02 / MARKET ANALYSIS

NLT143 RESEARCH

The market for actuators.

TAM, SAM, SOM. Cost curves through 2030. Supply chain map. McKinsey format, public version.

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The thesis

Actuators are the chokepoint of physical AI. Cognition is improving faster than embodiment. Models are not the binding constraint anymore. The binding constraint is whether you can buy enough actuators, at the right specs, at the right price, to put the model in the world. That fact reprices the layer. The actuator market through 2030 is the picks-and-shovels trade for humanoids, autonomous mobility, and the construction labor substitution that follows.

TAM, SAM, SOM

Sources cited: Yole Group humanoid actuator forecast 2024. Valuates Reports robotics market sizing 2024. IDTechEx humanoid robotics outlook 2024. Goldman Sachs humanoid TAM analysis January 2024.

- **TAM.** All motion and force-generating devices in industry, transport, healthcare, consumer products: $200B+ per year by 2030.
- **SAM.** Restricted to actuators above a complexity, intelligence, and force-density threshold relevant to physical AI: $40 to $60B per year by 2030.
- **SOM.** The humanoid robotics actuator slice, the most concentrated and fastest-growing wedge: $9.86B in the 2030 base case, $18B in the bull case.

Forecast, $ billions

Year	Bear · Base · Bull
2024	0.15 · 0.15 · 0.15
2026	0.55 · 0.95 · 1.60
2028	1.70 · 3.60 · 6.20
2030	4.20 · 9.86 · 18.00
2032	7.10 · 17.80 · 38.00
2035	10.80 · 31.20 · 75.00

The cost curve

A humanoid robot in 2024 costs around $150,000 at low volume. The actuator stack accounts for roughly 40 to 55 percent of the bill of materials. By 2030, the modal forecast is for total system cost to drop to $20,000 to $40,000 at scale, with the actuator share declining toward 30 percent. That cost curve only closes if actuator unit volumes ramp into the millions per year. The math is identical to lithium-ion in the 2010s.

Supply chain map

- **China.** Tier-1 BLDC motor manufacturing, harmonic drive production, planetary gearbox specialization. Humanoid OEM concentration in Hangzhou, Shenzhen, Suzhou.
- **Japan.** Specialty harmonic drives (Harmonic Drive Systems), high-precision encoders, robotic motion control IP.
- **Germany and Switzerland.** Maxon, Faulhaber, Nanotec on the high end of BLDC motors. SKF and Bosch Rexroth on linear actuation and servo drives.
- **United States.** Imports almost all high-end BLDC motors and harmonic drives. Strategic gap identified, political will partial, lead time roughly five years per supply chain segment.

The OEM cohort

- **Tesla Optimus.** Vertically integrating actuators in-house. Millions per year by 2030.
- **Figure 02.** BMW pilot live. Custom motor and gearbox pairing.
- **Apptronik Apollo.** Mercedes-Benz manufacturing partner. In-house actuators.
- **Agility Digit.** Amazon and GXO warehouse deployments.
- **Unitree G1, H1.** $16k consumer humanoid. Hangzhou supply leverage.
- **BYD.** Internal humanoid program, EV motor line crossover.
- **AgiBot RAISE A1, A2.** HongShan / Tencent backed.
- **UBTECH Walker S1.** Public on HKEX. NIO, BYD, Foxconn pilots.

Strategic implications

Industrial operators. Treat actuator supply as a strategic input. Single-vendor lock-in is the same exposure as single-source semis was in 2021. Qualify a second source before you need one.

Robotics builders. Vertical integration is now table stakes for cost and IP defensibility. The companies winning own their motors. The ones losing are buying off the shelf and racing on software. Software margins do not pay for hardware that is not under your control.

Capital allocators. The actuator layer is where physical AI economics get decided. Picks-and-shovels framing has a longer half-life than the platforms above it.

Policy makers. Domestic actuator capacity is a national security input. China's humanoid actuator supply chain is two to three years ahead. The CHIPS Act analog for actuators is overdue.