

Batteries to Enable Short Haul Electric Aviation



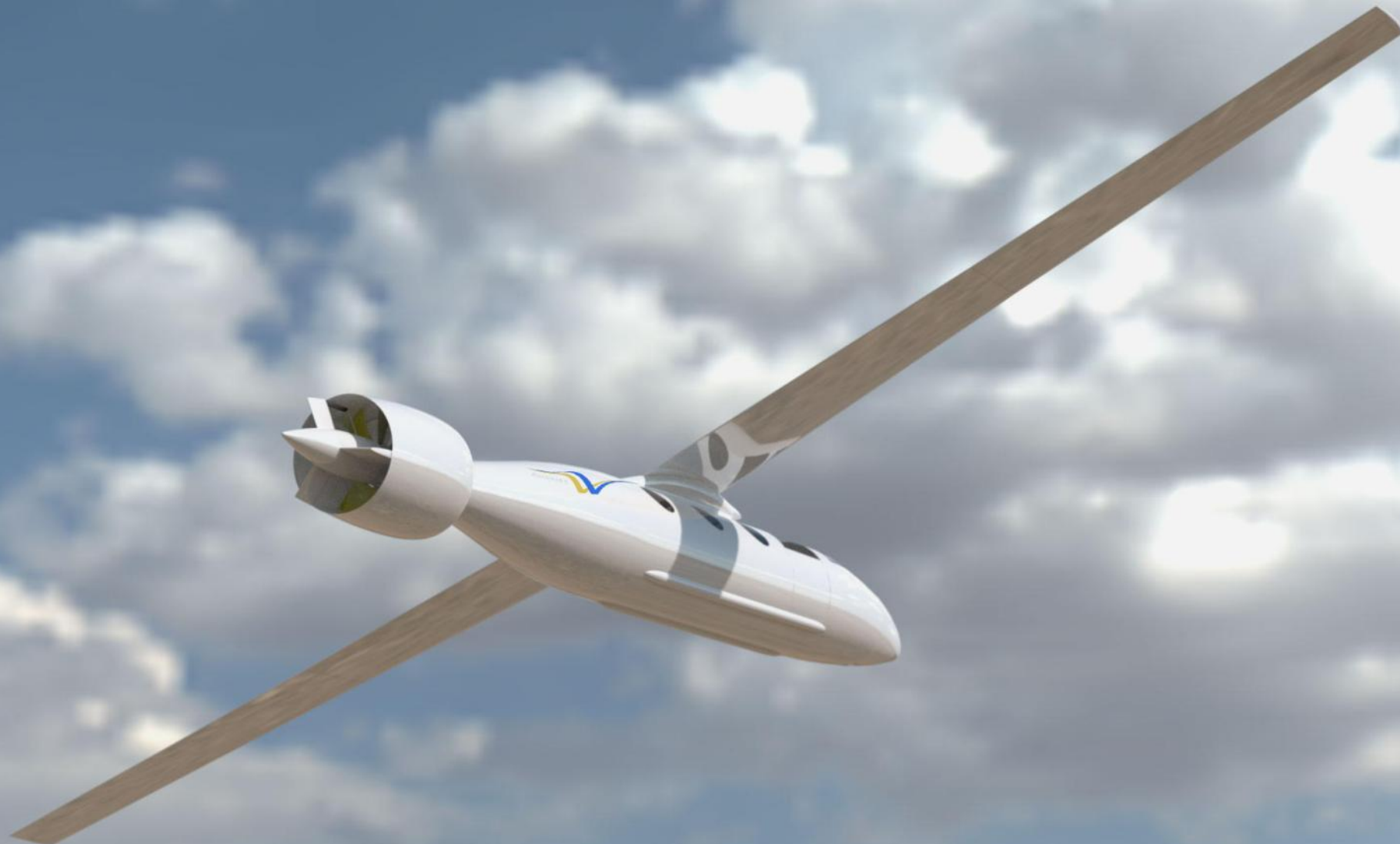
NAATBatt

INTERNATIONAL

Annual Meeting & Conference

February 12th, 2020 Pasadena, CA

Peter Savagian
SVP, Engineering
Ampaire, Inc



Ampaire Tailwind



Globally, aircraft make $\frac{1}{4}$ of the CO₂ of cars



No emission controls for NO_x, Particulates or others



Emissions are more active at altitude

A construction worker in a white safety vest and red gloves is using a jackhammer on a concrete surface. Another worker in an orange shirt is visible in the background. The image is overlaid with a semi-transparent dark blue filter.

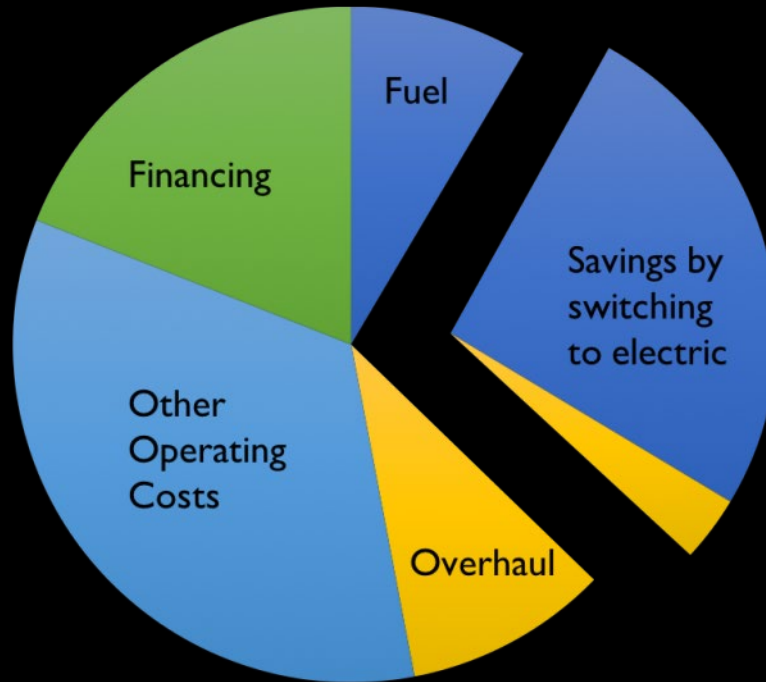
70% - 90% fuel cost savings

A low-angle, upward-looking photograph of an aircraft wing against a clear blue sky. A technician, wearing a dark blue long-sleeved shirt, a high-visibility yellow safety vest with reflective silver stripes, and a dark cap, is reaching up with their right arm to point at the underside of the wing. The wing's surface is metallic and features several circular access panels and rivets. Stenciled text on the wing includes '08 BAR', 'SUCTION', 'PRESSURE', and '03 BAR'. The overall image has a slightly desaturated, professional feel.

25% - 50% maintenance cost savings

Cost Savings Boost Airlines Bottom Lines

Fuel Overhaul
Other Financing



75-90%



25-50%

3x

Airline Profit
Margin Growth

A large array of solar panels is shown from a low angle, looking down the rows of panels towards the horizon. The panels are dark blue with a grid of silver lines. The sky is a clear, deep blue. The text "Customers value zero direct emissions" is centered in the upper half of the image.

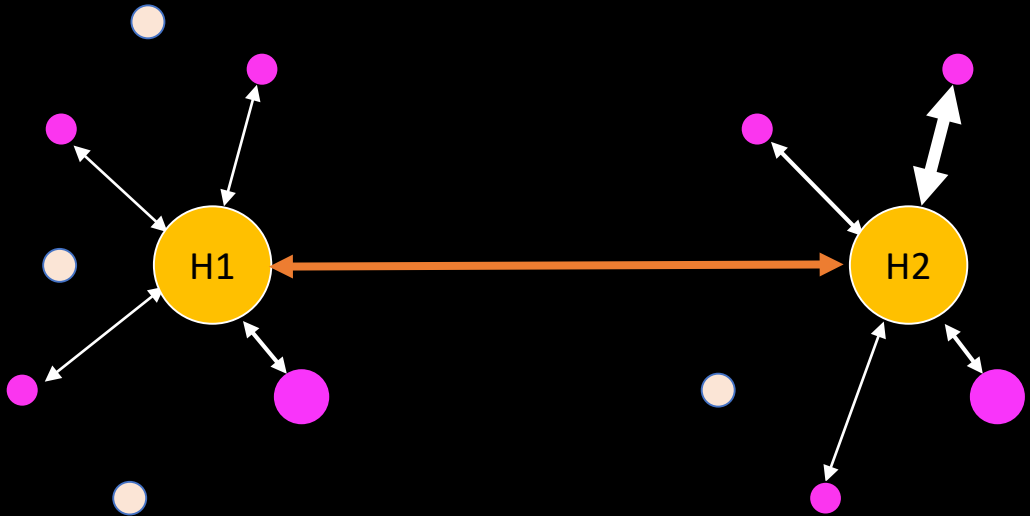
Customers value zero direct emissions

A view from an airplane window looking out over a landscape. The wing of the airplane is visible on the right side of the frame. The landscape below is a mix of fields and mountains, with a layer of clouds or haze in the distance. The sky is a deep blue.

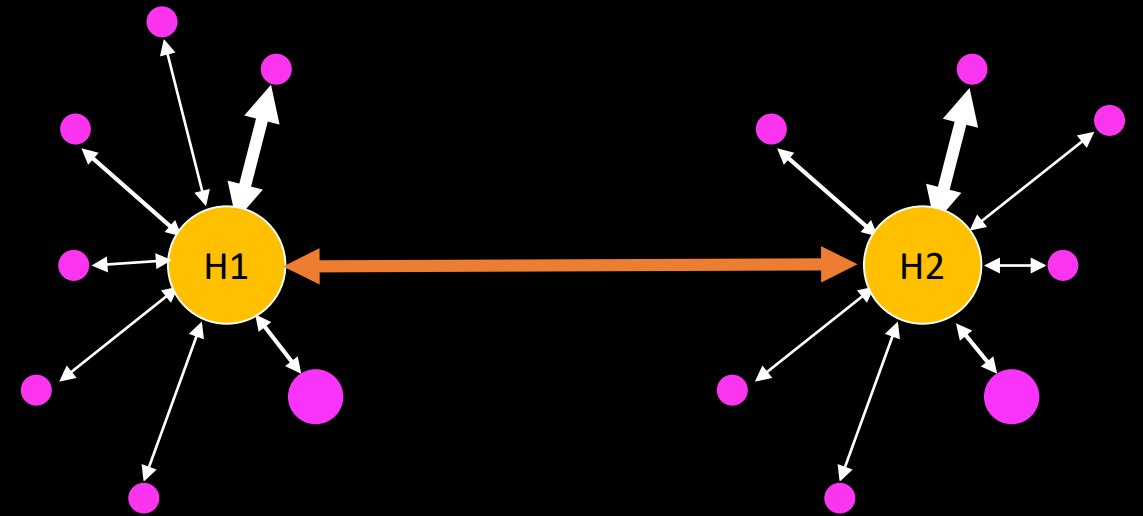
Customers Value quiet takeoffs and landings

Opening of Additional Short Distance Connections Feed Hubs and Enables Short Haul Aviation Growth

The air travel hub-and-spoke model...



is reinforced by lower economic and environmental costs of electric aviation



Hub



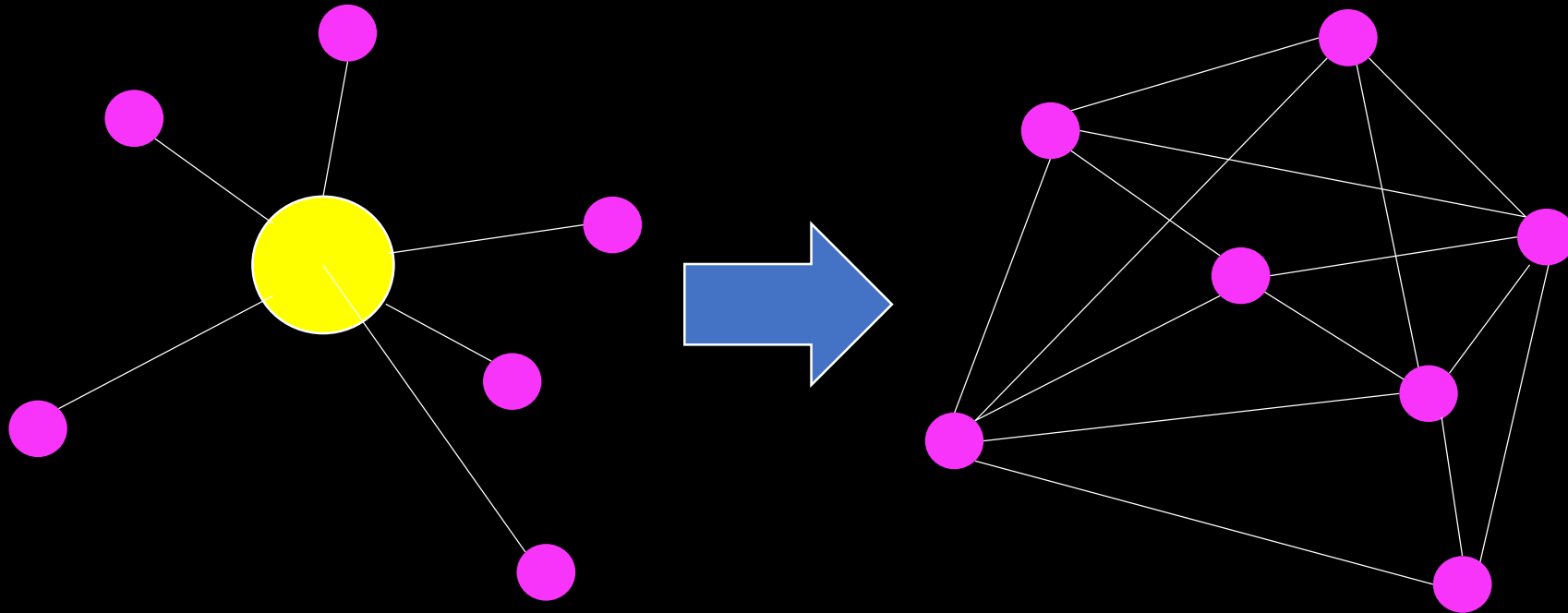
Spoke



Unserved location

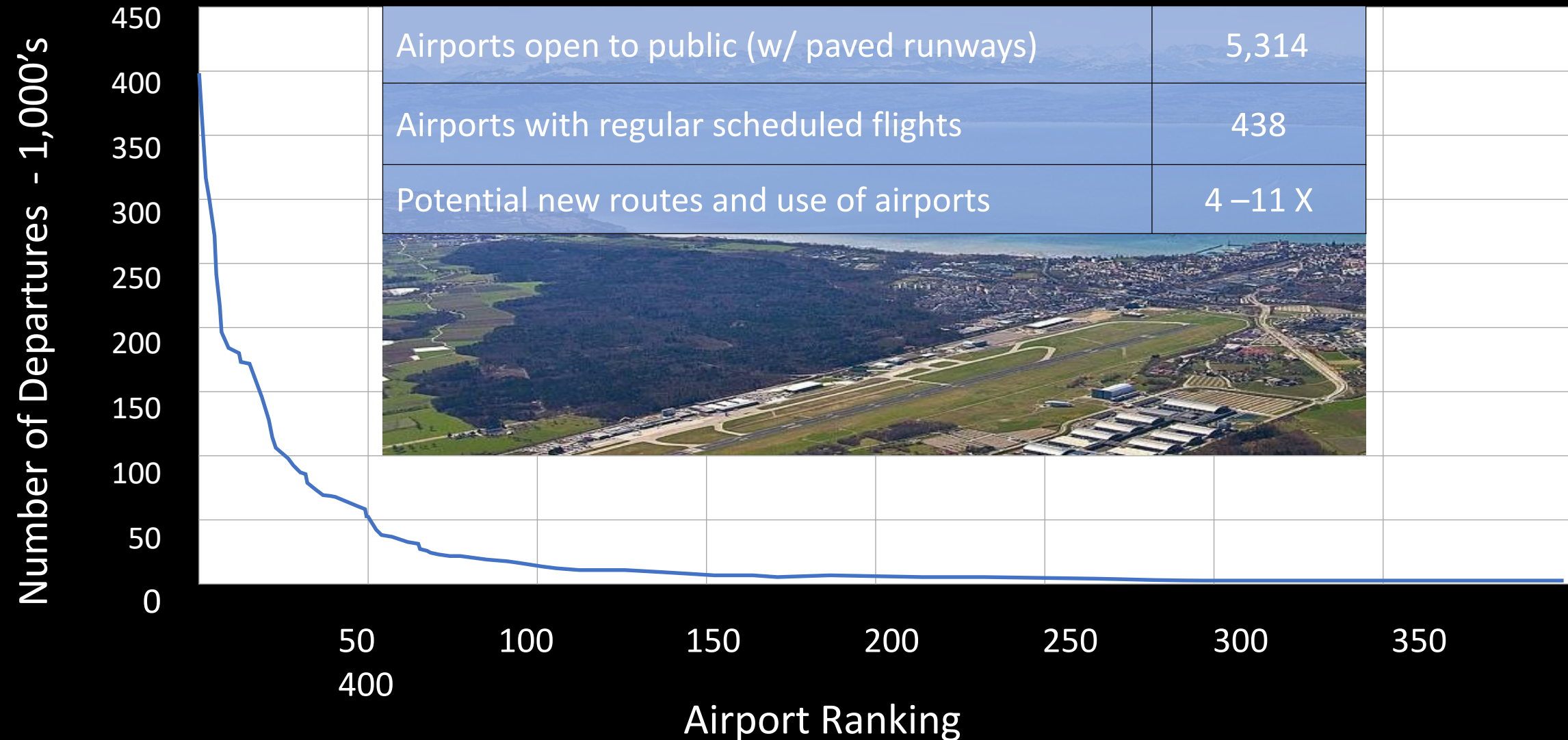
Point-to-Point (P2P) Travel Saves Travel Time and Further Lowers Environmental and Economic Costs

P2P TOPOLOGY and FREQUENCY is superior for throughput and total travel time

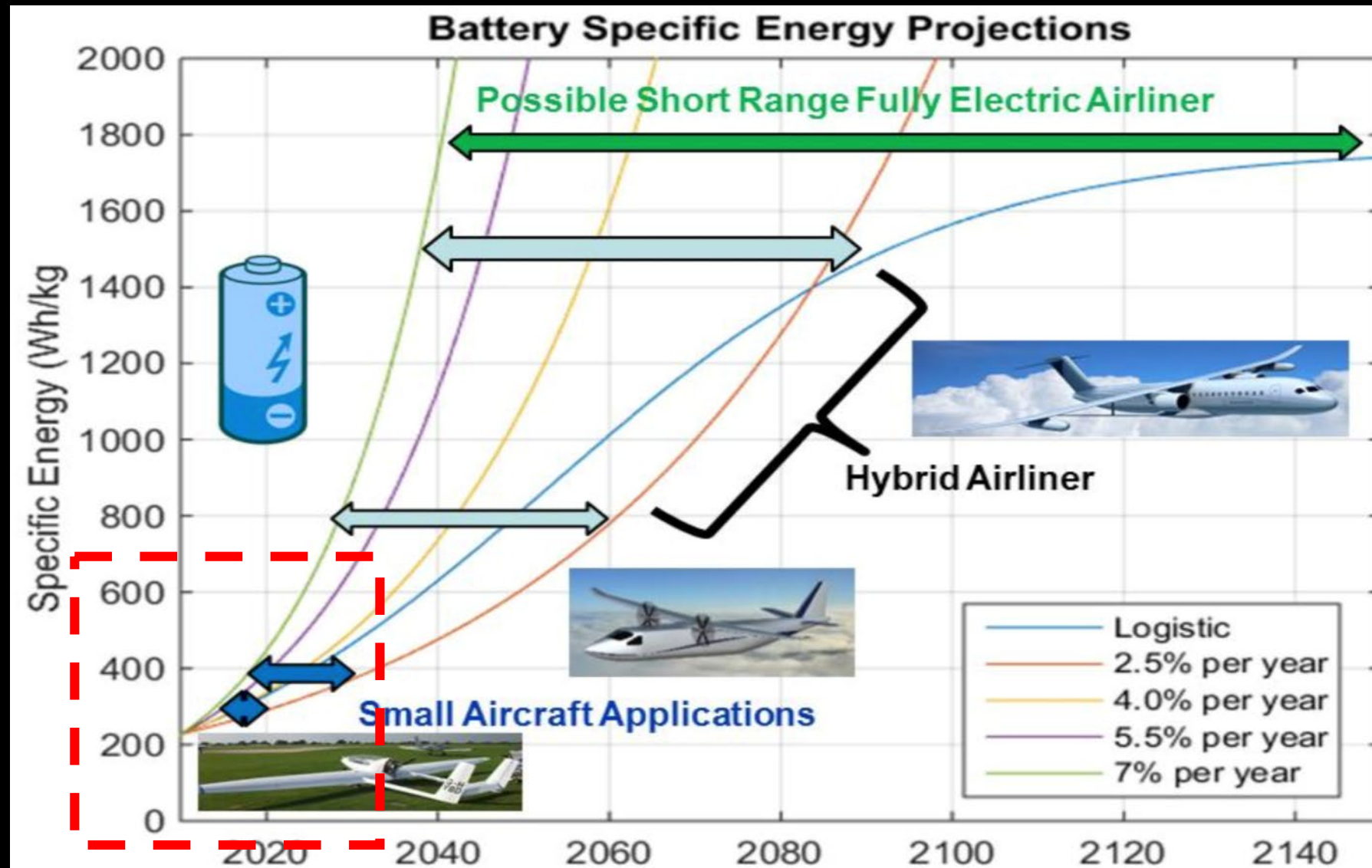


Excess Airport Capacity Supports Growth in P2P Travel

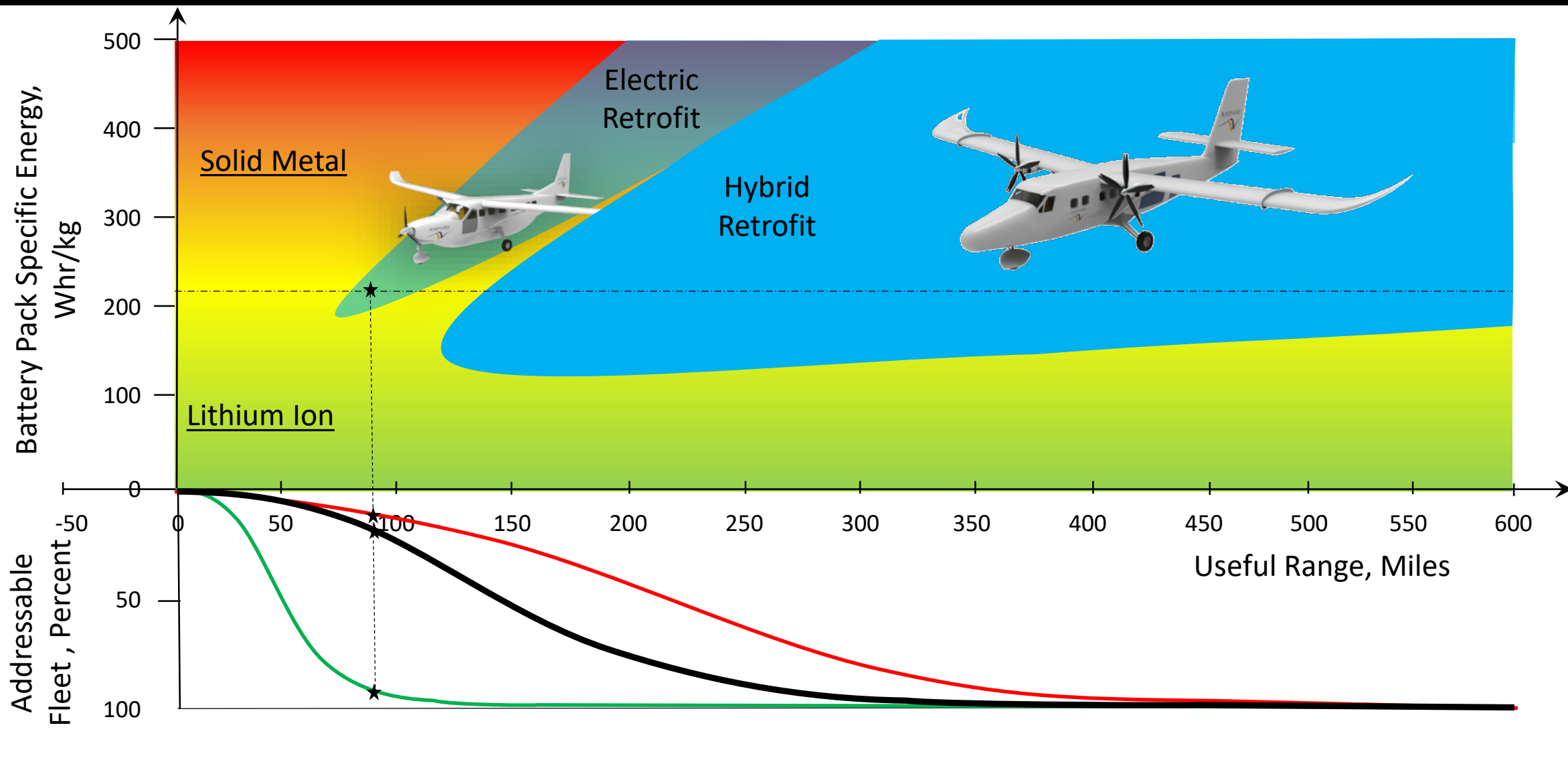
2018 Annual Departures – Passenger and Cargo (US)



Battery Technology Paces Electric Aviation



Thin-Haul Fixed-Wing Electrification Space



Battery Needs For Short-Haul Fixed-Wing Aviation

- Cost – not bound by automotive price targets
- Cycle Life – can work with lower cycle life
- Volumetric Density – no direct targets
- Pack designs must contain propagation and keep cabin safe
- Operating Temperature – can control discharge and charge temps
- Discharge C - rate
 - Electric ~3.0 for 5 minutes; max 1.5 thereafter
 - Hybrid ~5.0 for 5 minutes; max 2.0 thereafter
- Charge C - rate
 - ~ 0.5 or less with Swap Concept
 - ~ 3.0 or greater without Swap







Q and A

