

The background of the slide is a white space filled with numerous 100 US dollar bills falling from the top. The bills are shown in various orientations and positions, creating a sense of motion and abundance of money. The bills are slightly blurred, suggesting they are falling from a height.

# Components of UAM transportation cost

International Conference  
*Urban transportation of passengers by eVTOL*

*Claude Le Tallec*

# eVTOL – assumptions and claims

Many assumptions have been made about the potential UAM market and strong but questionable assertions have been stated. Here are a few :

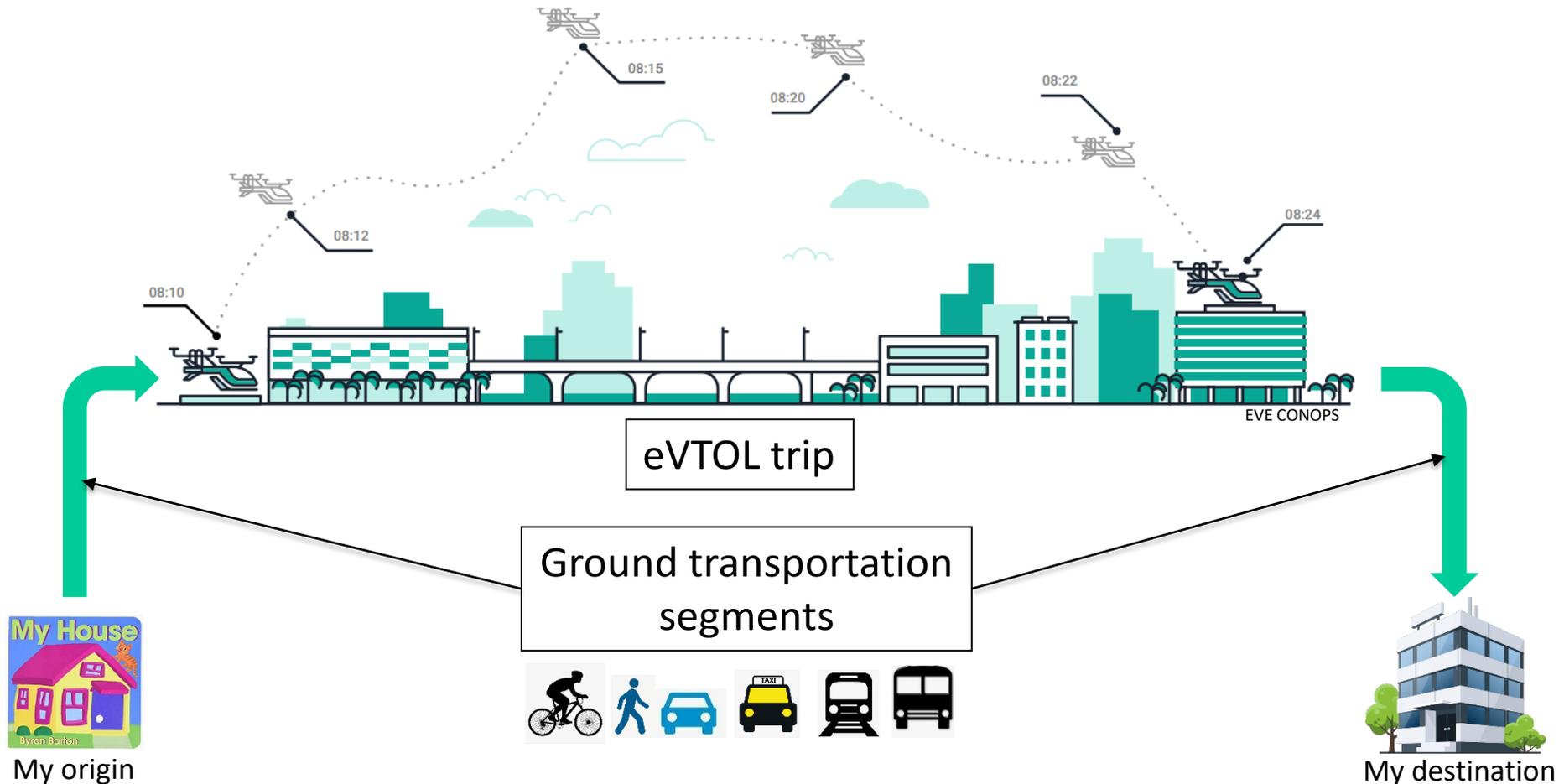
- eVTOL aircraft will democratize local air transport
- Price per passenger will be close to the cost of taking an Uber Black car service
- We aim to continue to drive operating costs down to the price of ridesharing and, eventually, to the cost of owning a car”
- ...

Is it realistic to believe all what is stated?

To form our own opinion on these assertions, let's analyze the components of the cost of an eVTOL trip

# What has to be considered: End to end trip

**Trip = eVTOL journey + potential complementary segments = multimodal transportation**



# What has to be considered: End to end trip

## Complementary segments, first leg



Offices in densely populated urban areas

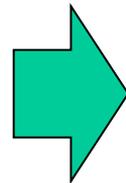


Conventional urban dwelling place in moderately populated area



Remote location

- In some cases, there is no vertiport nor vertistop in close proximity



Potential mandatory use of a taxi or of public transport with an additional cost

# What has to be considered: End to end trip

**Bonny Simi** (Head of Air Operations and People at Joby Aviation, interview with Robin Riedel from McKinsey, November 2021):

“Imagine waking up in the morning and thinking you could drive your car to work—but that might take an hour, an hour and a half.

Instead, you just open up an app.

**A car picks you up** and brings you to a heliport five minutes away. You ride in one of our aircraft.

The flight takes ten minutes.

At the other end, **there's a car waiting for you.**

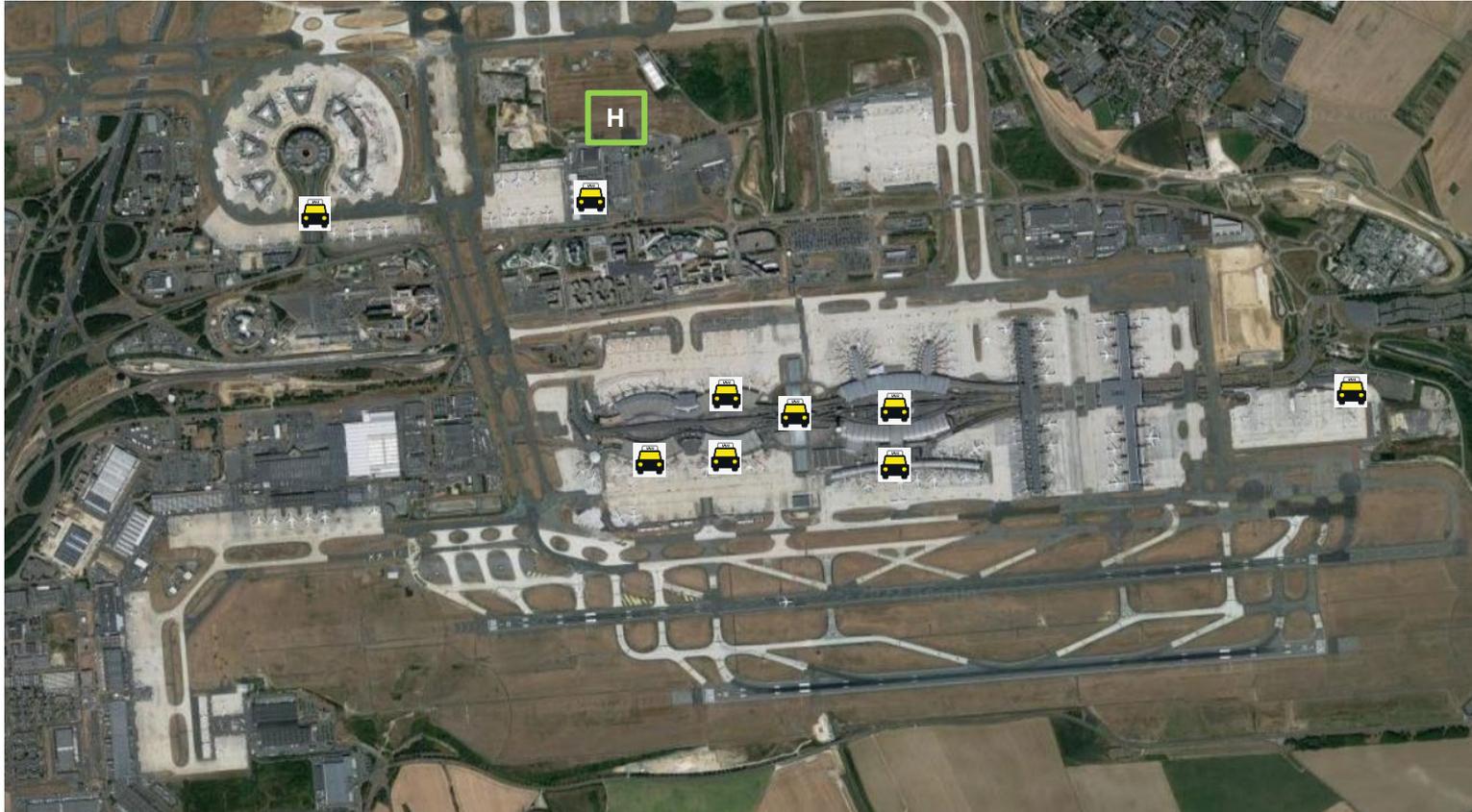
The entire ride is seamless, convenient, and affordable”

# What has to be considered: End to end trip

## Complementary segments, last leg

### Paris CdG airport, 9 conventional taxi pick-up locations:

- Terminal 1
- Terminal 2A
- Terminal 2C
- Terminal 2D
- Terminal 2E
- Terminal 2F
- Terminal 2G
- Terminal 3
- TGV station



# eVTOL journey: components of cost



UBER Elevate

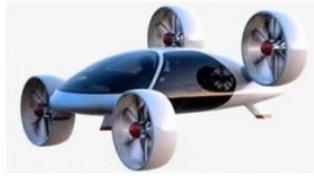


- Production & certification costs?
  - eVTOL simpler and a priori less expensive than conventional helicopters
  - strongly depends on the air vehicle production rate, announced costs:
    - Joby S4: M\$1.3 with the prospect of a halving in the future
    - Lilium: M\$ 2.5 per vehicle
    - Overair/Hanwha Group (Korea): M\$ 2.6 per vehicle (Butterfly)
  - Will vary with the automation / autonomy level
- Acquisition cost for an operator?
  - 10 to 20 times the cost of a ground cab
  - Purchase by driver unlikely
- Maintenance, repair and overhaul?
  - Facility location to be found
  - Financing will be closer to that of the maintenance of airliners than that of road vehicles



"The UAM world" insists on the need to eventually automate the aircraft

GAMA work about Simplified Vehicle Operation



• **SVO1** – Target: Current Pilots



**SVO2** - Target: Non-Pilots



**Near Fully Autonomous**



**SVO3** - Target : Current Passenger

- Skills necessary for piloting eVTOLs depend on the level of automation of the craft and on the various designs of eVTOLs
- Duty time? A 15-minute urban flight includes critical phases in a stressful environment

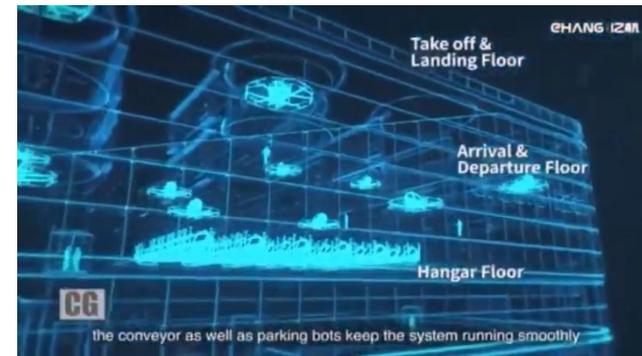


- Components of the cost of a pilot & other support staff
  - Initial education and training
  - Maintaining currency and proficiency
  - Salary
  - Other indirect costs linked to the pilot support staff
    - Human Resources costing
    - Information Technology costing
- Pilot cost assessments
  - Uber: k\$50 to k\$90 per year (young engineer profile?) other studies: annual cost of k\$280 to which must be added an annual cost of maintaining skills of k\$90
  - McKinsey: pilot = double the cost of the passenger seat (+105%)

# eVTOL Infrastructure



UAM infrastructure is a complex ecosystem made of many interconnected parts: landing infrastructure, power sources (electrical, hydrogen), flight management offices



- Vertiport / vertistop
  - Landing / take-off and boarding areas
  - Passenger accommodation & ticketing
  - eVTOL servicing (mainly recharge)
- eVTOL maintenance & storage facilities
  - Colocation with vertiport not easy (lack of space)
  - Additional cost if distant from vertiport



- Vertiport costs can be broken into capital costs (land purchase & use, development/building, large equipment, etc.) and operating costs (personnel, small equipment, upkeep, etc.).
  - Capital costs depend on "port" design (Vertiport or Vertistop)
    - \$3.5 million to \$12 million (L.E.K Consulting)
    - 10 millions euros (l'Usine Digitale, 2019)
  - Costs depend on "port" location, size and services (Vertipad, Vertistop, Vertistop or Vertihub)
    - Size depends on expected demand
    - Battery charging service may not be provided in all VertiX
- Operating cost depends on passenger throughput – and use for fret (?)
  - Global air traffic (includes UAS)
  - eVTOL turn time
  - Aircraft utilization & occupancy rate



## Financing the costs: service fees

- Landing fee that covers the use of airport infrastructure and equipment necessary for landing, taking off and taxiing
- Parking fee that covers the use of aircraft parking infrastructure and equipment
- Passenger fee that covers the use of passenger handling facilities and public spaces. This fee is based on the number of departing passengers
- Fees for check-in counters and boarding gates and origin/destination baggage handling
- User fee for connecting baggage handling facilities
- Provision fee for fixed power supply facilities
- User fee for aircraft de-icing facilities (not applicable for UAM?)
- Passenger assistance fee for passengers with disabilities or reduced mobility
- Badge application fee for accessing restricted areas
- User fee for aircraft water and sewage management services (not applicable for UAM?)

# Current airport fees cost mitigation



## **Helicopter Charter to or from London Gatwick Airport.**

Take 10 minutes to London Battersea Heliport by Helicopter or 1 hour by road

*However using Redhill save a vast amount of money on Gatwick airports landing fee and is only 10 minutes by road from Gatwick*

## **Helicopter Charter to or from London Heathrow Airport.**

At the peak of London's traffic can take as much as 1 hour 30 minutes to reach by car. By Hiring a Helicopter, this time is cut to a little over 15 minutes

*However, London Heathrow Airport does charge a substantial landing fee, with this in mind we have secured a private take off site approx 10 minutes by road from Heathrow airport*



Some certainties but many questions:

- Near term UAM operations are possible without any changes to ATM rules or policies as current eVTOL are Pilot On board Aircraft (POBA)
- The safe integration of these aircraft and operations into the airspace creates a challenge in terms of complexity and capacity limitations: applicability of different solutions depends on desired throughput levels
- Compatibility with Unmanned Aircraft Systems (UAS) Traffic Management (UTM) architecture necessary as UAM aircraft and UAS will share the same part of the airspace
  - Cost of low altitude ATC will be shared with UAS operators
  - Controller workload will be a limitation (voice control / data control)

What is most likely and expected is that UAM Traffic management will be implemented as a service whose capital and operating budgets will need to be paid for by users

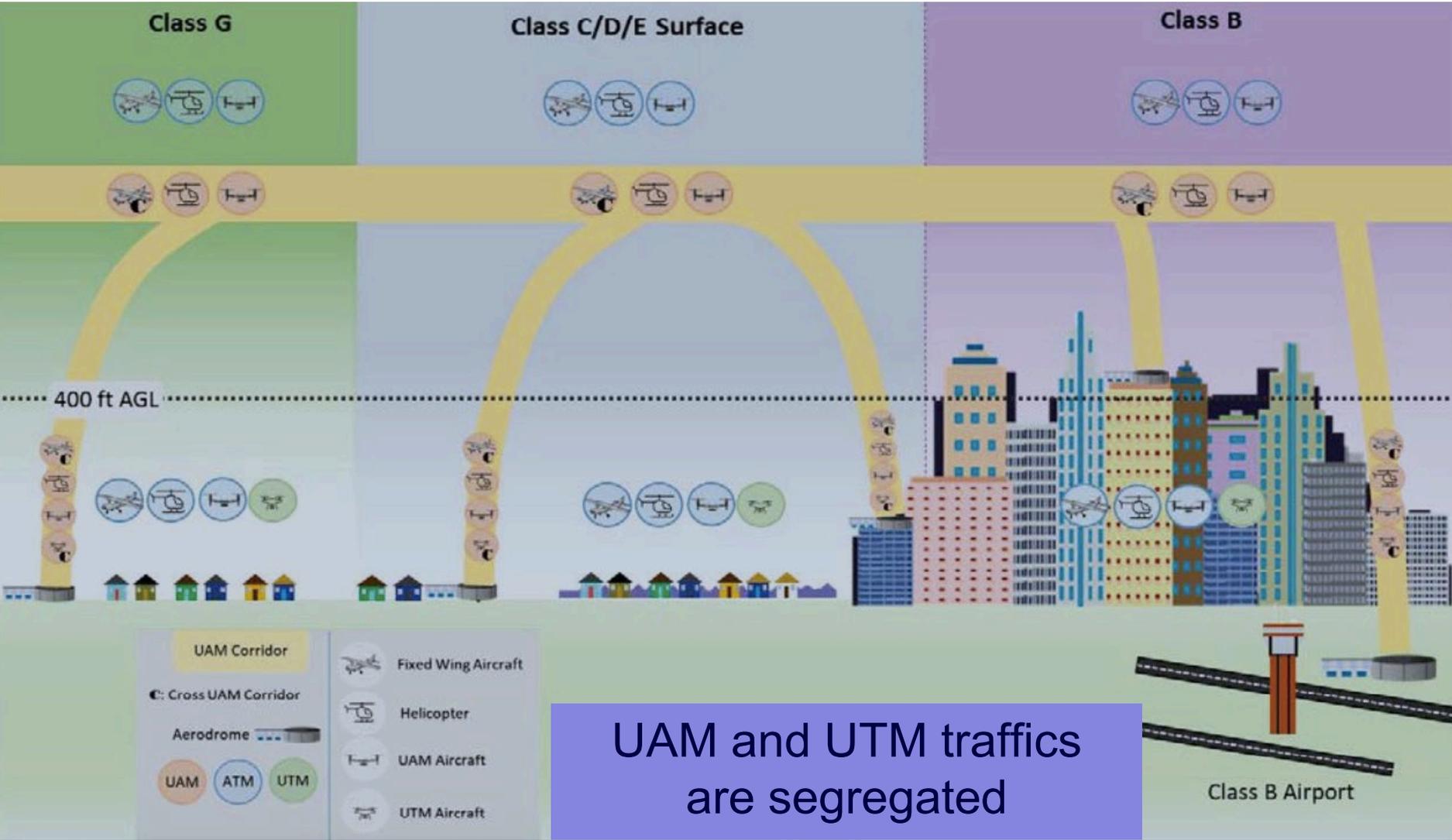
*The cost of ATM can increase significantly if UAS and eVTOLs traffic leads to a questioning of existing principles and rules due to a saturation of controllers*



Airspace Management

# Airspace air traffic management

## FAA - UAM ConOps (07/2020)







eVTOL operations are mostly innovative

- Not yet possible to build a robust cost estimation model based on previous operations data
- Will depend on eVTOL concepts of operation

Many tasks can be automated (low labor costs):

- Ticket sales
- Passport and ticket control
- Weighting of passengers?

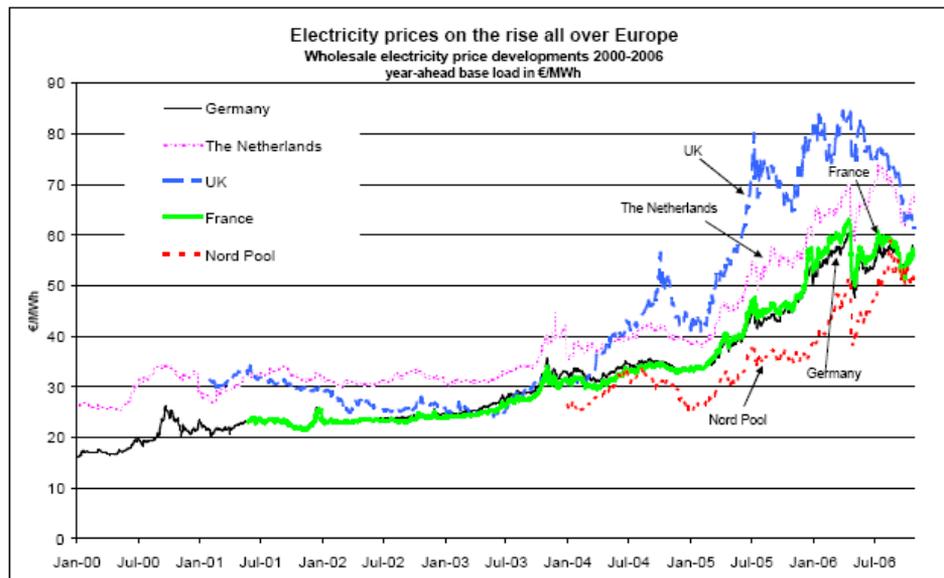
Others require a human presence (significant labor costs):

- Passenger boarding
- Baggage loading
- Security control
- Safety management

*The comparison of the cost of an eVTOL commercial operation with the cost of a ground taxi ride is not easy...*

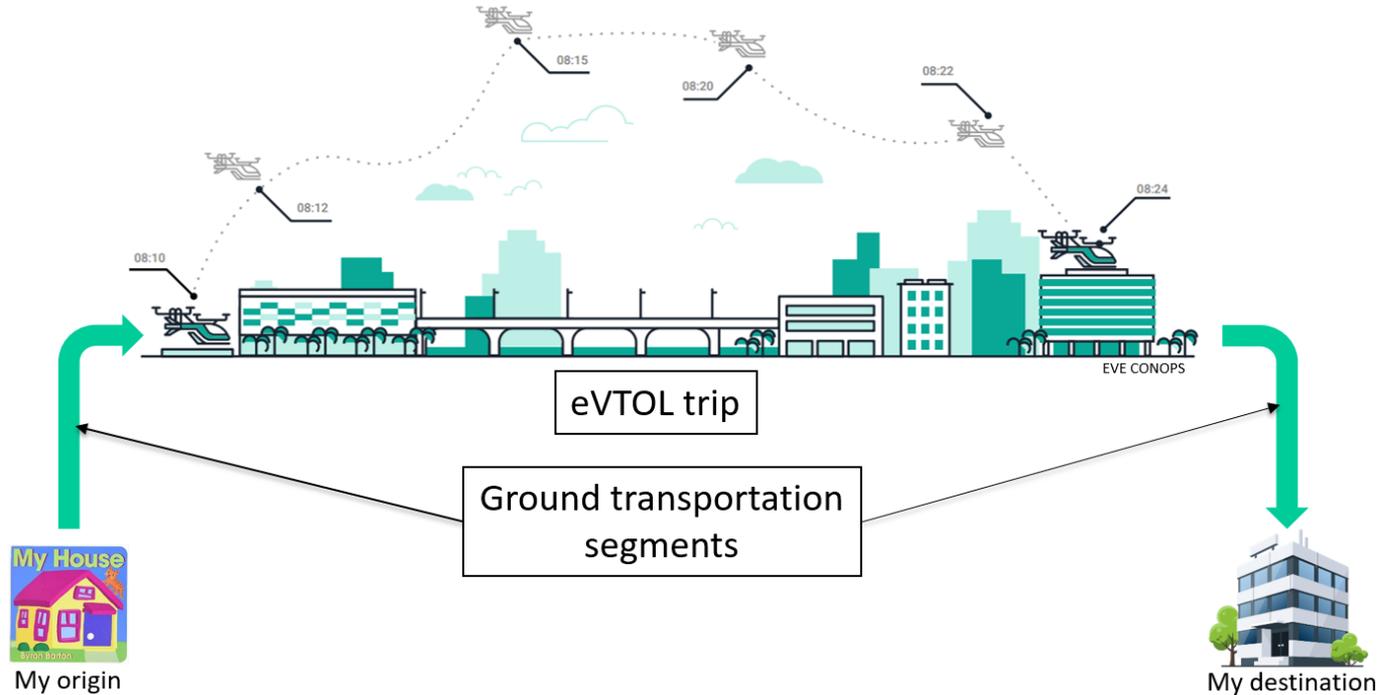
# Other costs

- Aircraft depreciation & insurance
- Operations
  - Repositioning empty vehicles
  - Repositioning of off-duty crew
  - Back-up solutions when weather is not suitable for eVTOL use?
  - Energy costs



Source: information received within the scope of the Sector Inquiry from Argus Media, Platts<sup>184</sup>, and Nord Pool.

# Conclusion



Urban transportation of passengers by eVTOL is a promising concept, any cost analysis should be made for the entire trip, end to end

*Components of UAM transportation cost are many and dependent on local situations, some are still unknown and some will evolve as the system matures (automation) and scales up*

An aerial photograph of a city at dusk or dawn, with a sky transitioning from blue to orange. Several drones are flying in the sky, leaving long, glowing white light trails that curve across the frame. The city below is illuminated with lights from buildings and streets, with a prominent highway interchange in the foreground. The text "Thank you, Questions at the end of the session" is overlaid in a bold, blue, sans-serif font on the right side of the image.

***Thank you,  
Questions at the end  
of the session***

Credits: NASA / Lillian Gipson

# Conclusion

- If you want to be a Millionaire, start with a billion dollars and launch a new airline. (Richard Branson)
- We aim to continue to drive operating costs down to the price of ridesharing and, eventually, to the cost of owning a car,” said Brett Adcock, Archer co-founder and co-CEO.
- eVTOL aircraft will democratize local air transport (Joby)
- Meanwhile, Jaunt Air Mobility puts its price per passenger close to the cost of taking an Uber Black car service.
- From Zigzag to Straight Line