TRB Webinar: Planning for the Emergence of Urban Air Mobility at Aviation Facilities

February 28, 2024

1:00pm-2:30pm

NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM

Today's Learning Objectives

- Understand UAM and its implications for aviation facilities.
- Recognize the benefits and challenges of integrating UAM within an airport.
- Use best practices and develop strategies to accommodate electric VTOL aircraft.
- Identify the main facility requirements that need to be addressed as part of UAM integration.

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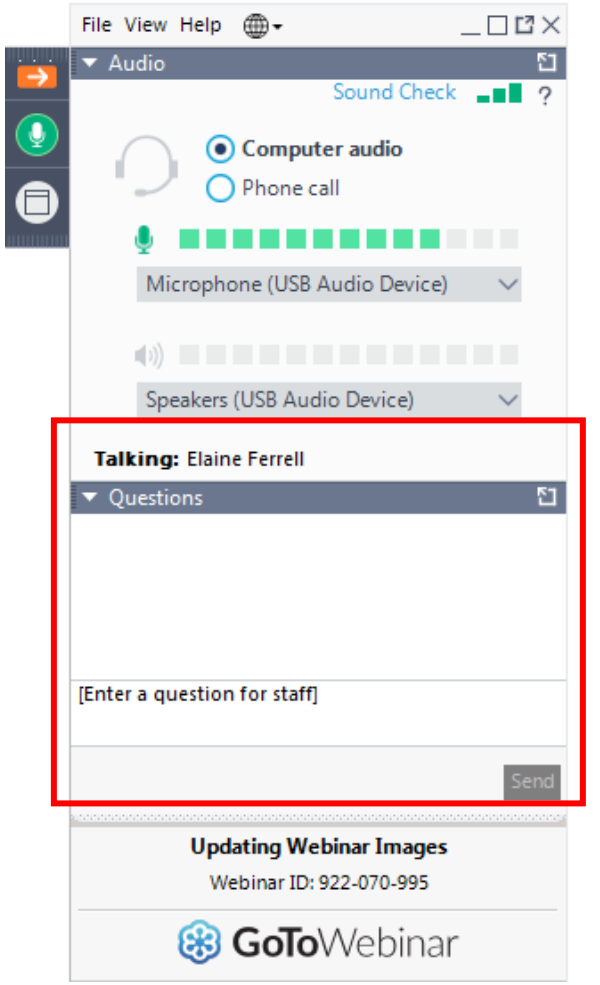
Questions and Answers

Please type your questions into your webinar control panel

We will read your questions out loud, and answer as many as time allows

#TRBwebinar



Today's Speakers

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Planning for UAM Services at Airports

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Gaël Le Bris, CM, ENV SP, PE

WSP USA

What is Advanced Air Mobility?

AAM

UAM

Use Cases/Missions:

- ***On-demand intra-urban transportation***
  - ➢ *VTOL aircraft (1-5 pax or equivalent payload)*

RAM

Use Cases/Missions :

- ***On-demand regional transportation***
  - ➢ *V/STOL aircraft (5-19+ pax)*

Use Cases/Missions:

- ***Last-mile cargo delivery***
  - ➢ *Small UAS (<250 lbs.)*
- ***Medical supply delivery***
  - ➢ *Small UAS (medical emergency supply)*
- ***Heavier air cargo deliveries***
  - ➢ *Larger UAS (>250 lbs.), STOL*
- ***Medevac***
  - ➢ *Larger UAS, V/STOL & CTOL aircraft*

What is Urban Air Mobility?

AAM

UAM

Use Cases/Missions:

- ***On-demand intra-urban transportation***
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RAM

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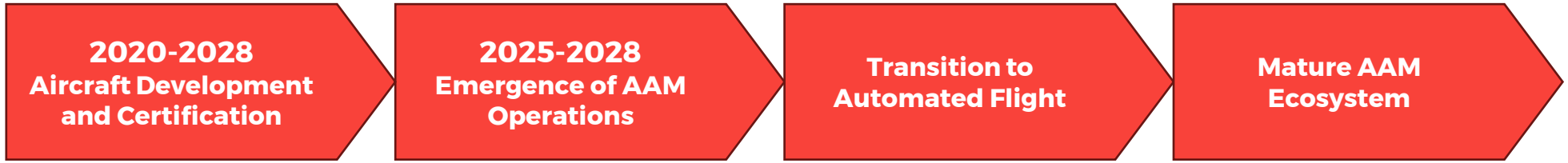
  - ➢ *Larger UAS (>250 lbs.), STOL*
- ***Medevac***
  - ➢ *Larger UAS, V/STOL & CTOL aircraft*

Market Trajectories

UAM is coming…

- **Leading OEMs have built and flown** demonstrators and production aircraft.
- **Agreements have been signed with major air carriers** to provide first- and last-miles.
- Pre-orders & other agreements signed for **thousands of eVTOLs**.



A Possible Scenario to UAM

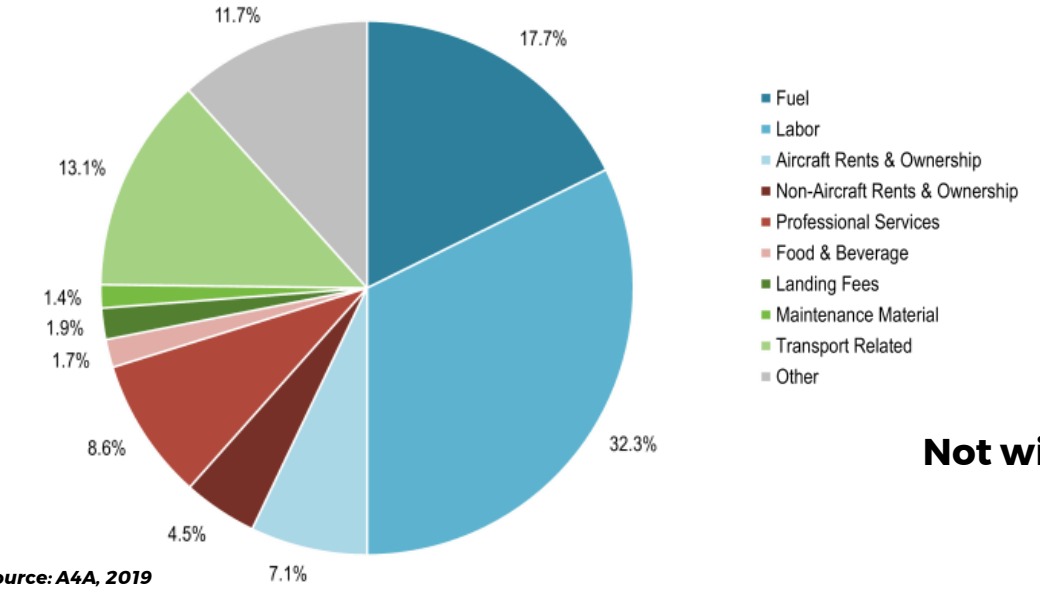
… But UAM is not here yet!

- **AAM is emerging.** No eVTOL certified today (except EHang in China with "conditional" TC).
- **UAM does not exist yet** except in primitive forms in some large cities (e.g., NYC, São Paulo).
- **Certification pathways are still being defined.** No EASA or FAA TC expected before 2025.
- **Over 300 eVTOL projects!** Is there a market for so many models? + "Hirschberg rule".

Market Trajectories

UAM is coming… But what does it mean?

- Early UAM operations = crewed eVTOL flying helicopter routes VFR.
- Service reliability requires IFR and straight routes to airport (no hovering).
- Delivering aircraft & recruiting pilots by the thousands… Supply vs demand!
- Insurance cost & innovation premium might hinder “TNC-like” fares as well.
- Airports have limited financial creativity due to grant assurances.



Source: A4A, 2019

Predicted BLADE Operating Cost Between JRA and JFK at eVTOL Introduction

 **$500**  **$430**

Source: BLADE Investor Pres., Nov. 2023

Fare Comparison for a Baseline 30-Mile Ride

- Basic ridesharing: **$45**
- UAM with eVTOL: **$110**
- Black car (limo) service: **$112.5**

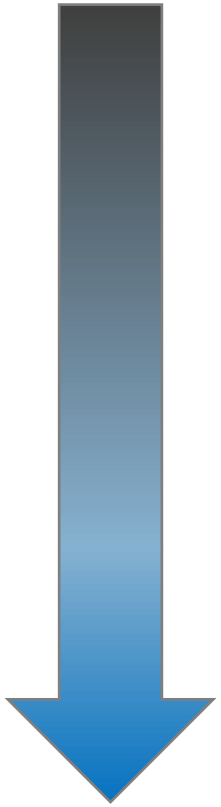
Source: McKinsey, 2022

Can we reduce costs further?

Not without enormous shifts in the way we operate aircraft and do business in aviation!

Decision-Making Environment

Speculative

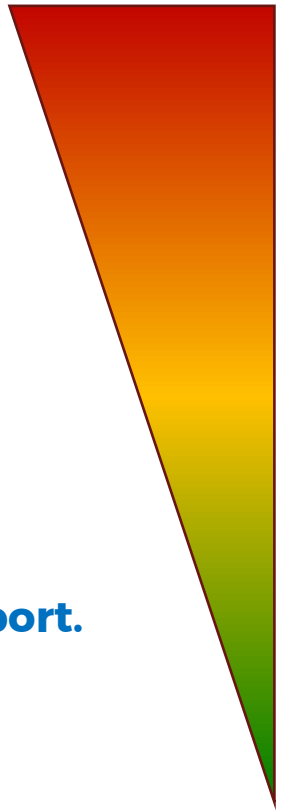


Reality

- Aspirational goal to accommodate UAM.
- Potential market for UAM in my metro/micropolitan area.
- Potential market served by heliports or VTOL-ready facilities.
- Flight operator interested in flying to my airport.
- Flight operator with VTOLs in their fleet ready to fly to my airport.

Risk at Inception

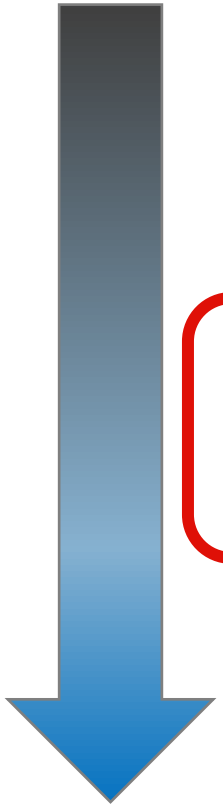
Higher Risk



Lower Risk

Decision-Making Environment

Speculative



- **Aspirational goal to accommodate UAM.**
- **Potential market for UAM in my metro/micropolitan area.**
- **Potential market served by heliports or VTOL-ready facilities.**
- **Flight operator interested in flying to my airport.**

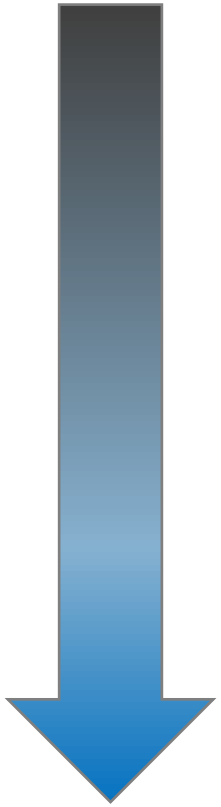
We are here

- **Flight operator with VTOLs in their fleet ready to fly to my airport.**

Reality

Airport Decision-Making Strategies Available

Speculative

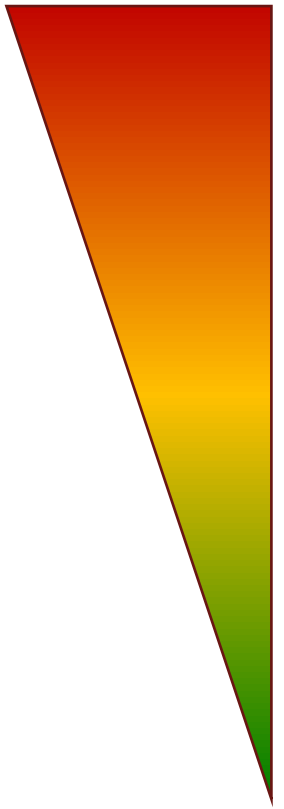


Reality

- Gather information and monitor the market.
- Investigate market opportunities.
- Add provisions for vertiport to long-term plans.
- Conduct pilot projects and demonstrations.
- Develop commercial vertiport.

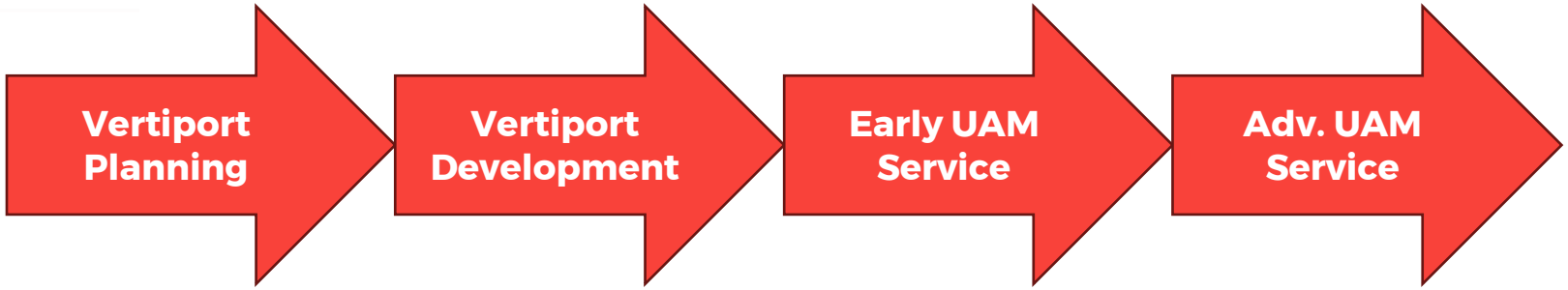
Risk at Inception

Higher Risk



Lower Risk

A Roadmap to UAM Services

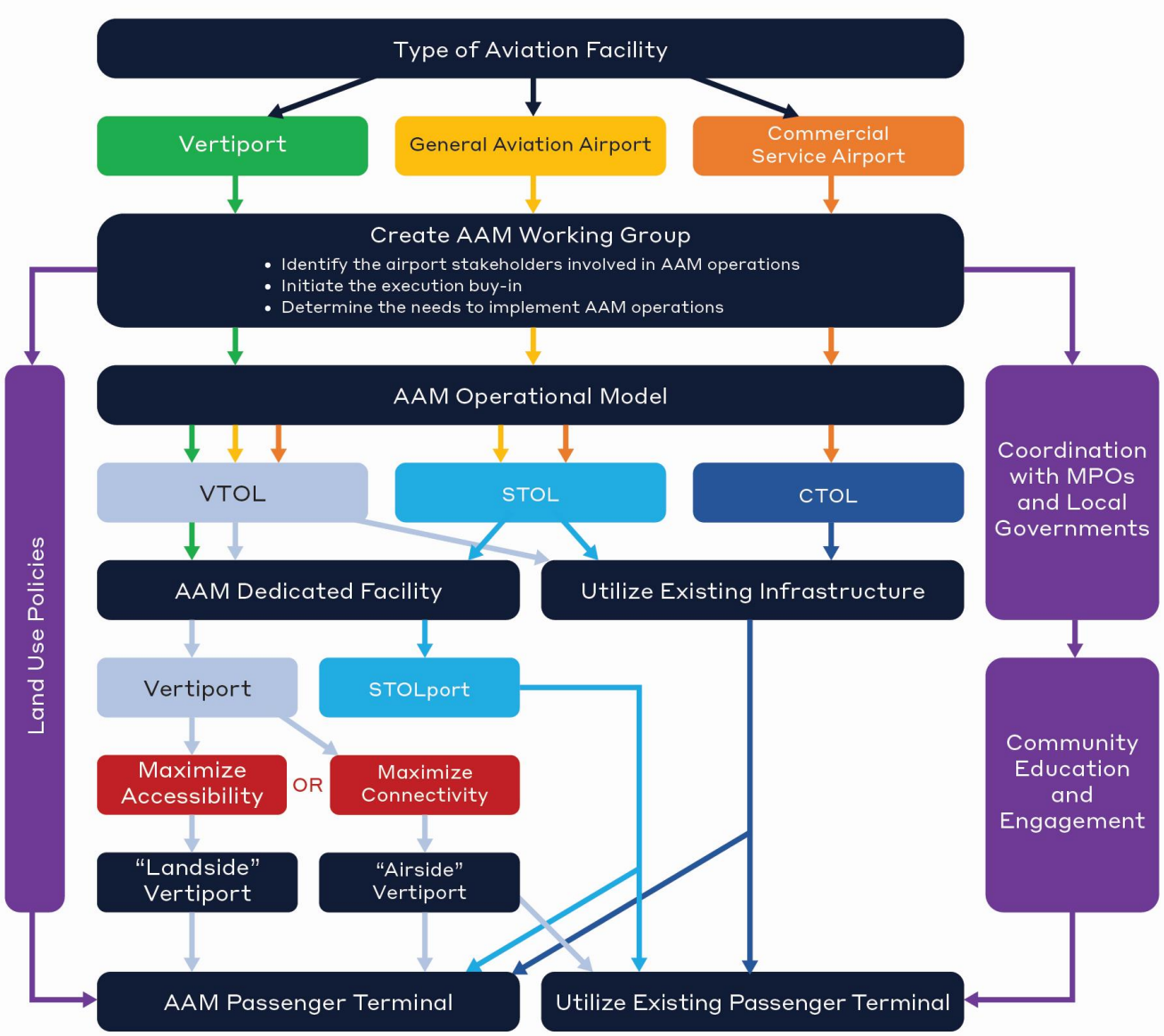


Horizon	Short-Term		Medium-Term	Long-Term
Implementation Stage	UAM strategy development.	Pilot projects and demonstrations.	VTOLs flying helicopter routes & VFR procedures.	VTOLs flying UAM corridors.
Airport Decision Points	Master plan level	Inclusion in CIP	Managing facility	Expanding services
Type of VTOLs	N/A	Prototypes	Crewed VTOL aircraft	Autonomous VTOL aircraft
Current Status	Guidance for UAM planning available	Emerging vertiport design standards	VTOL certification pending	CONOPS only

Engaging Communities

- **Community buy-in** is crucial for successful UAM integration at airports where environmental & sustainability requirements apply.
- Recent examples (e.g., SMO closure decision, NYC anti-helicopter movement, USDOT AAM RFI) highlight the importance of **public acceptance** for such service.
- There is a need to **educate the general public** about UAM and **demonstrate** sustainability goals will be met.
- **Community engagement** should be meaningful and involve people locally ("showroom at CES is not CE").
- Reaching **public desirability** should be the ultimate goal of UAM implementation.

AAM Planning Process



ACRP Research Report 243: Urban Air Mobility: An Airport Perspective

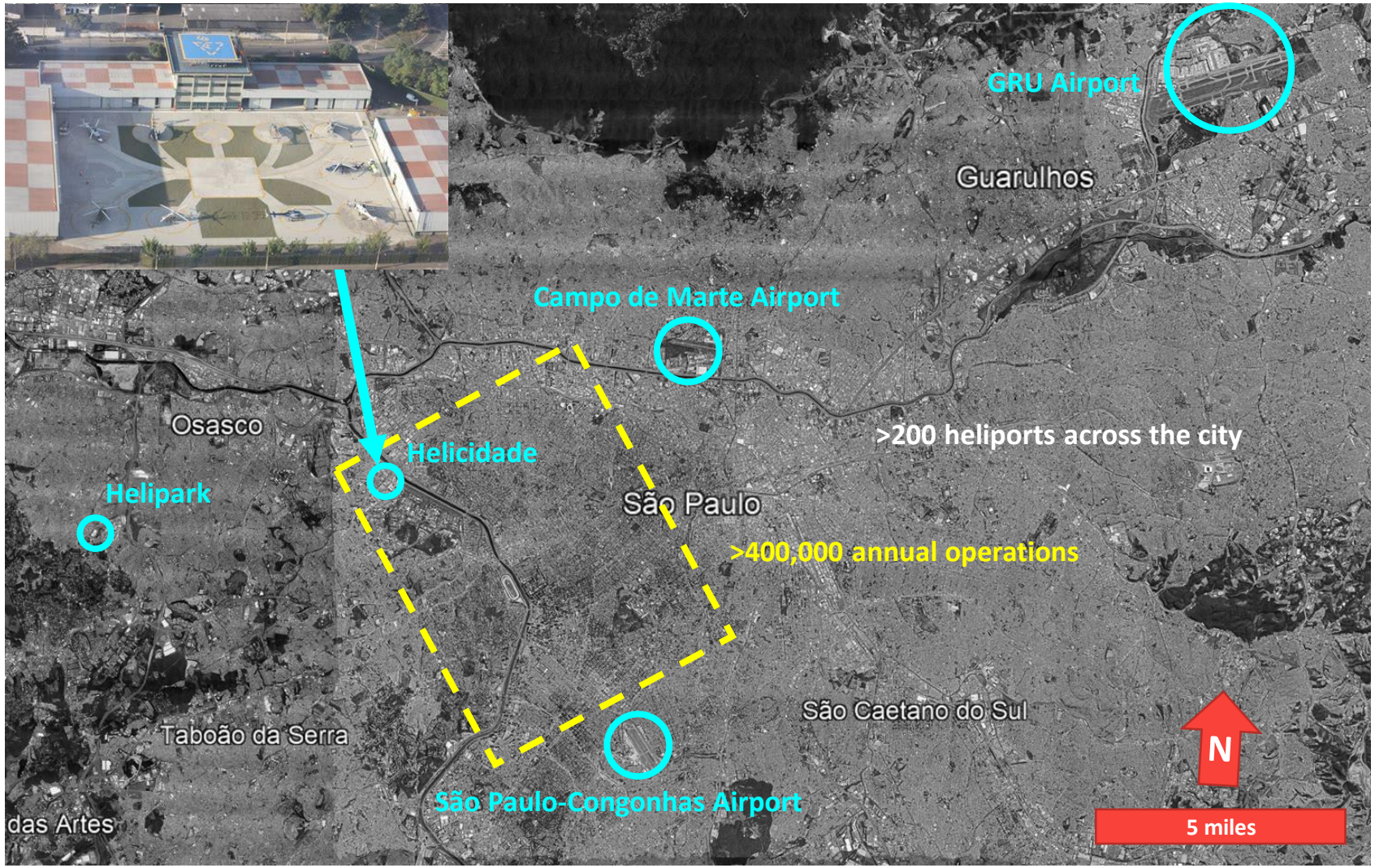
About STOL Aircraft for UAM

- Some AAM aircraft projects explore **Short Take Off and Landing (STOL)** concepts.
- Many eVTOLs can be flown as V/STOL aircraft.
- **Operating STOLs saves energy compared to VTOLs.**
- **A runway for small eSTOL aircraft could be as short as 300 ft…** It's like a long FATO than a short runway.
- Strategies for compact STOLports at airports were explored in the 1990s for urban tilt-rotor aircraft.

Source: Electra.Aero

Source: BETA

Can We Get There?!



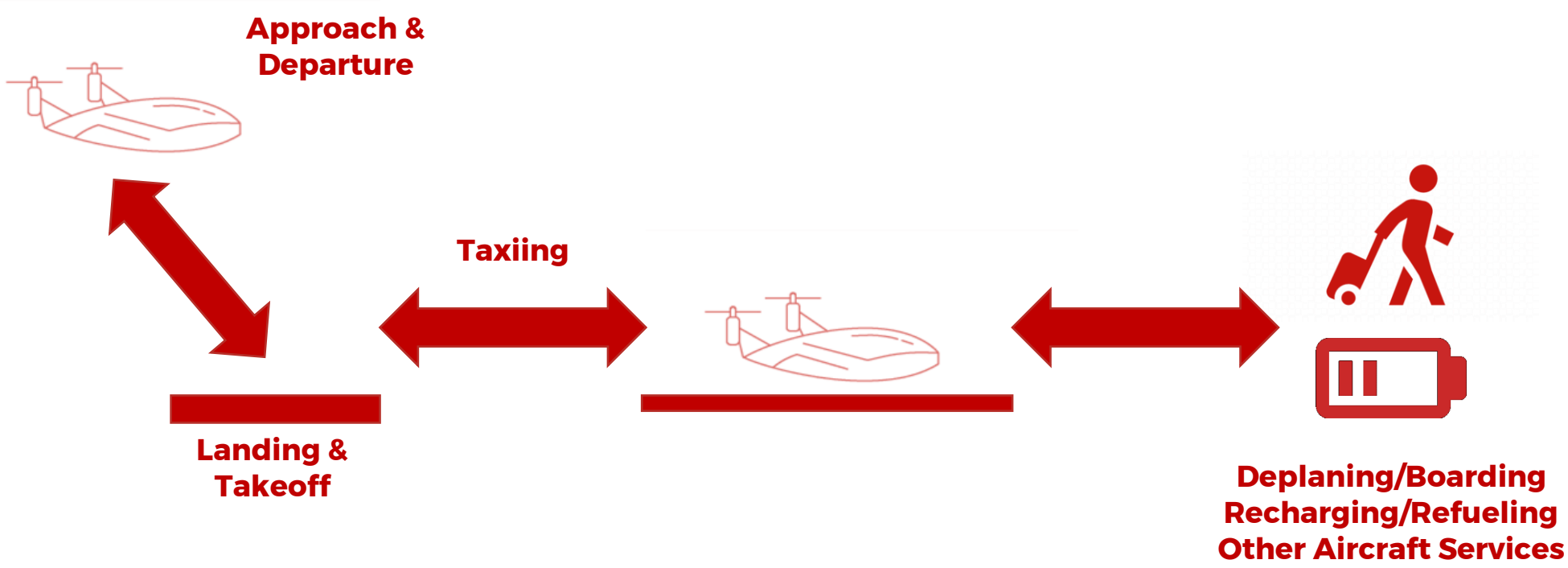
Challenges in Airport Operations & Safety

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

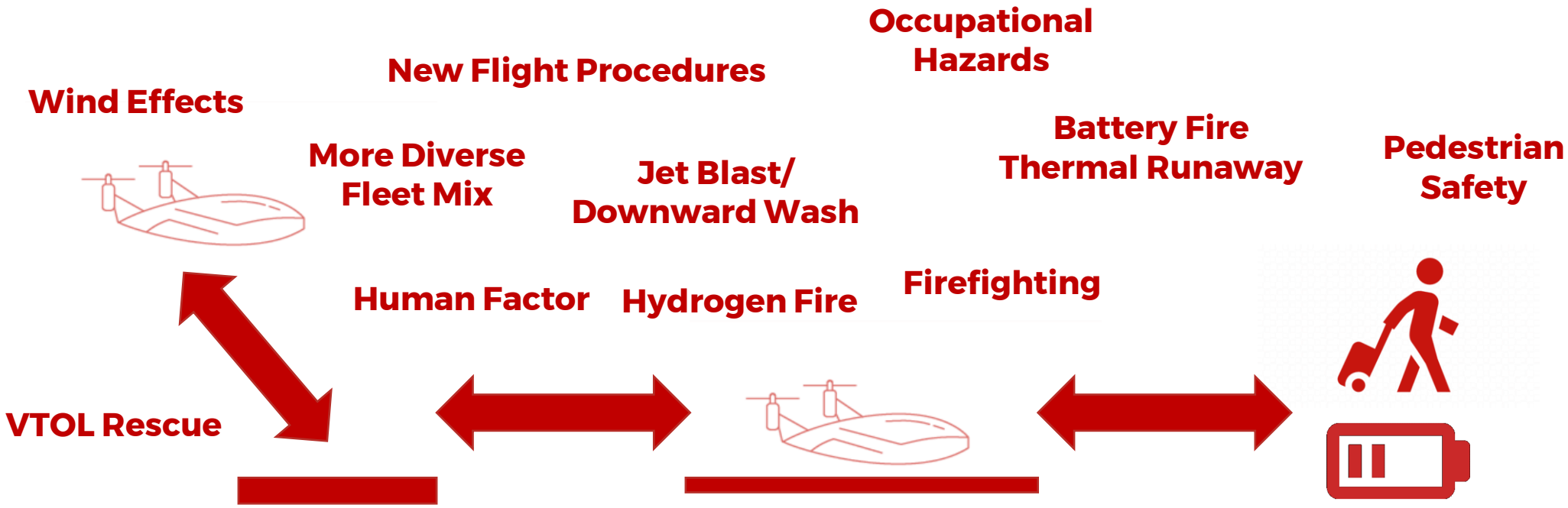
Loup-Giang Nguyen

WSP USA

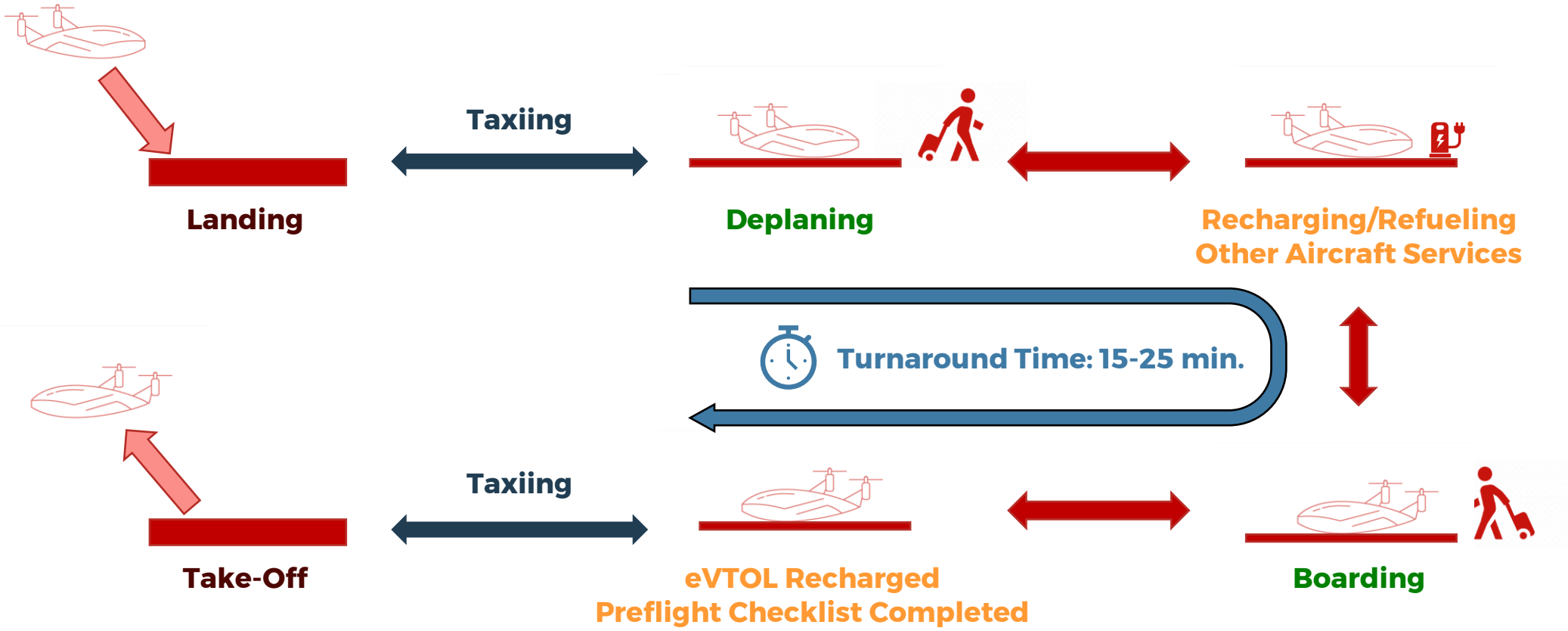
Anatomy of eVTOL Operations



Anatomy of eVTOL Operational Implications



The Turnaround Process



- Recharging time will depend on the type of charger (slow or fast charger).
- At airports or large vertiports, autonomous tugs may help eVTOL conserve energy.
- Cabin cleaning increases turnaround time if conducted between consecutive flights.

Introducing eVTOLs at Airports Safely

Safety First

- Inclusion into airport SMS
- SRA for novel aircraft features
- Safety audits and inspections

- “Landside” vertiport located within public area
- Downwash/outwash hazards

- Adapted GH procedures & practices
- Charging/fueling operations
- H_2 storage & distribution

Typology of Facilities

Growing Complexity & Traffic

Vertistation

1 FATO/TLOF
100 ft. x 100 ft. footprint
No ground support/service
Low intensity operations

Vertiport

1-2 FATO/TLOF + 2-10 stands
250 ft. x 250 ft. footprint
Limited support/services
Medium intensity operations

Vertihub

2+ FATO/TLOF w/ 10+ stands
400 ft. x 200 ft. footprint
Full support/services
High intensity operations

Airport

Runways and FATO/TLOF(s)
Large footprint
Passenger & aircraft services
High intensity w/ diverse fleet

"You've seen one airport… you've seen one airport"

Sources: LIBELaéro, NASA, NASEM/TRB, WSP

Typology of Operators and Services

	Who provides safety management?	Who provides operational safety?
Vertistop	Flight operators	Pilots
Vertiport/Vertihub	Flight operators Vertiport operator?	Pilots & ground handlers
Vertiport Network	Flight operators Vertiport operator?	Pilots, ground handlers, vertiport staff
Vertiport at Non-Certified Airport	Flight operators Airport operator?	Pilots, ground handlers, airport staff
Vertiport at Part 139 Airport	Airport, ATCT, Flight operators	ATCT, pilots, ground handlers, airport staff

Growing Complexity & Traffic

Note: Heliports are not required to comply with Part 139 requirements. Also, Part 139 typically does not apply to airports served by air carriers performing unscheduled operations with small aircraft (<31seats) and GA facilities.

Typology of Airside Safety Hazards

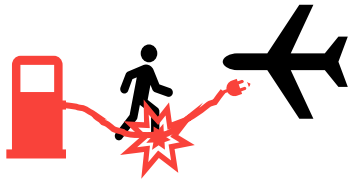
VTOL Design

Recharge/Refuel/ Swapping Operations

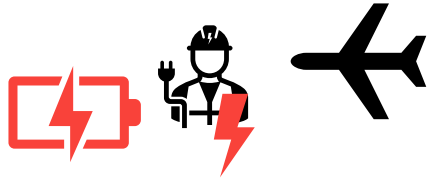
VTOL Accident/Incident

ARFF Ops

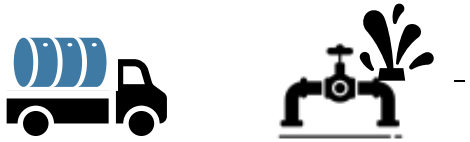
Batteries Heat/Smoke



Worker/Passenger Trips

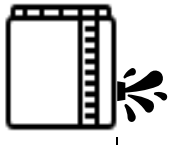


Arcing/Discharge



Hydrogen Transportation

Hydrogen Pit Leak



Hydrogen Storage Leak

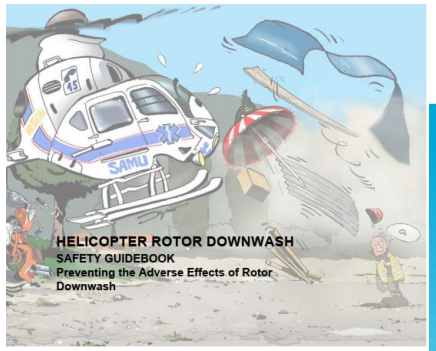
Understanding Rotor Downwash

- eVTOLs' distributed propulsion systems may generate **unique downwash/outwash patterns** differing from traditional helicopter rotor wash.

- Downwash can pose **ramp safety** and **public safety** risks.

- Few guidance documents available:
  - *Helicopter Rotor Downwash Safety Guidebook* (DGAC France)
  - CAP2576: *Understanding the downwash/outwash characteristics of eVTOL aircraft* (UK CAA)

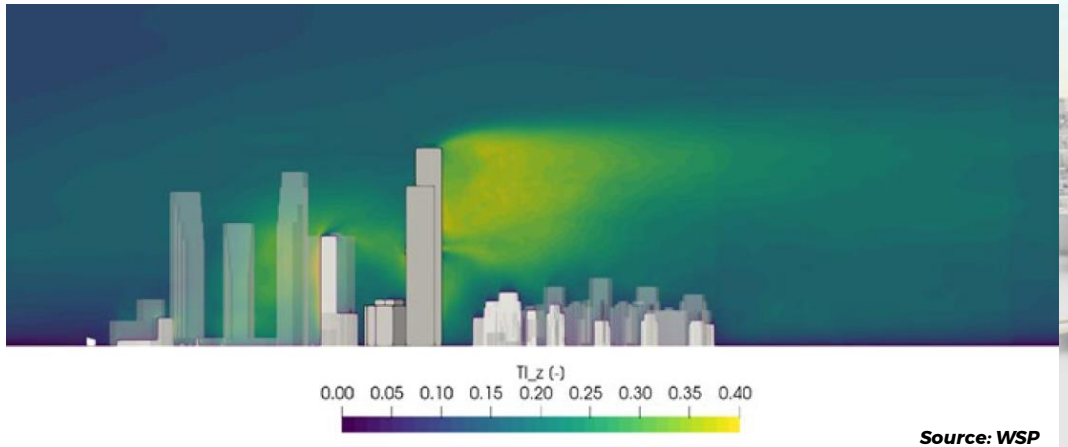
- Both EASA and FAA have funded research.



Understanding Wind Effects

- Elevated vertiports introduce unique challenges due to **wind patterns at elevated locations**.
- The wind can significantly impact eVTOL operations, affecting safety and operational efficiency.
- These hazards must be considered when conducting vertiport siting (wind modeling) and when planning flightpaths (microweather forecasting).

Download the white paper



Source: WSP

Source: WSP

Heliport and Vertiport Perspectives

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

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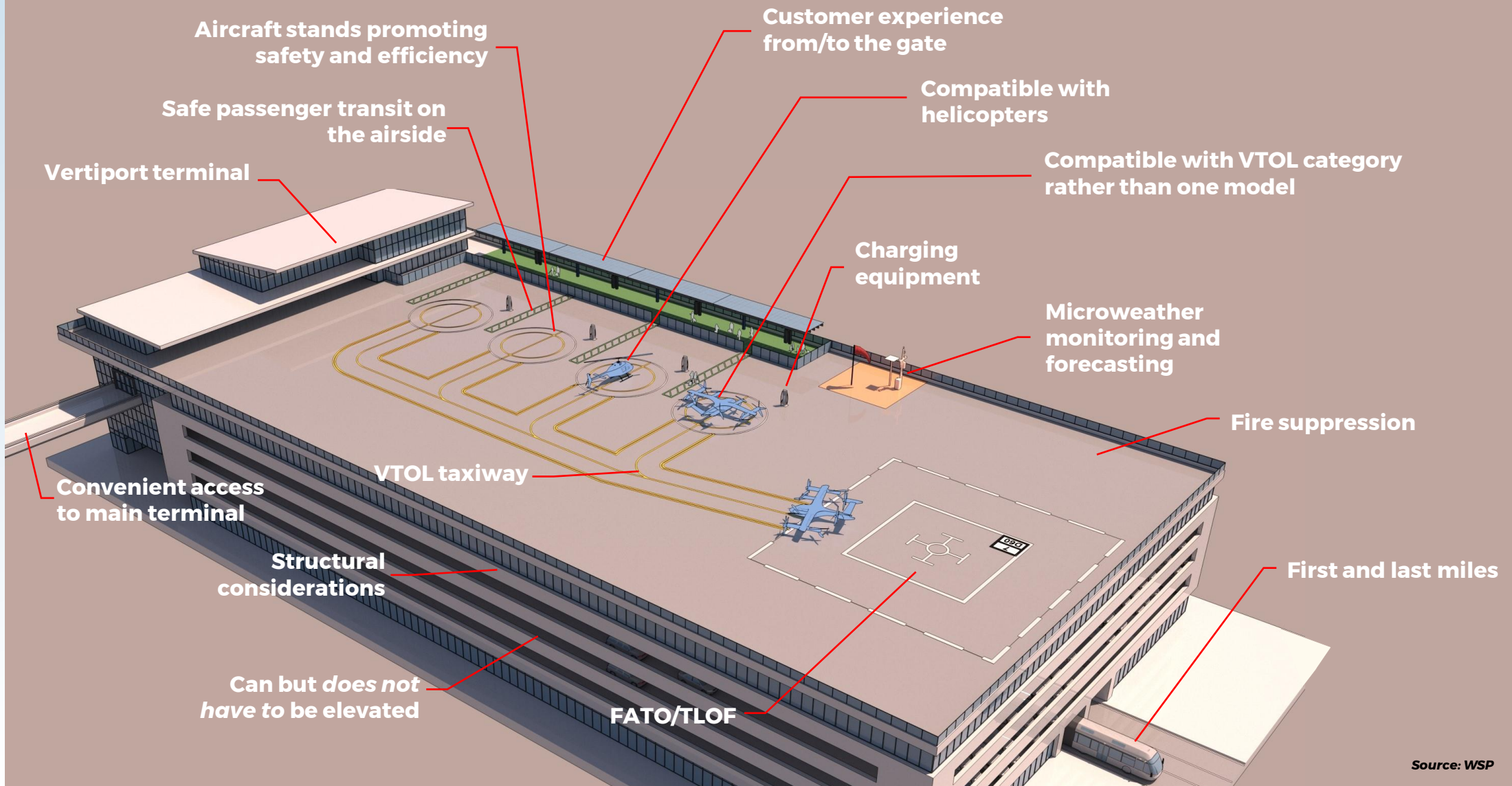
WSP USA

Anatomy of a Vertiport



Source: WSP

VTOL/Vertiport Compatibility Criteria

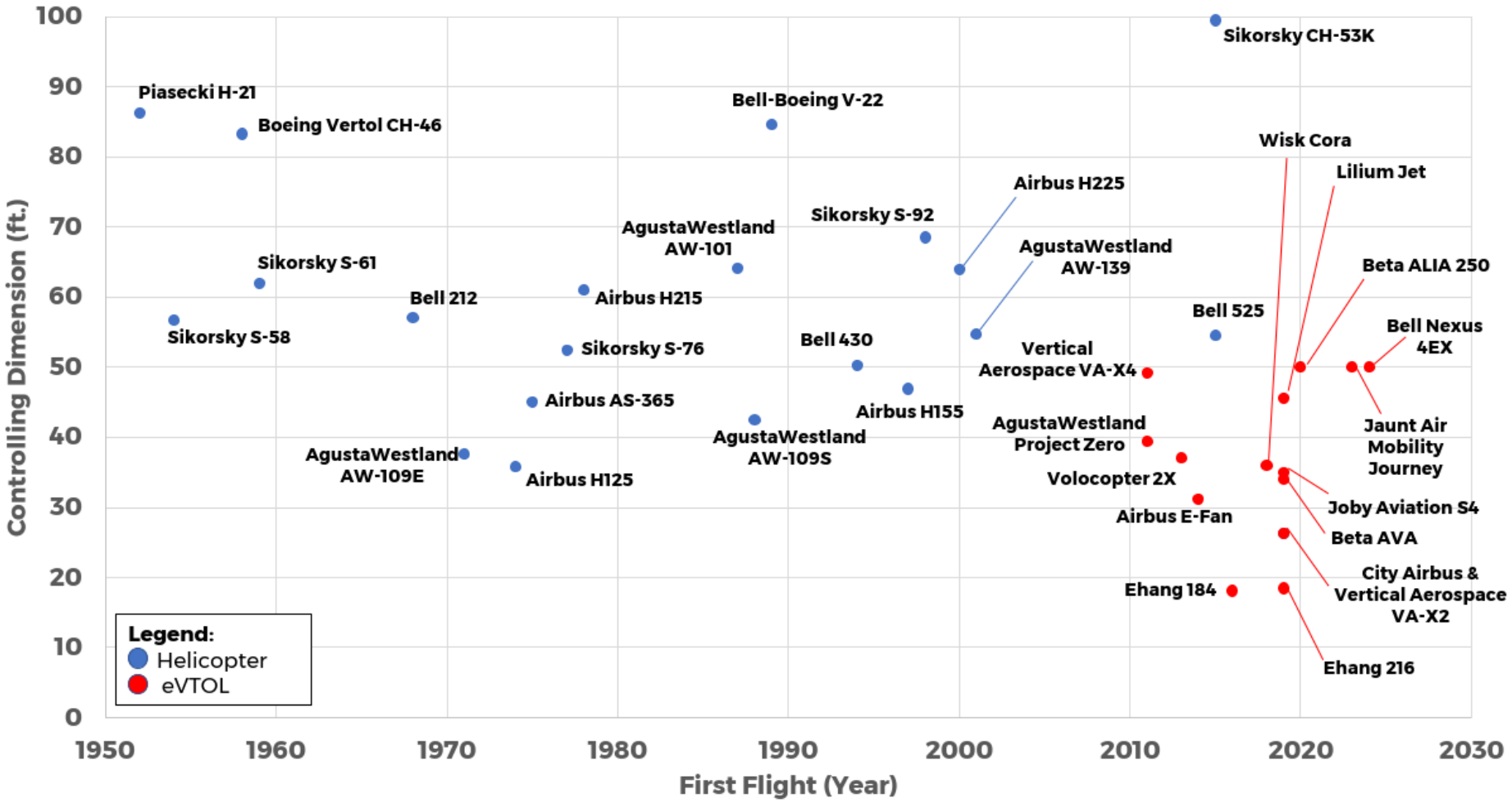
- Airfield geometry:
  - FATO, TLOF, safety area, etc.
  - Helicopter routes
  - Type & size of stands
- Performance vs. obstacles & procedures
- Load-bearing & structural considerations
- Ground operations & turnaround time
- Power requirements & hydrogen supply
- Local communities' buy-in (public desirability)
- Other criteria: ARFF, wind conditions, TSRs, FBO/MROs.

Download the research paper

"On the surface achieving compatibility between airports and aircraft seems a relatively simple task. […] However, the task becomes increasingly difficult as the details of the design are established"

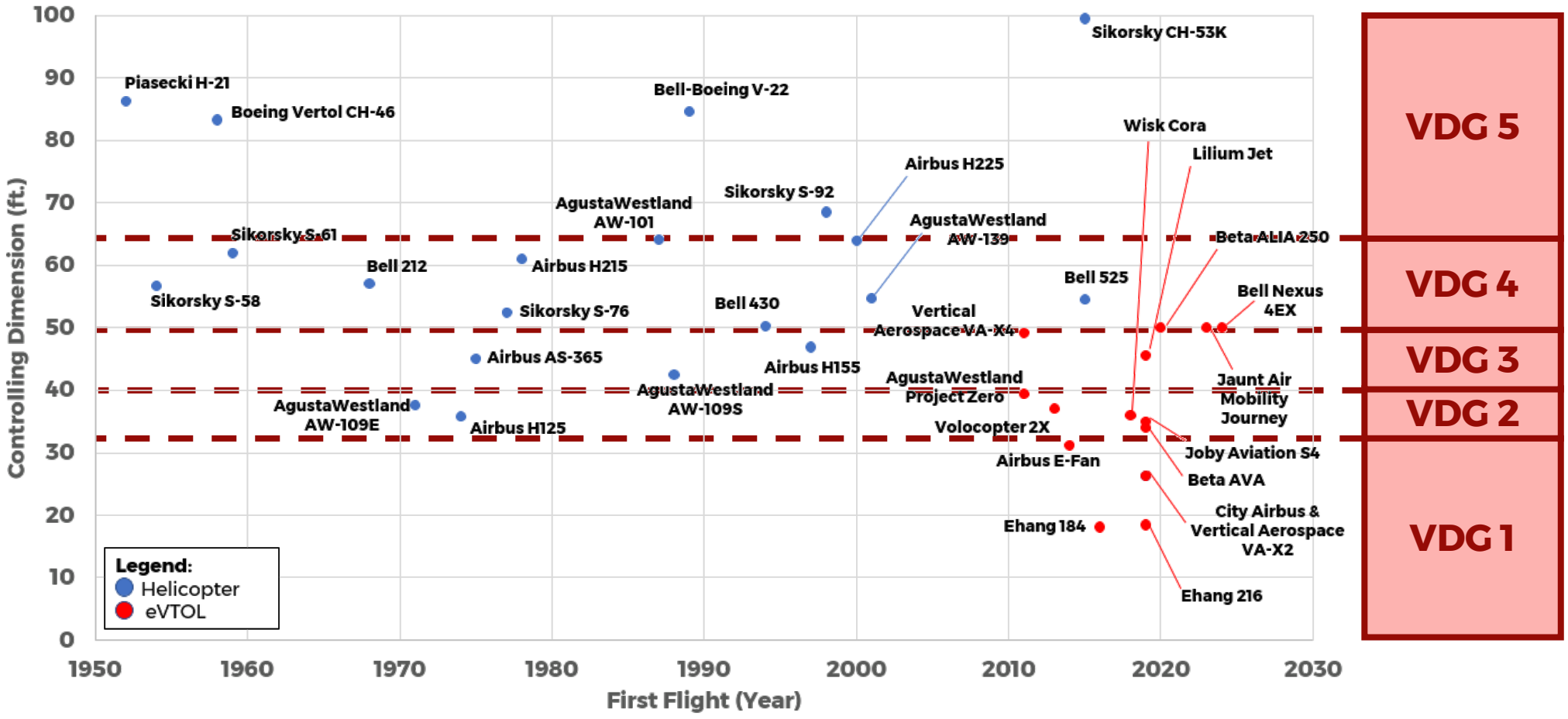
Parsons and Wilfert, 1981

Perspective on Future Fleets



Source: WSP

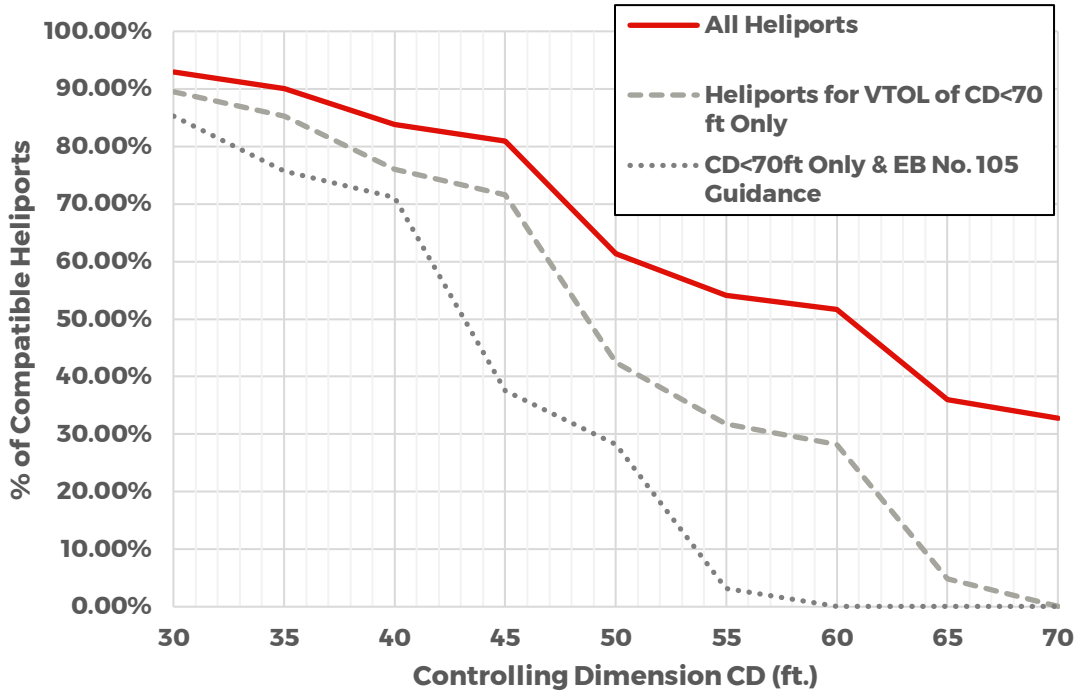
VTOL Design Group for Planning Purpose



Source: WSP

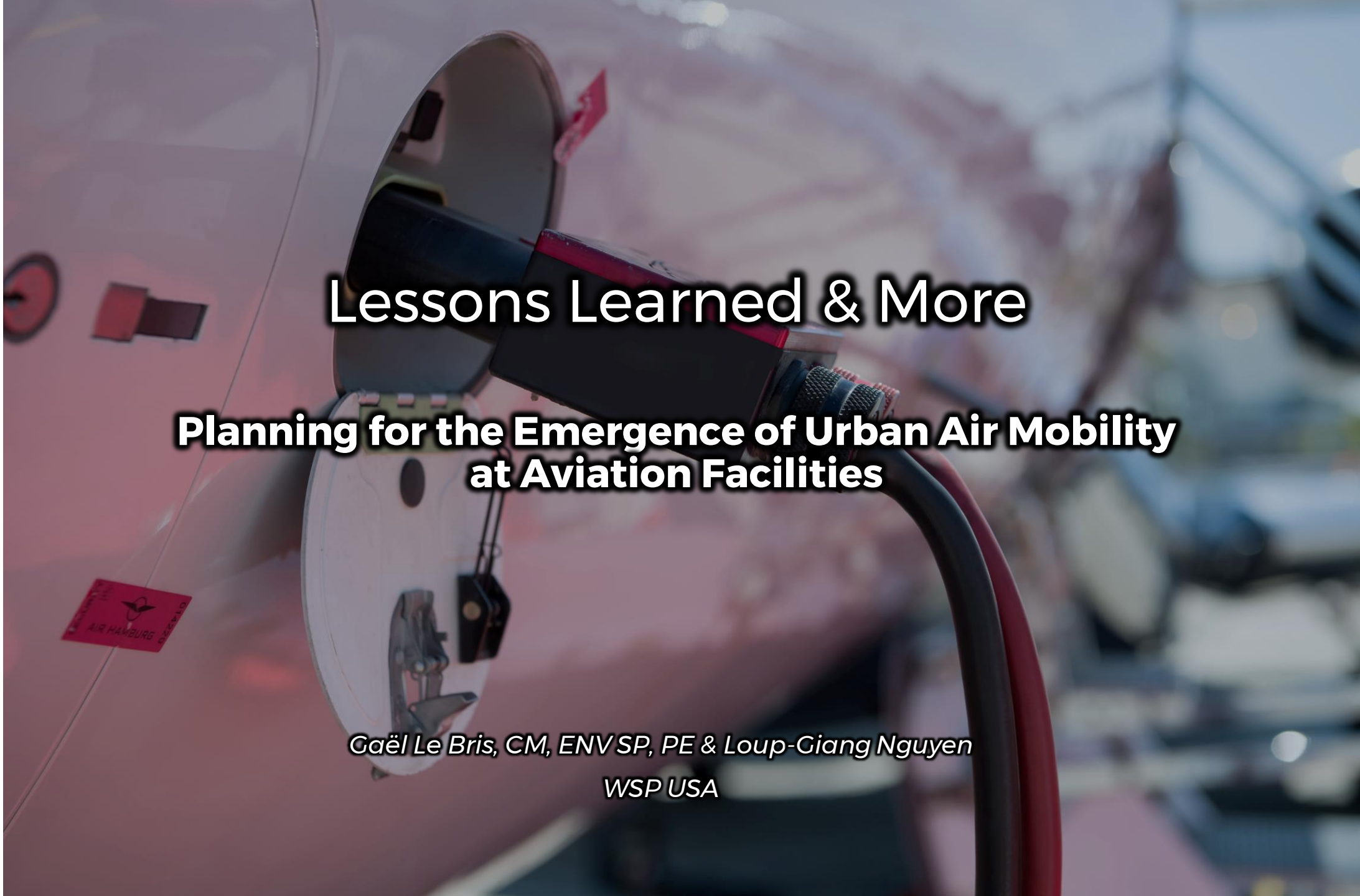
State of the U.S. Heliport Infrastructure

- To ensure successful implementation, eVTOL aircraft should be designed to operate from existing heliports.
- About **40%** of U.S. heliports* can accommodate VTOLs with a **CD=50 ft.,** and **85%** are compatible with VTOLs of **CD≤36 ft.**
- Uber Elevate's 2016 technical document highlights the significance of a **50 ft. CD**, providing access to a large number of heliports and EHLFs in the Los Angeles area.



***34%** of U.S. heliports can accommodate VTOLs with a **CD larger than 70 ft.**, many of which are U.S. Department of Defense (DOD) facilities. These are not accounted on this slide.

Source: WSP



Lessons Learned & More

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Gaël Le Bris, CM, ENV SP, PE & Loup-Giang Nguyen

WSP USA

Early Lessons Learned & Must-Do

- ✈ **Manage expectations**. Understand local potential. Admit uncertainty.
- ✈ Develop **realistic planning scenarios** rather than highly speculative forecasts.
- ✈ Consider groups of **aircraft with similar capabilities** rather than models/brands.
- ✈ It's never too early to **discuss the future** and prevent/limit obstacles…
- ✈ … But business decisions should be **demand-driven**.
- ✈ Pilot projects and demonstrations can serve as **low-risk early opportunities**.
- ✈ Don't create isolated vertiports. Consider the **door-to-door passenger journey**.
- ✈ Yes, eVTOLs have high power requirements to be **operationally viable**.

To-Do List for the Regulators and the Industry

- ❑ **Risk-based standards** on vertiport design enabling **performance-based MOS**.
- ❑ **Develop compatibility playbook** across stakeholders (e.g., ACI World ACG).
- ❑ Local and national **forecasts** for AAM traffic.
- ❑ Incorporate eVTOLs in guidance & tools on **capacity/delay, noise & emissions**.
- ❑ Guidance for **urban vertiport planning** including FLM (see ACRP 10-33).
- ❑ Guidance for **utility planning** in the era of the Electrification of Everything.
- ❑ Guidance to assess and manage **eVTOL downwash/outwash**.
- ❑ Strategies to mitigate the **impact of electric propulsion on fuel revenues**.

Further Reading

ACRP Research Report 236: Preparing Your Airport for Electric Aircraft & Hydrogen Technologies

ACRP Research Report 243: Urban Air Mobility: An Airport Perspective

Further Reading

An Airport & Vertiport/Aircraft Compatibility Approach of eVTOL Aircraft Design

Safety Considerations on the Operation of eVTOLs at Airports & Vertiports

Fly safe!

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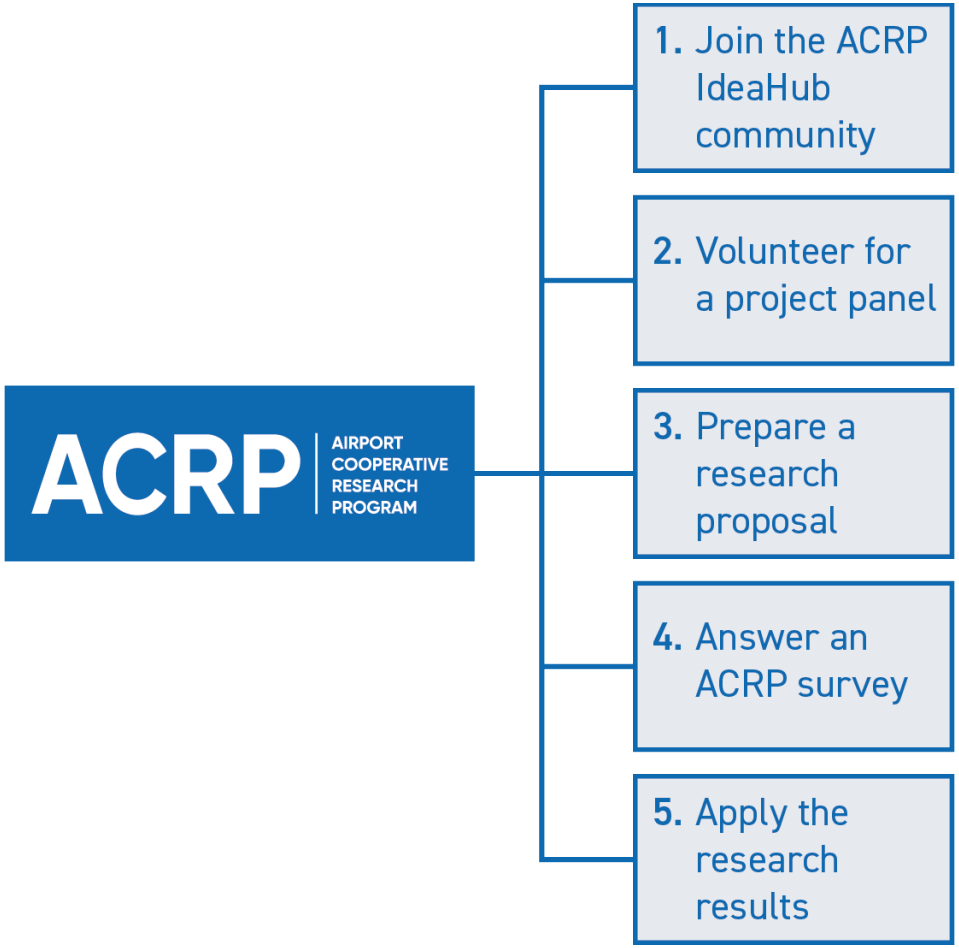

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