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Thematic investing series

Positioning portfolios for long-term transformational change

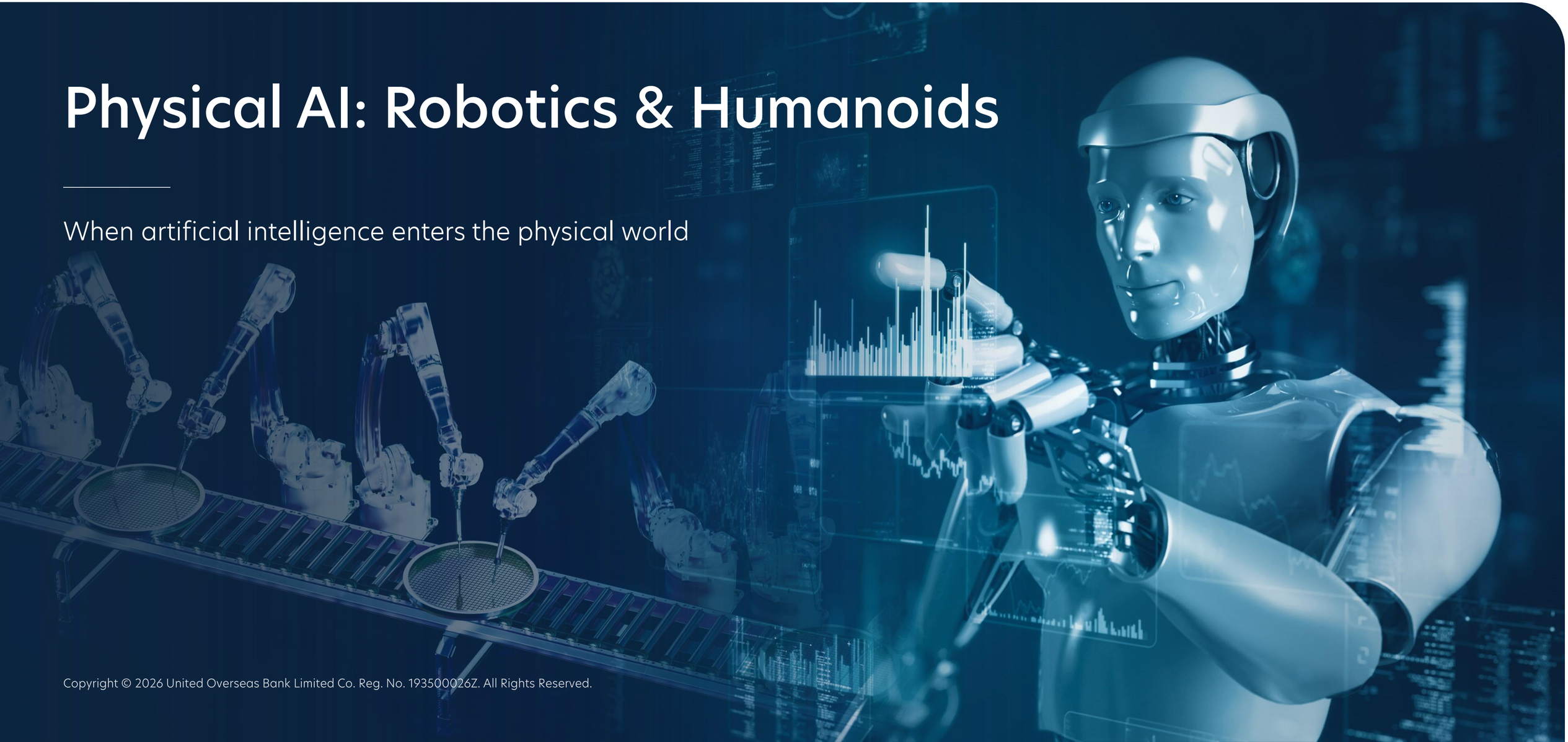
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Physical AI: Robotics & Humanoids

When artificial intelligence enters the physical world



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AI is moving from digital intelligence to physical action

What is Physical AI?

Physical AI combines artificial intelligence, sensors and robotics, allowing machines to perceive, reason and act in the physical world.



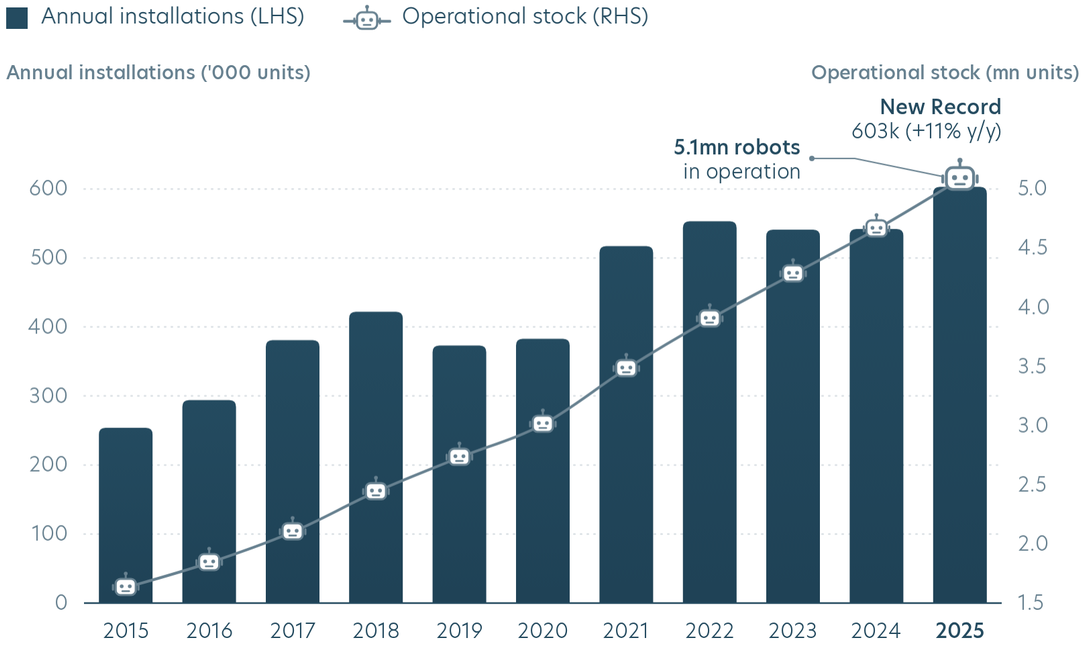
Traditional industrial robots typically follow predefined instructions in controlled environments.



Physical AI adds greater perception, adaptability and decision-making, enabling machines to handle more varied tasks and changing conditions.

Global industrial robot installations and operational stock

2015–2025



The installed base for industrial robots has more than tripled since 2015, providing a commercial foundation for physical AI.

Source: IFR World Robotics Reports (2022–2026). 2025 installations were a record 603k (+11% y/y).

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Physical AI turns perception into action

1 Perceive

- Identifies objects, movement and operating conditions
- Motion sensors, cameras and light detection and ranging (LiDAR)

2 Reason

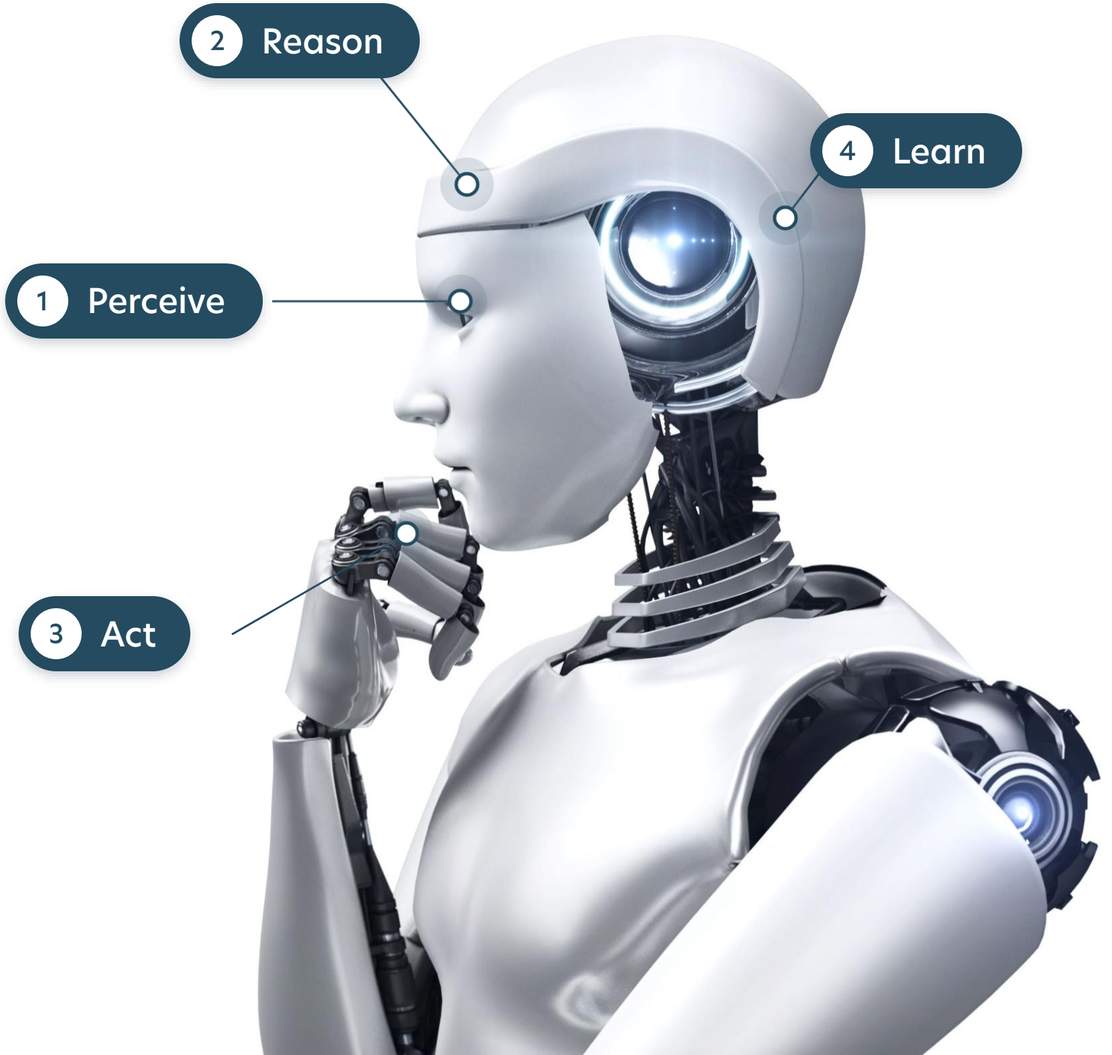
- Artificial intelligence models interpret the environment
- Plans actions and responds to unexpected changes

3 Act

- Converts digital decisions into physical activity
- Motors, actuators, grippers and mobile systems

4 Learn

- Simulation-based AI training on unpredictable processes and new environments



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Why now? Four forces are converging

Each driver is credible alone. Together, they improve the probability of commercial scale.

1



AI capability

Vision-language-action models and world models improve perception, reasoning and task execution.

2



Labour scarcity

Ageing workforces and hard-to-fill industrial roles strengthen the automation incentive.

3



Hardware deflation

Cheaper compute, actuators and components lower the economic threshold for deployment.

4

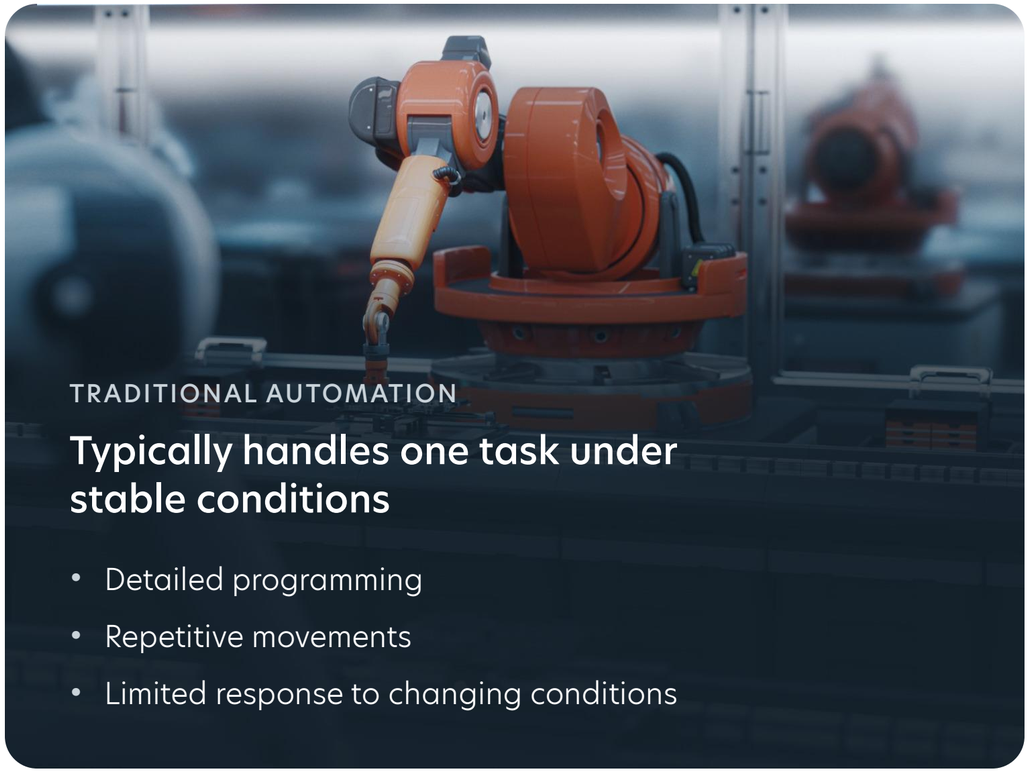


Operational data

More pilots create proprietary real-world data, improving performance and reinforcing adoption.

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AI's capability has improved significantly



TRADITIONAL AUTOMATION

Typically handles one task under stable conditions

- Detailed programming
- Repetitive movements
- Limited response to changing conditions



PHYSICAL AI

More flexible to change, multitasking is possible and responds intelligently to changes in conditions

- Learns from demonstrations and data
- Interprets language and visual information
- Potentially adapts through software

INSIGHT

The first major commercial breakthrough may come from smarter existing machines rather than humanoid robots.

An ageing workforce is reinforcing demand for automation

3.8m

Workers aged 55 or older

43.9 years

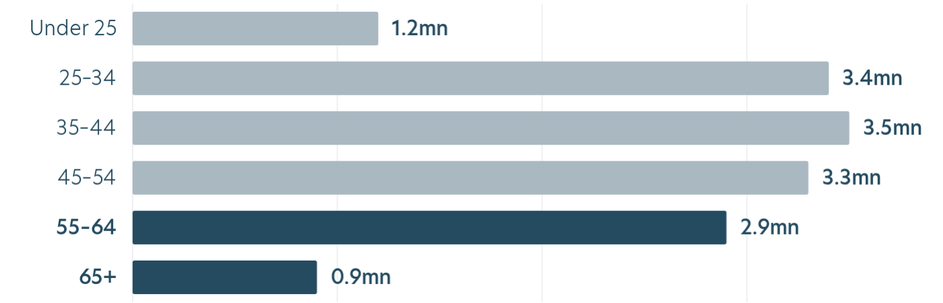
Median age of the manufacturing workforce

INSIGHT

Retirement exposure and a narrow younger-worker pipeline increase the need to preserve output with fewer available workers.

US manufacturing employment by age group, 2025

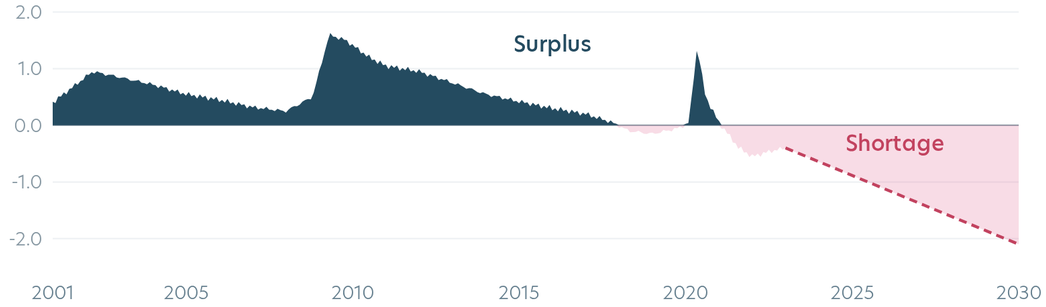
Employed workers (m)



Source: US Bureau of Labor Statistics, Current Population Survey, annual averages for 2025 (excluding October).

US manufacturing labour surplus/(shortage)

Million people, 2001-2030



Falling robot costs could bring commercial adoption closer

Demand-side incentive

High wages and worker shortages raise the potential value of automation, especially where labour availability constrains production.

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Supply-side enabler

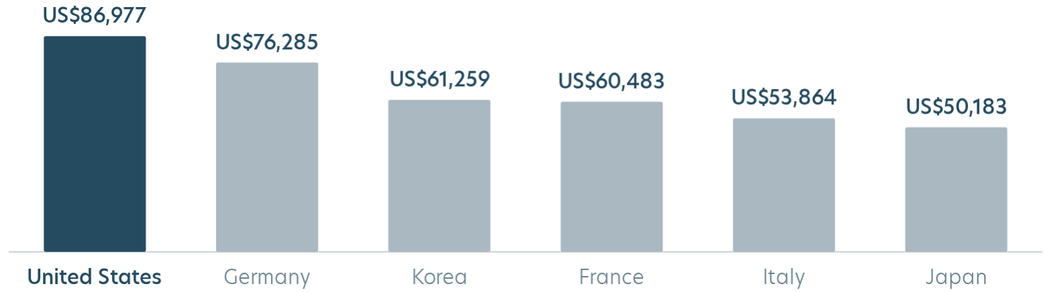
Lower component costs and manufacturing scale could reduce robot prices and shorten payback periods.

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Together, high labour costs and hardware deflation bring selected physical AI applications closer to commercial viability.

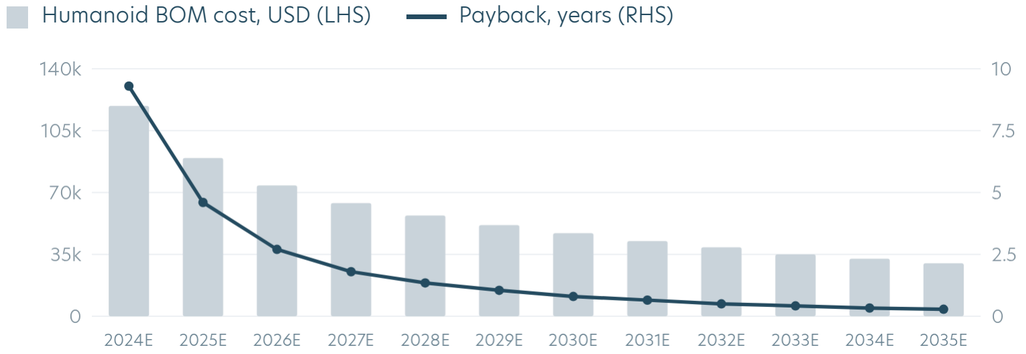
Average annual wages across selected developed economies, 2025

USD, PPP, 2025 prices



Source: OECD Average Annual Wages dataset

Cost and payback estimates for high-spec robots

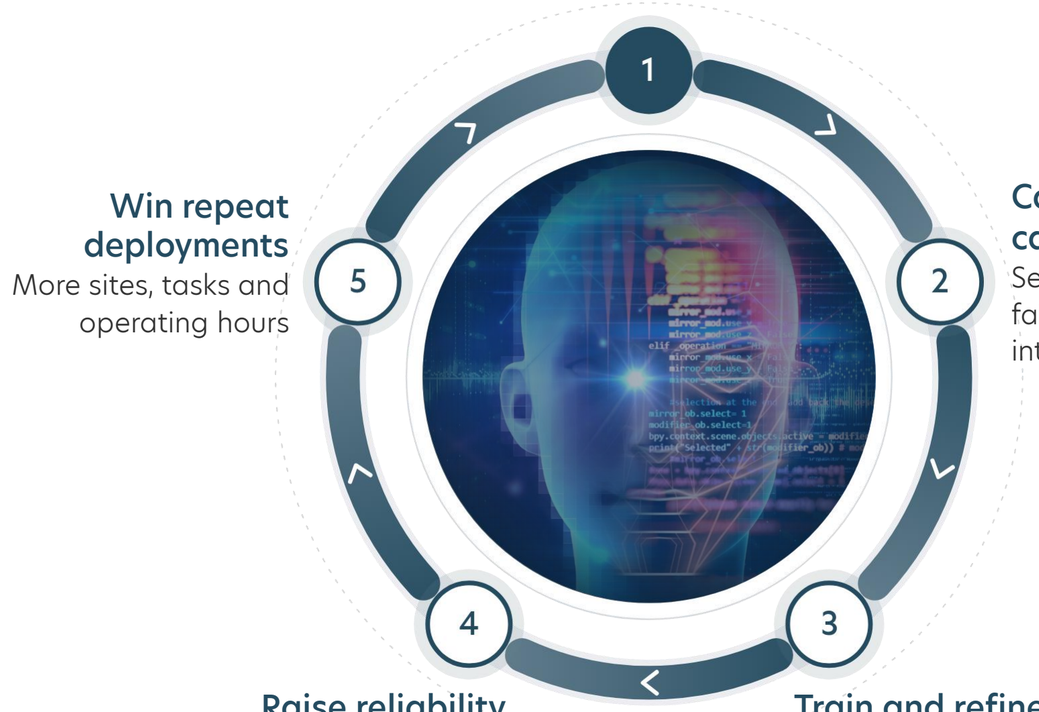


Source: Company data, GS estimates

Real-world deployment will create a physical AI data flywheel

Why real-world deployment matters

- Real-world edge cases are difficult to recreate fully in simulation.
- Deployment data can improve models and operating workflows.
- Better reliability can reduce supervision and integration costs.
- Fleet-wide learning can support repeat orders and wider adoption.



Continue the Physical AI Conversation

Physical AI could eventually transform industries such as manufacturing, logistics and healthcare, but widespread adoption remains in its early stages. The full publication explores where future value may accrue, which milestones matter most, and how investors can distinguish technological progress from investable opportunity.



Focus on commercial proof

Widespread adoption requires reliable deployment and clear economic value.



Look beyond Humanoids

Opportunities can extend beyond humanoid robots to the broader Physical AI ecosystem.



Manage expectations

Valuations, uncertain adoption timelines and execution risks are important considerations.

In the full publication

- Maturity framework and timing assessment
- Value-chain opportunity map
- Bull, base and bear scenario analysis
- Key risks across regulatory, clinical and commercialization risks
- Portfolio implementation considerations

Speak to your Senior Client Advisor for the full Physical AI thematic publication

Learn More

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