



An *Electric* Future of Aviation



May 20, 2021

Susan Ying, FRAeS, FAIAA
SVP, Global Operations, Ampaire
VP, Aerospace, SAE
susan@ampaire.com

Founded 2016

First prototype flight May 2019

World record X-C flight Oct 2020 342 miles

Market survey flights Hawaii Nov 2020

Global: US, UK, CN, NL

20+ employees



SURF AIR MOBILITY

Inventing the future of aviation, together

Three departments, one mission.



AMP

Electric powertrain
development

Aircraft upgrades



MARKETPLACE

Membership & flight
sales

Aircraft supply



AIR OPERATIONS

On Demand charter
logistics

Scheduled flight service

Top 10 emerging technologies of 2020

“From *electric planes* to tech sensors that can “see” around corners, this year’s list is packed with inspiring advances....”



From sun-powered chemistry to whole-genome synthesis, the 10 technologies span industry, healthcare and society.

Image: World Economic Forum

Did you know?

Electric engines in planes could not only eliminate direct carbon emissions, but also reduce fuel costs by up to 90%, maintenance by up to 50% and noise by nearly 70%



Electric vs. Traditional Small Aircraft

| For an hour of flight | Cessna 152 |
|--|--------------|
| Energy (fuel assumed Avgas rate in US, electric assumed grid charging in US) | \$34 |
| Inspections | \$18. |
| | |
| Power Plant MR & O | \$12 |
| Oil (including oil change) | \$3 |
| Operating Costs | \$67 |

~\$100 - \$120 to rent a Cessna 152

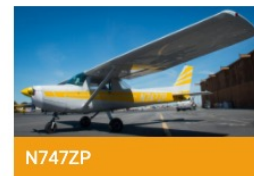
Assume 1500 life cycle, 4500 flight hours

| Aircraft Rental Rates | | | |
|-------------------------|-------------|-------------------|----------------------|
| Aircraft | Speed (kts) | Features | Rental Rate/Hr (wet) |
| Evektor SportStar | 90 | Garmin 296 | \$122.00 |
| Cessna 152 | 108 | Garmin 345 ADSB | \$113.00 |
| Cessna 172 (N&P Models) | 115 | GNS 430W GPS / L3 | \$129.00 |
| Cessna 172 (180 hp) | 120 | GNS 430W GPS / L3 | \$129.00 |
| Cessna 172 RG | 135 | GNS 530W / L3 | \$170.00 |
| Cessna 182R (230 hp) | 137 | Garmin GTN 650 | \$180.00 |
| Cessna 182 RG | 145 | GNS 430W GPS / L3 | \$180.00 |

BAY AREA AIRCRAFT RENTALS

Cessna 152

Rates: \$109 to \$119 per hour



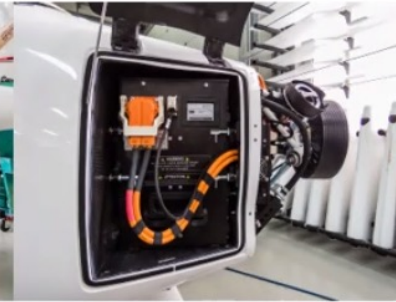
Electric vs. Traditional Small Aircraft

| For an hour of flight | Cessna 152 | Estimates of a 2-seater electric trainer |
|--|--------------|--|
| Energy (fuel assumed Avgas rate in US, electric assumed grid charging in US) | \$34 | \$3 |
| Inspections | \$18. | \$2 |
| Battery Replacement | | \$8 |
| Power Plant MR & O | \$12 | \$1 |
| Oil (including oil change) | \$3 | |
| Operating Costs | \$67 | \$14 |

Assume 1500 life cycle, 4500 flight hours



ALPHA ELECTRO, THE FIRST SERIALY PRODUCED ELECTRIC TRAINER



Made on 11 years experience of building electric aircraft
In-house designed and produced:

- Battery
- Battery management
- Engine
- Engine management
- Balancers
- Chargers



0,9€

ENERGY COSTS
PER HOUR

17€

OPERATING COSTS
PER HOUR

Including battery replacement,
maintenance and overhaul

33€

TOTAL COSTS
PER HOUR

Including also depreciation

Electric vs. Traditional Small Aircraft

| For an hour of flight | Cessna 152 | Estimates of a 2-seater electric trainer | Actual from Pipistrel (2020) |
|--|--------------|--|------------------------------|
| Energy (fuel assumed Avgas rate in US, electric assumed grid charging in US) | \$34 | \$3 | €0.9 (\$1.1) |
| Inspections | \$18. | \$2 | |
| Battery Replacement | | \$8 | |
| Power Plant MR & O | \$12 | \$1 | |
| Oil (including oil change) | \$3 | | |
| Operating Costs | \$67 | \$14 | €17 (\$20) |

Electric vs. Traditional Small Aircraft

| For an hour of flight | Cessna 152 | Estimates of a 2-seater electric trainer | % difference |
|--|--------------|--|--------------|
| Energy (fuel assumed Avgas rate in US, electric assumed grid charging in US) | \$34 | \$3 | -91% |
| Inspections | \$18. | \$2 | -89% |
| Battery Replacement | | \$8 | N/A |
| Power Plant MR & O | \$12 | \$1 | -91% |
| Oil (including oil change) | \$3 | | N/A |
| Operating Costs | \$67 | \$14 | -80% |

70 ~ 80% Reduction of Total Operating Cost

Does this scale? How will it scale?

Load Factor



passenger Miles per Gallon (pMPG)

Fuel Efficiency SEA to DCA by a Boeing 737

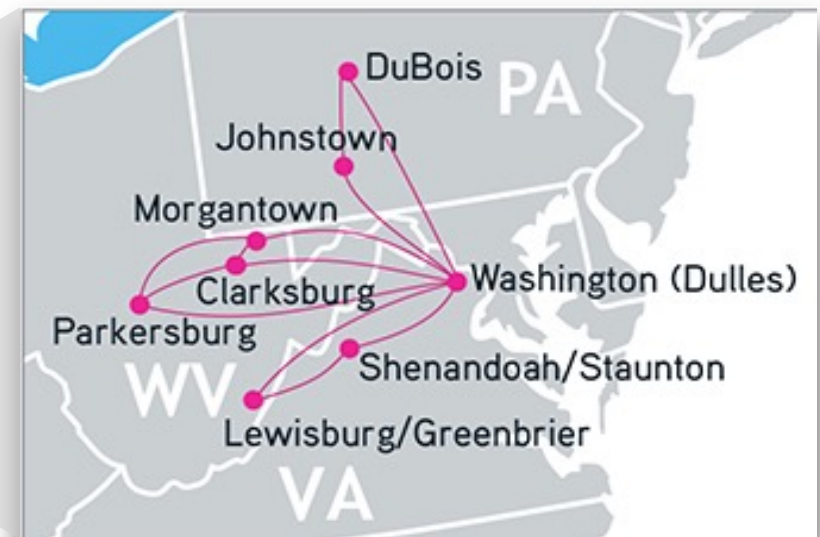
80% load factor ~ 81 pMPG



- 2,325 mi, 3,709 gal, 162 passengers (pax), 80% **load factor**
3,709 gal / 130 pax = 29 gal/pax
2,325 mi / 29 gal = **81 pMPG** (pax Miles Per Gallon), or 2.9 pL/ 100KM
- 737MAX ~ **103 pMPG** (2.28 pL/100KM)
- Typical car in CA (similar to Amtrak) ~ 25 mpg x 1.3 pax = 32 pMPG
- **Pipistrel USA (2011) ~ 403.5 pMPGe**

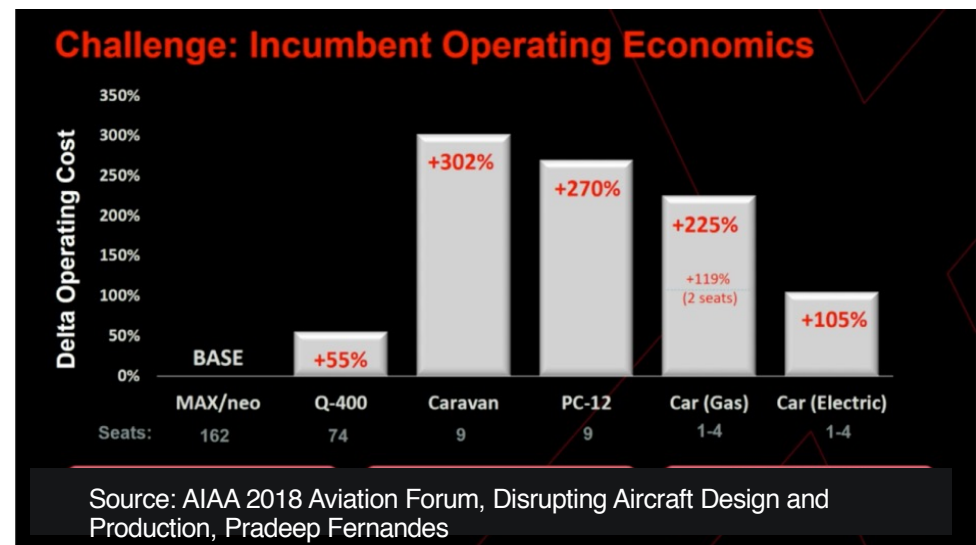
Source: Boeing

What if the final destination is “not” Washington DC?
The last 200 miles – Regional Air Mobility



Traditional Regional Aircraft from Hub to Final Destination
dramatically higher operating cost for short- or thin-haul routes

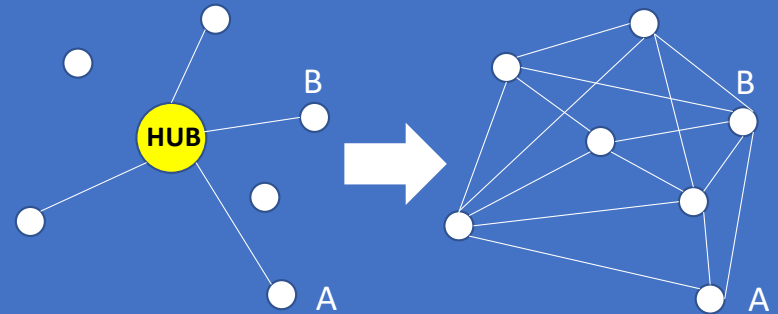
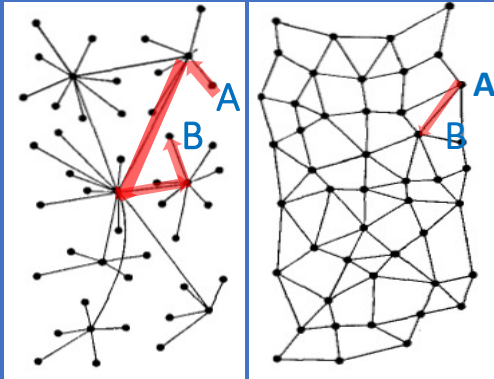
| Aircraft | Q-400 /Dash 8 | Caravan /Cessna 208 | PC-12 /Pilatus |
|------------------------|-----------------------|---------------------------|-------------------------|
| 1 st Flight | 1998 | 1982 | 1991 |
| PAX | 78 | 9 | 9 |
| pMPG | 70 (3.38 L/100 km) | 32 (7.35 L/100 km) | 41.6 (5.66 L/100 km) |



A map of British Columbia, Canada, illustrating ferry routes. Victoria is the central hub, with red lines radiating to various destinations. Key locations include Nanaimo, Vancouver, Pitt Meadows, South Vancouver (YYV), Langley, Richmond, and Seattle. The map also shows the Strait of Georgia, Juan de Fuca Strait, and various islands like Ganges, Salt Spring, and San Juan. A legend indicates the U.S.A. and Canada borders.



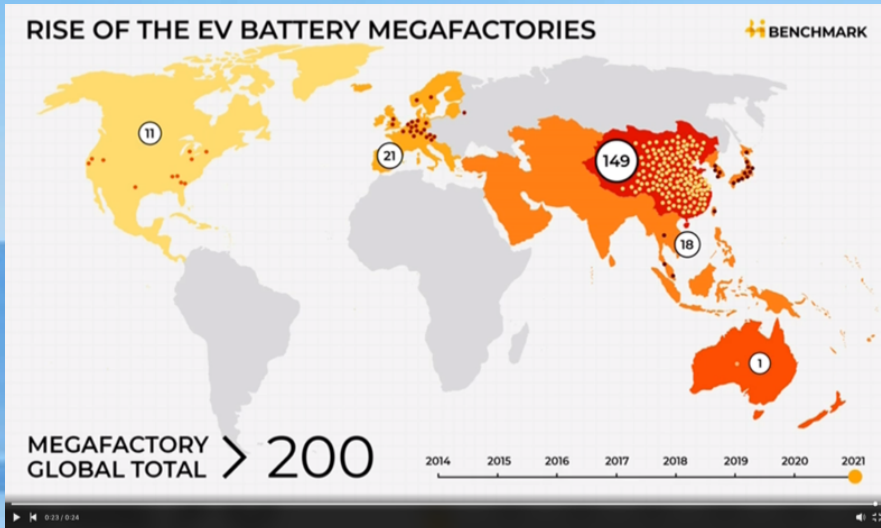
Catalyst to a Fundamental *Shift* in Regional Operations



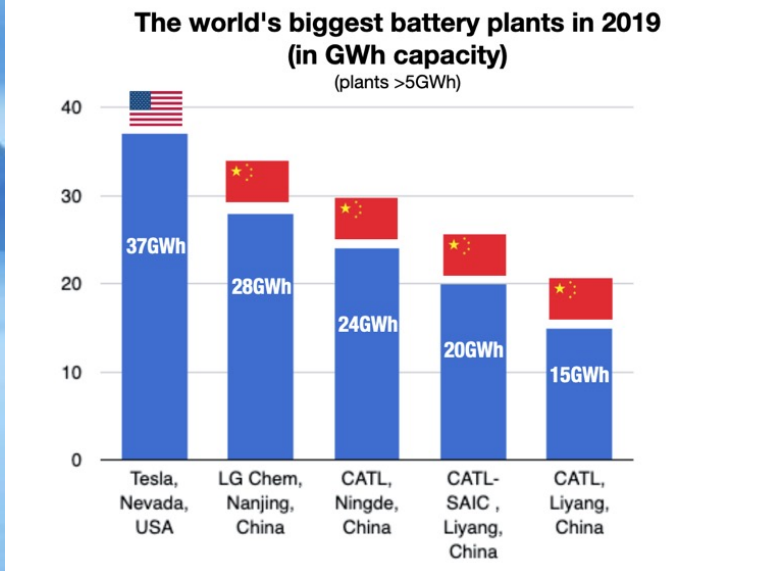
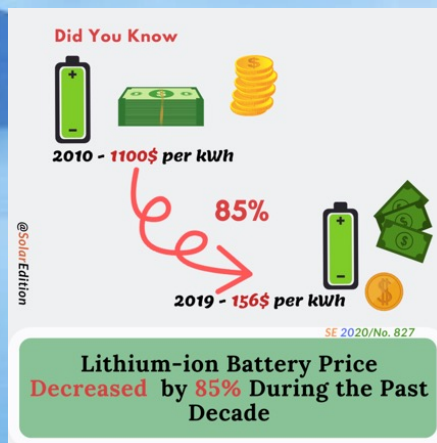
10x Destinations in US
4X Destinations in UK & EU
New Destinations in
Asia and Africa

Increased Accessibility
Connects Communities

Supply Chain: Economy of Scale from the EV Industry



Musk said in 2014 to his biographer Ashlee Vance: *“The competitors are all sort of pooh-poohing the Gigafactory. They think it’s a **stupid idea**, that the battery supplier should just go build something like that. ... You’ve got a chicken-and-egg problem where the car companies are not going to commit to a giant volume When will the first non-Tesla Gigafactory get built?*



Infrastructure: Airports as Future *Energy Hubs*



Towards Zero Emission Regional-Aircraft Operations (2ZERO)

UKRI Future Flight Challenge 2ZERO Consortium



- Aircraft Design Integration
- Systems Scaling & Integration
- Flight demonstration
- Consortium Lead



- R&D electric propulsion
- Propulsion systems
- Energy storage system



- ATM/ Airlines
- Operational Research
- Modeling & Simulations
- Aircraft Electrification
- University / R&T entity



- Strategic contract
- Future-ready power distribution network
 - Renewable energy, energy storage
 - Charge points



- Regional Airlines
- Operational Use Cases
- Pilots
- Maintenance & training



- Airport Operations



- Business led partnership between private sector, local authorities, and universities.
- The West of England Aerospace Forum

Towards Zero Emission Regional-Aircraft Operations (2ZERO)

Program Overview

Holistic systems approach to simulate and demonstrate the **regional operations of electric aircraft** and the **scalable ecosystem required** for optimised economic and environmental impact.

Uncover changes necessary to enable future operations including:

- electric aircraft performance, standards, rules, and certification;
- airport infrastructure and operational requirements;
- power management (storage, distribution, charging) for renewable energy required; and
- optimisation of airlines and air traffic route system.



Committee Report Jan 1941

Appointed by US Naval Academy of Science

Von Karman, Millikan, Kettering, Marks, Christie, Mason

“The GAS TURBINE could hardly be considered a feasible application to airplanes mainly because of complying with the stringent WEIGHT requirement imposed by aeronautics... The present internal combustion engine used in airplanes weighs about 1.1 lbs/hp, and to approach such a figure with a gas turbine seems BEYOND THE REALM OF POSSIBILITY with existing materials.”



Thank you!



May 20, 2021

Susan Ying, FRAeS, FAIAA
SVP, Global Operations, Ampaire
VP, Aerospace, SAE
susan@ampaire.com