~~The~~ future is electric

The present

Jens Trabolt 2024

Electric is no longer a fatamorgana

Example of the New Generation: German pilot Martin Buermann with his DG 1001 E neo makes long flights from a low vinch launch

- All 18 m gliders are now electrified, FES is ”everywhere”
- Battery capacity and engine power is already perfectly adequate for gliding
- We are now learning to use electric powertrains in real life operation *(Ronny Eriksson will tell us more later today)..*

New tech - new possibilities for trouble

- Very easy for club pilots to make the transition to new electric gliders

- But…..still fully possible to get in ”classic trouble” with new tech!

Example of aborted self launch with LAK 17 C FES due to undercharged battery at ELSKÅ Event 2022 in Falköping.

New tech - new possibilities for trouble

Czech pilot in JS3 RES outlanding in lake during after electric engine malfunction.
(Power electronics overheat?) (Uvalde 2024)

New tech - new possibilities for trouble

Charging interrupted due to melted extension cord after 2500 watts charging session. @ Stefan Langer (1500 watts worked ok)

Electric drivetrains basic facts

Areas of improvement

- Batteries still have limited energy but super high energy efficiency in electric motors helps. (90 % in EL vs 25 % fossil)

- Somewhat longish charging times (but glider sits in hangar + 12 hrs a day...)

- Costly, heavy and delicate batteries.

Areas of near perfection

- Quiet, vibration free, clean (no oil, smell or smoke)
- Low pilot workload
  (you tell the software what you want, it does the rest – (not PIK 20E)
- Few mechanical parts, hopefully less maintenance cost

More good things...

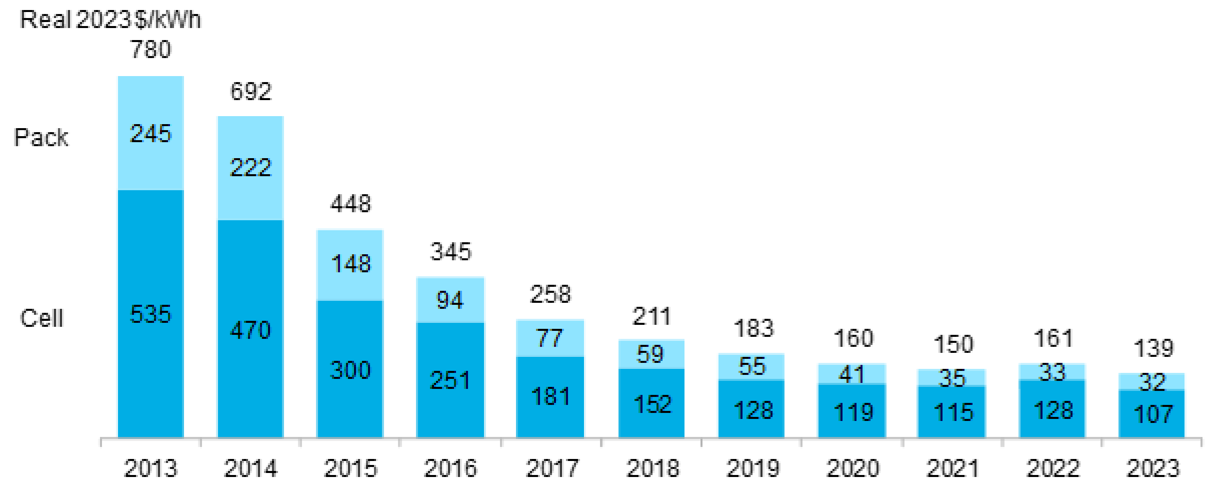
- No direct carbon emission during use

- A chance to makes aviation politically acceptable?
  We burned 12 599 liters of fuel in my club in 2023 (sustainable sport?)

- Massive global investments in EV tech (vs stagnant ICE-tech)

E-Gliding benefits from external investments

Figure 1: Volume-weighted average lithium-ion battery pack and cell price split, 2013-2023

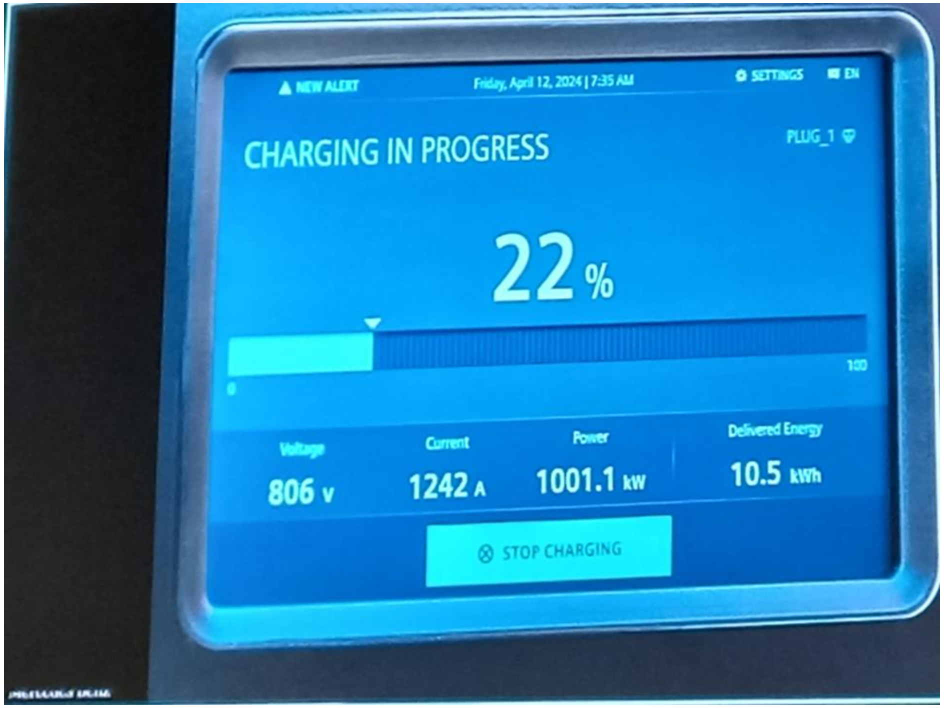


Source: BloombergNEF. Historical prices have been updated to reflect real 2023 dollars. Weighted average survey value includes 303 data points from passenger cars, buses, commercial vehicles, and stationary storage.

Battery electric drivetrains are forecasted to reach price parity with fossil drivetrains within 12-24 months. After that it's cheaper to manufacture EV-cars than fossil.

Trend: Battery cost is expected to fall further… to be continued…

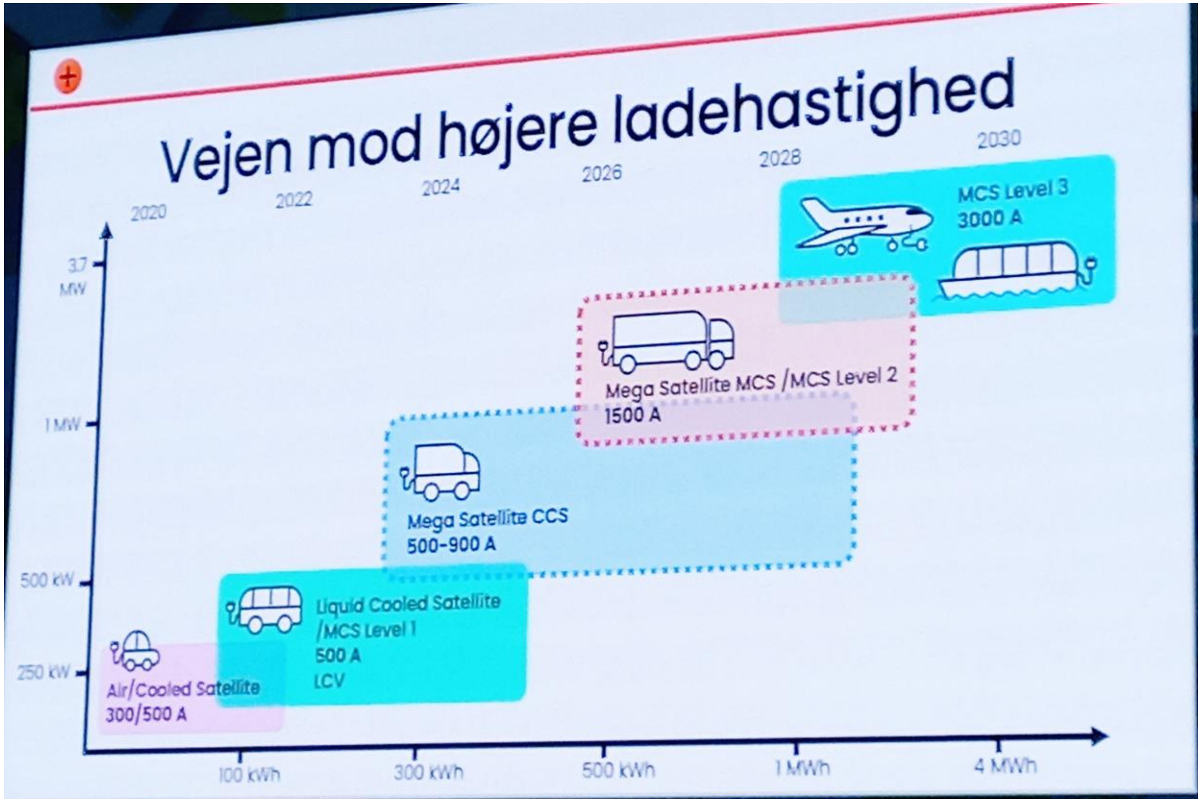
E-Gliding benefits from external investments



Trend: Charging speed is going up
Megawatt-charging of new Mercedes eActross 600 truck

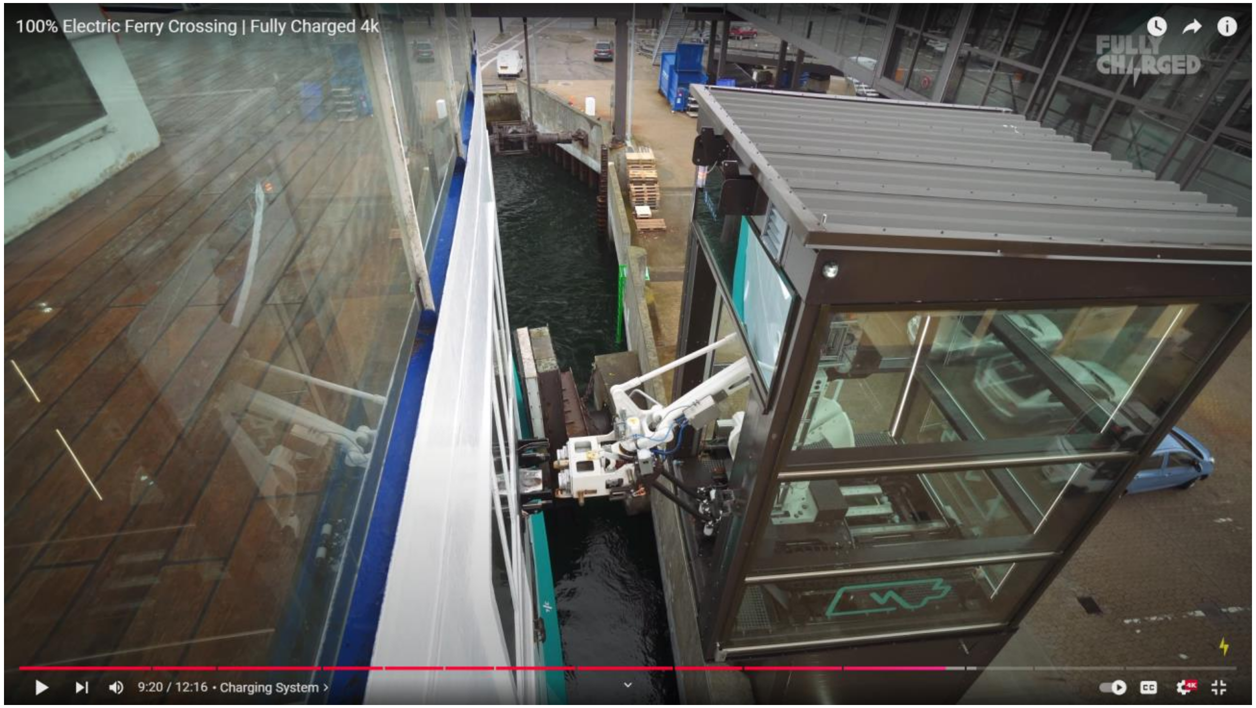
Plug supports up to 3700 kW (3,7 MW!)

E-Gliding benefits from external investments



MCS supports up to 3,7 MW allowing for future heavier applications.

E-Gliding benefits from external investments

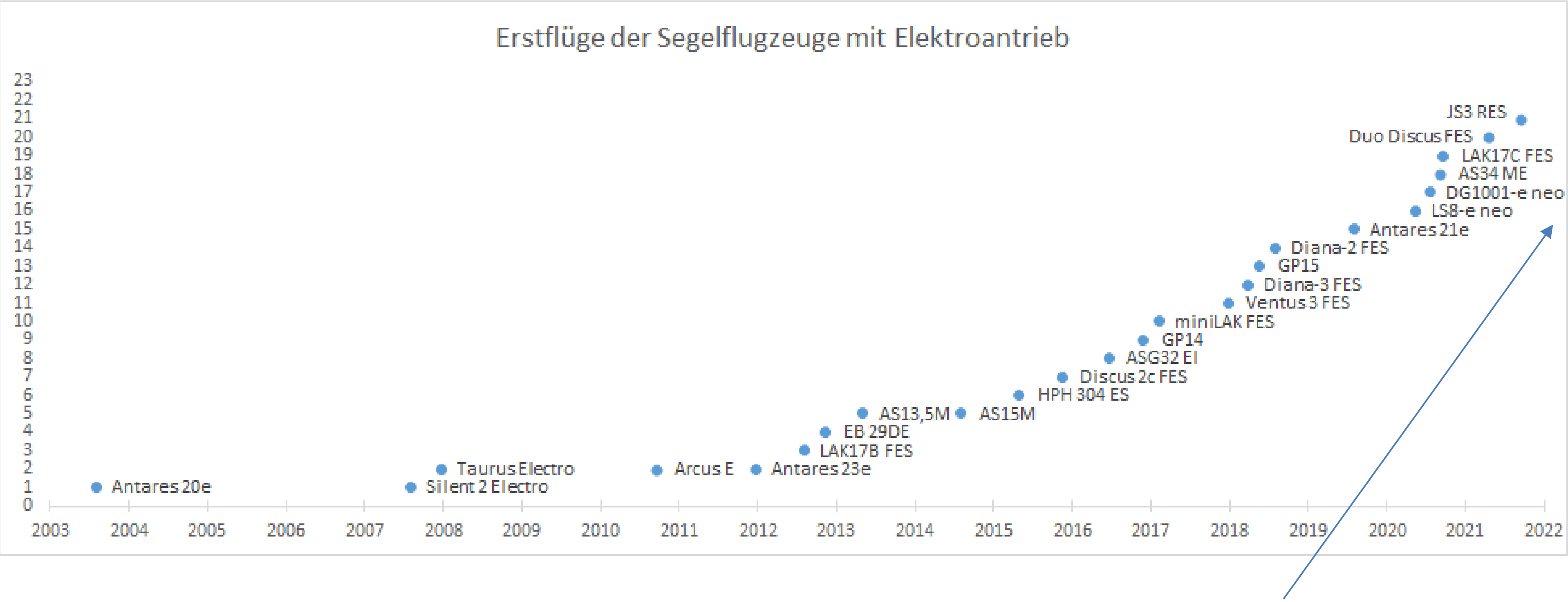


Extreme charging …

Helsingborg – Helsingør Ferry (charges 9 min in SWE/ 5 min in DK)
10 000 volt @ 600 amp = 6000 kW (6 MW!!)

One crossing consumes 1.100 kWh of the 4.160 kWh-battery.

The electric evolution in aviation starts with gliding



+ AS 33 Me (SLG)
+ SH Ventus 3e (SLG)
+ HPH Shark E (not flown yet)

Overview of electric aircraft


FES System
Most popular electric aircraft: 380 gliders flying (nov 2024)
Discus, Ventus, Shark, LS8 e, Diana, Mini Lak, Lak 17, Silent, DG 1001 e & Duo

Latest GEN4 batteries contain aprx 25 % more energy @ 1 kg weight increase

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

Pro Quick and stressfree operation, no complex pylon mechanism, no ”big airbrake” if engine fails.
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 less than half the volume!

AS 34 Me – 2020
15/18 M standard class SLG (based on ASW 28)
35 kW 228-Emrax-motor (from ”turbo” ASG 32 EL)
8,6 kWh battery in wings (improves cockpit load capacity, but heavy wings))

Total climb 2200 meters or 1 start to 600 m plus 125 km motor flight
Status: In production and CS 22 EASA-certified (more than 15 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)

Total climb 2200 meters or 1 start to 500 m plus 130 km motor flight
Status: Certified, first deliveries commenced.

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 (smaller motor and propeller than AS/SH)
2 x 25 kg battery weight. Fuselage mounted.

Approx. 2000 meter climb / 3,5 m/s
Certification completed 2023 - more than 100 delivered

Overview of electric aircraft

Schempp-Hirth Ventus 3E - 2024
15/18 M flapped SLG
9,2 kWh batteries - developed by Emetric (SOLO) 35 kW Emrax 228-motor
(bigger motor and propeller than Jonker JS3)
2 x 25 kg battery weight. Fuselage mounted.

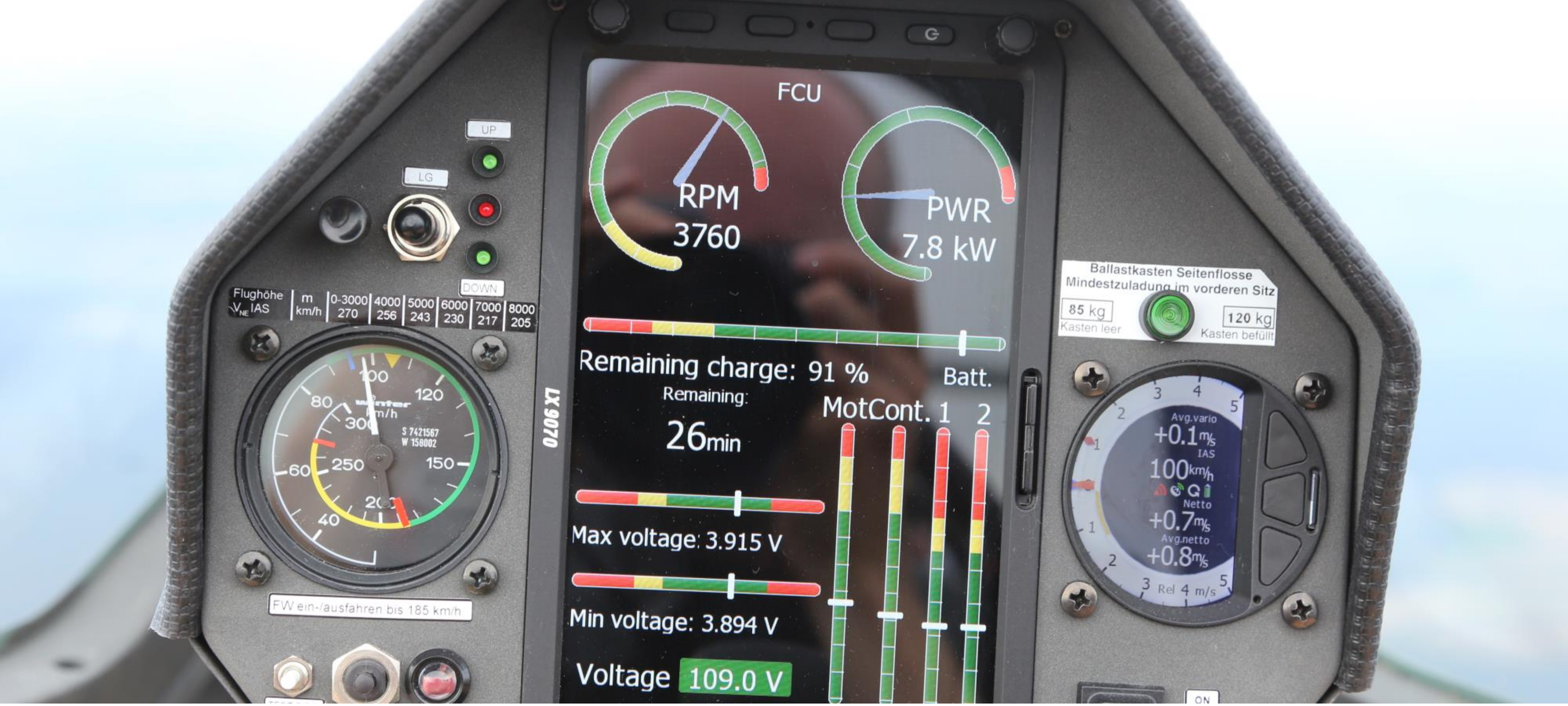
2478 m altitude gain was attained during testing 30/4 2024
Certification pending / Glider under development

Overview of electric aircraft

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

Overview of electric aircraft

Ventus 3E self launch on grass
https://youtu.be/DQTGQ_ccWlg



Myths and facts - Living with an electric glider?

"I need 500 km turbo range!"

Cold weather performance

Charging in the club?

Fire safety?

Battery life?

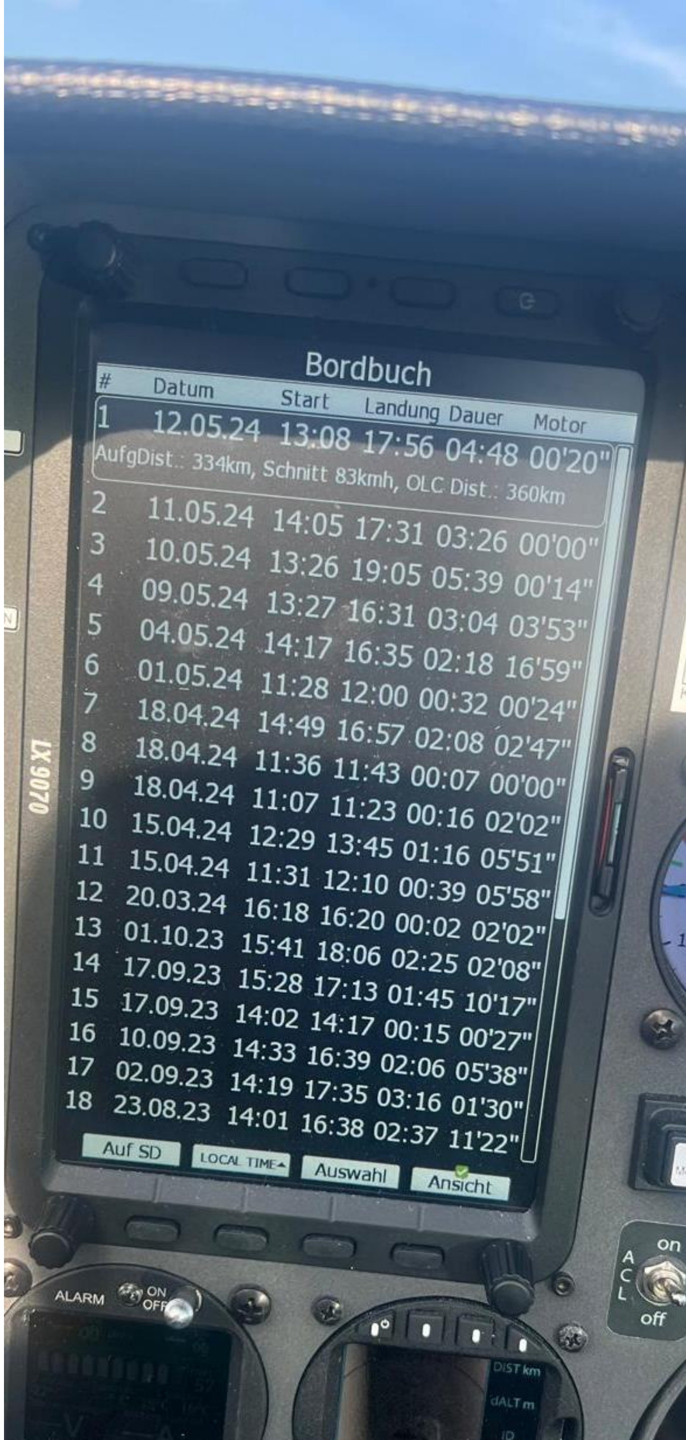
Myth

"I need 300 km turbo range in my batteries"

Most people don't

Screenshot of typical engine use during a season in a DG 1001 e neo with + 8 kWh batteries.

The batteries can sustain the glider at level flight for aprx 60 minutes = 100 km



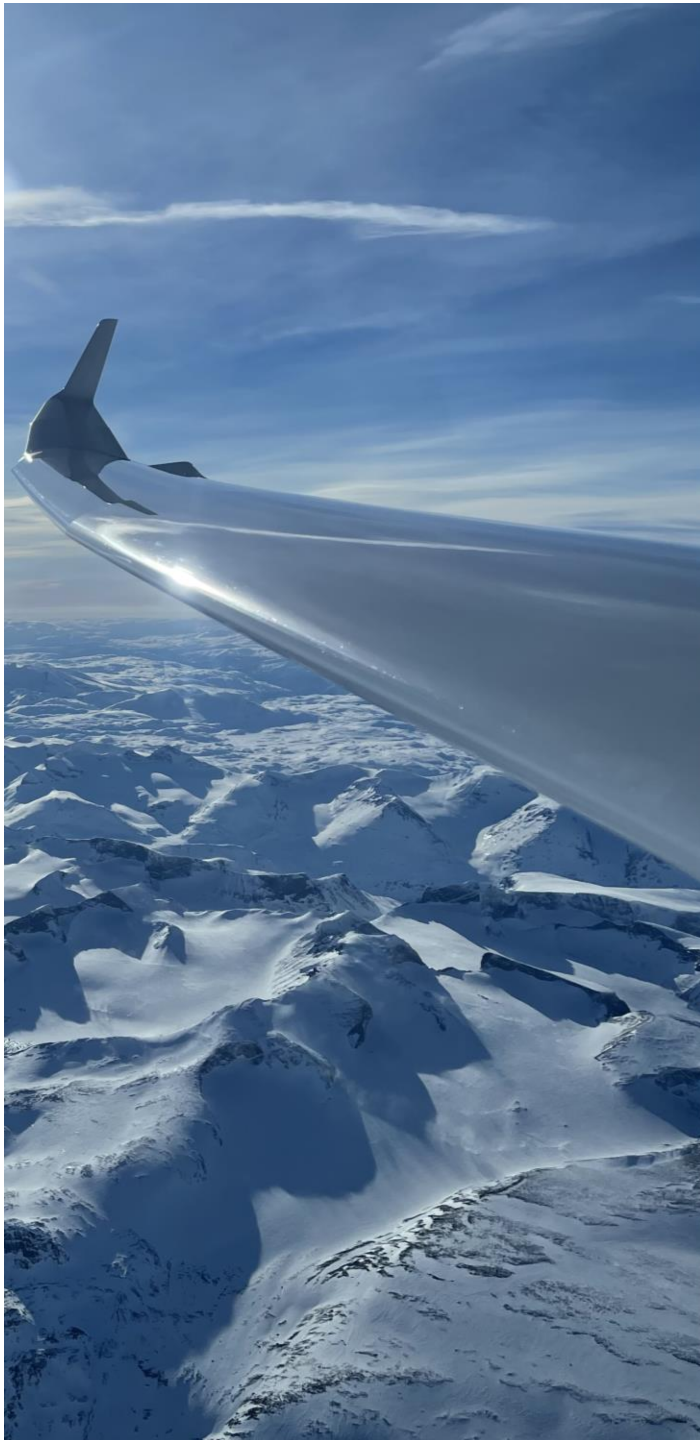
Cold Weather Performance

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 engine 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

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

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

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

- 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 internal resistance)

Fire safety

Battery fire test certification procedure

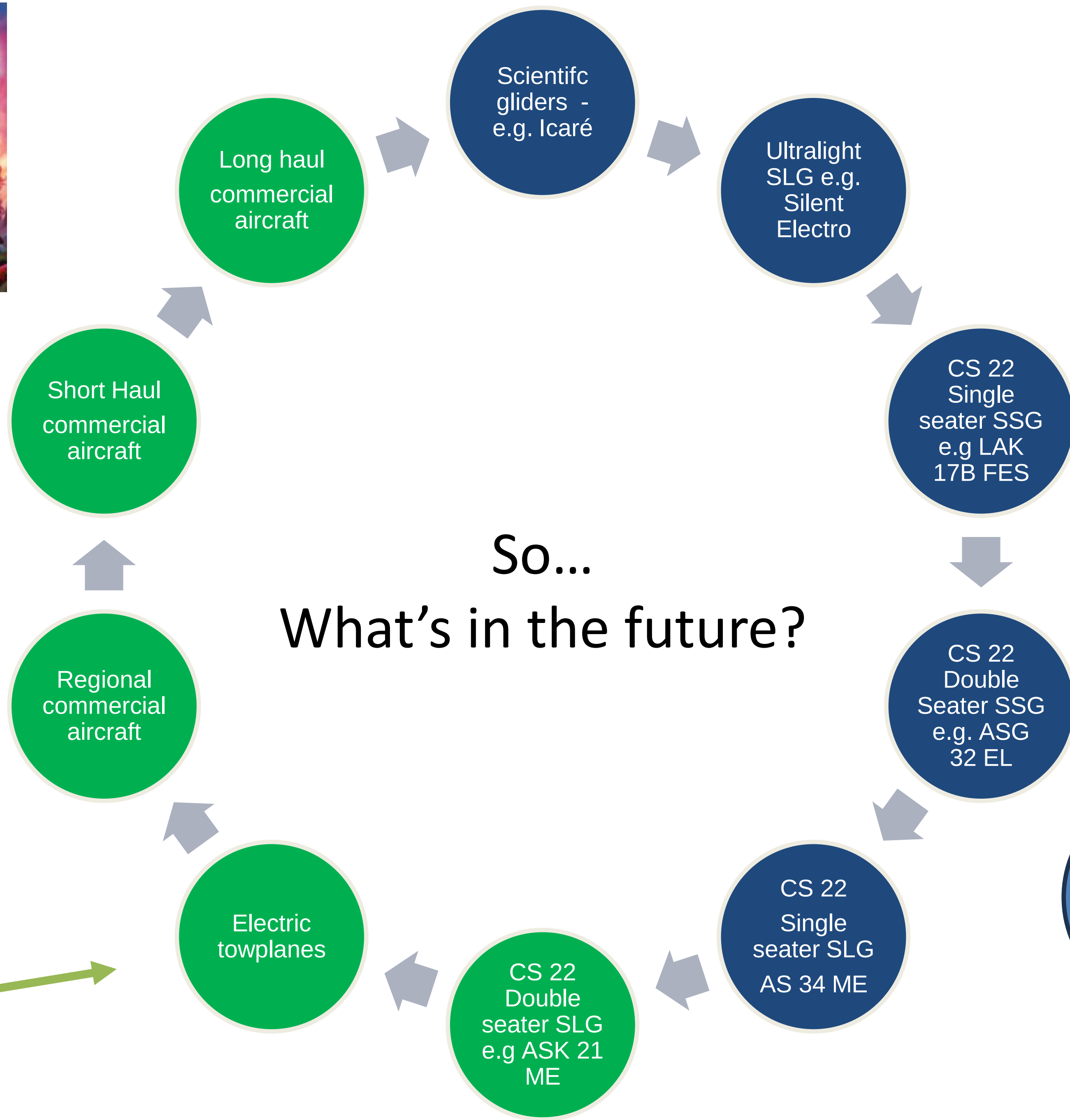
The whole pack is charged to 100 % and is mounted in a wing shell

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 not enter the fuselage, and is vented into the atmosphere through wing openings covered by blow-out-stickers.

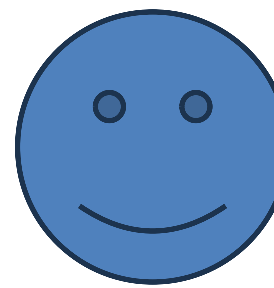
Fantasy land?

So…

What’s in the future?



Gliding fully electrified



Reality