	$479.33	$980.29	$1,481.26
E190	$518.14	$1,059.67	$1,601.21
E190-E2	$539.70	$1,103.76	$1,667.82
E195	$520.59	$1,064.68	$1,608.77
E195-E2	$539.70	$1,103.76	$1,667.82
MRJ 70	$456.45	$933.52	$1,410.58
MRJ 90	$470.98	$963.23	$1,455.48
CS100	$550.70	$1,126.25	$1,701.81
CS300	$581.83	$1,189.93	$1,798.03
ARJ-21-200	$474.82	$971.07	$1,467.32
A319ceoC	$624.70	$1,277.60	$1,930.50
A319neoPW	$625.45	$1,279.14	$1,932.83
737-700	$602.67	$1,232.55	$1,862.43
737MAX7	$612.15	$1,251.95	$1,891.74
A320ceo C	$635.89	$1,300.49	$1,965.08
A320neoPW	$639.58	$1,308.03	$1,976.48
737-800	$639.94	$1,308.78	$1,977.61
737MAX8	$652.67	$1,334.81	$2,016.95

Adding landing and navigation fees, the total cost for each mission are as follows.

Figure 29 Landing & Navigation Fees per Mission

Landing and Navigation Fees			
US Dollars per Mission			
Aircraft	500nm	1,000nm	1,500nm
CRJ-700	$740.93	$1,173.16	NA
CRJ-900	$825.95	$1,291.78	NA
CRJ-1000	$877.66	$1,363.19	NA
SSJ100	$996.84	$1,525.95	$2,055.06
E170	$830.23	$1,297.71	$1,765.18
E175	$857.92	$1,335.98	$1,814.05
E175-E2	$919.11	$1,420.08	$1,921.04
E190	$1,032.04	$1,573.57	$2,115.10
E190-E2	$1,097.24	$1,661.30	$2,225.36
E195	$1,039.35	$1,583.44	$2,127.53
E195-E2	$1,097.24	$1,661.30	$2,225.36
MRJ 70	$855.27	$1,332.33	$1,809.40
MRJ 90	$895.60	$1,387.84	$1,880.09
CS100	$1,131.20	$1,706.75	$2,282.31
CS300	$1,229.83	$1,837.93	$2,446.03
ARJ-21-200	$906.37	$1,402.62	$1,898.87
A319ceoC	$1,371.70	$2,024.60	$2,677.50
A319neoPW	$1,374.25	$2,027.94	$2,681.63
737-700	$1,297.92	$1,927.80	$2,557.68
737MAX7	$1,329.45	$1,969.25	$2,609.04
A320ceo C	$1,409.89	$2,074.49	$2,739.08
A320neoPW	$1,422.58	$2,091.03	$2,759.48
737-800	$1,423.84	$2,092.68	$2,761.51
737MAX8	$1,468.07	$2,150.21	$2,832.35

Overall Economic Comparisons

Adding fuel, maintenance, crew, landing and navigation fees, we developed an overall operating economic comparison for the regional and small mainline aircraft with which the E2 Jets compete.

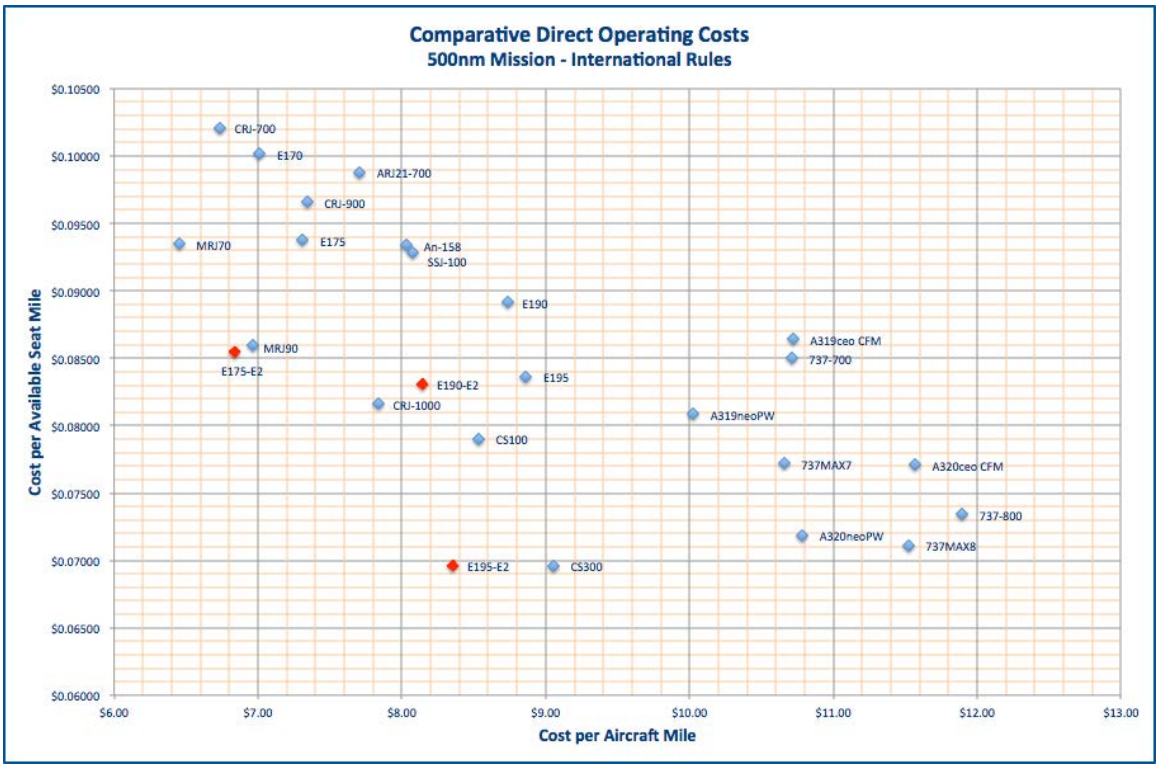
Our comparative analyses are shown for US operations, in which only landing and terminal fees are included. For a European comparison, the data per 500nm can be multiplied for 1,000 and 1,500nm missions to reflect the higher rates.

Conclusion

The economics of the E2-Jets are quite competitive. Along with the CSeries from Bombardier and MRJ from Mitsubishi, these aircraft provide class-leading economic performance.

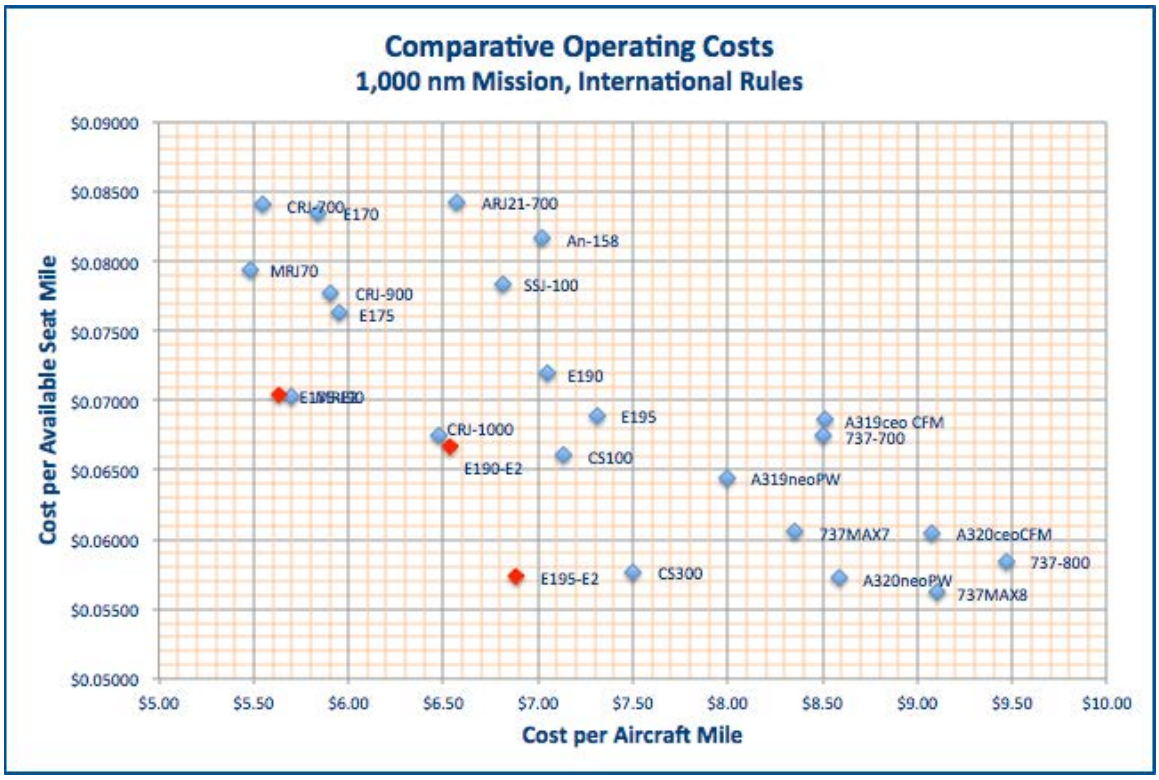
The following chart compares the E2 Jet series against competing aircraft, both regional and narrow-body for a 500nm mission. The competitiveness of the E-Jets with larger aircraft, enabling airlines to right-size operations without paying an economic penalty, is quite apparent.

Figure 30 Comparative Direct Operating Costs - 500NM



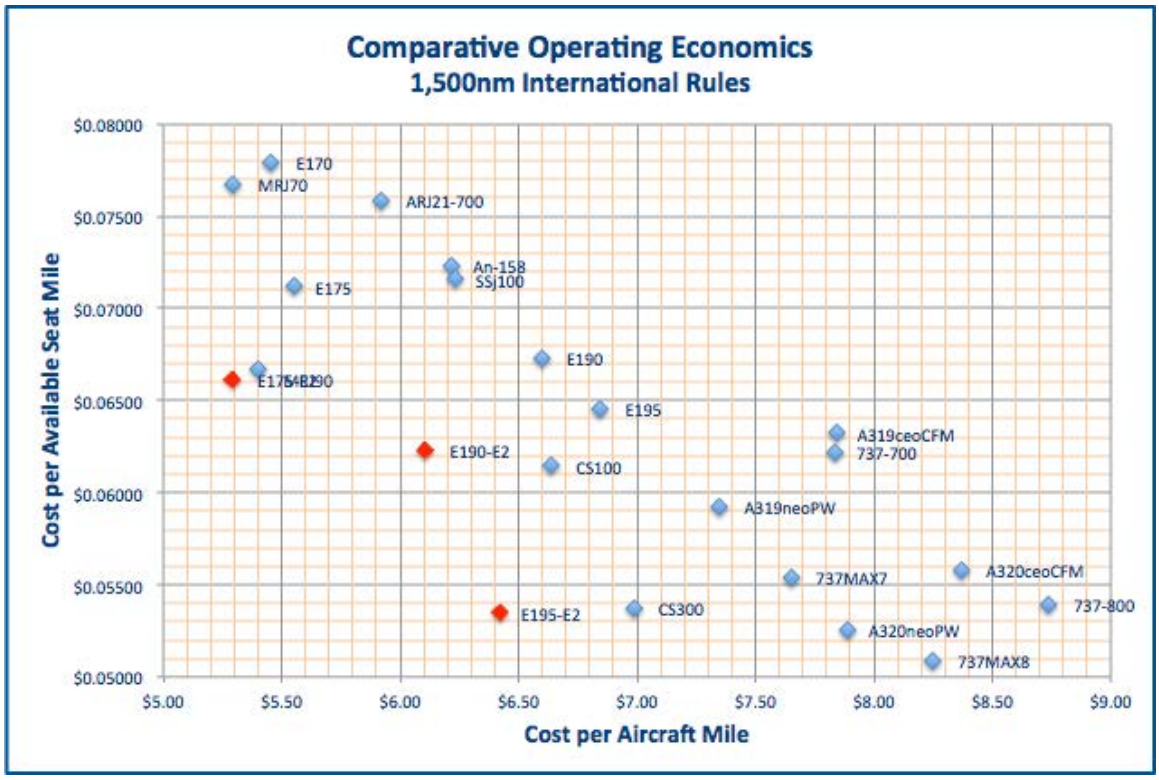
Similarly, for a 1,000nm mission, the E2 Jets also fare well against new technology and larger competitors. With the advantage of a proven airframe and maintenance costs, the E2-Jets are a low risk alternative to new technology aircraft from Bombardier and Mitsubishi.

Figure 31 Comparative Operating Costs - 1,000NM



For a 1,500nm route, some competitors for the E2-175, including the Bombardier CRJ series, cannot fly that range. This provides an advantage in flexibility for the E2-175, as shown in the following chart.

Figure 32 Comparative Operating Costs - 1,500NM



The operating economics of the E2-Jets provide a substantial improvement over those of the base E-Jets and are competitive on a seat-mile basis with larger aircraft from Airbus and Boeing. This will enable airlines to "right-size" their operations without compromising economics and yields, a compelling value-proposition.

IX. PROGRAM OUTLOOK AND CONCLUSIONS

The E2 models from Embraer are well positioned in their market segments, and should be commercially successful. The market for "right-sized" aircraft is returning, especially with low fuel prices predicted for the foreseeable future. With air travel doubling every 15 years, demand for replacement and growth in this segment is substantial.

Market Forecasts and the Potential Market

The major aircraft OEMs have each prepared forecasts of the market. Airbus forecasts narrow-body aircraft that are 100 seats or greater in size, which includes the market for the E190-E2 and E195-E2. Their forecast calls for 23,530 aircraft over the next 20 years, with the majority in the 150-200 seats range. Boeing forecasts 2,380 regional jet deliveries over the next 20 years, and 28,140 narrow-bodies between 100 and 200 seats. Bombardier forecasts 5,700 deliveries between 60-100 seats, including both jets and turboprops, over the next 20 years, and 7,000 deliveries between 100-150 seats for that same period. Embraer forecasts demand for 2,300 regional jets between 70-90 seats and 4,100 jets between 90-130 seats over the next 20 years. Embraer also forecasts demand for 2,040 turboprops between 70-90 seats.

A comparison of the forecasts is shown below.

Figure 33 Market Forecast

Market Forecast Comparison																
Number of Seats	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
Airbus								23,530								
Boeing		2,380						28,140								
Bombardier		5,700					7,000									
Embraer		2,300			4,100											

AirInsight developed its own projections for these markets, and projects 2,400 regional jets between 60-100 seats, 3,900 jets between 100-130 seats, and 23,900 narrow-body jets above 150 seats over the next 20 years.

The 70-100 Seat Market

The market for regional aircraft between 70-100 seats will be shared by turboprops and jets, on roughly a 40%/60% split. We expect 2,400 regional jets will be sold in this market between five competitors: Bombardier CRJ series, COMAC ARJ-21, Superjet, MRJ and E-175 and E-175 E2.

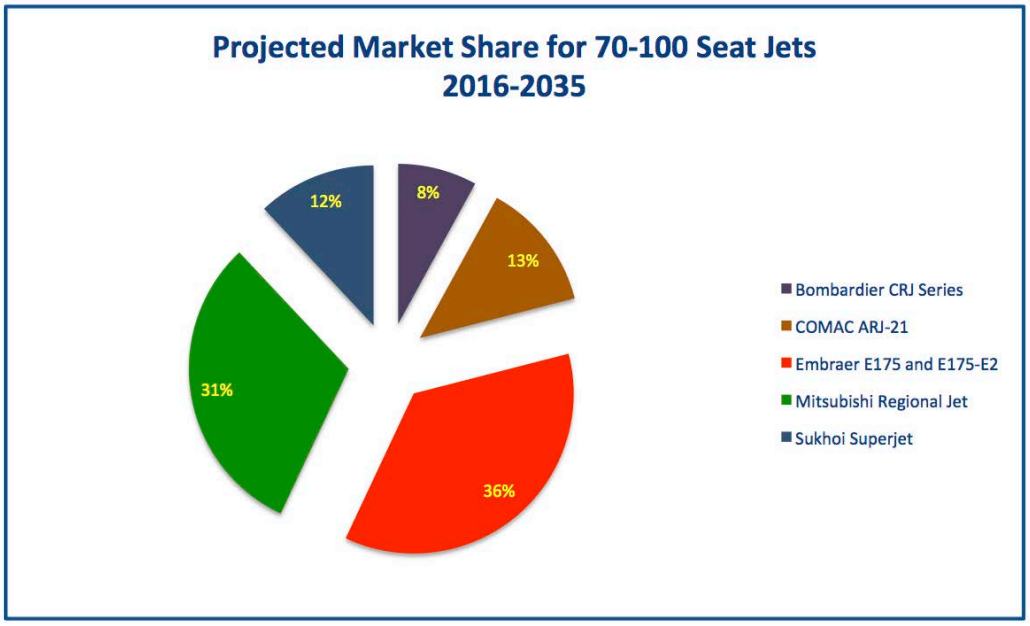
We believe that the COMAC ARJ-21 will only be successful in China, and despite western components, the Superjet will have limited penetration in markets outside Russia and the CIS. Bombardier's CRJ series is older technology that will be made obsolete by the new MRJ and E-175 E2, which are the two airplanes we expect to take the lion's share of this segment. The following table shows the AirInsight forecast for deliveries in the 70-100 seat market from 2016-2035.

Figure 34 Projected Deliveries 70-100 Seats

Projected Deliveries 2016-2035		
70-100 Seat Jets		
Aircraft	*Deliveries*	*Market Share*
Bombardier CRJ Series	192	8%
COMAC ARJ-21	312	13%
Embraer E175 and E175-E2	864	36%
Mitsubishi Regional Jet	744	31%
Sukhoi Superjet	288	12%
Total	2,400	100%

AirInsight's forecast market share in the 70-100 seat jet category is shown in the following chart.

Figure 35 Projected Market Share 70-100 Seats



The 100-130 Seats Market

Figure 36 Projected Deliveries 100-130 Seats

Projected Deliveries 2016-2035		
100-130 Seat Jets		
Aircraft	*Deliveries*	*Market Share*
Airbus A319ceo/neo	108	3%
Bombardier C Series	1,763	45%
Embraer E190/E2 and E195/E2	1,907	49%
Boeing 737-700 and MAX 7	122	3%
TOTAL	3,900	100%

Projected Orders and Market Share

Embraer competes in the 70-130 seat market segments. Our forecast is that this market will account for 6,300 deliveries, and that Embraer will maintain a leadership market share position in this segment, as shown in the table below.

Figure 37 Projected Deliveries 70-130 Seats

Projected Deliveries 2016-2035		
70-130 Seat Jets		
Manufacturer	*Deliveries*	*Market Share*
Airbus	108	2%
Boeing	122	2%
Bombardier	1955	31%
COMAC	312	5%
Embraer	2771	44%
Mitsubishi	744	12%
Sukhoi	288	5%
Total	6300	100%

Strong Likelihood for Success

With a proven airframe, a strong customer base operating some 990 E-Jets today, new engine technology and strong economics, the E2 from Embraer should continue the success of their predecessors. We project sales of more than 2,700 E2 over the next 20 years, which would make it the third most successful program after the A320neo and Boeing 737 MAX families.

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