🛧 LILIUM

Battery Webinar

The battery power behind the world's first electric VTOL Jet November 10th, 2023

ALL CALLER

Legal Disclaimer p. 1

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This presentation contains certain forward-looking statements within the meaning of the federal securities laws, including, but not limited to, statements regarding (i) the Lilium Group's proposed business and business model, the markets and industry in which the Lilium Group operates or intends to operate. (ii) the anticipated timing of the commercialization and launch of the Lilium Group's business and the expected results of the Lilium Group's business and business model, including when launched in phases, (iii) the application and performance of battery technology in aviation and eVTOL aircraft, (iv) estimates regarding power density, life cycle, weight and other expected specifications of battery technology, (v) the performance of the Lilium Jet, including its projected range, (vi) expectations regarding the manufacture of Lilium's battery cells, (vii) the scope and benefit of Lilium Group's procurement and supply chain strategy, (vii) the potential impact of regulations on the Lilium Jet, and (viii) Lilium's affirmation of previously provided guidance for the second half of 2023, including estimated cash spend. 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(x) difficulties in managing growth and commercializing operations; (xi) failure to commercialize Lilium's strategic plans; (xii) any delay in completing testing and certification, and any design changes that may be required to be implemented in order to receive type certification for the Lilium Jet; (xiii) any delays in the development, certification, manufacture and commercialization of the Lilium Jets and related technology, such as battery technology or electric motors; (xiv) any failure of the Lilium Jets to perform as expected or an inability to market and sell our Lilium Jets; (xv) any failure of suppliers to achieve serial production of the proprietary and/or novel software, battery technology and other technology systems still in development; (xvi) reliance on third-party suppliers for the provision and development of key emerging technologies, components and materials used in the Lilium Jet, such as the lithium-ion batteries that will power the jets, a significant number of which may be single or limited source suppliers, and the related risk that any of these prospective suppliers or strategic partners may choose not to do business with us at all, or may insist on terms that are commercially disadvantageous, and as a result we may have significant difficulty procuring and producing our jets; (xvii) if any of Lilium's suppliers become financially distressed or go bankrupt, Lilium may be required to provide substantial financial support or take other measures to ensure supplies of components or materials, which could increase costs, adversely affect liquidity and/or cause production disruptions; (xviii) third-party air carriers are expected to operate Lilium Network services in the U.S., Europe, the Kingdom of Saudi Arabia, the United Kingdom and Brazil, among other countries, using the Lilium Jets, and these third parties, as well as Lilium, are subject to substantial regulation and complex laws, and unfavorable changes to, or the third-party air carriers' or Lilium's failure to comply with, these regulations and/or laws could substantially harm Lilium's business and operating results; (xix) any inability to operate the Lilium Network services after commercial launch at the anticipated flight rate, on the anticipated routes or with the anticipated Vertiports could adversely impact Lilium's business, financial condition and results of operations; 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Estimates and Data Regarding Battery Cell Technology

This presentation contains certain estimates and illustrative data regarding battery cell technology expected to be used in the Lilium Jet that is based on or derived from sources that Lilium reasonably believes to be representative of our expectations for such technology as of the date of this presentation. However, the subject matter of this presentation is complex and the performance of battery cell technology can be impacted, in some cases materially, by numerous variables and applicable aircraft operating conditions (e.g., altitude, temperature, aircraft loading, maneuvers, etc.). Additionally, the estimates and illustrative data used in this presentation are based in part on testing and data collected from different generations of battery cells manufactured by various suppliers. While these different generations of battery cells use the same chemistry, and we believe that we have applied the data accumulated in a reasonable manner, there may be minor deviations in certain aspects of the manufacture and/or composition of different generations of battery cells that impact performance and the applicability of measurements as between different generations. Therefore, actual battery cell technology and performance necessary for the Lilium Jet to achieve our expectations may differ materially from the estimates and illustrative data set forth in this presentation.

Description of Key Partnerships

This presentation contains descriptions of some of Lilium's key business partnerships with whom Lilium has entered into feasibility studies, indications of interest, term sheets, memoranda of understanding or other preliminary arrangements. These descriptions are based on the Lilium management team's discussions and the latest available information and estimates as of the date of this presentation. In each case, these descriptions are subject to negotiation and execution of definitive agreements that may not have been completed as of the date of this presentation and, as a result, the nature, scope and content of these key business partnerships remain subject to change.

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Graphic Representations

Aircraft depicted in this presentation have been rendered utilizing computer graphics.

The information contained herein is made as of 10 November 2023, and does not reflect any subsequent events.

Agenda

1. Opening

- 2. Why Battery Powered Flight?
- 3. What is the power consumption of the Lilium Jet? How did you validate it?
- 4. You need miracle batteries to supply the power of the Lilium Jet. When will they exist?
- 5. Would losing a battery pack make the resulting power draw unfeasible?
- 6. How does the reserve concept work and affect your operating range?
- 7. Did you test power profiles and missions on a real cell?
- 8. Did you test the cycle life of your High Silicon Anode cells?
- 9. Regarding safety, won't your battery get too heavy once requirements are included?
- 10. Do you have suppliers for those cells? Will it not take years to set up production?
- 11. Do you have alternatives/backups from a chemistry and production standpoint?
- 12. What's your cell technology roadmap to increase aircraft range in the future?

13. Q&A

Time

Daniel Wiegand

Lilium Founder Chief Engineer for Innovation

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Batteries offer highest overall efficiency – any flight that can be done using batteries will be done with batteries

	Batteries	E-Hydrogen	E-Fuels (SAF)	Kerosene (today)
		remon	Powered by Sustainable Aviation Fuels	
Primary Energy Efficiency ¹	73%	22%	13%	50%
Electricity Price ²	~ \$0.36 / kWh			
Cost / kWh shaft power	~ \$0.5 / kWh ³	~ \$1.7 / kWh ³	~ \$2.8 / kWh	~ \$0.5 / kWh ⁴
Flight Range ⁵	1,100 (2040) – 2,000 km (2050)	Up to ~3,400 km overs ~80% of all scheduled commercial flights	Up to ~16,000 km	Up to ~16,000 km

Sources: 1. WTT (World Bank, LBST, IEA), TTW, T&E calculations, Swiss Federal Office for Civil Aviation; 2. Statista; 3. Does not consider material cost for depletion of battery cells or fuel cells; 4. Transportation Research Procedia, Volume 59 (2021) 253-259, Jet A1 Fuel; 5. International Council on Clean Transportation and Lilium internal assessment

Battery is the major driver of the performance of an eVTOL







COSTS

SAFETY

CYCLE LIFE

CARBON FOOTPRINT MATERIALS AVAILABILITY

000

RECYCLABILITY



Our key differentiators

Largest Cabin Low Operating Cost

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Regional Flights

LILIUM Source: Lilium

P. 8

Passengers prefer ducted fans



Simple power requirements can be obtained from general aerospace principles



Sources: 1. Hover vertical lift efficiency graph illustration from <u>NASA SP-2000–4517</u>; 2. For illustration only; 3. Estimate based on Type Certificate jet configuration with a weight of 3,175kg; 4. Propeller-based eVTOL estimate based on peer websites, press clippings and the <u>NASA SP-2000–4517</u>

Electric Hover Power simplified calculation²



Comparing simple power estimates to in-flight measurements



Demonstrator total measured Specific Power [kW/kg] – Sea Level, ISA+0

UNIT LILIUM DEMONSTRATOR JET RESULTS 1,150 **Disc Loading** kg/m² 1,150 **Specific Electric Power** kW/kg 0.68 (D) 0.62 Gross weight 3,175 kg (E) **Electric Hover Power** kW 2,147 $(F = D \times E)$.969

Hover Power simple estimate¹ vs. real measurements²

CONCLUSION

Measured demonstrator power draw is slightly lower than simplified estimates.

Sources: 1. For illustration only, e.g. full calculation would consider global efficiencies; 2. Measurements from Lilium's demonstrator "Phoenix 2"; 3. Estimate (e) based on Type Certificate jet configuration; 4. Extrapolated number based on Type Certificate jet's weight and real flight-testing data

We're using industry best practice tools to obtain precise power estimates – evidence-based engineering



We believe Lilium's Jet design is the best suited eVTOL configuration for regional missions

Power profile on a 175 km regional mission

Power [kW]



Hover (less than 20kts speed) makes 9% of mission energy. A propeller would only reduce this to ~4%. However,... ...in Cruise, our engine cross section is better sized and will be significantly more efficient than propeller based eVTOLs.



Overall, Lilium's Jet consumes less Energy for longer missions

Translating aircraft power draws to cell level power requirements

Our requirements at cell level¹



Specific Cell Power [kW/kg]

We have a flying proof that our jet design works with standard Li-ion chemistries



Phoenix 1

First flight: 2019

Discloading: 1,150 kg/m²

Cell¹: LG HG2



Cell type: Cylindrical – 18650 Cell design Year: 2013 Main application: e-Cigarettes

We switched to pouch cells as they have less overhead mass, higher energy density and allow for better packaging efficiency





Phoenix 2

First flight: 2021

Discloading: 1,150 kg/m²

Cell¹: KOKAM Li-ion

Cell type: Pouch Cell design Year: 2015 Main application: Forklifter

Conforming A/C battery cell specifications

ELEMENT	DESCRIPTION
Design	IDNELOX (California, USA) Investors include Temasek, Applied Materials and Lilium
Design Year	2021
1 st Manufacturer	CUSTOMCELLS® (Tübingen, Germany)
Form factor	Pouch-cell
Anode chemistry	Silicon dominant
Anode chemistry Cathode chemistry	Silicon dominant NMC811
Anode chemistry Cathode chemistry Specific power	Silicon dominant NMC811 5 kW/kg @ 50% SOC
Anode chemistryCathode chemistrySpecific powerSpecific Energy	Silicon dominant NMC811 5 kW/kg @ 50% SOC 330 Wh/kg
Anode chemistryCathode chemistrySpecific powerSpecific EnergyCapacity	Silicon dominant NMC811 5 kW/kg @ 50% SOC 330 Wh/kg 330 Wh/kg 38 Ah 38 Ah



Our cell performance is in line with current high-performance chemistry specs



Energy Density [Wh/kg]

Sources: Lilium: Company Information; Swaytronic: Company Information on Sway Graphene HC-LiPo; Tesla: Batemo and EV Database; Farasis P73: Batemo; Amprius; CATL: Company Information and Lilium assessment

By the time Lilium's Jet will enter the market, Silicon Anode Technology will be state of the art in premium automotive

IEEE Spectrum

"The Age of Silicon Is Here...for Batteries. The mainstay material of electronics is now yielding better energy storage.



"Group14 Technologies, in Woodinville, Wash., should have its silicon battery setup in a Porsche EV by next year."



"[...] Sila Nanotechnologies' **silicon anode**, [...] will be in the **Mercedes G-Class SUV by 2026.**"



"[...] General Motors and OneD Battery Sciences in Palo Alto, Calif., are putting OneD's silicon nanotechnology into GM's Ultium battery cells."

Our aircraft has 10 independent battery packs providing sufficient power in case of failure



In case of failure of 1 pack, power increases by +11% across the rest of the 9 independent packs



All battery safety requirements included

- Crash protection
- Cell fire containment
- Flight loads
- Redundant power distribution
- Dissimilar and redundant battery management
- Traceability and Process Control



All battery safety requirements included for both European and U.S. certification

WHAT IS THE RESERVE CONCEPT YOU ARE USING and what is the resulting operating range which is left using this reserve concept? Is it agreed with the regulator and what if the regulator imposes a three-minute hover time on this segment?

Applicable reserve concepts to our A/C

	European Union Aviation Safety Agency	Federal Aviation Administration DRAFT Public comment closed on 13.08.2023
Regulation	 Part IAM (Innovative Air Mobility Operations) 	 SFARs (Special Federal Aviation Regulations)
Hover time	 NO specification Part IAM is a performance-based framework 	 NO specification Not performance-based
Rules extract	 Contingency Final Reserve Alternates with Critical Failures Evidence required that the pilot and the A/C can consistently execute the landing procedures 	 The FAA have a 30-minute energy reserve requirement for VFR day and 45-minute for VFR night.
Analogies	 Stricter than any other operating framework for helicopters (vertiport landing in all cases) 	 U.S. and Global industry are pushing to converge towards performance-based framework for energy reserves and the SFAR in general.
How do we comply?	 Lilium's operating range target of 175km built upon the EASA Part IAM reserves 	 Lilium's commentaries submitted on August 12, 2023, pending FAA next step on SFAR

🕑 and what is the resulting operating range which is left using this reserve concept? Is it agreed with the regulator and what if the regulator imposes a three-minute hover time on this segment?

The aerospace industry is broadly requesting performance-based reserve requirements to the FAA

US applicants asking for a performance-based approach:



General Aviation Manufacturers Association "GAMA advocates for the adoption of appropriate operating rules based on each aircraft's performance characteristics, highlighting the need to modernize legacy fuel-based energy reserves and reconsider the requirement for dual control variants."



"...it is suggested to introduce the possibility to have more practical performance-based reserve requirements also considering the type of energy used for propulsion that would guarantee similar safety margins considering the particular concept of intended operations."



"Archer recommends that the FAA consider performance-based requirements for energy reserves, as well as other range and endurance related criteria that align with the capabilities and intended operations of the aircraft."



"BETA recommends the FAA revise the SFAR rules §91.151, §91.167, §135.209, and §135.223 to add an option for use of a performance-based reserve that can be determined based on the capability of the aircraft and the intended flight plan."



"Eve recommends the FAA introduces in the SFAR more practical **performance-based** energy reserve requirements applied for routes planning definition, considering the type of energy used by the powered-lift aircraft which guarantee equivalent level of safety margins regarding the intended concept of operation applied for each type of aircraft (shorter range, alternate landing sites, energy capacity, performance capabilities). "



"Joby champions performance-based reserve frameworks that bolster mission-specific range and endurance hazard evaluations."



"Revise the existing fuel reserve requirement to a performance-based standard for powered-lift to maintain an equivalent level of safety. "

European applicants asking for a performance-based approach:



"Language should be included such as "as determined by the Administrator" that would permit future operators to use performance-based reserve solutions."



"Given the variation of aircraft designs within the powered-lift category, we encourage the FAA to take a **performance-based** approach, setting fuel requirements based on the performance and the type of operation of the specific aircraft" P. 23

WHAT IS THE RESERVE CONCEPT YOU ARE USING and what is the resulting operating range which is left using this reserve concept? Is it agreed with the regulator and what if the regulator imposes a three-minute hover time on this segment?

Deep dive on EASA Part IAM and implications for Lilium

Part IAM Reserves Requirements





🥑 and what is the resulting operating range which is left using this reserve concept? Is it agreed with the regulator and what if the regulator imposes a three-minute hover time on this segment?

Validated landing performance in ~750 landings simulations with different pilots



- Mixed reality 3D simulator with motion platform
- Validated control laws and representative cockpit
- Night, rain and wind simulations
- Provides statistical evidence for landing performance



Pilots consistently execute landing in <25 sec. hovering, leaving +45 sec. Part IAM hover reserve

We've been intensively testing our cells based on reference flight profile

Iterative testing of max range missions based on reference flight profile



Subtracting PART IAM reserves yields <u>175 km</u> operational range (achieved in tests)

Our cells show similar cycle life as standard Li-ion cells'

Ionblox cell testing – Cycle capacity summary



Key highlights

- Rate: 1C / 1C
- Depth of discharge: 100%
- Voltage: 2.5 4.2 Volts
- Format: Full Size Pouch



88% capacity retention over 809 full cycles

Cycle Life increases with real flight profiles



- Charge End: 100%
- **Profile: Reference Flight Profile**
- Peak Power: 2.9 kW/kg
- Capacity check: every 50 cycles
- Flight Distance: ~130km





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- No adverse effects on cycle life found from high power pulses at take-off and landing and the fast charge
- 88% capacity retention over **1450 flight** cycles (business case target is 800 cycles)
- Avoiding discharge to 0% due to reserves at landing increases cycle life and Charge rate significantly



Deep dive on our production ramp-up with CustomCells



Key highlights

- Dedicated production line for Lilium
- Shipping cells every week
- Prototype production started in 2021
- Compliant with aerospace traceability and conformity
- State-of the art electrode and cell production machine

Lilium's cells can be manufactured on standard, available manufacturing lines



Deep dive on Pre-Lithiation: improving cell capacity and cycle life

Pre-Lithiation set-up at CustomCells production line (illustrative)



- Simple "Calendaring" process
- Pre-Lithiation can be done with most Li-lon Chemistries and increases Energy and Cycle Life
- Si Anode can be used without Pre-Lithiation but with lower capacity
- Currently many high performance cells in development using Pre-Lithiation

We are de-risking our battery production thanks to a multi-sourcing approach

Primary cell production with (C)



- Prototype cells production of the lonblox technology in increasing numbers
- Collaboration towards consistent aerospace grade quality

New partnership with inoBat (supported by 6 Gotion)

- Inobat to produce Lilium battery cells, with support from Inobat investor Gotion High-Tech
- Gotion High-Tech is one of the world's largest manufacturers of battery cells, contracted for 80% of Volkswagen Group's future battery demand
- Inobat production due to start in early 2024

We have two credible partners for battery manufacturing



Battery performance improvement roadmap

Incremental energy increase using proven technologies, existing partners, and manufacturing lines



We are continuously investing together with our partners to stay on the cutting edge of battery technology

We believe energy density will increase by ~4.5% p.a. and Lilium capabilities will enable a wider portfolio of electric aircraft



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Note: Targeted aircraft development vision through 2040 estimates based on Company analysis; The illustration of future aircraft capabilities is forward-looking, subject to significant uncertainties and contingencies, many of which are beyond Lilium's control and are based upon assumptions with respect to future decisions and events, which are subject to change. Actual results will vary & those variations may be material. Nothing in this presentation should be regarded as a representation by any person that future aircraft capabilities will be achieved as described herein. 1. Estimate based on Physicsworld and Lithium-ion batteries historical improvement

The battery dominates 20049961001103-435-D75 eVTOL performance

Our battery is a clear competitive advantage and moat to our eVTOL technology.

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