HARVARD | BUSINESS | SCHOOL

9-522-084

REV: SEPTEMBER 27, 2022

NAVID MOJIR
VINCENT DESSAIN
METTE FUGLSANG HJORTSHOEJ
EMER MOLONEY

# Lilium: Preparing for Takeoff

*We believe in a world where anyone can fly anywhere, anytime. That world has never been closer.*

— Daniel Wiegand, Lilium Co-Founder & CEO

On a crisp fall day in November 2021, Daniel Wiegand, co-founder and CEO of air taxi start-up Lilium, took a moment to reflect on the company's eventful journey. While Wiegand's dream of air taxis could have been dismissed as mere science fiction just a few years earlier, in September 2021, Lilium had reached an important milestone by going public through a merger with special purpose acquisition company (SPAC) Qell Acquisition Corp. Since its initial seed investment in 2015, it had grown to a company of more than 750 employees and had raised over $826 million.[1] Investors were genuinely intrigued by the idea that Lilium might represent a fundamental change in how people would travel in the future.

Founded by Wiegand and three engineer friends from the Technical University of Munich (TUM), Lilium sought to revolutionize short-distance air travel by developing an electric Vertical Take-off and Landing (eVTOL) jet for a fleet of flying taxis that would be easy and affordable to book, like Uber.[2] Wiegand, a life-long aircraft enthusiast, who began piloting gliders at 14, firmly believed in his vision and was excited by the opportunities that Advanced Air Mobility (AAM) represented.[a] He visualized the year 2025, when people would jump into air taxis to travel to their destinations of choice, rising above urban road congestion. The AAM market held enormous potential and could become a $1.5 trillion market by 2040.[3] But as a nascent industry, Lilium was operating in an uncertain environment dependent on a series of assumptions on infrastructure, regulatory developments and AAM's public acceptance.

Lilium had already addressed a number of strategic choices that had dominated its boardroom discussions in the early years. Having tested two-seater and five-seater jets, it had placed its bet on a seven-seater aircraft, which was undergoing certification with regulatory authorities. Lilium's new jet, unveiled as part of its recent investor presentation, boasted a cruise speed of 175 mph at 10,000 feet

[a] Advanced Air Mobility (AAM) included both Urban Air Mobility (UAM) and Regional Air Mobility (RAM). While UAM was focused on air transportation in dense urban areas, RAM was usually focused on longer distance flights between nearby cities.

Professor Navid Mojir, Executive Director Vincent Dessain, Research Associate Mette Fuglsang Hjortshoej, and Senior Researcher Emer Moloney (Europe Research Center) prepared this case. It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

with a maximum range of 155 miles and used electric engines to reduce pollution and noise (see **Exhibit 1**).[4] Wiegand believed that certification was achievable by 2024. In parallel, the team was working on a 16-seater version to be launched in later years. Lilium had set out its stall to focus on the inter-city market (i.e., Regional Air Mobility, RAM). In 2021, Lilium announced launch networks in Germany, the United States and Brazil, with commercial operations projected to begin in 2024.

With jet certification now a question of when rather than if, the company was still grappling with where to position itself along the value chain; offering a turnkey enterprise solution by selling its jets and aftermarket services to airlines as an original equipment manufacturer (OEM) under a business-to-business (B2B) model, or, rather, operating a full-service air taxi fleet under a business-to-consumer (B2C) model. The OEM option would allow Lilium to book revenues immediately as orders came in from eager airlines, but would the company be at risk of commoditization further down the line? Sweetening the OEM prospect was strong interest from logistics players, whose deep pockets and efforts to differentiate themselves worked in Lilium's favor. However, the lure of the full-service model was strong; it would allow the company to control the entire customer experience and build an enduring brand around it. At the same time, it would be complex to pull off.

One by one, Lilium's main competitors had also begun to reveal their jet designs and the positions they intended to take. While Joby Aviation was planning to have a full-service air taxi operation in place by 2024, Vertical Aerospace had opted for a pure OEM model, having already secured pre-orders for up to 1,000 of its aircraft. For now, Lilium was hedging its bets with a hybrid approach, both selling jets as an OEM and operating a full-service air taxi fleet—a strategy also adopted by competitor Archer Aviation. But was this the best course of action? With a 16-seater jet potentially in the pipeline, should Lilium rethink its future strategy?

## The eVTOL Technology

The concept of vertical mobility went back to the fifteenth century, when Leonardo da Vinci sketched his design for an "aerial screw", a precursor to the helicopter.[5] VTOL had been around since the turn of the twentieth century in the form of helicopters and military aircraft, but they were expensive, noisy, and unsafe. People had been dreaming of "flying cars" since the 1950s but it was only in recent years, that the maturation of several key technologies—battery energy density, electric motors, sensors, control systems, simulation tools—made that dream a real possibility. Electrification meant that new eVTOL aircraft could be more silent, cost effective (low maintenance and production costs), safe (no single point of failure), and less polluting.

As on the ground, the limitation for electric aviation was primarily battery capacity.[6] In 2021, the strongest batteries available on the market packed 14 times less usable energy by weight than regular jet fuel. Given how much brute power was needed to propel an aircraft up in the air, it was a hurdle for all aspiring air taxi manufacturers to crack the code of developing battery packs with enough energy storage to fuel the eVTOLs with enough range and carrying capacity to make business sense, and to be safe enough for commercial use.[7] To date, tested battery technologies only allowed for shorter distances such as from city centers to the airport.[8]

There were also other technical challenges like increasing speed to reduce travel time, simplifying designs to lower the manufacturing and maintenance costs, and lowering noise emissions. For AAM to be possible in dense, heavily populated environments (i.e., UAM), aircrafts would need to emit socially acceptable levels of noise.[9] Engineers were experimenting with different designs; the objective was to achieve low enough noise levels that eVTOLs would effectively blend into background noise.[10]

Finally, before eVTOLs could operate in any country, they would need to receive airworthiness approval from aviation authorities. These regulations were in place to ensure that aircrafts complied with all safety standards.[11] Regulatory requirements were likely to differ across use cases depending on the perceived risks involved—an eVTOL concept for cargo transportation, for instance, would likely have less airworthiness requirements than for air taxis transporting humans.[12]

## AAM Infrastructure Needs

To offer sustainable services, flying vehicles needed places to take off, land, receive maintenance, charge their batteries and park, so called vertiports. Future urban planning would need to encompass AAM infrastructure, which could take any of the forms outlined in **Exhibit 2**. The specific design requirements for an AAM network would vary by city, depending on its size, population density and average income level.[13] (See **Exhibit 3** for estimates of AAM infrastructure requirements, capital expenditure and operating costs for different categories of cities).

To provide an attractive and convenient service offering, eVTOL jet players needed to have sufficient locations to place landing pads.[14] Given both limited urban space and rising real estate prices they planned to leverage the existing infrastructure of helipads and airfields, which—in the US alone—comprised thousands of landing pads. Indeed, the very design equation of eVTOL jets had been developed to ensure that aircraft wingspan and weight were compatible with existing pads, and trade-offs in passenger load, noise, range, and speed were decided accordingly by each competitor. Industry players in some metropolitan areas were also exploring the option of retrofitting existing structures.[15] For example, it was deemed possible for some eVTOLs to land on reasonably large building rooftops, as long as local regulations allowed for the use of pre-existing infrastructure for these purposes.[16]

The long timelines for designing, constructing, and obtaining space for a viable AAM network further added to the complexity.[17] Also, before any air taxis could take off, operators would need to demonstrate that they had met all of the requirements for safe, robust, and scalable operations.[18] Even so, companies, governments and other stakeholders in several cities had started taking thoughtful steps towards creating an environment that enabled the wider deployment of AAM solutions.[19]

For example, as early as 2018, a total of 64 cities around the world were already experimenting with the implementation of urban drone operations, from providing security and emergency services to mail deliveries.[20] Furthermore, several European cities had joined the AAM Initiative, a EU-funded project launched in 2018, which brought together citizens, industries, companies, investors, researchers, and other smart city actors to discuss the optimal conditions for creating a future AAM market in Europe.[21]

## The AAM Market

Mobility was the lifeblood of cities and vital to sustaining urban life by ensuring the seamless movement of people and goods.[22] For congested cities, AAM vehicles could be a promising alternative to ground transportation.[23] Every day, commuters all over the world wasted millions of hours sitting in traffic with negative consequences in terms of lost time, increased fuel consumption, higher emissions, and stress levels. The average inhabitant of Los Angeles, for example, spent approximately 102 hours a year sitting in traffic jams, followed by Moscow and New York with 91 hours, and São Paulo with 86 hours.[24] As cities continued to accommodate an increasing population, their need for mobility also increased.[25] Driven by these factors and advances in aircraft technology, AAM was beginning to emerge as a new industry.[26]

There were multiple market size estimates available on the future potential of AAM. One consulting firm projected that the global opportunity for air taxis would be in the order of $32 billion by 2035.[27] Another firm estimated the specific market size for human transport in eVTOLs to reach $851 billion by 2040.[28] A 2021 PitchBook report estimated that by 2025 the global air taxi passenger mobility market could grow to $1.5 billion in revenue, and by 2035 jump to $150.9 billion, which was equivalent to about 19.4% of expected global airline revenue in 2021.[29] Morgan Stanley forecasted that by 2040, the total AAM market (including drone courier services and passenger eVTOL services) could become a $1.5 to $3 trillion industry.[30] (See **Exhibit 4** for Lilium's view about the market size.)

As was the case with Lilium, many aviation start-ups had been enthusiastically welcomed by public markets, despite the early stage of their businesses and uncertain revenue prospects.[31] Investors were rushing to gain a foothold in this nascent market and poured millions into the necessary commercialization efforts to make AAM a new reality.[32] Many industry players were already targeting 2023 to 2025 for the deployment of their flying taxis. Some analysts projected that AAM could indeed progressively kick off in the coming years, with an estimated total of 98,000 electric flying vehicles for intercity flights, intracity air taxis, and airport shuttles in operation worldwide by 2050 (see **Exhibit 5** for a breakdown).[33] Others worried that these timelines were too optimistic, pointing to the related sector of autonomous cars, in which companies as recently as 2015-2018 had wrongly predicted to have tens of thousands of robotaxis on the road by 2020.[34]

As the AAM market was developing, eVTOL jet manufacturers needed to make assumptions about the future market and choose the use case that they considered to be the most promising. Each use case—which comprised intracity air taxis, airport shuttles and intercity flights—had its own benefits and limitations, and not all technologies and aircraft concepts suited all applications.[35] All addressable markets had the potential to reach billions in market size and deciding which market to address had been a burning question for Lilium and others.

### *The Intracity Opportunity*

Many eVTOL jet manufacturers were focused on the intracity opportunity. Like conventional ride-hailing services, intracity air taxi services would allow city dwellers—particularly those living in congested cities—to reduce their travel time. The service could be on demand or scheduled, linking points of interest such as train stations, hotels, business offices, or shopping malls.[36] The market for air taxis operating inside cities was estimated to grow at a 35% CAGR to reach $21 billion by 2035. The Asia-Pacific region was projected to become the largest market by far capturing 45% of revenues in 2035, followed by the U.S. (30%), and the rest of the world (25%).[37]

For urban air taxis to succeed, they would need to fly passengers from point A to B at a price that was competitive with ground transportation while offering sufficient time savings. Some analysts claimed this could be done, provided operators managed to identify and connect the most popular routes for urban commuters. Data showed that even without traffic jams, it was rare to travel within megacities (cities with a population of five million or more) at an average speed of more than 31 mph. It was even rarer to find a direct straight-line connection by public transport between two major locations inside a megacity. This meant that if an eVTOL was able to travel between key points of interest at an average speed of 50 to 62 mph, a 14 miles trip would take 18 to 22 minutes—reducing travel time in congested areas by up to 50%.[38] However, many in the field believed using eVTOLs for intracity transport was impractical as it required a high density of landing pads to minimize the first and last mile of travel to levels such that the total travel time could be reduced.

### *The Airport Shuttle Opportunity*

eVTOL jets could also potentially operate as airport shuttles. In fact, any eVTOL jet with a range of between 17 and 22 miles would be able to connect more than 90% of the world's largest cities to airports.[39] For example, data on the average travel time between midtown Manhattan and John F. Kennedy International Airport, a distance of approximately 18 miles, showed that 90% of taxi trips took longer than 60 minutes. Instead, this distance could be covered by an air taxi in just 20–25 minutes.[40] Furthermore, data on ground journeys across the world indicated that demand for ridesharing airport services was quite substantial—nearly one-sixth of all Uber bookings were to or from an airport.[41]

### *The Intercity Opportunity*

eVTOL players could also target intercity flights to connect cities that were too close to be viable for regular aviation links.[42] Analysts projected that intercity transportation could be a $11 billion market by 2035.[43] A white paper suggested that urban air taxis would mainly be used by so-called "mega commuters," or people who commuted more than 90 miles per day.[44] Beyond the commuter market, intercity connections could be used by those wishing to visit a neighboring city to shop, attend an event, or to spend time with friends and family. For regions with poor transportation infrastructure, eVTOLs could open up new opportunities. Yann de Vries, VP corporate development at Lilium (HBS 2001), said, "Like wireless broadband, eVTOLs will have a profound impact on a country's competitiveness by seamlessly connecting cities of any size into a regional high-speed network. This a great opportunity, especially in emerging markets."

As with the other use cases, time and money savings were important determinants for customers to choose RAM over regular ground transportation, and the longer distances between cities gave higher potential for both. Analysts calculated that AAM would only win against other modes of transportation when passengers could save at least 20% in total travel time, notwithstanding transfers.[45] Finding the optimal vehicle size and flight frequency was important for reducing the operating costs. Above all, said Geoff Richardson, Lilium CFO, "The brutal laws of utilization and costs drive your free cash flow. A scheduled predictable service makes utilization easier than on an ad-hoc basis."

## Lilium

Wiegand was a life-long aircraft enthusiast.[46] At school, when asked to draw the future, he drew a house on top of a cliff with a family and a flying car parked in the backyard. Reflecting on his childhood, he mused, "I was seriously unhappy that I was born as a human and not as a bird."[47] In 2013, as an exchange student in Scotland, he began to explore the idea of flying cars more seriously, locking himself in his room to develop different aircraft concepts. He kept working on the idea when he got back to TUM, where he studied aerospace engineering and flight propulsion.[48]

In 2015, Wiegand and three of his TUM classmates—lightweight aerostructures engineer Sebastian Born, aerodynamics specialist Patrick Nathen, and mechatronics engineer Matthias Meiner—founded Lilium.[49] (See **Exhibit 6** for the founders' bios.) The founders' vision was of a world where anyone could fly wherever and whenever they wanted, while at the same time benefitting society by reducing their environmental footprint, driving economic growth, and connecting communities. They sought to offer urban air travel that was affordable and accessible, with the possibility for Lilium customers to "do more, see more, and be more—and still be home by bedtime."[50]

Lilium's financing breakthrough came in 2016 when it received seed funding from German tech-investor Frank Thelen and his investment firm Freigeist (formerly e42).[51] Thelen still remembered the intrigue he felt upon receiving Lilium's pitch by email. His team immediately travelled to meet the founders in what Thelen described as "true love at first pitch." Despite the early stage of Lilium's development, Thelen was determined to be part of its mission. In December 2015, he wrote an e-mail to the founders starting with, "The heart says YES—but the mind says NO!" "The risk of losing our money was absurdly high," Thelen said. He recalled, "After announcing our partnership, many friends and other investors from our network called us crazy. One friend offered me a place to crash and food for a year because he was convinced that we would lose all our money. Another one sent me a list of failed airplane projects from billionaires."[52]

Later in 2016, Thelen introduced Lilium to Skype co-founder Niklas Zennström, who joined the board.[53] Between 2016 and 2020, Lilium raised more than $300 million in three rounds. The last private funding round in March 2020 gave Lilium an estimated valuation of between $750 million and $1 billion, making the company one of Europe's 60 unicorns.[54] (See **Exhibit 7** for a summary of Lilium's various funding rounds). In March 2021, Lilium announced its plan to go public through a merger with Qell Acquisition Corp., a SPAC.[55] Upon finalization of the merger, Lilium received approximately $580 million from the deal.[56]

In recent years, a few eVTOL jet manufacturers had been able to raise hundreds of millions of dollars with SPACs to scale their companies. SPACs were publicly listed shell companies with no operations, established for the purpose of identifying promising private companies and taking them public through business combination agreements (or de-SPAC transactions). They were also commonly known as "blank check" companies, because their initial investors did not know which private company would be selected as an acquisition target.[57] Raising such amounts in private markets or via IPO would have been almost impossible, because these companies had no revenues and were still 2-3 years away from launch. The Covid-19 pandemic—and the ensuing tightening of financial markets—had also played a role in creating the conditions for a boom in SPACs.[58] Despite their challenges, they had been a key enabler for the industry to take off and for start-ups to lead the pack.

Lilium was advancing its jet design in parallel with its efforts to raise capital. After the initial seed investment, in 2016, the founders looked at more than 20 existing aircraft concepts but realized none of them could deliver what they wanted. They were searching for levels of efficiency close to the limits of physics, delivered in the simplest way, and eventually chose to design the jet from scratch.[59] The founders began developing small-scale demonstrators to validate their design using chipboard and foil.[60] In April 2017, they conducted a successful test flight of a two-seater demonstrator, marking an important milestone in the company's history. In May 2019, Lilium's five-seater demonstrator, built for a range of 186 miles, took off for the first time. There followed a series of flight tests, including the maneuver from vertical to forward flight, the most challenging phase for the Lilium technology.[61]

Despite the progress, in February 2020, the Lilium team experienced a setback when its first full-scale five-seater demonstrator was destroyed in a fire, which broke out during ground maintenance activities at the headquarters.[62] De Vries recalled, "A battery pack, which was not yet aerospace ready, caught fire during a maintenance routine. Luckily, nobody got hurt, but it was a big setback for the company because it prevented us from continuing our flight test plan in time. On the other hand, it forced us to double down on safety and migrate from a tech start-up to a much more rigorous aerospace company." When asked about whether the fire had deterred investors, Wiegand said, "They know that the fire was annoying, but not a catastrophe. Our investors have given us a strong vote of confidence."[63]

In 2021, as part of its SPAC deal investor pitch, Lilium revealed with enthusiasm a brand new seven-seater jet having scrapped its initial plans for a five-seater jet. The new eVTOL was designed to achieve a range of 155 miles, a speed of 175 mph, and a noise level of 60 decibels (dB) at a 100-meter distance during hover, which allowed the jet to operate in dense city centers—in comparison, traffic noise on an urban street typically came in at around 70 dB, while a lawn mower was around 90 dB, and an older aircraft was 110 dB.[64] The proceeds from the SPAC would significantly contribute to funding the remaining steps ahead of Lilium's planned start of commercial operations around 2024, including finalizing serial production facilities in Germany, launching the serial production of the aircraft, and completing certification with the appropriate authorities.[65] While most competitors seemed to be targeting the short haul intracity use case, Lilium's primary target had moved towards longer-range intercity and regional transportation.[66] Since most customers would need to sandwich their air taxi ride between car, bus or train trips to cover the first and last miles, Lilium generally saw eVTOL time savings start at trips greater than 45 minutes.[67]

## Strategic Positioning in the Competitive Landscape

Given the expected market potential, many UAM competitors had emerged. There were over 200 players in the air taxi space—including traditional aerospace companies such as Boeing and numerous start-ups—with the ambition to design, manufacture or operate eVTOL vehicles, all at different stages of development.[68]

To succeed in the AAM space, eVTOL jet manufacturers had to decide where in the value chain to focus their efforts. Players could offer either B2C or B2B solutions: a passenger mobility network (in which it would run its own fleet of air taxi services for individual passengers), and a turnkey enterprise solution (selling or leasing aircraft to airlines and other customers).

**Integrated service model** In opting for a fully integrated service, the eVTOL manufacturer would essentially be placing a bet on its ability to build its own operating network. In a full-service model scenario, eVTOL jet manufacturers would have to secure the buy-in of partners to the eVTOL technology and AAM market potential and engage them to provide their expertise in areas of established competencies: financing, planning, construction of vertiports and operations. The eVTOL manufacturer would have to be ready to generate end user demand, fulfill the demand, handle a large number of bookings and transactions and deal with cancellations, delays, and other customer facing aspects of the business.

Market research revealed that most people were either positive or neutral about the prospect of travelling in an AAM vehicle.[69] Generally, survey respondents were most interested in an AAM trip if it was the fastest travel option and offered significant time savings in comparison with regular ground transportation. Familiarity with the AAM concept was a strong factor influencing willingness to fly and a participant's decision to take an AAM trip, suggesting that public education would play an important role in introducing AAM as a new travel mode.[70] (See **Exhibits 8**, **9**, **10** and **11**.) In most cases, potential passengers' willingness to embrace UAM depended on their perception of safety.[71] Some respondents admitted they would be more likely to embrace automated UAM solutions from known brands, such as Google and IBM, than from lesser-known or start-up companies.[72] A Lilium executive, commented,

> Probably, in the next year, people will start to think, "Flying taxis, what does that mean for me?" Once operations are announced in a given city, suddenly that city stops being excited and starts becoming worried. They're thinking, "Is it safe? Is it noisy? What does it mean for visual pollution? Will I be able to afford it or is it just for the elite few? What's

> the customer experience? How will you regulate? How do you stop them from bumping into each other?"

When asked about price, respondents indicated that air taxi services would need to be made available at reasonable fares to compete with ground transportation (see **Exhibit 12**). In this context, they would be willing to pay 10-20% more than for an equivalent Lyft or Uber ride covering the same distance.[73] Wiegand added, "There is a perception of quality linked to the price. You have to go higher than Uber. On the other hand, a lower price could mean more tolerance for noise."

The first critical step in implementing an integrated service model would be to seek out an infrastructure partner to design and construct the vertiport facilities and to take on the operation and maintenance contract. Timing was on eVTOL jet manufacturers side as geopolitical pressure was increasing for big dollar investments in infrastructure projects. A record $272 billion in sustainable infrastructure projects were announced in 2020, nearly double the levels seen a decade ago.[74] Secondly, eVTOL jet manufacturers would need to source a renewable energy provider to electrify the pads. They would need to weigh up the option of buying the necessary hardware and installing it themselves versus renting the charging service.

With the infrastructure and charging elements in place, the eVTOL jet manufacturer would need to find a local airline operator partner with an airline operating certificate (AOC). To obtain an AOC from a regulatory authority, an operator had to demonstrate that it had fully trained and qualified personnel, infrastructure, systems, processes and procedures in place to ensure the safety of the general public and its employees, both on the ground and in the air.[75]

The eVTOL jet manufacturer would take on the development of the digital platform that would tie all the elements together. With smart eVTOL jet technology, the jet would know where it needed to go, how much battery was left, and the optimized route given the remaining battery power and weather conditions. The platform would be plug and play, with all partners along the value chain having access to it. All customer bookings would be handled by the eVTOL jet network operator.

Players expected that such an integrated service model approach would generate more attractive unit economics. Assuming strong passenger demand, there would be high recurring revenues every year per route and high margins. Players expected that this model would allow them to retain customers and keep control. In theory, it was easier to innovate and differentiate in a closed, end-to-end system—the comparison commonly cited was Apple versus Microsoft. It was also assumed that it would also be easier for companies to build their own brand in an integrated service model setting. Once the blueprint was set up it was expected to be relatively easy to set up operations in different markets and to require almost zero capital.

On the other hand, players projected that an integrated service model would be harder to scale. There was higher complexity (digital platform, operations management, pilot training, etc.) There was dependence on multiple stakeholders: infrastructure, airlines, Maintenance, Repair, and Overhaul (MRO), regulators, etc. Companies would need to develop their own customer acquisition channels and marketing strategy. It also came with significant financing needs, including the investment needed to build a fleet ahead of revenue generation, the R&D to develop the operating platform, initial infrastructure commitments and higher marketing costs. There would be no revenues and higher uncertainty until launch; the company would bear the full risk of achieving targeted operations. One company pursuing this strategy was California-based Joby Aviation.

***Joby Aviation*** Joby had developed a four-passenger eVTOL jet which boasted a top speed of 200 mph and a maximum range of 150 miles.[76] Joby was the eVTOL pioneer and the first to go public via a

SPAC announced in February 2021 and started trading in August 2021, which provided the company with approximately $1.6 billion in cash, resulting in a post-money valuation of $6.6 billion.[77] In December 2020, it had acquired Uber Elevate, an urban air transportation initiative formed by the ride-sharing app Uber. Established in 2016, Uber Elevate had played an important role in laying the groundwork for the aerial ridesharing market by bringing together regulators, civic leaders, real estate developers, and technology companies around a shared vision for the future of air travel. It had developed a set of software tools that built on more than a decade of experience enabling on-demand mobility. Both companies agreed to integrate their respective services into each other's apps to enable seamless integration between ground and air travel for future customers. Uber had invested a total of $125 million in Joby.[78]

With a vision of building an on-demand, aerial ride-sharing service, Joby Aviation aspired to save "a billion people an hour every day," by allowing them to commute in flying taxis at a price of roughly $3.00 per filled passenger mile.[79] Joby Aviation was starting to make a name for itself as it had secured airworthiness approval from the U.S. Air Force, allowing it to begin flying missions for the military.[80] The company planned to start manufacturing aircraft later in 2021 at a 450,000 $ft^2$ facility that it had designed with Toyota. In 2021, the carmaker had led a $620 million investment round in Joby, which led to closer cooperation between engineers of both companies.[81] The aim was to refine the components of the aircrafts in order to make them more suitable for mass production akin to the automotive industry.[82] Where Joby would first launch had yet to be determined, but the company was, reportedly, in dialogue with several cities in the U.S. to deploy its network.[83]

**Pure OEM model** Others bet on an OEM scheme, where they would sell or lease aircraft and establish an aftermarket, like traditional players such as Airbus or Boeing. Industry experts believed that a maximum of a few hundred eVTOLs on the market in the first years after certification would result in intense competition from airlines and other customers to get their hands on them. Preordering was critical to secure production; those making a bet now would gain a first footing in the market. Given the supply constraints they could secure a valuable competitive advantage. Richardson commented, "Securing these kinds of deals has a big impact on eVTOL manufacturers' credibility."

There were three main opportunities for selling eVTOLs to other businesses. First, many major airlines collaborated with regional airlines to connect smaller cities close to major urban centers where they had hubs. Regional airlines like SkyWest, Envoy Air, and CommutAir operated their fleet under the brand name of the regional fleet of each major airline (e.g., United Express). (See **Exhibit 13a** for information about major regional airlines in the US and **Exhibit 13b** for their typical organizational chart.) These regional airlines usually used smaller aircrafts manufactured by companies like Bombardier and Embraer for these regional routes (see **Exhibit 14** for characteristics of jets they used).

Airlines would purchase or lease eVTOLs to diversify their fleets and serve niche markets. One such market was the replacement of regional short-haul routes, which airlines were coming under increasing pressure to remove, as governments tried to fundamentally reduce $CO_2$ emissions. For example, in the past two years, both Austria and France had banned short-haul internal flights, which applied to routes where a train journey of less than 3 hours or 2 hours 30 minutes could be provided as an alternative, respectively.[84] Moreover, access to eVTOLs could potentially allow airlines to have much more frequent flights with smaller jets to more local destinations. For airlines that had a hub and spoke model, more frequent flights with smaller jets meant more efficient fleets without increasing passengers' layover wait times. For airlines with a point-to-point network, eVTOLs meant more expansive networks. Airlines had been hit hard by the Covid-19 pandemic—those that had survived were coming out of a period of restructuring. They cared about reliability, low operating costs, high uptime, all aspects on which eVTOL jets were projected to deliver, versus helicopters and small aircraft.

Because of the pandemic, smaller vehicles with fewer passengers also meant more trust and comfort for riders.

Second, urban mobility companies like Uber and Lyft had also shown interest in using eVTOLs in their fleets. For example, prior to its acquisition by Joby, Uber Elevate had been working with several aircraft manufacturing partners to build vehicles to fit its requirements for aerial ridesharing—an electronic aircraft that could fly relatively quietly, carrying four passengers at 150 to 200 mph for 25 to 60 miles.[85] Since urban mobility companies already had an active user base across many cities with large ground transportation fleets that could help solve the last-mile problem of eVTOLs, they could utilize these flying machines to provide a much better service in congested urban areas. The average cost of operating a ride-sharing platform in this industry was estimated at about 48 cents per passenger mile (not including the payment to drivers). (See **Exhibit 15** for the market share and financials of top urban mobility providers in the US.)

Finally, as e-commerce continued to drive global growth for the parcel sector, courier and local delivery providers were looking to generate faster links between micro-fulfillment centers to be closer to their customers. Following supply chain disruption caused by Covid-19, they were also trying to improve the reliability and efficiency of their networks by investing in their own fleets. For example, Amazon had begun its foray into air operations with a fully leased fleet but went on a plane buying spree in summer 2020, hastened by the Covid-19 pandemic.[86] In August 2021, DHL Express added 12 electric aircraft to its fleet.[87] With limited space in urban delivery centers, these companies needed a high-payload, quiet, fast vehicle to re-distribute goods where the demand was. The market was highly concentrated, with UPS holding a 35% market share in the US in 2020.[88] The average cost in the industry was estimated at $9.18 per piece. (See **Exhibit 16** for the market share and financial information of major courier and local delivery providers in the US.)

While upfront cash flows from airlines, which usually made cash deposits ahead of aircraft delivery, could help OEMs, and some believed selling jets to other businesses was less complex than dealing with passengers, others were not so optimistic. An OEM business model could mean a one-time sale, arguably with lower margins and much less control over end user data ownership and branding. As more eVTOL manufacturers entered the market, the heightened competition would cut further into their margins. eVTOL jet manufacturer Vertical Aerospace had opted for the pure OEM model.

***Vertical Aerospace*** Bristol, UK based Vertical Aerospace had developed an eVTOL jet priced at roughly $4 million, which was able to carry four passengers and a pilot more than 100 miles travelling at more than 200mph. Founded in 2016, Vertical announced its plans to go public through a merger with the SPAC Broadstone Acquisition Corp in June 2021 with a value of $2.2 billion.[89] At the same time, it announced pre-orders for up to 1,000 of its aircraft from American Airlines, Virgin Atlantic, and the world's third-largest aircraft leasing company, Avolon.[90] It started trading in December 2021.

Investors in Vertical included American Airlines and Avolon, as well as Honeywell, Microsoft and Rolls-Royce. Dómhnal Slattery, chief executive of Avolon, said, "Whether it is airlines operating this as an add-on product or ride sharing businesses in different jurisdictions, I think it is going to take a lot of different forms over time."[91] Shai Weiss, the chief executive of Virgin Atlantic, said the airline would be exploring a joint venture "to bring short-haul, electric vehicle connectivity to cities and our UK airport hubs, starting with London Heathrow as well as Manchester and London Gatwick". Virgin believed that the jet could also be used to transfer passengers between home and airports.[92]

**Hybrid** Some players decided to place themselves between the two options, taking a hybrid approach. For example, an eVTOL jet manufacturer could decide to sell 60% of its jets to airlines and logistics providers and build up a service network with the remaining 40%. Such an approach could

allow eVTOL jet manufacturers to reduce future fundraising risks until market launch by immediately booking revenues. Keeping both options open meant that the company could observe how the market would evolve and be nimbler in its response. On the other hand, not placing a bet on either model could represent a lack of focus. It brought additional complexity and there was the risk that the company could fail at both models. One player pursuing this model was Archer Aviation.

***Archer Aviation*** Launched in 2020, California-based Archer Aviation was the latest start-up to enter the increasingly crowded UAM industry. Despite the recent market entry, the company had managed to attract top industry talent, notably from other first-mover competitors, to develop a five-seater jet with the capacity to carry four passengers and one pilot for up to 60 miles at speeds of up to 150 mph.[93] The plan was to launch a network of urban air taxis in Los Angeles by 2024.[94]

In February 2021, Archer announced plans to go public with a SPAC backed by US investment banker Ken Moelis, giving it a public valuation of $3.8 billion.[95] The announcement came only two weeks after it landed United Airlines as a customer and an investor.[96] More specifically, under the terms of the agreement, which closed in September 2021, United would acquire up to 200 of Archer Aviation's aircrafts to offer its customers airport shuttle services within the next five years.[97] Archer started trading in September 2021.

A United executive noted that Archer's launch of their first eVTOL aircrafts in Los Angeles meant United customers were "another step closer to reducing their carbon footprint at every stage of their journey, before they even take their seat," adding, "We're confident that Los Angeles is only the beginning for Archer and we look forward to helping them extend their reach across all of our hubs."[98]

Archer had yet to mass produce its aircraft and aimed to start volume manufacturing in 2023. In terms of vertiports, Archer said it was open to using existing infrastructure such as helipads and parking garages in the early years, within which its eVTOL was built to fit.[99]

Archer's target city for launch, Los Angeles, was taking steps to prepare for UAM. An Urban Air Mobility Partnership, a one-year initiative between Los Angeles Mayor Eric Garcetti's office, the Los Angeles Department of Transportation and Urban Movement Labs, was working to develop a plan for how to integrate urban aircraft into existing transportation networks and land use policies. Urban Movement Labs, launched in November 2019, was a public-private partnership involving local government and companies to develop, test and deploy transportation technologies.[100]

## The Road Ahead: Preparing for Takeoff

Amid the COVID-19 crisis, Lilium had grown to over 700 employees, of whom some were working from home and others on-site under strict precautions to run various test programs. Wiegand intended to progress through the design and manufacturing phases of the first prototypes of the seven-seater by 2023. He was aiming for flight test and certification in the period 2023-2024 and deployment of Lilium's flying taxis by the end of 2024/beginning of 2025.[101] In terms of its strategic positioning, Lilium chose the hybrid option for now. The company was planning to sell 50% of aircraft to partners and at the same time build up a service network with 50% of its production, beginning with Germany and Florida. (See **Exhibit 17** for Lilium's expected unit economics for each option (B2C and B2B).)

While Lilium—unlike some of its competitors—had grown in its early years without any major strategic partners, the company had recently announced a series of partnerships with both infrastructure partners—to set up the necessary vertiport network—and various aerospace suppliers and development partners.[102] Wiegand commented, "It's very much an ecosystem approach. It means less capital expenditure investments on our side, and we can leverage the strengths of all the strong

players in the industry. There's no need for us to do something that others can already do great and have perfected over decades."[103] Richardson mused, "Deciding on how asset heavy or light to be has been a topic for debate. We needed to be clear about what exactly Lilium's competitive advantage is."

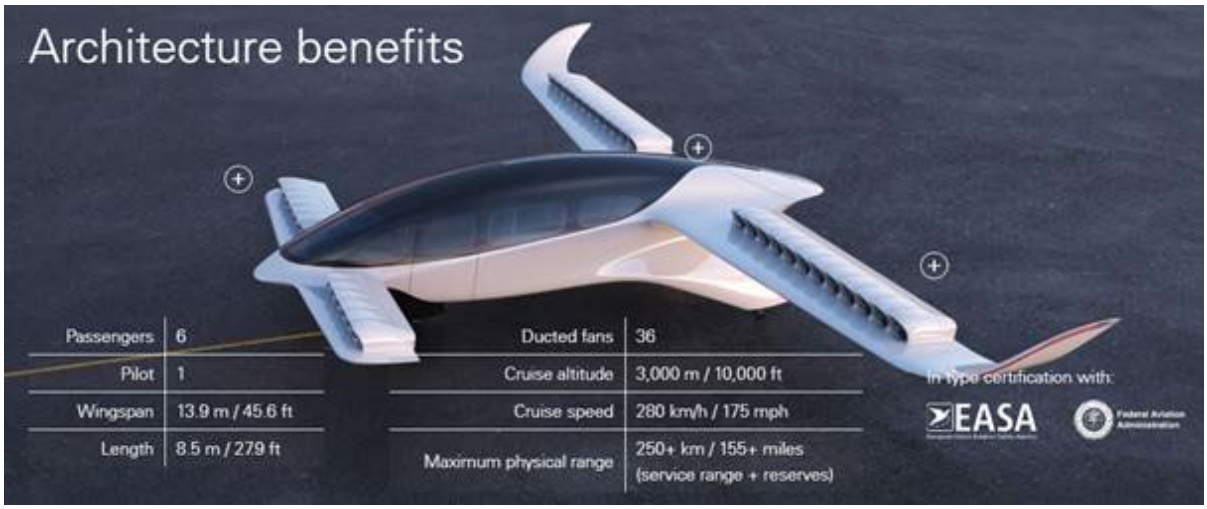
Through a partnership signed with the Brazilian airline Azul in 2021, Azul would receive 220 of Lilium's aircraft to operate and maintain on the network created by the two companies.[104] The network was expected to start in 2025 for an aggregate value of up to $1 billion.[105] Lilium also planned to build 14 vertiports and deploy about 125 jets across Florida in partnership with Spanish infrastructure company Ferrovial, which was the owner of London's Heathrow Airport.[106] (See **Exhibit 18** for the proposed Florida launch.) In parallel, Lilium was in talks with Düsseldorf and Cologne/Bonn airports to explore how a UAM network could be deployed out of the densely populated North Rhine-Westphalia state in Germany.[107] (See **Exhibit 19** for the proposed Germany launch.) Wiegand also confirmed ongoing negotiations to roll out 10 additional sites in other parts of Europe.[108]

Some were concerned about Lilium's promises, calling their timeline "unrealistic." For example, clearing certification for a small conventional airplane could take up to five years.[109] One industry expert also warned that moving eVTOL programs through certification alone could require $3 billion.[110] Furthermore, to develop the aircraft and build manufacturing facilities to produce hundreds of aircraft a year, some industry experts estimated that Lilium would need hundreds of millions more dollars. The opportunity to get additional capital through a SPAC came after Lilium failed to raise as much money as it had hoped last year.[111] (See **Exhibit 20** for competitor analysis.)

There were also challenges for Lilium's marketing organization resulting from its hybrid positioning. Lilium had to adapt its marketing organization to both its B2C and B2B customers. For its B2C customers, Lilium's marketing team was focused on access routes, landing sites, pricing, willingness to change, customer acceptance and data analytics. On the B2B side Lilium had assembled a more traditional aerospace team with individuals experienced in negotiating with airlines and dealing with such topics as contract contingencies, financing options and commercial terms. While such background added value, the team still had to develop expertise to be able to help B2B customers understand how an eVTOL network worked. The team was able to leverage the extensive knowledge the B2C team had been building up over the years. Lilium would initially be selective with its B2B partners. Given that at the beginning the number of jets would be limited, it aimed to find a handful of companies with an agile approach. Lilium planned to be the primary source of parts in the after-market to keep a close link with customers.

As developers of a nascent technology in a completely new category, Lilium's founders and senior management were faced with a tremendous amount of uncertainty. Getting the strategy right was key, but speed was essential. "Start-ups don't have the time to run multi-year consulting projects," remarked Wiegand. Execution would also be critical given the intense competition, including industry giants like Airbus and car OEMs like Hyundai, which were venturing into the market. There was a keen sense of urgency among eVTOL jet players to gain first mover advantage in this new industry. What were the critical next steps for Lilium to become a market leader, or even just to survive in this incredibly competitive and unforgiving environment? Was it a wise strategic decision to hedge its bets with a hybrid approach? Richardson reflected, "Having considered the various time dimensions we adopted a 50-50 hybrid model, but was that the right percentage? And, given that choice, should we change the organizational structure to have two separate commercial departments for B2B and B2C customers?" How should Lilium think about the B2C value chain and the margin it could capture? Would Lilium be able to build the necessary eco-system, attract experienced partners and develop a differentiated experience for customers? Should it revisit the economics, strategic considerations, risks and opportunities of the two models?

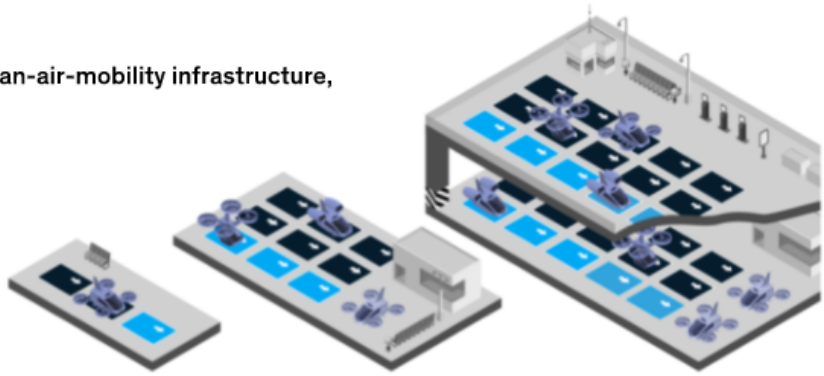
**Exhibit 1** Lilium's Seven-Seater Jet




Source: Lilium, "The Jet," https://lilium.com/jet, accessed May 2021.

**Exhibit 2** UAM Infrastructure Estimations, as of 2020

**Potential archetypes for urban-air-mobility infrastructure,** illustrative

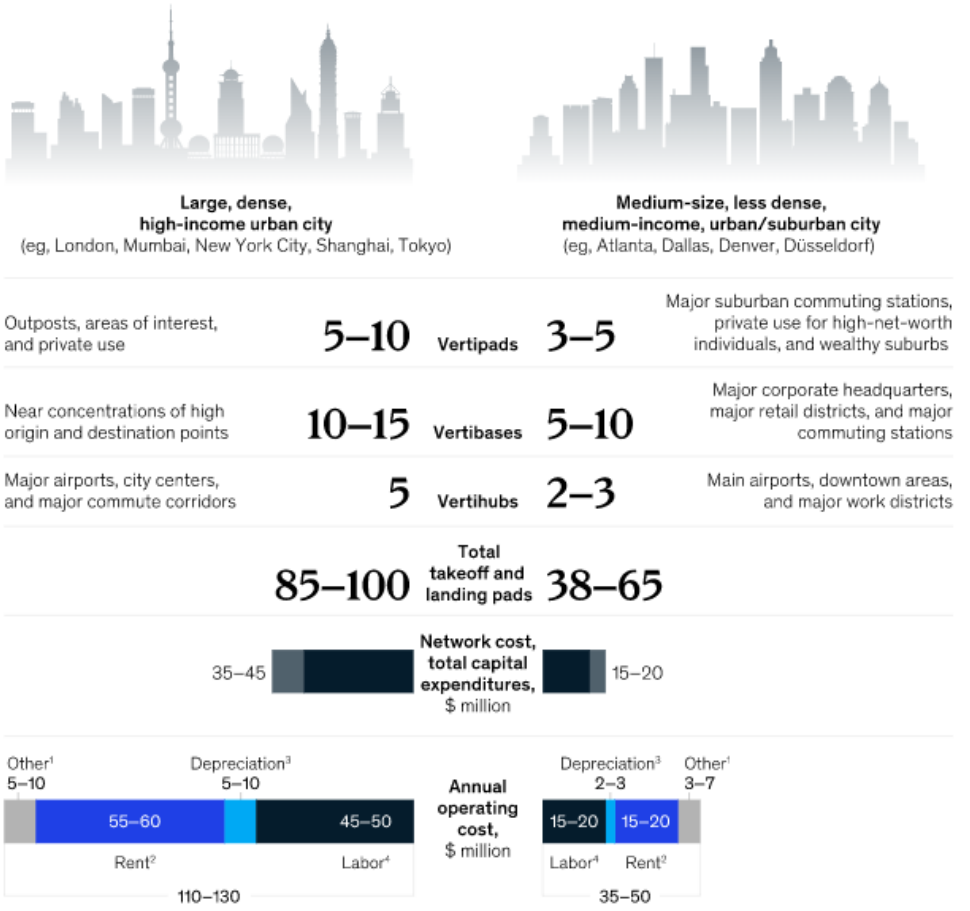


| | Vertipad (new or retrofit) | Vertibase (new or retrofit) | Vertihub (new) |
|---|---|---|---|
| Dimensions | 100 × 60 feet | 230 × 100 feet | 400 × 175 feet (2 floors) |
| Landing/takeoff pads | 1 | 3 | 10 |
| Parking/charging spots | 2 | 6 | 20 |
| Capital expenditures, $ million | 0.2–0.4 | 0.5–0.8 | 6.0–7.0 |
| Operating expenditures, $ million | 0.6–0.9 | 3.0–5.0 | 15.0–17.0 |

McKinsey & Company

Source: Johnston, Tore, Robin Riedel, and Shivika Sahdev, "To take off, flying vehicles first need places to land," McKinsey & Company, August 31, 2020, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/to-take-off-flying-vehicles-first-need-places-to-land, accessed May 2021. 

**Exhibit 3** Illustrative Example of Vertihub-Centered-Network and Infrastructure Cost Estimation



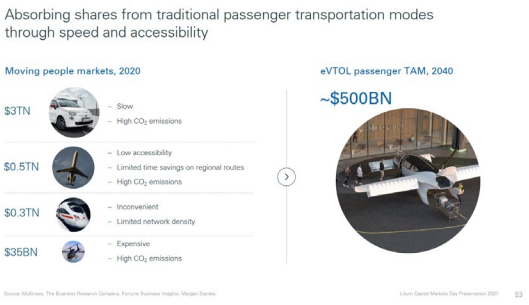

[1]Connectivity costs and regulatory fees. [2]Cost per square foot multiplied by structure dimensions. [3]30-year useful life for buildings/land. [4]Security, customer service, maintenance, and management.

McKinsey & Company

Source: Johnston, Tore, Robin Riedel, and Shivika Sahdev, "To take off, flying vehicles first need places to land," McKinsey & Company, August 31, 2020, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/to-take-off-flying-vehicles-first-need-places-to-land, accessed May 2021. 

**Exhibit 4** Lilium's View of eVTOL Market Potential in Various Segments.

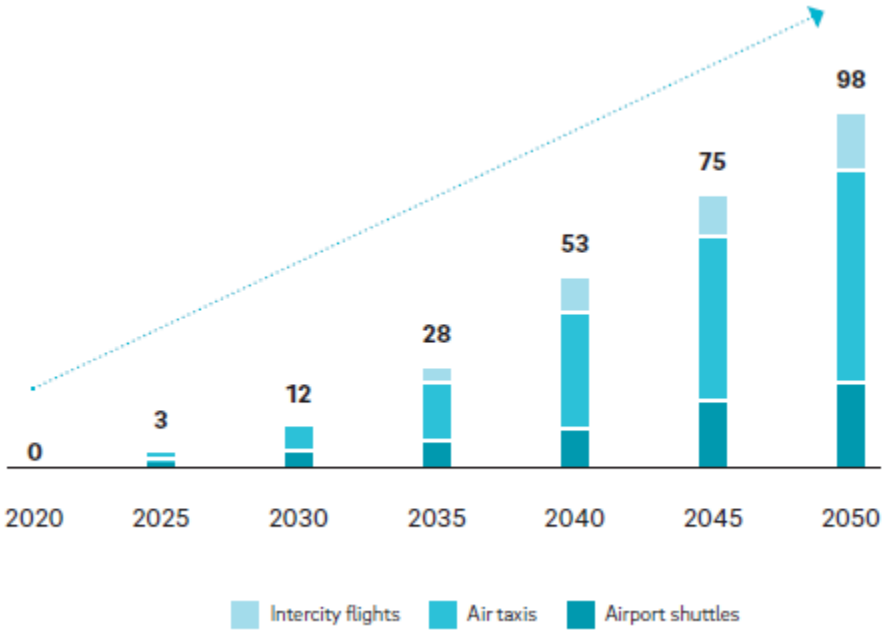
Passenger market segment:




Cargo/Logistics market segment:


Source: Lilium, "Capital Markets Day Presentation," August 2, 2021, https://lilium.com/files/redaktion/refresh_feb2021/investors/20210802_Capital_Markets_Day.pdf, accessed December 2021.

**Exhibit 5** Estimated Number of Passenger eVTOLs in Operation Worldwide (In Thousands)




Source: Roland Berger, "Urban Air Mobility" (November 2018), https://www.rolandberger.com/publications/publication_pdf/Roland_Berger_Urban_Air_Mobility.pdf, accessed May 2019.

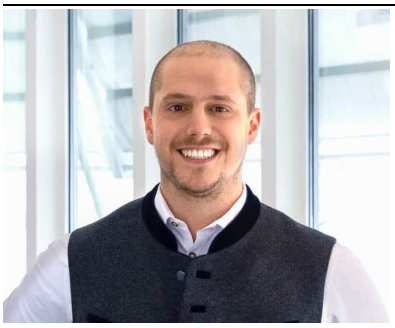
**Exhibit 6** Lilium's Founders

**Daniel Wiegand,** Co-founder and CEO

Described by CN Traveller as the man changing the way we travel, Daniel Wiegand holds a degree in Aerospace Engineering from Technical University of Munich (TUM). Having focused his studies on flight propulsion systems, Daniel had the idea for a revolutionary urban air mobility solution during a visit to Glasgow in 2013. Having brought three fellow TUM students together as Co-Founders in 2014, Daniel now leads the team at Lilium, performing the joint roles of CEO and Chief Engineer. Winning the "Jugend Forscht" in 2004, Germany's most recognized tech competition, was a sign of things to come, with the MIT Technology Review naming Daniel their 'Under 35 Innovator of the Year' in 2017. More recently, Daniel was a finalist in Ernst & Young's Entrepreneur Of The Year competition in 2018.

**Matthias Meiner,** Co-Founder and Head of Autonomous Systems

Matthias Meiner is Co-Founder and Head of Flight Control for Lilium. Identified by Forbes magazine as one of Europe's 30 under 30 leading innovators in 2017, Matthias is responsible for the development of Lilium's pioneering autonomous flight systems. Matthias studied robotics at the Technical University of Munich, during which time he explored his passion for control engineering and aviation through his research at the German Aerospace Center (DLR). An alumnus of the German National Academic Foundation, Matthias also won Europe's largest youth science and technology competition, "Jugend Forscht", in 2014.



**Patrick Nathen,** Co-Founder and VP Product

As co-founder and VP Product, Patrick Nathen leads the global product strategy for Lilium, ensuring we put the customer at the very center of all our digital and physical products throughout the passenger experience. Patrick studied Aerospace Engineering at the Technical University of Munich where he won the VDI Prize for outstanding academic records and academic engagement in 2010. He was subsequently awarded not only the highly respected Grand Prize but was also selected as the jury's choice at the Hello Tomorrow Challenge in Paris in 2016. He has been an alumnus of the German National Academic Foundation since 2009.

**Sebastian Born**, Co-Founder and Head of Mechanical Engineering

At the age of seven, Sebastian Born announced to his sister that he would 'become an inventor.' By age 14 he had cracked computer programming and was already developing his own electronic devices. After completing his Bachelor's Degree at Technical University of Berlin while also working as a research student at the Fraunhofer Institute, Sebastian went on to complete a Masters in Development and Construction at Technical University of Munich and started his career at the Institute of Machine Elements as a research associate. As Co-Founder and Head of Mechanical Systems and Verification, Sebastian is responsible for the development and design of the aircraft structure, with a focus on composites, as well as all testing activities, including flight test.

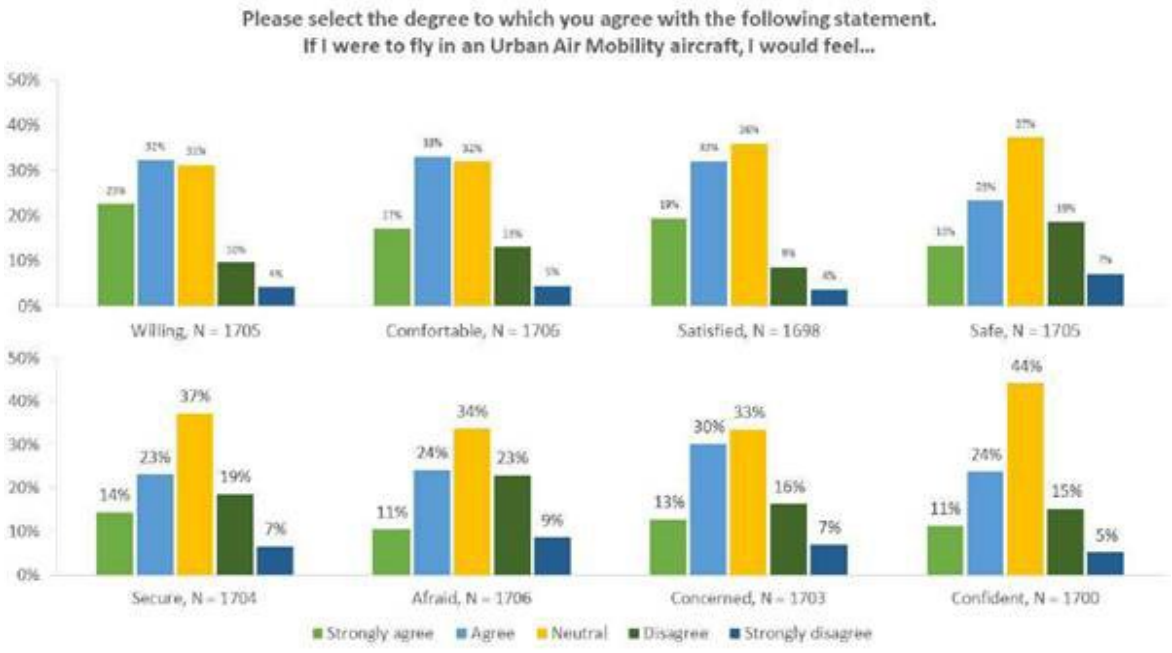
Source: Company documents.

**Exhibit 7** Lilium's Funding Rounds Before Going Public in March 2021

| Funding Round | Funding Amount ($ million) | Investors |
|---|---|---|
| Series A | 11 | Atomico |
| Series B | 90 | Atomico, Tencent, LGT, Obvious Ventures |
| Series C | 240 | Led by Tencent |

Source: Compiled by casewriters from Davis, Alexander, "Electric Plane Maker Lilium Aviation Lifts Off With Funding," The Wall Street Journal, December 5, 2016, via Factiva, accessed May 2021; Lilium, Newsroom, "Lilium secures $90 million in series B funding round" https://lilium.com/newsroom-detail/lilium-secures-90-million-in-series-b-funding-round, accessed March 2021; and Hollinger, Peggy, "Flying taxi start-up raises $240m from existing investors led by Tencent," *Financial Times*, March 23, 2020, https://www.ft.com/content/9eb5fcfe-6bda-11ea-89df-41bea055720b, accessed March 2021.

**Exhibit 8** Feelings about Flying in an Urban Air Mobility Aircraft, as of 2018




Source: Booz Allen Hamilton, "UAM Market Study - Technical Out Brief," October 19, 2018, p. 42., https://ntrs.nasa.gov/api/citations/20190000517/downloads/20190000517.pdf, accessed May 2019.

**Exhibit 9** Willingness to Fly Among Age Groups, as of 2018

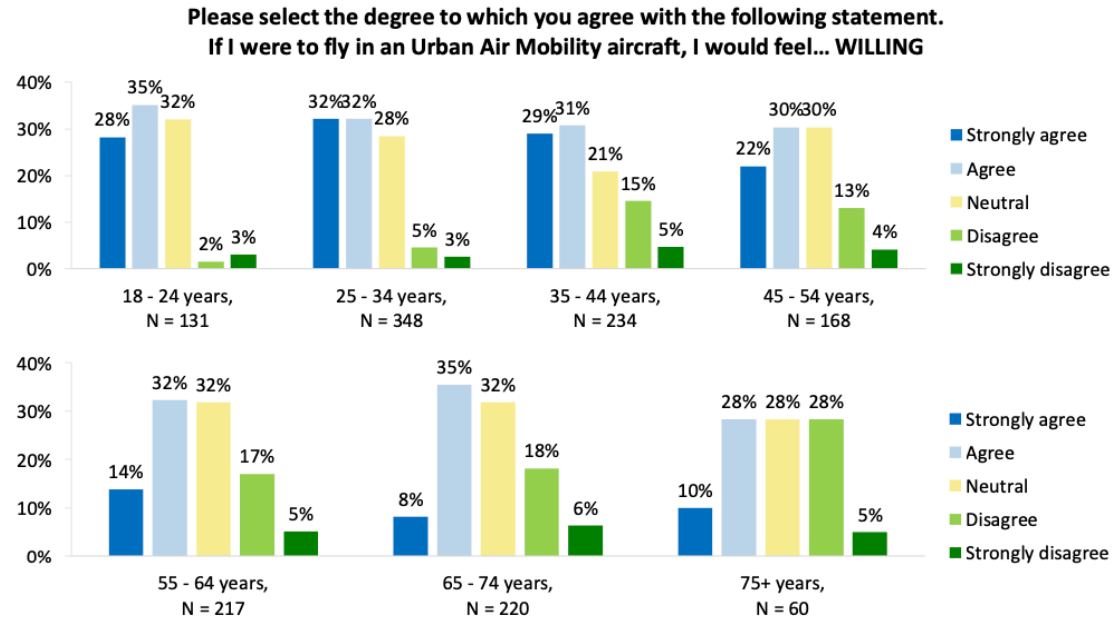
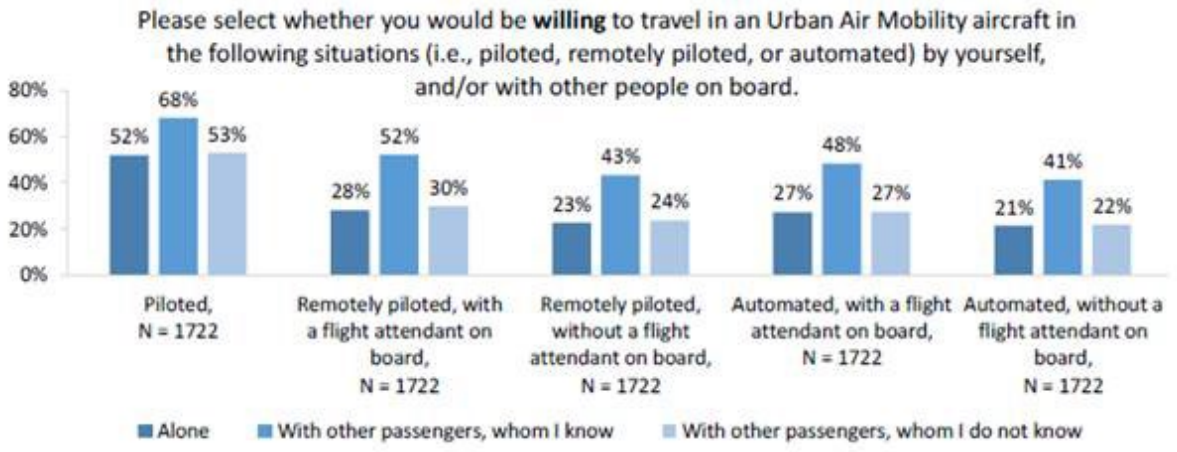



**Figure 22: Willingness to fly among age groups**

Source: Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, p. 64., https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2021.

**Exhibit 10** Perceptions Towards Technology and UAM, as of 2018




Source: Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, p. 65., https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2021.

**Exhibit 11** Thoughts and Impressions about Urban Air Mobility, as of 2018

After presenting the UAM concept to participants, the moderator then facilitated a discussion to gauge initial reactions to the concept, likes, and dislikes. Initial reactions to the concept included:

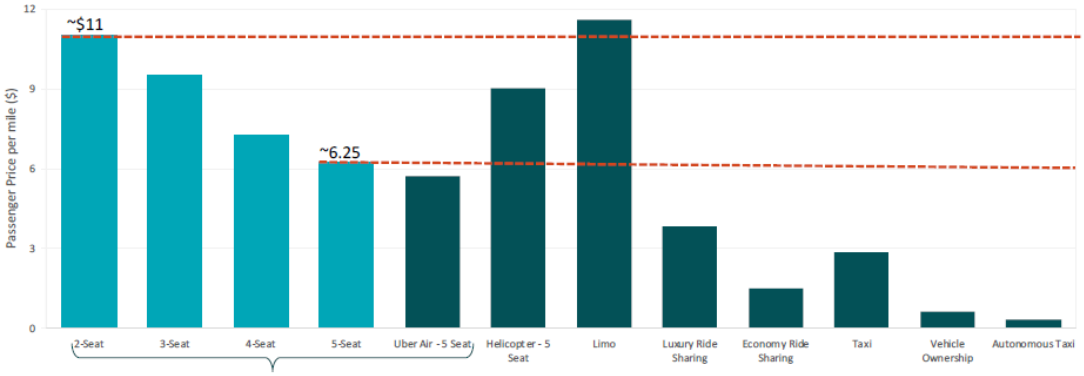
- Appreciation for not having to drive or sit in traffic;
- Convenience;
- Time savings and the ability to go farther distances faster than driving or public transportation;
- The ability to enjoy scenic views while flying; and
- The concept just "sounds cool."

However, not all initial reactions to the concept was positive. Common negative initial reactions included:

- The service looked expensive;
- Concern that the service will operate similar to a bus (with multiple take-off and landings for a single passenger trip);
- Impracticality for short distance travel;
- Inconvenient number of transfers as the concept assumes that you have to take a first-and-last mile connection using another travel mode to get to or from a vertiport;
- Demand would exceed available supply leading to high costs, long waits, or both;
- Limitations on landing locations;
- Low-level flight could be unsafe or visually undesirable;
- Greater safety risks associated with accidents than with ground transportation; and
- Potentially noisy in urban areas.

Source: Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, p. 54., https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2021.

**Exhibit 12** Price Comparison With Other Modes of Transportation, as of 2018




Source: Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, p. 92., https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2021.

**Exhibit 13** Regional Airlines in the US

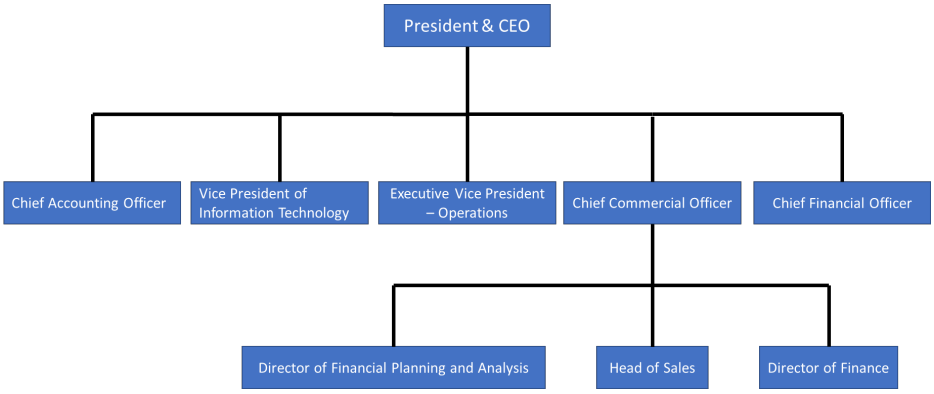
**a.** Key Figures for Regional Airlines in the US

| Major Local Airlines | Active Fleet Size (Parked Excluded) | Cities Served (2018) | Main area of focus | Market Share (#passengers 2020) | Market Share (Seats) | Gross (Net) Margin | | | | Aircraft Types |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2017 | 2018 | 2019 | 2020 | |
| SkyWest Airlines | 469 | 257 | Midwest | 34% | 37% | 12% (16%) | 12% (9%) | 9% (7%) | -20% (-4%) | Bombardier CRJ200s Bombardier CRJ700s Bombardier CRJ900s Embraer E170/175 |
| Republic Airways | 210 | 100 | Northeast | 15% | 18% | 16% (36%) | 12% (4%) | 12% (6%) | -3% (17%) | Embraer E170/175 |
| PSA Airlines | 123 | 100 | East Coast | 14% | 10% | 4% (3%) | -4% (-3%) | -1% (-1%) | -45% (-19%) | Bombardier: CRJ700s Bombardier: CRJ900s |
| Mesa Airlines | 122 | 129 | South, East | 12% | 10% | 16% (8%) | 14% (6%) | 16% (6%) | 8% (19%) | Boeing 737 Bombardier CRJ900s Embraer E170/175 |
| Endeavor Air | 154 | 145 | Mid, East | 12% | 13% | -10% (-11%) | -9% (-9%) | -10% (-10%) | -21% (-30%) | Bombardier CRJ200s Bombardier CRJ700s Bombardier CRJ900s |
| Envoy Air | 153 | 150 | South, Mid | 14% | 12% | 1% (1%) | -3% (-3%) | 1% (0%) | -23% (-0%) | Embraer E140/145 Embraer E170/175 |

Source: Compiled by casewriters from various sources, including: U.S. Department of Transportation, "Airline Quarterly Financial Review," "Major Group Passenger and All-Cargo Carriers," and "National Group – Passenger Carriers Only" https://www.transportation.gov/policy/aviation-policy/airline-quarterly-financial-review, SEC 10-K filings, https://www.sec.gov/, U.S. Department of the Treasury, "Airline and National Security Relief Programs," https://home.treasury.gov/policy-issues/coronavirus/assistance-for-american-industry/airline-and-national-security-relief-programs#:~:text=The%20ARP%20was%20enacted%20on,Eligible%20contractors%3A%20%241%20billion, accessed January 2022.

Note: Financial data for regional airlines are collected from the Department of Transportation (might include non-GAAP figures). Net margins in 2017 are occasionally larger than gross margins due to the Tax Cut and Jobs Act of 2017, enacted in December 2017. The same pattern in 2020 might be due to Covid relief from the Airline and National Security Relief Program under the CARES Act, the Consolidated Appropriations Act, and the American Rescue Plan Act.

**b.** Organizational Chart of a Typical Regional Airline




Source: Compiled by casewriters from Sky West Incorporated, "Corporate Information," "Leadership," https://inc.skywest.com/corporate-information/leadership/, The Org, "SkyWest Airlines," https://theorg.com/org/skywest-airlines, The Official Board, "SkyWest," https://www.theofficialboard.com/org-chart/skywest, all accessed January 2022.

Note: This chart is mainly based on organizational of SkyWest, the largest regional airline in the US.

**Exhibit 14** The Most Common Vehicles Used in Regional Air Travel Industry

| Aircraft Type | Average Capacity | Average Range (miles) | Number of Active Vehicles in the US | Cost Per Available Seat Mile (ASM) in US Cents |
|---|---|---|---|---|
| Bombardier CRJ900s | 73 | 1550 | 157 | 5.66 |
| Bombardier CRJ700s | 67 | 1280 | 321 | 6.72 |
| Bombardier CRJ200s | 50 | 1043 | 469 | 13.21 |
| Embraer E170/175 | 73 | 1564 | 624 | 4.88 |

Source: Compiled by casewriters from SkyWest, "Aircraft," https://www.skywest.com/about-skywest-airlines/aircraft, PlaneStats, "Aircraft Cost and Operations," https://www.planestats.com/bhsr_2019sep, Federal Aviation Administration, "Aircraft Operating Cost Categories," https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/econ-value-section-4-op-costs.pdf, Wikipedia, "List of Embraer E-Jet operators," https://en.wikipedia.org/wiki/List_of_Embraer_E-Jet_operators and Wikipedia, "List of Bombardier CRJ operators," https://en.wikipedia.org/wiki/List_of_Bombardier_CRJ_operators, all accessed January 2022.

Note: Capacity and range data are based on SkyWest Aircraft Report, which might differ from each vehicle's manufacturer's nominal figures. Cost per ASM for each aircraft is averaged across multiple airlines.

**Exhibit 15** Top Ride-Hailing Service Providers in the US

| Urban Mobility Providers | Fleet Size in US (end of 2020) | Cities Served in US | Major area of focus | Market Share (2020) | Market Share (of all medium distance travels) | Gross (Net) Margin | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2017 | 2018 | 2019 | 2020 |
| Uber | 1 million | 266 | US&CA, LatAM, Europe, ANZ, MEA, India | 71% | 25% | -55% (-54%) | -29% (10%) | -66% (-65%) | -44% (-61%) |
| Lyft | 1 million | 644 | US&CA | 29% | | -67% (-65%) | -45% (-42%) | -75% (-72%) | -76% (-74%) |

Source: Compiled by casewriters from SEC 19-K filings, https://www.sec.gov/, Uber, https://www.uber.com/, and Lyft, https://www.lyft.com/, accessed January 2022.

**Exhibit 16** Courier and Local Delivery Providers in the US

| Main courier and local delivery service providers | Fleet Size (Trucks/Delivery vans, Airplanes) | Market Share (2020) | Gross (Net) Margin | | | |
|---|---|---|---|---|---|---|
| | | | 2017 | 2018 | 2019 | 2020 |
| UPS | 127000, 288 | 35% | 11% (7%) | 10% (7%) | 11% (6%) | 9% (2%) |
| FedEx | 87000, 684 | 34% | 8% (5%) | 7% (7%) | 6% (1%) | 3% (2%) |
| Amazon (Delivery) | 40000/30000, 70 | 10% | - | - | - | - |

Source: Compiled by casewriters from SEC 19-K filings, https://www.sec.gov/, CNBC, https://www.cnbc.com/, Statista, https://www.statista.com/, accessed January 2022.

**Exhibit 17** Lilium's Expected 2026 Unit Economics for Its Two Complementary Business Lines, as of 2021

| **Lilium Network (B2C)** | |
|---|---|
| selling tickets on Lilium's own passenger networks operated by certified air carriers | |
| Annual revenue | ~$5 M |
| Annual contribution margin | ~25% |
| Jet payback period | ~2 years |
| Lifetime profit per jet | ~$10 M |

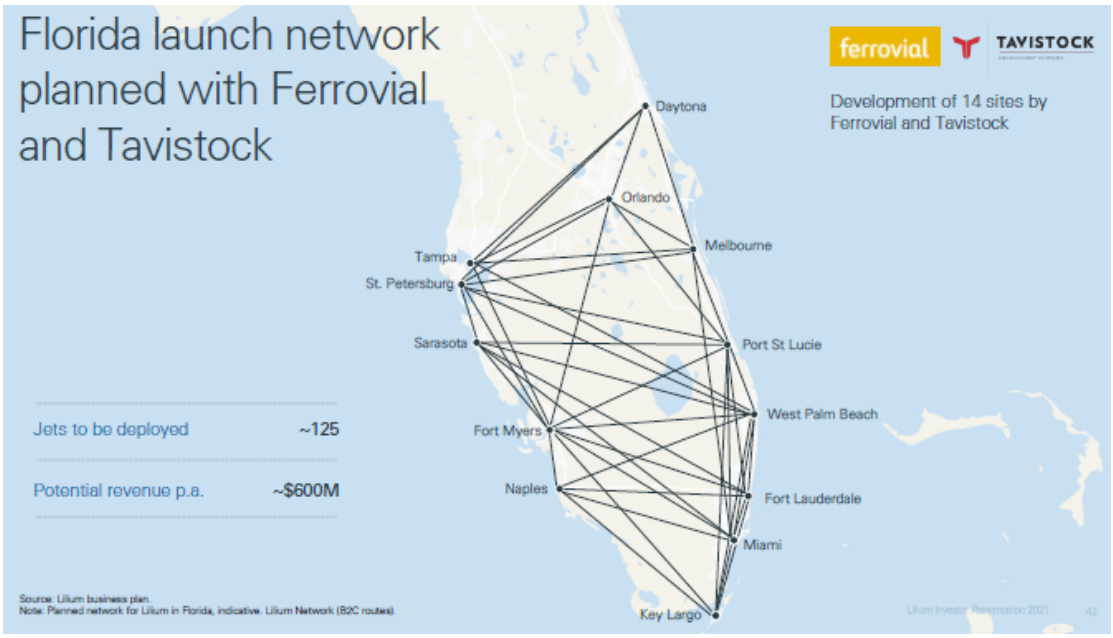
| **Turnkey Enterprise Solution (B2B)** | |
|---|---|
| selling fleets of aircraft with arranged service & maintenance support to corporates & governments | |
| Upfront payment | ~$4 M |
| Aftermarket support/year | ~$1 M |
| Jet payback period | immediate |
| Lifetime profit per jet | ~$5 M |

Source: Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf; and Lilium, "Capital Markets Day Presentation," August 2, 2021, https://lilium.com/files/redaktion/refresh_feb2021/investors/20210802_Capital_Markets_Day.pdf, all accessed December 2021

Note: Seven-Seater: 2026E. Figures converted at USD/EUR of 1.21. B2C LT profit calculated as contribution margin for given year * lifetime of jet (equal to 8 years). B2B LT profit calculated as upfront payment minus initial costs plus annual service margin * lifetime of jet (equal to 8 years). Aftermarket support includes spare parts (replacement parts and aircraft servicing) and digital infrastructure (software tools for safe and efficient operations, including aircraft health monitoring platform still under development, for predictive maintenance, flight planning, battery monitoring etc.), not operations. The annual service margin includes profits from these spare parts that Lilium intended to sell to operators with a margin and from the digital backend platform that it intends to sell with the jet.

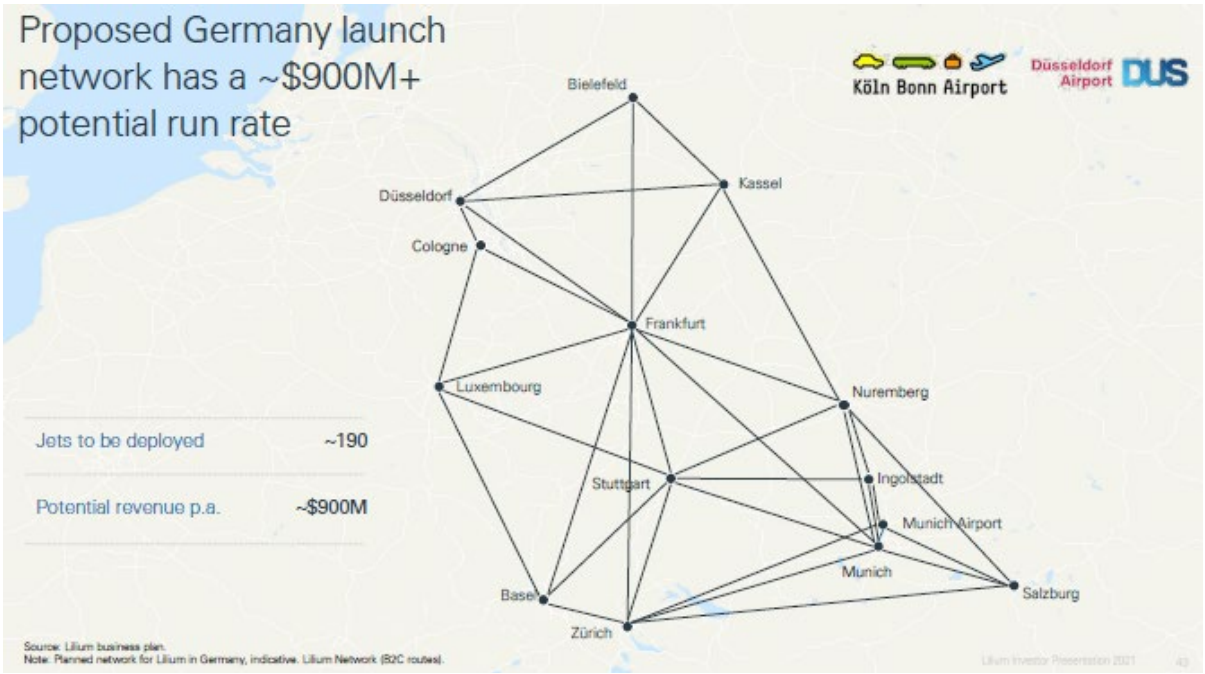
Lilium was considering the operating cost of its vehicle to be $1.75 per mile per passenger and was planning to charge $2.25 per mile per passenger.

**Exhibit 18** Lilium's Planned Florida Launch




Source: Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf, accessed May 2021.

**Exhibit 19** Lilium's Planned Germany Launch




Source: Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf, accessed May 2021.

**Exhibit 20** eVTOL Competitor Analysis

| | Lilium | Joby (Full-service) | Vertical (OEM) | Archer (Hybrid) |
|---|---|---|---|---|
| Range | 155+ miles | 150 miles | 100+ miles | 60 miles |
| Speed | 175 mph | 200mph | 200+mph | 150mph |
| Noise level | ~60dBA | 65dBA | 15dBA lower than a comparable helicopter | 45 dBA |
| Number of seats | 1 pilot, 6 passengers | 1 pilot, 4 passengers | 1 pilot, 4 passengers | 1 pilot, 4 passengers |
| Expected price per passenger mile | ~$2.25 | $3.00 | - | $3.30 |
| Expected revenues (million/jet/year) | $5 | $2.2 | - | $2.4 |
| Expected aircraft production | 2024E 90<br>2025E 325<br>2026E 600<br>2027E 950 | 2024E 115<br>2025E 272<br>2026E 550<br>- | 2024E 50<br>2025E 250<br>2026E 1,000<br>2027E 1,500 | 2024E 10<br>2025E 250<br>2026E 500<br>2027E 650 |
| Expected revenue ($bn) | 2024E 0.2<br>2025E 1.3<br>2026E 3.3<br>2027E 5.9 | 2024E 0.1<br>2025E 0.7<br>2026E 2.1<br>- | 2024E 0.2<br>2025E 0.9<br>2026E 3.6<br>2027E 5.4 | 2024E 0.0<br>2025E 1.0<br>2026E 2.2<br>2027E 3.4 |
| Expected EBITDA margin | -<br>2025E 5%<br>2026E 21%<br>2027E 25%<br>-<br>-<br>- | -<br>-<br>-<br>-<br>-<br>-<br>- | 2024E 5%<br>2025E 29%<br>2026E 38%<br>2027E 38%<br>2028E 38%<br>-<br>- | -<br>2025E 24%<br>2026E 29%<br>2027E 32%<br>2028E 33%<br>2029E 35%<br>2030E 37% |
| Expected Free Cash Flow ($mn) | 2024E (258)<br>2025E (69)<br>2026E 476<br>2027E 946 | 2024E (621)<br>2025E (718)<br>2026E (629)<br>- | 2024E (52)<br>2025E 127<br>2026E 772<br>2027E 1,263 | 2024E (205)<br>2025E (10)<br>2026E 157<br>2027E 500 |

Source: Compiled by casewriters from Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf; Joby Aviation, "Joby Dec'21 Corporate Deck," December 10, 2021, https://d1io3yog0oux5.cloudfront.net/_244994b597a7d747f769e82eef9bb555/jobyaviation/db/1086/9769/pdf/Investor+Deck+December+2021.pdf, Vertical Aerospace, "Vertical Investor Deck 2021," https://vertical-aerospace.com/wp-content/uploads/2021/06/pdf_Investor_Presentation.pdf; and Archer Aviation, "Archer Investor Deck 2021," https://s27.q4cdn.com/936913558/files/doc_presentations/Investor-Presentation.pdf, all accessed December 2021.

Note: Joby's per passenger mile price is calculated using its $1.73 reported price per mile available seat and a load factor of 2.3 for a 4-seater jet. Joby's aircraft production calculated based on average number of revenue generating aircraft per year. Joby FCF approximated using EBITDA less capex. Lilium FCF approximated using operating cash flow less capex.

## Endnotes

[1] Crunchbase, "Lilium," https://www.crunchbase.com/organization/lilium-aviation/company_financials, accessed December 2021.

[2] Palmer, Maija, "Lilium hopes to soar with launch of electric air taxis," *Financial Times*, March 15, 2019, https://www.ft.com/content/e0b66e56-1364-11e9-a168-d45595ad076d, accessed May 2021.

[3] Morgan Stanley, "Are Flying Cars Ready for Takeoff?" January 23, 2019, https://www.morganstanley.com/ideas/autonomous-aircraft, accessed May 2021.

[4] Reichmann, Kelsey, "Lilium Reveals New 7-Seater eVTOL and Merger with Qell," *Aviation Today*, March 30, 2021, https://www.aviationtoday.com/2021/03/30/lilium-reveals-new-7-seater-evtol-merger-qell/, accessed May 2021.

[5] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[6] Gleb Tritus, "Zunum — A High-flyer with Tesla-like Ambitions?," *Medium*, August 15, 2018, https://medium.com/@glebtritus/zunum-a-high-flyer-with-tesla-like-ambitions-5c3ac3f77f04, accessed May 2021.

[7] Bogaisky, Jeremy, "Lilium's New Course: On Verge Of Going Public, It's Working On A Bigger Air Taxi. Can It Deliver?" *Forbes*, February 10, 2021, https://www.forbes.com/sites/jeremybogaisky/2021/02/10/lilium-evtol-spac-air-taxi/?sh=49ad0205627c, accessed May 2021.

[8] Hader, Manfred, "How Airbus is positioning itself and overcoming the challenges of the UAM market," Roland Berger, April 17, 2020, https://www.rolandberger.com/en/Insights/Publications/Urban-Air-Mobility-The-way-to-a-sustainable-intercity-air-transport.html, accessed May 2021.

[9] Morgan Stanley Research, "Flying Cars: Investment Implications of Autonomous Urban Air Mobility" (December 2, 2018), accessed May 2019.

[10] Uber, "Uber Elevate," "Fast-Forwarding to a Future of On-Demand Urban Air Transportation," (October, 2016), https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf, accessed May 2019.

[11] Idem.

[12] NASA, "Urban Air Mobility Market (UAM) Study" (November 2018), https://www.nasa.gov/sites/default/files/atoms/files/uam-market-study-executive-summary-v2.pdf, accessed May 2019.

[13] Johnston, Tore, Robin Riedel, and Shivika Sahdev, "To take off, flying vehicles first need places to land," McKinsey & Company, August 31, 2020, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/to-take-off-flying-vehicles-first-need-places-to-land, accessed May 2021.

[14] Uber, "Uber Elevate," "Fast-Forwarding to a Future of On-Demand Urban Air Transportation," (October, 2016), https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf, accessed May 2019.

[15] Lineberger, Robin, Aijaz Hussain, Matt Metcalfe and Vincent Rutgers, "Infrastructure barriers to the elevated future of mobility," Deloitte, May 30, 2019; and Duvall, Tyler, Alastair Green, Meredith Langstaff, and Kayla Miele, "Air-mobility solutions: What they'll need to take off," McKinsey and Company, February 19, 2019, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/air-mobility-solutions-what-theyll-need-to-take-off, accessed May 2021.

[16] Zannoni, Mark, "Cities Must Develop Regulations Now for Urban Air Mobility," *Medium*, March 5, 2020, https://medium.com/@MarkZannoni/cities-must-develop-regulations-for-urban-air-mobility-today-d73aafd559d1, accessed May 2021.

[17] Duvall, Tyler, Alastair Green, Meredith Langstaff, and Kayla Miele, "Air-mobility solutions: What they'll need to take off," McKinsey and Company, February 19, 2019, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/air-mobility-solutions-what-theyll-need-to-take-off, accessed May 2021.

[18] Lineberger, Robin, Aijaz Hussain, Matt Metcalfe, Vincent Rutgers, "Infrastructure barriers to the elevated future of mobility," Deloitte, May 30, 2019, https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/infrastructure-barriers-to-urban-air-mobility-with-VTOL.html, accessed May 2021.

[19] Tyler Duvall, Alastair Green, Meredith Langstaff, and Kayla Miele, "Air-mobility solutions: What they'll need to take off," McKinsey and Company, February 19, 2019, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/air-mobility-solutions-what-theyll-need-to-take-off, accessed May 2021.

[20] Unmanned Airspace "Urban air mobility takes off in 64 towns and cities worldwide," December 10, 2018, https://www.unmannedairspace.info/urban-air-mobility/urban-air-mobility-takes-off-63-towns-cities-worldwide/, accessed May 2021.

[21] EU Commission, "Commission welcomes European cities joining the Urban Air Mobility initiative," May 30, 2021, https://transport.ec.europa.eu/news/commission-welcomes-european-cities-joining-urban-air-mobility-initiative-2018-09-28_en, accessed May 2021.

[22] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[23] "To go from science fiction to reality, urban flying vehicles need to operate way more cheaply than helicopter shuttles do," McKinsey & Company, September 14, 2020, https://www.mckinsey.com/featured-insights/coronavirus-leading-through-the-crisis/charting-the-path-to-the-next-normal/to-go-from-science-fiction-to-reality-urban-flying-vehicles-need-to-operate-way-more-cheaply-than-helicopter-shuttles-do, accessed May 2021.

[24] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[25] Volocopter, "The Roadmap to scalable urban air mobility" (2021), https://www.volocopter.com/content/uploads/20210324_Volocopter_WhitePaper_Roadmap_to_scalable_UAM_m.pdf, accessed May 2021.

[26] Hader, Manfred, "Passenger drones ready for take-off," Roland Berger, November 21, 2018, https://www.rolandberger.com/en/Insights/Publications/Passenger-drones-ready-for-take-off.html, accessed May 2021.

[27] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[28] Morgan Stanley, "Flying Cars: Investment Implications of Autonomous Urban Air Mobility," December 2, 2018.

[29] Reichmann, Kelsey, "Air Taxis Likely to Not Deploy in Early to Mid 2020s as Predicted, New Report Says," *Aviation Today*, April 9, 2021, https://www.aviationtoday.com/2021/04/09/air-taxis-likely-to-not-deploy-in-early-to-mid-2020s-as-predicted-report-says/, accessed May 2021.

[30] Archer Aviation, "Archer Investor Deck 2021," https://s27.q4cdn.com/936913558/files/doc_presentations/Investor-Presentation.pdf, accessed May 2021; and "Morgan Stanley Predicts $1.5 Trillion market for Urban Aviation by 2040," *Transport Up,* December 10, 2018, https://transportup.com/headlines-breaking-news/infrastructure/morgan-stanley-predicts-1-5-trillion-market-for-urban-aviation-by-2040/, accessed May 2021.

[31] McGee, Patrick and James Fontanella-Khan, "LinkedIn and Zynga founders near deal to buy flying taxi start-up Joby," *Financial Times*, February 11, 2021, https://www.ft.com/content/42feff1d-8228-4c93-bd78-b537d9eb9fa7, accessed May 2021.

[32] Hornyak, Tom, "The flying taxi market may be ready for takeoff, changing the travel experience forever," CNBC, March 7, 2020, https://www.cnbc.com/2020/03/06/the-flying-taxi-market-is-ready-to-change-worldwide-travel.html, accessed May 2021.

[33] Roland Berger, "Urban Air Mobility" (November 2018), https://www.rolandberger.com/publications/publication_pdf/Roland_Berger_Urban_Air_Mobility.pdf, accessed May 2019.

[34] McGee, Patrick and James Fontanella-Khan, "LinkedIn and Zynga founders near deal to buy flying taxi start-up Joby," *Financial Times*, February 11, 2021, https://www.ft.com/content/42feff1d-8228-4c93-bd78-b537d9eb9fa7, accessed May 2021.

[35] Roland Berger, "Urban Air Mobility" (November 2018), https://www.rolandberger.com/publications/publication_pdf/Roland_Berger_Urban_Air_Mobility.pdf, accessed May 2019.

[36] "Volocopter VoloCity," *Electric VTOL News*, https://evtol.news/volocopter-volocity#:~:text=by%20ground%20transportation.-,Noise%20Emissions,coming%20from%20the%20propeller%20tips., accessed May 2021.

[37] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[38] Volocopter, "Pioneering the urban air taxi revolution 1.0" (June 2019), https://www.volocopter.com/content/uploads/Volocopter-WhitePaper-1-01.pdf, accessed May 2021.

[39] Volocopter, "VoloCity," *Electric VTOL News*, https://evtol.news/volocopter-volocity#:~:text=by%20ground%20transportation.-,Noise%20Emissions,coming%20from%20the%20propeller%20tips., accessed May 2021.

[40] Volocopter, "Pioneering the urban air taxi revolution 1.0" (June 2019), https://www.volocopter.com/content/uploads/Volocopter-WhitePaper-1-01.pdf, accessed May 2021.

[41] Uber, "Uber Elevate," "Fast-Forwarding to a Future of On-Demand Urban Air Transportation," (October, 2016), https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf, accessed May 2019.

[42] Roland Berger, "Urban Air Mobility" (November 2018), https://www.rolandberger.com/publications/publication_pdf/Roland_Berger_Urban_Air_Mobility.pdf, accessed May 2019.

[43] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[44] Uber, "Uber Elevate," "Fast-Forwarding to a Future of On-Demand Urban Air Transportation," (October, 2016), https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf, accessed May 2019.

[45] Porsche Consulting, "The Future of Vertical Mobility" (March 2018), https://newsroom.porsche.com/en/themes/porsche-consulting/porsche-consulting-study-the-future-of-vertical-mobility-flights-cities-transportation-future-taxis-15088.html, accessed May 2019.

[46] Palmer, Maija, "Lilium hopes to soar with launch of electric air taxis," *Financial Times*, March 15, 2019, https://www.ft.com/content/e0b66e56-1364-11e9-a168-d45595ad076d, accessed May 2021.

[47] Bogaisky, Jeremy, "Lilium's New Course: On Verge Of Going Public, It's Working On A Bigger Air Taxi. Can It Deliver?" *Forbes*, February 10, 2021, https://www.forbes.com/sites/jeremybogaisky/2021/02/10/lilium-evtol-spac-air-taxi/?sh=3d8bc843627c, accessed May 2021.

[48] Lilium, "Meet the Founders," https://lilium.com/newsroom-detail/meet-the-founders, accessed July 2019.

[49] Palmer, Maija, "Lilium hopes to soar with launch of electric air taxis," *Financial Times*, March 15, 2019, https://www.ft.com/content/e0b66e56-1364-11e9-a168-d45595ad076d, accessed May 2021.

[50] Lilium, "Our beliefs," https://lilium.com/our-beliefs, accessed May 2021.

[51] Dorbian, Iris, "Lilium Aviation Picks up Series A Funds," *PE Hub Network*, December 5, 2016, via Factiva, accessed May 2021.

[52] Thelen, Frank, "Our Lilium Aviation journey: from seed to 700+ people and over one billion in funding," Linkedin, April 1, 2021, https://www.linkedin.com/pulse/our-lilium-aviation-journey-from-seed-700-people-over-frank-thelen, accessed May 2021.

[53] Alexander Davis, "Electric Plane Maker Lilium Aviation Lifts Off With Funding," *The Wall Street Journal*, December 5, 2016, via Factiva, accessed May 2021.

[54] Hollinger, Peggy, "Flying taxi start-up raises $240m from existing investors led by Tencent," *Financial Times*, March 23, 2020, https://www.ft.com/content/9eb5fcfe-6bda-11ea-89df-41bea055720b, accessed March 2021; and Pojuner, Isabella, "Europe now has 70 startup unicorns," *Sifted*, May 10, 2021, https://sifted.eu/articles/europe-unicorns-2021/, accessed January 2022.

[55] Hawkins, Andrew J. "Flying taxi startup Lilium goes public via SPAC, unveils its new electric aircraft, " *The Verge*, March 30, 2021, https://www.theverge.com/2021/3/30/22358027/lilium-flying-taxi-evtol-spac-electric-aviation-gm-engle, accessed May 2021.

[56] Lilium, "Lilium closes business combination with Qell Acquisition Corp., will begin trading on Nasdaq under the symbol "LILM" on September 15," September 14, 2021, https://lilium.com/newsroom-detail/lilium-closes-business-combination-with-qell-begin-trading-on-nasdaq-under-lilm, accessed January 2022.

[57] Head, Elan, "Air taxi SPACs tout ambitious projections, but is a reality check on the way?," *eVTOL.com*, April 14, 2021, https://evtol.com/features/evtol-air-taxi-spacs-ambitious-projections-liability/, accessed December 2021.

[58] Aliaj, Ortenca and Miles Kruppa, "The Spac machine sputters back to life after dramatic meltdown," Financial Times, November 21, 2021, https://www.ft.com/content/d1723a8e-c146-4d48-8475-01cc9947a5d6, accessed December 2021.

[59] Lilium, "Lilium Newsroom," "An introduction to the Lilium Jet", May 21, 2019, https://lilium.com/newsroom-detail/youve-never-seen-anything-like-this-an-introduction-to-the-lilium-jet, accessed May 2021.

[60] Wiegand, Daniel, "Lilium Blog," "Introducing the future of transport," September 19, 2016, https://blog.lilium.com/lilium-news-fa5dd029cebd, accessed May 2021.

[61] Thelen, Frank, "Our Lilium Aviation journey: from seed to 700+ people and over one billion in funding," Linkedin, April 1, 2021, https://www.linkedin.com/pulse/our-lilium-aviation-journey-from-seed-700-people-over-frank-thelen, accessed May 2021.

[62] Head, Elan, "Lilium eVTOL prototype damaged in ground fire," *eVTOL*, February 28, 2020, https://evtol.com/news/lilium-evtol-catches-fire/#:~:text=The%20German%20eVTOL%20developer%20Lilium,ground%20maintenance%20activities%20on%20Feb.&text=In%20October%2C%20Lilium%20shared%20footage,%2Fh%20(62%20mph)., accessed May 2021.

[63] "Air taxi startup Lilium raises $240 million despite coronavirus scare," *Reuters*, March 23, 2020, https://www.reuters.com/article/us-aviation-taxis-lilium-idUKKBN21A19I, accessed May 2021.

[64] Alcock, Charles, "Lilium offers a clearer view of the science and technology behind its ducted fan eVTOL aircraft," Future Flight, April 14, 2021, https://www.futureflight.aero/news-brief/2021-04-14/lilium-offers-clearer-view-science-and-technology-behind-its-ducted-fan-evtol, accessed May 2021.

[65] Reichmann, Kelsey, "Lilium Reveals New 7-Seater eVTOL and Merger with Qell," *Aviation Today*, March 30, 2021, https://www.aviationtoday.com/2021/03/30/lilium-reveals-new-7-seater-evtol-merger-qell/, accessed May 2021.

[66] Bogaisky, Jeremy, "Lilium's New Course: On Verge Of Going Public, It's Working On A Bigger Air Taxi. Can It Deliver?" *Forbes*, February 10, 2021, https://www.forbes.com/sites/jeremybogaisky/2021/02/10/lilium-evtol-spac-air-taxi/?sh=49ad0205627c, accessed May 2021.

[67] Bogaisky, Jeremy, "Lilium To Launch Air Taxi Network In Florida Centered On Orlando," *Forbes*, November 11, 2020, https://www.forbes.com/sites/jeremybogaisky/2020/11/11/lilium-to-launch-air-taxi-network-in-florida-centered-on-orlando/?sh=7f1da0e173a0, accessed May 2021.

[68] Johnston, Tore, Robin Riedel, and Shivika Sahdev, "To take off, flying vehicles first need places to land," McKinsey & Company, August 31, 2020, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/to-take-off-flying-vehicles-first-need-places-to-land, accessed May 2021.

[69] Palmer, Maija, "Lilium hopes to soar with launch of electric air taxis," *Financial Times*, March 15, 2019, https://www.ft.com/content/e0b66e56-1364-11e9-a168-d45595ad076d, accessed May 2021.

[70] Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2019.

[71] "McKinsey forecasts demand for 60,000 air taxi pilots by 2028," *eVTOL.com*, June 10, 2020, https://evtol.com/news/mckinsey-uam-pilot-forecast/, accessed May 2021.

[72] Booz Allen Hamilton, "Urban Air Mobility (UAM) Market Study," November 21, 2018, https://ntrs.nasa.gov/api/citations/20190001472/downloads/20190001472.pdf, accessed May 2019.

[73] Idem.

[74] Refinitiv, "Sustainable infrastructure: The green rush," https://www.refinitiv.com/en/infrastructure-investing/insights/sustainable-infrastructure, accessed December 2021.

[75] Air Niugini, "Air Niugini receives Air Operator's Certificate (AOC)," June 29, 2016, https://www.airniugini.com.pg/about-us/news/air-niugini-receives-air-operators-certificate-aoc/, accessed December 2021.

[76] Joby Aviation, "All-Electric Air Mobility," https://www.jobyaviation.com/, accessed May 2021.

[77] Garrett-Glaser, Brian, "Joby Aviation raises $1.6 billion in SPAC merger at $6.6 billion valuation," *eVTOL.com*, February 24, 2021, https://evtol.com/features/joby-aviation-evtol-spac-merger-reinvent-technology/; and McGee, Patrick and James Fontanella-Khan, "LinkedIn and Zynga founders near deal to buy flying taxi start-up Joby," *Financial Times*, February 11, 2021, https://www.ft.com/content/42feff1d-8228-4c93-bd78-b537d9eb9fa7, accessed May 2021.

[78] Joby Aviation, "Joby Aviation Welcomes New $75M Investment from Uber as it Acquires Uber Elevate and Expands Partnership," December 8, 2020, https://www.jobyaviation.com/news/joby-aviation-welcomes-new-75m-investment-from-uber-as-it-acquires-uber-elevate-and-expands-partnership/, accessed May 2021.

[79] Joby Aviation, "Joby Dec'21 Corporate Deck," December 10, 2021, https://d1io3yog0oux5.cloudfront.net/_244994b597a7d747f769e82eef9bb555/jobyaviation/db/1086/9769/pdf/Investor+Deck+December+2021.pdf, accessed December 2021.

[80] Garrett-Glaser, Brian, "Joby Aviation receives first airworthiness approval from U.S. military for electric VTOL aircraft," *Verticalmag,* December 10, 2020, https://verticalmag.com/news/joby-aviation-receives-first-airworthiness-approval-electric-vtol-aircraft/, accessed May 2021.

[81] Fontanella-Khan, James and Patrick McGee, "Flying taxi start-up Joby to go public in deal with LinkedIn and Zynga founders," *Financial Times*, February 24, 2021, https://www.ft.com/content/fed9f16e-0ebf-471b-bd10-9698784537df, accessed May 2021.

[82] Bogaisky, Jeremy, "With Toyota's Help, This Secretive Entrepreneur May Finally Give Us Flying Cars," *Forbes,* November 23, 2020, https://www.forbes.com/sites/jeremybogaisky/2020/11/23/joby-toyota-flying-cars/?sh=616ec2fe4cb8, accessed December 2020.

[83] McGee, Patrick, "Toyota makes big bet on flying taxi company Joby," *Financial Times*, January 16, 2020, https://www.ft.com/content/bfaabfe0-37ea-11ea-a6d3-9a26f8c3cba4, accessed May 2021.

[84] Morgan, Sam, "Austria's trains take over short-haul flight route," *EURACTIV*, July 3, 2020, https://www.euractiv.com/about-euractiv/; and, Grasso Macola, Ilaria, "EU ponders short-haul flight ban," *Airport-technology.com*, July 13, 2021, https://www.airport-technology.com/analysis/should-eu-impose-ban-short-haul-flights/, accessed December 2021.

[85] Rushing, Ellie, "Urban Transit Looks to the Skies; Two local N.J. firms are teaming up with Uber to make air taxis an affordable option. The company hopes to roll them out by 2023," *The Philadelphia Inquirer*, July 28, 2019, via Factiva, accessed September 2019.

[86] Rivero, Nicolás, "Amazon's ambitions to build an air freight empire got a lift from the pandemic," *Quartz*, October 21, 2021, https://qz.com/2076674/the-pandemic-hastened-amazons-plans-to-build-a-freight-airline/, accessed December 2019.

[87] Reichmann, Kelsey, "DHL Express Adds 12 Electric Aircraft to Fleet with New Purchase," *Aviation Today*, August 6, 2021, https://www.aviationtoday.com/2021/08/06/dhl-express-adds-12-electric-aircraft-fleet-new-purchase/, accessed December 2021.

[88] Statista, "Market share of the leading couriers and local delivery providers in the United States in 2020," September 2021, https://www.statista.com/statistics/940072/market-share-of-couriers-local-delivery-providers-united-states/#:~:text=This%20statistic%20illustrates%20the%20market,10%20percent%20of%20the%20market, accessed January 2022.

[89] Topham, Gwyn, "UK air taxi firm Vertical Aerospace to float on New York stock market," *The Guardian*, https://www.theguardian.com/technology/2021/jun/11/uk-air-taxi-firm-vertical-aerospace-to-float-on-new-york-stock-market, June 11, 2021, accessed November 24, 2021.

[90] Head, Elan, "How Vertical Aerospace is progressing toward first flight of the VA-X4 eVTOL," *eVTOL.com*, September 1, 2021, https://evtol.com/q-and-a/tim-williams-vertical-aerospace-va-x4-evtol-progress/, accessed November 24, 2021.

[91] "Vertical Aerospace to go public in $2.2 billion SPAC deal," *Reuters*, June 11, 2021, https://www.reuters.com/business/aerospace-defense/american-airlines-invest-electric-aircraft-maker-vertical-aerospace-2021-06-10/, accessed November 24, 2021.

[92] Topham, Gwyn, "UK air taxi firm Vertical Aerospace to float on New York stock market," *The Guardian*, June 11, 2021, https://www.theguardian.com/technology/2021/jun/11/uk-air-taxi-firm-vertical-aerospace-to-float-on-new-york-stock-market, accessed November 24, 2021.

[93] Electric VTOL News, "Archer (Unnamed Five Seat eVTOL)," https://evtol.news/archer/, accessed May 2021.

[94] Kirsten Korosec, "Archer Aviation aims to launch network of urban air taxis in Los Angeles by 2024," February 23, 2021, https://techcrunch.com/2021/02/23/archer-aviation-aims-to-launch-network-of-urban-air-taxis-in-los-angeles-by-2024/, accessed May 2021.

[95] Fontanella-Khan, James and Patrick McGee, "Flying taxi start-up Joby to go public in deal with LinkedIn and Zynga founders," *Financial Times*, February 24, 2021, https://www.ft.com/content/fed9f16e-0ebf-471b-bd10-9698784537df, accessed May 2021.

[96] Rucinski, Tracy and Niket Nishant, "Archer to go public, United Airlines invests and orders electric aircraft," Financial Times, February 10, 2021, https://www.reuters.com/article/us-archer-m-a-atlas-crest-idUSKBN2AA1EL, accessed May 2021.

[97] Garrett-Glaser, Brian, "Archer to go public at $3.8 billion valuation, United Airlines orders $1 billion worth of eVTOL aircraft," *eVTOL*, February 10, 2021, https://evtol.com/features/archer-public-billion-valuation-united-airlines-orders-evtol-aircraft/, accessed April 2021 and United Airlines, Newsroom, "United to Work with Archer Aviation to Accelerate Production of Advanced, Short-Haul Electric Aircraft," February 10, 2021, https://hub.united.com/2021-02-10-united-to-work-with-archer-aviation-to-accelerate-production-of-advanced-short-haul-electric-aircraft-2650426294.html, accessed December 2021.

[98] Korosec, Kirsten, "Archer Aviation aims to launch network of urban air taxis in Los Angeles by 2024," *TechCrunch*, February 23, 2021, https://techcrunch.com/2021/02/23/archer-aviation-aims-to-launch-network-of-urban-air-taxis-in-los-angeles-by-2024/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAMViZnd_xZNmu69CXw_fPZ8l0IztFroltbYHXBsemQveD0YPRsARyqKXeFVUi2JnQt-I8mYfTN3JYk4jBkEP5lqIurOdjmXc5Cl2rYo271BpEB6pM9TWwKq7kC50cm2MnzKGfk2fYXnBb3NuGtfB644BujlIki12bkxl1cK-PRrr, accessed May 2021.

[99] Idem.

[100] Idem.

[101] Fontanella-Khan, James and Patrick McGee, "Flying taxi start-up Joby to go public in deal with LinkedIn and Zynga founders," *Financial Times*, February 24, 2021, https://www.ft.com/content/fed9f16e-0ebf-471b-bd10-9698784537df, accessed May 2021.

[102] Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf, accessed May 2021.

[103] Head, Elan, "Lilium reveals seven-seat eVTOL and confirms SPAC merger with Qell," eVTOL, March 30, 2021, https://evtol.com/news/lilium-seven-seat-evtol-spac-merger-qell/, accessed May 2021.

[104] Reichmann, Kelsey, "Lilium Expands into Brazil with Billion Dollar Azul Deal," *Aviation Today*, August 2, 2021, https://www.aviationtoday.com/2021/08/02/lilium-expands-brazil-billion-dollar-azul-deal/, accessed December 2021.

[105] Lilium, "Lilium holds Capital Markets Day, announces plan for $1 billion commercial deal & strategic alliance with leading Brazilian airline Azul and the appointment of new board members following business combination with Qell," August 2, 2021, https://lilium.com/newsroom-detail/capital-markets-day-planned-1-billion-commercial-deal-with-brazilian-airline-azul-appointment-of-new-board-members, accessed December 2021.

[106] Martin, Iain "German Air Taxi Startup Lilium To List In $3.3 Billion SPAC Merger," Forbes, March 30, 2021, https://www.forbes.com/sites/iainmartin/2021/03/30/german-air-taxi-startup-lilium-to-list-in-33-billion-spac-merger/?sh=690d0a48482c; and Reichmann, Kelsey, "Lilium Reveals New 7-Seater eVTOL and Merger with Qell," *Aviation Today*, March 30, 2021, https://www.aviationtoday.com/2021/03/30/lilium-reveals-new-7-seater-evtol-merger-qell/, accessed May 2021.

[107] "Lilium announces collaboration with Düsseldorf and Cologne/Bonn airports," *eVTOL*, September 8, 2020, https://evtol.com/news/lilium-collaboration-dusseldorf-cologne-bonn-airports/, accessed May 2021.

[108] Lilium, "Investor Presentation—March 2021," https://qellspac.com/assets/documents/Qell-and-Lilium-Investor-Presentation.pdf, accessed May 2021.

[109] Bogaisky, Jeremy, "Lilium's New Course: On Verge Of Going Public, It's Working On A Bigger Air Taxi. Can It Deliver?" *Forbes,* February 10, 2021, https://www.forbes.com/sites/jeremybogaisky/2021/02/10/lilium-evtol-spac-air-taxi/?sh=3d8bc843627c, accessed May 2021.

[110] Donovan, Dean, " Joby, Volocopter And Lilium Are Making A Risky, Expensive Bet On Vertical Integration To Invent Urban Air Mobility," *Forbes*, December 15,2020, https://www.forbes.com/sites/deandonovan/2020/12/15/joby-volocopter-and-lilium-are-making-a-risky-expensive-bet-on-vertical-integration-to-invent-urban-air-mobility/?sh=365b3b0122d7, accessed May 2021.

[111] Bogaisky, Jeremy, "Lilium's New Course: On Verge Of Going Public, It's Working On A Bigger Air Taxi. Can It Deliver?" *Forbes,* February 10, 2021, https://www.forbes.com/sites/jeremybogaisky/2021/02/10/lilium-evtol-spac-air-taxi/?sh=3d8bc843627c, accessed May 2021.