Emerging Technology and Alternatively Powered Aircraft

Mead & Hunt

COLORADO AIRPORT OPERATORS ASSOCIATION (CAOA)

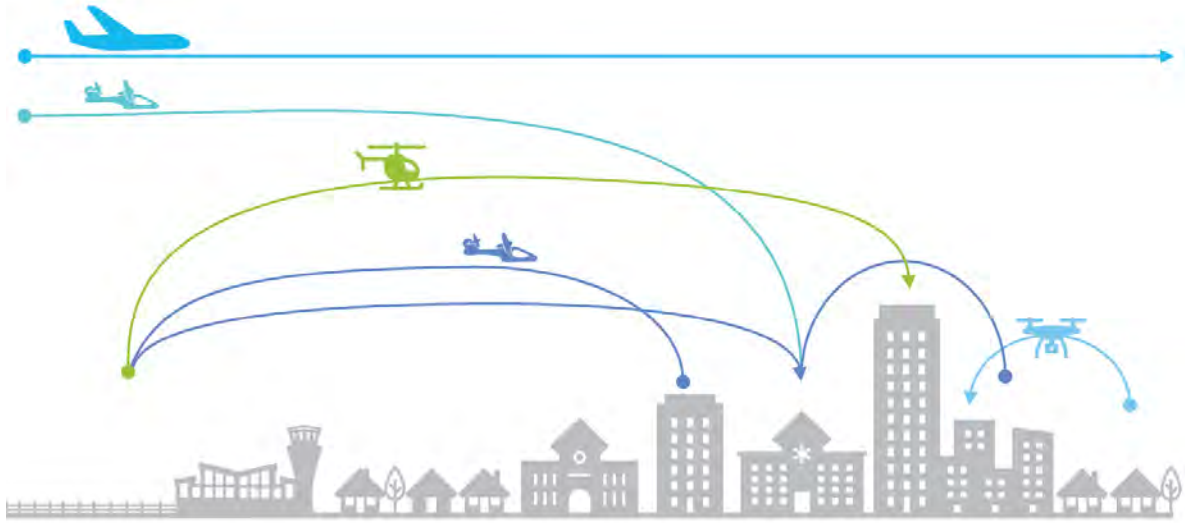
WINTER CONFERENCE - JANUARY 2023

Introductions

- **David Ulane, Director**
  - CDOT Division of Aeronautics
- **Ryan Hayes, Airport Planner**
  - Mead & Hunt

Talking Points

- Spring Conference Panel Ideas
- Planning and Environmental Considerations
- Guidance
- CDOT Aeronautics Division/NREL/NASA
  - CO Alternatively Powered Aircraft



Advanced Air Mobility (AAM) Network,
Mead & Hunt, Inc.

Emerging Tech Acronyms

- AAM – Advanced Air Mobility
- UAM – Urban Air Mobility
- ADG – Aircraft Design Group
- eCTOL – Electric Conventional Takeoff and Landing
- eVTOL – Electric Vertical Takeoff and Landing
- RAM – Regional Air Mobility
- UAV – Uncrewed Aerial Vehicle
- OEM – Original Equipment Manufacturer

Alternatively Powered Aircraft

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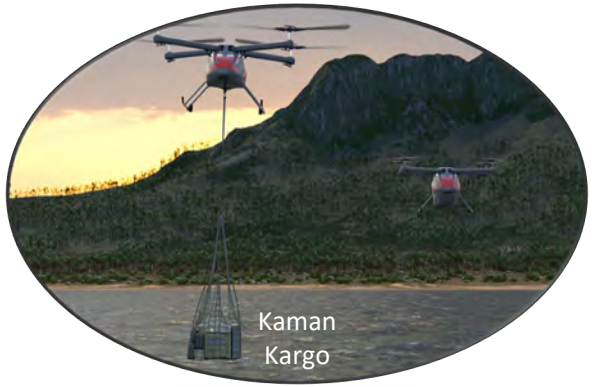
Aircraft

Existing Design, eCTOL

Magnix
C208 Caravan

UAVs



Kaman
Kargo

Hybrid-Electric

Airbus
E-Fan X

New Design, eVTOL

BETA
Alia 250

New Design, eCTOL

Heart Aerospace
ES-19

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Air mobility startup market map

eVTOL passenger aircraft

JOBY AVIATION · ARCHER · LILIUM · VOLOCOPTER · EHANG 184 · KITTY HAWK · Aurora FLIGHT SCIENCES · KAREM · DUFOUR AEROSPACE · JXV · TALYN · ZEVA · JAUNT · EVA · OPENER · ASX · Flyt · The ePlane Company · ALAKA'I TECHNOLOGIES · AtlasAero · BETA · Hyundai Aerospace · Jump Aero · XTI AERO · Overair · SKYWORKS · tetra · URBAN · VERTICAL · VOYZON AEROSPACE · wisk · EVE · AUTOFLIGHT

eCTOL aircraft

EVIATION · HYE · pyka · ZUNUM Aero · AMPAIRE · Wright · hypoint · BLUE · Heart Aerospace · faradair

Electric propulsion & motors

PIPISTREL · ep GENERAL POWER · ZeroAVIA · H55 · LAUNCHPOINT · GPL · MAGiCALL · magniX

Roadable aircraft

SKYDRIVE · AEROMOBIL · TERRAFUGIA

Autonomous autopilot & airspace management

EMERALIAN · Skyryse · XWING · ALTITUDE · SKYDIO · NEAR EARTH AUTONOMY

Air mobility startup market map

Drones

zipline · Skydio · 3DR · dji · DroneDeploy · PRECISION · AIROBOTICS · SKYCATCH · DRONE RACING LEAGUE · BAILDRONE · Makeblock · Clobotics · AIRMAP · Dedrone · kespry · YUNEEC · SPECS · DELAIR · FORTEM TECHNOLOGIES · FLYPRO Just Move · D-FEND · IRIS AUTOMATION · WINDCOPTER · ELROY AIR · Flirtey · JOUAV · IMPOSSIBLE · FLYTREX · Cloudline

Battery technology

northvolt · QuantumScape · microvast · SILA · SVOLT · FREYR · Амотех · ENOVIX · Livent · VARTA · ROMEO · ENEVATE · Sion Power · GROUP14 · SolidPower · CUBERG · ULTIUM CELLS

Supersonic aircraft

BOOM · RAMGEN · AERION SUPERSONIC · AMPAIRE · EXOSONIC · SPIKE AEROSPACE

Air mobility services

WHEELS UP · VISTAJET · BLADE · VICTOR · RELIABLE ROBOTICS · HYBRID Air Vehicles · JETSUITE · APIS AVIATION · WHEE · OPENJET · PRIVATEFLY · JET SET GO · FlightBridge · EVOLUX · JETINSIGHT · FLYT · avinode · FlexJet

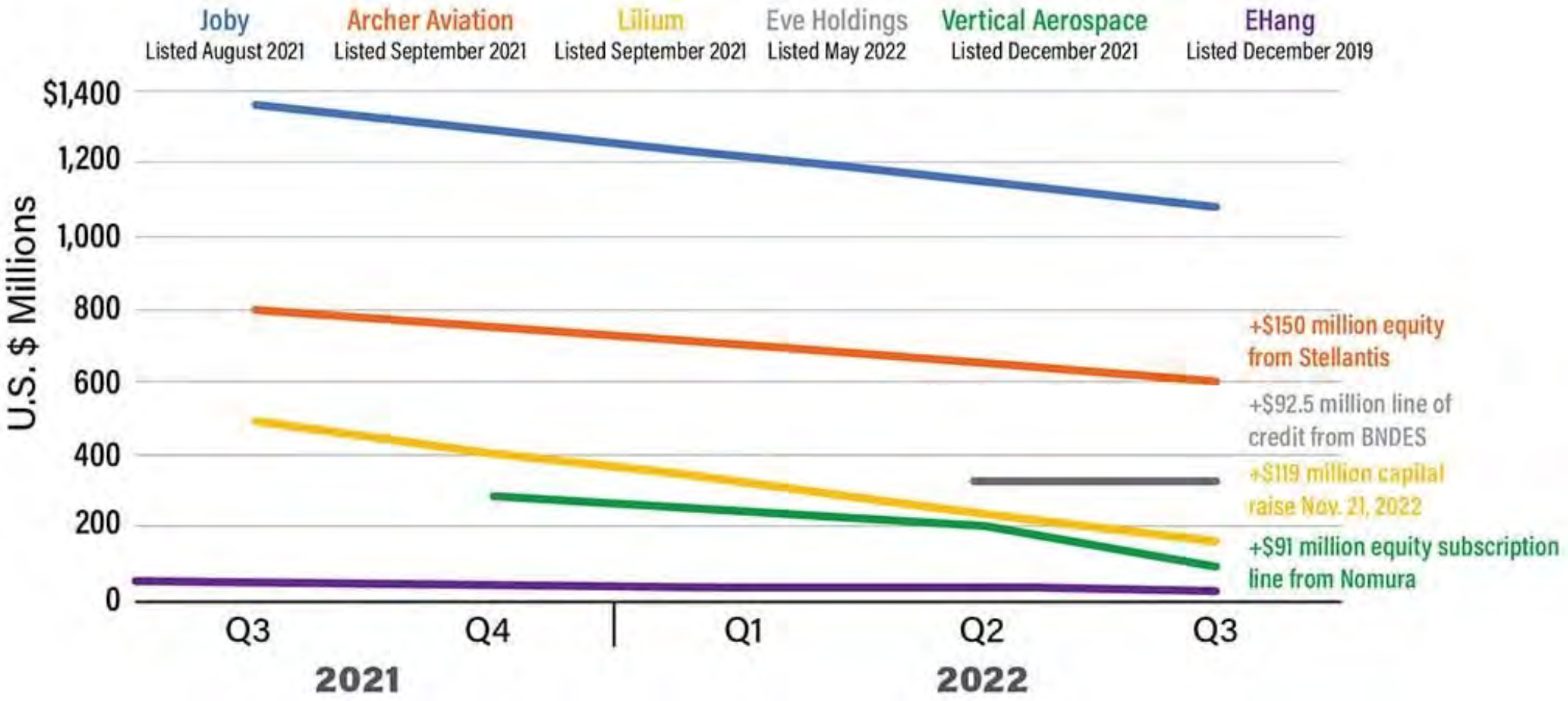
Source: Pitchbook Air Taxi Startup Handbook, 2021

eVTOL Manufacturers

	2023 Rank	2022 Rank	Change
Joby	1	1	Service entry delayed to 2025. Pilot production begun. Delta Air Lines partnership.
Archer	2	5	Service entry on track for 2025. Stellantis manufacturing partership, investment.
Volocopter	3	3	+$382 million raised. Certification flight tests underway. Service entry slipped to 2024.
EHang	4	7	Certification expected early in 2023. China market only at first.
Beta	5	2	+$375 million raised. Flight test progress. Certification and production plans TBD.
Eve	6	8	$377 million special-purpose acquisition company. Engineering support from Embraer. United Airlines investment.
Lilium	7	4	Shift to premium private market for launch. More funding needed.
Vertical	8	6	Full-scale tethered hover tests performed. More funding needed.
Airbus	9	9	Certification in 2025 doubtful. Air medical services initial market focus.
Wisk	10	10	Unveiled production four-seat autonomous eVTOL. No service entry date announced yet.
AutoFlight	11	—	Full-scale proof-of-concept flights. European certification with Chinese manufacturing.
Overair	12	12	+$145 million from Hanwha (total $175 million). Plan to fly prototype in 2023.
Supernal	13	11	Collaborating with BAE Systems, EPS, Honeywell, Microsoft, Urban-Air Port.

Source: Aviation Week and Space Technology

eVTOL Liquidity – Burning Cash



Source: Aviation Week and Space Technology, Company Financials

Certification Race

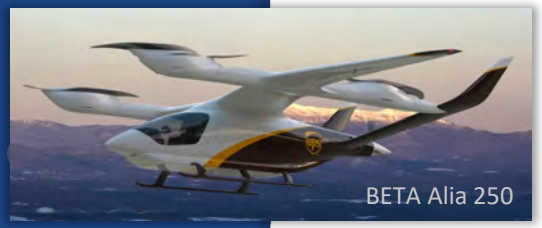
- **Short-Term**
  - ADG I and II fixed wing and eVTOL
  - General aviation, air taxi, small cargo
- **Medium/Long-Term**
  - Designs larger than ADG II
  - Air carrier
    - Hybrid, hydrogen, and sustainable aviation fuels vs. pure electric


Pipestrel
Alpha Electro

Magnix
C208 Caravan


Eviation
Alice

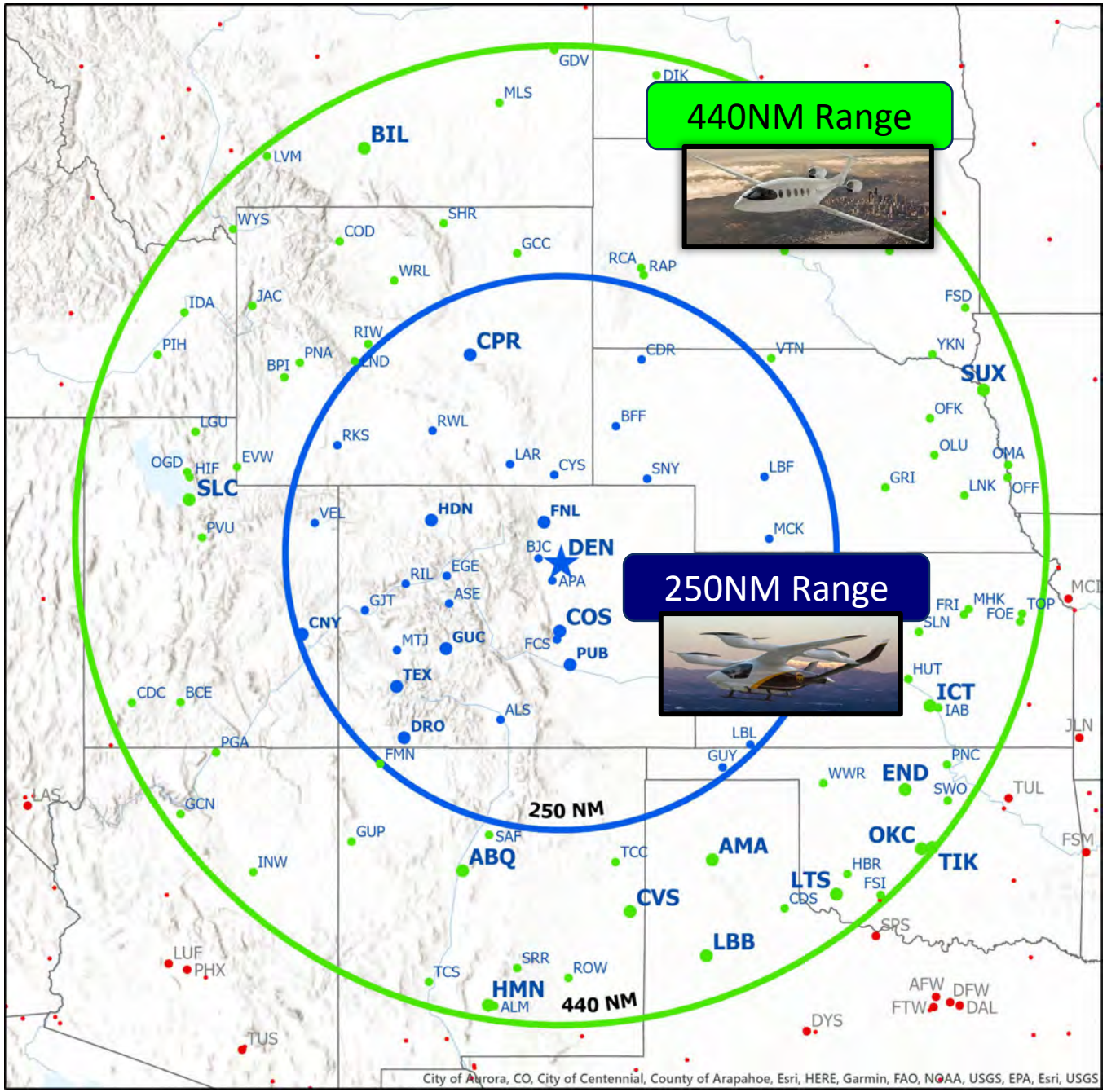
Low and Zero-Carbon Energy Sources



	2020	2025	2030	2035	2040	2045	2050
Commuter » 9-19 seats » < 60 minute flights » <1% of industry CO_2	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
Regional » 50-100 seats » 30-90 minute flights » ~3% of industry CO_2	SAF	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
Short haul » 100-150 seats » 45-120 minute flights » ~24% of industry CO_2	SAF	SAF	SAF	SAF potentially some Hydrogen	Hydrogen and/or SAF	Hydrogen and/or SAF	Hydrogen and/or SAF
Medium haul » 100-250 seats » 60-150 minute flights » ~43% of industry CO_2	SAF	SAF	SAF	SAF	SAF potentially some Hydrogen	SAF potentially some Hydrogen	SAF potentially some Hydrogen
Long haul » 250+ seats » 150 minute + flights » ~30% of industry CO_2	SAF	SAF	SAF	SAF	SAF	SAF	SAF

Source: ATAG Waypoint 2050

Near-term Capability



Planning & Environmental Considerations

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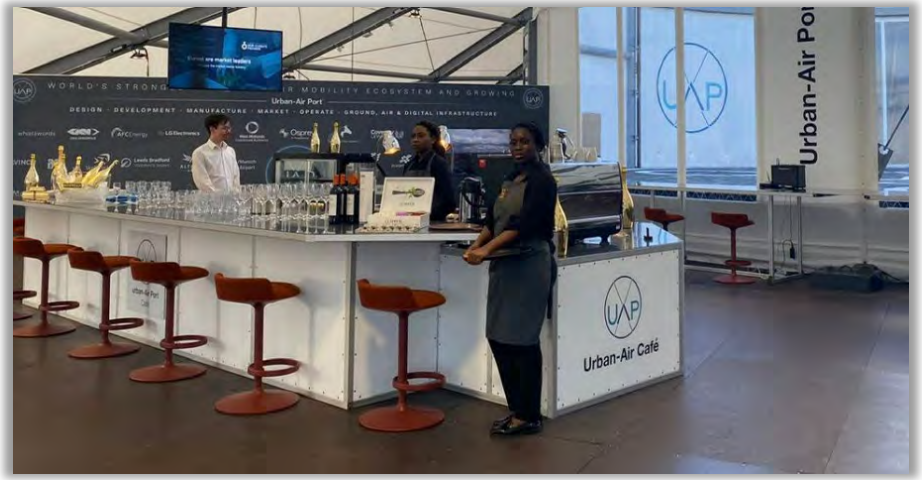
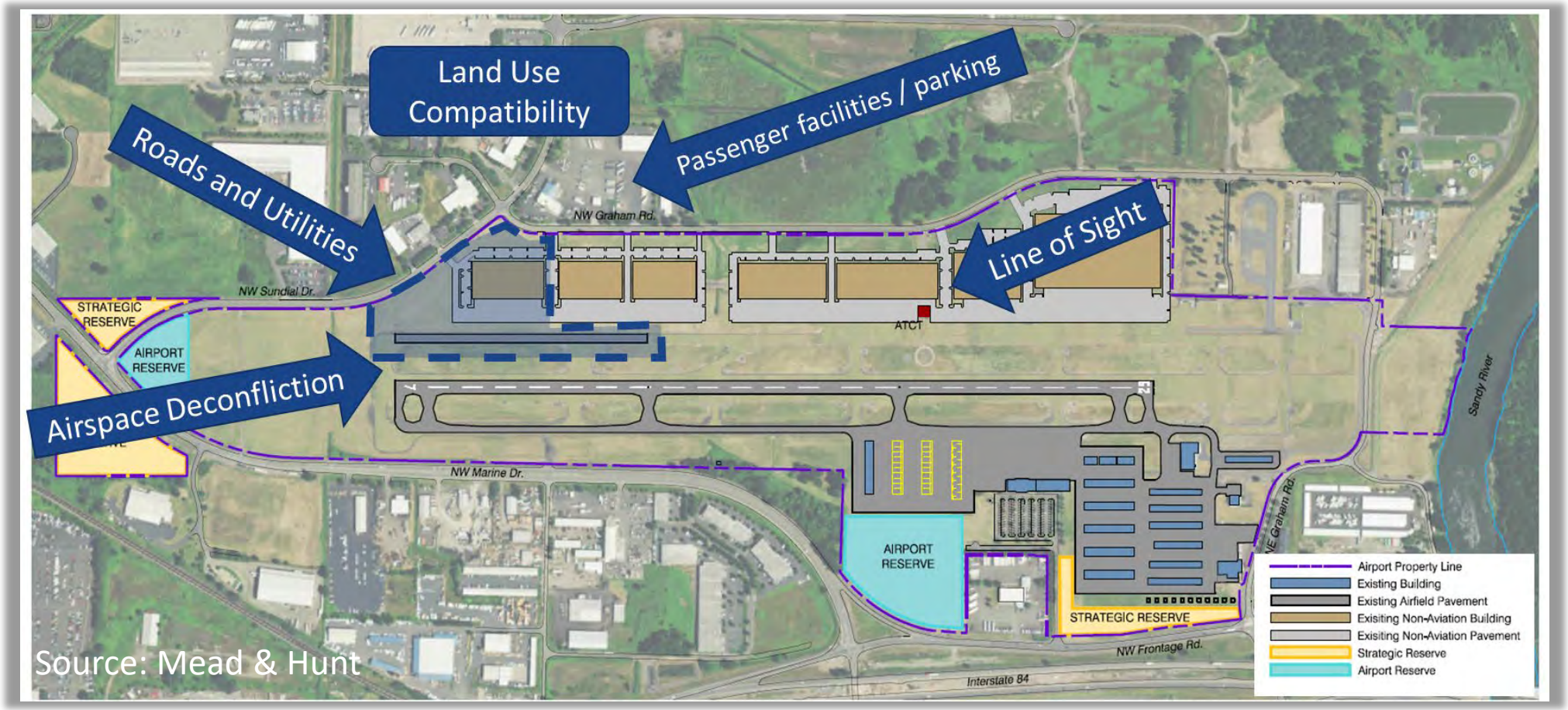
Terminal Planning Considerations

- Airside
- Interior
- Landside

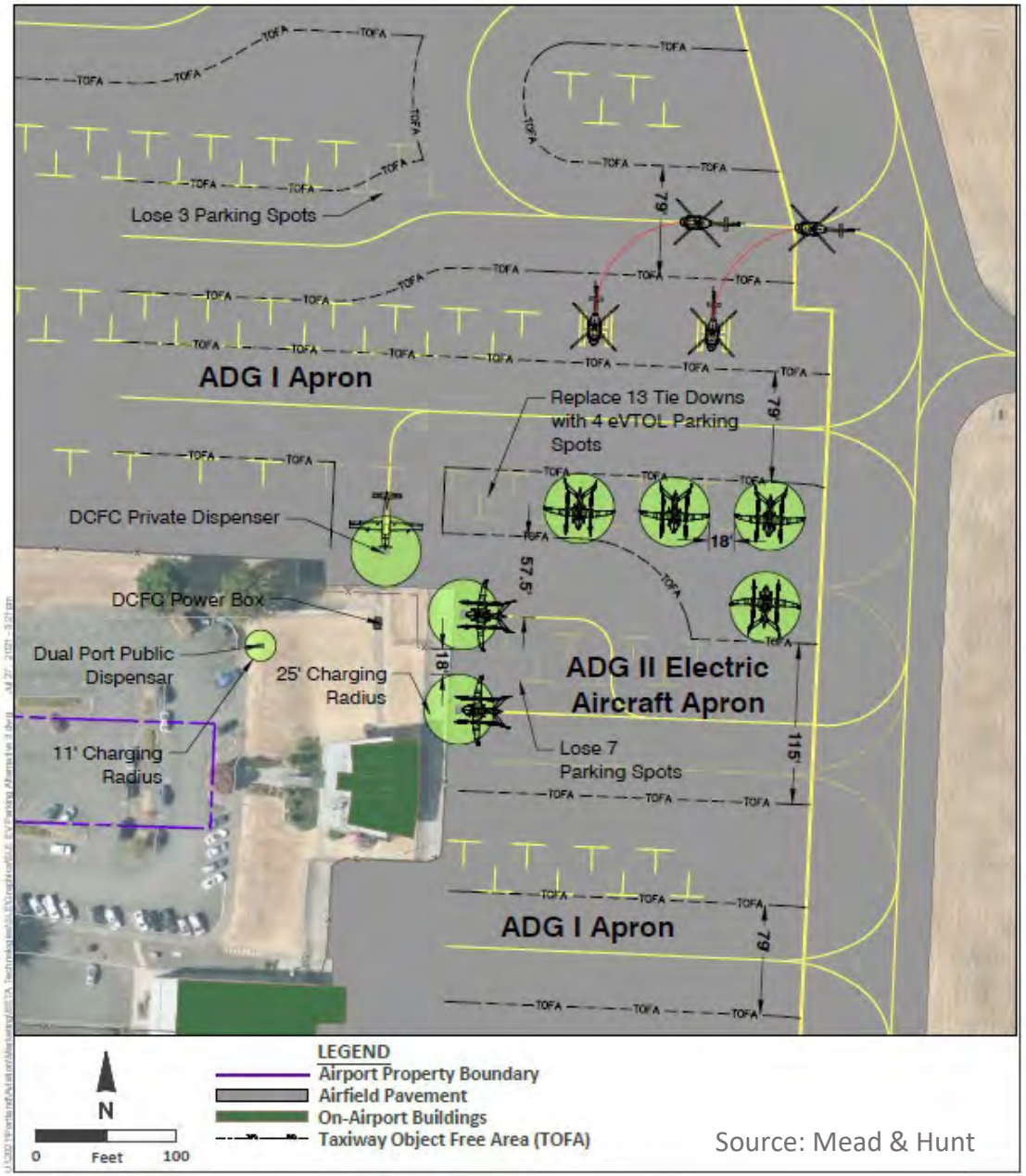




Source: Mead & Hunt

- **Power Supply**
  - Simultaneous charging
  - Comprehensive need
- **Airside Planning**
  - Aircraft type
  - Airfield compatibility
- **Landside Planning**
  - Transit tie-in
  - Auto parking and road network
- **Environmental**
  - Noise and overflight
  - NEPA

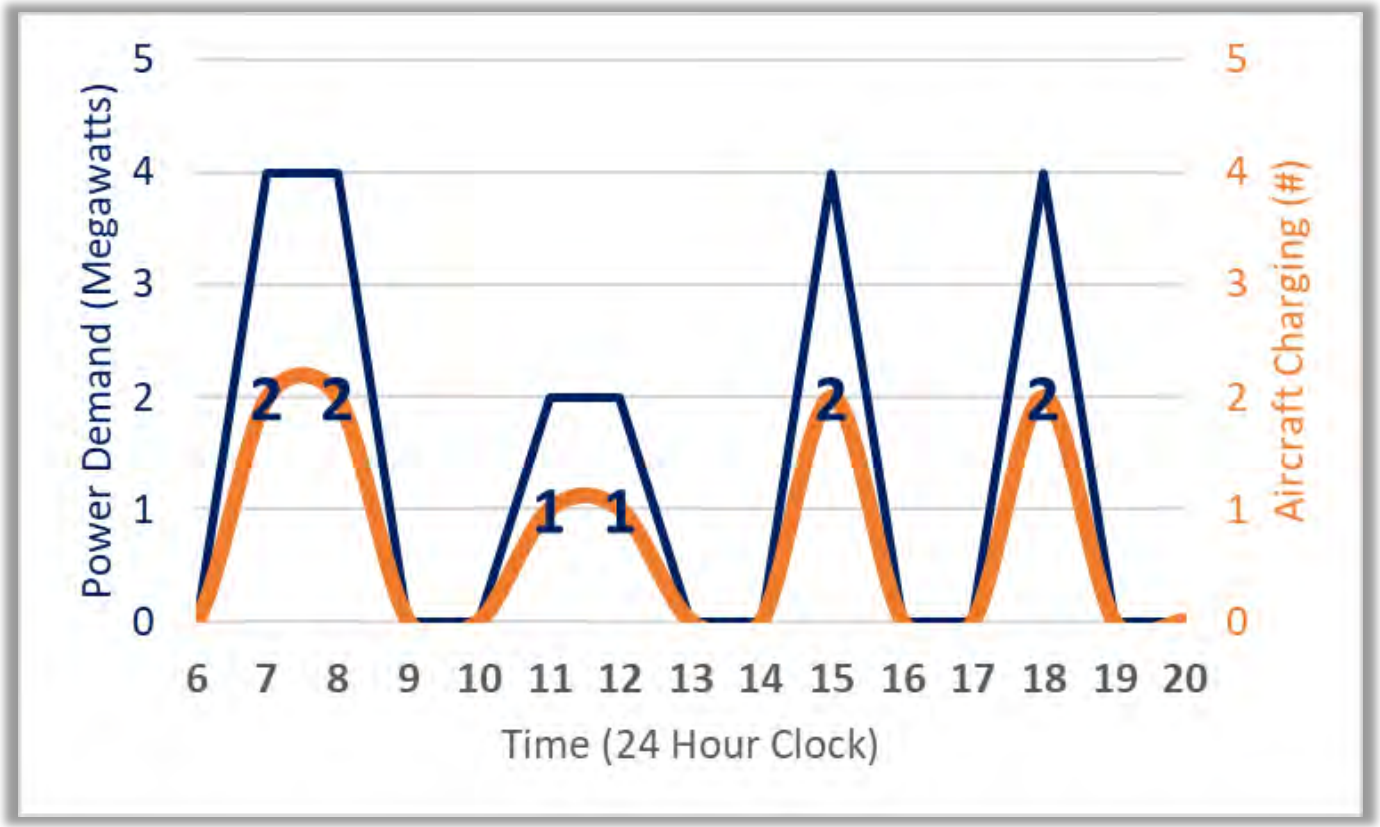
- **Landside Planning**
  - Distance to power
  - Setbacks
  - Compatibility
  - Rotor wash
  - Pilot services
  - MRO facilities
  - Car charging
- **Environmental**
  - Trenching
  - Facilities
  - Noise/Perception



Source: Mead & Hunt

Electricity Demand

- **1 megawatt = 5-10 acres of panels**
- **In addition to other demands**
  - Buildings
  - Rental Cars
  - Passenger Cars
  - Ground Equipment



Data: National Renewable Energy Labs, 2021
Modeling essential air service demand at Denver International (DEN)

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Guidance Documents

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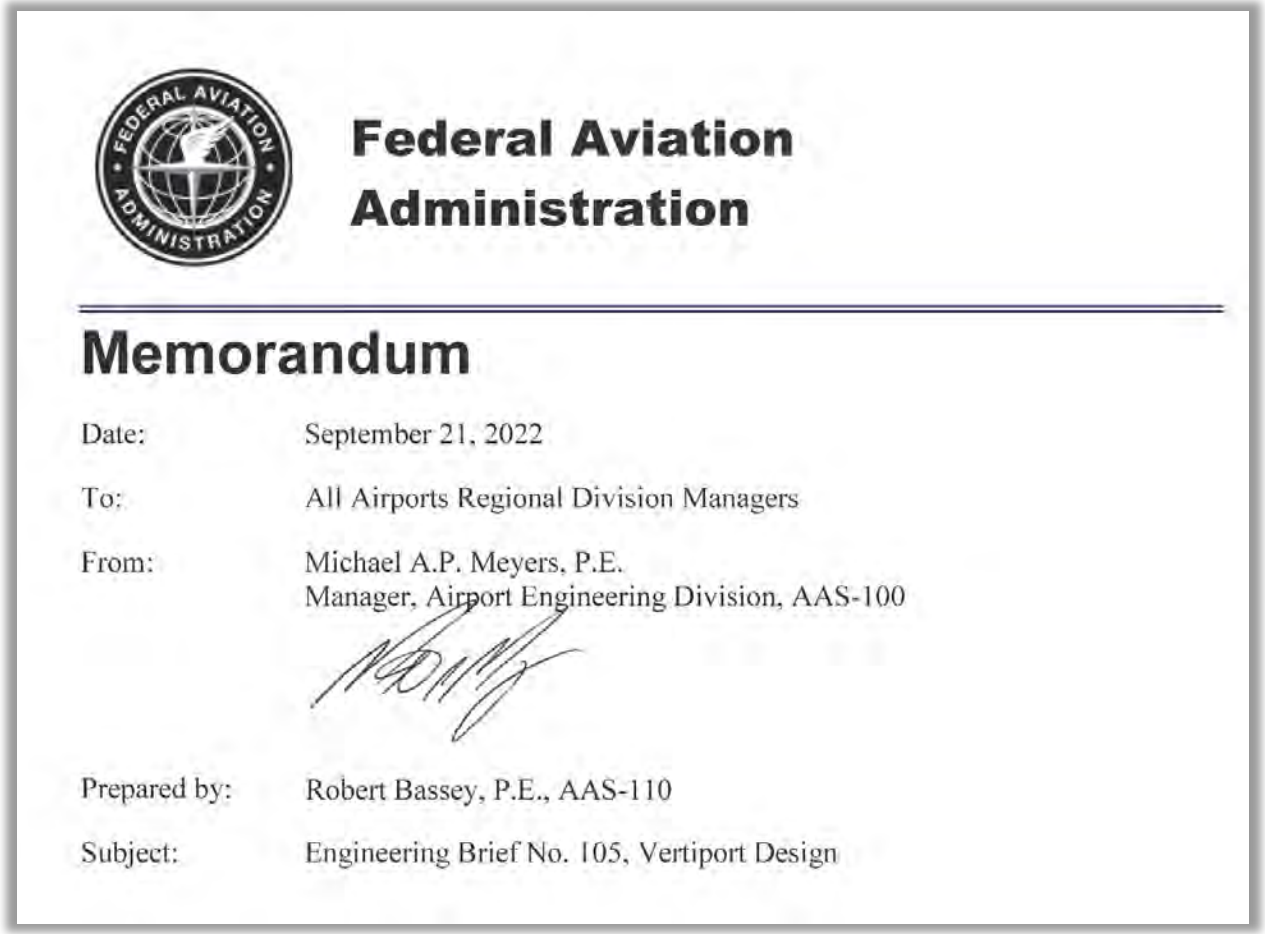
FAA Guidance

- **EB No. 105**
  - Comments submitted 4/18/22
  - FAA revised document
  - Final published 9/21/22
- **Contents**
  - Design and Geometry
  - Marking, Lighting, Visual Aids
  - Charging Infrastructure
  - On-Airport Vertiports
  - Safety Elements
- **Key Takeaways**
  - Plan like helicopters for now
  - More guidance to come, potentially in May 2023



Federal Aviation Administration

Memorandum

Date: September 21, 2022

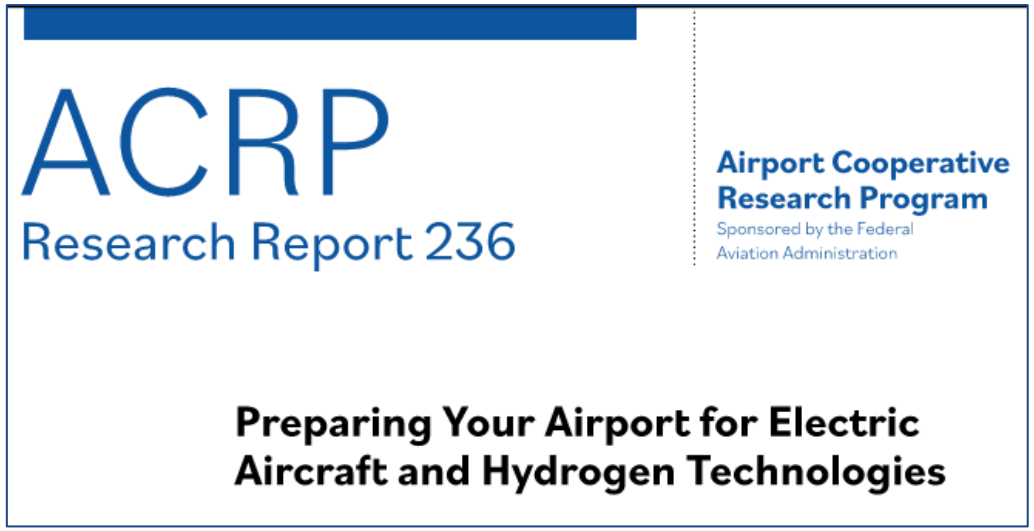
To: All Airports Regional Division Managers

From: Michael A.P. Meyers, P.E.
Manager, Airport Engineering Division, AAS-100

Prepared by: Robert Bassey, P.E., AAS-110

Subject: Engineering Brief No. 105, Vertiport Design

ACRP Guidance



- **ACRP Report 236**
  - Electric Aircraft Overview
- **ACRP Project 11-02/43 - Pending**
  - Successful Community Inclusion in AAM

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Other Guidance

- **Agency Guidance**
  - European union Aviation Safety Agency (EASA)
  - National Renewable Energy Laboratory (NREL)
- **Private Guidance**
  - Lillium
    - Vertiports
    - Taxiways
    - Charging Requirements
    - Apron and Terminal

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CDOT Division of Aeronautics

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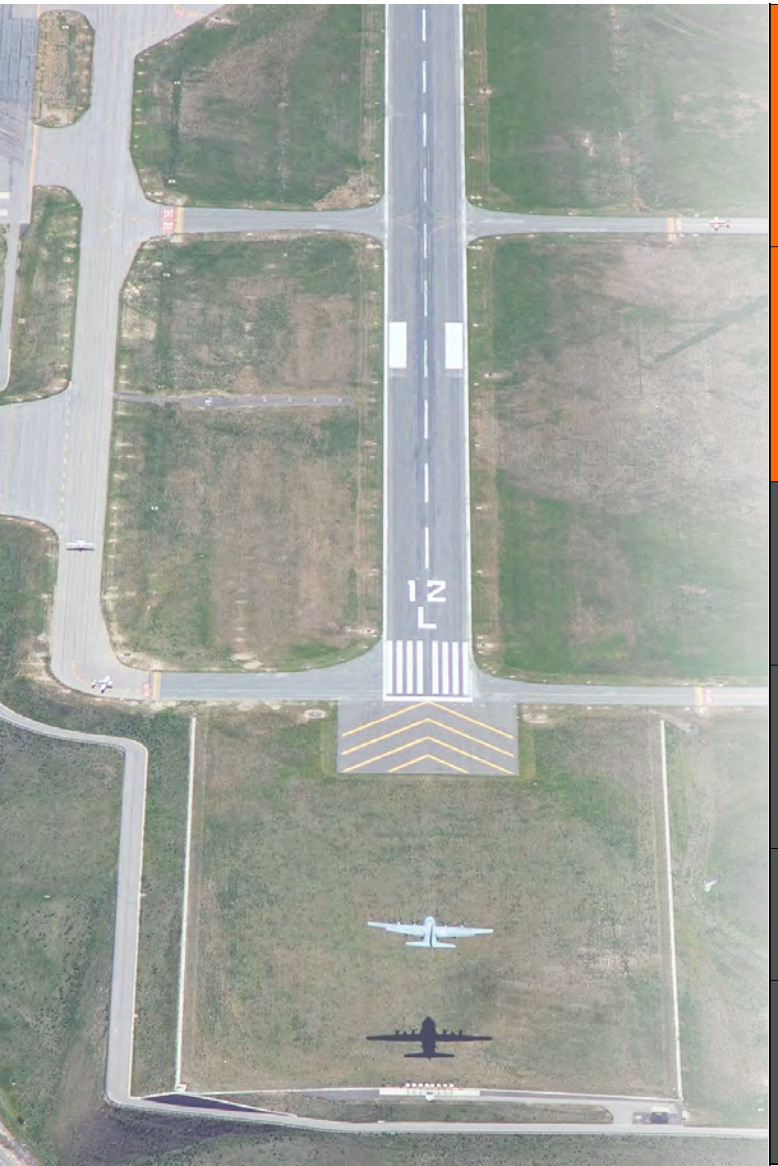
COLORADO
Department of Transportation
Division of Aeronautics

2021 Division Strategic Plan



Mission	**The Mission of the CDOT Division of Aeronautics** is to support Colorado's multi-modal transportation system by advancing a safe, efficient, and effective statewide aviation system through collaboration, investment, and advocacy.
Vision	**The Vision of the CDOT Division of Aeronautics** is to be the leading state aviation organization by enhancing the efficiency, economic benefit, and sustainability of Colorado's aviation system through funding, innovation, education, and support of current and emerging technologies.
Goal 1	**Engage with industry to support and facilitate emerging technologies (e.g., alternatively powered aircraft, aviation fuels, navigation, air traffic control, etc.) by the end of fiscal year 2024.**
Goal 2	**Expand the Division's outreach, education, and advocacy programs to facilitate engagement with stakeholders and industry partners by the end of fiscal year 2024.**
Goal 3	**Enhance internal professional development to strengthen the capabilities of the Division by the end of fiscal year 2024.**
Goal 4	**Explore and, where appropriate, implement or support new and improved statewide initiatives that sustain the aviation system by the end of fiscal year 2024.**

Battery & Electric Powered Aircraft

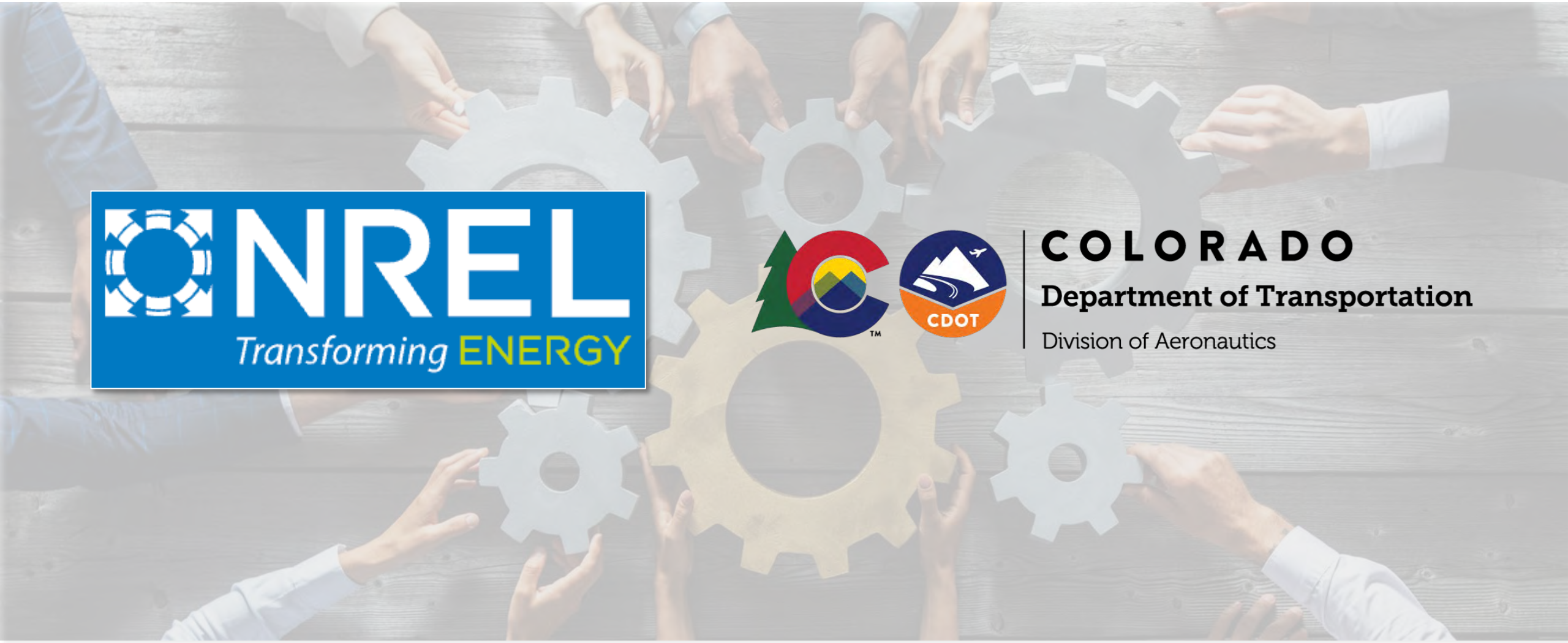
EVIATION

ALICE

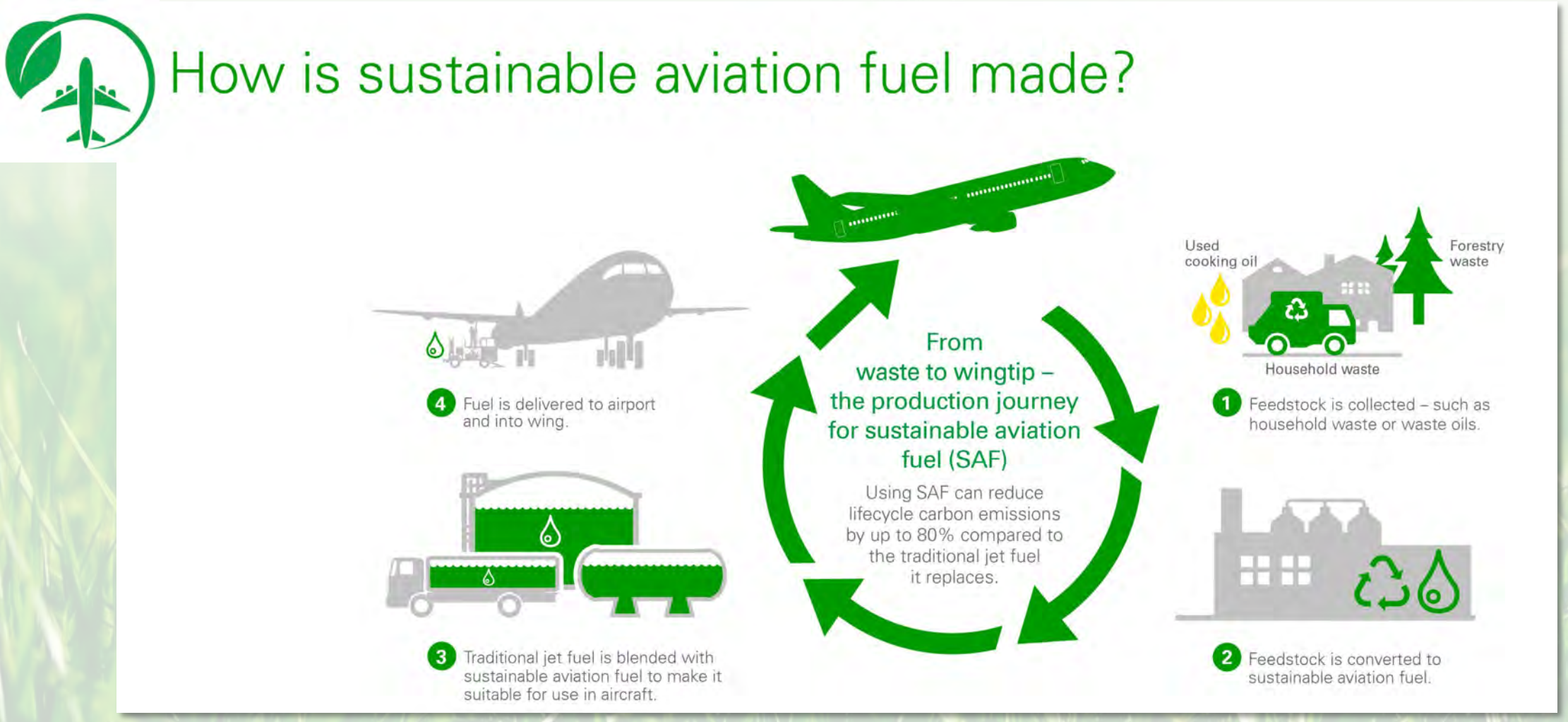
Battery & Electric Powered Aircraft

Hybrid/Hydrogen Fuel Cell Powered Aircraft

Working Together



Sustainable Aviation Fuel



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Thank You!

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