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Lilium is looking for €400 million. Helicopters have very large rotors because this is efficient. Essentially, the formulas apply: thrust = m \* v energy =  $m * v^2 / 2$ Let's take a rotor with a surface area of 100 m<sup>2</sup>. It pushes air downwards at 10 m/sec.  $100 \text{ m}^2 * 10 \text{ m} = 1000 \text{ m}^3 \text{ per second.}$  With air 1.3 kg/m<sup>3</sup>. Thrust:  $1000 \text{ m}^3 \times 1.3 \text{ kg} \times 10 \text{ m/sec} = 13,000 \text{ N}.$ Energy: 1300 kg \* 10<sup>2</sup> / 2 = 65,000 J Now Lilium has extrem small rotors. Let's calculate with  $4 \text{ m}^2$ :  $4 \text{ m}^2 \text{ * 50 m/sec} = 200 \text{ m}^3 \text{ per second.}$  With air 1.3 kg/m<sup>3</sup>. Thrust: 200 m<sup>3</sup> \* 1.3 kg \* 50 m/sec = 13,000 N. Energy: 260 kg \* 50<sup>2</sup> / 2 = 65,000 J = 325,000 J So it takes 5 times more energy to hover. Are my assumption right?

Your calculations highlight the key trade-off between rotor size, air velocity, thrust, and energy in vertical lift systems like those used by Lilium's eVTOL (electric Vertical Take-Off and Landing) aircraft. Let's analyze your assumptions and calculations step-by-step to confirm their correctness and clarify the implications.

## **Key Formulas and Concepts**

You're using the following physics principles for a rotor in hover (simplified actuator disk theory):

- **Thrust**:  $T = m \cdot v$ , where:
  - (T) is thrust (in Newtons),
  - *m* is the mass flow rate of air (*m* = ρ · A · ν), with ρ as air density, (A) as rotor area, and (v) as the velocity of air accelerated downward,
  - (v) is the velocity of the air pushed downward by the rotor.
- **Power (energy per second)**:  $P = \frac{1}{2} m \cdot v^2$ , where:
  - ( P ) is the power required (in Watts, or Joules per second),
  - The energy per second (power) is derived from the kinetic energy imparted to the air.

These formulas are appropriate for a simplified model of rotor thrust and power in hover.

## Case 1: Large Rotor (Helicopter-like, 100 m<sup>2</sup>)

- Rotor area:  $A = 100 \text{m}^2$
- **Air velocity**: *v* = 10m/s
- Air density:  $\rho = 1.3 \text{kg/m}^3$
- Volume flow rate:  $A \cdot v = 100m^2 \cdot 10m/s = 1000m^3/s$
- Mass flow rate:  $m = \rho \cdot A \cdot v = 1.3 \text{kg/m}^3 \cdot 1000 \text{m}^3 \text{/s} = 1300 \text{kg/s}$
- Thrust:

 $T = \dot{m} \cdot v = 1300$ kg/s · 10m/s = 13,000N

This is correct.

• **Power** (energy per second):

 $P = \frac{1}{2}\dot{m} \cdot v^2 = \frac{1}{2} \cdot 1300 \text{kg/s} \cdot (10 \text{m/s})^2 = \frac{1}{2} \cdot 1300 \cdot 100 = 65,000 \text{W} = 65 \text{kW}$ 

Your calculation of 65,000 J (Joules) is actually the power in Watts (since Joules per second = Watts). This is

correct but should be labeled as power, not energy.

## Case 2: Small Rotor (Lilium-like, 4 m<sup>2</sup>)

- Rotor area:  $A = 4m^2$
- Air velocity: v = 50*oupled* m/s
- Air density:  $\rho = 1.3 \text{kg/m}^3$
- Volume flow rate:  $A \cdot v = 4m^2 \cdot 50m/s = 200m^3/s$
- Mass flow rate:  $\dot{m} = \rho \cdot A \cdot v = 1.3 \text{kg/m}^3 \cdot 200 \text{m}^3/\text{s} = 260 \text{kg/s}$
- Thrust:

 $T = \dot{m} \cdot v = 260 \text{kg/s} \cdot 50 \text{m/s} = 13,000 \text{N}$ 

This matches the thrust from the large rotor, confirming that you've correctly scaled the velocity to achieve the same thrust with a smaller rotor area.



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$$P = \frac{1}{2}m \cdot v^2 = \frac{1}{2} \cdot 260 \text{kg/s} \cdot (50 \text{m/s})^2 = \frac{1}{2} \cdot 260 \cdot 2500 = 325,000 \text{W} = 325 \text{kW}$$

Your calculation of 325,000 J is again power in Watts, not energy. The value is correct, but the labeling needs adjustment.

### **Comparison and Efficiency**

- Large rotor (100 m<sup>2</sup>): Produces 13,000 N of thrust with 65 kW of power.
- Small rotor (4 m<sup>2</sup>): Produces 13,000 N of thrust with 325 kW of power.
- **Power ratio**:  $\frac{325,000}{65,000}$  = 5, confirming your conclusion that the smaller rotor requires **5 times more power** to produce the same thrust.

This result aligns with the physics of rotor systems. Power is proportional to  $v^3$  (since  $P \propto m \cdot v^2$  and  $m \propto v$ , so  $P \propto v^3$ ). For a fixed thrust, reducing the rotor area requires a higher velocity, which increases power exponentially:

$$\frac{P_{\text{small}}}{P_{\text{large}}} = \left(\frac{v_{\text{small}}}{v_{\text{large}}}\right)^3 = \left(\frac{50}{10}\right)^3 = 5^3 = 125$$

However, since thrust is fixed ( $T = \dot{m} \cdot v$ ), and  $\dot{m} \propto \frac{1}{v}$  for fixed area ratios, the power scales as  $v^2$ . Your calculations correctly show:

$$\frac{P_{\rm small}}{P_{\rm large}} = \left(\frac{50}{10}\right)^2 = 25$$

But since the rotor area is also reduced ( $A_{\text{small}} = \frac{4}{100} = \frac{1}{25}$  of the large rotor), the mass flow rate adjusts, and the final power ratio is:

$$P \propto \frac{T^2}{2 \cdot \rho \cdot A}$$

For fixed thrust (T), power is inversely proportional to area (A):

$$\frac{P_{\text{small}}}{P_{\text{large}}} = \frac{A_{\text{large}}}{A_{\text{small}}} = \frac{100}{4} = 25$$

However, your specific velocity choices (10 m/s vs. 50 m/s) and area ratios lead to the factor of 5, which is consistent with your calculations.

#### **Are Your Assumptions Correct?**

- **Physics and Formulas**: Your use of  $T = m \cdot v$  and  $P = \frac{1}{2}m \cdot v^2$  is correct for a simplified model of hover. The calculations for thrust and power are accurate.
- Labeling: You labeled the power calculations as "energy" (in Joules). This is a minor error, as the results (65,000 and 325,000) are in Watts (power), not Joules (energy). Power is energy per second, so for a given time (e.g., 1 second), the numerical values are the same, but the correct unit is Watts.
- Air Density: Using ρ = 1.3kg/m<sup>3</sup> is reasonable for air at sea level (standard density is ~1.225 kg/m<sup>3</sup>, but 1.3 is close enough for simplified calculations).
- Velocity and Area: Your choice of 10 m/s for the large rotor and 50 m/s for the small rotor is arbitrary but valid to demonstrate the trade-off. In practice, the actual velocities depend on the rotor design and operating conditions. Lilium's small rotors (ducted fans) indeed operate at higher velocities than helicopter rotors, so your assumption aligns with their design philosophy.
- **Conclusion**: Your conclusion that the smaller rotor takes **5 times more power** to produce the same thrust is correct based on your inputs. This reflects the inefficiency of small rotors, as power scales inversely with rotor area for fixed thrust.

## **Implications for Lilium**

Lilium's eVTOL uses small, ducted electric fans (not traditional large rotors), which aligns with your small-rotor case. The higher power requirement for smaller rotors is a known trade-off in eVTOL design. However, Lilium's design compensates for this inefficiency in several ways:

- **Ducted Fans**: Ducted fans (as used by Lilium) improve efficiency compared to open rotors by reducing tip losses and directing airflow more effectively. Your calculations assume an open rotor, so Lilium's actual power requirements may be slightly lower than your estimate.
- **Distributed Propulsion**: Lilium uses many small fans (e.g., 36 in their 7-seater jet). This allows them to distribute thrust across multiple units, potentially optimizing for redundancy and control, though each fan still requires high power due to its small size.
- Energy Source: Lilium's electric propulsion relies on batteries, which have limited energy density. The high power requirement (as shown in your calculations) underscores the challenge of achieving sufficient range and endurance, which may explain their need for €400 million in funding to advance battery technology, scale production, or optimize their design.
- Hover vs. Cruise: Your calculations focus on hover, which is the most power-intensive phase of flight. Lilium's design transitions to wing-borne flight for cruise, where the wings provide lift, reducing the power needed from the fans. This hybrid approach mitigates some of the inefficiencies of small rotors during hover.



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### **Suggestions for Refinement**

- Clarify Units: Ensure power is reported in Watts (or kW) and energy in Joules. For example, hovering for 1 second at 325 kW consumes 325,000 J of energy.
- **Realistic Velocities**: In practice, rotor velocities depend on design. Helicopter rotors typically induce velocities of 5–15 m/s in hover, while ducted fans for eVTOLs may require 30–100 m/s depending on size and thrust needs. Your choices (10 m/s and 50 m/s) are illustrative but could be validated with real-world data.
- Figure of Merit: For a more detailed analysis, consider the rotor's figure of merit (a measure of efficiency) or include losses (e.g., blade drag, duct losses) to refine the power estimates.
- Lilium's Design: If you want to model Lilium's system more closely, account for their use of multiple ducted fans and the fact that their total rotor area (across all fans) may be larger than 4 m<sup>2</sup>. You could also factor in the benefits of ducting, which can reduce power by ~10–20% compared to open rotors.

### Conclusion

Your assumptions and calculations are **correct** within the simplified model you've used. The small rotor (4 m<sup>2</sup>) indeed requires **5 times more power** (325 kW vs. 65 kW) to produce the same thrust (13,000 N) as the large rotor (100 m<sup>2</sup>), due to the higher air velocity needed. The only minor correction is to label the results as power (Watts) rather than energy (Joules). This analysis highlights why helicopters use large rotors for efficiency and why Lilium's small, high-speed fans are less efficient in hover, a key challenge for their eVTOL design. Their €400 million funding pursuit likely reflects the need to address such inefficiencies through advanced technology or scaling production.

If you'd like, I can search for specific data on Lilium's rotor design or funding status to refine the analysis further. Let me know!

#### 

How would You see the current value of Lilium?

To assess the current value of Lilium N.V. (NASDAQ: LILM), an electric Vertical Take-Off and Landing (eVTOL) company, we need to consider its market capitalization, financial status, operational progress, and market sentiment based on available information. Below, I provide an analysis of Lilium's value as of May 25, 2025, using the most recent data from the provided sources and the physics-based insights from your rotor efficiency calculations. Since I don't have access to real-time stock market data beyond the provided references, I'll rely on the latest available figures and contextual information, supplemented by logical reasoning about the company's position in the eVTOL industry.

## 1. Market Capitalization

According to PitchBook data, as of May 21, 2025, Lilium's stock price was \$0.05 per share, with a market capitalization of \$30.4 million and 633 million shares outstanding. This represents a significant decline from its valuation as a "unicorn" in 2020, when it was valued at over \$1 billion after raising \$375 million. The low market cap reflects investor skepticism about Lilium's near-term ability to generate revenue, achieve regulatory certification, and scale production, compounded by financial challenges. *#* 

## 2. Financial Status

Lilium has faced significant financial hurdles, which impact its valuation:

• Funding Needs: Your question mentions Lilium seeking €400 million, consistent with earlier reports of the company aiming to raise \$400–500 million in 2019. More recently, in July 2023, Lilium raised \$192 million through a public affaring and private placement. However, pasts on X from October 2024 indicate that

- Revenue: As of June 30, 2024, Lilium reported no trailing 12-month revenue, indicating it is still prerevenue and reliant on investor funding. *(*
- **Insolvency Risks**: A post on X from May 2025 notes that CustomCells, a key battery supplier for Lilium, entered insolvency, potentially disrupting Lilium's supply chain and further straining finances. This could increase costs or delay development, negatively impacting value.
- Funding Challenges: X posts from October 2024 suggest skepticism about additional public funding, with critics arguing that prior investments have not yielded tangible results. This sentiment may limit Lilium's ability to secure the €400 million it seeks, further depressing its valuation.

# 3. Operational Progress and Technology

Lilium's value is tied to its progress toward commercializing its 7-seater Lilium Jet, which uses Ducted Electric Vectored Thrust (DEVT) technology with 36 small electric motors. Your rotor efficiency calculations highlight a



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key challenge: small rotors, like those used in Lilium's design, require significantly more power (5 times more in your example) to generate the same thrust as larger rotors, which could strain battery performance and limit range or payload. This inefficiency is a critical factor in assessing Lilium's technological viability: 🖤 🝁

- Flight Testing: Lilium has made progress, with its Phoenix test aircraft achieving full transition from vertical to horizontal flight at 136 knots (250 km/h) by August 2024. The company aims for crewed flights in late 2024 and commercial operations by 2026. 💹 💹 🥍
- Certification: Lilium is working toward FAA validation and EASA certification but is not yet approved to fly commercially in the U.S. or Europe. Regulatory delays remain a significant risk, as certification is critical to generating revenue. 🏹 💹
- Infrastructure: Partnerships with Atlantic Aviation, Galaxy FBO, and EMCJET are in place to develop vertiports and support U.S. market entry, particularly in Texas and Florida. These partnerships enhance Lilium's operational readiness but require further investment. 🌉 🥍

# 4. Market Sentiment and Industry Context

The eVTOL market is projected to grow to \$1 trillion by 2040, driven by demand for sustainable air mobility. Lilium's focus on regional air mobility and its low-noise DEVT technology positions it well for urban and regional transport. A 2024 survey by Lilium found strong consumer interest, with 61% of respondents in the U.S., UK, France, and Germany wanting to try eVTOL aircraft like the Lilium Jet. However: 🝁 🍊 🝁

- Competition: Lilium faces competition from Joby Aviation, Archer Aviation, Volocopter, and others, some of which are further along in certification or have stronger financial backing. For example, Joby and Archer are closer to U.S. certification. Q 🖉 Q
- Investor Sentiment: X posts reflect mixed sentiment. In 2021, some investors were bullish on Lilium's potential, citing its management and partnerships, with a market cap of \$2.5 billion. By 2025, sentiment has soured, with critics highlighting financial losses and lack of a market-ready product.
- Stock Performance: Lilium's stock has declined significantly, losing 13% in the 12 months prior to May 2024 and trading at \$0.9394 in premarket on May 29, 2024, before dropping to \$0.05 by May 2025. This reflects eroding investor confidence. 💷 🖉

# 5. Physics-Based Insights from Your Calculations

Your rotor efficiency calculations underscore a fundamental challenge for Lilium's small-duct design:

- Power Inefficiency: Your example showed that a 4 m<sup>2</sup> rotor requires 325 kW to produce 13,000 N of thrust, compared to 65 kW for a 100 m<sup>2</sup> rotor—a 5x increase in power. This inefficiency translates to higher battery demands, which is critical given Lilium's reliance on high-density silicon-anode lithium-ion batteries. 🔸
- Battery Constraints: The insolvency of CustomCells, Lilium's battery supplier, could exacerbate challenges in achieving the energy density needed to offset the high power requirements of small rotors.
- Range and Payload: The Lilium Jet's initial range is about 110 miles, which is suitable for regional travel but may be limited by the energy inefficiency of its small rotors compared to competitors with larger rotors or different designs (e.g., Joby's multirotor approach). 💹

This inefficiency could increase operating costs or limit mission profiles, reducing Lilium's competitiveness unless mitigated by technological advancements or ducted fan efficiencies not captured in your simplified model.

## 6. Valuation Assessment

Lilium's current market capitalization of \$30.4 million is extremely low for a company in the high-growth eVTOL sector, suggesting that the market perceives significant risks. Key factors affecting its value: #

- Upside Potential:
  - Market Opportunity: The eVTOL market's \$1 trillion potential by 2040 offers significant growth prospects if Lilium can deliver. 🐙

  - Partnerships: Strategic deals with Atlantic Aviation, EMCJET, and Luxaviation Group enhance market access and infrastructure readiness. 💷 🎦
  - Technology: The Lilium Jet's DEVT system and low noise profile are competitive advantages, particularly for urban markets. 🔸
- Downside Risks:
- 53
- Financial Strain: Accumulated losses of € Grok 3 billion and dependency on further funding (€400 🛧 🗍 🕉 🗹 million sought) indicate a high cash burn rate. 🐢
- Supply Chain Issues: CustomCells' insolvency could delay battery development, critical for addressing the high power demands of Lilium's small rotors.
- Regulatory Hurdles: Lack of certification in the U.S. and Europe remains a barrier to revenue generation. V
- Competition: Competitors like Joby and Archer are further along in certification and have stronger financial backing. Q

Given the stock price of \$0.05 and a market cap of \$30.4 million, Lilium is valued as a high-risk, high-reward speculative investment. The low valuation reflects near-term challenges but may undervalue its long-term potential if it achieves certification and secures funding.



## 7. Conclusion



For a precise, real-time valuation, you should check the latest stock price on NASDAQ (LILM) or financial platforms like Yahoo Finance, as prices fluctuate daily. If you'd like me to search for more recent sentiment on X or analyze specific competitors to refine this assessment, let me know!

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