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Focus Economics - Mobility

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"Urban Air Mobility": Multicopter & Co approach the starting field

Short & clear

- Urban Air Mobility, i.e. the new mobility in urban airspace, is taking shape: New companies and innovative projects around the use of unmanned, electrically powered flight systems are in the starting blocks.
- Air taxis, airport shuttles and intercity flights are the focus of the competition for the best drive concepts.
- Significant market growth from 2030 onwards is expected to be accompanied by industry consolidation.

Record funding for air taxi pioneers

▶ The market for "urban air" mobility is growing rapidly

The commercial use of small drones for observation purposes is already part of everyday life today, e.g. for the inspection of power lines, roofs or the monitoring of agricultural areas and infrastructure. In the meantime, however, more and more concepts are being developed for drone applications for the transport of goods and people.

A lot has happened in recent years, especially in the future market of so-called "urban air mobility" (UAM), i.e. mobility in urban airspace. New companies and innovative projects around the use of unmanned, electrically powered flight systems are driving the growth of the industry. The number of UAM projects has increased rapidly since 2016. Accordingly, financing has also grown rapidly in recent years, so that in 2020 alone, more than 1 billion US dollars in venture capital was invested in the UAM market, even though the companies are not yet making any sales. And this record amount has already been surpassed in the first months of 2021. Currently, there are about 200 companies worldwide that deal with this topic - the majority of them are start-ups (about 150 companies), but established aviation groups such as Boeing or Airbus and some car manufacturers (e.g. Porsche) are also active here.

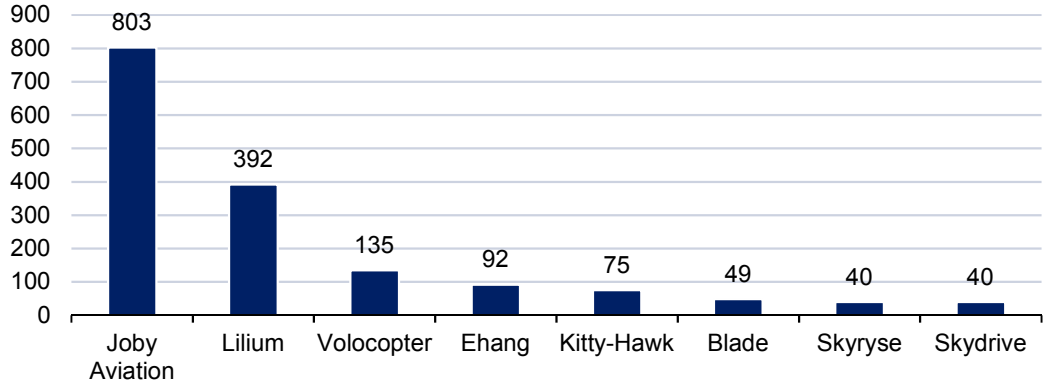
▶ Confident investors

The reason for the high investments lies in the increasing confidence in the feasibility of the start-ups' prototypes. In addition, there is growing public acceptance of the flight vehicles - one of the biggest hurdles to overcome for market success. At the same time, however, open issues such as safety, infrastructure (take-off and landing sites), data protection and the feasibility of autonomous flight systems still need to be clarified.

Regardless, the regulatory basis for UAM is increasingly improving. Singapore, Dubai and Sao Paolo, for example, are currently promoting the staffing of drones with pilots, while this is still subject to regulatory hurdles in other locations. It can be assumed that the first air

taxis will go into operation where, on the one hand, the need is great to relieve the road network and, on the other hand, economic and, above all, regulatory hurdles are low.

Financing volumes of start-ups in the UAM market
Balance until 31.12.2020, in million US dollars



Sources: Handelsblatt, Roland Berger, BayernLB Research

In the meantime, the companies are very optimistic and ambitious and plan to launch the first passenger services before 2025. Despite the challenges that still exist and the Corona pandemic, the companies expect the market to continue to develop positively with increasing investments.

▶ Start-ups drive market entry

In order to be able to realise their ambitious goals, some start-ups are already preparing intensively for market entry, applying for the approval of their aircraft and dealing with the development of the necessary infrastructure. One of the leading companies in terms of marketability is Joby Aviation from the USA with 20 active patents in the field of air taxis (as of the end of 2020). German UAM pioneers Lilium and Volocopter are also pushing ahead with their market launches. Lilium plans to obtain approval for its jet in the USA and Europe at the end of 2023. The first passenger flights are then to follow from 2024. Volocopter has already applied for approval for its VoloCity taxi in the USA and Europe and hopes for approval by the end of 2022. Passengers are then to be transported for the first time in a publicity-boosting manner at the Olympic Games in Paris in 2024. A first test flight recently succeeded at the Paris Air Forum and received a lot of public attention.

Three areas of application for passenger drones

The concepts of the flight vehicles are essentially based on three possible uses for which profitable markets are expected.

▶ Constructions of the flight vehicles depending on the area of application

The first application is the **air taxi**. Here, the use of drones with a short range (up to 50 km) lends itself to transporting one to two passengers with light luggage (up to 20 kg) over short distances. Volocopter's VoloCity taxi, which was designed specifically for this use, falls into this category. In general, air taxi drones - like traditional car taxis - must be accessible on demand. This leads to a high coordination effort, as the individual taxis have to be distributed to different locations and the charging stations as well as landing points have to be accessible at all times.

▶ Airport shuttle for business transport

The second type of application is **airport shuttles**, which are expected to enter the market the fastest. As most airports are located well outside city centres, these passenger drones must be able to cover longer distances with several passengers and heavy luggage (between 50-80 kg) compared to air taxis. The landing sites in the cities need to be positioned

at strategic points, as mainly business people are likely to use this means of transport in the initial phase. The flights are probably usually booked in advance and can therefore be planned well for the providers, the coordination effort is less than for air taxis.

▶ Intercity flights offer fast transport

The third area of application is **intercity flights**. These typically have to cover longer distances of up to 250 km. The number of passengers to be transported is also significantly higher than with air taxis and airport shuttles. Since the flights are booked in advance and flown on fixed routes, it is relatively easy to set up a predictable and regular operation. Start-ups like Lilium and Joby Aviation have specialised in this market sector with their prototypes.

For the areas of application of UAM to establish themselves in the market, other, overriding success factors are crucial: the fastest travel option, a favourable fare, the safe and interesting flight experience, the integrated mobility solution and an appealing service. In addition, the further improvement of battery and electric propulsion technology and autonomous flying must make a decisive contribution to the market breakthrough, because it is precisely here that costs can be significantly reduced (e.g. when a pilot is no longer needed).

Use Cases	Advantages	Disadvantages
Air taxis	– High network coverage – Short flight times	– Availability depending on the number of air taxis – Construction of some routes and landing sites required to cover strategic points – Large airspace required
Airport shuttle	– Fast transport – Short transfer times	– Disruption of traditional flight operations possible
Intercity flights	– Fast travel times between two cities – No major infrastructure requirements necessary – Plannable operation with predictable demand	– High technical challenge due to longer flight times – Alternate landing sites required for emergencies

Source: Roland Berger, BayernLB Research

Currently, the companies are also testing their prototypes in the area of air cargo transport, as there are significantly fewer requirements to fulfil here than for the transport of passengers. In addition, other areas of application for passenger drones are being tested, such as the transport of emergency doctors or short passenger transport over water.

Different types of drones

The manufacturers of drones cannot rely on existing aircraft models and technologies for their developments, but must invest a great deal of innovative energy in the design of the new types of aircraft. As a result, various types of drones have evolved whose design ultimately reflects their intended use and which are characteristic of urban operations or intercity flights. At the same time, no design has yet emerged that is equally suitable for all purposes. The technology competition to find the right concepts continues.

▶ Quadcopters and multicopters are suitable as air taxis

Quadcopters and multicopters with four or more fixed propellers can primarily be used for short distances and are very suitable for urban areas due to their low speeds and good hovering and stability characteristics (due to the propellers). They are mainly considered as

inner-city air taxis (landing pads on high-rise buildings or parking garages) and - with restrictions - as airport shuttles.

Covering longer distances requires higher forward speeds, which can be realised with aircraft types such as **tilt-wing/convertible concepts, hybrid concepts** or **fixed-wing concepts.** However, with increasing speed, the hovering stability of the aircraft deteriorates and special landing surfaces are required.

Against this background, the fixed-wing aircraft - the concept with the highest speed and the longest range - is primarily geared towards intercity flights, while tilt-wing/convertible aircraft and the hybrid models can be used more flexibly.

Aircraft types for "Urban Air" Mobility

Aircraft type	**Characteristics**
Multicopter	– Wingless aircraft concepts with more than four fixed propellers – Space for 2 to 4 passengers – Speed: 80 to 100 km/h – Example: VoloCity taxi (Volocopter)
Quadcopter	– Wingless aircraft concepts with four fixed propellers – Space for 2 to 6 passengers – Speed: 120 to 150 km/h – Examples: eHang 184, CityAirbus, Pop.Up Next
Hybrid models	– Fixed, forward-facing propellers for forward motion – Propellers pointing upwards for the take-off and landing phase – Space for 2 to 4 passengers – Speed: 150 to 200 km/h – Example: Uber Air
Tilt-wing/convertible concepts	– Multiple propellers installed on fixed or tiltable blades – The wings can change their angle to assume the required positions in the take-off, landing, flight and hovering phases – Space for 2 to 4 passengers – Speed: 180 to 250 km/h – Example: Vahana (from Airbus)
Fixed-wing aircraft	– Aircraft taking off and landing vertically – Drives can be variably adjusted depending on the flight phase – Space for 2 to 4 passengers – Speed: 200 to 300 km/h – Example: Lilium jet

Source: Roland Berger, BayernLB Research

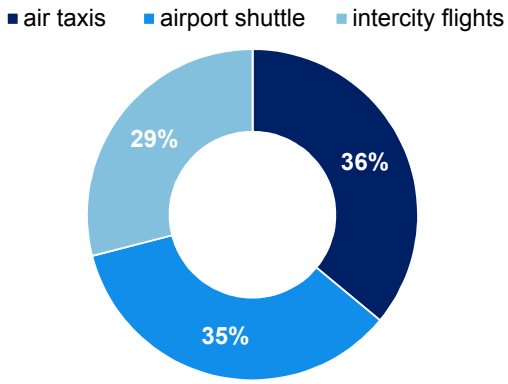
Market growth of 25% p.a. possible from 2030 onwards

▶ "Urban Air" mobility gains momentum from 2030 onwards

The consulting firm Roland Berger forecasts that the market volume of "urban air" mobility will grow to 90 billion US dollars by 2050, with about 160,000 commercial passenger drones in the air by then. According to the forecast, about one-third of the revenue will be generated from airport shuttles (35%), intercity flights (29%) and air taxis (36%) respectively.

The Fraunhofer IAO assumes that the first model projects will come onto the market between 2025 and 2030, and industry experts expect sustainable business models from 2030 onwards. Roland Berger also assumes that the UAM market will only gain momentum after 2030, but then with high annual growth rates (around 25% p.a. in the period from 2030 to 2050).

Areas of application for drones in 2050
In percent



Sources: Roland Berger, BayernLB Research

Consolidation process expected

Currently, there are still over 100 prototypes from various manufacturers on the UAM market. Market observers assume that only about 20% of these aircraft will actually make it to market and survive there. Thus, a strong market shakeout and consolidation process is expected for the next few years, as despite the many suppliers on the market, no manufacturer or business model has yet been able to decisively assert itself. The start-ups Joby Aviation and Lilium are financially well prepared for this consolidation process. Both companies are valued at over 1 billion dollars each, which already makes Lilium one of the German unicorns.

- Innovation means high costs

The lack of a resilient business model and a continuously revenue-generating product are currently the biggest challenges in the UAM sector. Therefore, the continuous development and optimisation of systems and prototypes is an important prerequisite to drive the development and growth of the market. At the same time, the development of new aircraft concepts incurs very high costs (between $500 million and $1 billion), so access to capital is an important prerequisite for the further development of the industry. This is often a major challenge, especially for start-up companies.

- Cooperations necessary

Another important success factor for the UAM market is the expansion of cooperations between drone manufacturers, operators, infrastructure providers and the public sector. Only the establishment of a comprehensive UAM ecosystem can rapidly drive the growth of the industry. Especially at the beginning of market entry, the cost of using a passenger drone will be high and the supply low. As a result, only a small part of the population will initially be able to use this form of transport. Only over time will further technical developments, economies of scale, a nationwide infrastructure and a growing supply lead to falling prices and thus to higher demand.

- Germany wants to become a lead market for UAM

Germany has selected five model regions for UAM initiatives (Aachen, Hamburg, Ingolstadt, Münster and Northern Hesse) as part of the European innovation partnership "Smart Cities and Communities". In this way, the Federal Republic aims to expand its position in the UAM sector and develop into a lead market for transport and passenger drones. Against this backdrop, national research funding in this area will also be expanded to further support German pioneering companies such as Lilium and Volocopter and to consolidate their market position.

For example, Volocopter is currently working with the DLR (Deutsches Zentrum für Luft- und Raumfahrt) on a system for automated decision-making for safety procedures, which is an important building block for series production readiness and further acceptance of air taxis. The research project, which is budgeted at more than 348,000 euros, is 76% funded by the German Federal Ministry of Transport. The UAM project in Ingolstadt is also to receive 100 million euros in funding from the two-billion-euro pot of Bavaria's high-tech agenda. Accordingly, 15 million euros in funding are earmarked for 2021, 25 million euros for 2022 and 60 million euros for the following years.

As the market matures, the financing structures of the sector are also likely to change. While the importance of venture capitalists is declining, commercial banks will increasingly become involved with promotional loans, hedging of exchange rate risks or guarantees. Further opportunities exist in financing the aircraft for an operator if, for example, the operator is to contractually supply UAM to a city for a certain period of time. And once the urban air mobility model is firmly established, this simplifies the financing of the aircraft, as they can be resold in the event of non-payment.

Conclusion: Great potential, but also risks

Notwithstanding the potential, the UAM market also has some risks. In particular, government regulation, public acceptance and the pace of technological progress are unclear. Nevertheless, investors obviously believe in the potential of the market and the start-ups involved are also very optimistic. It remains to be seen to what extent the providers can keep to their schedule and which business model will ultimately prevail. The coming years will be decisive for the further development of the industry and the companies will have to be measured against their promised goals.

The extent to which the Corona pandemic will influence this development is difficult to assess. While traditional aviation is heavily impacted by the pandemic consequences, this cannot be directly transferred to the UAM market. The key drivers of the market, such as congestion avoidance, urbanisation and the desire to save time, will remain regardless of the pandemic. Some developments may be delayed, but the Corona pandemic should not change the basic market potential.

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