Gliding electrifed?

Jens Trabolt 2023

Discus FES, 22 kW engine
(but will fly on 4kW)

F-16, 100 000 kW engine… / 125 000 hp
(no electrification possible …)

Least and most powerful aircraft in my logbook

NORDIC GLIDING
& Aviation magazine

Jens Trabolt
Editor, NORDIC GLIDING

Glider Pilot and Flight Instructor (gliders, motorgliders)

Test flights on several types of electric aircraft (AS 34 Me, ASG 32 EL, Discus 2C Fes, LS8 e neo, DG 1001 e neo, Duo Discus FES, eGenius, SunSeeker Duo, Pureflight Onix, Pipistrel Alpha Trainer Electro, Taurus Electro etc)

Contents of this talk

- Pros and cons of going electric?
- What is possible **today**: Types of electric gliders
- **Living with an electric glider**
- Cold weather performance
- Charging in the club?
- Fire safety?
- Battery life?

Electric event Sweden Ålleberg / Falköping august 2022

Mission

Learn about electric gliders to be able to make informed future decisions.

Target group

Club officials

https://www.youtube.com/watch?v=MvWvX6dBaBM&ab_channel=NORDICGLIDING

Event content

14 x presentations on elec-drivetrains and on the electrification of the club (safety, performance, batteries etc)

Test flights (The biggest collection of electric gliders in the Nordics ever at the same place)

DG 1001 e neo (FES turbo)
AS 34 ME (Pylon SLG)
ASG 32 EL (Pylon turbo)
Discus 2 c FES (FES turbo)
LAK 17 C FES (FES SLG)

What did we learn?

- Very easy for club pilots to make the transition to new electric gliders
- Still fully possible to get into ”classic trouble” with new tech!

Example of aborted self launch with LAK 17 C FES due to undercharged battery! (only 30 mins after a safety lecture on this very topic!)

Electric drivetrains basic facts

Pro

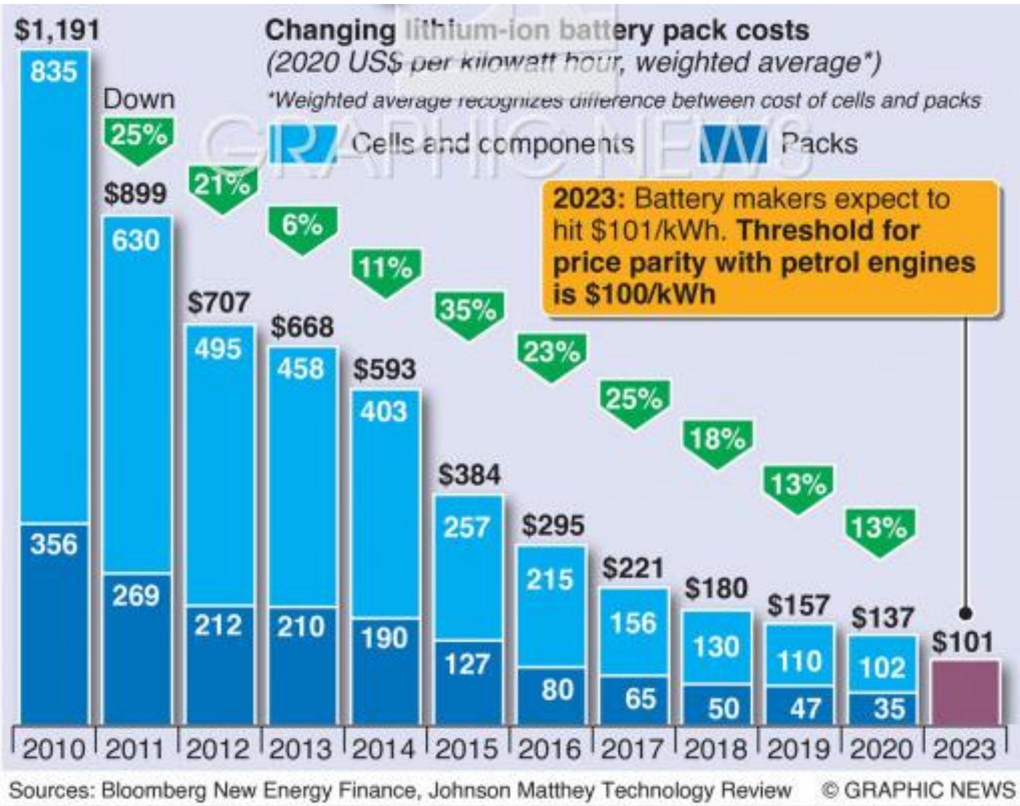
- Quiet, vibration free, clean (no oil, smell or smoke)
- Low pilot workload (you tell the software what power setting you would like, it does the rest)
- Few mechanical parts, less maintenance cost
- Low ”fuel” costs
- No direct carbon emission during use (with green electricity - DK renewable energy share 50 % 2020)
- Area of global massive investment thanks to EV-industry (vs stagnant ICE-tech)

Electric drivetrains basic facts

Cons (all battery related!)

- Limited energy density in even the best batteries, but much higher motor efficiency helps to level the disadvantage - 90% vs 20-25% fossil turbo.
- Costly (so far), heavy and delicate batteries.
- Ressource-demanding batteries (but recycling standards are improving)

Batteries are the main area of improvement – costs are going down



2018 = 180 $/kWh at pack level for Tesla Model 3

2021 = 130 $ (est.)

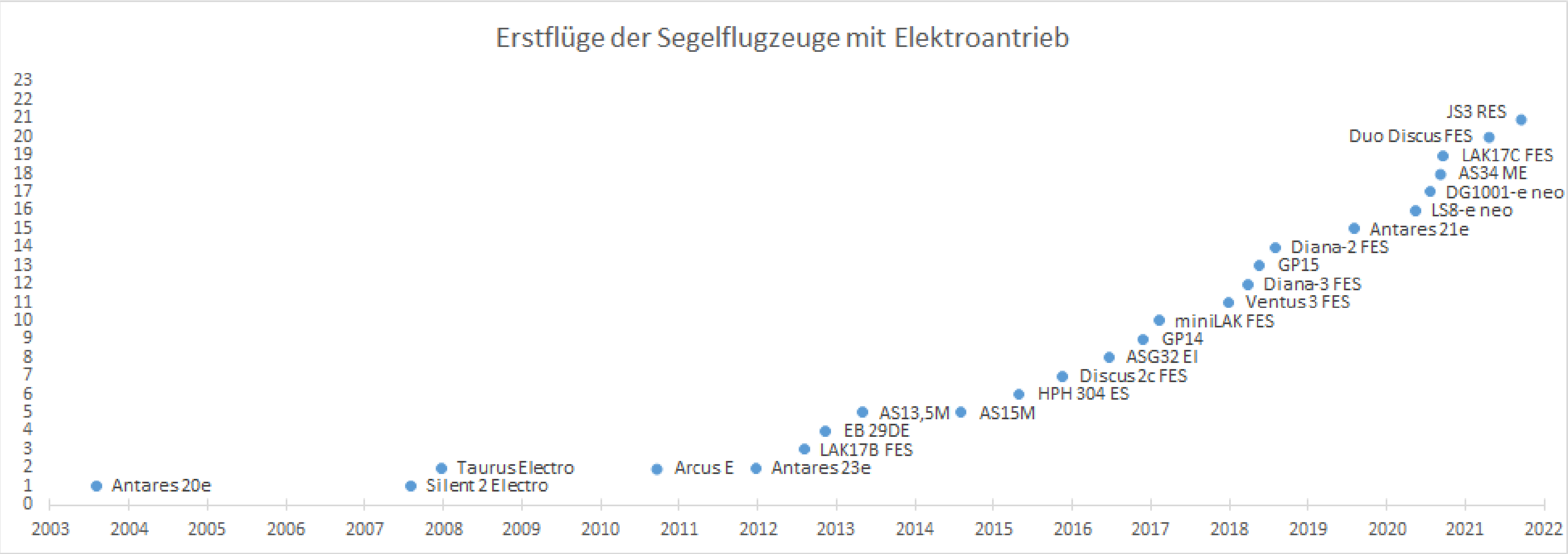
2023 (est.) 100 $/kWh
Price parity threshold with the cost of a fossil powertrain (engine, fuel tank,cooling, exhaust, gearbox et)

Battery cost is expected to fall further with expansion of global production capacity

Gliding = birthplace of electric innovation in aviation

Gliders are a good place to experiment
Gliders can fly on very little power – if we want to power a airliner, it's a good beginning to start with a glider.
Gliding is engineering culture. (e.g. winglets, carbon fibre for aviation use etc)

The electric glider market is booming



Early electric pioners

Gossamer Penguin 1979 – barely…
First solar electric flight, barely
Pioneered by Paul MacCready

Icaré 2 1996
Stuttgart University
12 kW motor, 3,5 kW peak solar panels
Can fly on just 2 kW!

SunSeeker 1 1990
First solar electric flight across America by Eric Raymond

Overview of current light electric aircraft

Lange Antares 20/21/23E (2003)
Claim to fame: First real CS22 EASA-certified electric aircraft
Aprx 60 produced
42 kW motor
Battery pack 15 kWh/80 kg from 2022 (new 21700 ”Tesla”-batteries)
Climb performance 4,0 m/s / + 4200 meters alt.gain / + 5600 m in Long Range-version

Overview of electric aircraft

FES System
Most popular electric aircraft: More than 300 gliders flying
Discus, Ventus, Shark, LS8 e, Mini Lak, Lak 17, Silent, DG 1001 e & Duo

4,2 kWh batteries (2 x 15 kg) (8,9 kWh version in design phase)
22 kW air cooled motor.

Horizontal flight with 4 kW, 100 km/h / aprx 80-100 km range

Pro No pylon drag if engine fails, no complex pylon mechanism, quick and stressfree operation
Cons A small, but measurable extra drag from the propeller blades (1-2 L/D),

Overview of electric aircraft

Fun fact:
The AS 34 ME scored almost 10 dB(A) lower in noise certification tests than the relatively quiet ASH 31 Mi.
That is subjectively half the volume!

AS 34 Me – 2020
15/18 M standard class SLG (based on ASW 28)
35 kW 228-Emrax-motor (from ASG 32 EL)
8,6 kWh battery in wings (improves cockpit load capacity, but heavy wings))
Climb speed 3,7 m/s / 2,5 m/s cont.
Total climb 2200 meters or 1 start to 600 m plus 125 km motor flight
Status: In production and CS 22 EASA-certified (12 built / 50 order list)

Overview of electric aircraft

AS 34 Me self launch cockpit
https://youtu.be/GHW18hJSCD8

Overview of electric aircraft

Fun fact:
60 % of AS 33 orders are electric Me-version, says Schleicher

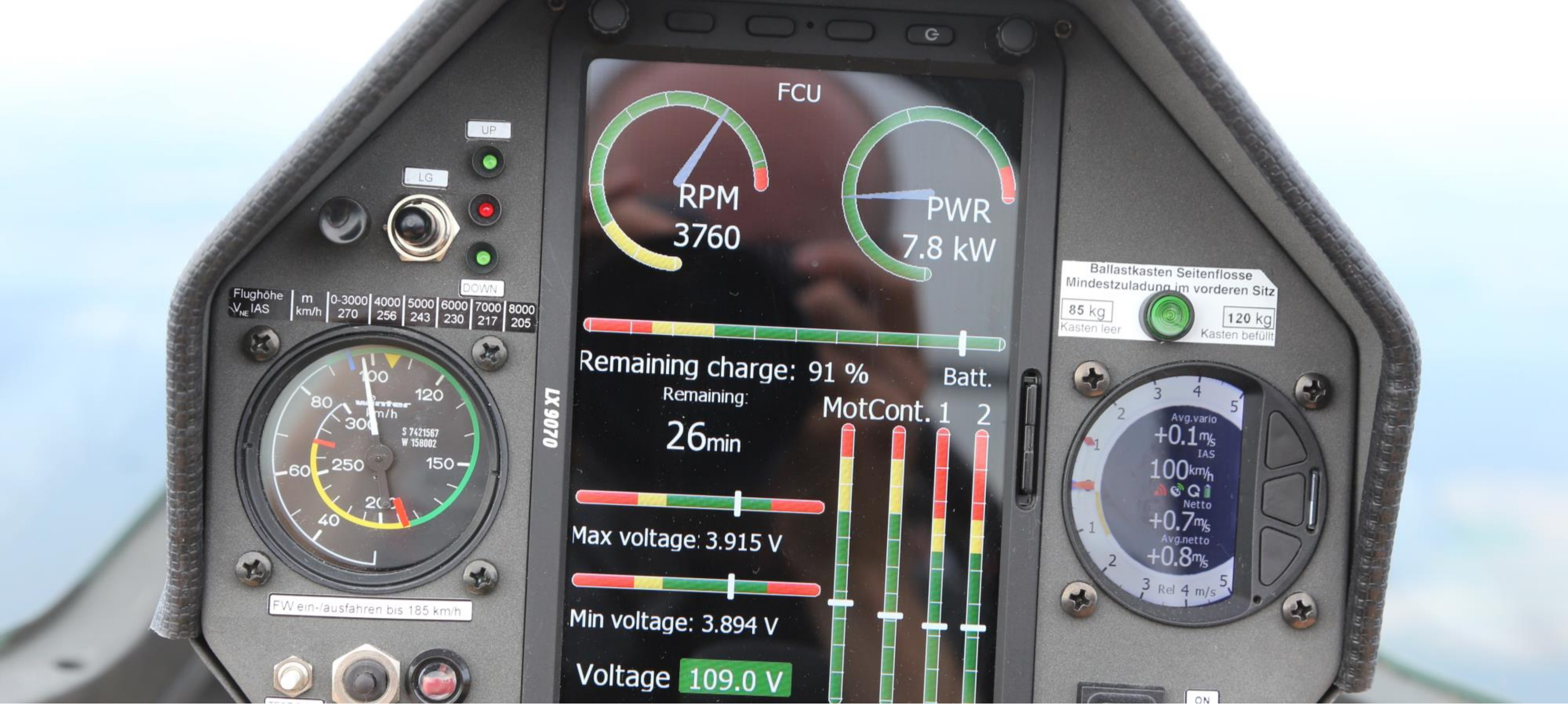
AS 33 Me – 2022
15/18 M flapped glider (successor to ASG 29)
35 kW 228-Emrax-motor (from ASG 32 EL and AS 34 Me)
8,6 kWh battery in wings (improves cockpit load capacity, but heavy wings)
Climb speed 3,5 m/s / 2,5 m/s cont.
Total climb 2200 meters or 1 start to 500 m plus 130 km motor flight
Status: Certification completed, first delivery spring 2023

Overview of electric aircraft

Jonker JS3 RES – 2021
15/18 M flapped SLG (up to 575 kg)
9,2 kWh batteries - developed by Emetric (SOLO) 40 kW Emrax 208-motor.
2 x 25 kg battery weight. Fuselage mounted.
Can be flown with single (75 km sustainer) or double batteries.
Approx. 2000 meter climb / 3,5 m/s
In development – delays due to global electronic component shortage –
Certification hopefully completed 2023 (?)

Overview of electric aircraft

Jonker JS3 RES self launch Peter Millenaar
https://youtu.be/OO8ScrzeyEw



Living with an electric glider?
Myths and facts

Cold weather performance
Charging in the club?
Fire safety?
Battery life?

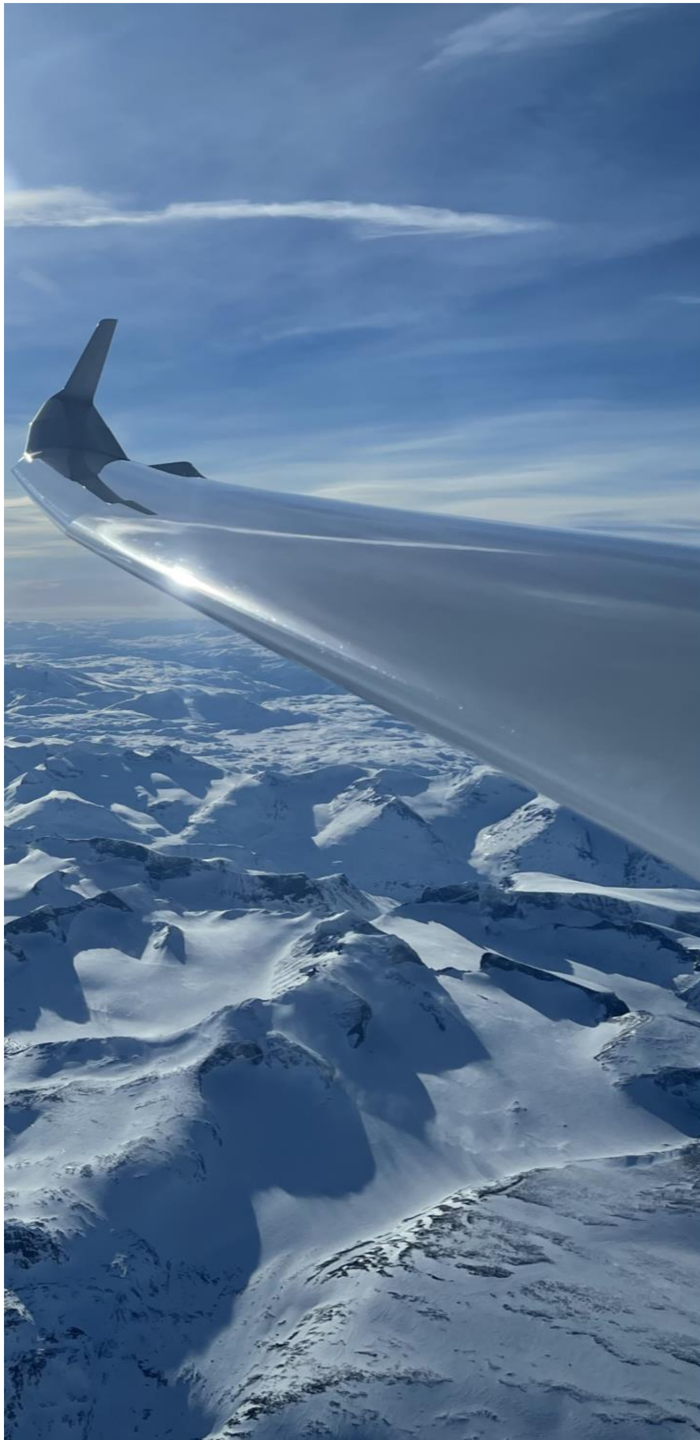
Cold Weather Performance

Electric motor does not really care
Batteries are temperature sensitive

Case: Fully charged ASG 32 EL battery left outside during the night
@ 0 C – expect 10 % capacity reduction
@ -10 c – expect 20 % capacity reduction

AS 34 Me Self launch is permitted if:
A) Battery SOC more than 60 % and
B) 30 kW is achieved at take off power.

Turbo can still be used outside A and B.
Long term storage below -20 C is not permitted



Cold Weather Performance

Q: So can you leave your glider on the ice in – 20 C and expect to take off next morning with zero problems?
A: Probably not

Q: Could you heat the batteries with moderate power on the ground?
A: In theory, yes!

Q: Can I use the motor as turbo after a few hours of very cold wave flight?
A: Probably yes,
Once varm, the batteries retain their heat very well due to large mass and insulation in wing.

Your results may vary!
We have very little real life knowledge!

Cold Weather Performance

Solutions to cold weather parking?

FES glider / Jonker JS3 RES
Solution = remove batteries, charge them inside, keep them in warm car until use.

Schleicher gliders
(de facto non removable batteries in wings/fuselage)

Solution 1: Disassemble glider and place an electric heater inside trailer to keep temperature at acceptable levels during the night.

Solution 2: Keep the wings heated with actively heated electric blankets/pads under the wing covers.

Charging in the real world?
examples

Charging is not a problem.
Gliders are parked for +12 hrs in the hangar
Most owners charge at low power

FES gliders
Charger power 2 x 600 watts (2 x batteries in the glider)
Charging time (from 20 – 100 % SOC) around 3 hrs

AS 33/34
Charger power 1600 / 3200 watt
Charging time 9 hrs /4,5 hrs

ASG 32 EL (turbo)
Charger power 1600 watt / 3200 watt
Charging time 7 hrs / 3,5 hrs

Life time on components / Maintenance

Examples

AS 33/34/32 EL

Motor tbo 1000 hrs (100 years at 10 hrs/year!)

Propeller 1000 hrs

Batteries No degradation the first 300 full cycles (roughly 100 motor hours)

From FES battery manual

In order to keep maximum battery health:

- Do not keep the batteries fully charged for longer periods of time, only charge them fully the day or night before flight.
- Do not expose the batteries to extreme heat
- Do not discharge the batteries fully (harmful dendrites can form inside the battery increasing the risk of malfunctioning)

Fire safety

Battery fire test certification procedure

The whole pack is charged to 100 % and is mounted in a wing shell

1) all cells are heated to 54 degrees C. (takes all night!)
2) a single cell is targeted with the CID-fuse sabotaged and massively over-charged.
3) The resulting fire in the single cell must not spread to the other cells.
4) The resulting gasses must be vented into the atmosphere through wing or fuselage openings covered by blow-out-stickers.

So you want electric gliders?

What can we do as flying community?

- Vote with your wallet: Buy electric gliders/aircraft
- Interact with manufacturers
- Lobby for development of electric towplanes
- Form work groups

If we succeed, we will hopefully experience:

- Less noise complaints from neighbors
- More fun in flying
- Increased safety (end of the usual turbo accidents?)
- Less social and political pressure (maybe even elevation to role models and rewards!)
- New member-attraction?

We as a sport will emerge strengthened from this.
But only if we adress these issues now.

2023: The ultimate club package?

Local solar power + Electric club glider + Electric winch (order one now)

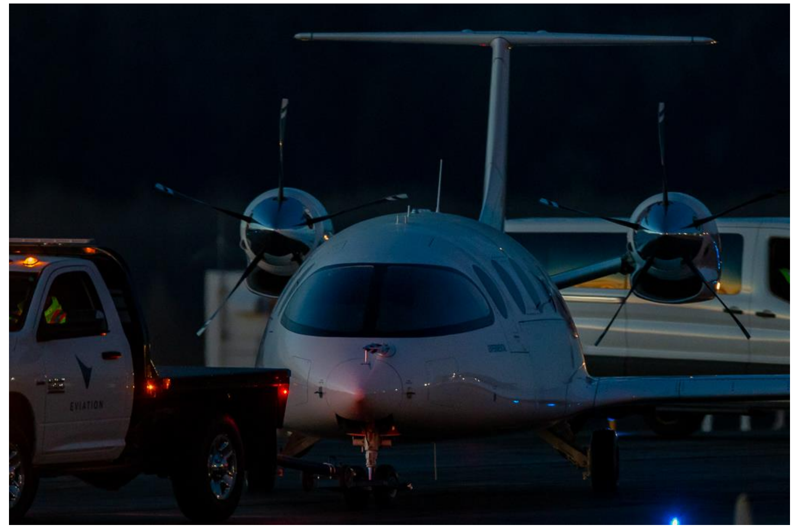
The ultimate in eco/neighbor friendly launches

- Generate own electricity
- Charge your own SSG/SLG-gliders / golf carts / member electric cars.
- Offset club house power consumption (my own club house uses 30 000 kwh p.a.)
- Winch launch electrically and use glider electric engines to connect to thermals

Example 2022

LSV Rheinstetten (Karlsruhe) has installed a 100 kWp solar system on hangar (with local citizen owner-partnership) + electric winch with 1200 m electric cables plowed into to airfield.

Current commercial aviation projects

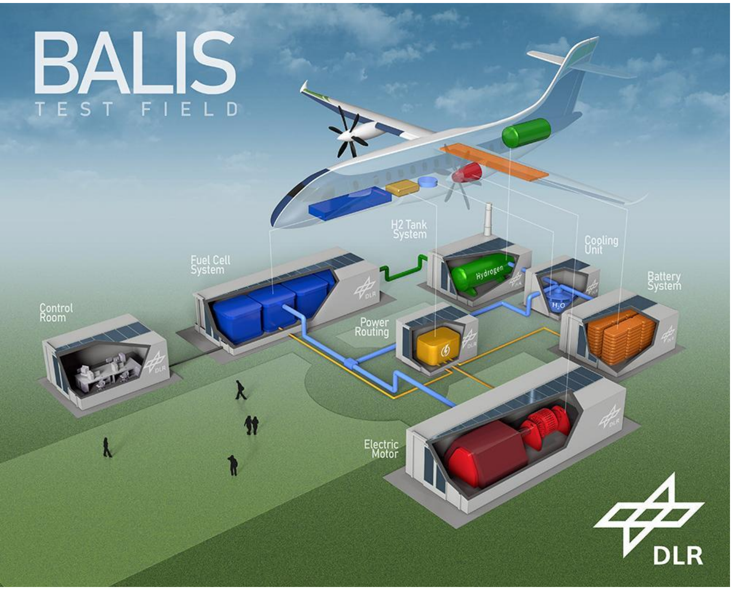


Eviation Alice, taxi-testing January 2022 in Seattle-area
19 m battery electric 9 passenger commuter
Range 800 km (+reserves)
Max cruise speed 390 – 440 km/h
Motors 2 x 640 kW MagniX (comparable power to PT-6 jet turbine)
Battery pack 850 kWh, weight 3700 kg (or 60%) of MTOW.
Planned delivery 2024 (Place your bets now! CS23-Certification of new airframe, legacy tech drivetrain and subsystems usually takes longer…)
Lots of performance has to be measured and documented before launch

Current commercial aviation projects

Heart Aerospace ES 19, engine testing 2021 in Göteborg
Battery electric 19 passenger commuter (offspring to ELISE, (Elektrisk Lufttransport i Sverige) with Chalmers Tekniska Högskola, GTBG)
Range 400 km (Stockholm - Oslo, Helsinki, Östersund, Göteborg)
Max cruise speed 320 km/t (est)
Motors 4 x 400 kW
Runway requirements Min. 750 meters, i.e. small airfields.
Battery pack Aprx 400 kWh, weight 1500-1600 kg
Planned delivery 2026 (Place your bets now!)

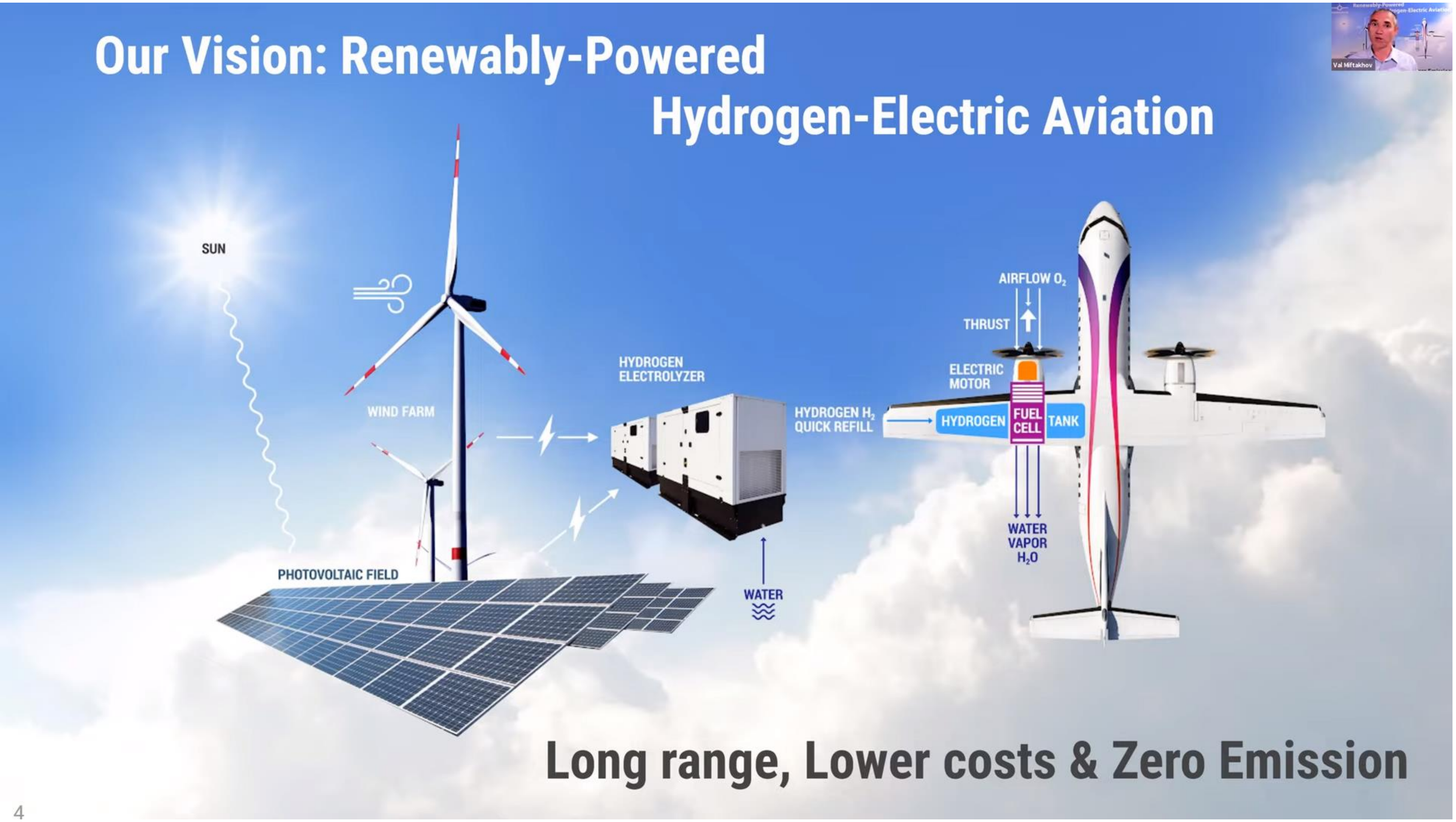
Current commercial aviation projects



BALIS Hydrogen Electric powertrain demonstrator site, German National AeroSpace DLR, Stuttgart
Object: To build a stable and scalable fuel cell powertrain 1,5 MW range

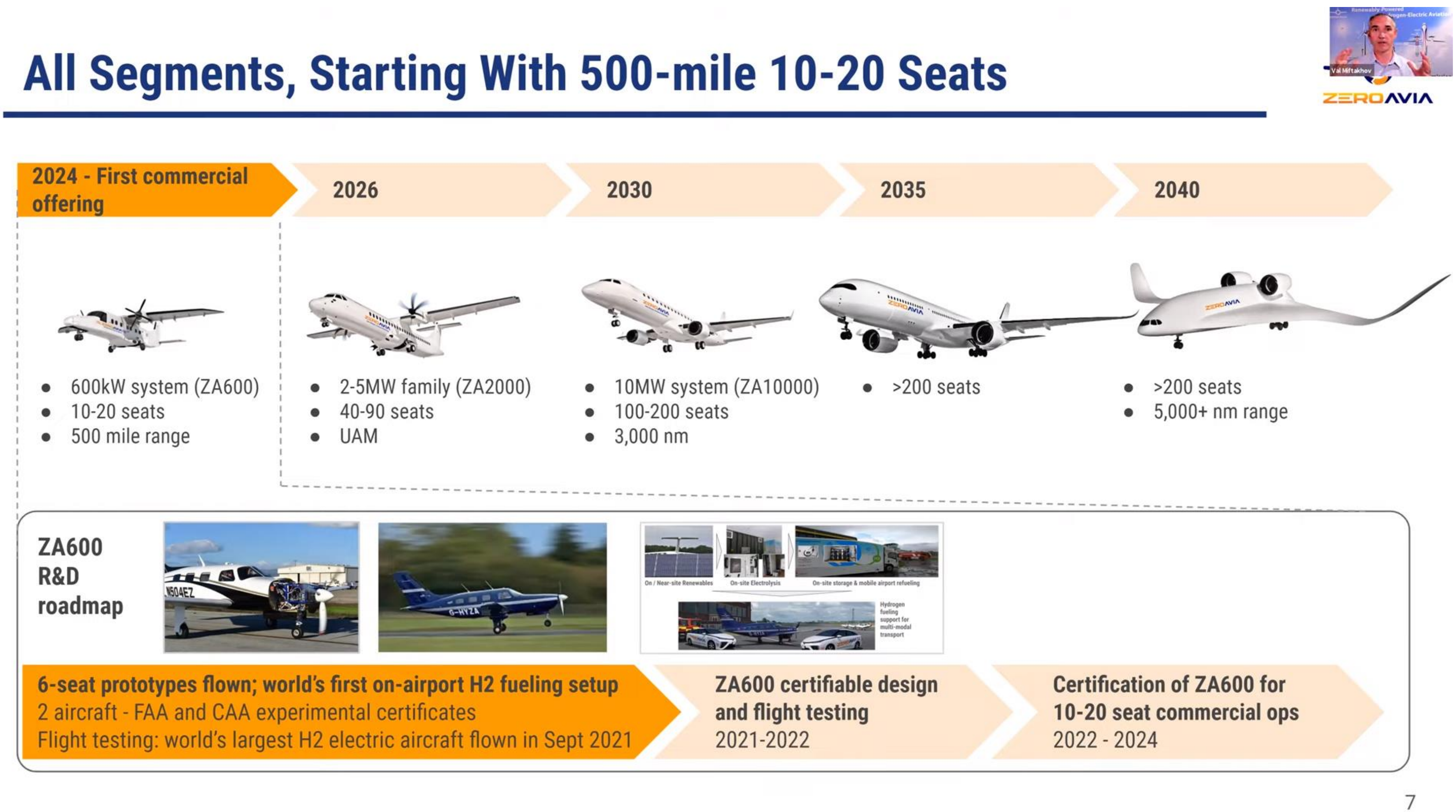
Aimed at proving a powertrain for a 40-60 seat airliner with 1000 km range
Project funding 26 million euros, operation from late 2022
Areas of focus: Fuel cell system, Hydrogen tank tech, Electric motor and the control technology.

Current commercial aviation projects



Zero Avia ,
Hydrogen electric passenger commuter

Current commercial aviation projects



Zero Avia ,

Hydrogen electric passenger commuter

Powertrain development:
Certification standards are written in blood V2

Zero Avia hydrogen electric power train demonstrator
Quote ”Off airport landing” outside Cranfield Airport, April 2021, due to sudden powertrain failure. (despite dual inverters and fuel cells)

The Piper Mirage aircraft takes off on battery electric power.
Continous flight is performed on electricity from a compressed hydrogen gas fuel cell. Zero Avia is aiming at using a future liquid tank technology.

Current commercial aviation projects

Zero Avia hydrogen electric power train demonstrator
Retrofit of electric engines and fuel cell system on a ”classic” Dornier 228 turboprop aircraft.
Commercial operation from 2024 (Optimistic, but using a proven legacy airframe and subsystems makes it possible to apply for a shortcut STC, Supplementary Type Certificate)

What remains to be seen before we can able to book tickets on an BEV or Hydrogen-electric passenger aircraft

- **Certification: Proven safety and performance** in battery and fuel cell powered large commercial aircraft (motors, power electronics, fuel cells, tank technology etc). Aviation regulators are – despite any political pressure - not willing to throw away a century of safety improvements.
- **Cost effectiveness** over time
- **Practical** in day to day commercial operations (refuelling and charging times)
- **Mass scale H2 production and logistics infrastructure**