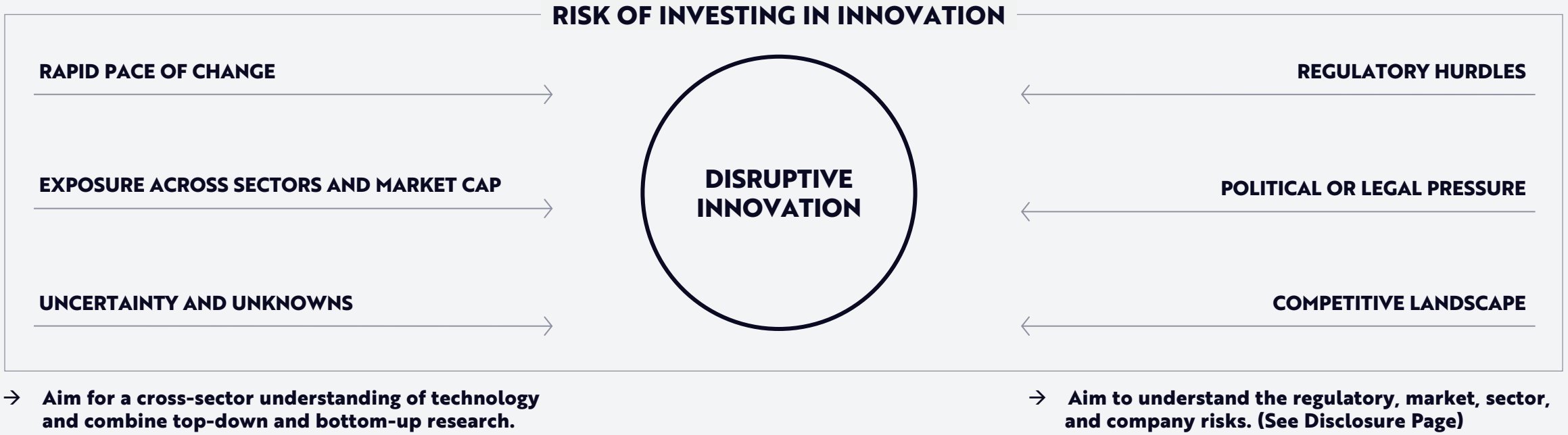
ARK INVEST

BIG IDEAS 2025

Risks Of Investing In Innovation

Please note: Companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so. ARK aims to educate investors and seeks to size the potential investment opportunity, noting that risks and uncertainties may impact our projections and research models. Investors should use the content presented for informational purposes only, and be aware of market risk, disruptive innovation risk, regulatory risk, and risks related to certain innovation areas.

Please read risk disclosure carefully.



Sources: ARK Investment Management LLC, 2023.

Table Of Contents

BIG IDEAS 2025

Unlocking Exponential Growth Through Disruptive Innovation

As we stand on the cusp of a new era of unprecedented growth, ARK Invest's "Big Ideas 2025" illuminates the complex convergences between and among the five technologically enabled innovation platforms evolving today: Artificial Intelligence, Robotics, Energy Storage, Public Blockchains, and Multiomic Sequencing. These platforms should drive exponential advances across industries and catalyze a step change in global economic growth.

Presented in this year's report are 11 Big Ideas illustrating the massive transformations occurring today. Our research suggests that these Big Ideas are poised to boost productivity dramatically, to revolutionize industries, and to create long-term investment opportunities.

Join our journey into the future of innovation and its profound implications for investors, businesses, and society at large.

Welcome to ARK's Big Ideas 2025.

The Second Half Of The Chessboard

Convergence Among Technology Platforms Leading To Significant Acceleration In Macroeconomic Growth

Brett Winton
CHIEF FUTURIST

Five Innovation Platforms Are Catalyzing Accelerated Growth

Public Blockchains

Upon large-scale adoption, all money and contracts will likely migrate onto Public Blockchains that enable and verify digital scarcity and proof of ownership. The financial ecosystem is likely to reconfigure to accommodate the rise of **Cryptocurrencies** and **Smart Contracts**. These technologies increase transparency, reduce the influence of capital and regulatory controls, and collapse the costs of contract execution. In such a world, **Digital Wallets** will become increasingly necessary as more assets become money-like and corporations and consumers adapt to the new financial infrastructure. Corporate structures may be called into question.

AI

Computational systems and software that evolve with data can solve intractable problems, automate knowledge work, and accelerate technology's integration into every economic sector. The adoption of **Neural Networks** should prove more momentous than electrification and potentially create tens of trillion dollars of value. At scale, these systems will require unprecedented computational resources, and AI-specific compute hardware should dominate the **Next Gen Cloud** datacenters that train and operate AI models. The potential for end-users is clear: a constellation of AI-driven **Intelligent Devices** that permeate people's lives, changing the way that they spend, work, and play. The adoption of artificial intelligence should transform every sector, impact every business, and catalyze every innovation platform.

Multiomics

The cost to gather, sequence, and understand digital biological data is falling precipitously. **Multiomic Technologies** provide research scientists, therapeutic organizations, and health platforms with unprecedented access to DNA, RNA, protein, and digital health data. Cancer care should transform with pan-cancer blood tests. Fed by rich multiomic data and powered by **Programmable Biology**, AI systems running autonomous labs could collapse the cost of drug discovery, development, and trial, transforming returns in a sector that has stagnated. Biological discoveries should power novel **Precision Therapies** that target and cure rare diseases and chronic conditions, unlocking profound economics. Over time, the design and synthesis of novel biological constructs will yield advances in agriculture, material science, and even computation.

Energy Storage

The declining costs of **Advanced Battery Technology** should cause an explosion in form factors, enabling **Autonomous Mobility** systems that collapse the cost of transportation. Electric drivetrain cost declines should unlock micro-mobility and aerial systems, including flying taxis, enabling business models that transform cities. Autonomy should reduce the cost of taxi, delivery, and surveillance by an order of magnitude, enabling frictionless transport that will increase the velocity of e-commerce and make individual car ownership the exception rather than the rule. These innovations combined with large-scale stationary batteries and **Distributed Energy Generation**, notably solar and small-scale fission, should cause a transformation in energy, substituting electricity for liquid fuel and increasing system-wide resilience, reliability, and production.

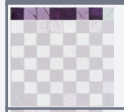
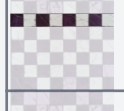
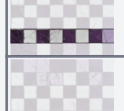
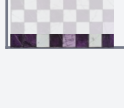
Robotics

Catalyzed by artificial intelligence, **Humanoid Robots** should operate alongside humans and navigate legacy infrastructure, changing the way products are made and sold, and eventually the way we live our lives at home. **3D Printing** should contribute to the digitization of manufacturing, increasing not only the performance and precision of end-use parts, but also the resilience of supply chains. Meanwhile, the world's fastest robots, **Reusable Rockets**, should continue to reduce the cost of launching satellite constellations and enable uninterruptible connectivity and earth observation. A nascent innovation platform, robotics could collapse the cost of transporting across distance, with hypersonic travel, the cost of manufacturing complexity with 3D printers, and the cost of physical work with AI-guided robots.

In Compounding, The Real Action Takes Place On The Second Half Of The Chessboard

Legendarily requesting his reward for inventing chess, the 6th century advisor to the Indian ruler:

I don't require much, your highness, just a grain of wheat on the first square of the board, doubling consecutively on each square thereafter.

Row	2^X	Wheat Grains	Value	Year Computers Crossed The Same Compounding Threshold
	8	128	2 teaspoons of wheat	1975
	16	65 thousand	9 loaves of bread	1983
	24	17 million	4 year's sustenance	1998
	32	4 billion	7 pounds of gold	2008
	**40**	**1 trillion**	**1 ton of gold**	**2018**
	**48**	**300 trillion**	**20% of India GDP in 600 AD**	**2023**
	**56**	**70 quadrillion**	**50x Global GDP in 600 AD**	**2027e**
	**64**	**18 quintillion**	**9x Global GDP in 2024**	**2030e**

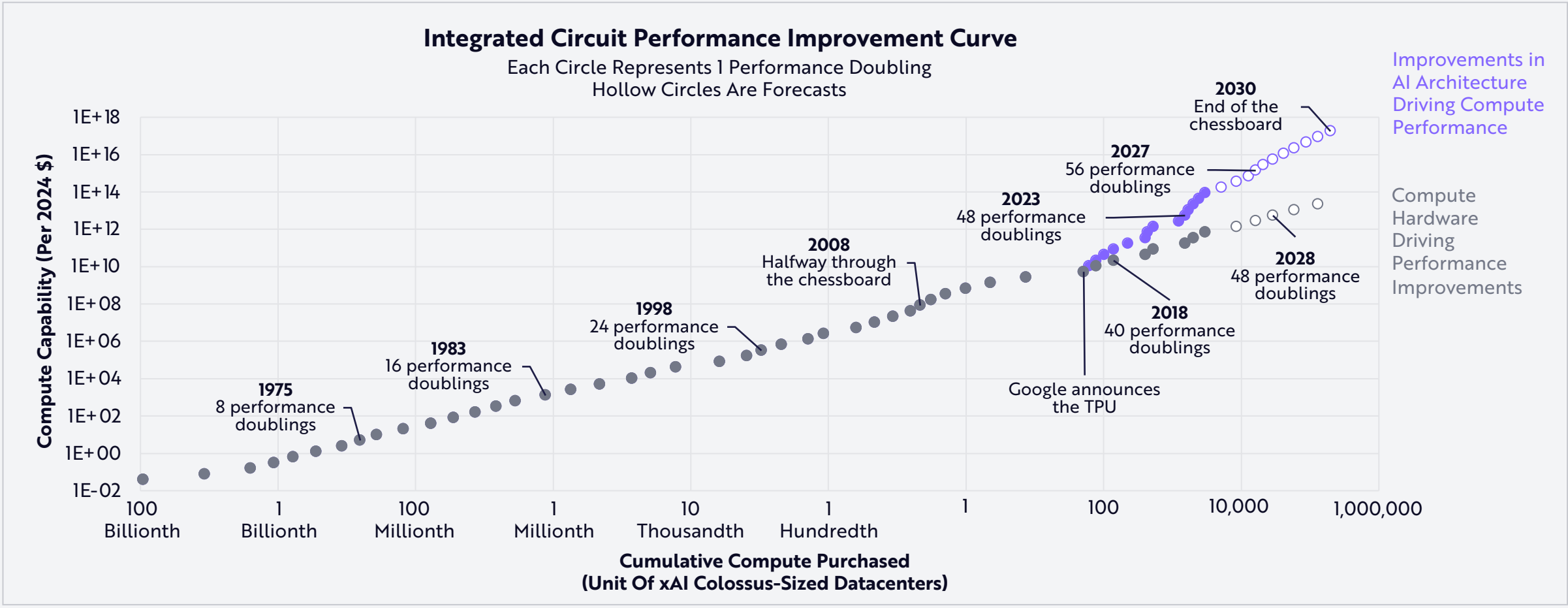
By lore, when he agreed to the reward, the Indian ruler thought it quite reasonable. By the 6th row of the chessboard, however, he had exhausted India's treasury, having paid just ~.001% of the bill.

Today, computational advance has completed the equivalent of the 6th row on the chessboard. Entering the AI cycle in 2018, computers had crossed 40 performance doublings and in 2023 surpassed 48. By the end of this decade, thanks to the acceleration in AI, computation could reach the end of the chessboard.

Note: "GDP": Gross Domestic Product, aggregate global production for the global datapoints. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, Kurzweil 2006 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Is Accelerating The Performance Doubling Rate, Closing In On The End Of The Chessboard

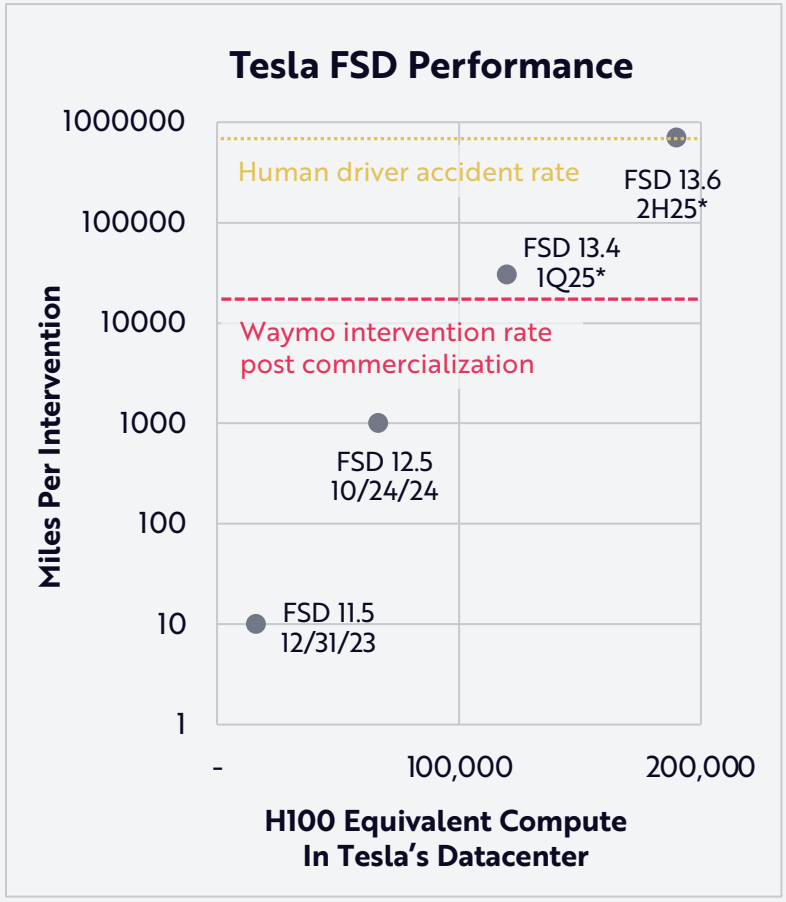
Enabled primarily by architectural improvements in AI systems, performance per dollar of AI compute is expected to improve >1000x by 2030. At that time, we expect that compute performance will have doubled 64 times since the advent of the integrated circuit.

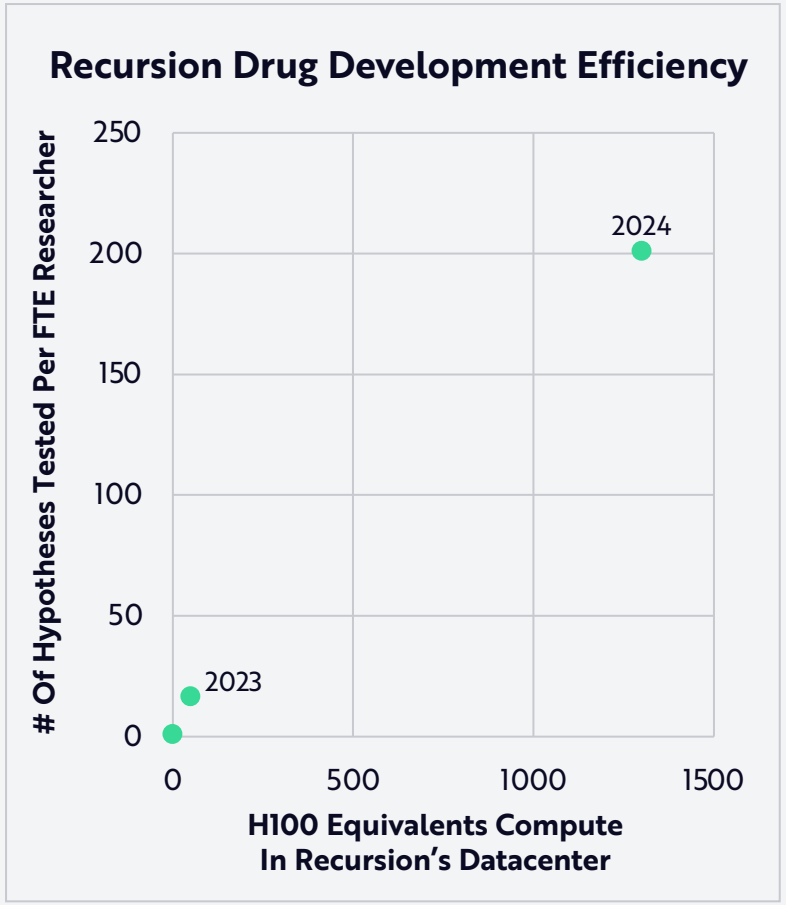


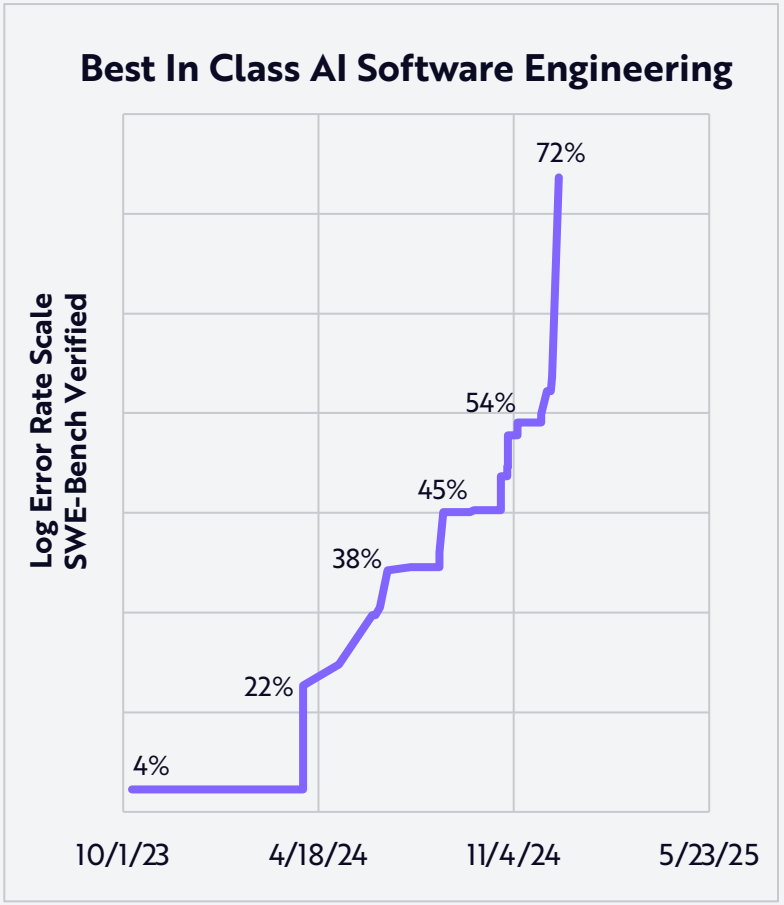
Note: The "Compute Capability per $2024 Dollar" displayed on the Y axis above is a single metric that measures 1000s of computations per second purchasable for $1. For AI compute performance, computational impact is adjusted upwards by the rate of AI architectural performance per dollar improvements according to ARK's research. It's a very large number, so we use scientific notation, e.g., "1E+21," meaning 1 followed by 21 zeros. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Kurzweil 2005 and Jurvetson 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Advances Should Unlock Massive Market Opportunities

As AI continues to accelerate, robotaxis should proliferate, drug development timelines and costs should collapse, and AI agents should solve software engineering challenges autonomously, monitoring and modifying systems around the clock.





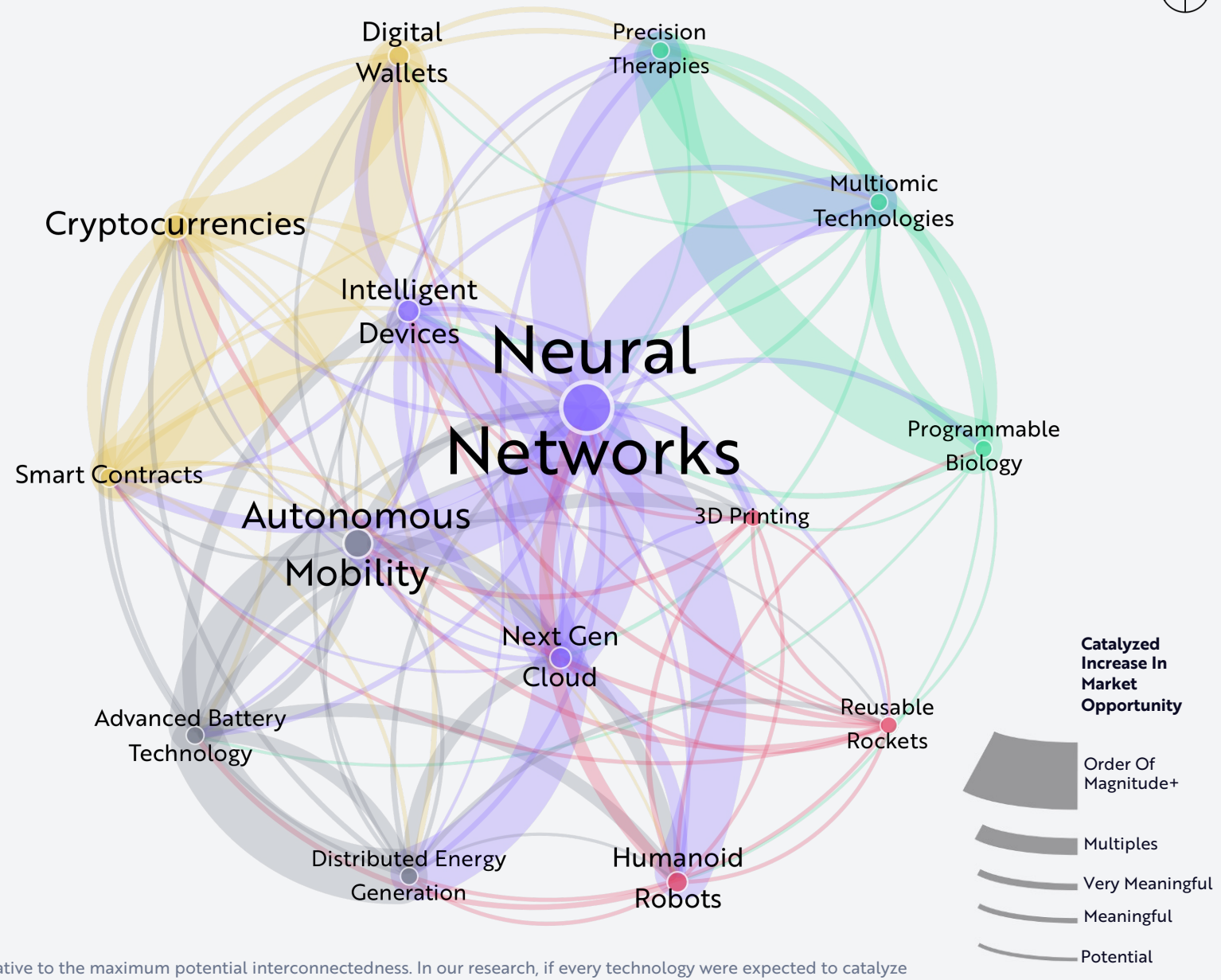


*Estimates. Note: "FSD": Full Self-Driving. SWE-bench is a dataset that tests systems' ability to solve GitHub issues automatically. The dataset collects 2,294 Issue-Pull Request pairs from 12 popular Python repositories. Evaluation is performed by unit test verification using post-PR behavior as the reference solution. See Jiminez et al. 2024. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Tesla, Recursion, and SWEbench.com, and OpenAI as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Convergence Is Accelerating The Technology Revolution

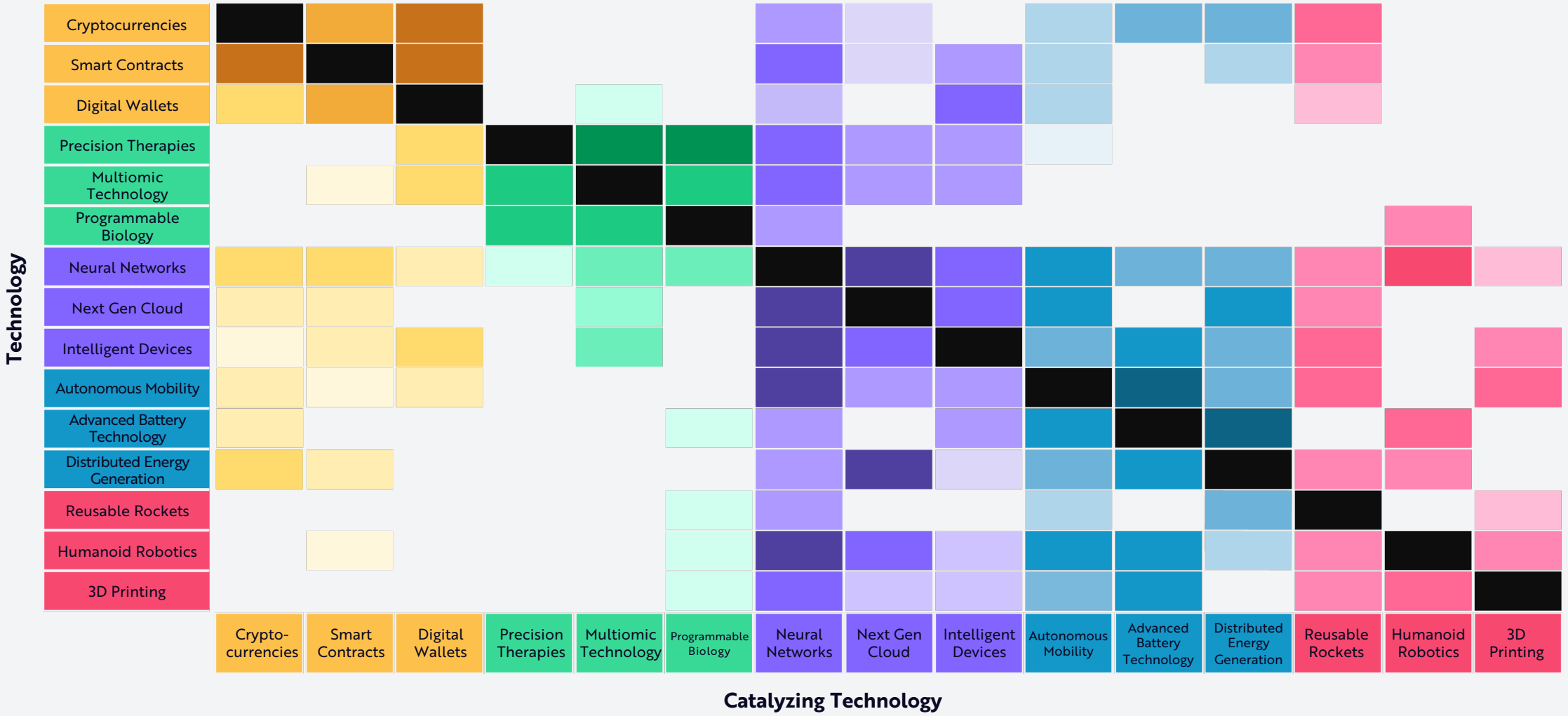
ARK measures the degree to which technologies serve as catalysts between and among innovation platforms. The convergences among them are increasing, with network density up 30% in the past year.

AI is proving more critical to unlocking the value of **Precision Therapies** and **Multiomic Technologies**. **Smart Contract** ecosystems are serving as test beds in which autonomous **AI** agents can be renumerated for sharpening their capabilities. **Next Gen Cloud** energy demand is pulling forward timelines for **Distributed Energy Generation**.



Note: "Network density" measures the degree of interconnectedness between nodes relative to the maximum potential interconnectedness. In our research, if every technology were expected to catalyze another technology to increase in value by an order of magnitude or more, that would equate to a fully interconnected network. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

The Acceleration In Neural Networks Is Accelerating Every Other Disruptive Technology



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

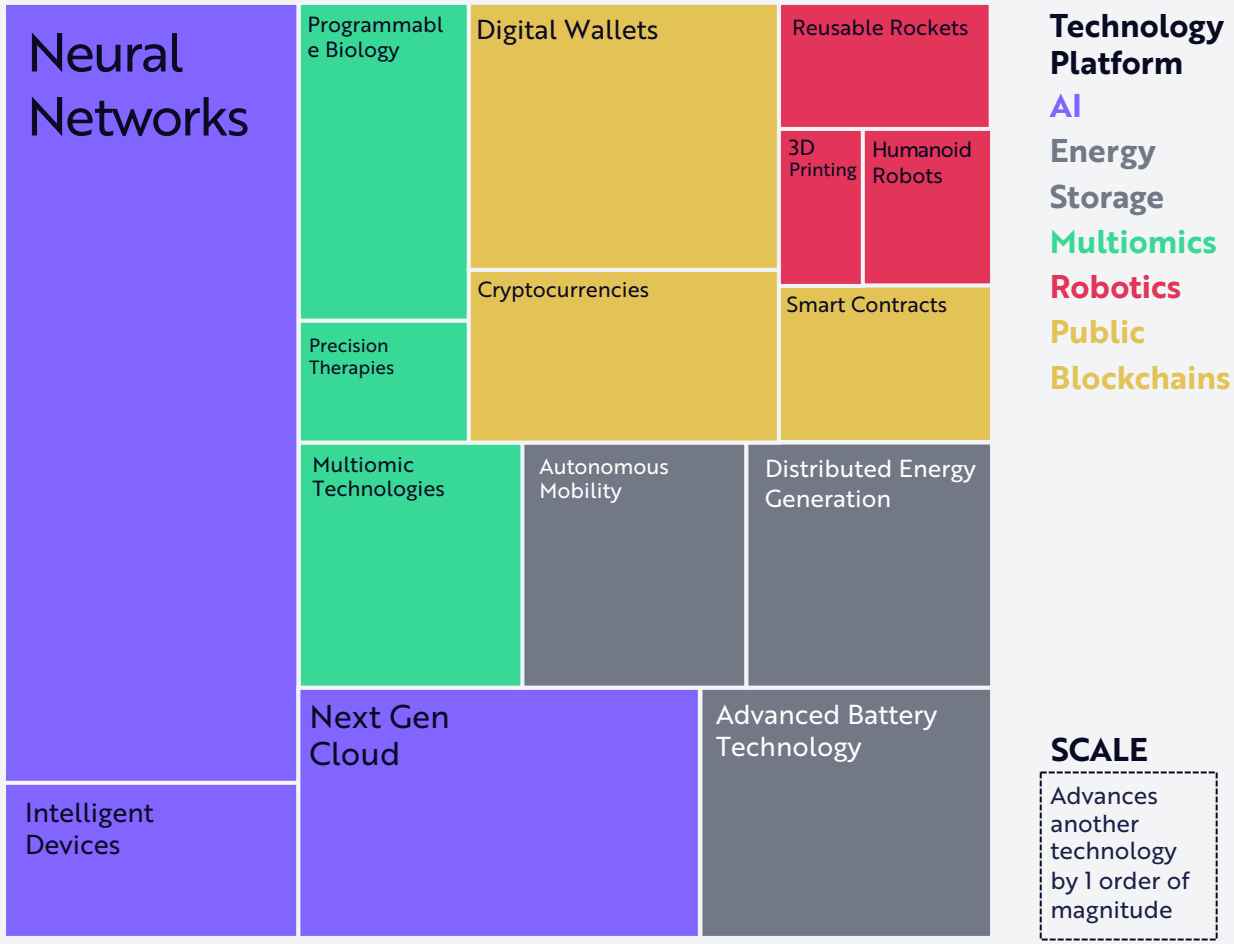
Advances In AI, Energy Storage, And Public Blockchains Are Critical To The Pace Of Technological Advance

Among disruptive technologies, **Neural Networks** are the most important catalyst.

According to our research, advances in neural networks will increase the value of six of the other 14 technologies by at least an order of magnitude, creating massive market expansions for **Next Gen Cloud**, **Intelligent Devices**, **Autonomous Mobility**, **Humanoid Robots**, **Precision Medicine**, and **Multiomic Technology**.

The AI-led revolution in technology is likely to lead to dramatic productivity gains and a step-function increase in economic growth.

Technology Importance As A Catalyst



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Technology Inflection Should Lead To GDP Inflection

Structural changes in the underlying rate of macroeconomic growth are the historical rule, not the exception.

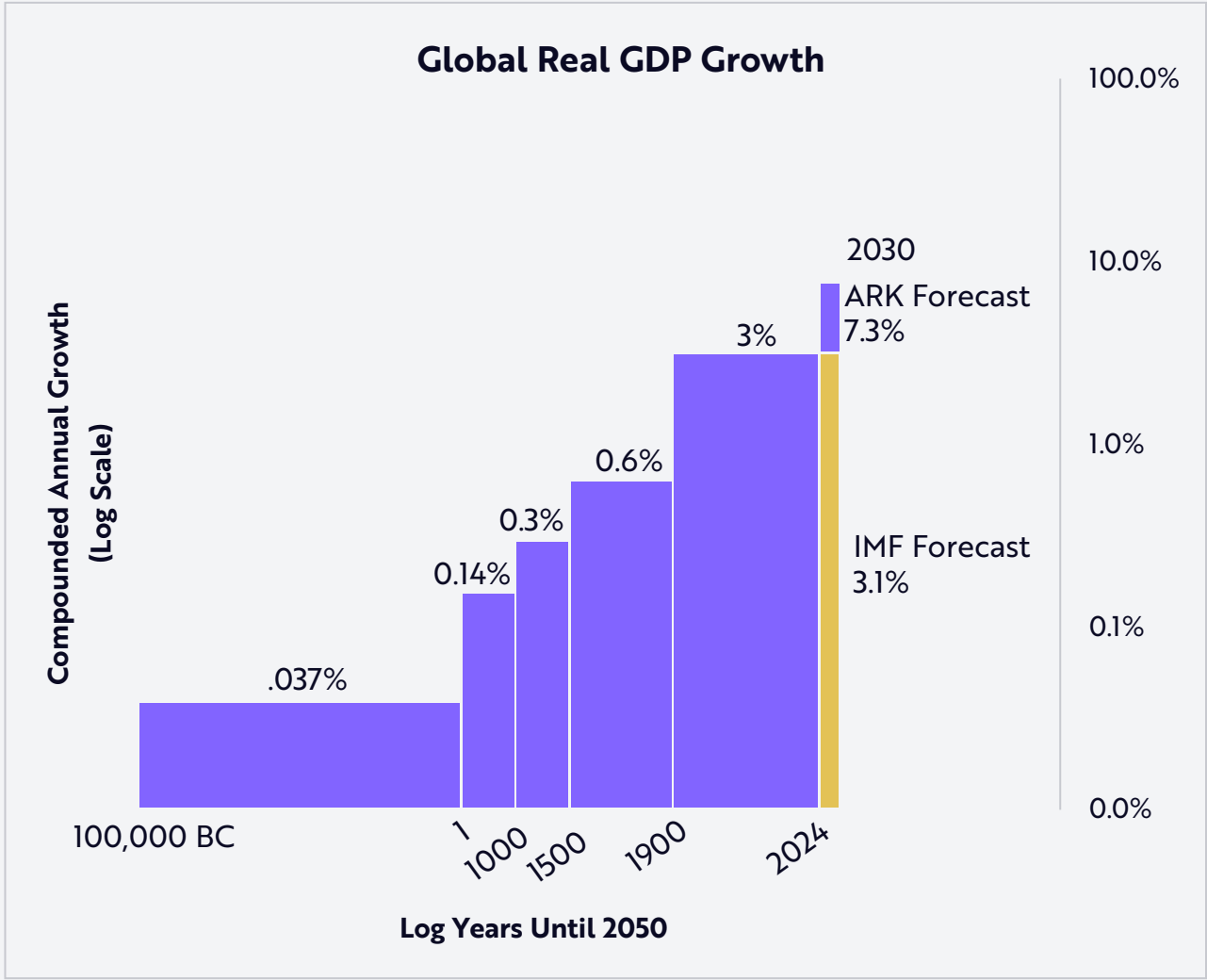
After 100,000 years of economic stagnation leading to year 1, innovations, notably writing, allowed empires to stitch together continents, which quadrupled real growth through 1000 AD.

Agricultural innovations enabled denser populations and labor specialization, leading to a doubling of growth through 1500 to 0.3% per annum.

During the 400 years through 1900, annual GDP growth doubled again to 0.6% as the Enlightenment and Industrial Revolution swept the globe.

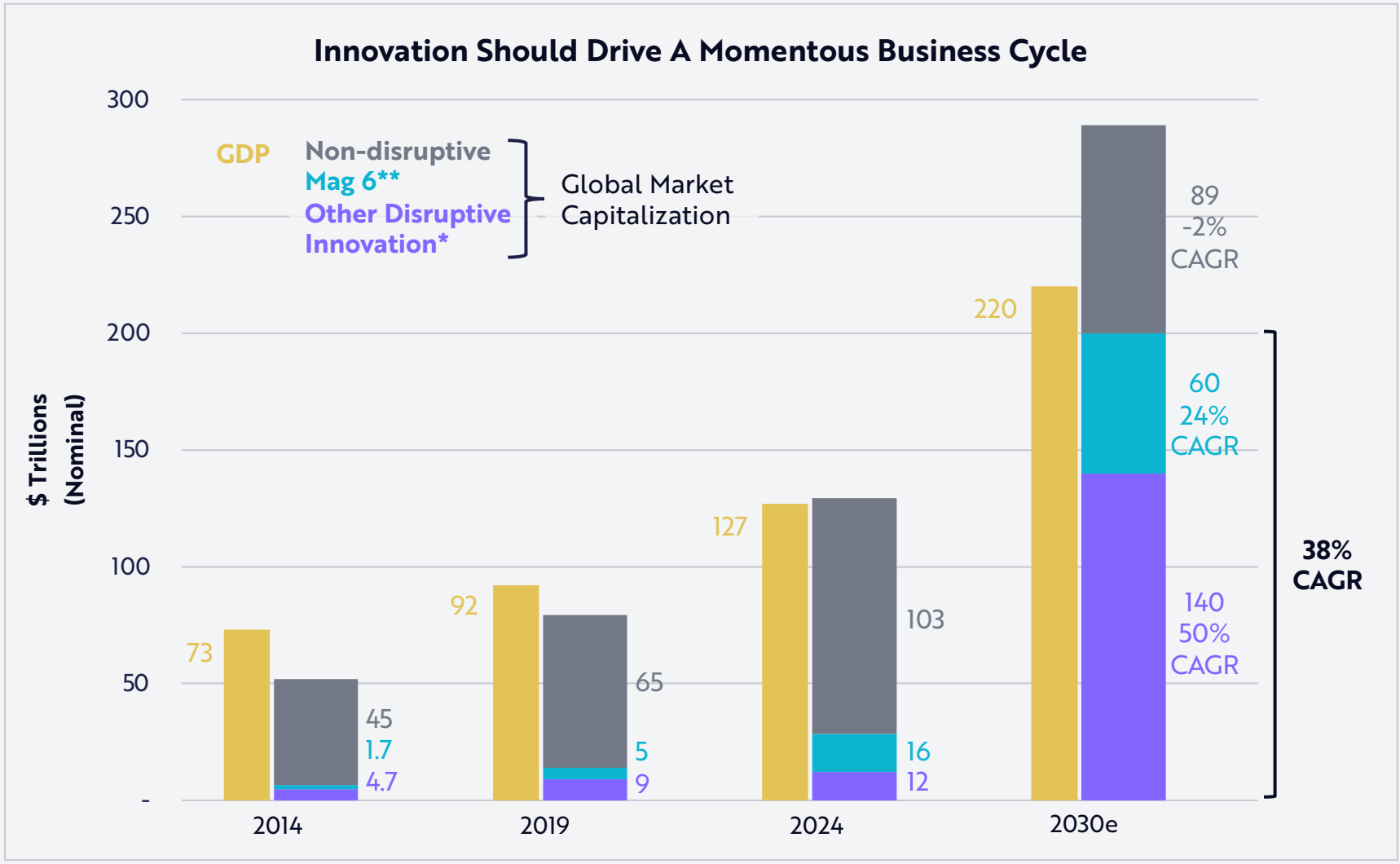
The Second Industrial Revolution—marked by electrification, the automobile, and telephony—ushered in the modern age and quintupled growth to 3% on average over the last 125 years.

Technological breakthroughs in **AI**, **Autonomous Mobility**, and **Humanoid Robots** are likely to turbocharge productivity again, causing another step function in growth over the next 5 to 10 years.



Note: "Real GDP": Aggregate Global Production adjusted for changes in price levels. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources including DeLong 1998 and Open Philanthropy as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Disruptive Innovation Could Grow To Dominate Markets



Disruptive innovation could command more than two-thirds of the global equity market, compounding at a 38% rate through 2030.

Within innovation, market value could broaden out beyond the so-called Mag 6.

Non-innovation businesses could begin to shrink as technological deflation associated with innovation threatens margins and competitiveness, even amid rapid macroeconomic growth.

Note: "CAGR": Compounded Annual Growth Rate. *We include cryptocurrencies and crypto assets in disruptive innovation capitalization. **Microsoft, Nvidia, Meta, Apple, Amazon, and Alphabet. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Agents

Redefining Consumer Interactions And Business Workflows

Nicholas Grous
ASSOCIATE PORTFOLIO MANAGER

Varshika Prasanna
RESEARCH ASSOCIATE, NEXT GENERATION INTERNET

Frank Downing
DIRECTOR OF RESEARCH, NEXT GENERATION INTERNET

Jozef Soja
RESEARCH ANALYST, NEXT GENERATION INTERNET

What Are AI Agents?

AI agents are poised to accelerate the adoption of digital applications and create an epochal shift in human-computer interaction.

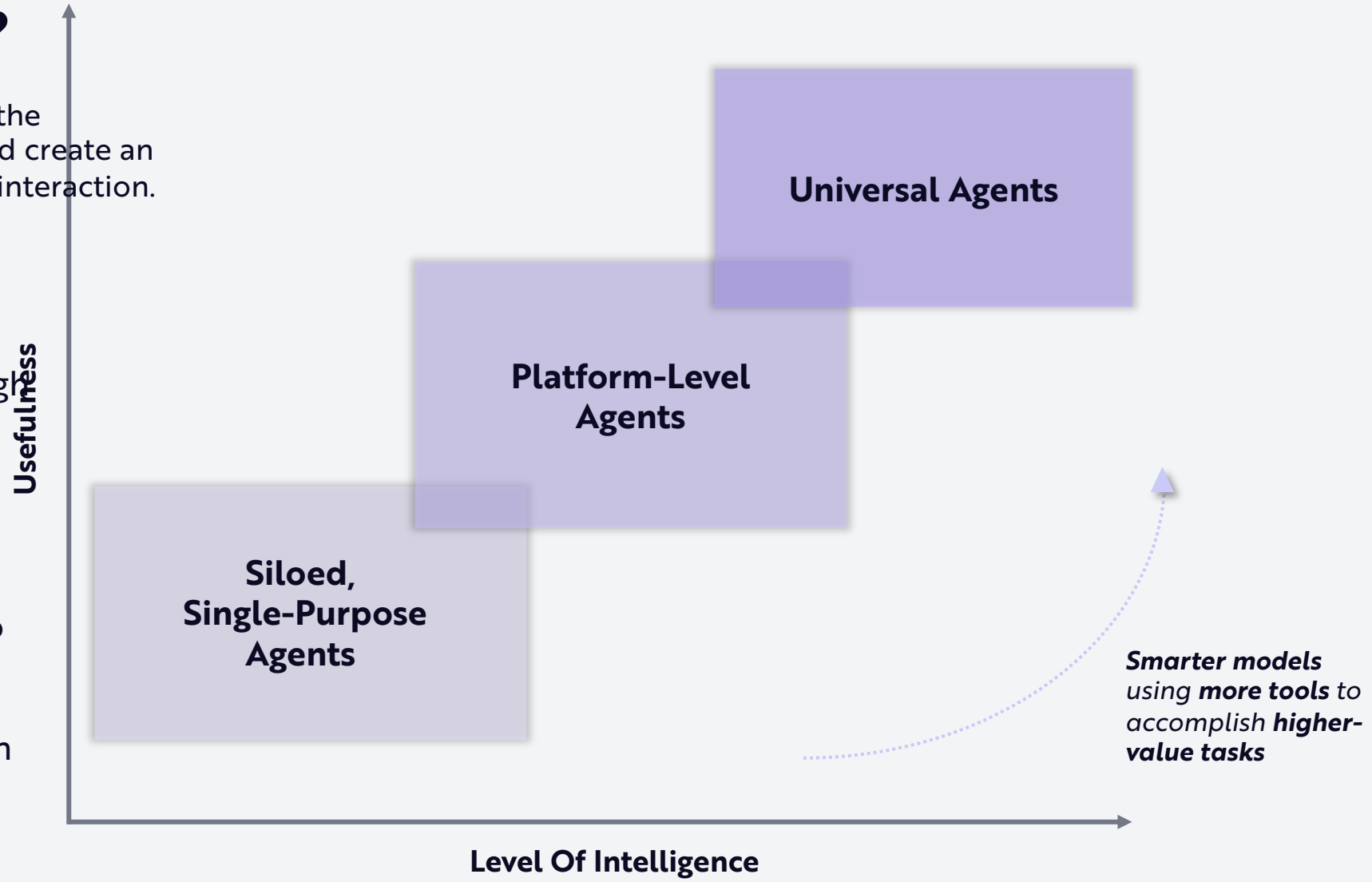
AI Agents:

Understand intent through natural language

Plan using reasoning and appropriate context

Take action using tools to accomplish the intent

Improve through iteration and continuous learning

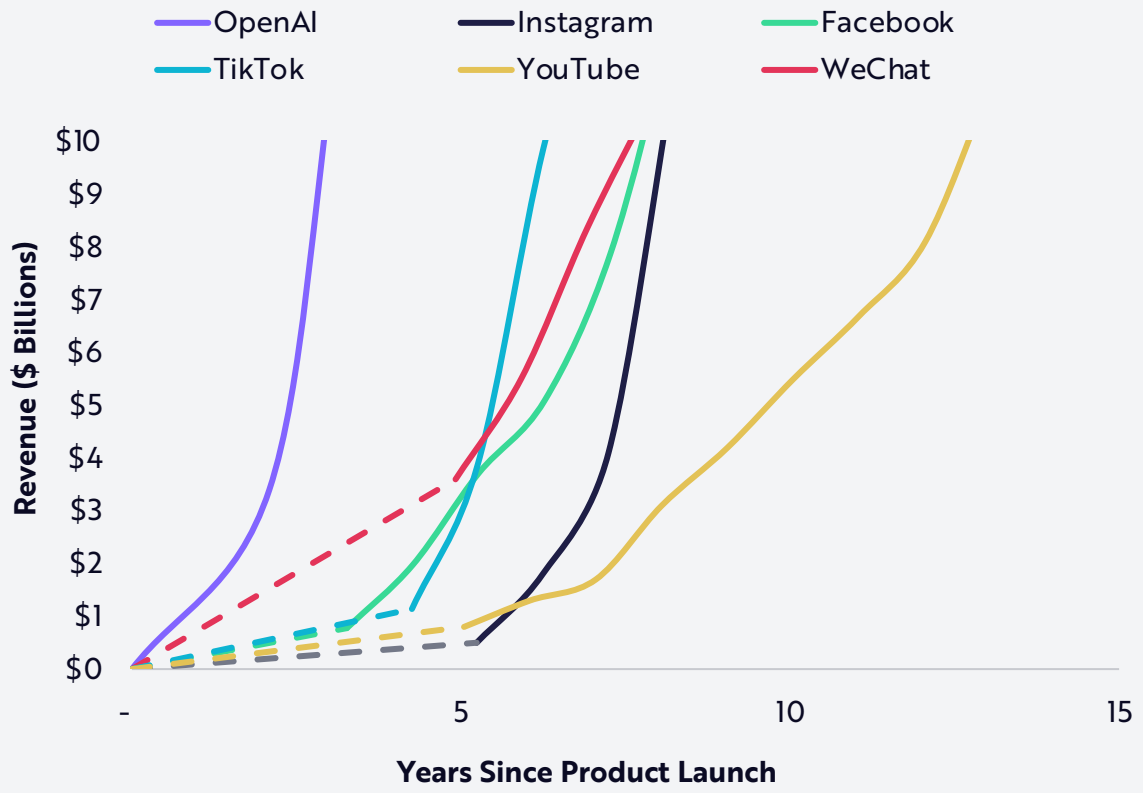


Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

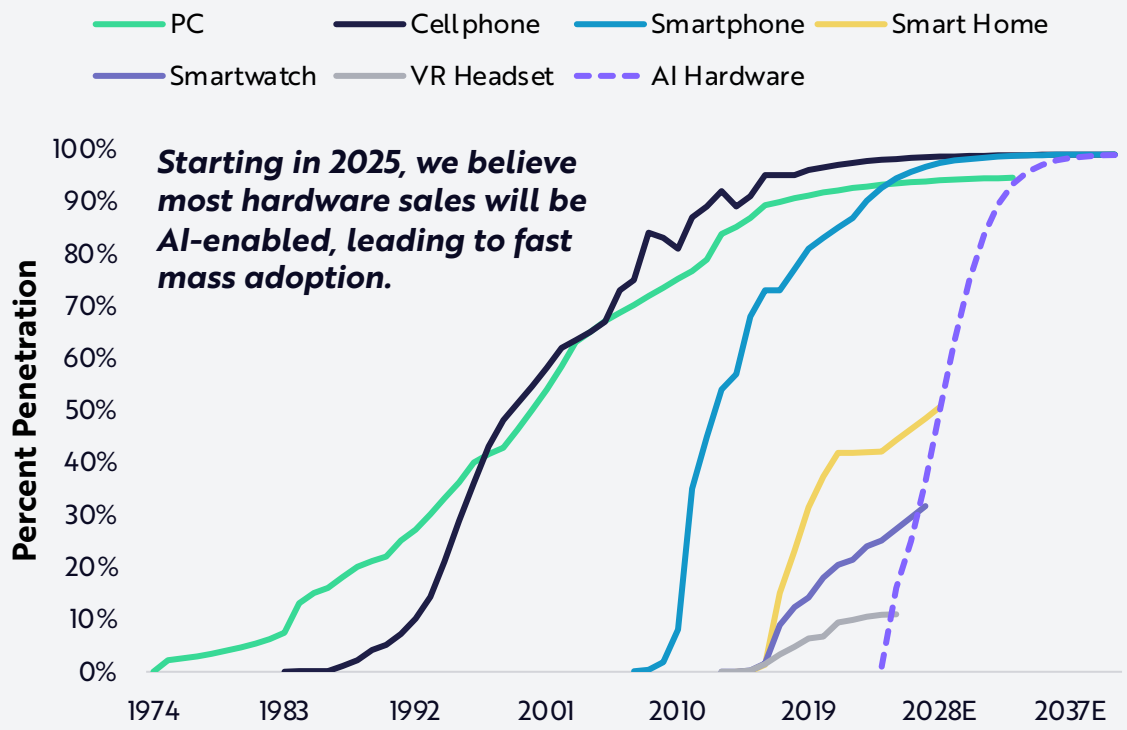
AI Is Accelerating The Adoption of Hardware And Software

OpenAI could surpass $10 billion in revenue in 2025, monetizing at a faster rate than social media companies over the past decade. If the adoption of ChatGPT is an indicator, AI should drive rapid demand for a range of new technologies.

AI Monetization Is Outpacing Social Media



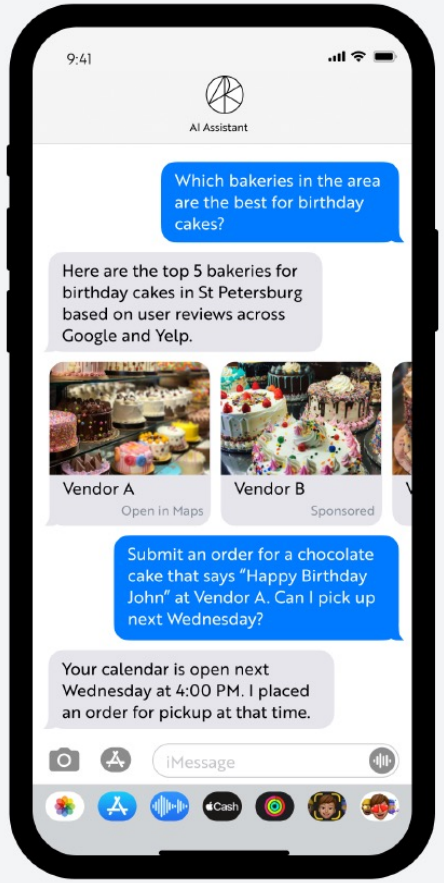
US Consumer Hardware Adoption

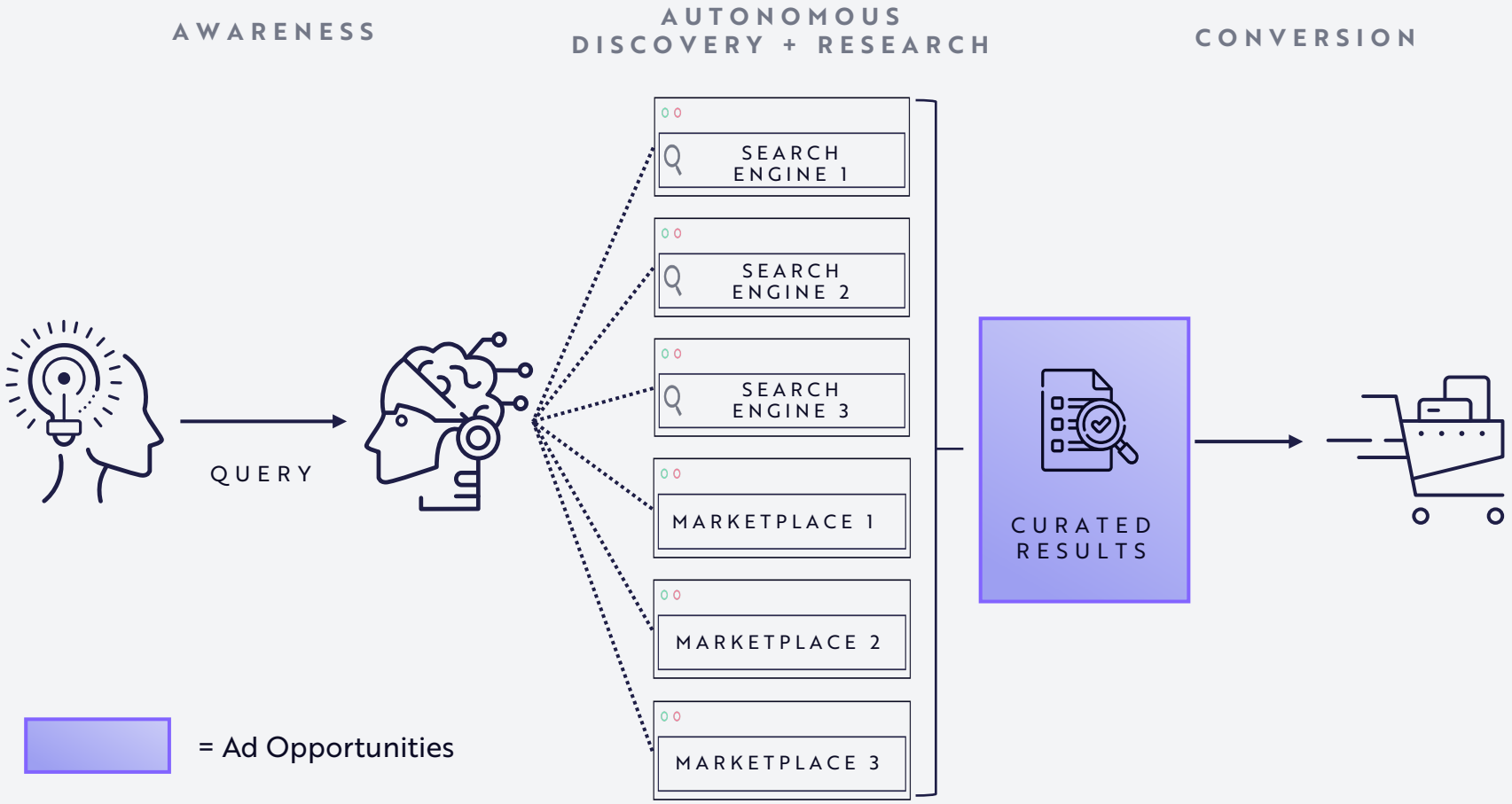


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Hartig 1998, Dediu 2017, and Sidoti et al. 2024, as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Agents Will Transform Consumer Search And Discovery

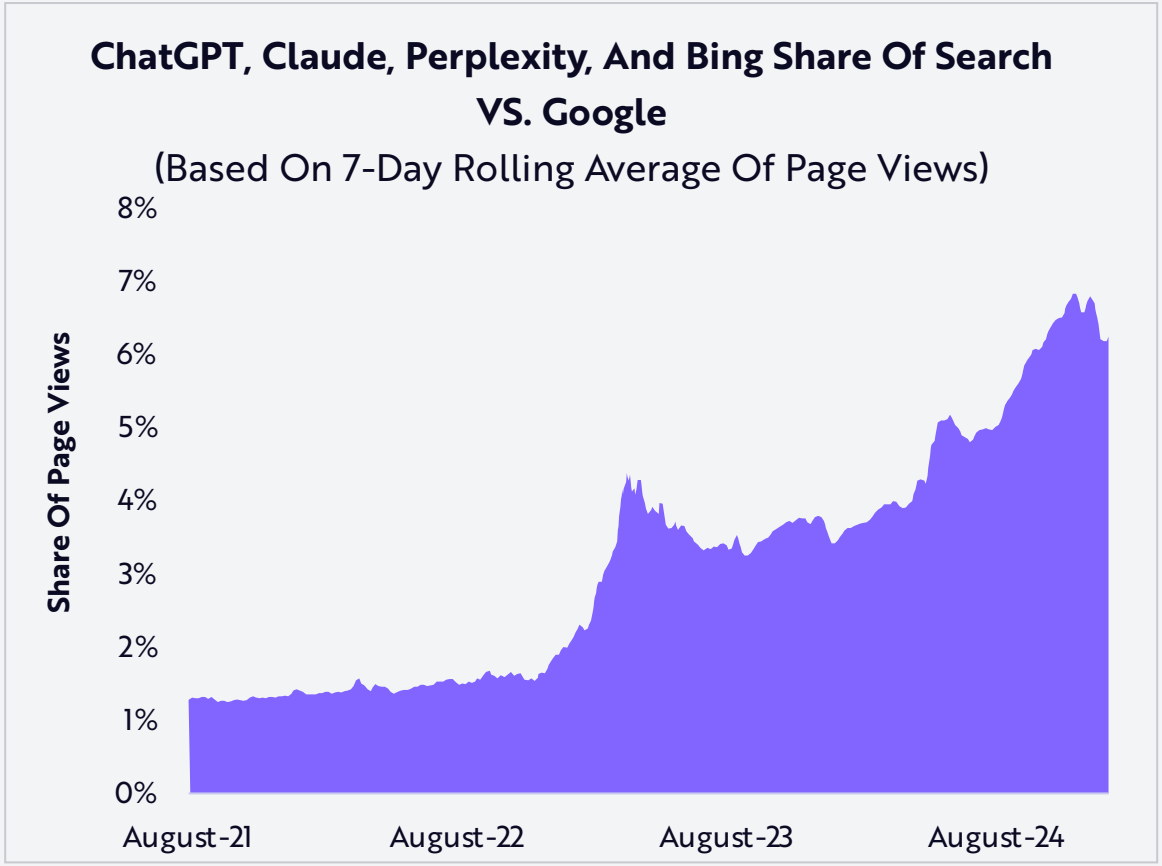
Embedded in the operating systems of consumer hardware, AI agents empower consumers to delegate all discovery and research to AI—a massive time-saver. Curated AI results will contextualize digital ad impressions.

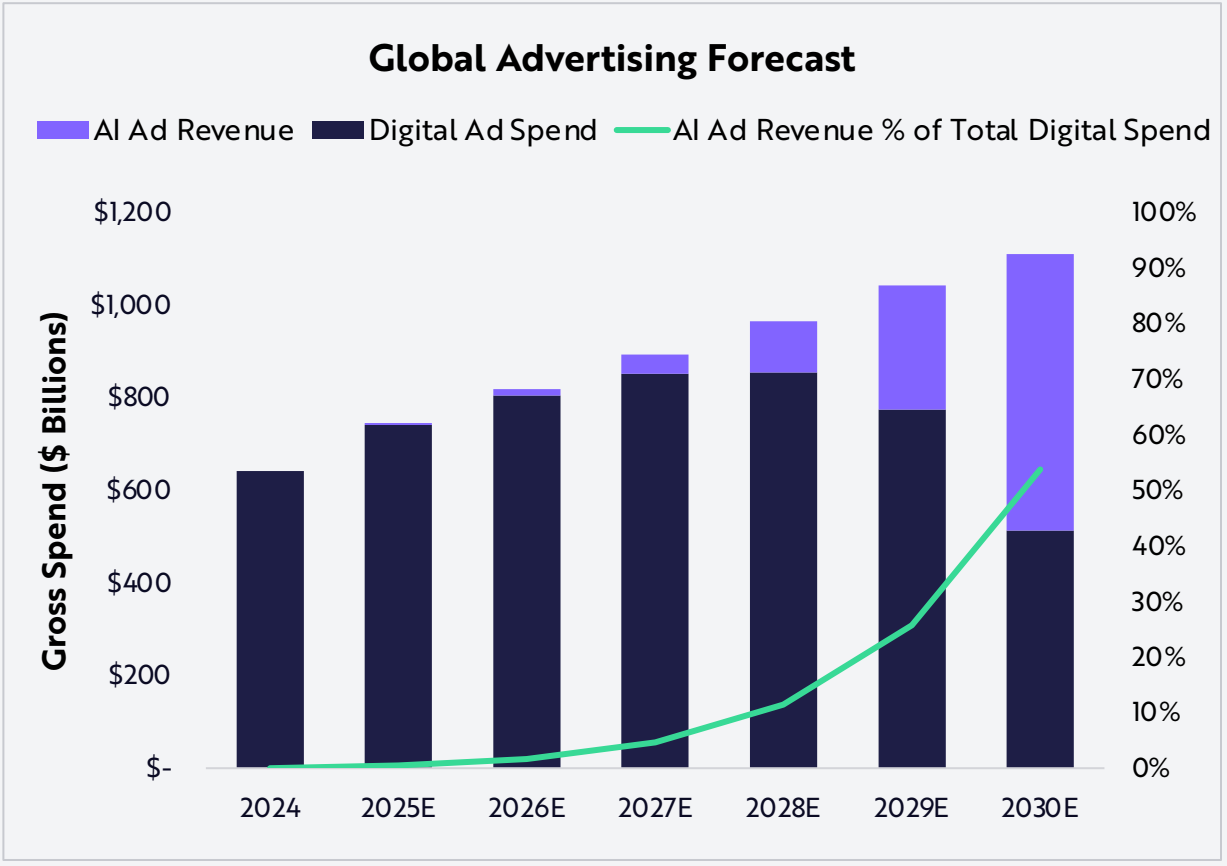




AI-Mediated Ads Should Take The Lion's Share Of Digital Ad Revenue by 2030

If search shifts to personal AI agents, AI-mediated ad revenue could surge. By 2030, we believe AI ad revenue could account for more than 54% of the $1.1 trillion digital ad market.



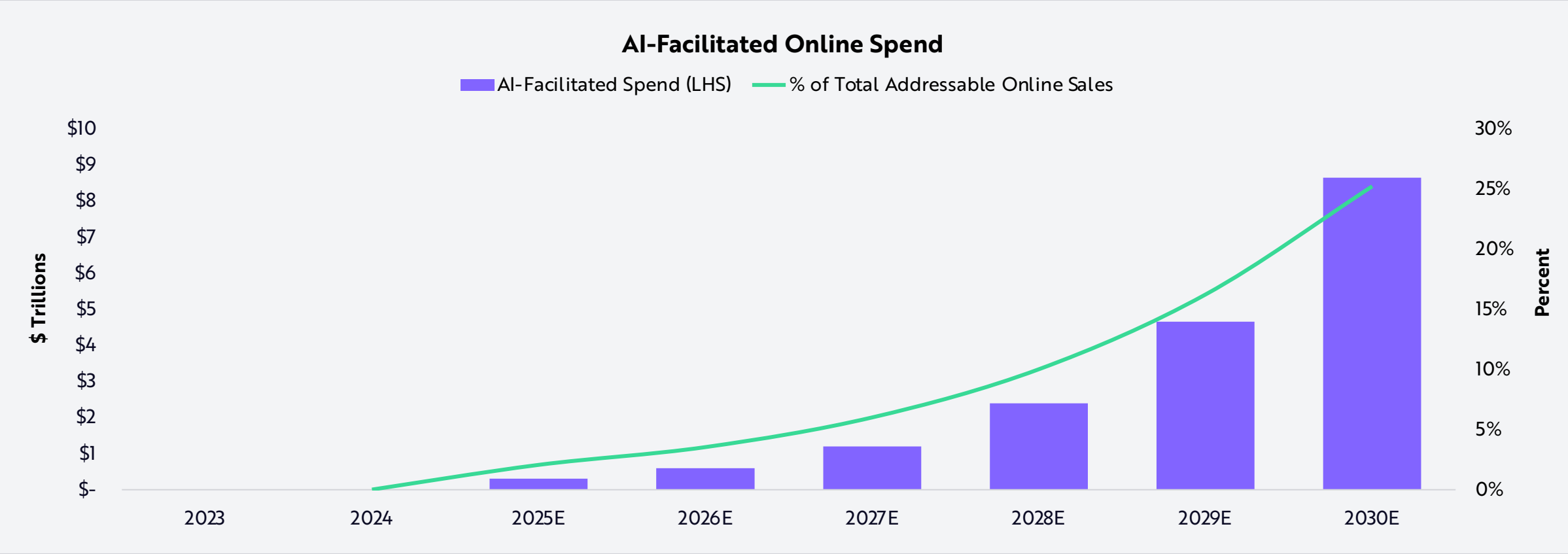


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI-Mediated Shopping Is Likely To Approach 25% Of Addressable Online Sales Globally By 2030

The growing use of AI agents in consumer shopping should streamline product discovery, personalization, and purchasing.

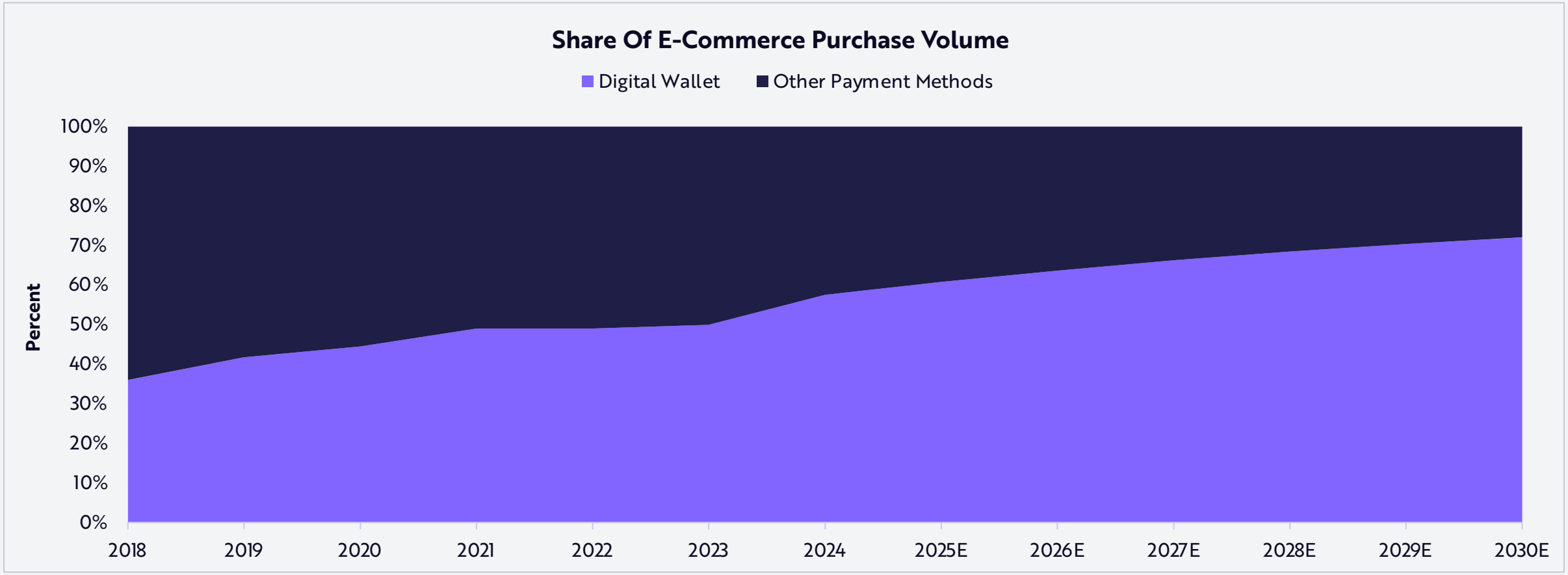
ARK research suggests that AI agents could facilitate nearly $9 trillion in global gross online consumption by 2030.



Note: ARK measures "total addressable online sales" using internal and external estimates for global e-commerce and addressable services spending out to 2030. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Digital Wallets Are Positioned For Continued Share Gains In E-Commerce

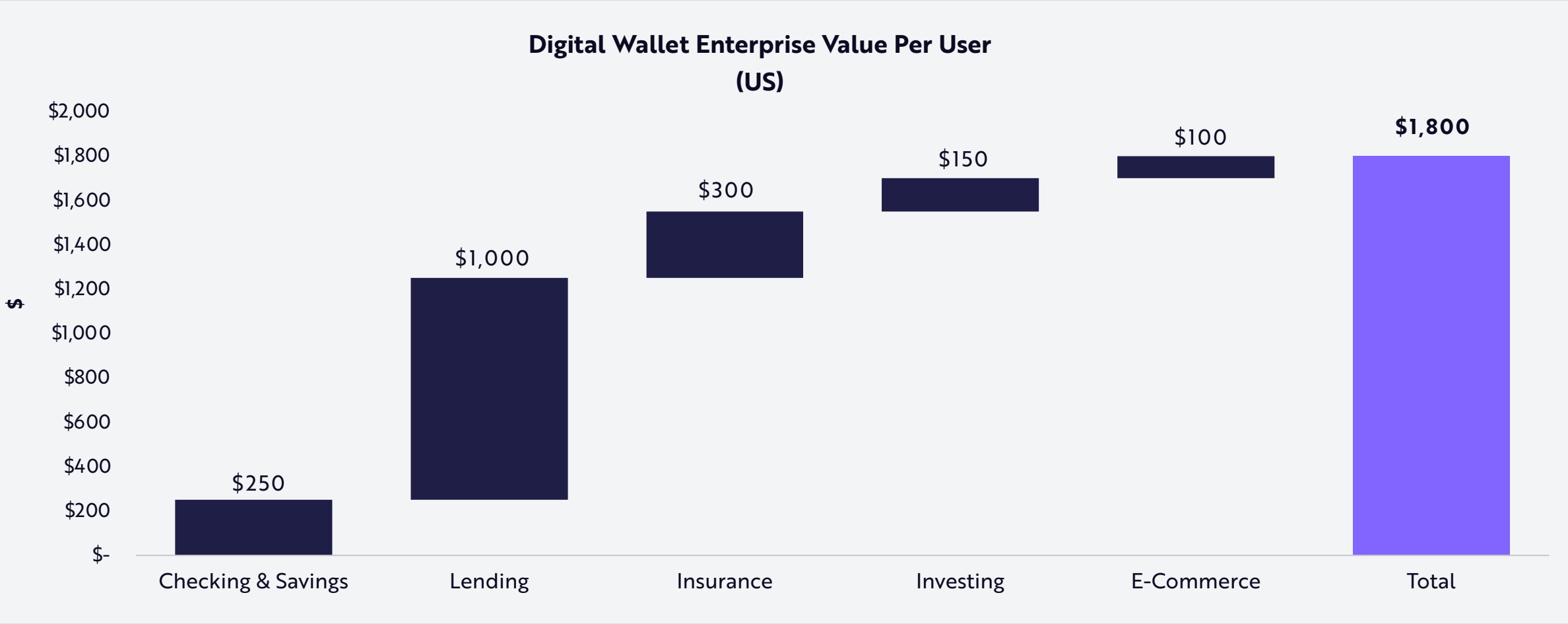
ARK's research suggests that digital wallets empowered by AI purchasing agents—taking share from payment methods like credit and debit cards—could account for 72% of all e-commerce transactions by 2030.



Note: Other Payment Methods for E-commerce purchase volume include Credit Card, Debit Card, Bank Transfer, Cash on Delivery, and Buy Now Pay Later (BNPL). "Credit Card" and "Debit Card" refer to stored card credentials, while "Digital Wallet" includes credit/debit cards stored within the digital wallet. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including WorldPay as of December 31, 2024, which may be provided upon request. 2018-2023 figures are documented in the Worldpay Global Payments Reports. 2024-2030 figures are ARK's adoption estimates for e-commerce payment methods. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Digital Wallets Are Consolidating Financial Services And E-Commerce

Based on their consumer-facing operations, the market is valuing leading digital wallet platforms like Block, Robinhood, and SoFi at $1,800 per user today.



Note: "Checking & Savings" data include Checking & Savings, Debit Card, and Peer to Peer Payments. "Lending" data include Loans & Mortgages, Credit Card, and Buy Now Pay Later (BNPL). Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources representing the revenues, margins, and multiples of leading digital wallets and established incumbents. as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Digital Wallet Purchasing Agents Could Become Central To The Shopping Journey

Agentic lead generation should move digital wallets upstream to capture market share in e-commerce and digital spending globally. "One-click checkout" should give way to "one-query purchasing."

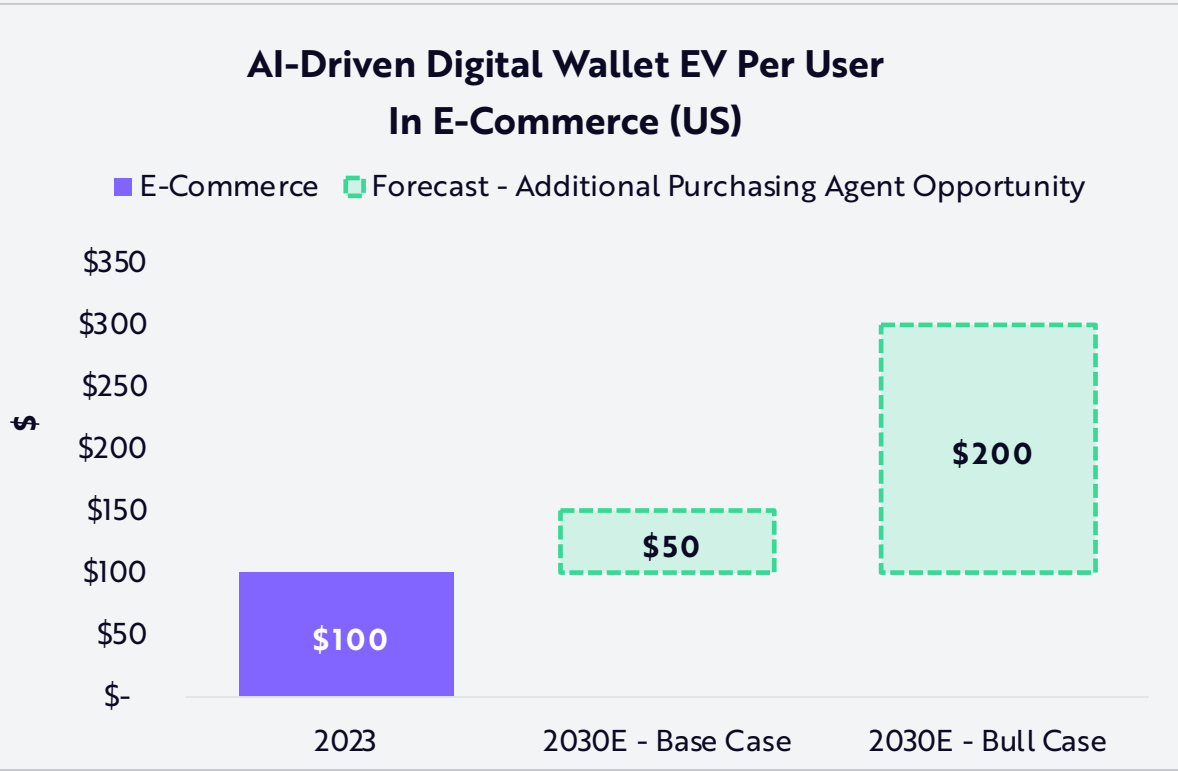
Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

Purchasing Agents Should Increase The Enterprise Value Of Digital Wallets, Notably In E-Commerce

Based on lead-generation take rates, AI purchasing agents could generate global revenue between $40 billion and $200 billion—ARK's base and bull cases, respectively—for digital wallet platforms in 2030.

In 2030, AI-powered purchasing agents could add between $50 and $200 per user to the enterprise value (EV) of digital wallets in the US.

2030 Forecast				
Global Gross Spend Powered By AI Agents		~ $9 Trillion		
		Percent Of AI Agent Spend In Digital Wallets		
		5%	**10%**	**20%**
Lead Generation Take-Rate For Digital Wallets	2.5%	$10B	$20B	$40B
	5%	$20B	**$40B**	$90B
	10%	$40B	$90B	**$200B**

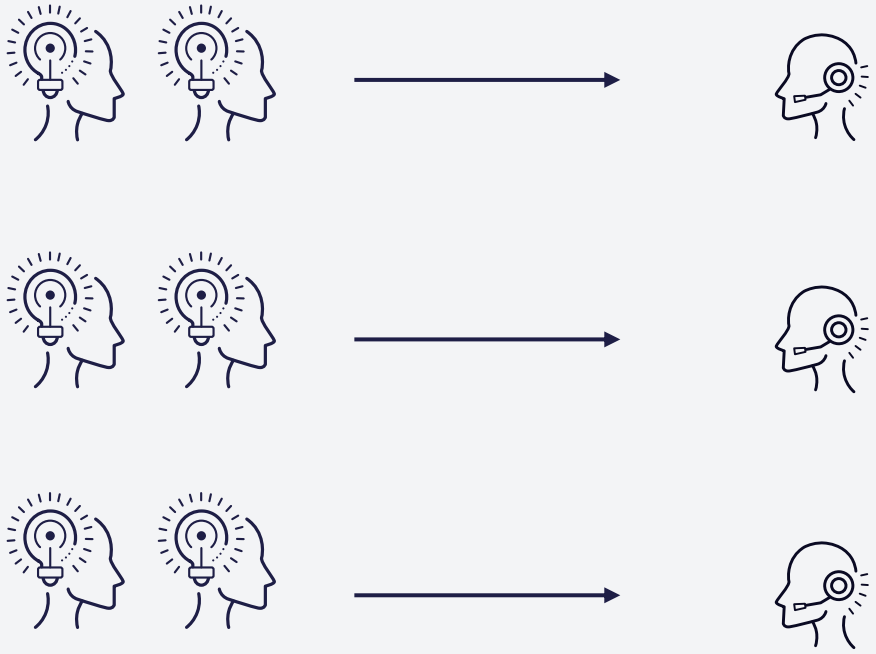


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

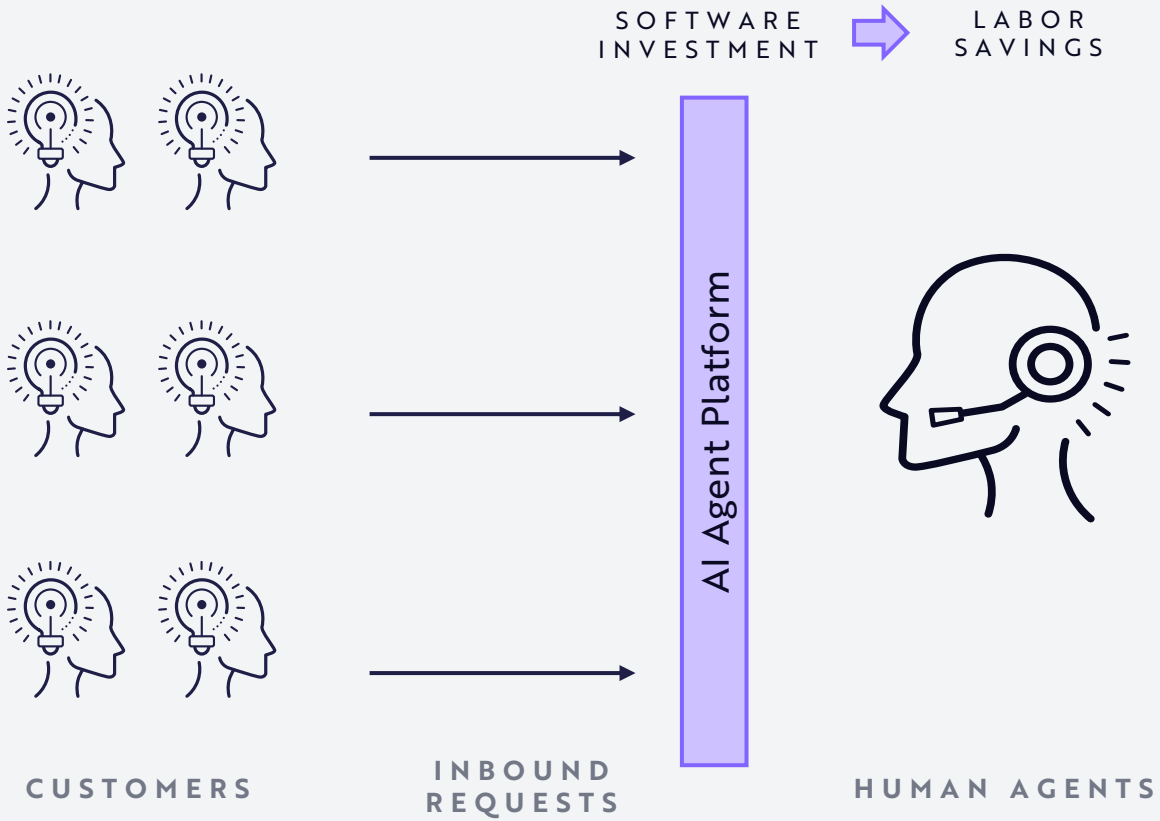
In The Enterprise, Agents Will Increase Productivity Via Software

Companies that deploy agents should be able to increase unit volume with the same workforce and/or optimize their workforce toward higher-value activities. As AI evolves, agents are likely to handle a higher percentage of workloads and to complete higher-value tasks independently.

Traditional Customer Support



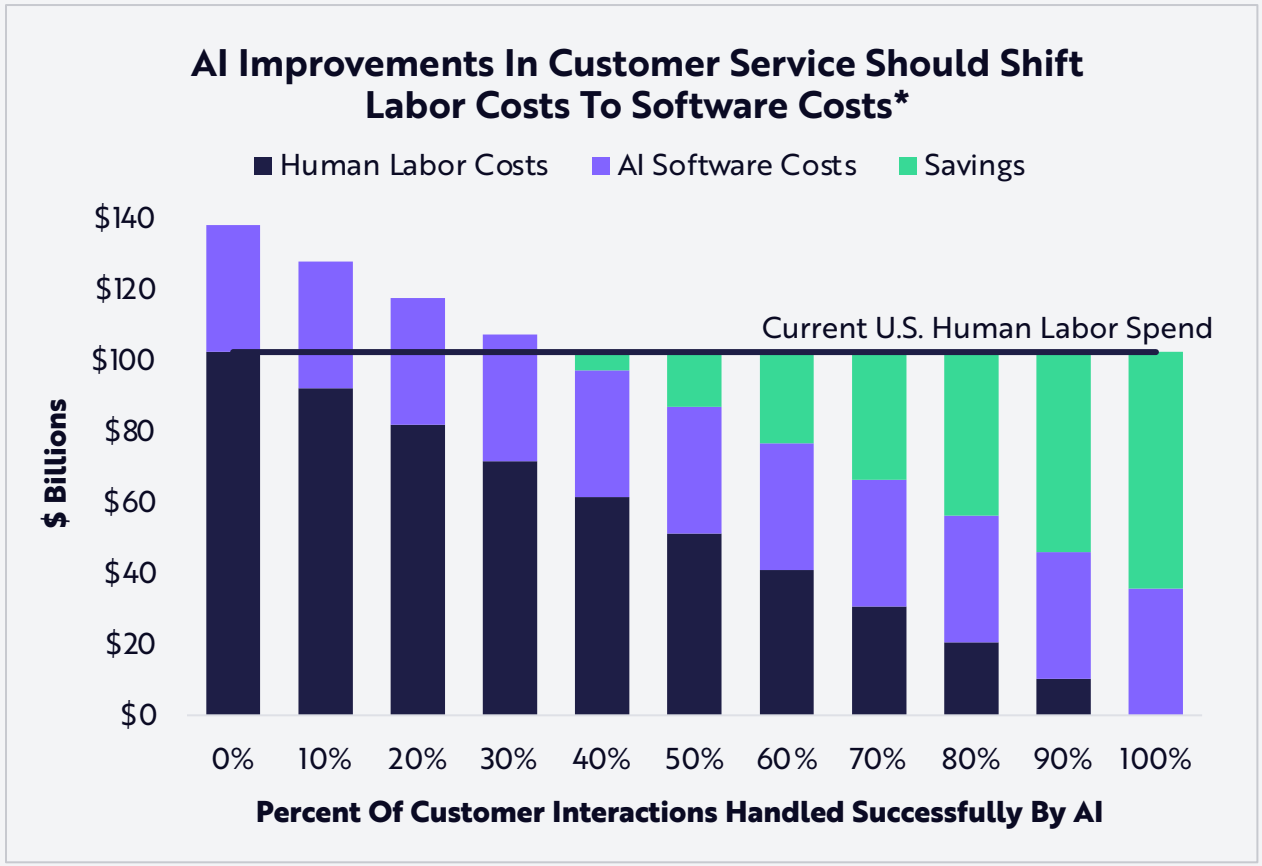
AI-Enabled Customer Support

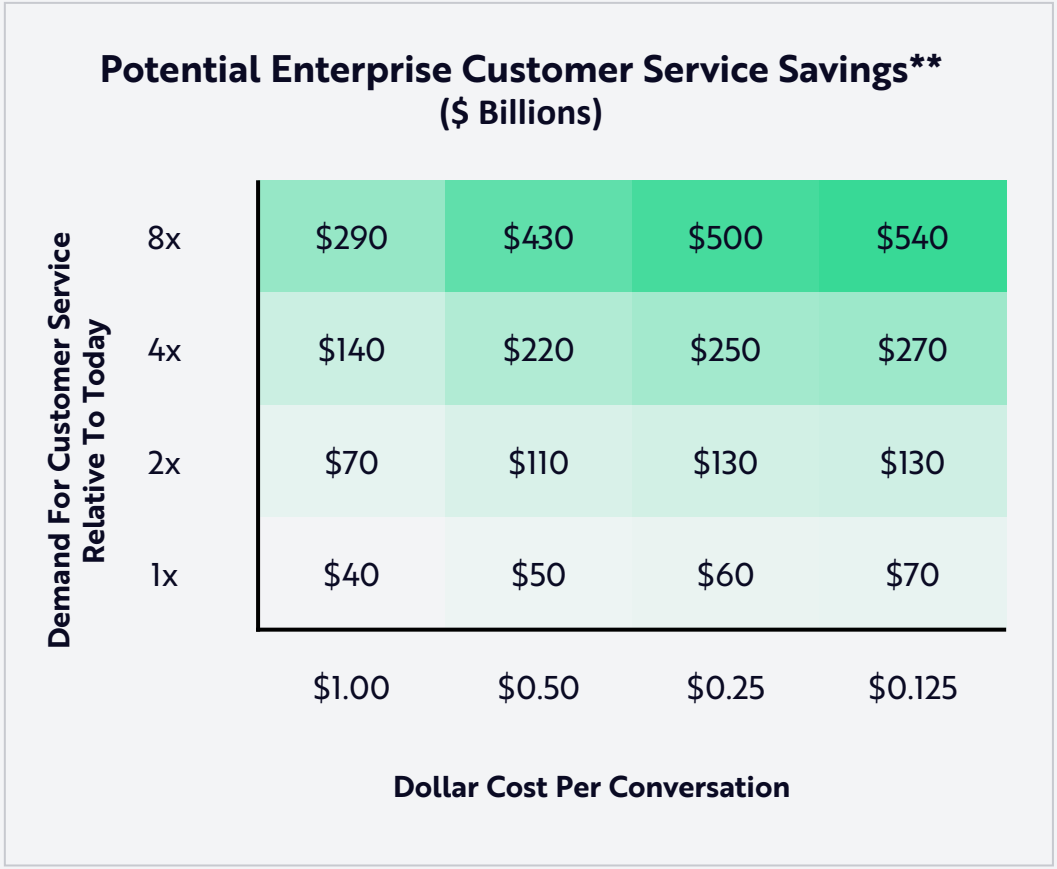


Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.

AI Cost Declines Should Impact Agent Economics Significantly

New products from OpenAI and Salesforce are supplementing human customer service representatives cost-effectively. Even at a fixed cost of $1 per conversation, AI agents could save enterprises significant sums once they can handle 35% of customer service inquiries. AI agents also should lower onboarding and hiring costs, as well as seat-based software costs, while scaling more easily than human labor.

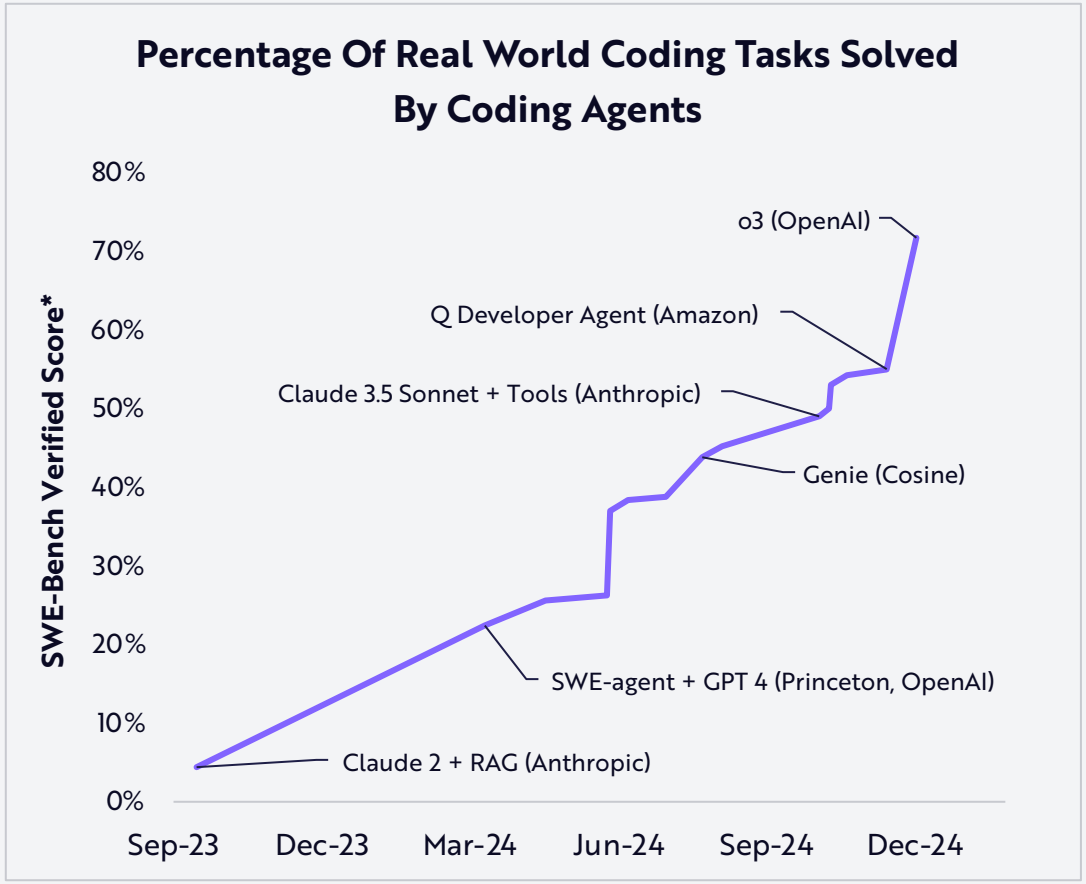


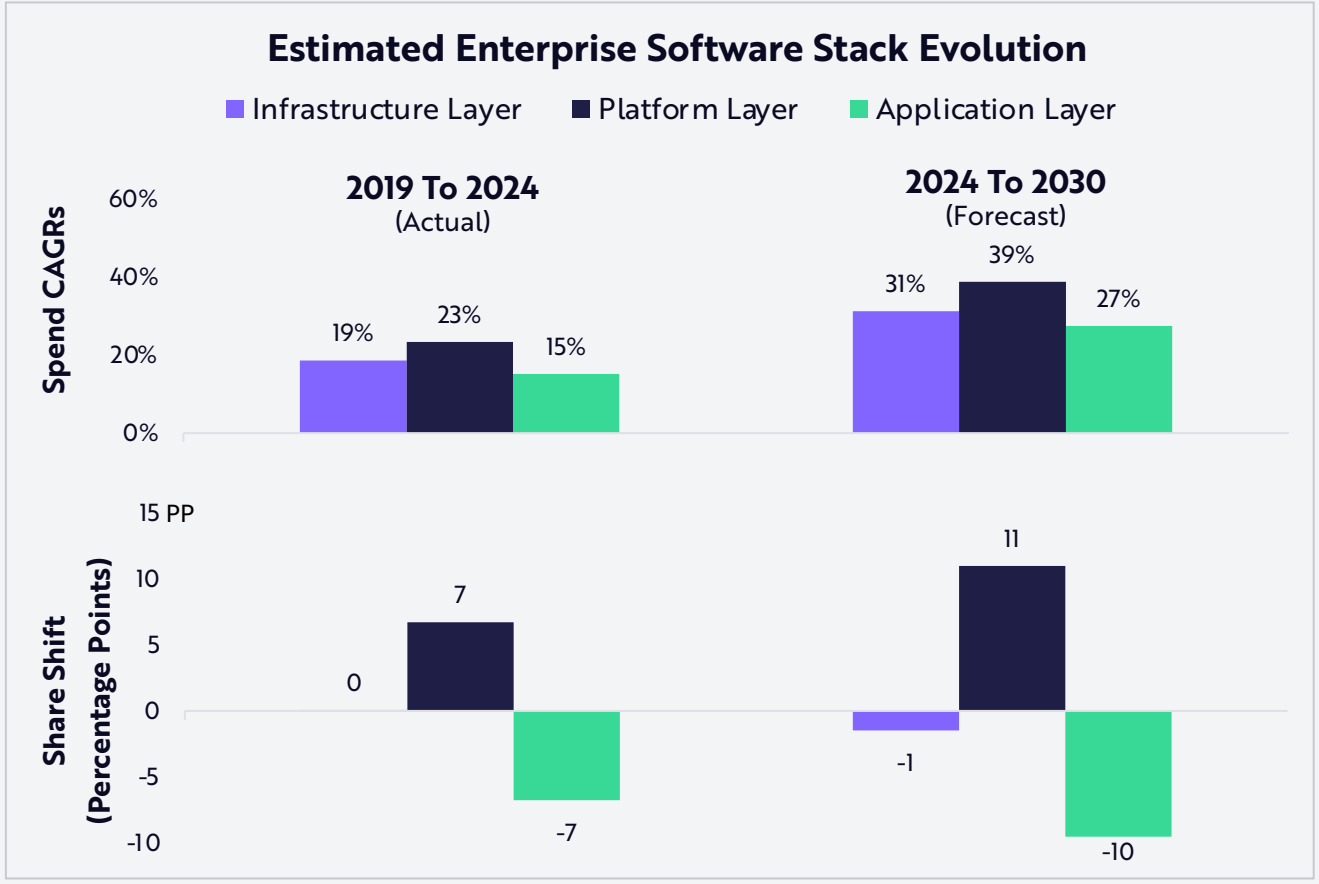


*Assumes fixed cost of $1 per customer interaction. **Assuming 70% of interactions can be handled by AI in all scenarios, corresponding to the 70% bar in the left-hand chart. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including ZipRecruiter and OpenAI, as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Is Reshaping The Software Value Chain

The coding skills of AI agents are improving rapidly, accelerating the software development lifecycle. As the cost to create software declines, software production should accelerate and sway enterprise "build vs. buy" decisions, displacing traditional software incumbents that are slow to adapt. As customer software proliferates, growth in all layers of the software stack should accelerate, even as share shifts toward the platform layer.





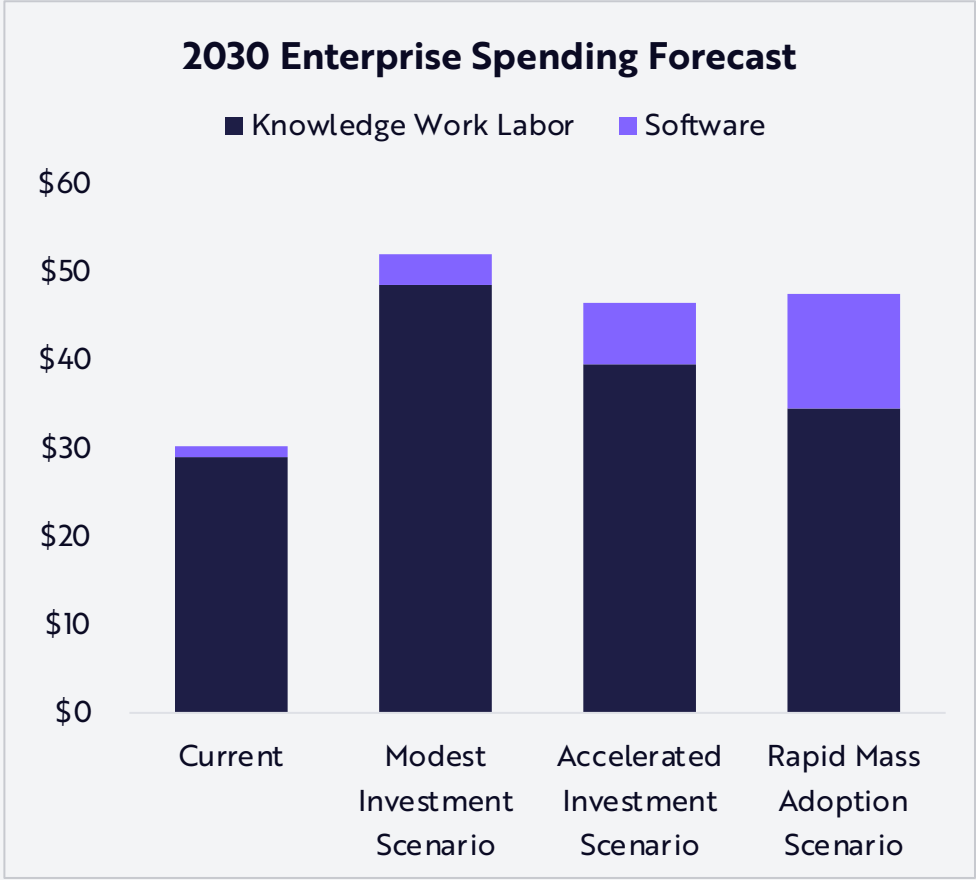
Note: "CAGR": Compound Annual Growth Rate. *SWE-Bench is a benchmark that measures AI agents' ability to write code autonomously. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Will Supercharge Knowledge Work

AI is driving a Cambrian explosion in software. Through 2030, we expect the amount of software deployed per knowledge worker to grow considerably as businesses invest in productivity solutions. Depending on adoption rates, global spend on software could accelerate from an annual rate of 14% over the last ten years to annual rates of 18% to 48%.

Adoption Scenarios

	Modest Investment	Accelerated Investment	Rapid Mass Adoption
Annual knowledge worker employment growth	6.3%	3.2%	1.3%
Percentage of current working time automated by 2030	31%	61%	81%
Reduction in productive working hours	0%	8%	20%
Productivity surplus created*	$22 trillion	$57 trillion	$117 trillion
Value capture of productivity solutions**	10%	10%	10%
New software revenue	$2.2 trillion	$5.7 trillion	$11.7 trillion
2030 Software Market Estimate (current size + AI revenue)	**$3.5 trillion** 18% CAGR	**$7 trillion** 33% CAGR	**$13 trillion** 48% CAGR



Note: "CAGR": Compound Annual Growth Rate. *Traditional production statistics are unlikely to adequately capture the surplus created by AI software. **Value capture rates are likely to vary across scenarios based on competition in the market and other factors. The rate is held constant in these scenarios for simplicity. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Bitcoin

A Maturing Global Monetary System With Sound Network Fundamentals And Growing Institutional Adoption

Yassine Elmandjra

FORMER DIRECTOR OF DIGITAL ASSETS

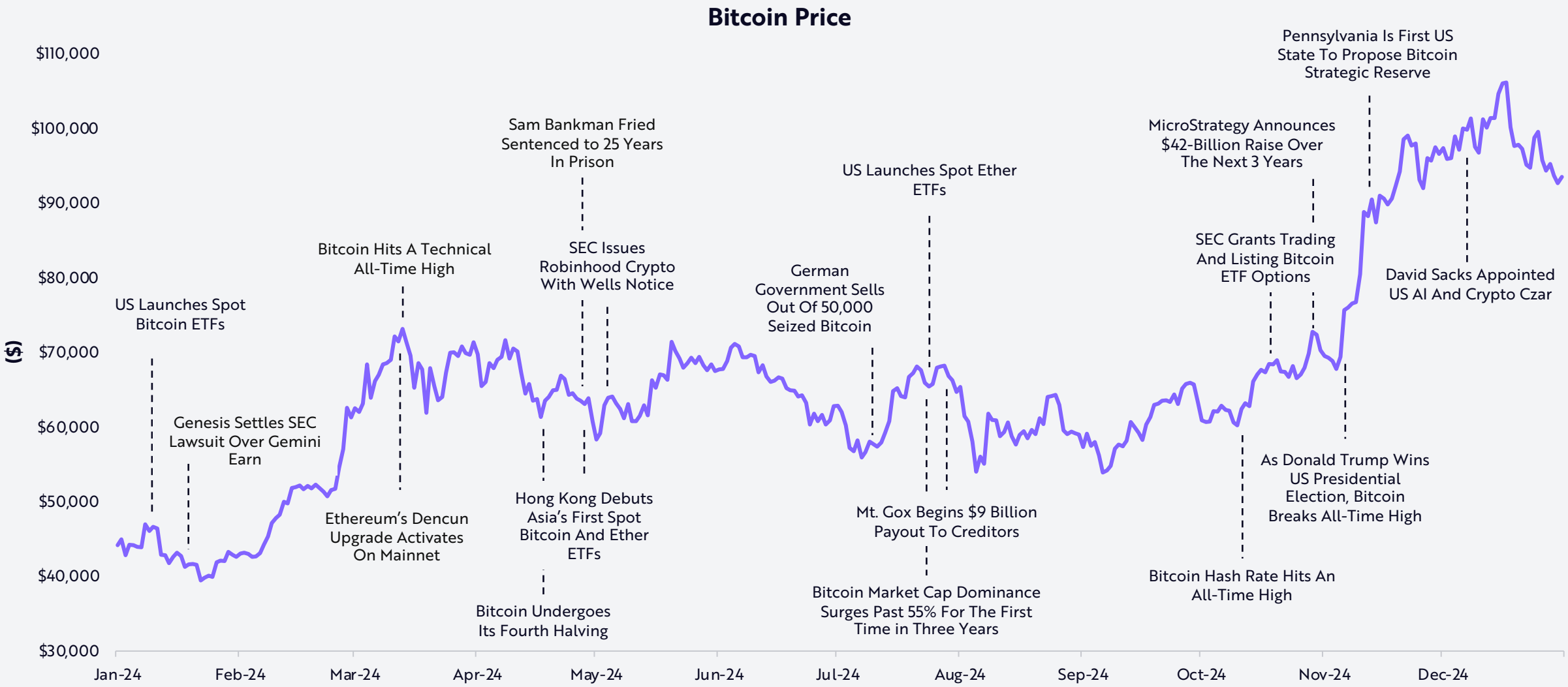
David Puell

RESEARCH TRADING ANALYST & ASSOCIATE PORTFOLIO MANAGER, DIGITAL ASSETS

Lorenzo Valente

DIRECTOR OF DIGITAL ASSETS

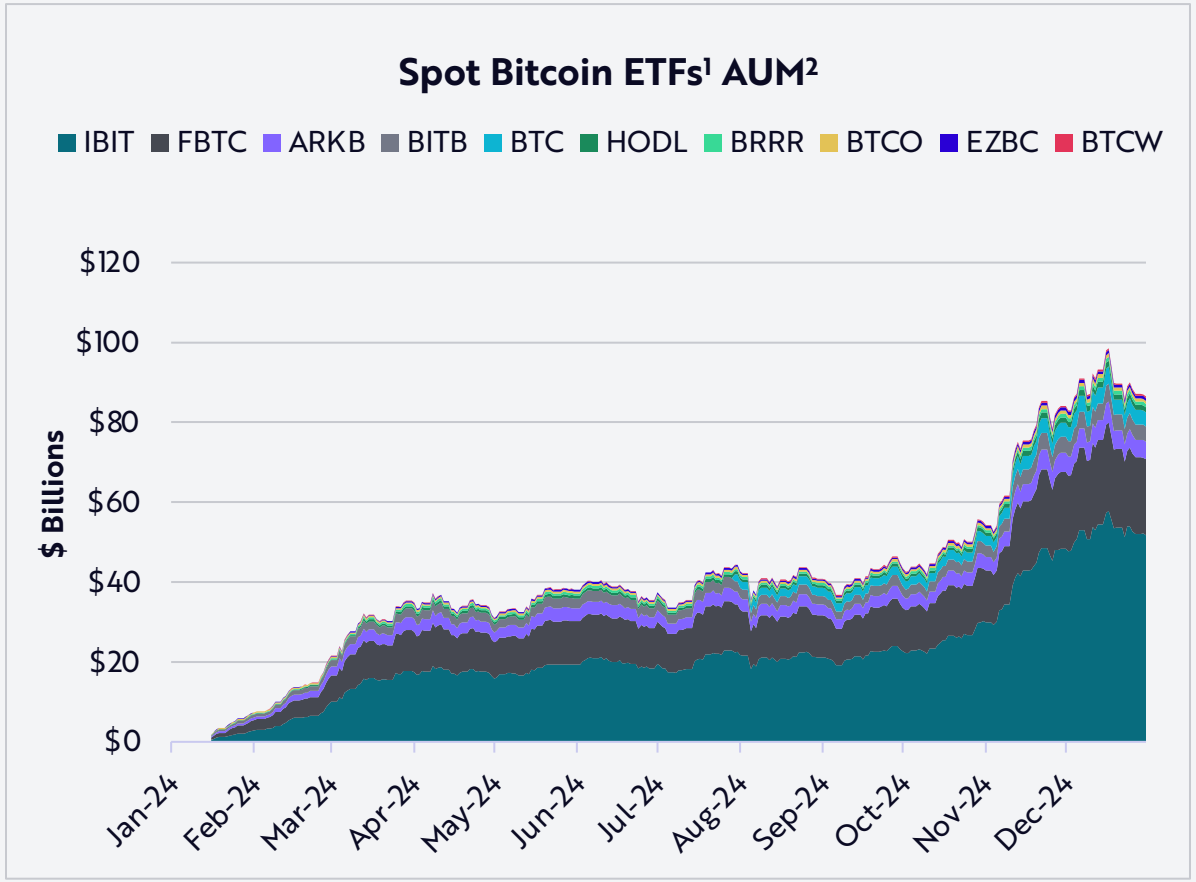
Bitcoin Hit An All-Time High In 2024

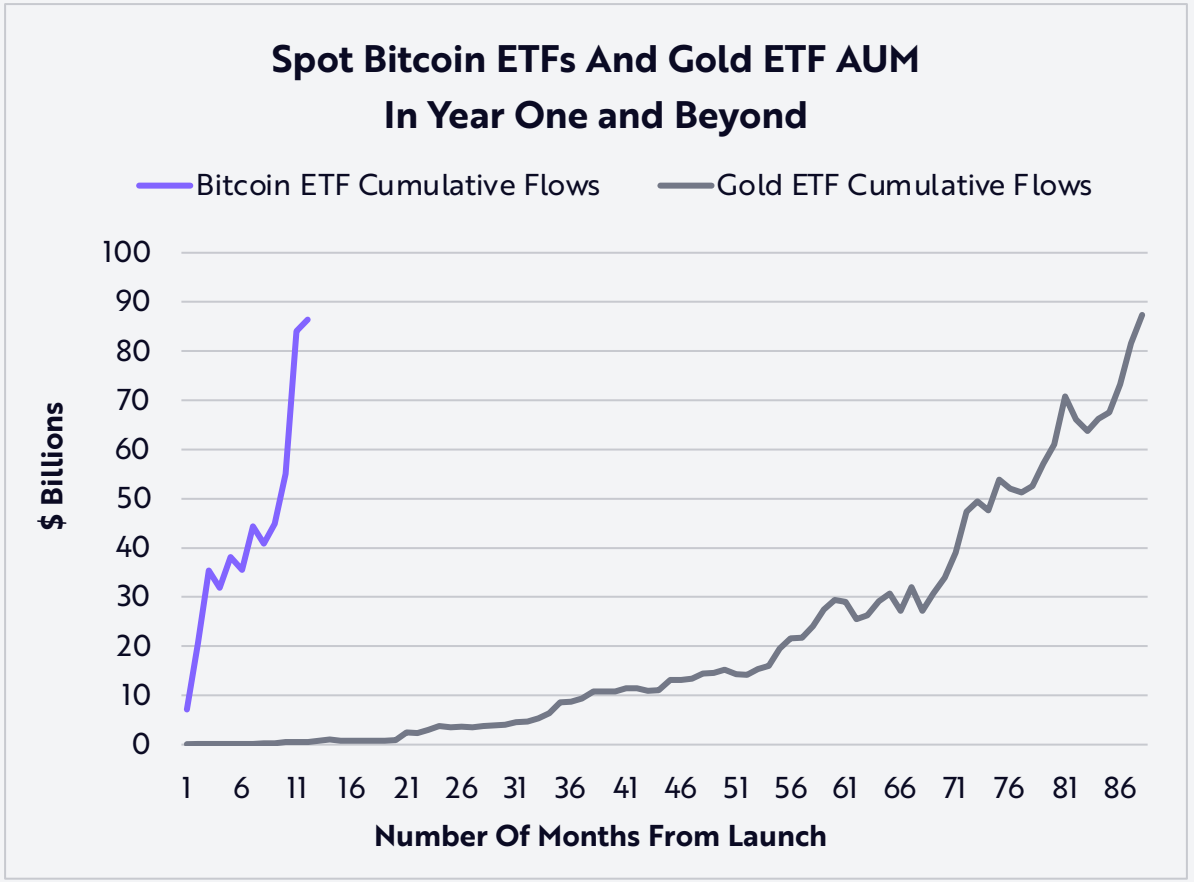


Source: ARK Investment Management LLC, 2025, based on data from Glassnode and TradingView as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

The Spot Bitcoin ETF Complex Was The Most Successful ETF Launch In History

On their first day of trading, the spot bitcoin ETFs attracted over $4 billion of inflows, a record high for ETF launches, surpassing the $1.2 billion that flowed into the gold ETF in its first month in November 2004. Inflows into the spot bitcoin ETFs have dwarfed the first-month inflows into each of the ~6,000 ETFs launched over the past 30 years.

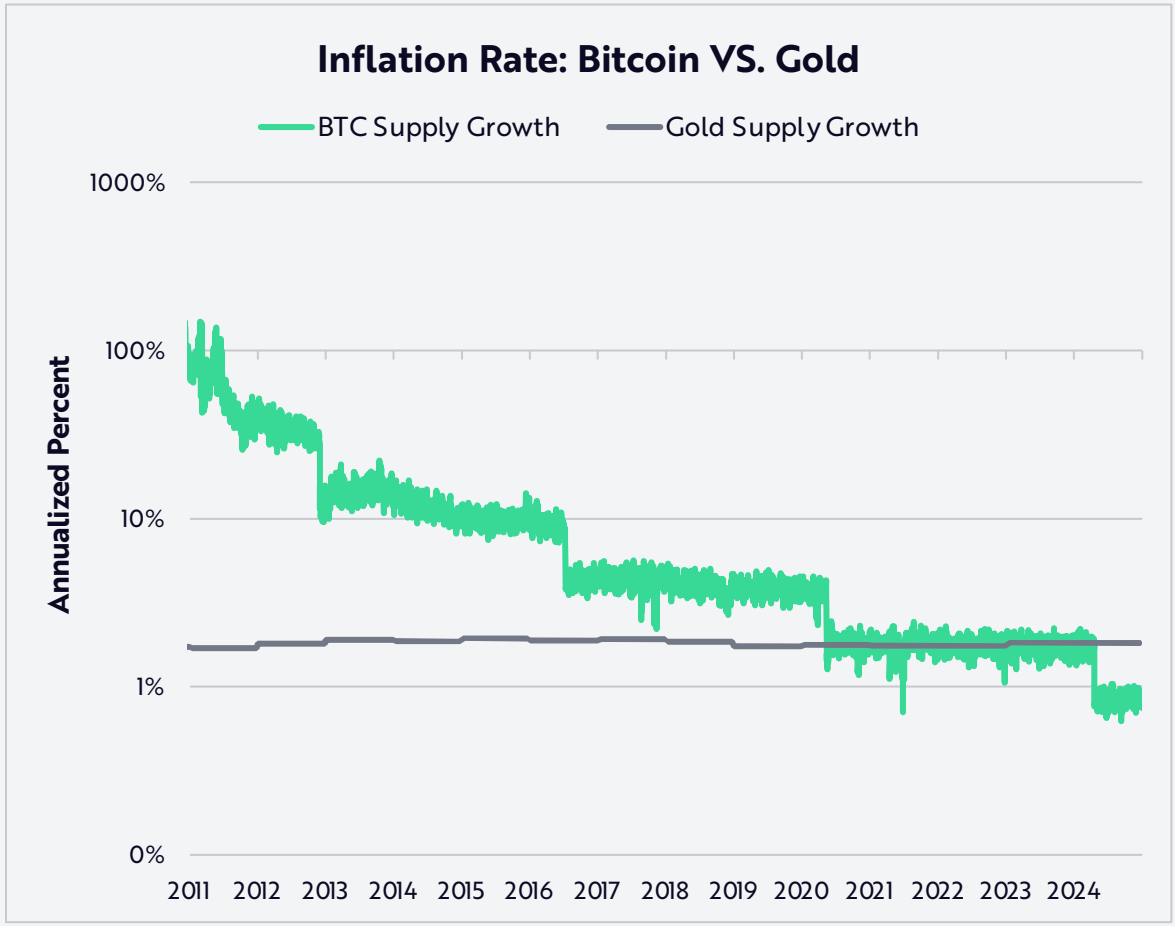


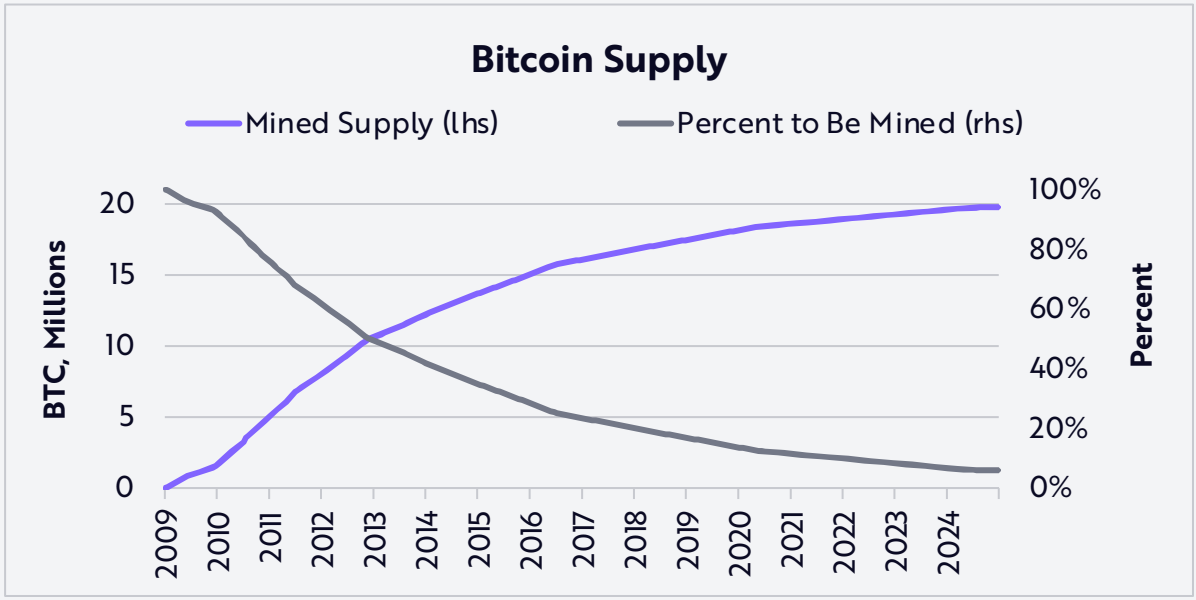


[1] GBTC and DEFI are not included. [2] "AUM": assets under management. Source: ARK Investment Management LLC, 2025, based on data from Glassnode and World Gold Council as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Upon Its Fourth Halving, Bitcoin's Inflation Rate Dropped Below Gold's Long-Term Supply Growth

Growth in the supply of bitcoin "halved" for the fourth time in history, dropping from ~1.8% at an annual rate to ~0.9%. Critical to its design, the halving highlights bitcoin's predictable monetary policy and its role as a scarce asset.





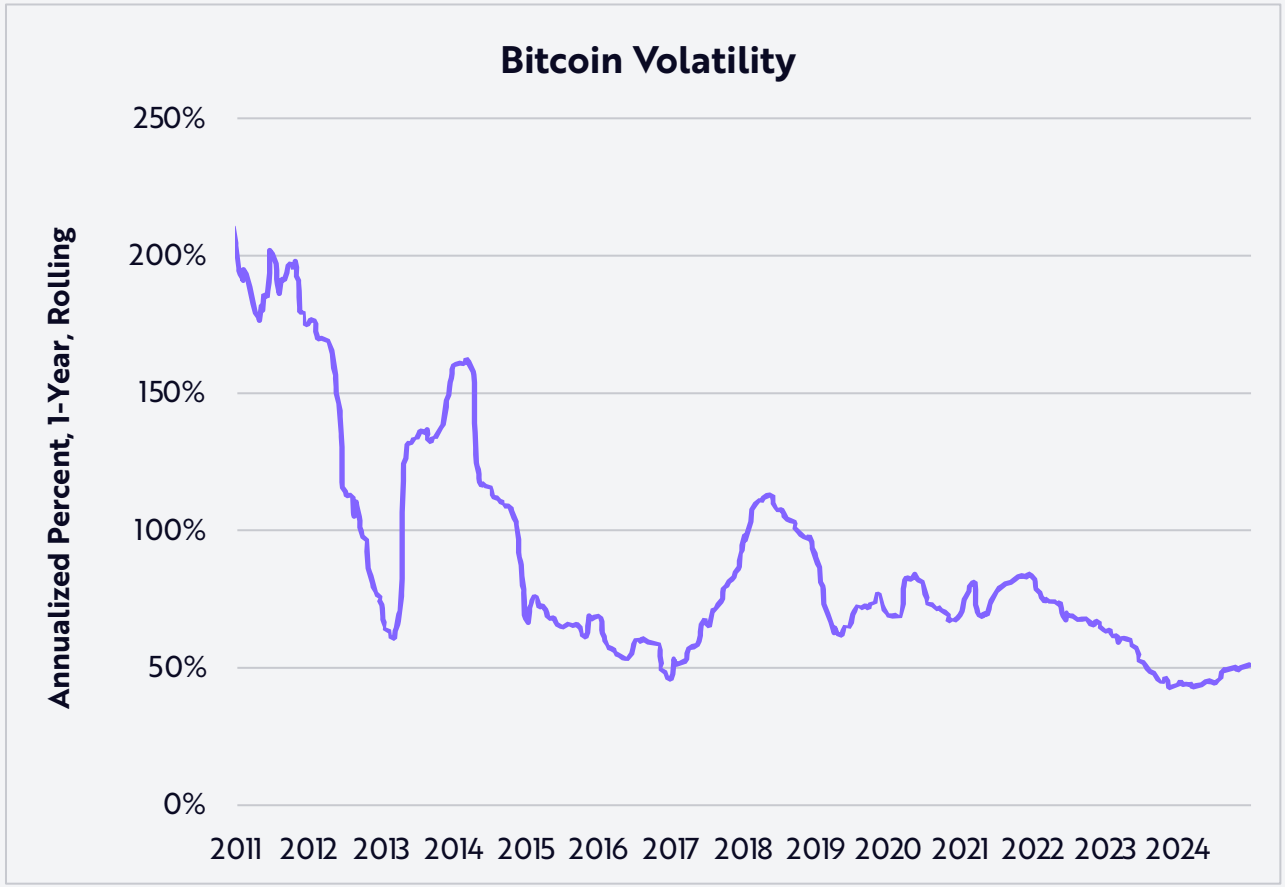
Seven Lines Of Code Created Bitcoin's Mathematically-Metered Monetary Policy[1]

```
CAmount GetBlockSubsidy(int nHeight, const Consensus::Params& consensusParams)
{
    int halvings = nHeight / consensusParams.nSubsidyHalvingInterval;
    // Force block reward to zero when right shift is undefined.
    if (halvings >= 64)
        return 0;

    CAmount nSubsidy = 50 * COIN;
    // Subsidy is cut in half every 210,000 blocks which will occur approximately every 4 years.
    nSubsidy >>= halvings;
    return nSubsidy;
}
```

[1] Screenshot as of December 31, 2024, sourced from (github.com/bitcoin/bitcoin/blob/master/src/validation.cpp) lines 1939-1949. Source: ARK Investment Management LLC, 2025, based on data from Glassnode and World Gold Council as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Bitcoin's Annual Volatility Fell To An All-Time Low, While Its Risk-Adjusted Returns Remained Superior To Most Major Asset Classes

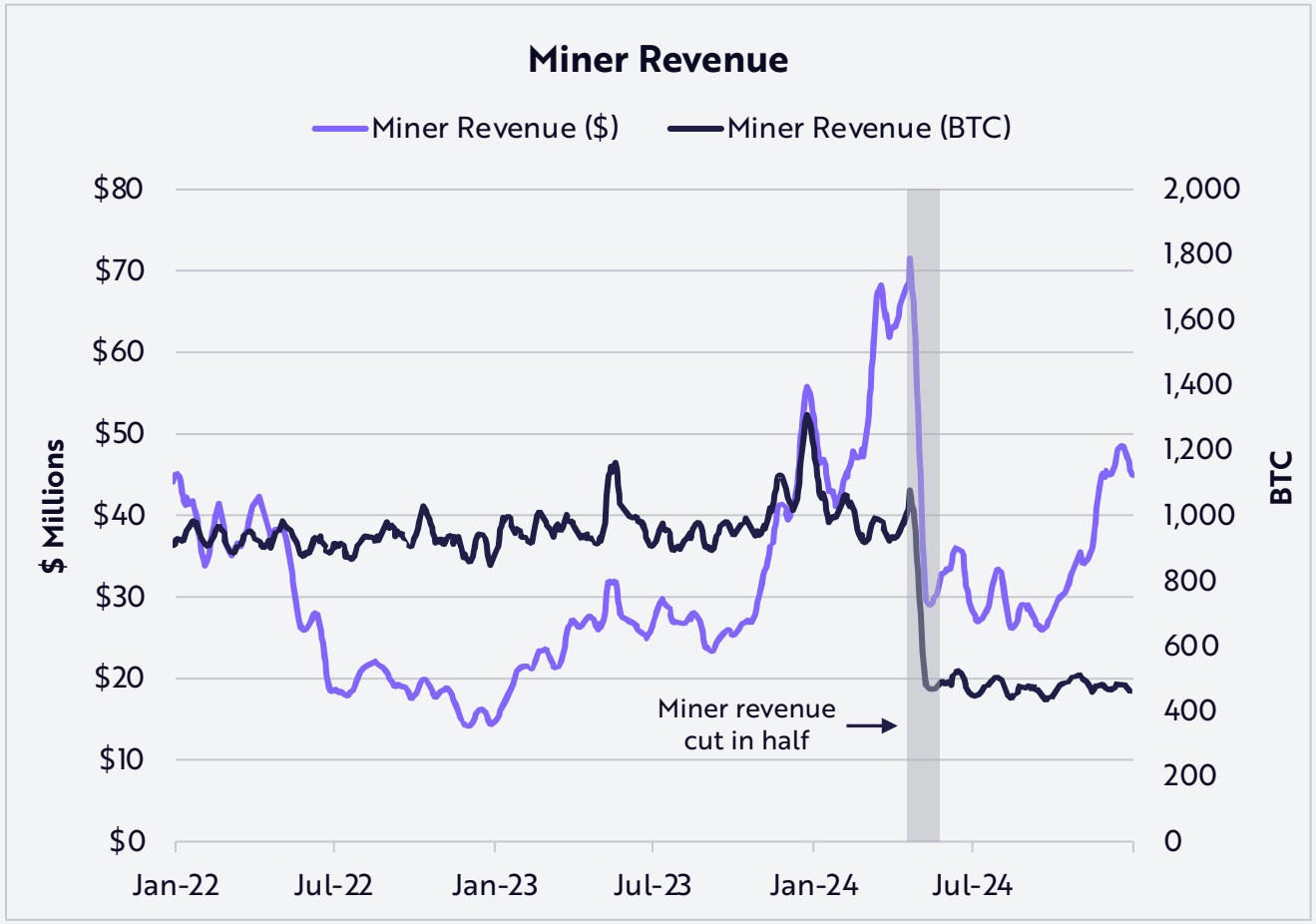


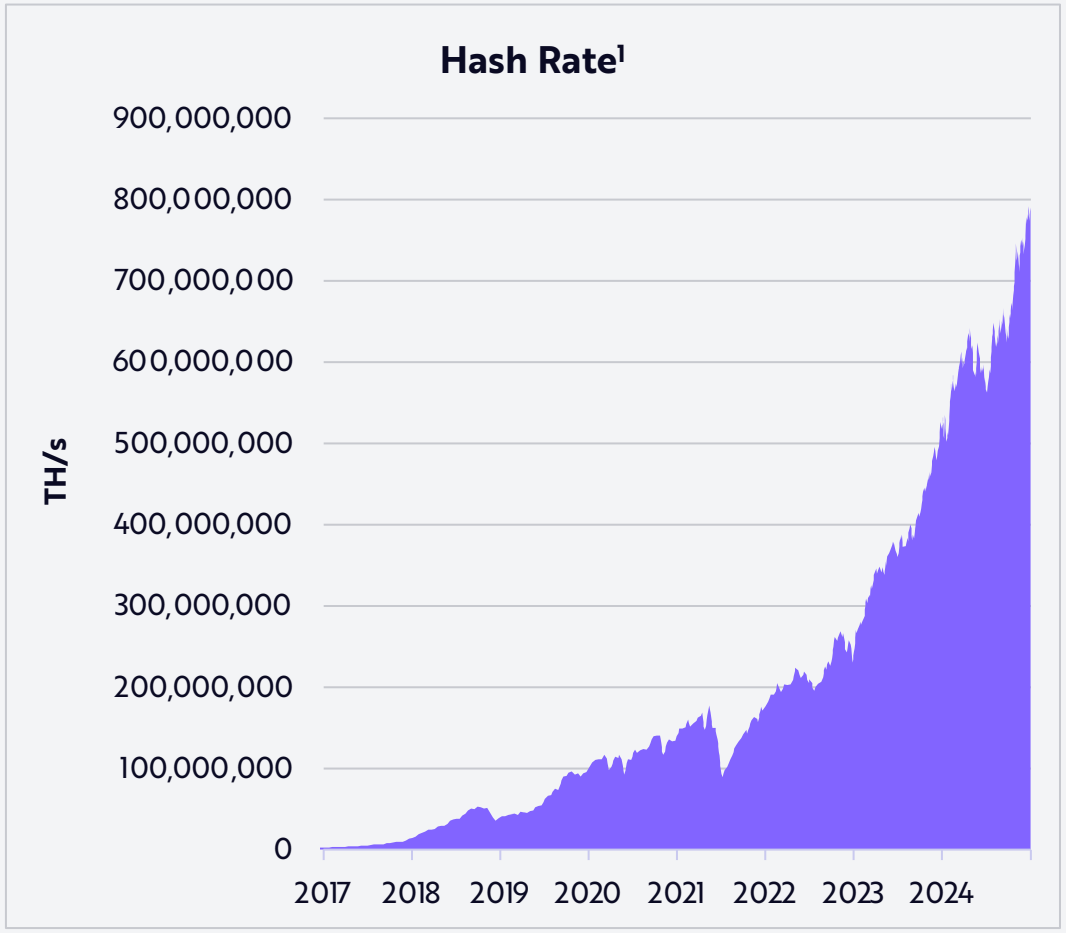
Asset Class[1]	2024 Return	Sharpe Ratio[2]	Sortino Ratio[3]	5-Year CAGR[4]
Bitcoin	122.2%	1.4	4.1	67.2%
Gold	26.6%	1.7	4.8	10.4%
Equities	19.2%	1.3	2.3	11.7%
Emerging Markets	8%	0.2	0.4	2.1%
Real Estate	3.9%	-0.01	-0.01	1.5%
Bonds	-3.1%	-1.1	-1.2	-2.7%

[]1 Data used for calculations are as follows: S&P Bitcoin PR USD for bitcoin; S&P GSCI Gold TR for gold; MSCI World GR USD for equities; MSCI EM GR USD for emerging markets; S&P Global REIT TR USD for real estate; and Bloomberg Gbl Agg Govt TR USD for bonds. The returns shown are of unmanaged indices and therefore do not reflect the deduction of any fees or expenses that would be applicable to investors in these asset classes, which would lower the returns shown. [2] Sharpe ratio is calculated using average returns over 2024 adjusted for the risk-free rate, divided by the standard deviation. [3] Sortino ratio is calculated using average returns over 2024 adjusted for the risk-free rate, divided by the downside deviation. [4] "CAGR": Compound Annual Growth Rate. Source: ARK Investment Management LLC, 2025, based on data from Glassnode and Morningstar Direct as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Despite A Steep Decline In Miner Revenue After The Halving, Bitcoin's Hash Rate Hit An All-Time High

Even though the halving cut bitcoin miner revenue by 50%, its hash rate—a proxy for network security—hit a record high. In other words, miners' long-term conviction in bitcoin remains strong.

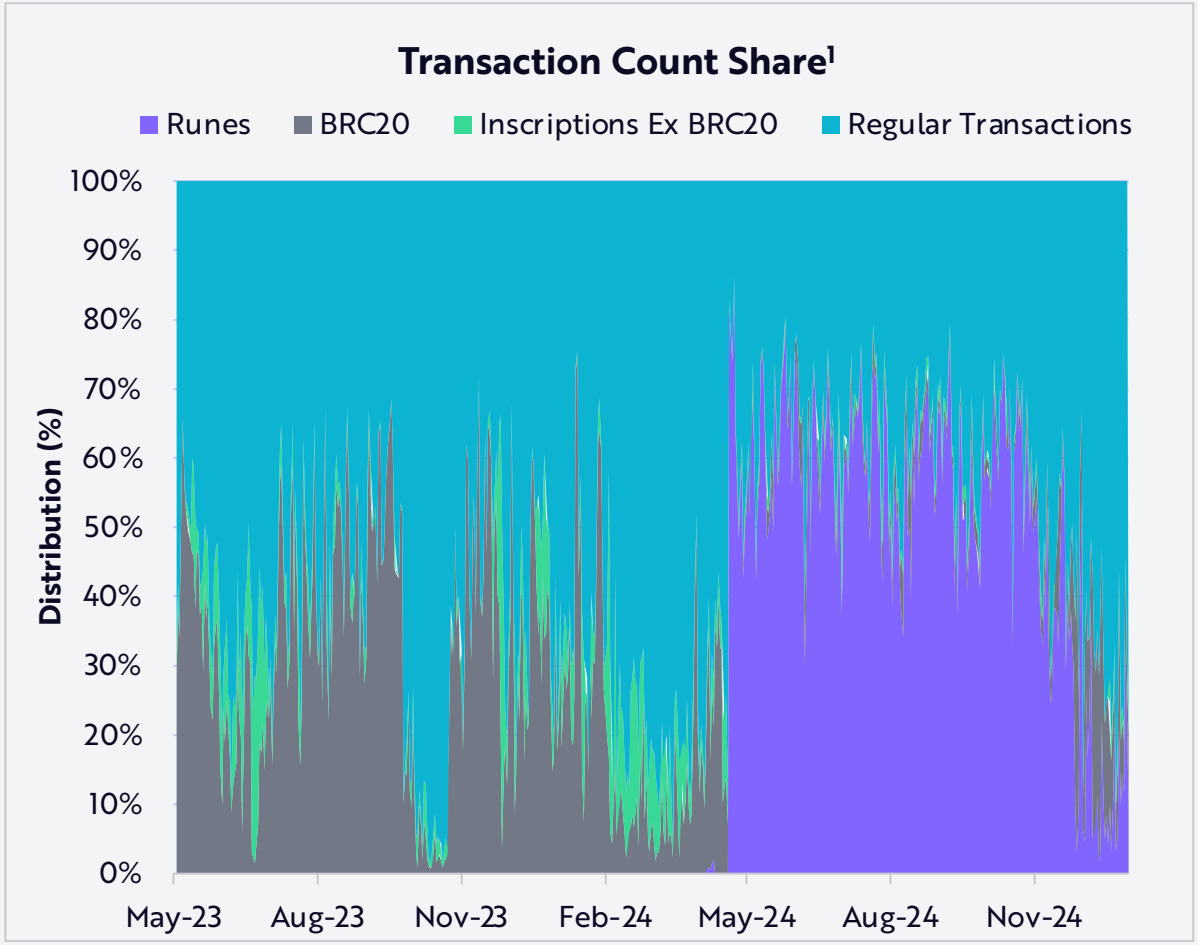


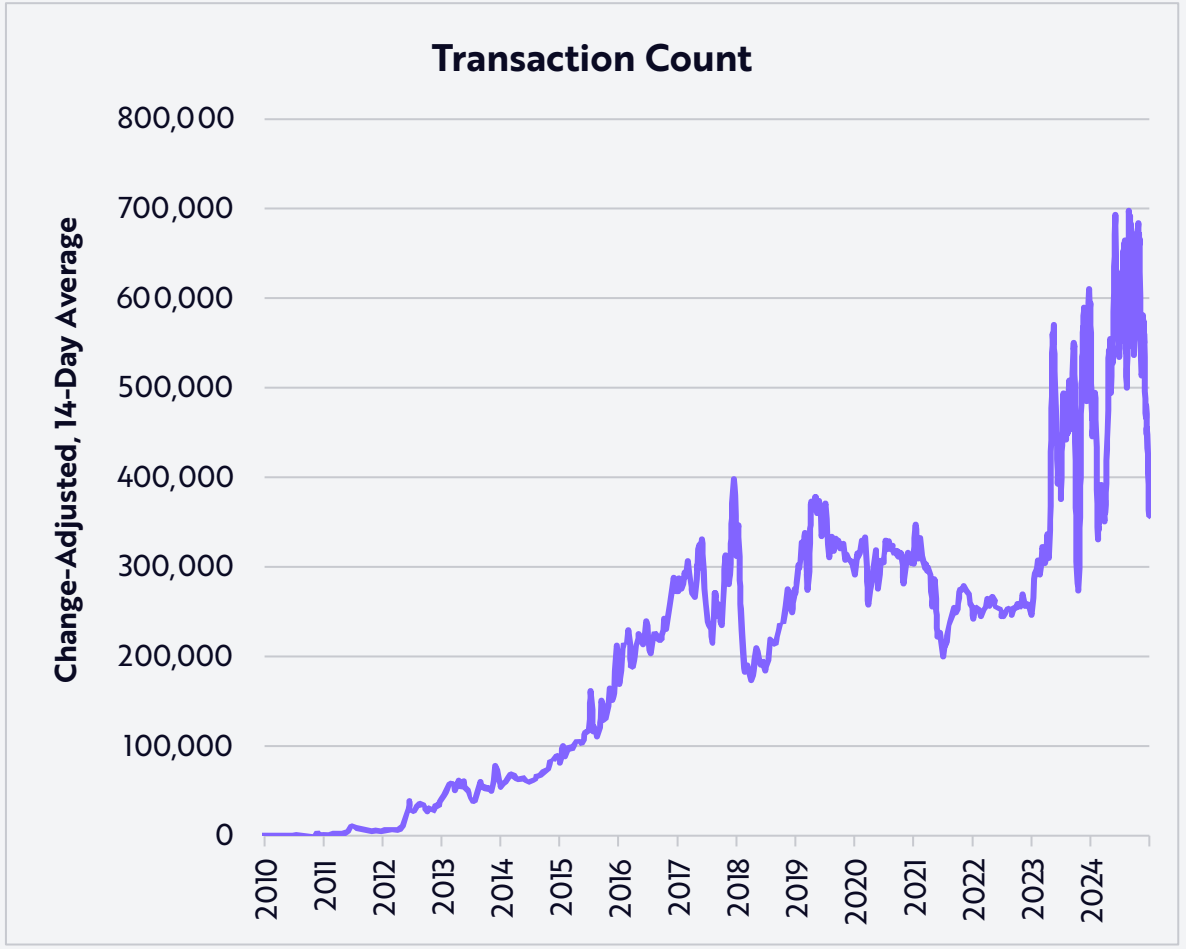


[1] In terahashes per second, a unit of measurement used to determine the estimated rate of processing power securing the Bitcoin network. It equals 1 trillion hashes per second. Source: ARK Investment Management LLC, 2025, based on data from Glassnode as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Transaction Count Soared, Thanks To Runes

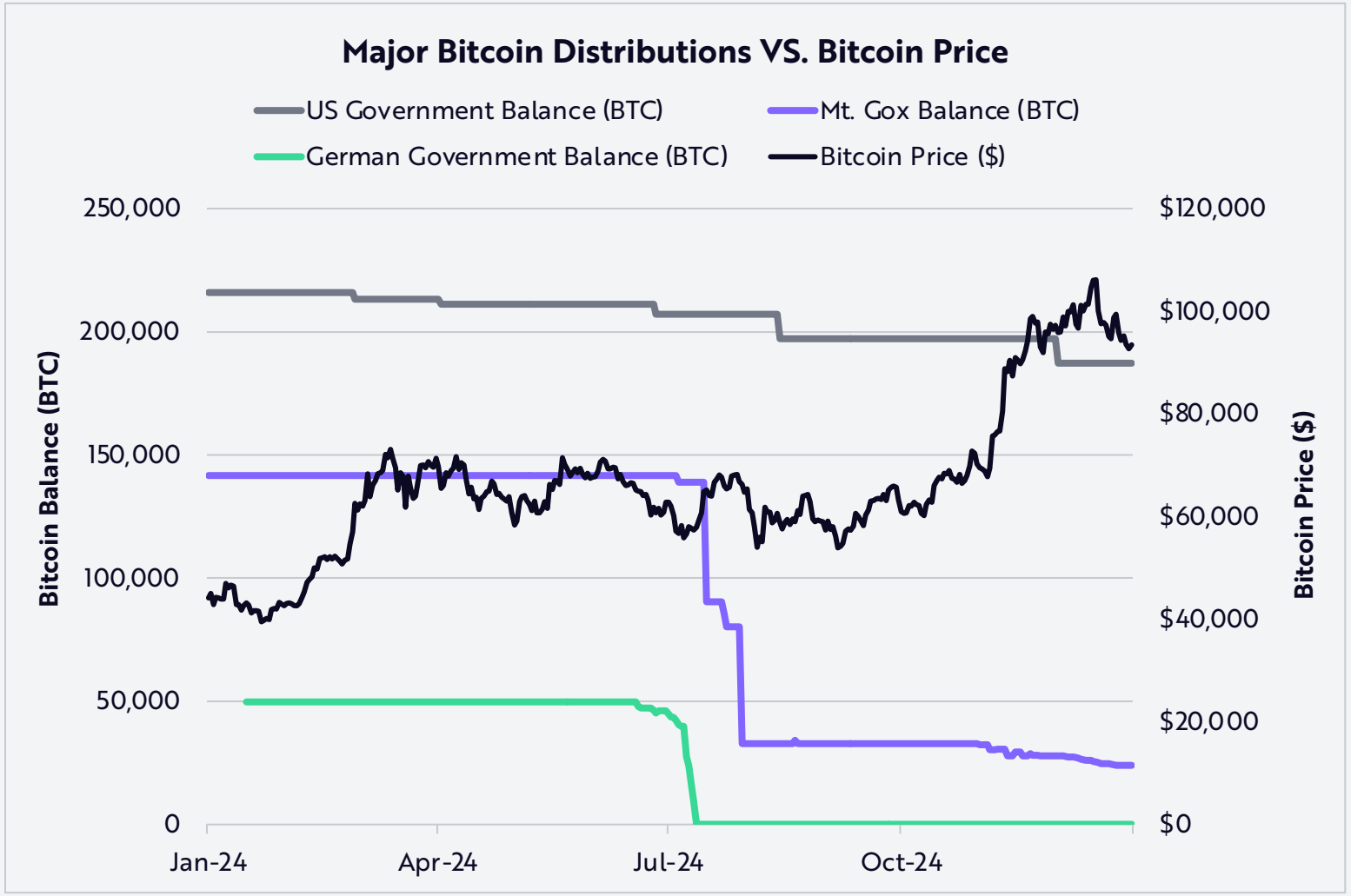
Bitcoin's daily transaction count hit a record high, thanks to the launch of the Runes protocol. Runes facilitates the creation of fungible tokens directly on the Bitcoin blockchain.





[1] "BRC20": Token standard that enables the minting and transaction of fungible tokens via the Ordinals protocol on the Bitcoin network. Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics and Glassnode as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Bitcoin Absorbed Major Selling Pressure In 2024



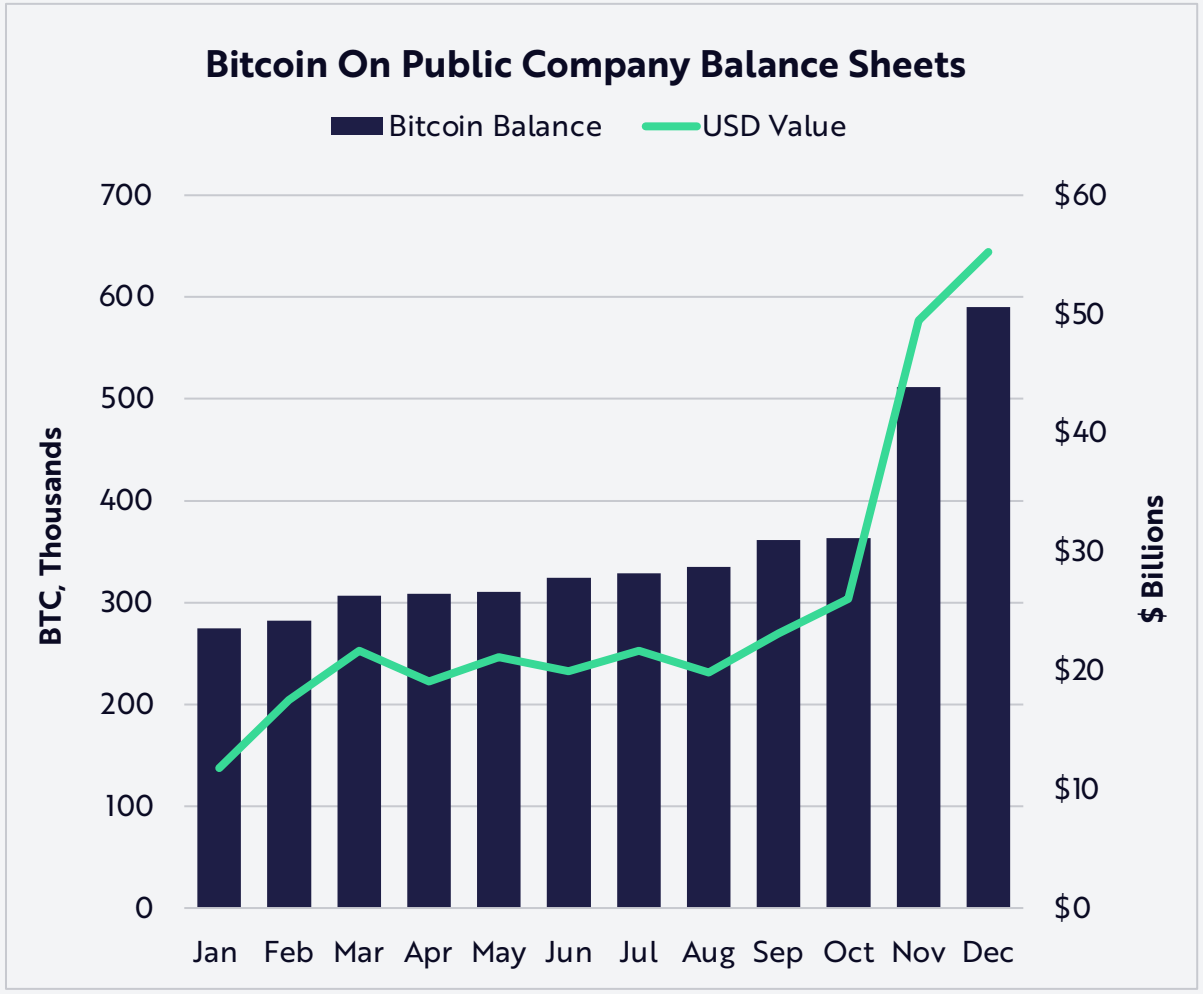
In January 2024, the German government seized 50,000 bitcoin linked to an online piracy group. Six months later, it sold the bitcoin. The market absorbed the supply successfully, and then the price of bitcoin rallied from $53,000 to $68,000.

Also, around mid-year, the long-awaited Mt. Gox[1] creditor repayment process distributed more than 109,000 bitcoin, removing its largest overhang.

[1] Mt. Gox was a bitcoin exchange that once handled up to 70% of bitcoin's total trading volume. It declared bankruptcy in 2014 after it was found to have run a fraudulent fractional reserve, incurring the loss of 850k bitcoin from users' funds at the time. During 2024, a large portion of reclaimed bitcoin was repaid to creditors, from an estimated 141,686 bitcoin at the start of the year to 27,877 by November 13. Data estimates sourced from Glassnode. Source: ARK Investment Management LLC, 2025, based on data from Glassnode as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

An Increasing Number Of Public Companies Now Hold Bitcoin

Seventy-four public companies now hold bitcoin on their balance sheets. The value on corporate balance sheets quintupled during the past year, from $11 billion in 2023 to $55 billion.

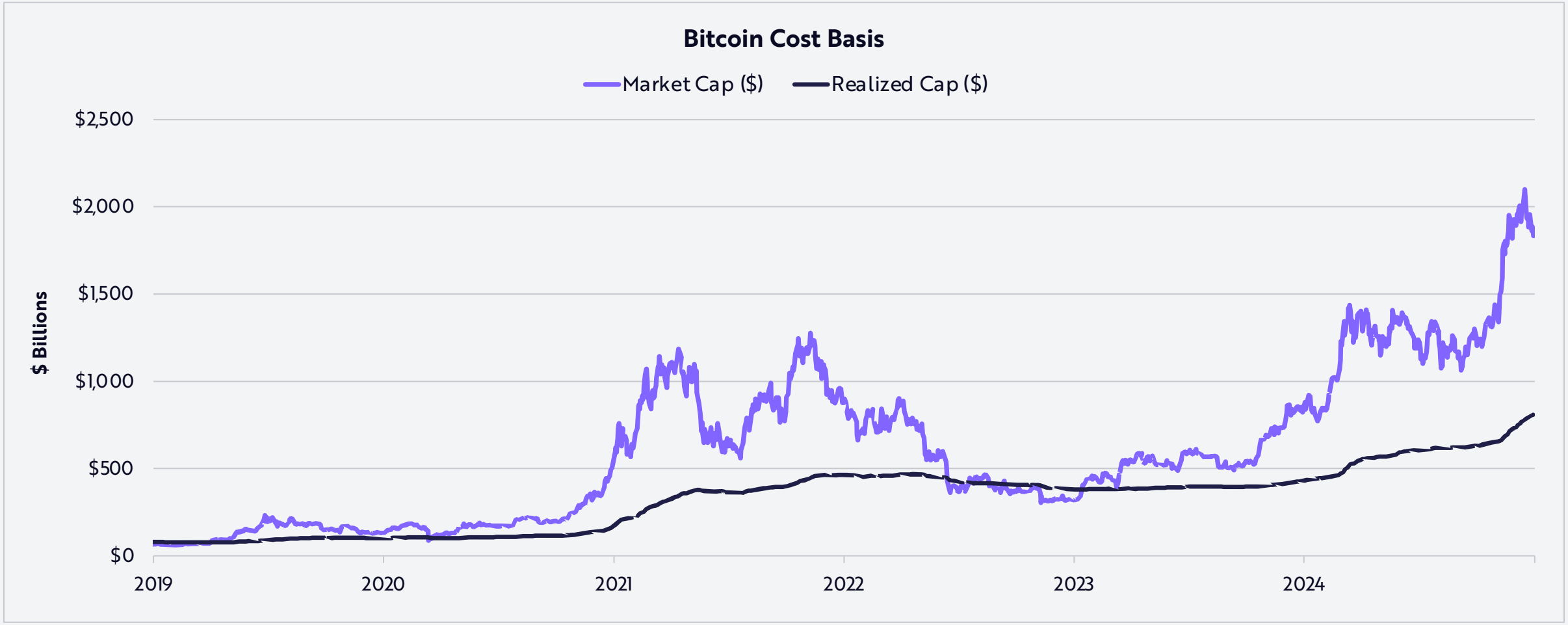


Public Company (Top 10)	Bitcoin Holdings	USD Value (Millions)	BTC Holdings As Percentage Of Market Cap
Microstrategy (MSTR)	446,400	$41,780	58.7%
Marathon Digital (MARA)	44,893	$4,201	73.8%
Riot Platforms (RIOT)	17,429	$1,631	46.4%
Hut 8 Mining (HUT)	10,096	$944	49.4%
Tesla (TSLA)	9,720	$909	0.07%
Coinbase (COIN)	9,480	$887	1.4%
CleanSpark (CLSK)	9,297	$870	32.3%
Block (SQ)	8,363	$782	1.4%
Bitcoin Group SE (ADE)	3,589	$335	133.5%
Boyaa Interactive (BOYAA/0434.HK)	3,183	$297	10.4%

Source: ARK Investment Management LLC, 2025, based on data from Bitcoin Treasuries and TradingView as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Bitcoin's Aggregate Cost Basis Hit A New High In 2024

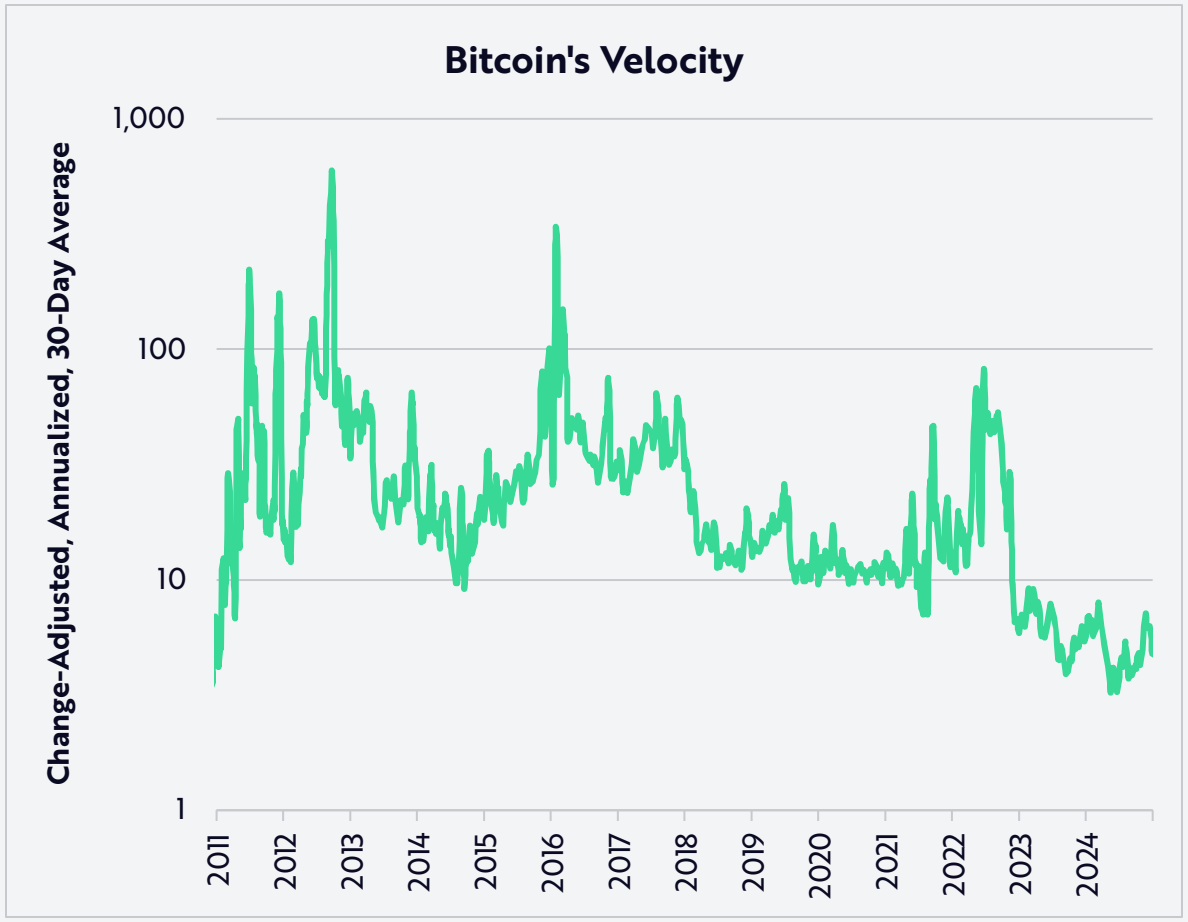
In 2024, Bitcoin's realized capitalization—or cost basis—grew by 86%, as its average acquisition cost hit a record high at $40,980 per bitcoin, or $811.7 billion in total.

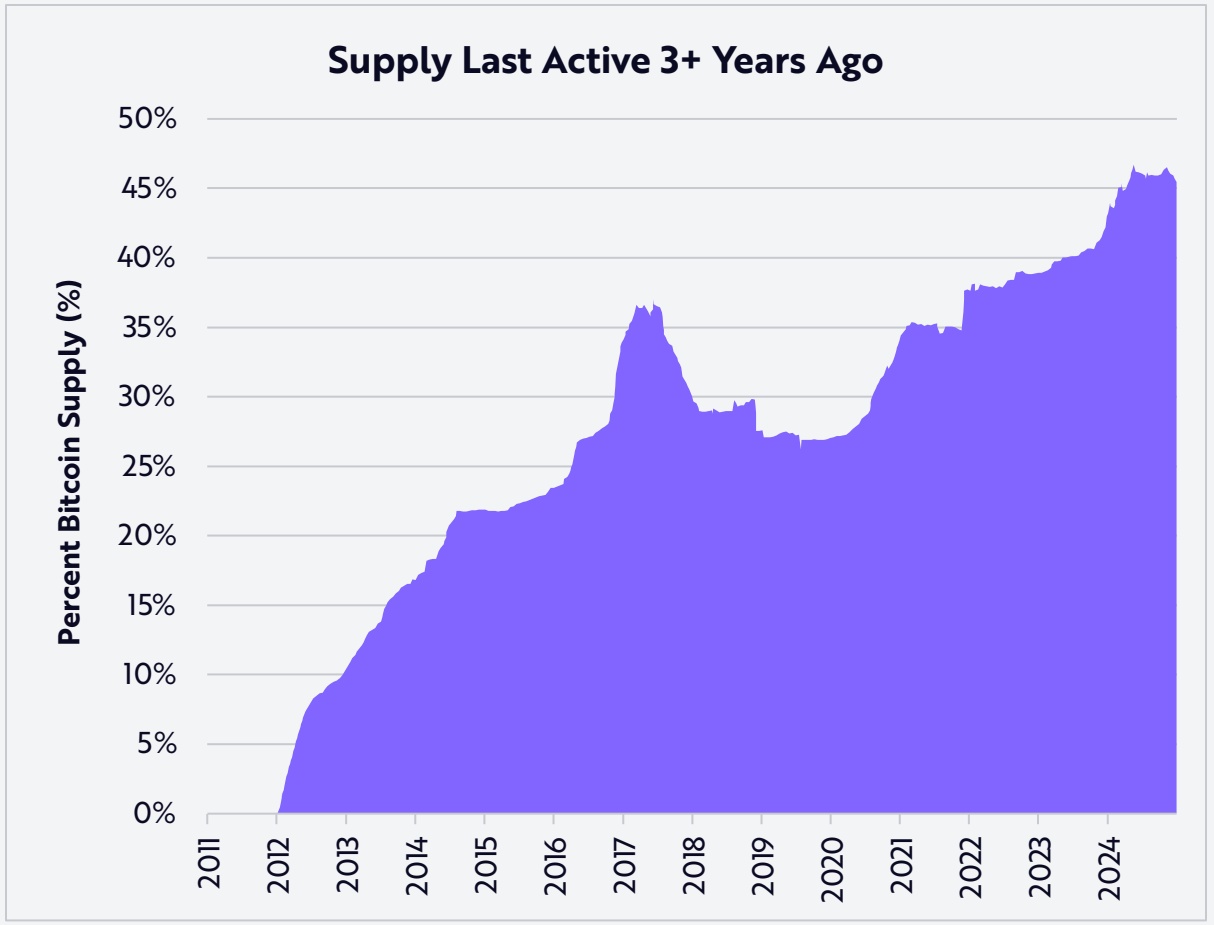


Source: ARK Investment Management LLC, 2025, based on data from Glassnode as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Bitcoin's Transaction Velocity[1] And Holding Behavior Underscore Its Role As A Store Of Value

Bitcoin's velocity dropped to a 14-year low in 2024, as supply held for three years or more reached an all-time high.





[1] "Velocity": a measure of how quickly bitcoin units circulate in the network, calculated by dividing the on-chain bitcoin transaction volume by the outstanding supply (annualized). Source: ARK Investment Management LLC, 2025, based on data from Glassnode as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Stablecoins

Reshaping The Digital Asset Space

Yassine Elmandjra
FORMER DIRECTOR OF DIGITAL ASSETS

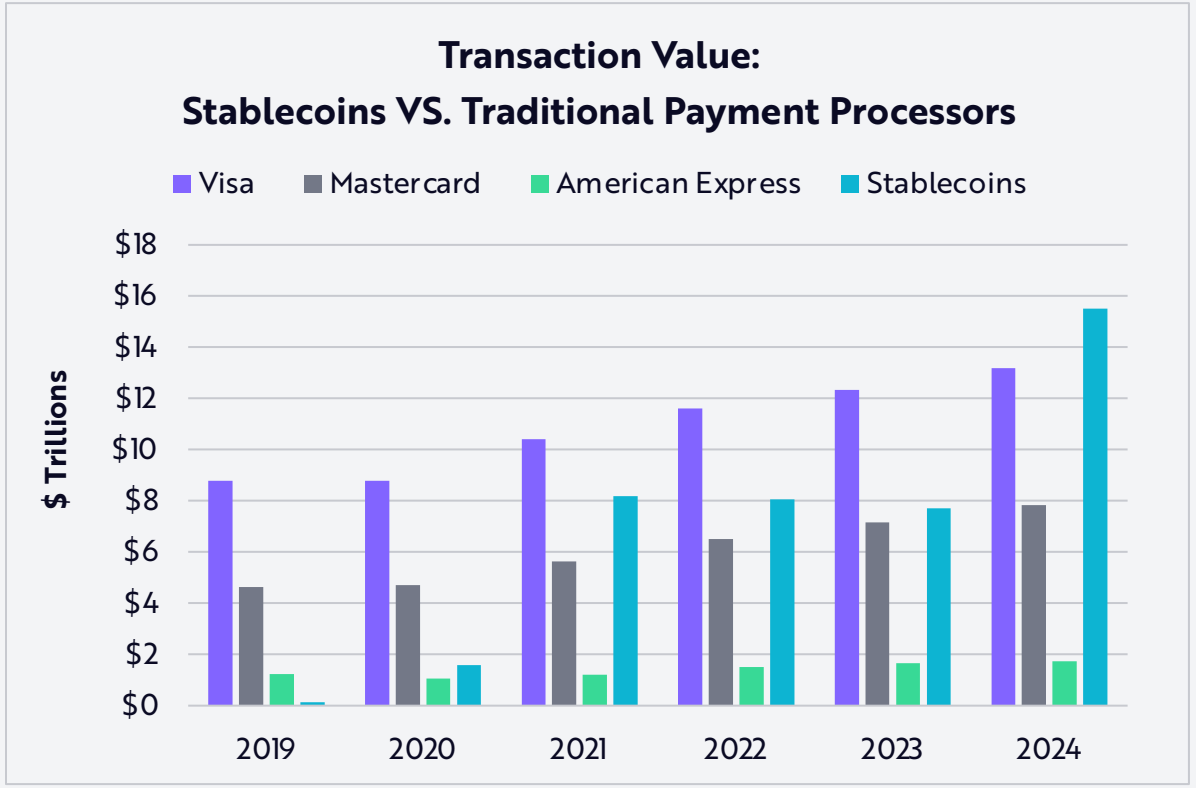
Lorenzo Valente
DIRECTOR OF DIGITAL ASSETS

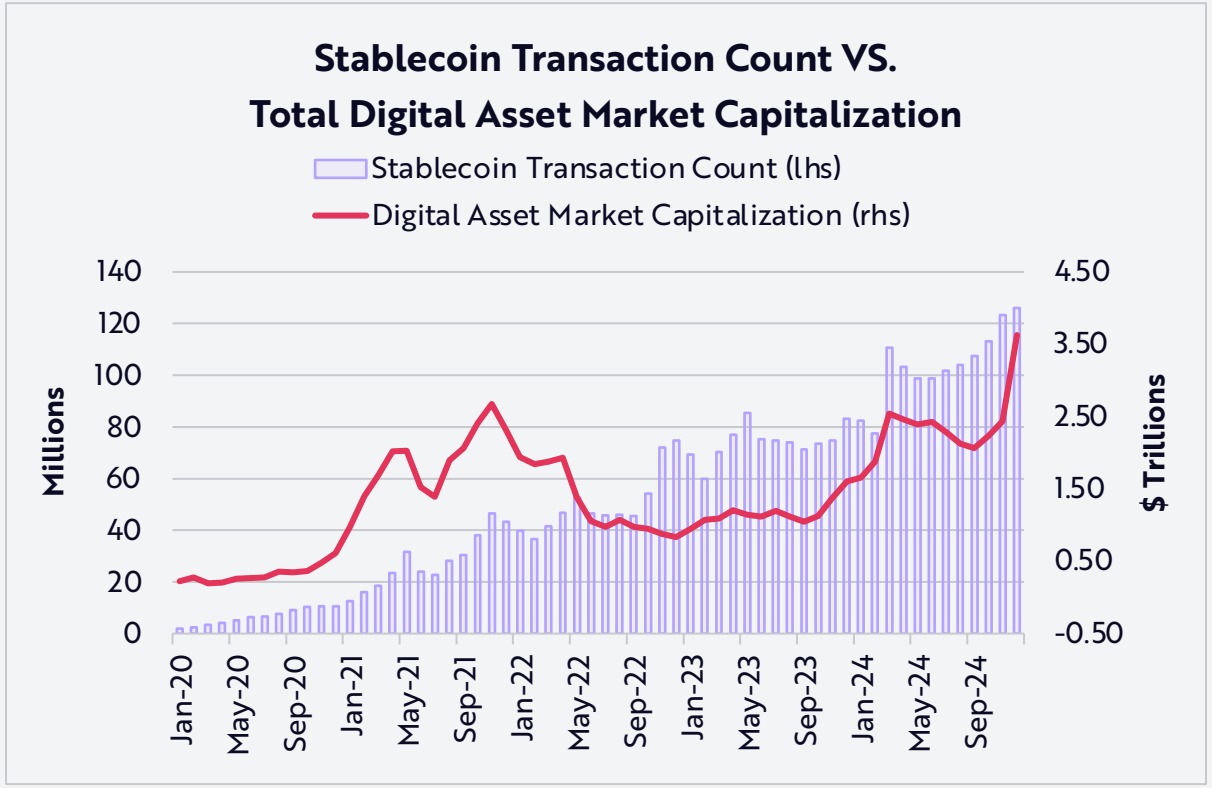
David Puell
RESEARCH TRADING ANALYST & ASSOCIATE PORTFOLIO MANAGER, DIGITAL ASSETS

Frank Downing
DIRECTOR OF RESEARCH, NEXT GENERATION INTERNET

One Of The Fastest-Growing Segments In Digital Assets, Stablecoins Overtook Mastercard And Visa In Transaction Value In 2024

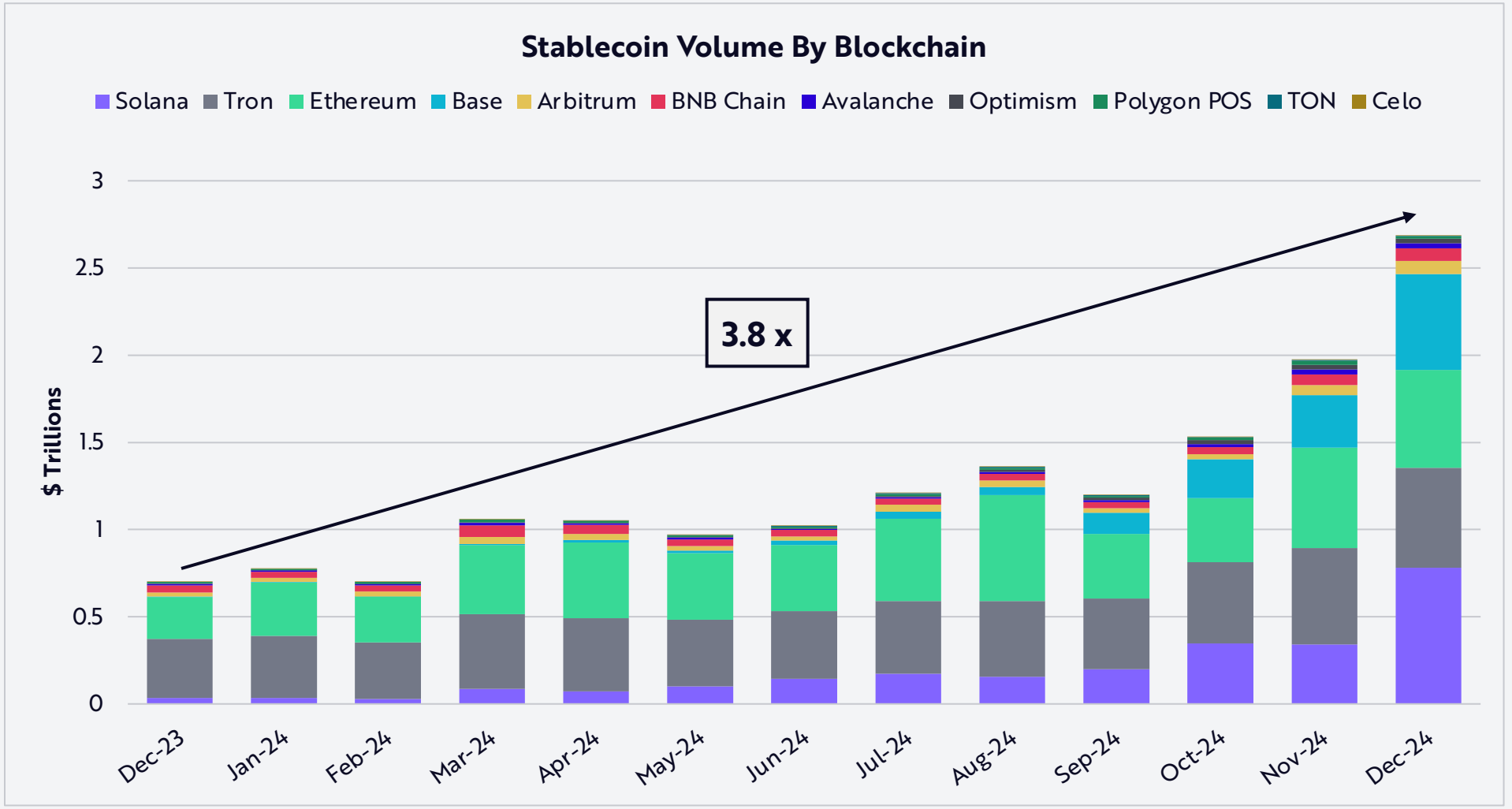
Despite a two-year bear market and a 70%+ decline in market capitalization, stablecoin growth has remained uninterrupted. In 2024, the annualized transaction value of stablecoins hit $15.6 trillion—roughly 119% and 200% that of Visa and Mastercard, respectively. The number of transactions hit 110 million monthly, roughly 0.41% and 0.72% of those processed by Visa and Mastercard, respectively. In other words, the stablecoin value per transaction is much higher than that for Visa and Mastercard.





Note: In the lefthand chart, stablecoins data are for calendar year, while credit card data are for fiscal year. Source: ARK Investment Management LLC, 2025. This ARK analysis is based on a range of external data sources, including Wall Street Zen, CoinGecko, and Visa OnChain Analytics, as of December 31, 2024, which may be provided upon request, For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Stablecoin Volumes Hit Record Highs In December 2024



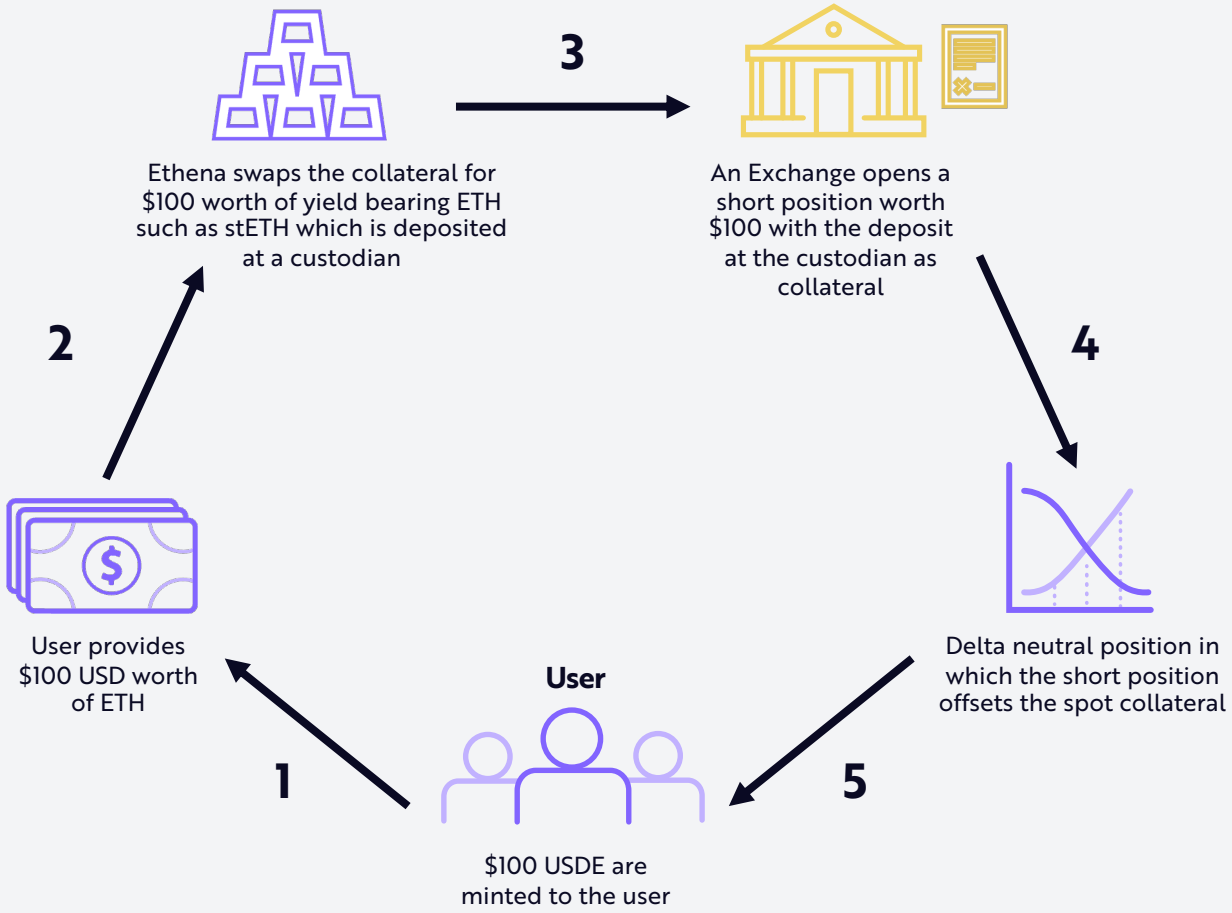
Solana, Tron, Ethereum, and Base are the leading blockchains that drove stablecoin volume in 2024.

December 2024 set new records with a daily volume of $270 billion and a monthly volume of $2.7 trillion, highlighting the sector's rapid growth.

Source: ARK Investment Management LLC, 2025., based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Ethena Labs Tokenized A Popular Basis Trade And Amassed $6 Billion In 12 Months

Innovation in the stablecoin space is thriving, with Ethena Labs as one of the fastest-growing projects. Despite criticism of its novel design, the project has captured significant share of the non-fiat-backed stablecoin market and has become a key competitor in this $200 billion space.



Ethena Labs reached $6 billion in total value locked during its first twelve months.

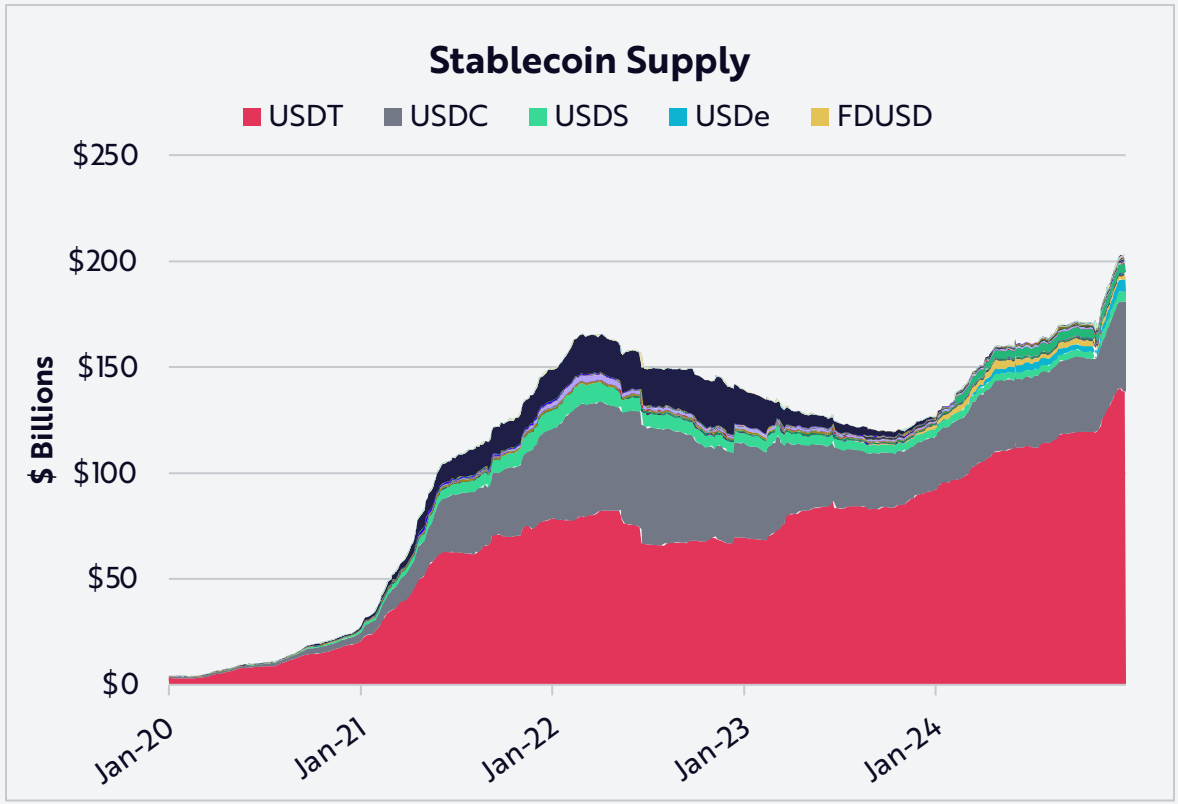
By tokenizing a delta-neutral position, Ethena Labs can offer yields as high as 20%-30%, depending on market conditions. The yield could turn negative in a bear market.

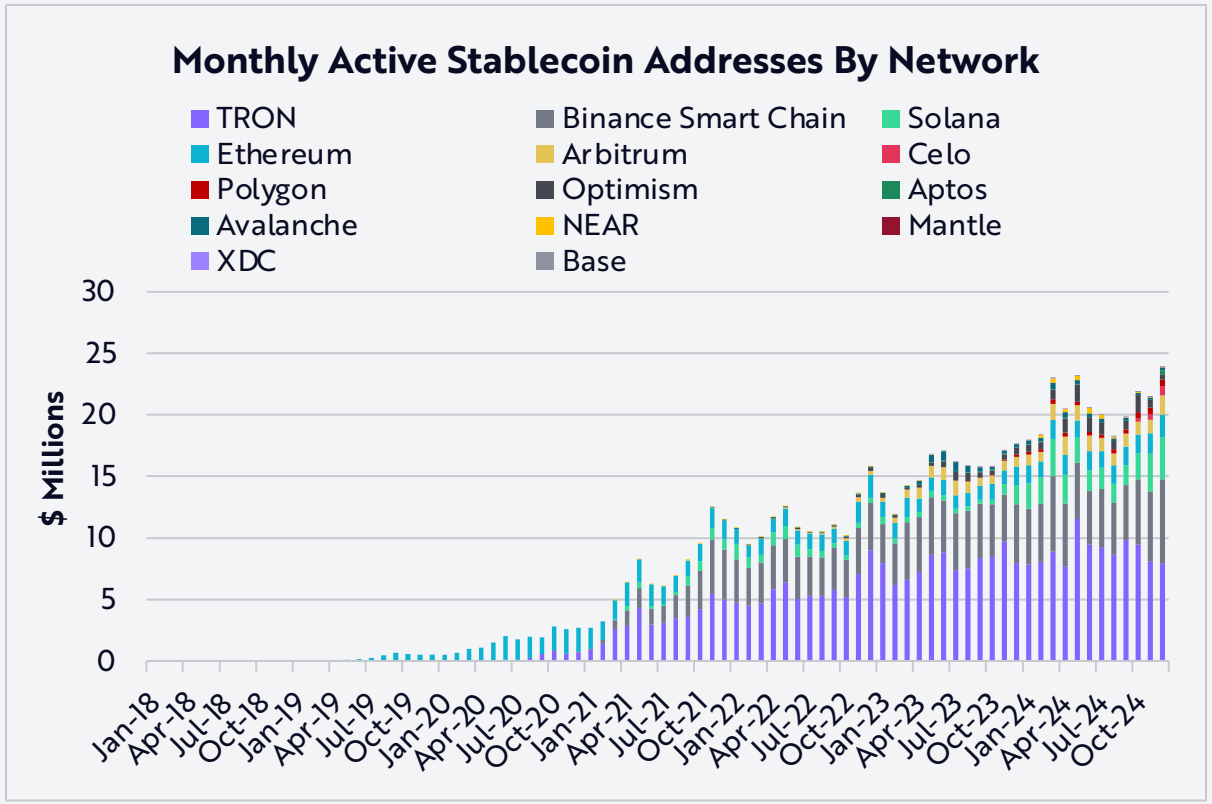
Having captured 10% of total Ether open interest, Ethena Labs is expanding into Solana and Bitcoin delta-neutral trades.

Note: A delta neutral position in finance is a strategy designed to hedge against price movements in the underlying asset. Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

After A Drawdown In 2023, The Supply Of Stablecoins And The Number Of Active Stablecoin Addresses Hit All-Time Highs In 2024

UDST (Tether) continues to dominate the stablecoin landscape, followed by USDC (Circle). Together, they account for 90% of the total supply. Stablecoins are "multichain" and have penetrated almost every major Layer 1 blockchain. At $203 billion, the stablecoin supply represents ~0.97% of M2* money supply in the US. During December, active stablecoin addresses hit 23 million, an all-time high. As measured by monthly active addresses, Tron is the leading network, favored in emerging markets for its low transaction fees.



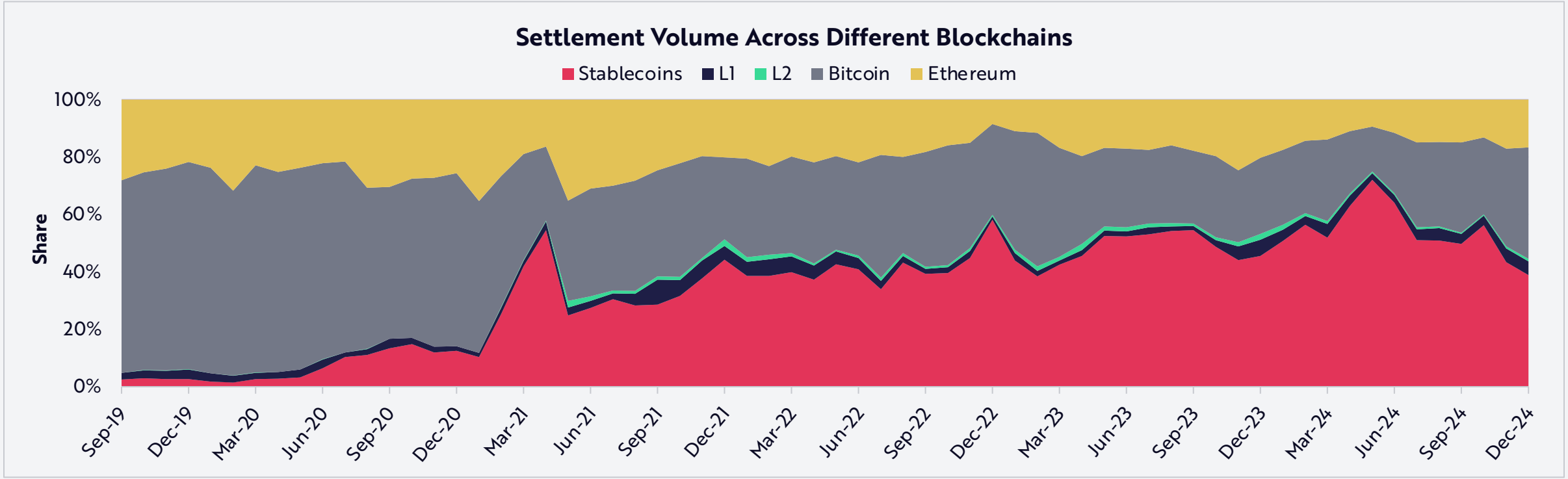


*M2 is a measure of the US money stock that includes M1 (currency and coins held by the non-bank public, checkable deposits, and travelers' checks) plus savings deposits (including money market deposit accounts), small time deposits under $100,000, and shares in retail money market mutual funds. Source: ARK Investment Management LLC, 2025, based on data from rwa.xyz ("Stablecoins") as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

As Some Countries Shift Away From The Dollar, Digital Assets Are Moving Toward It

Digital Assets are undergoing "stablecoinization" and "dollarization," while China and Japan have sold record volumes of US Treasuries, Saudi Arabia has ended its 45-year petrodollar agreement, and BRICS* nations have reduced their reliance on US dollar payments by circumventing the SWIFT network. Historically, bitcoin and ether were the bridges into the digital asset ecosystem. During the past two years, however, stablecoins have dethroned them and now account for 35% to 50% of on-chain transaction volumes.

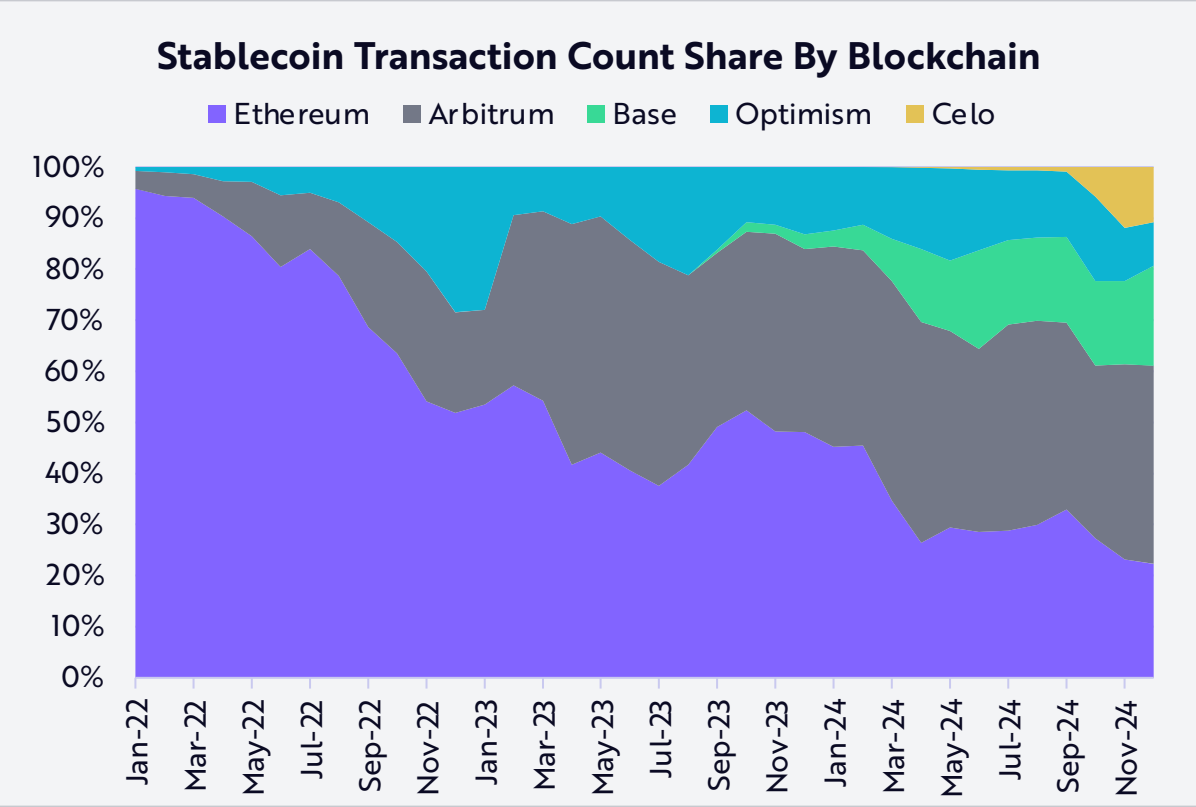
Dollar-pegged stablecoins dominate, accounting for 98%+ of the supply, followed by Gold-backed and Euro-backed stablecoins, with ~1% and ~0.5%, respectively. ARK's research suggests that the market will expand and include Asian currency-backed stablecoins.

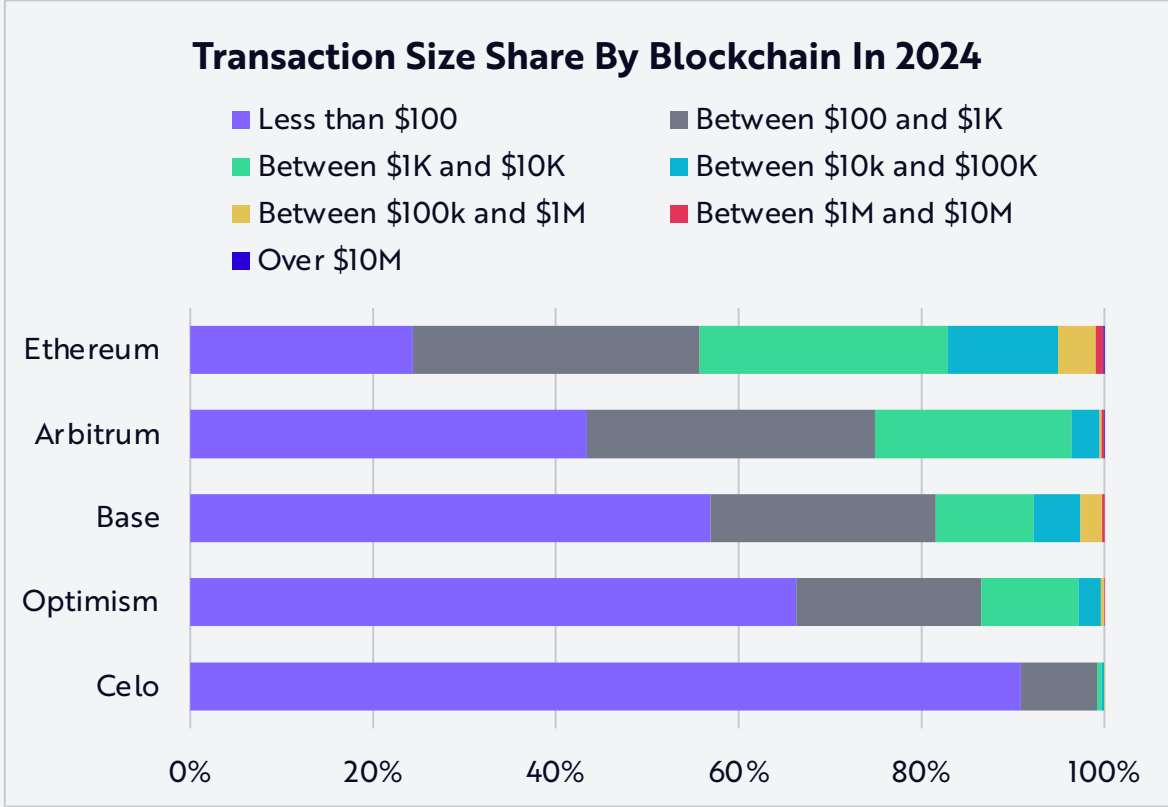


*BRICS refers to five major emerging economies—Brazil, Russia, India, China, and South Africa. Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Stablecoins Are Attracting Retail Interest, Thanks To The Lower Cost And Higher Efficiency Of Layer 2s

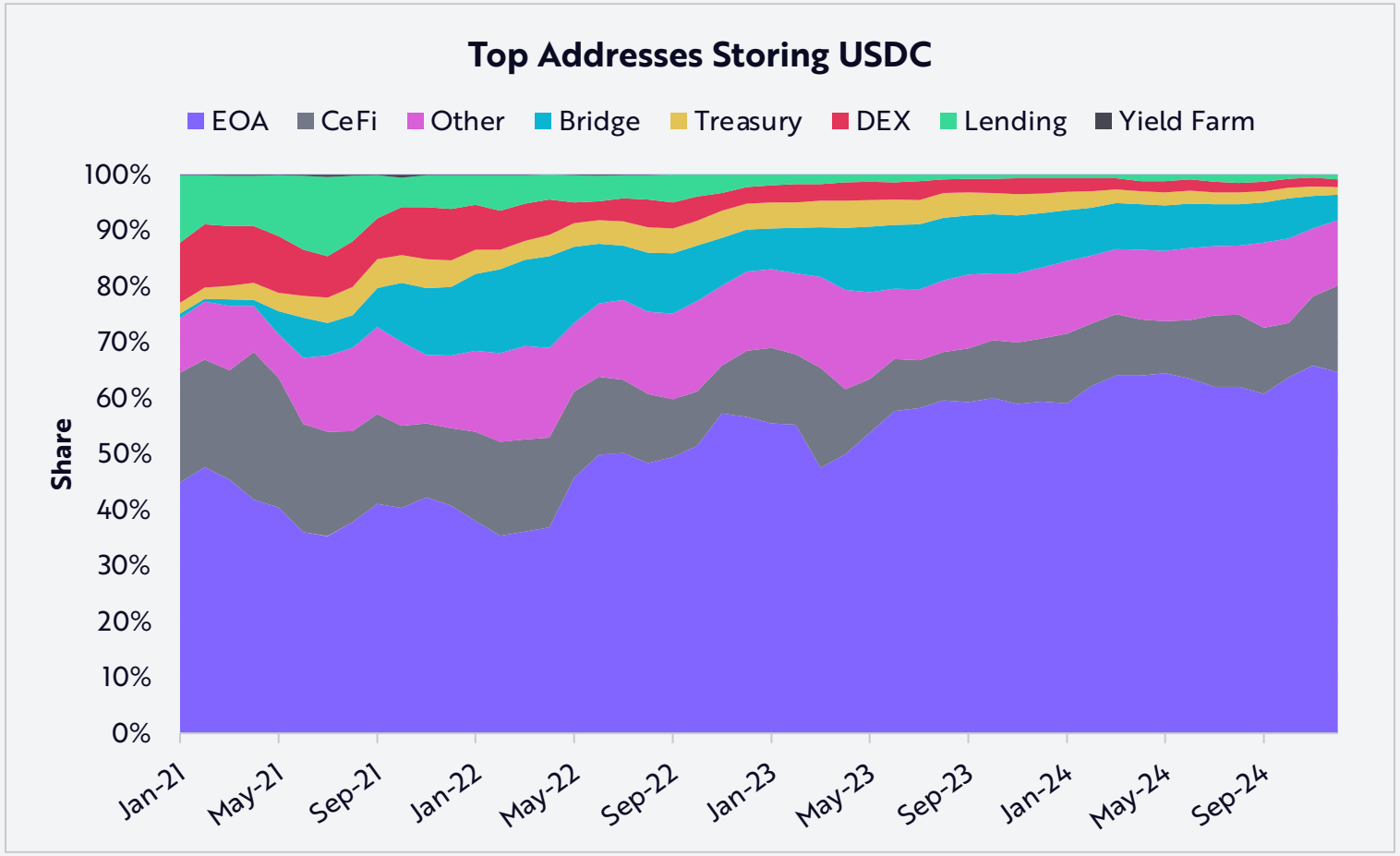
Retail investors are flocking to Layer 2s for less expensive and more convenient stablecoin transactions, increasing the market share of Blockchains like Arbitrum, Base, and Optimism. Meanwhile, whales* and institutions continue to operate on Ethereum's base layer. Transactions below $100 dominate activity on Base and Optimism, while those above $100 dominate Ethereum's base layer.





*"Whale": an individual or entity that holds a large amount of a specific cryptocurrency, usually north of 5-10 million dollars depending on the asset. Source: ARK Investment Management LLC, 2025, based on data from Visa OnChain Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Peer-to-Peer Transactions And Personal Wallet Storage Dominate Stablecoin Use Cases



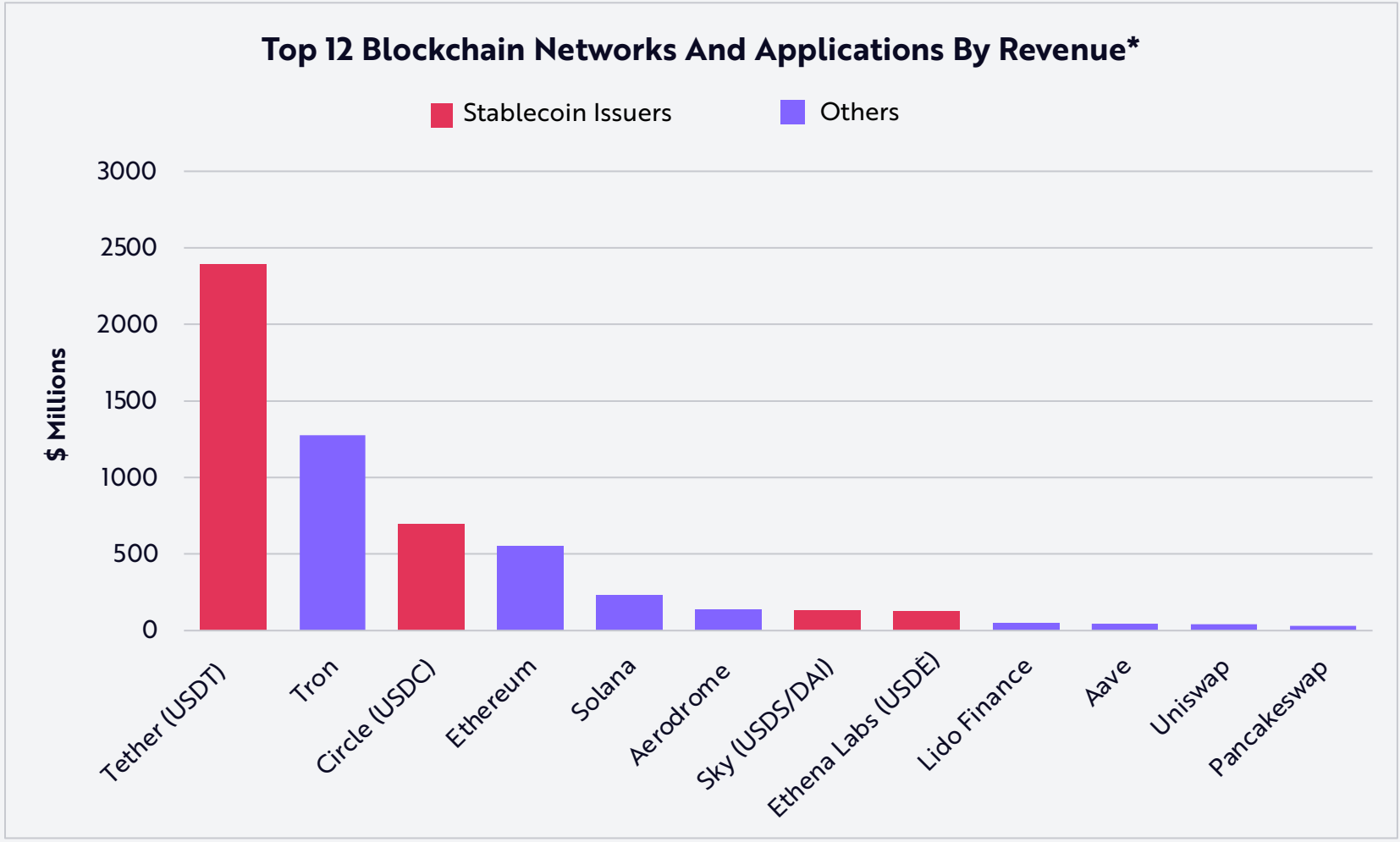
Externally Owned Accounts (EOAs)—standard Ethereum addresses used for peer-to-peer (P2P) transactions and storage—account for 60% of USDC's usage, while **centralized exchanges** account for 11%, **bridges** across Layer 2 solutions for 7%, and **decentralized exchanges** (DEXs) and **money markets** each for 1.7%.

As DeFi usage surges in the next few years, DEXs, Bridges, and Money Markets are likely to retake market share from P2P.

While usage in lending/borrowing markets, DEXs, and Bridges fluctuates with market cycles, P2P transactions and storage are more resilient because of product-market fit beyond trading.

Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Four Stablecoin Issuers Dominate The Revenue Generated In Digital Assets



With fewer than 200 employees, Tether reported $5.2 billion in profits during the first half of 2024, including USDT, the rest of its products and services, and unrealized gains on its Digital Assets—clearly one of the most capital-efficient businesses in history.

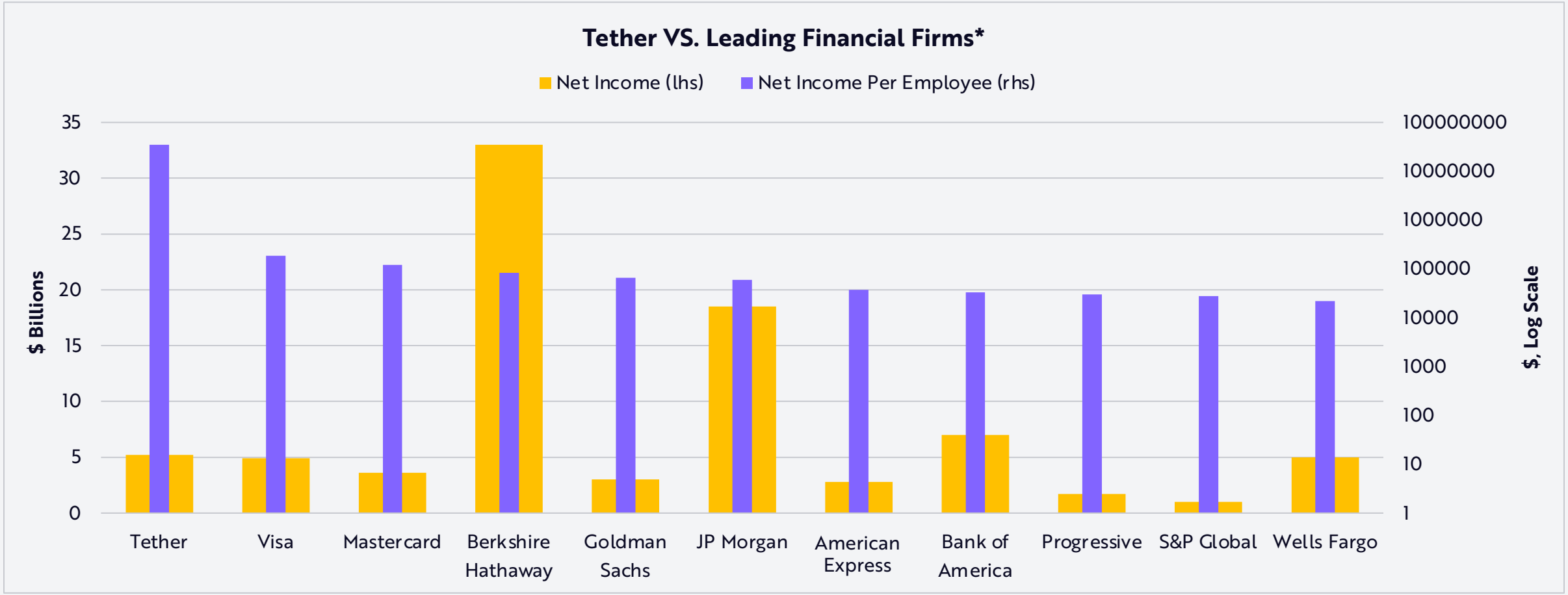
Tether (USDT) and Circle (USDC) account for 60% of the revenue generated by the top five networks and applications.

Collectively, stablecoins USDT, USDC, DAI/USDS, and USDE generated revenues of $3.35 billion, or $6.7 billion at an annual rate, during the second half of 2024.

*Second Half of 2024. Source: ARK Investment Management LLC, 2025, based on data from Token Terminal of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

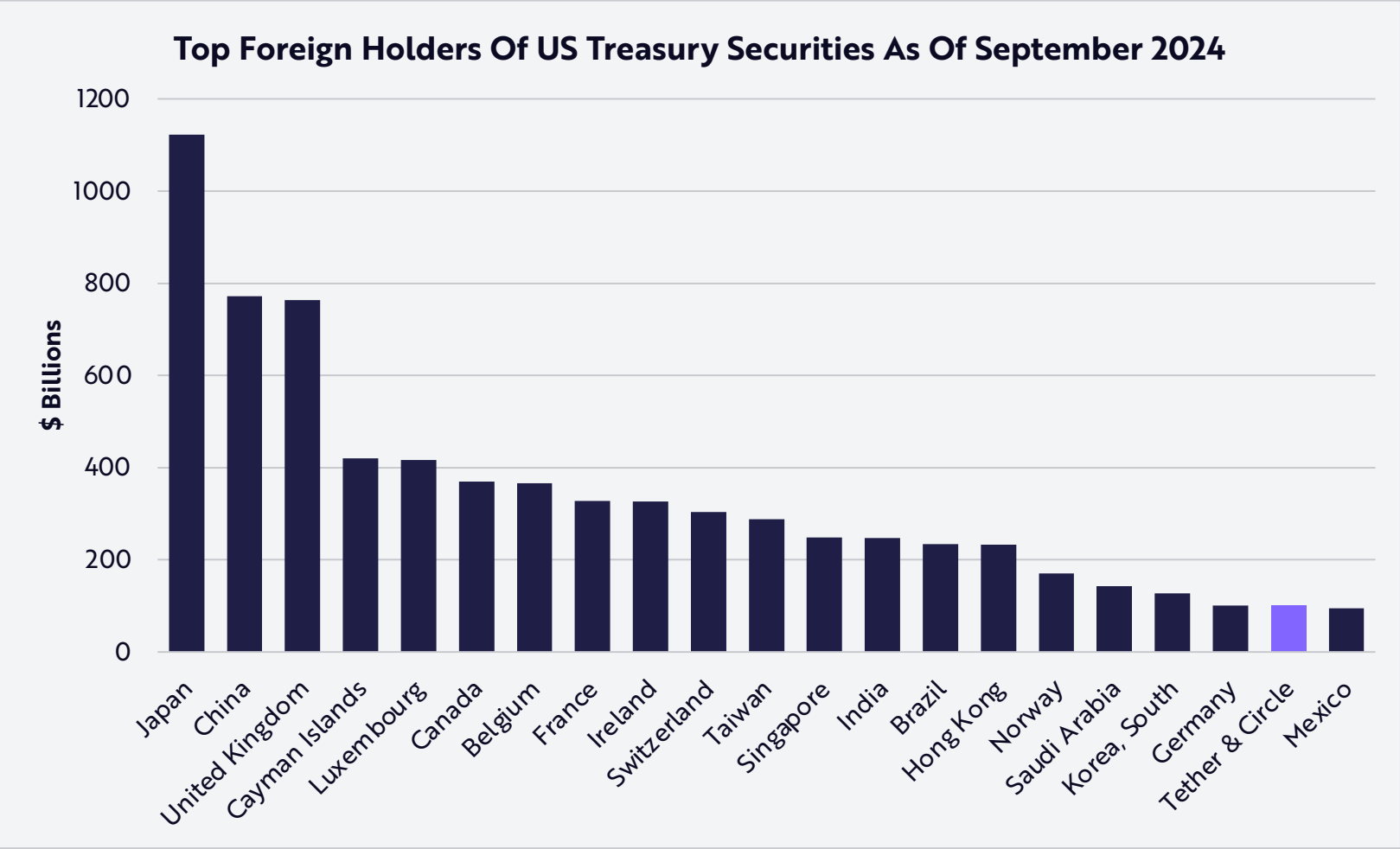
Tether's Financial Performance Is Stunning, Both Absolutely And Relatively

Tether employs fewer than 200 people compared to 300,000+ each at JP Morgan and Berkshire Hathaway. The only institutions in the S&P Financial Select Sector Index generating more net income than Tether in the first half of 2024 were Berkshire Hathaway, JP Morgan, Bank of America, and Wells Fargo.



*First Half of 2024. Source: ARK Investment Management LLC, 2025. This ARK analysis is based on a range of external data, sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Counterbalancing "De-Dollarization," Stablecoins Are Increasing The Demand For US Government Debt As Collateral



In a world trending toward de-globalization and de-dollarization, stablecoins could drive steady demand for US Treasury securities. Combined, Tether and Circle already ranked as the 20th largest holder of US Treasuries as of December 2024.

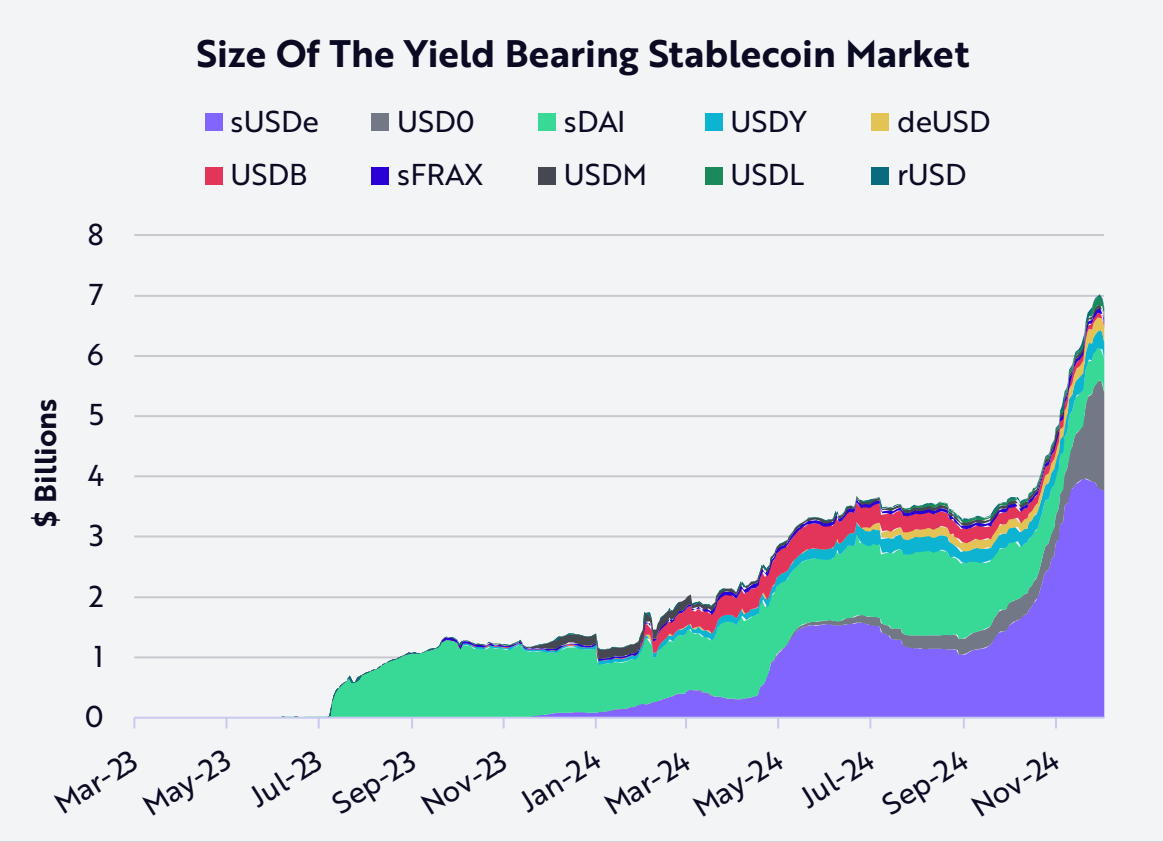
In populous emerging markets like Brazil, Nigeria, Turkey, Indonesia, and India, individuals and companies are adopting stablecoins as a store of value, means of payment, and cross-border currency. Stablecoins could become one of the most effective ways to export US dollars.

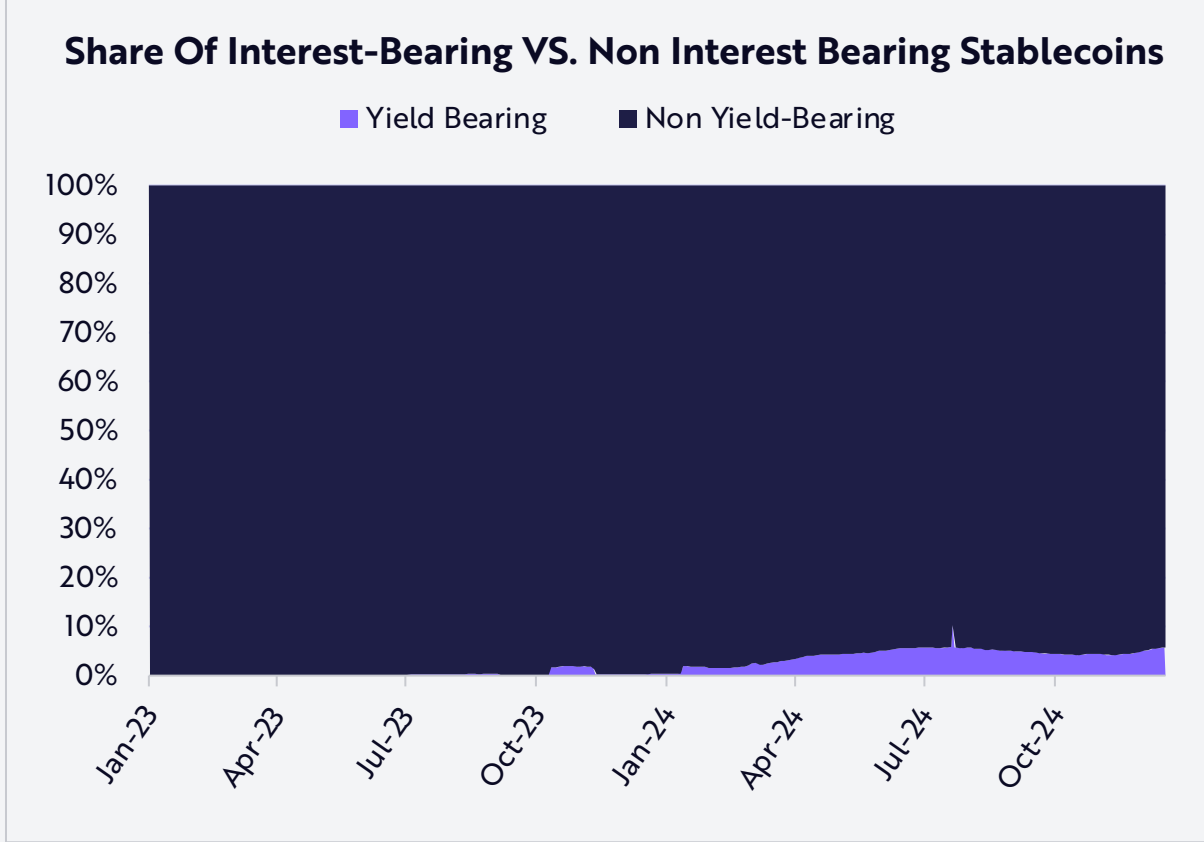
Source: ARK Investment Management LLC, 2025. This ARK analysis is based on a range of external data sources, including Tether, Circle, and TicData Treasury, as of December 31, 2024, which may be provided upon request.
For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Stablecoin Issuers Are Transferring Risk-Free Rates To Users

Circle and Tether have been generating billions in revenue from Treasury bills and other securities serving as collateral for their stablecoins. In 2024, however, in response to competition and demand, stablecoins operating outside of the US began to pass a significant portion of their interest income to users.

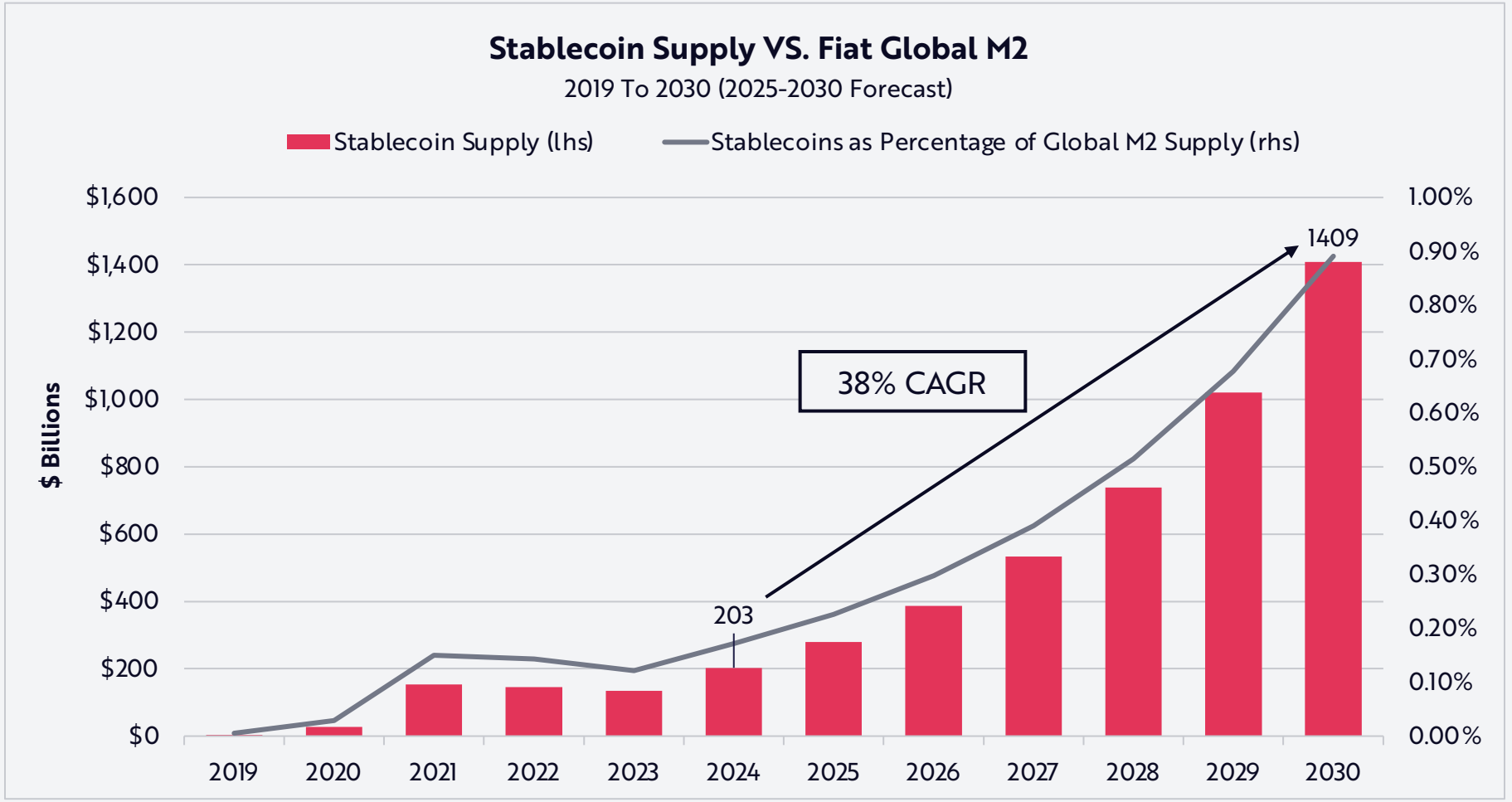
Circle and Tether are unlikely to follow the trend until absolutely necessary. Though still small, yield-bearing stablecoins are the fastest-growing category in the stablecoin market.





Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Stablecoins Could Increase From 0.17% to 0.9% Of Fiat* Global M2 Supply By 2030



Currently $203 billion, or 0.17% of global M2** supply, stablecoins could grow to $1.4 trillion and 0.9%, respectively, by 2030.

If so, stablecoins would be the 13th largest currency in circulation, behind Spain and ahead of Netherlands.

Note: "CAGR": Compound Annual Growth Rate. *Fiat money is a type of currency that is issued by a government and has value because the government declares it to be legal tender. **M2 is a measure of the US money stock that includes M1 (currency and coins held by the non-bank public, checkable deposits, and travelers' checks) plus savings deposits (including money market deposit accounts), small time deposits under $100,000, and shares in retail money market mutual funds. Source: ARK Investment Management LLC, 2025, based on data from rwa.xyz ("Stablecoins") as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Scaling Blockchains

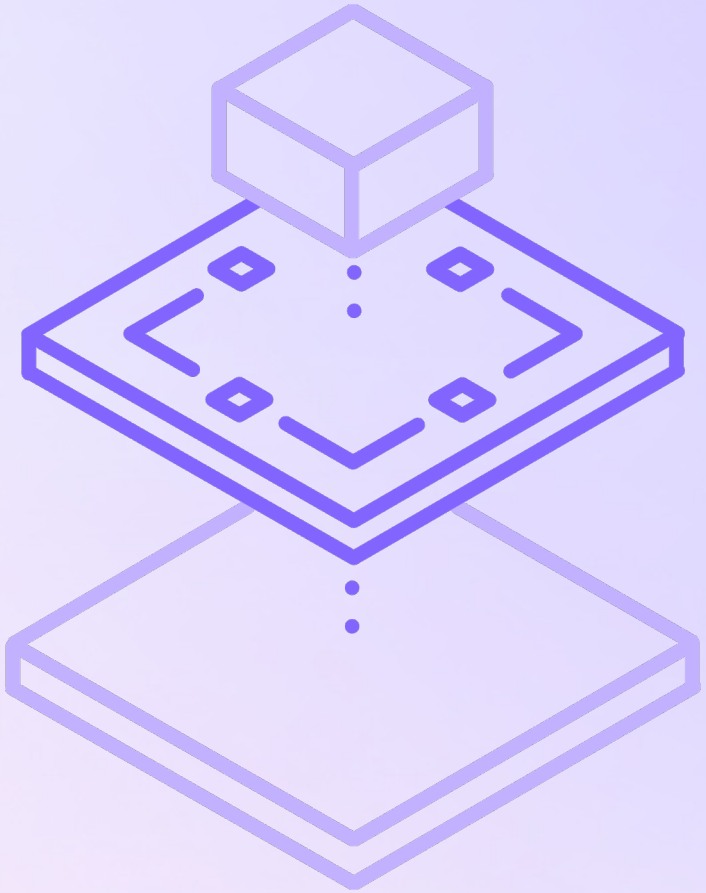
Enabling Steep Cost Declines And New Use-Cases At The Application Layer

Yassine Elmandjra
FORMER DIRECTOR OF DIGITAL ASSETS

Lorenzo Valente
DIRECTOR OF DIGITAL ASSETS

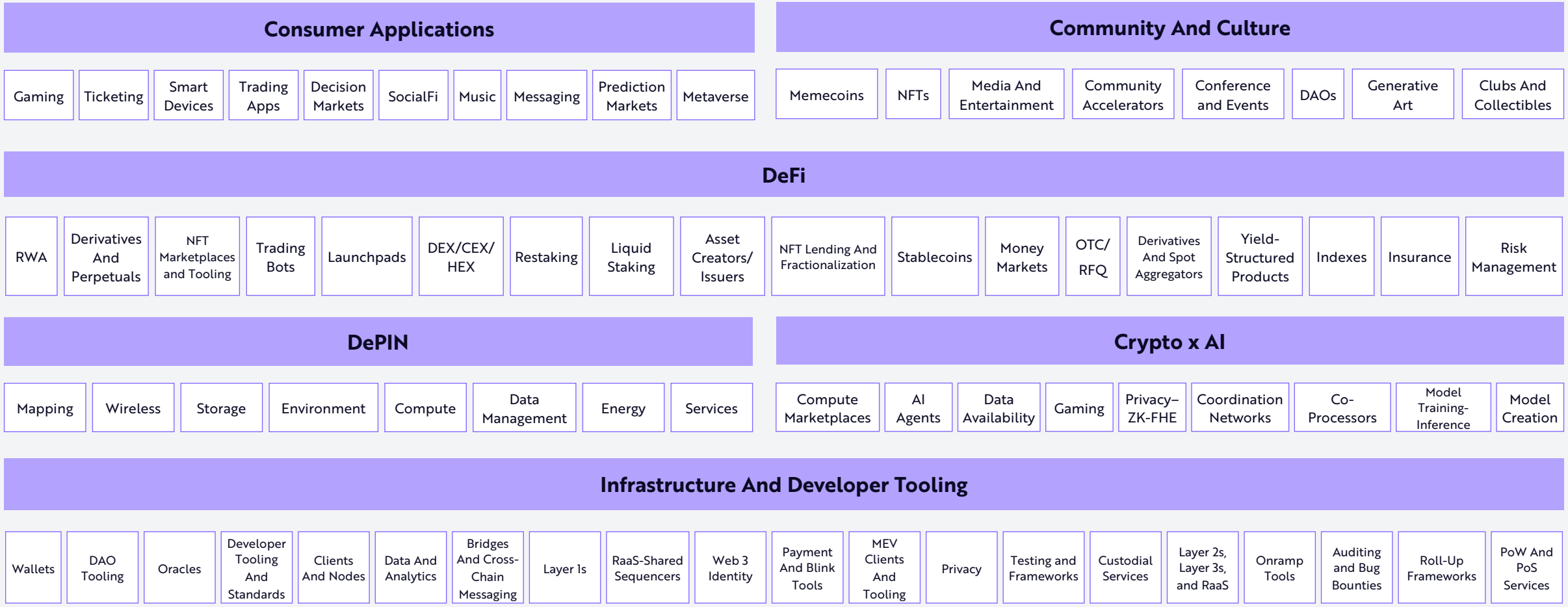
David Puell
RESEARCH TRADING ANALYST & ASSOCIATE PORTFOLIO MANAGER, DIGITAL ASSETS

Frank Downing
DIRECTOR OF RESEARCH, NEXT GENERATION INTERNET



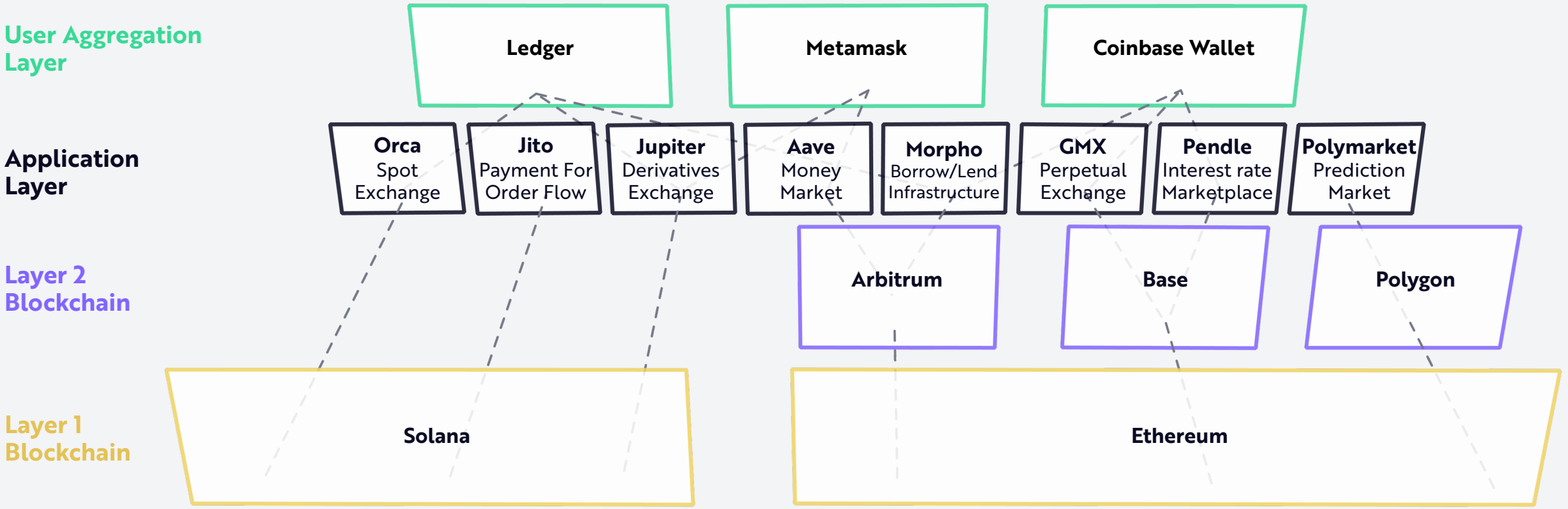
Navigating The Smart Contract Landscape

As the digital asset space becomes increasingly complex, smart contracts are driving innovation across a growing number of sectors. The ecosystem is evolving rapidly to meet diverse and dynamic needs—from user-focused applications like gaming and SocialFi, to advanced financial tools like derivatives and structured products, to decentralized infrastructure networks powering wireless connectivity and energy storage.



Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency.

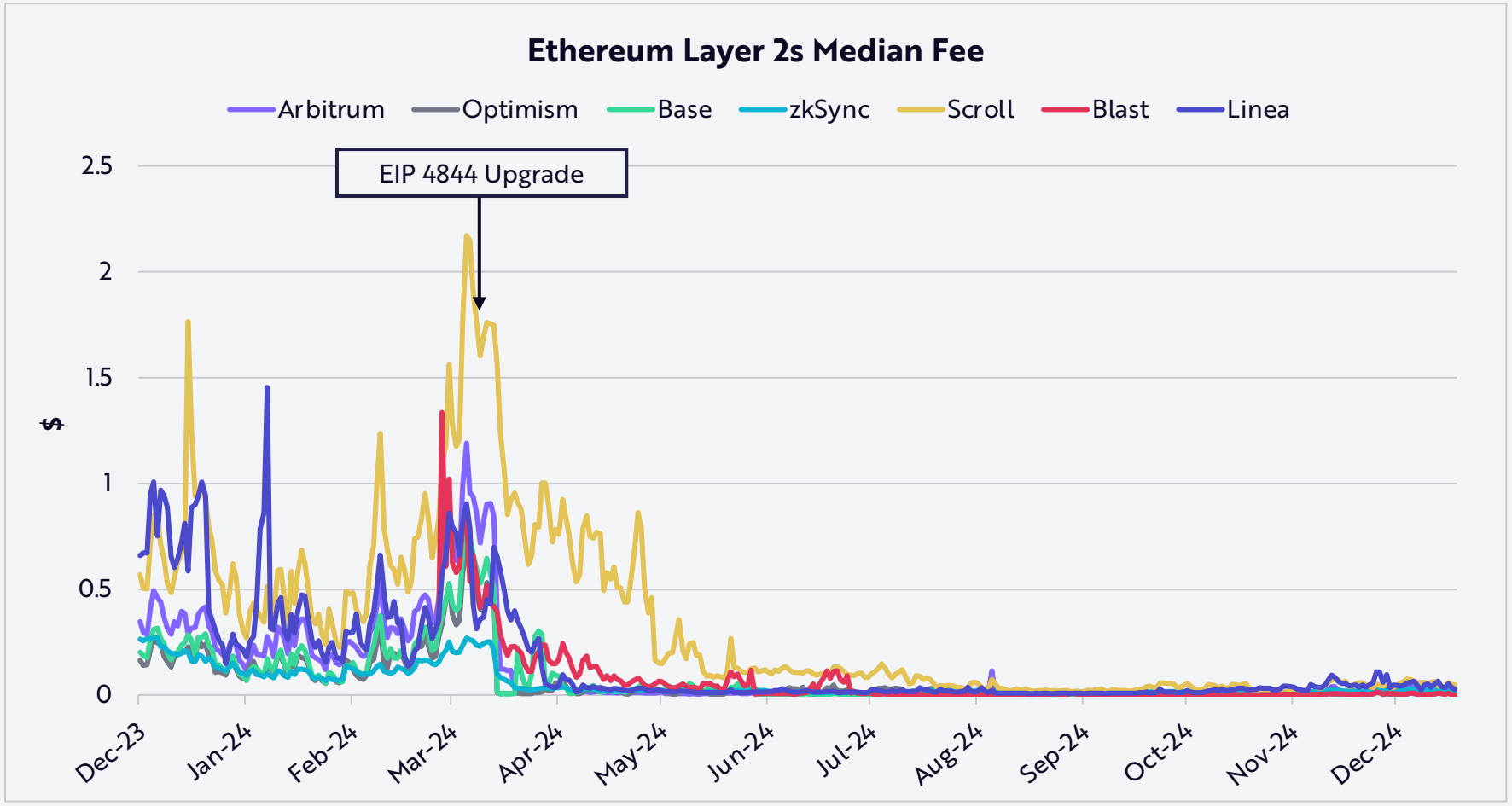
Applications Seeking Lower Fees And Greater Efficiency Deploy Either On Solana's High Throughput—Layer 1—Or On Ethereum's Layer 2s



Source: ARK Investment Management LLC, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security.
Past performance is not indicative of future results.

Ethereum's EIP 4844 Technical Upgrade Cut Transaction Costs By 10x, Spurring Use

One of Ethereum's most significant technical upgrades to date, EIP 4844, impacted Layer 2 networks by enabling faster, less-expensive transactions.



Prior to the EIP 4844 upgrade, the average transaction fee on Ethereum Layer 2s was ~$0.50. Now, users pay ~$0.05.

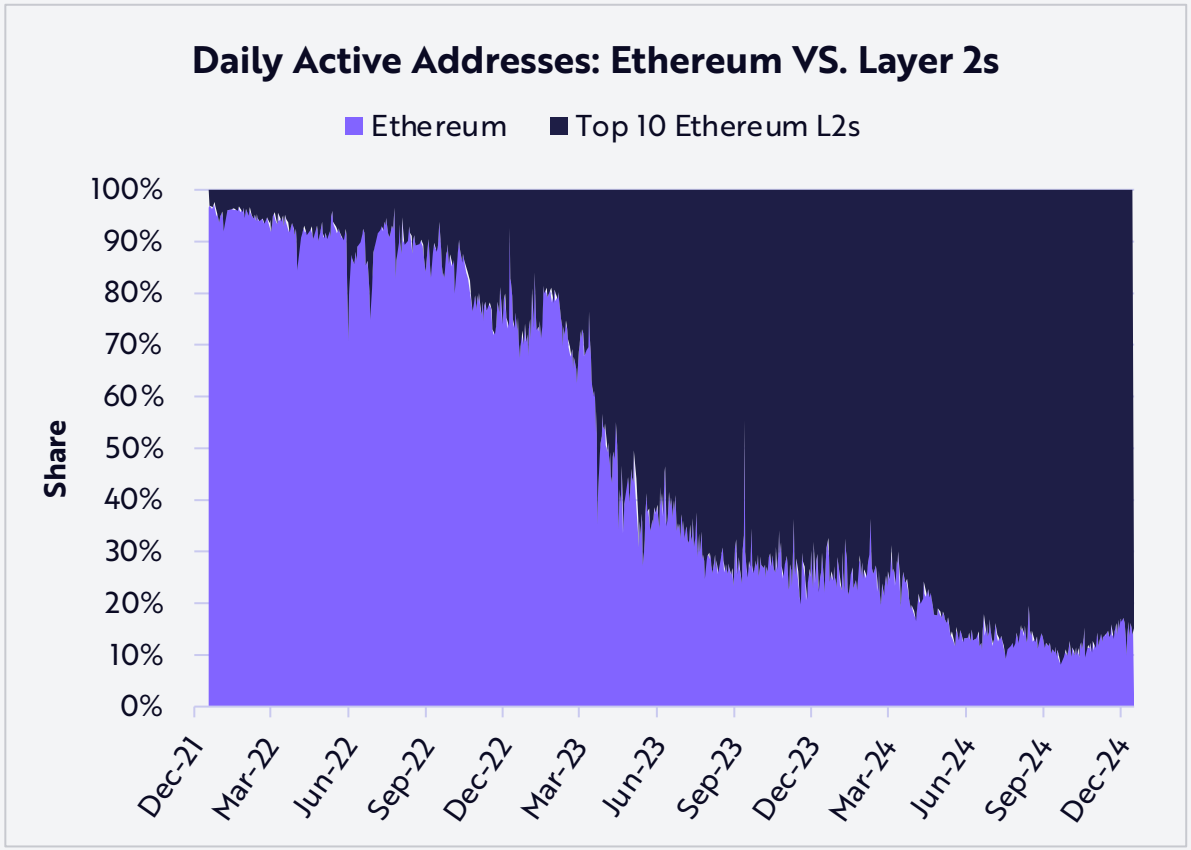
EIP 4844 was the first milestone in a roadmap that should enable a 250- to 1250-fold increase in transactions per second (TPS) from ~400 today to 100,000-500,000.

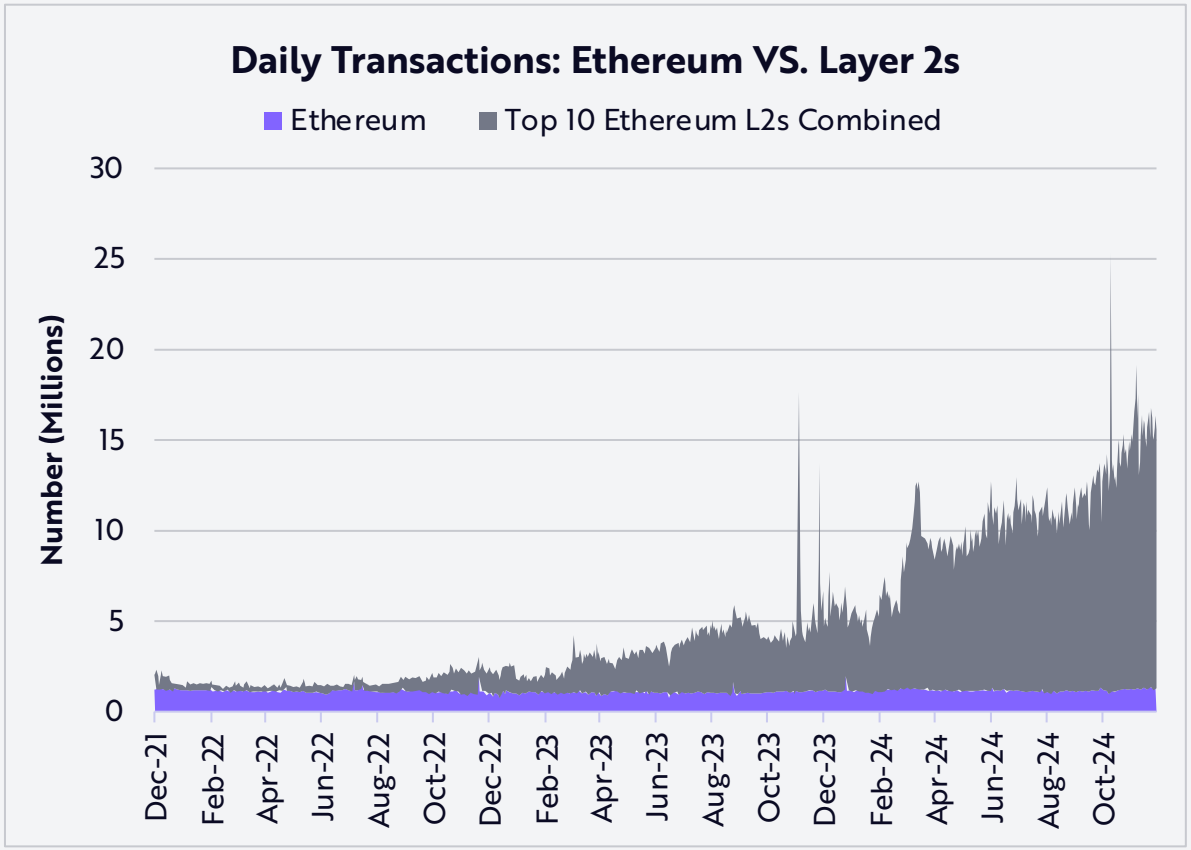
More than 200 Layer 2 projects have launched, with others on the way.

Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Plummeting Transaction Costs Have Led To A Boom In Layer 2 Activity, Pulling Users Away From Ethereum's Base Layer

Of the Daily Active Addresses transacting on the Ethereum ecosystem, Layer 2s have captured 85% share. The activity on Layer 2s enabled Ethereum to scale daily transactions by 400% from 3 million to 15 million in 2024.

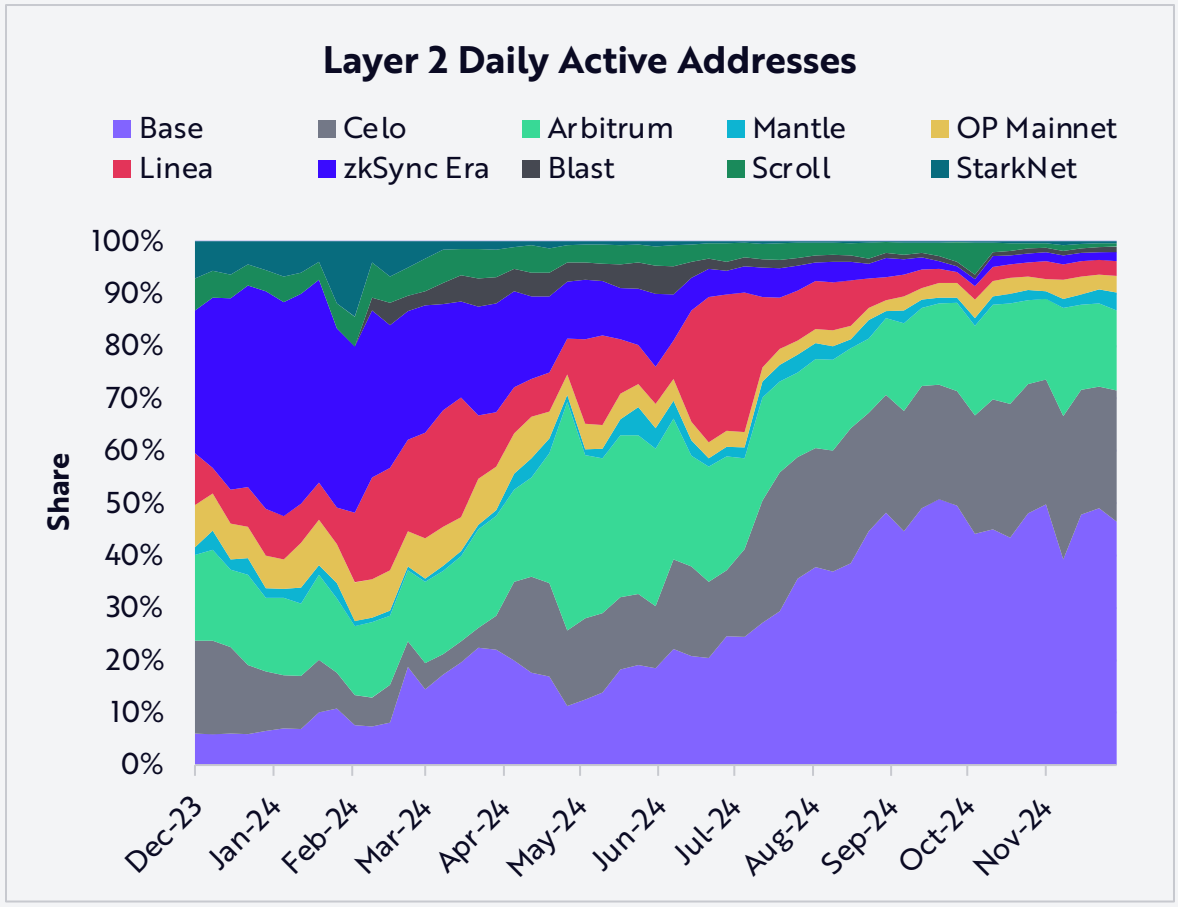


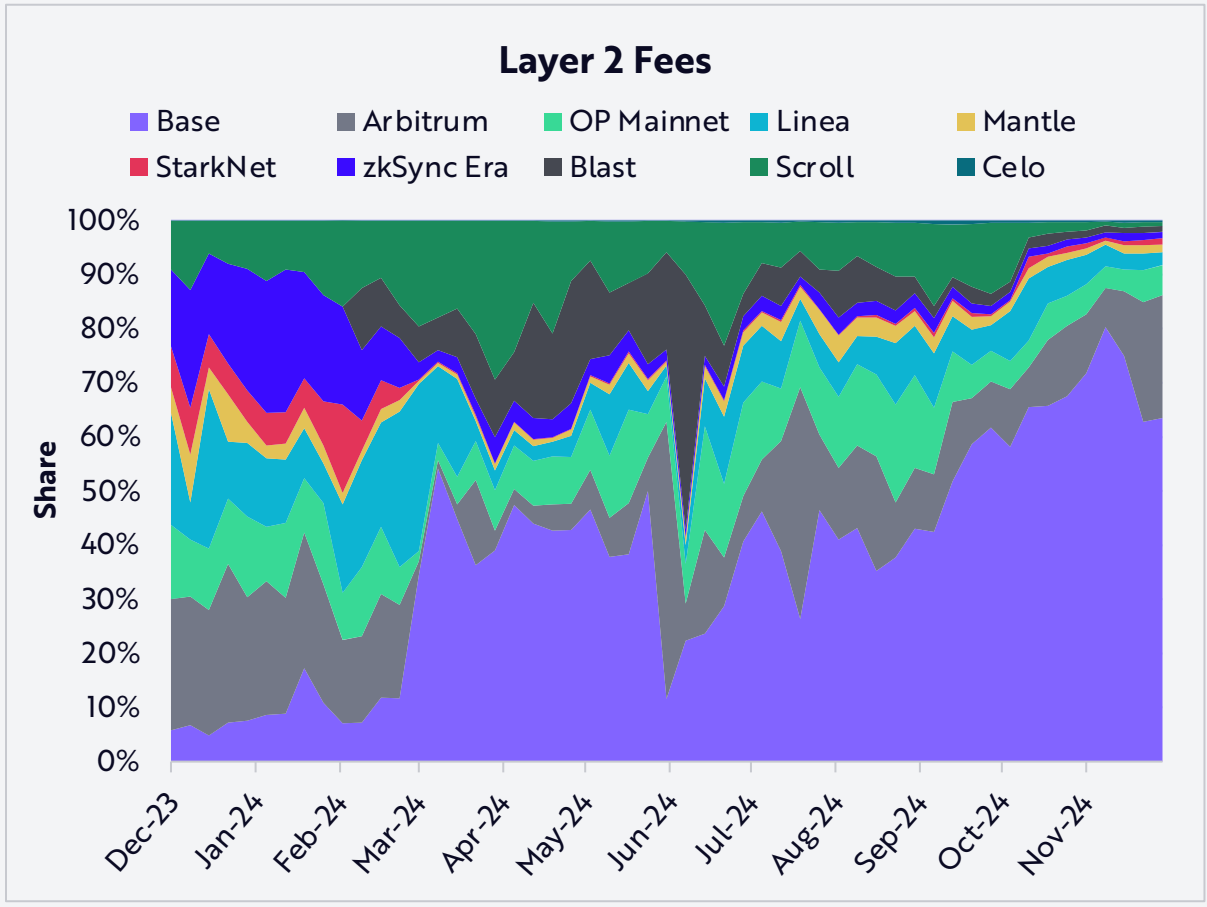


Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Base Is The Fastest Growing Ethereum Layer 2 Blockchain

Within one year of launch, Base outpaced all other Ethereum Layer 2 solutions in growth and market share. In 2024, Base captured 46% of active users and generated 63% of fees among Ethereum Layer 2s. With $15 billion in total value locked and more than 300 applications deployed, Base has been contributing significantly to Coinbase's cash-flows.

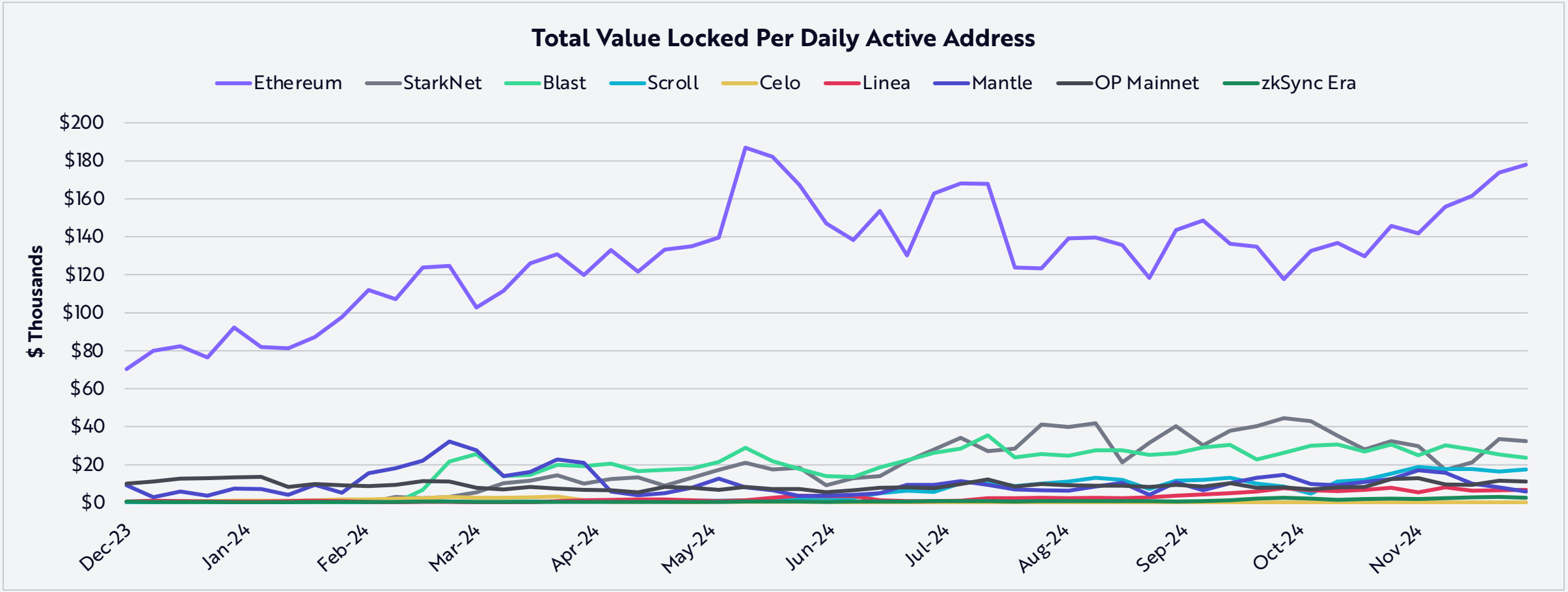




Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Despite Migration To Layer 2s, Ethereum's Base Layer Still Dominates High-Value Storage And Settlement

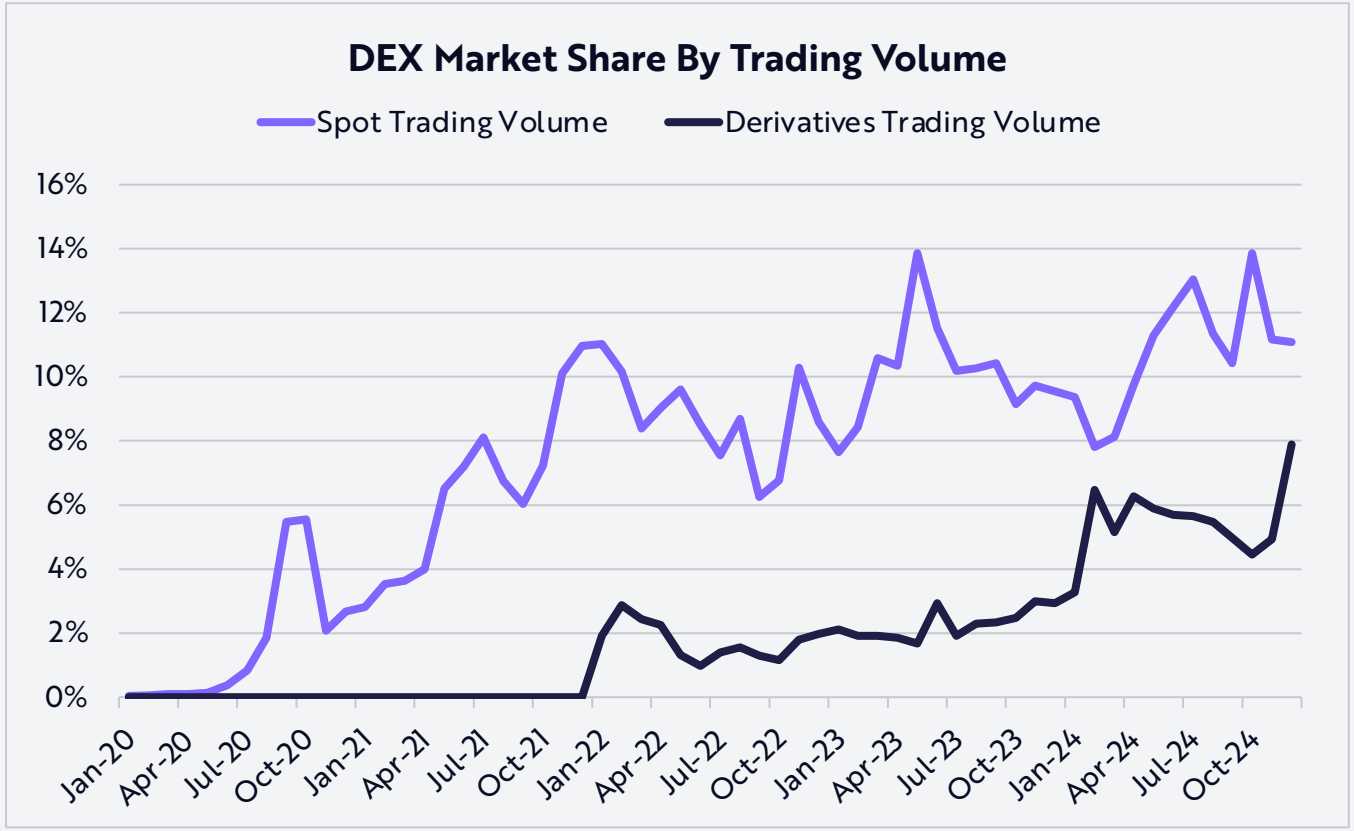
Institutions, high-value users, and whales are settling their transactions primarily on the Ethereum base layer. The unit economics of Ethereum's base layer, as measured by Total Value Locked (TVL) and Decentralized Exchange (DEX) volume per user, are unparalleled.

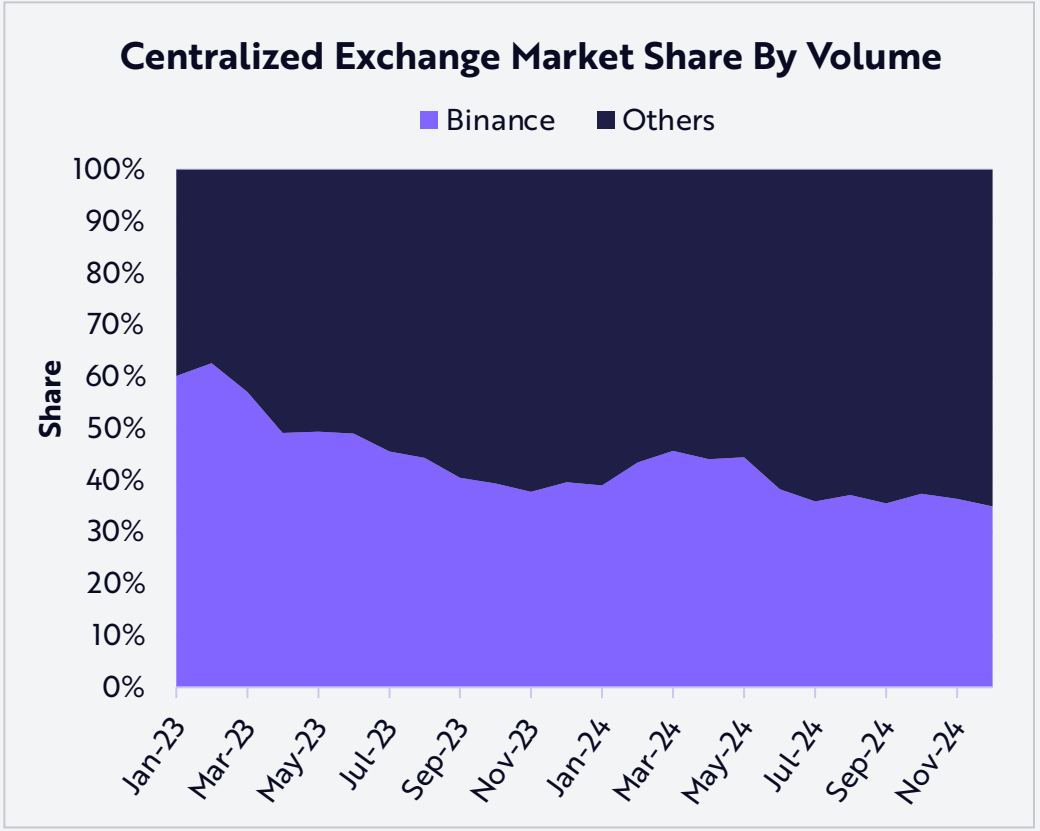


Note: "Whale": an individual or entity that holds a large amount of a specific cryptocurrency, usually north of 10 million dollars depending on the asset. Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

As Decentralized Finance (DeFi) Surged To All-Time Highs, Decentralized Exchanges Challenged Centralized Venues In Both Spot And Derivatives Trading

When Binance settled with the U.S. Securities and Exchange Commission (SEC) for more than $4 billion and its CEO stepped down in 2024, centralized exchanges (CEXs) lost some share to decentralized exchanges (DEXs). From January to their peaks, spot and derivatives DeFi volume nearly doubled their market share from 8% and 3%, respectively, to 14% and 8%, reaching all-time highs. During the same period, Binance's market share among centralized exchanges dropped from 62% to 35%.

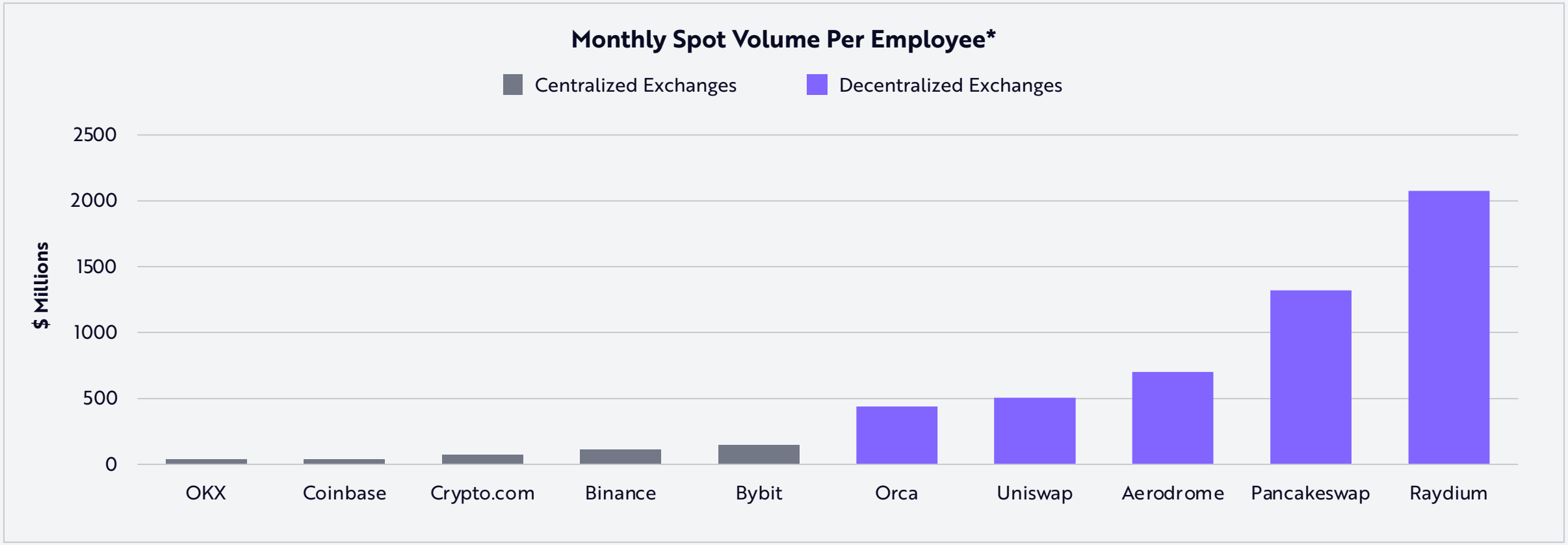




Source: ARK Investment Management LLC, 2025, based on data from The Block as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Smart Contract-Powered Exchanges Are 5-10 Times More Efficient Than Their Centralized Counterparts

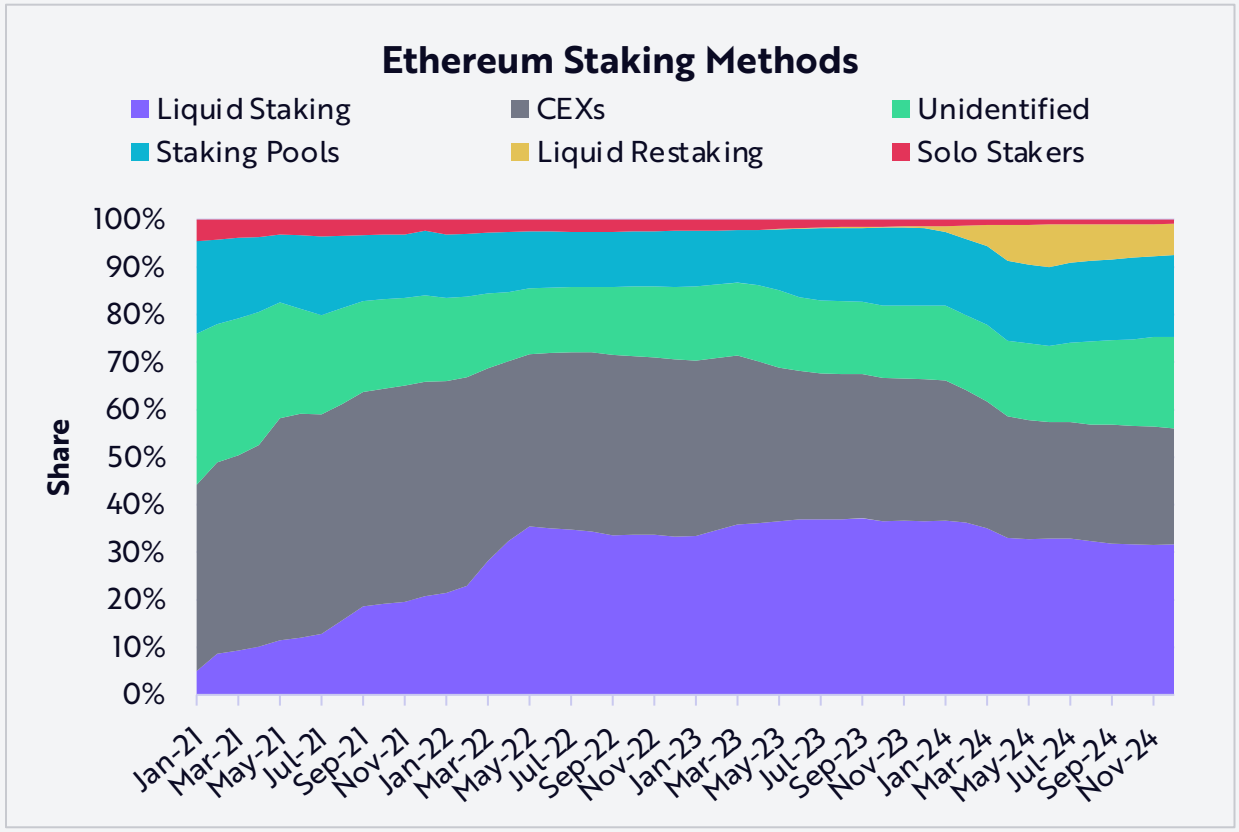
Decentralized exchanges (DEXs) like Uniswap, Aerodrome, and Raydium leverage the efficiency of small, agile teams to develop and maintain core protocol infrastructure. With massive efficiency advantages over centralized venues, DEXs have one-tenth the headcount. With ~9,000 employees, Binance leads the centralized exchange space headcount.

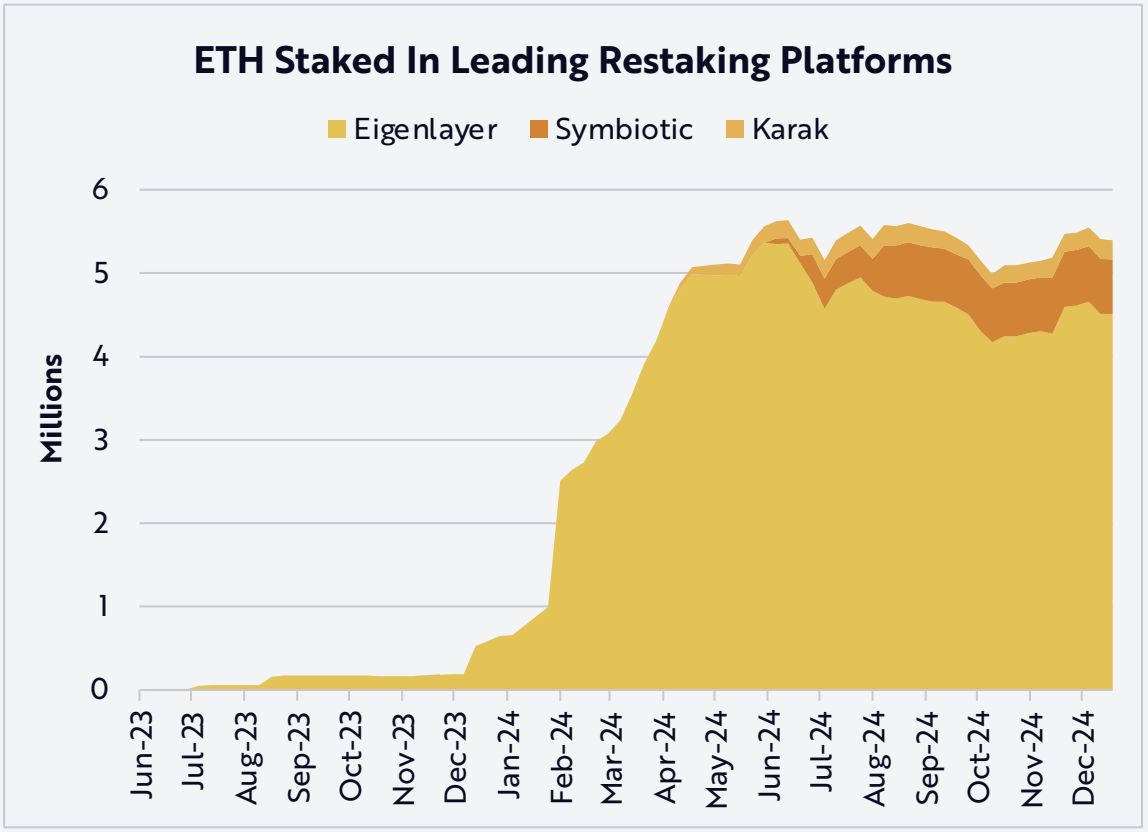


*The Spot Volume per Employee data are from the month of November 2024. Source: ARK Investment Management LLC, 2025, based on data from Token Terminal, Coin Gecko, and Pitchbook as of November30, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Liquid Staking And Restaking Protocols Are The Preferred Solutions For Staking And Rehypothecating ETH

Liquid staking and restaking have become the preferred methods for generating yield on Ether. Thanks to their yield-bearing properties, liquidity, and accessibility, they now account for 40% of ETH staking. Demand for rehypothecating staked ETH to increase yield has created restaking platforms that now account for ~5.5 million Ether, or 17% of staked ETH.

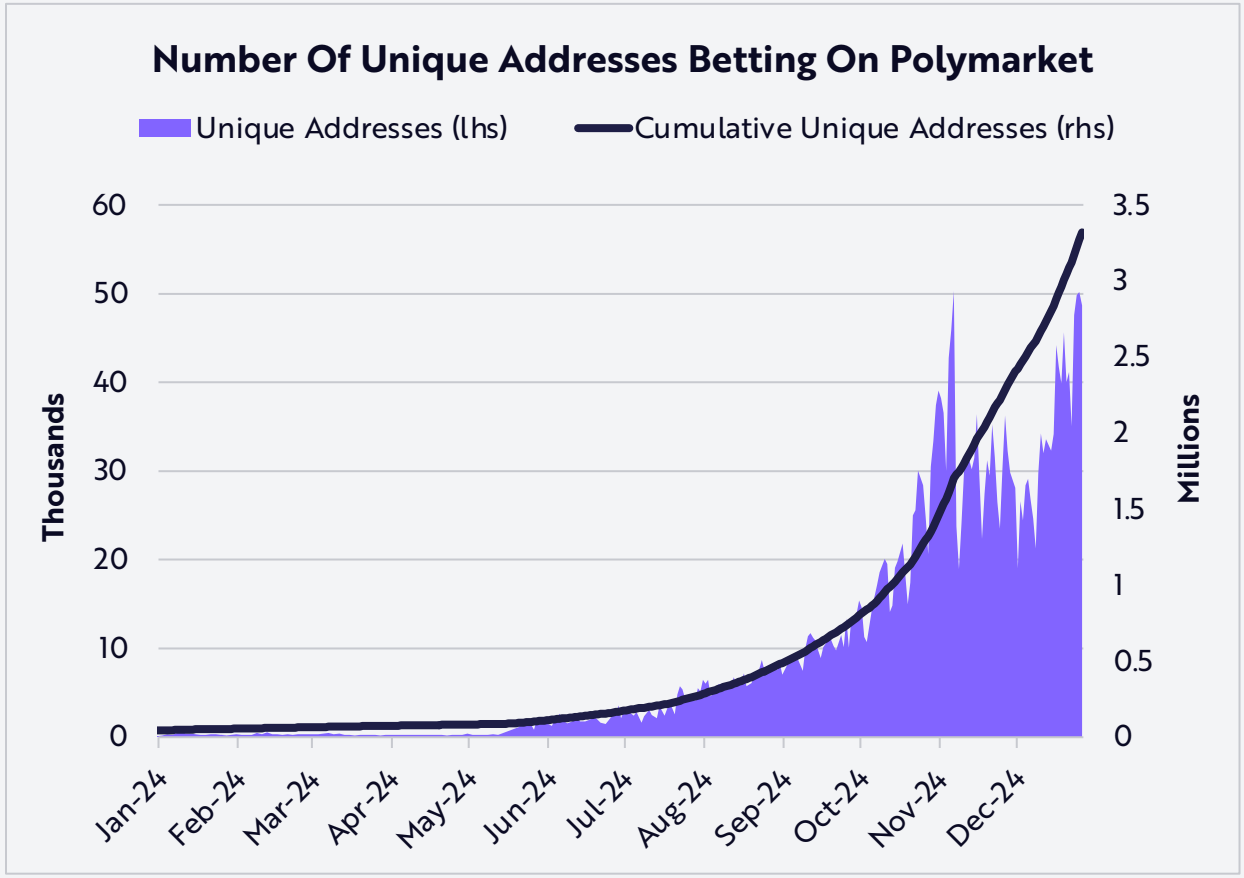


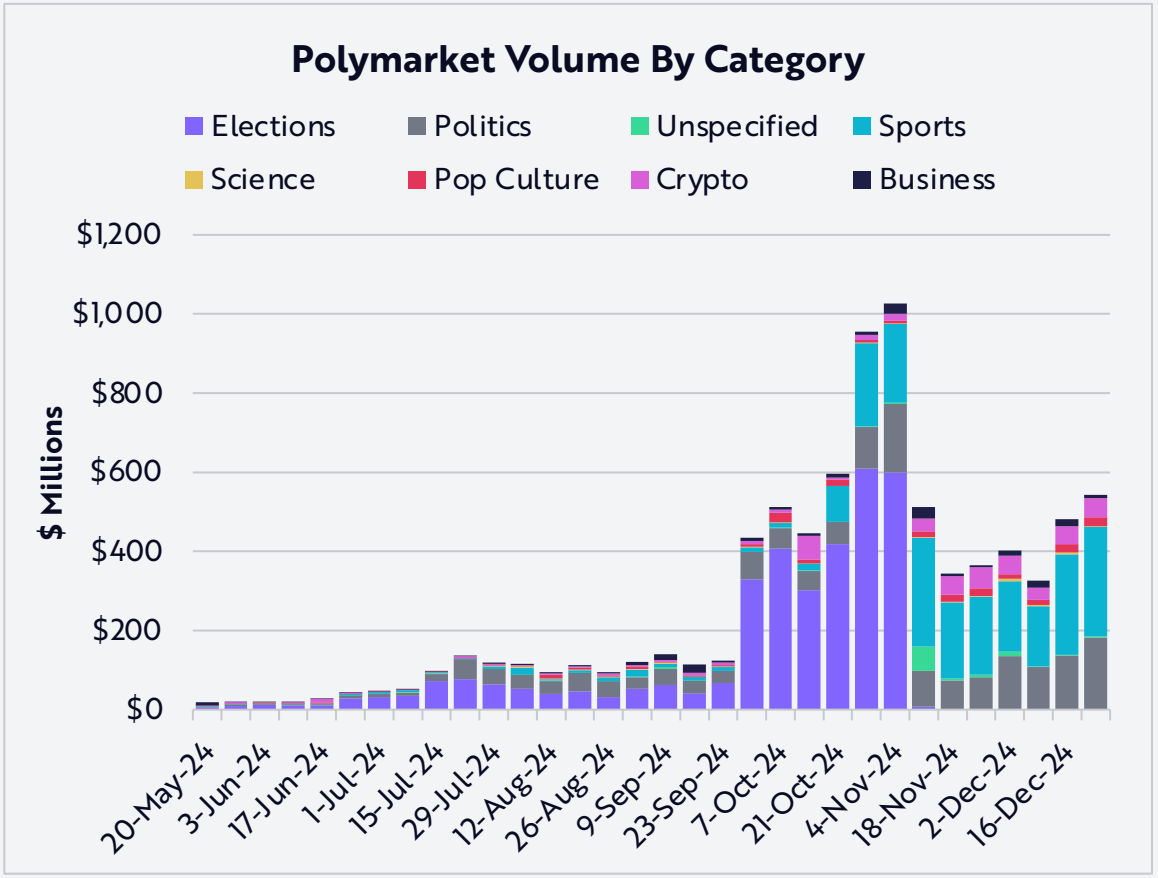


Note: Staking involves locking up a cryptocurrency in a wallet to support the operations of a blockchain network, typically for Proof-of-Stake (PoS) or similar consensus mechanisms. Liquid staking is an enhancement of traditional staking where users can stake their tokens while still having access to liquidity. Restaking refers to using the same staked assets or their derivatives for multiple purposes or layers of staking. Rehypothecation occurs when assets (such as staked tokens or derivatives) are used as collateral multiple times by various entities. Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Led By Polymarket, Prediction Markets Became The Breakout Consumer Application In 2024

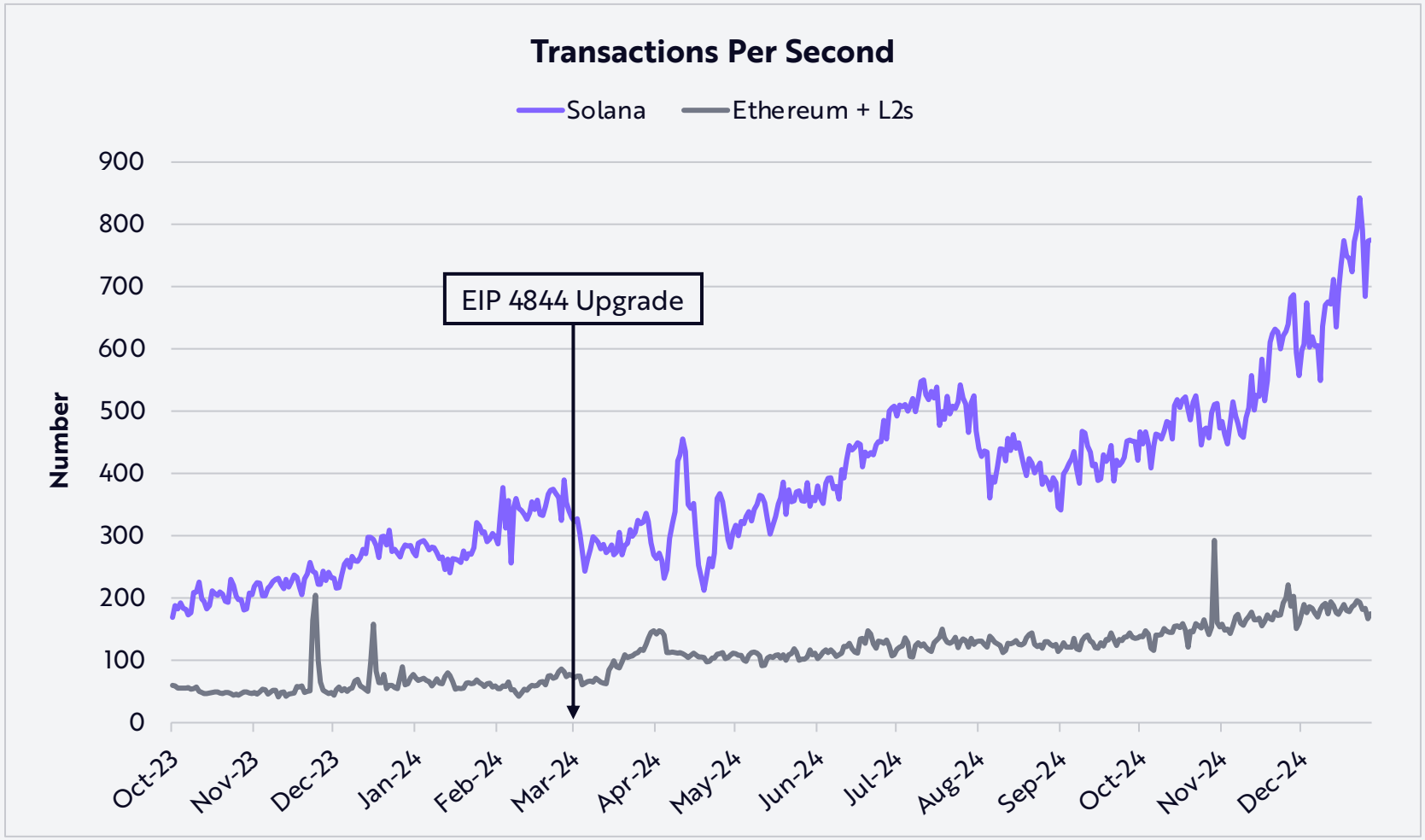
During 2024, Polymarket surpassed three million cumulative users and $1.2 billion in monthly volume, with elections and politics driving 70% of its activity. After a brief post-election pull-back, the number of unique daily users has recovered to 50,000 and volume is trending back up with Sports being the most important category.





Source: ARK Investment Management LLC, 2025, based on data from Dune Analytics as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Solana's Throughput Is Higher Than Ethereum's, Thanks To High-Performance Design And Strategic Trade-Offs



Thanks to Layer 2s and the EIP 4844 upgrade, Ethereum's throughput has more than doubled to ~200 transactions per second (TPS). Nonetheless, Solana continues to outperform, with an average throughput of ~800TPS.

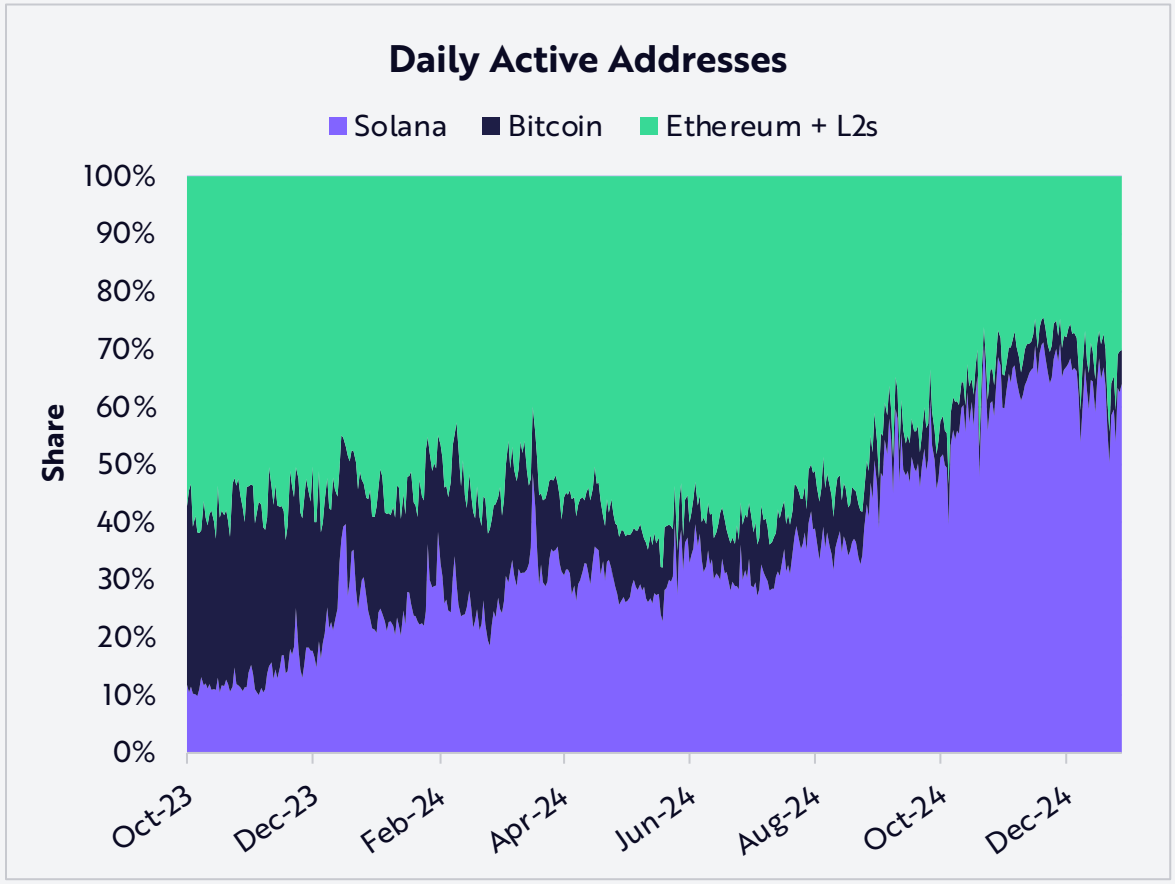
Solana's success is based on a set of trade-offs, including more expensive hardware requirements and parallel transaction processing.

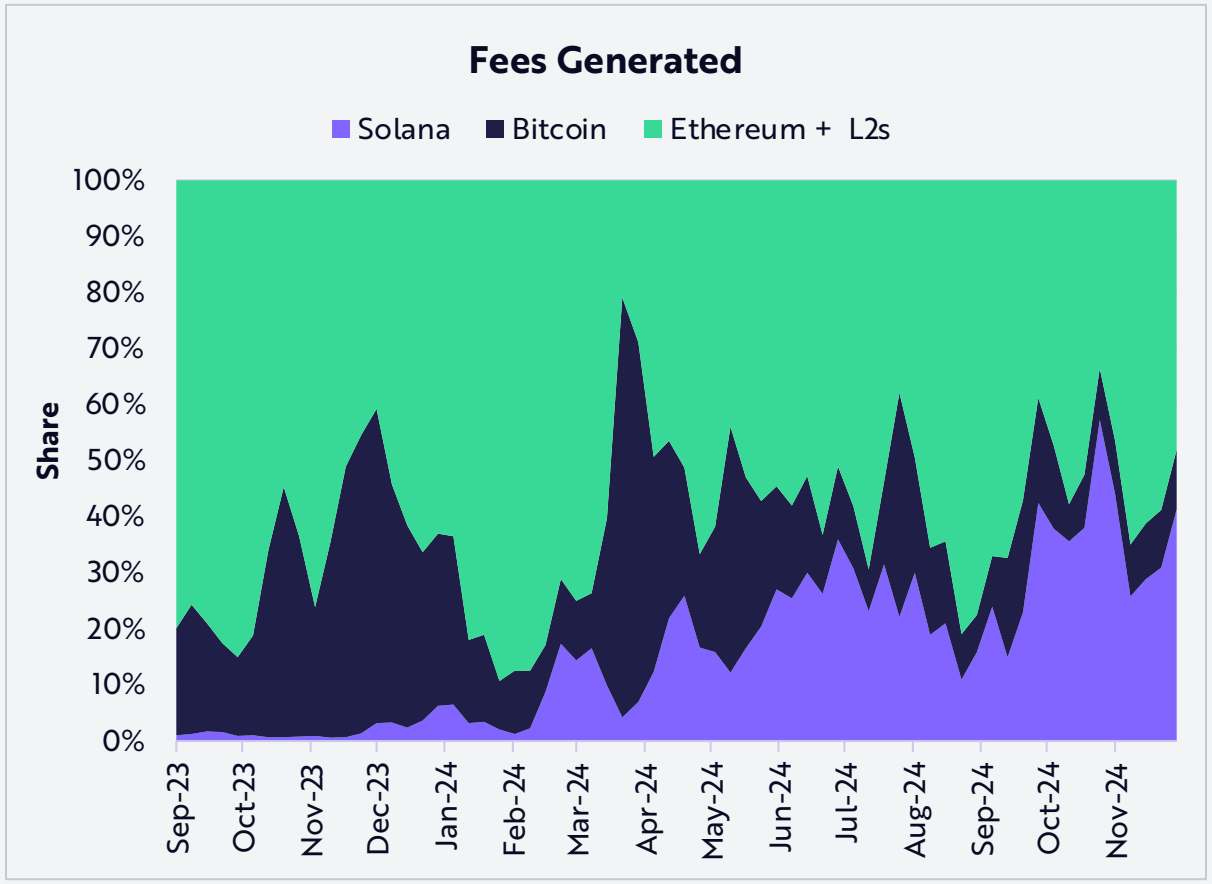
Solana's new Firedancer client could increase its throughput to hundreds of thousands of TPS.

Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Thanks To Retail Adoption, Solana Has Gained Share Based On Several Metrics

After hitting bear market lows at $8 in 2023, Solana has turned around dramatically relative to other Layer 1s. Daily active users, revenue, transaction count, and total value locked (TVL) reached all-time highs or grew by an order of magnitude. Solana is the only Layer 1 that competes with Ethereum and Bitcoin on metrics like daily active addresses and revenue.

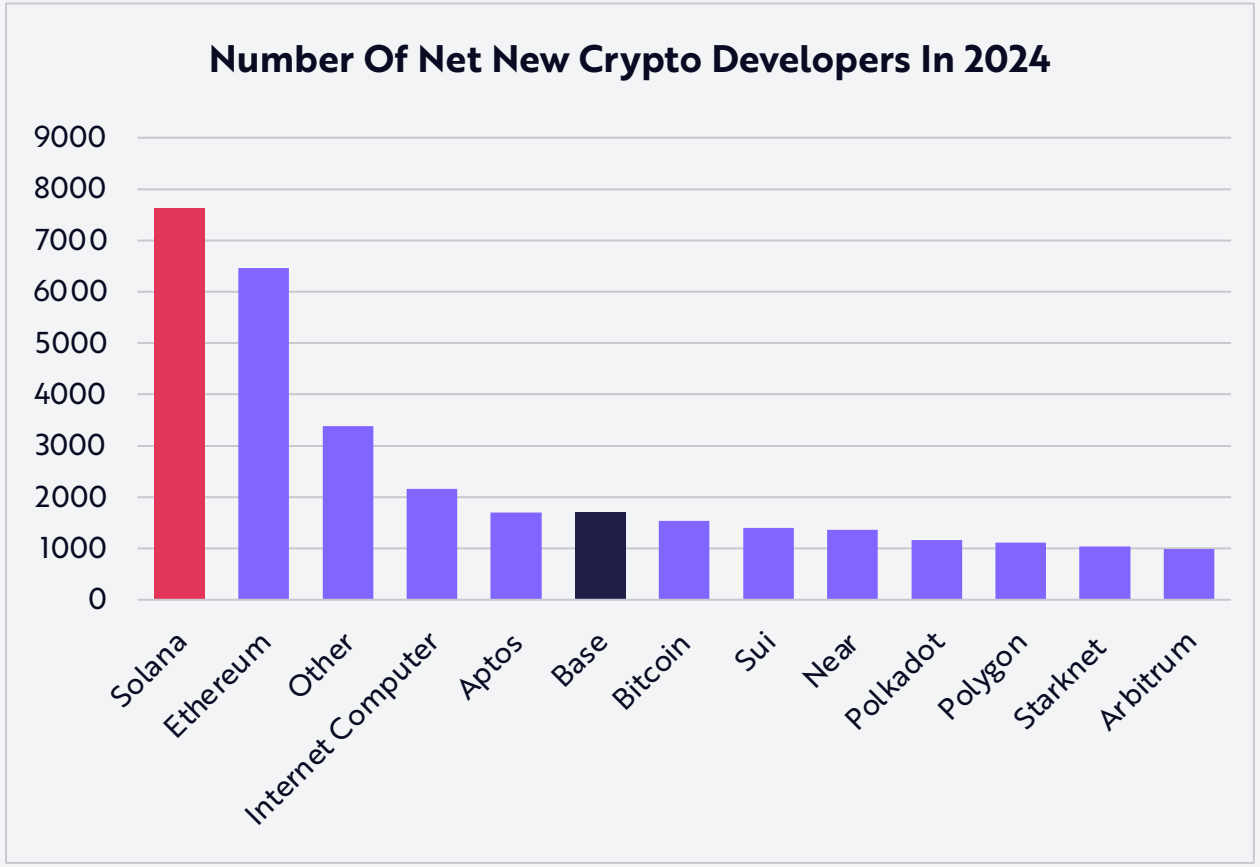


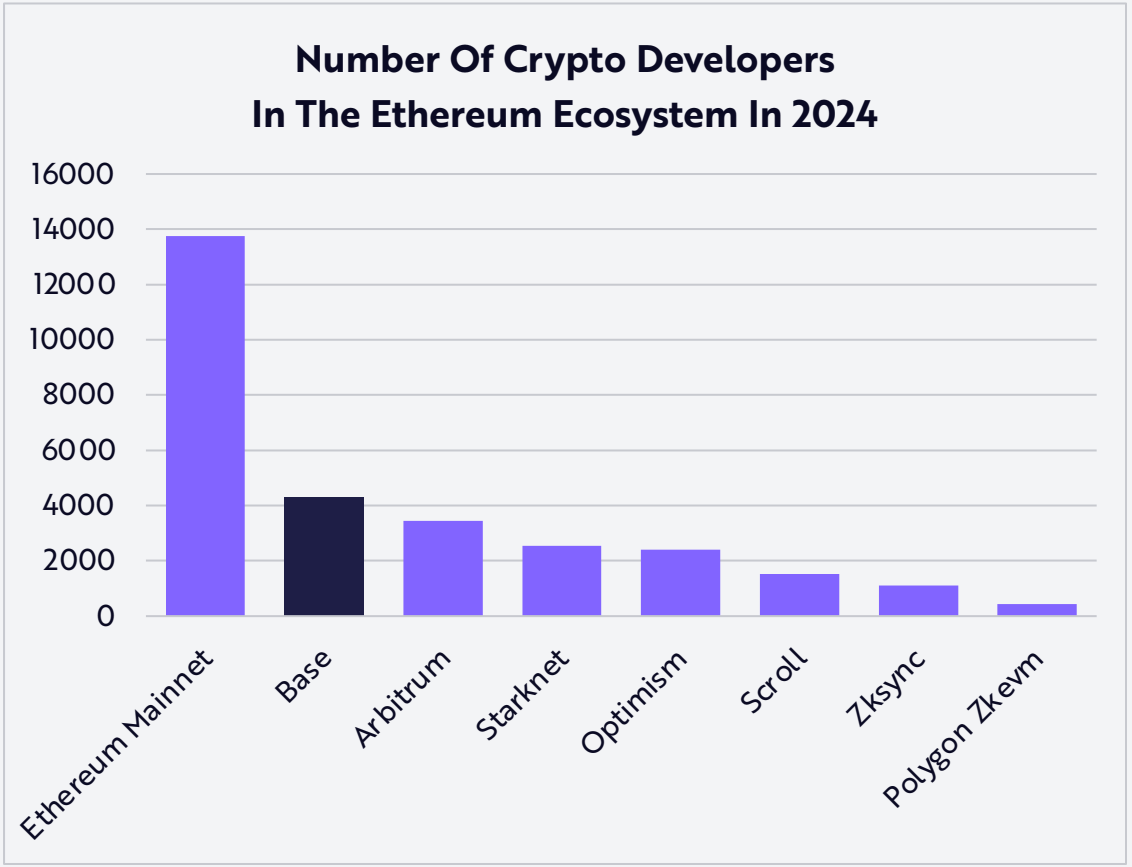


Source: ARK Investment Management LLC, 2025, based on data from Artemis Terminal as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Solana And Base Are Leading The Way In Developer Adoption And Mindshare

Of the 39,139 new crypto developers in 2024, Solana led the way with 7,625, surpassing Ethereum Mainnet. With 4,287 developers in total, Base was sixth overall, surpassing both Arbitrum and Starknet as the leading Layer 2 solution on Ethereum.

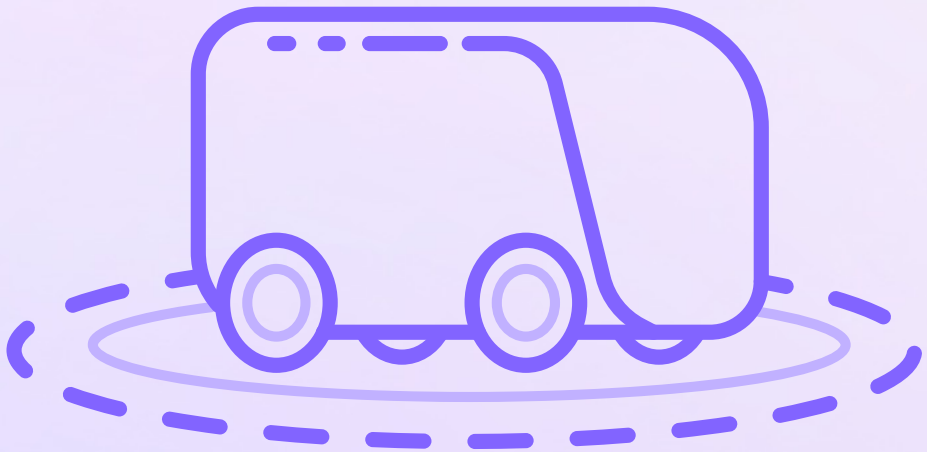




Source: ARK Investment Management LLC, 2025, based on data from Electric Capital 2024 as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Robotaxis

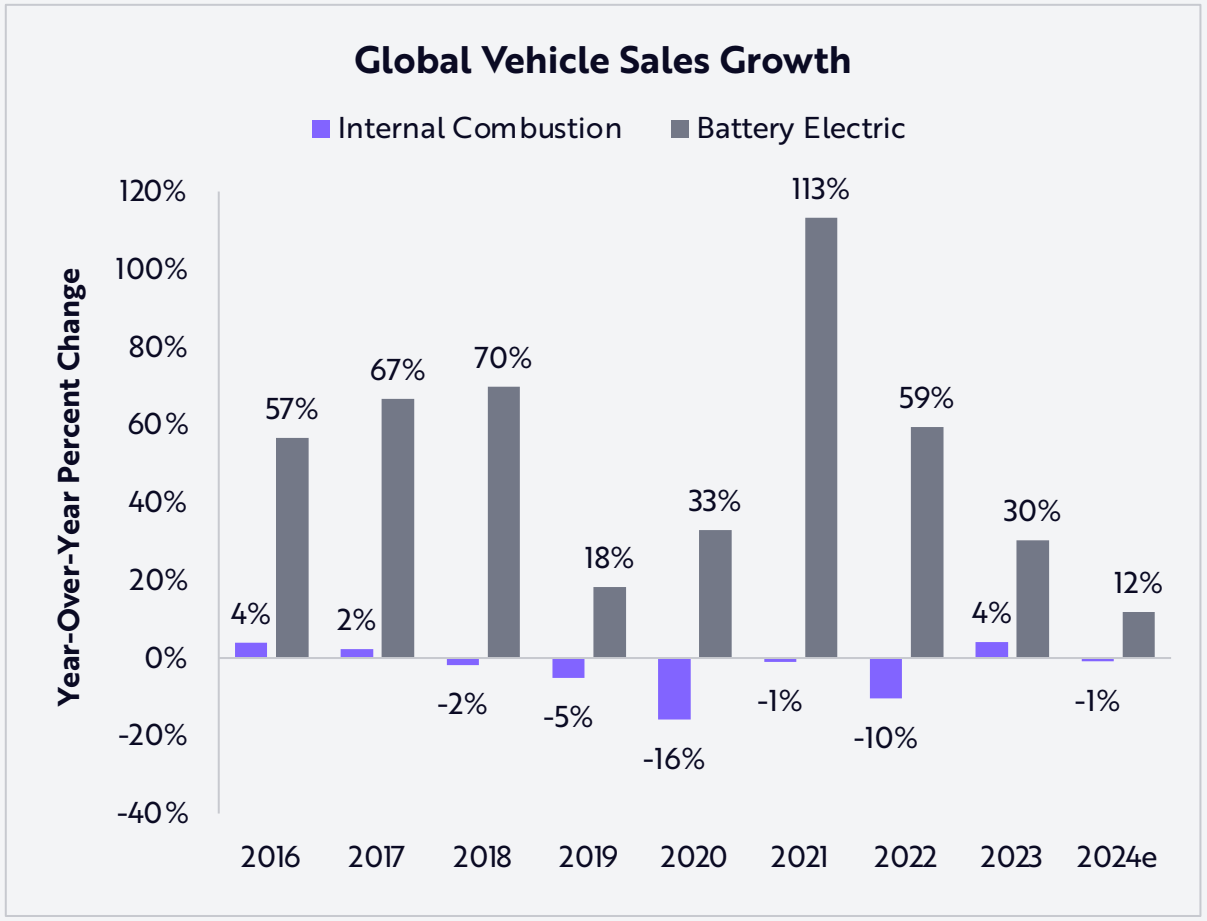
Transforming Personal Mobility While Lowering Costs And Enhancing Safety

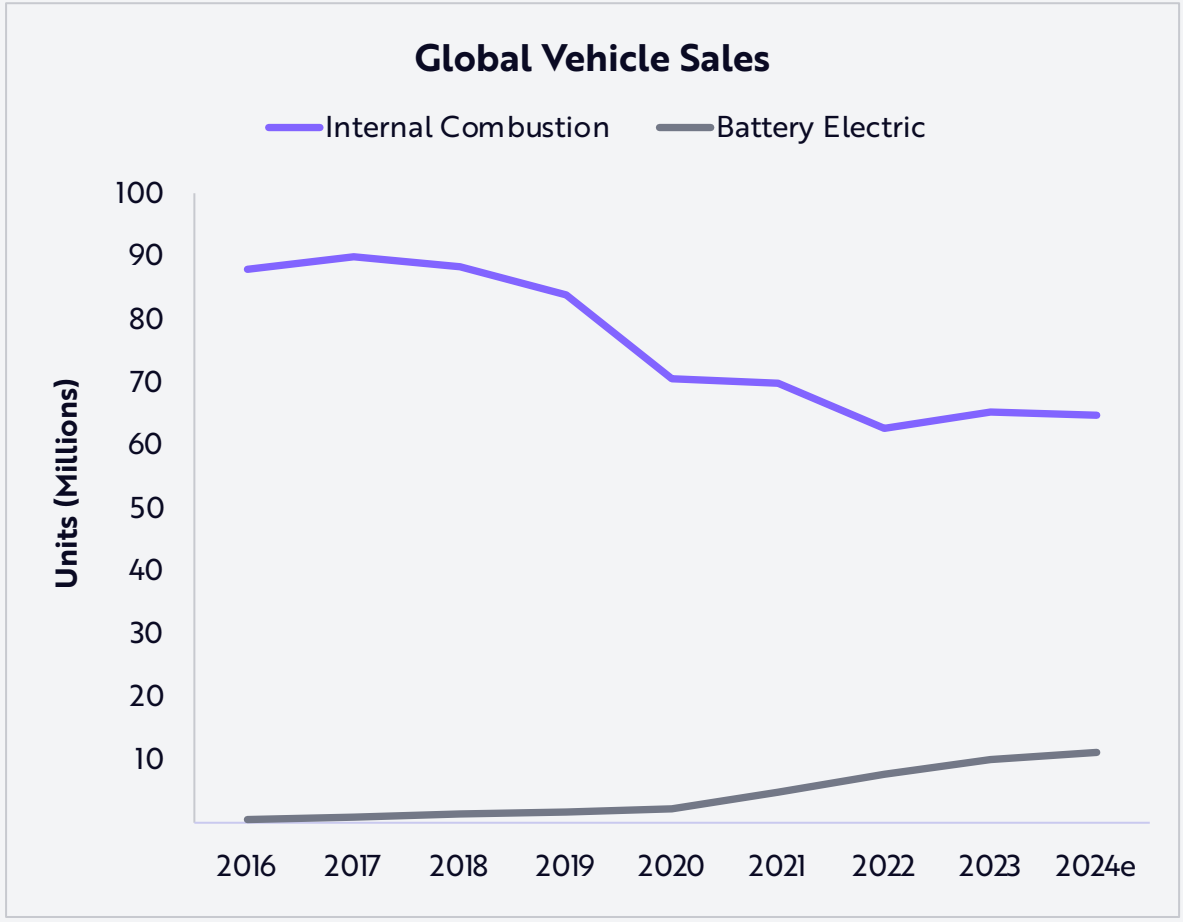


Tasha Keeney, CFA
DIRECTOR OF INVESTMENT ANALYSIS & INSTITUTIONAL STRATEGIES

Daniel Maguire, ACA
RESEARCH ANALYST, AUTONOMOUS TECHNOLOGY & ROBOTICS

Electric Vehicles Continue To Take Share From Internal Combustion Engine Vehicles

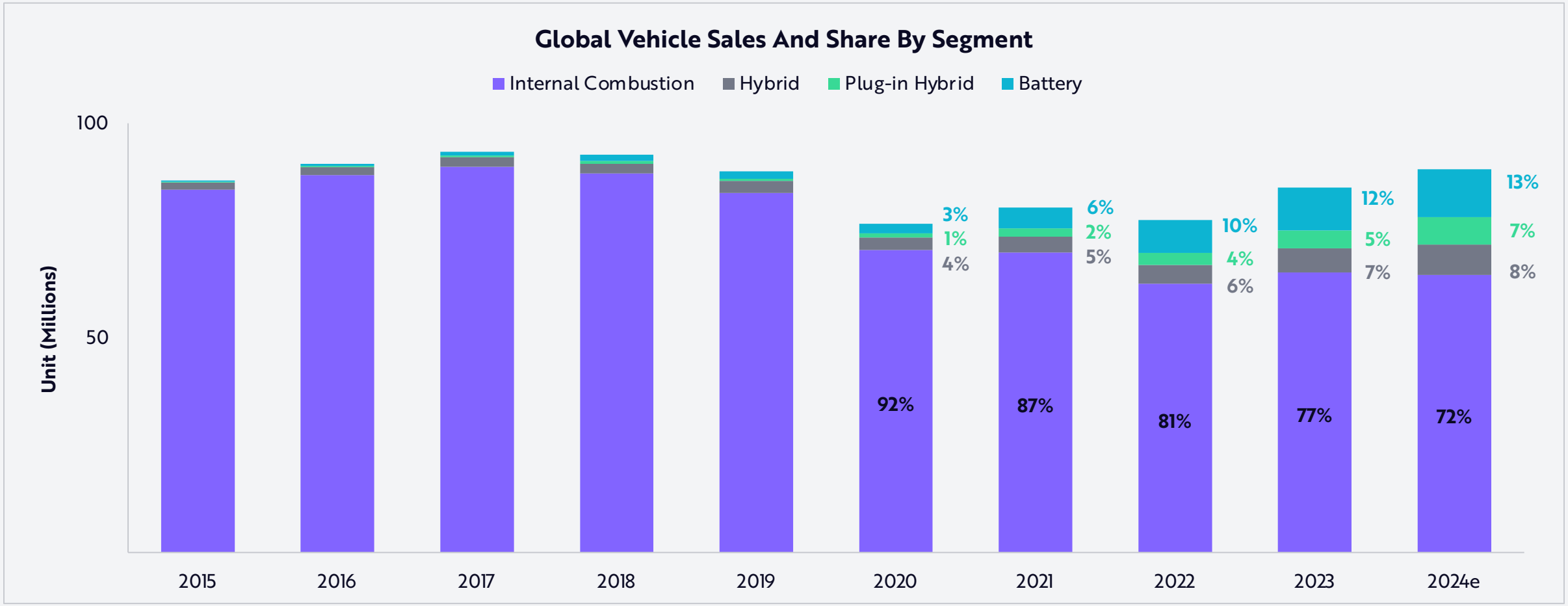




Slide by **Sam Korus**, Director and **Akaash TK**, Associate, Autonomous Technology & Robotics. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including EV-Volumes as of January 3, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

The Future Is Autonomous Electric Vehicles

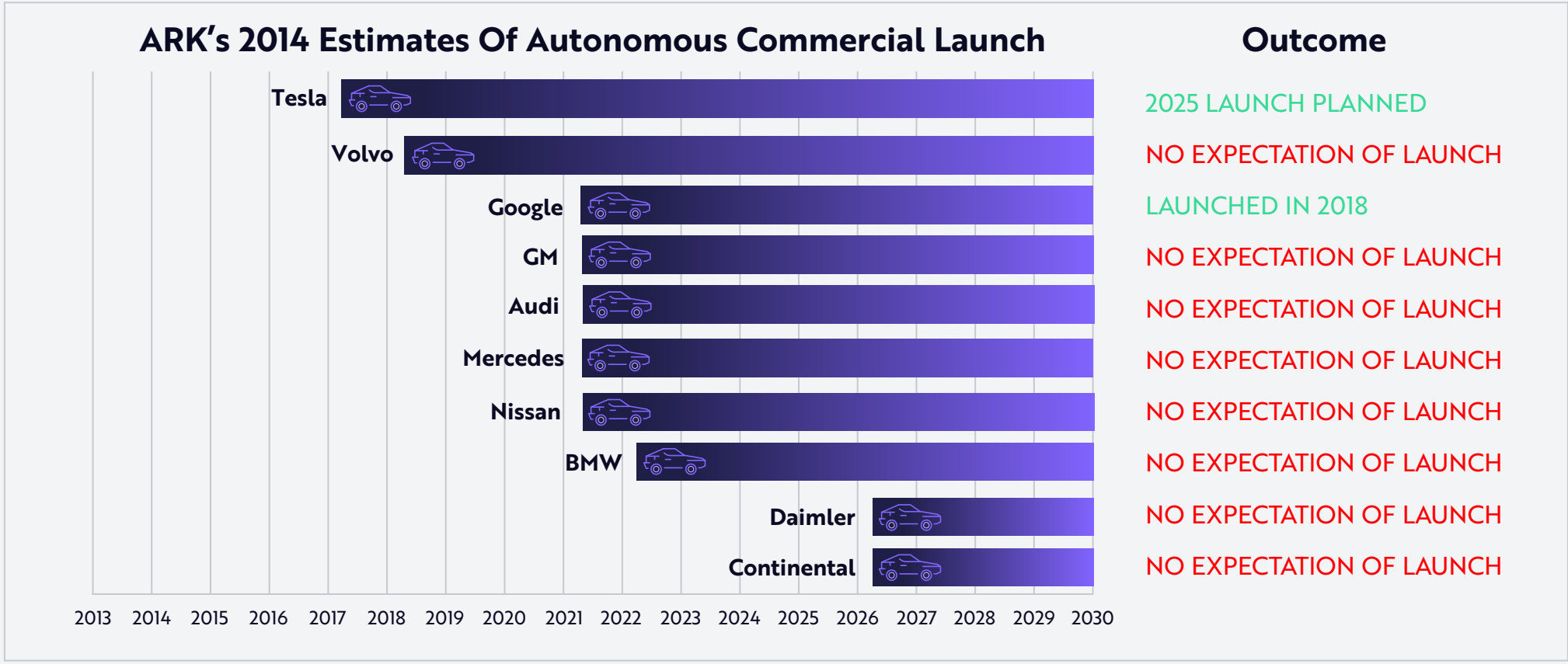
Despite the recent slowdown in the growth of electric vehicles, the trend is clear: the internal combustion engine is on its way out.



Slide by **Sam Korus**, Director and **Akaash TK**, Associate, Autonomous Technology & Robotics. Note: Percentages may not total 100% due to rounding. Source: ARK Investment Management LLC, 2025, based on data from EV-Volumes as of January 3, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

After More Than A Decade, Most Automakers Have Dropped Out Of The Autonomy Race. Tesla And Waymo Remain.

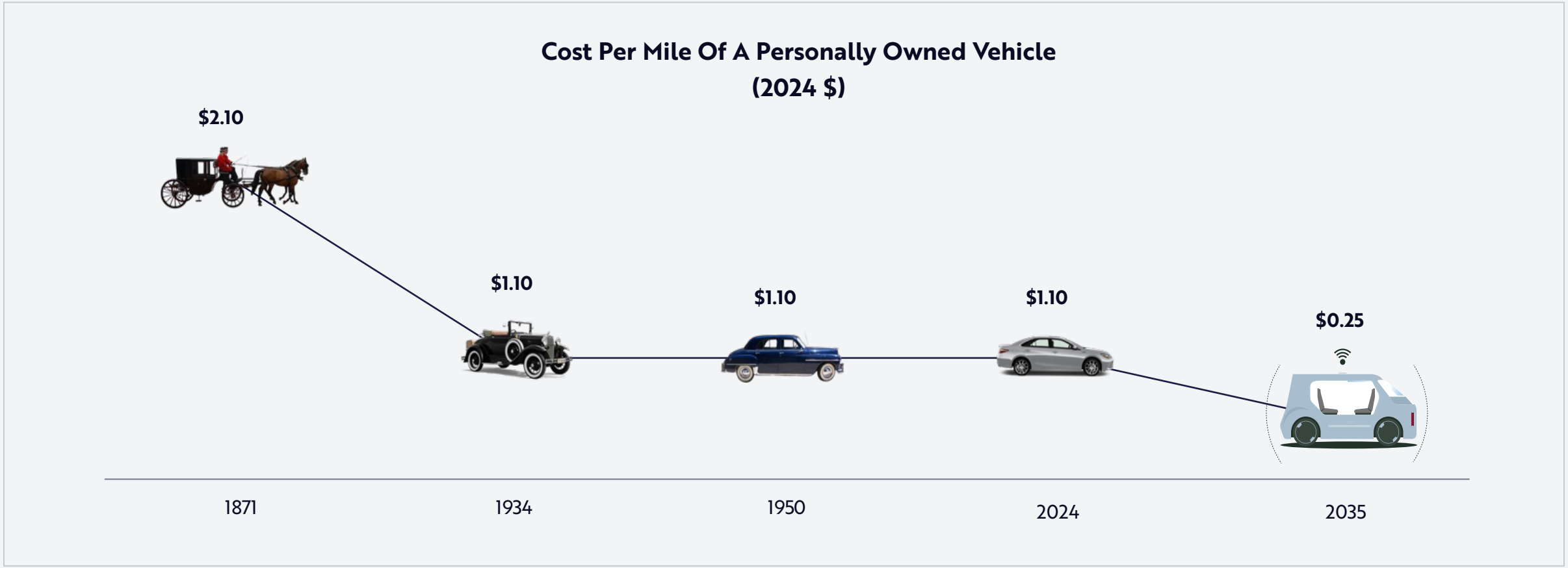
In 2014, many automakers expected to debut an autonomous vehicle by 2020. Only Waymo delivered, launching its first commercial autonomous rides in 2018. Tesla plans to launch in 2025. Waymo's launch and Tesla's internal testing of robotaxis suggest that 2025 could be the standout year in which consumers and businesses agree that the future of transportation is autonomous.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Autonomous Ride-Hail Should Increase Access To Convenient Point-To-Point Transportation

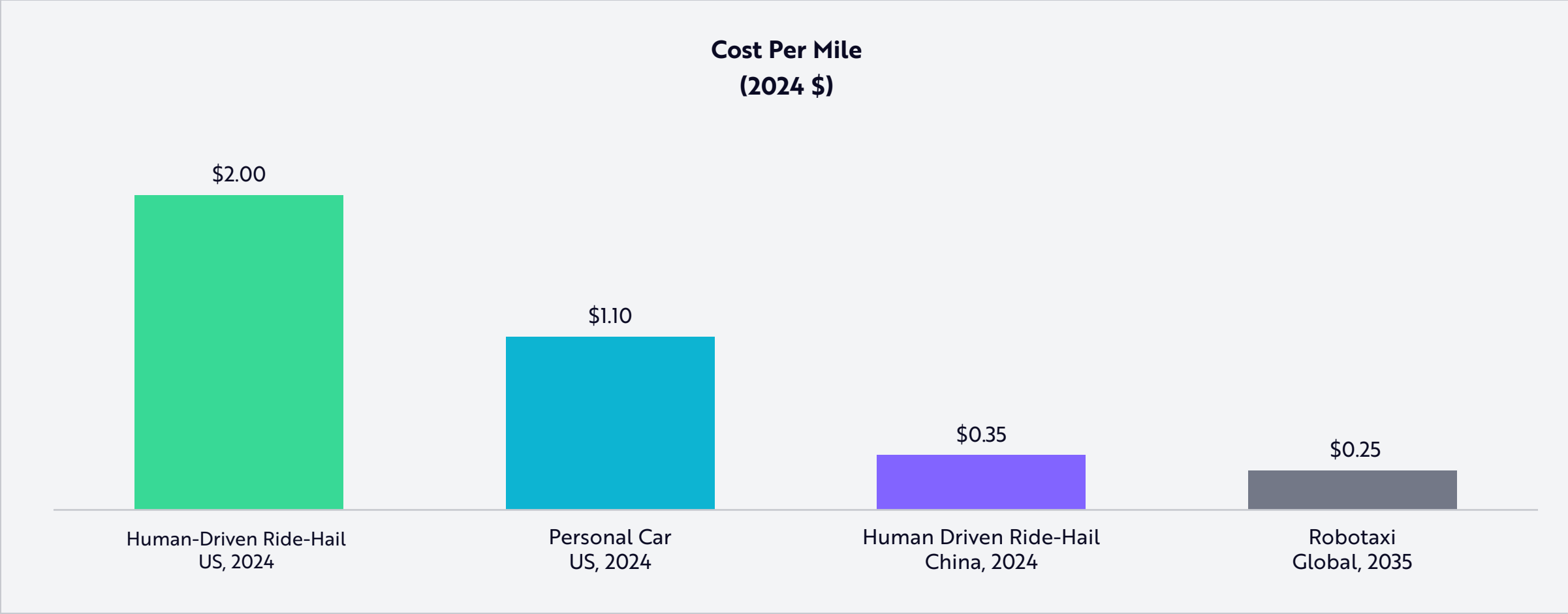
Adjusted for inflation, the cost of owning and operating a personal car has not changed since the Model T rolled off the first assembly line more than 100 years ago. ARK estimates that autonomous taxis at scale could cost consumers as little as $0.25 per mile, spurring widespread adoption.



Note: Figures are rounded. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Ulvog 2012, Model T Ford Forum 2010, American Automobile Association 1950, and American Automobile Association 2024, as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Autonomous Ride-Hail Will Lower The Cost Of Point-To-Point Transportation

In early days, robotaxi companies are likely to price rides close to those for human-driven ride-hail. With scale and increased utilization, autonomous technology is likely to drive the cost per mile below that of personal vehicle travel.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

The US And China Are Blazing The Robotaxi Trail, Followed By The Middle East And Europe

Price competition in China could continue to push local players into more lucrative partnerships abroad.

United States

- Tesla
- Waymo
- Zoox
- Wayve
- Pony.ai
- WeRide

China

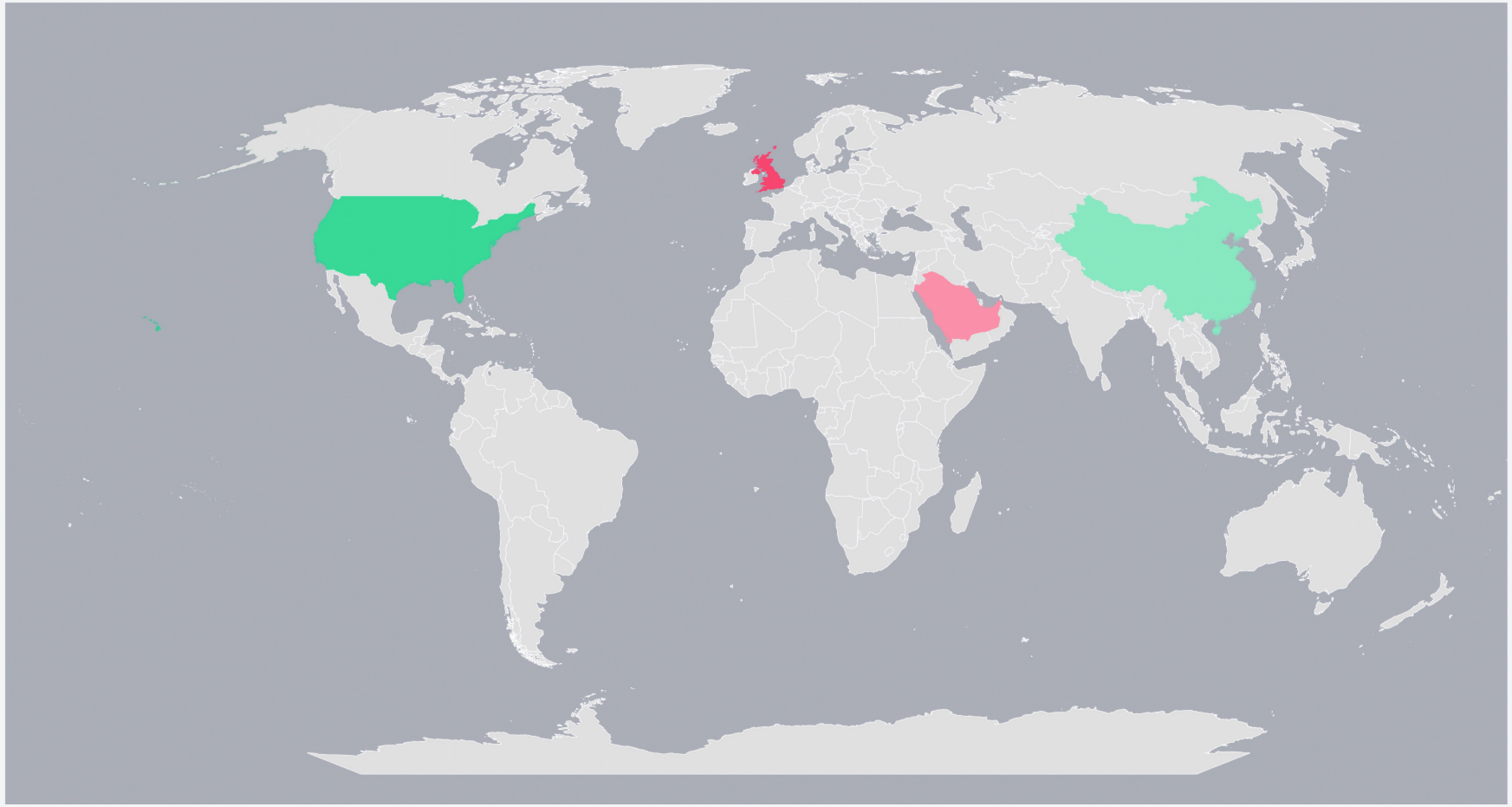
- Baidu Apollo Go
- Tesla
- Pony.ai
- WeRide

Saudi Arabia & UAE

- WeRide
- Pony.ai
- Baidu Apollo Go

United Kingdom

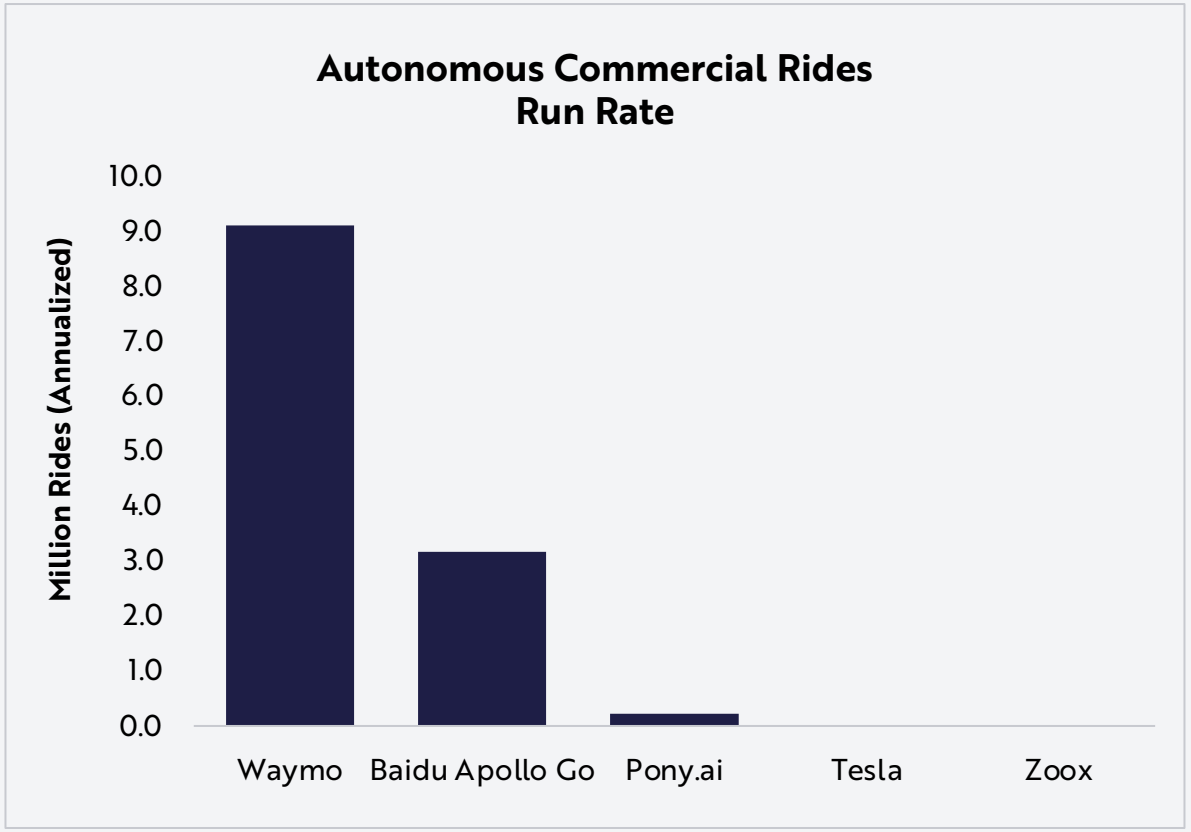
- Wayve

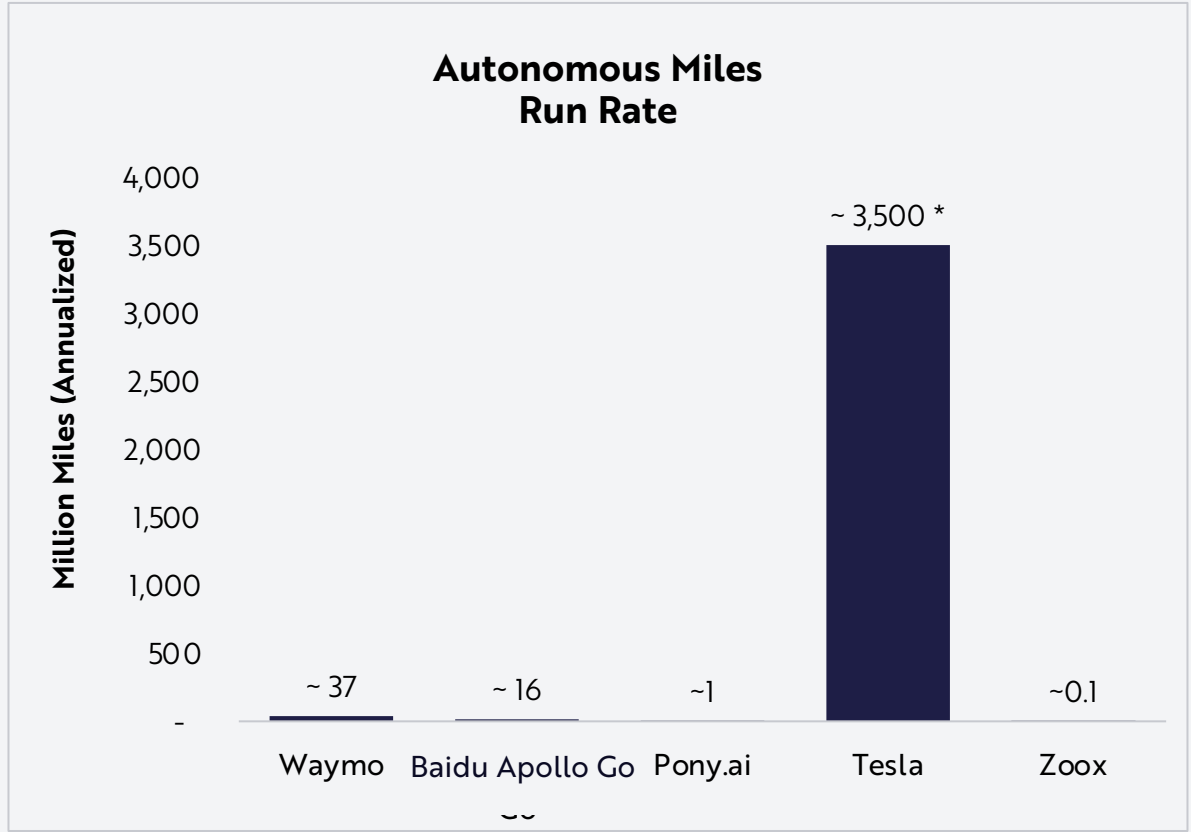


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Robotaxis Already Have Hit 12 Million Rides At An Annual Rate

Waymo and Baidu are responsible for most of the autonomous rides in the US and China, respectively, as shown on the left below. With the largest data lake of all players globally, its proprietary data advantage should give Tesla a competitive edge if it launches ride-hail operations as planned in 2025.

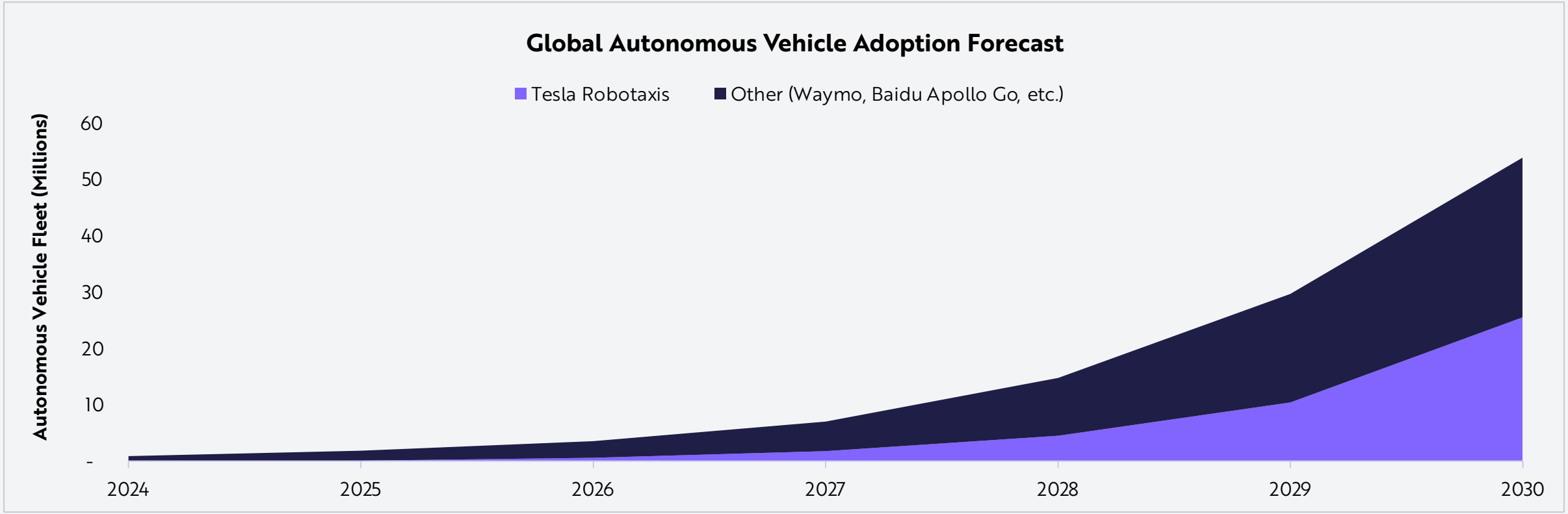




*Tesla Full Self-Driving (FSD) currently is supervised and requires a human behind the wheel. Waymo opened driverless operations to the pubic in October 2020 and now completes ~175,000 weekly rides. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Krafcik 2020, as of January 29, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Theoretically, Tesla Alone Could Hit ARK's Robotaxi Industry Forecast In 2030

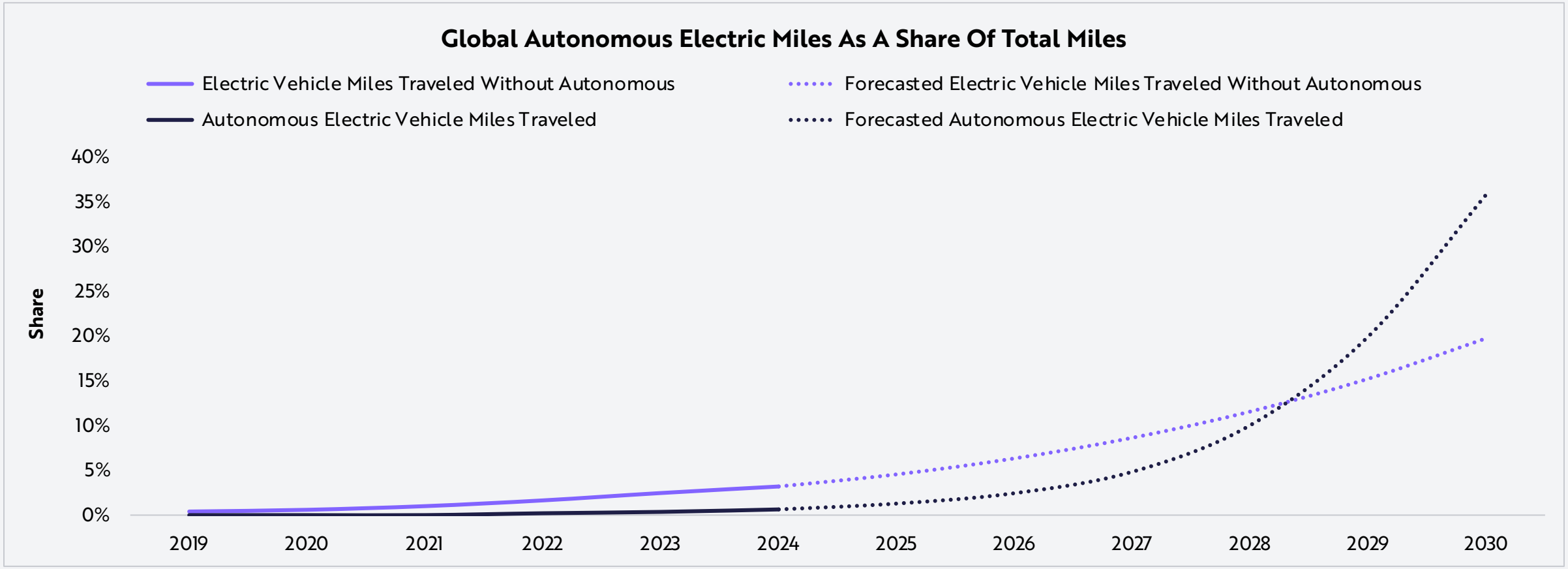
By 2030, ARK's research suggests that the number of robotaxis will have scaled to roughly 50 million globally, with Tesla at ~50% market share. Competitors could face barriers to scale, given the intense price competition in China and the lack of alignment between technology providers and traditional automakers. Separately, if it were to allocate *100%* of its future vehicle production to robotaxi service—instead of the ~30-40% assumed—Tesla alone could hit ARK's robotaxi industry forecast in 2030.



Note: Autonomous adoption curve overestimates figures in initial years. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Autonomous Electric Vehicles Could Rapidly Shift Vehicle Miles Traveled (VMT) To Electric

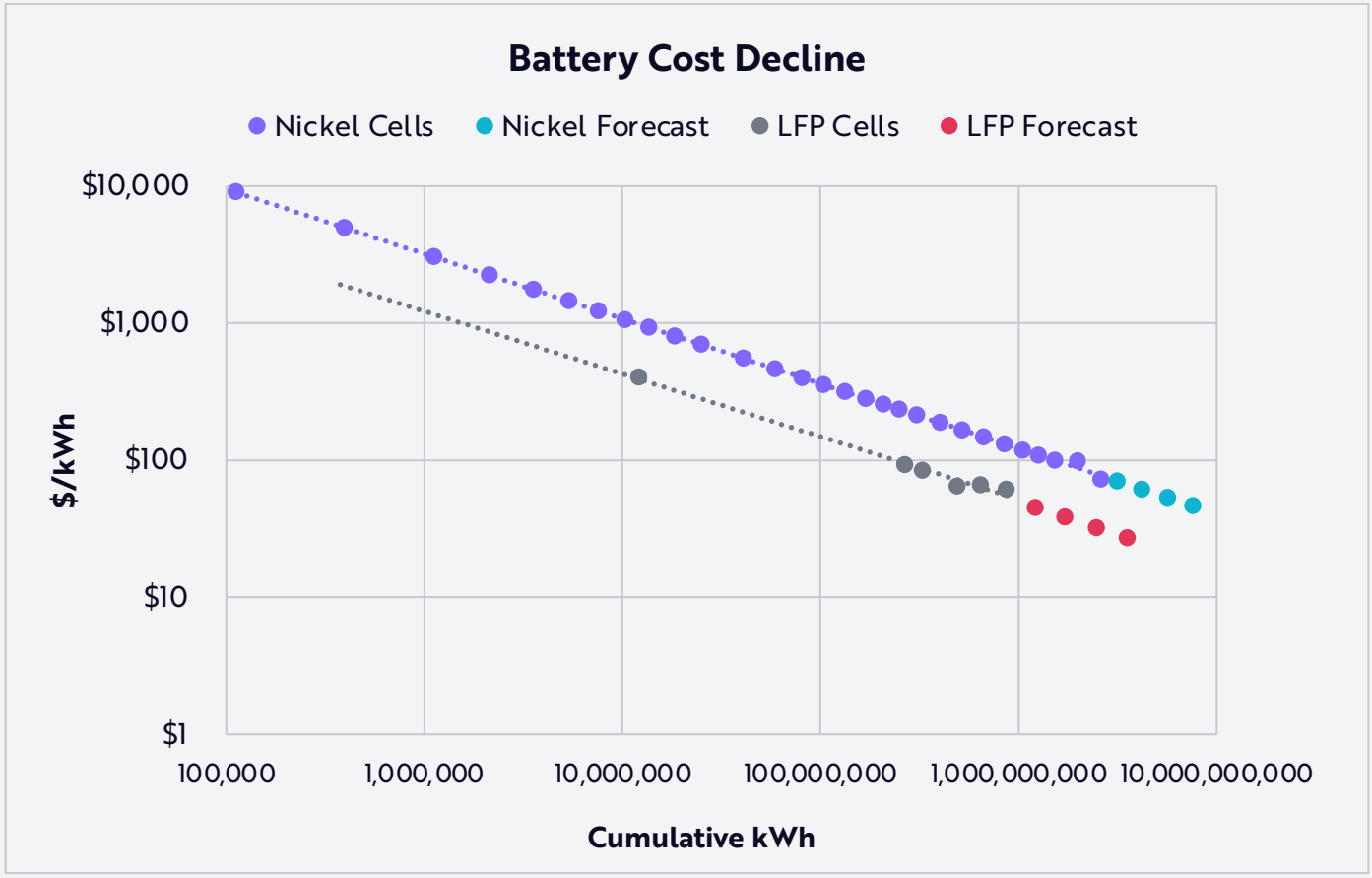
Autonomous electric vehicles could exceed 50% utilization, pushing a disproportionate number of miles traveled from gas-powered vehicles to electric drivetrains.



Slide by **Sam Korus**, Director, **Daniel Maguire**, Analyst, and **Akaash TK**, Associate, Autonomous Technology & Robotics. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 27, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Wright's Law Suggests That A $15,000 Robotaxi Is Possible

Tesla has suggested that the Cybercab will have an efficiency of 5.5 miles/kWh. Paired with the battery cost decline anticipated by Wright's Law, that efficiency suggests that the battery could cost as little as $2,300. Typically, the drivetrain of a vehicle is ~20% of the total vehicle cost, which suggests a Cybercab could be profitable at a price of $15,000 or below.



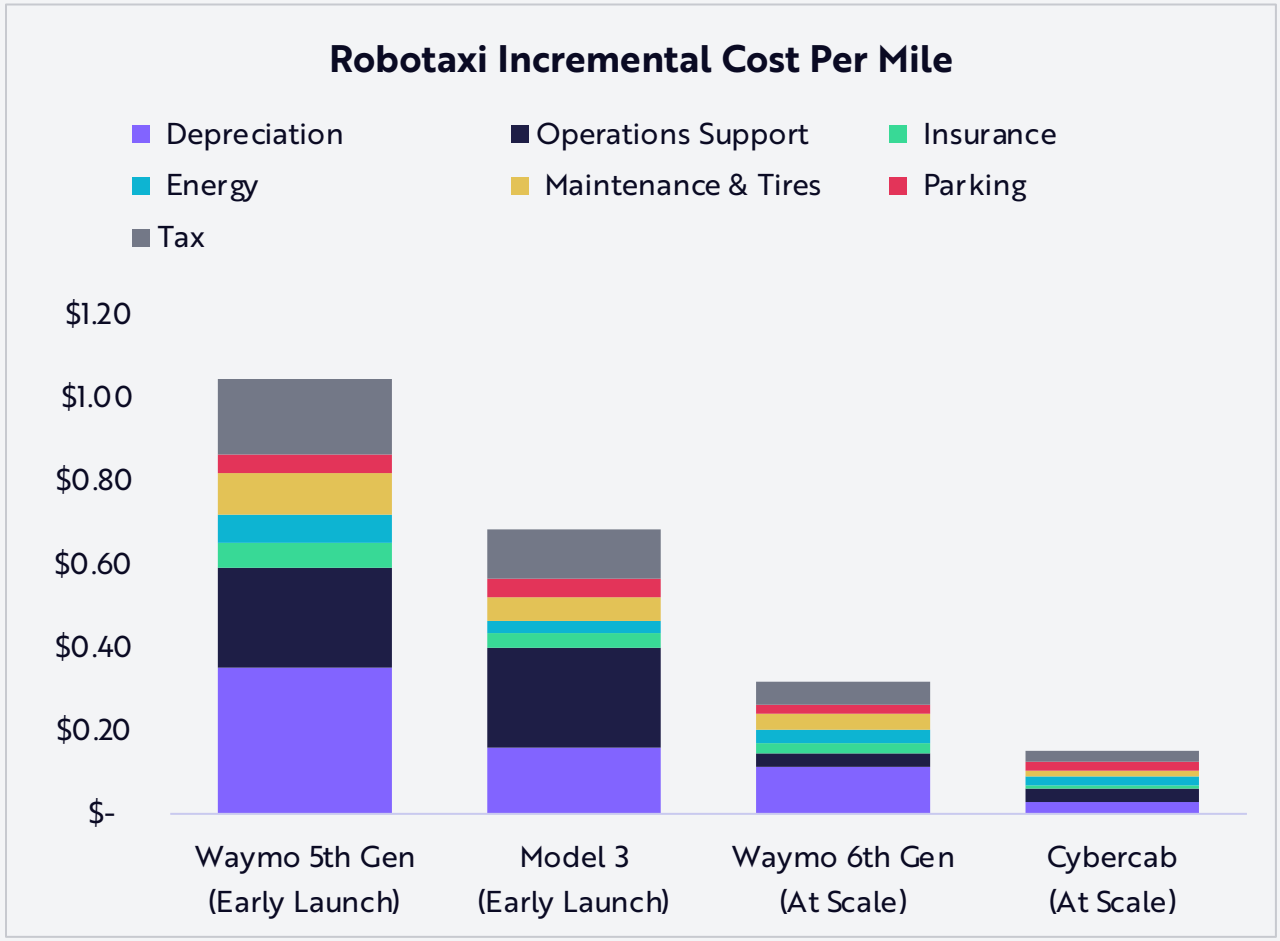
		Battery Cost ($/kWh)		
		$100	**$75**	**$50**
Miles/kWh	**4**	$6,250	$4,688	$3,125
	4.5	$5,556	$4,167	$2,778
	5	$5,000	$3,750	$2,500
	5.5	$4,545	$3,409	$2,273

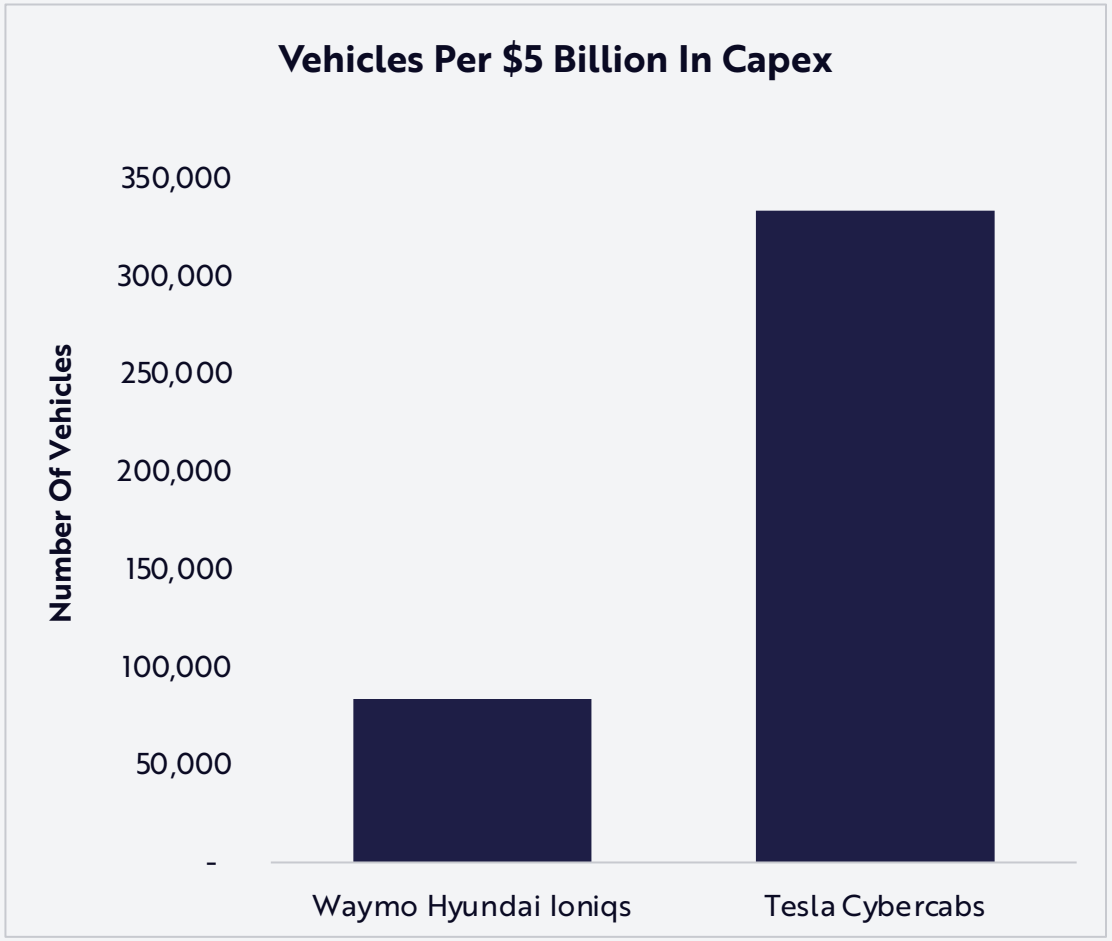
Assumes a 250-mile range vehicle

Slide by **Sam Korus**, Director of Research, Autonomous Technology & Robotics Research. Note: Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. See Winton 2019. "kWh": Kilowatt-hour, a unit of energy, representing the use or generation of 1 kilowatt of power for 1 hour. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Tesla's Cost Per Mile Is ~30-40% Lower Than Waymo's

Its higher cost structure is likely to make Waymo less competitive or less profitable than a Cybercab robotaxi service. Waymo's dependence on LIDAR and higher cost auto manufacturers are two drags on its competitive positioning.

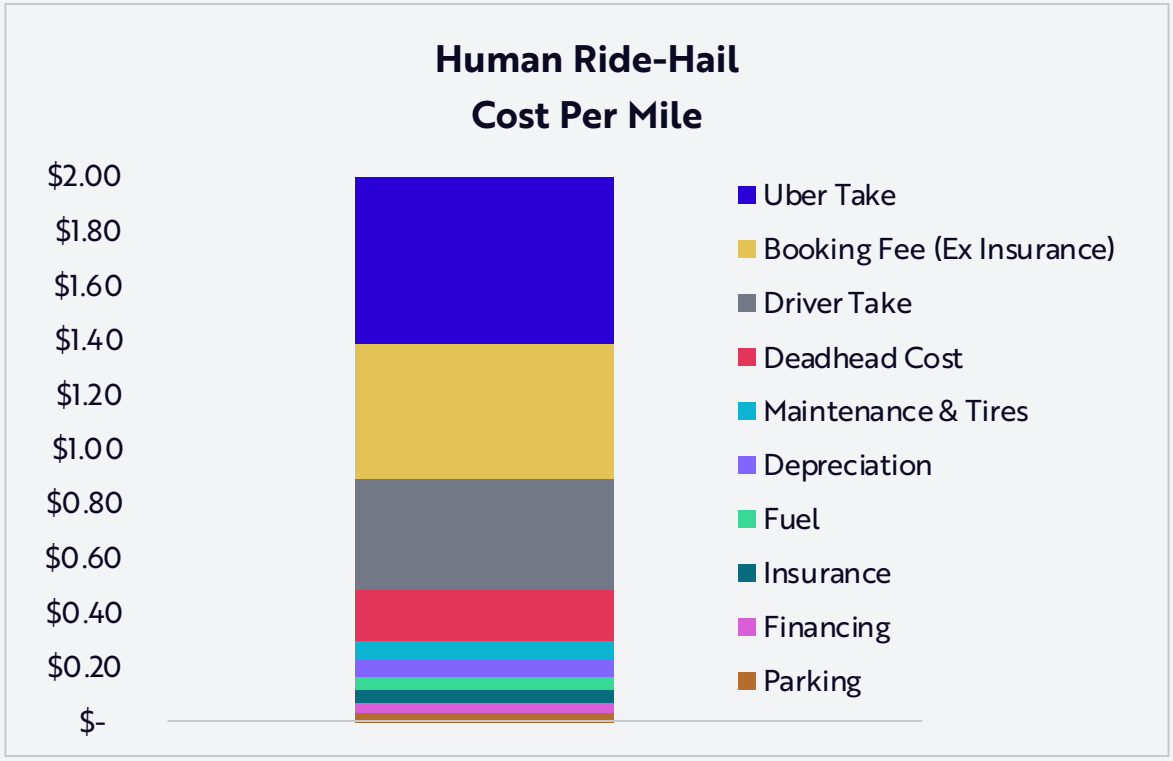


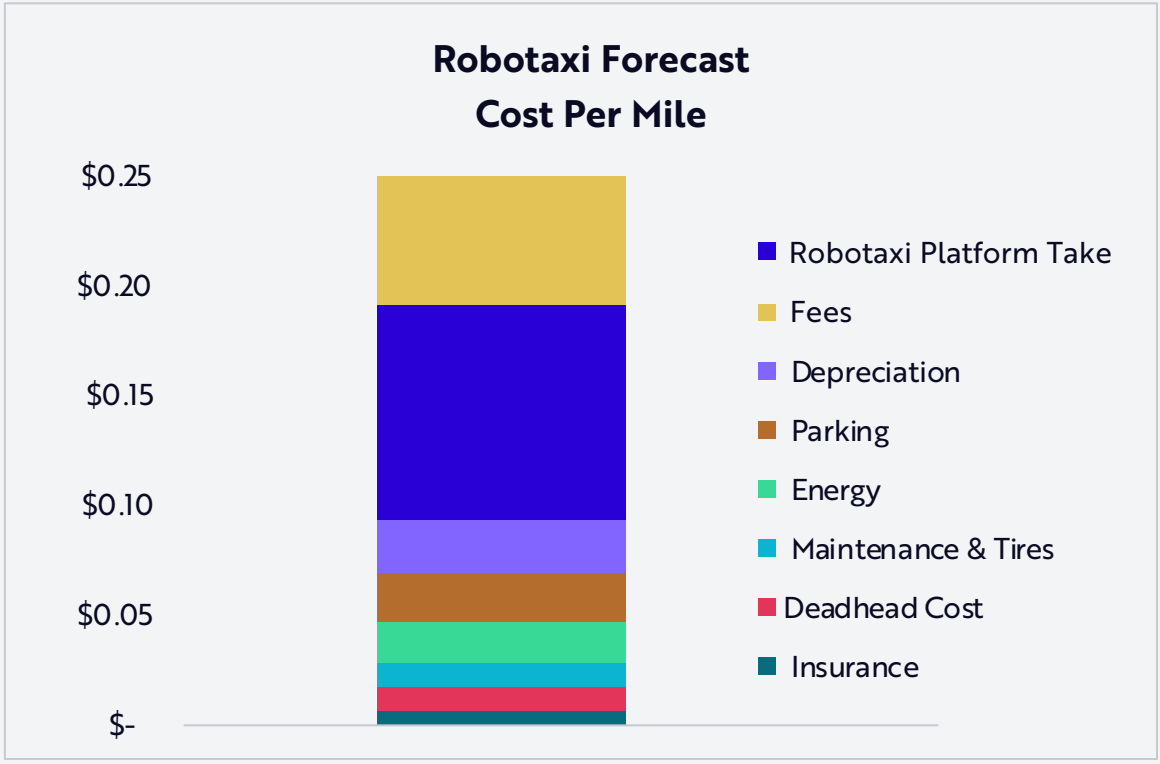


Note: "Capex"/"Capital Expenditure" is a one-off upfront cost required to build or deploy an asset. "Early launch" assumes ten cars per remote operator with utilization rates roughly equivalent to ride-hail today. "At scale" assumes 100 cars per remote operator with an improved autonomous operation utilization rate. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Autonomous Ride-Hail Should Reduce Costs, Including Deadhead Miles

Autonomous electric travel should reduce costs, including fuel, insurance, and deadhead miles, thanks to higher utilization, increased safety and efficiency, and electric drivetrains. Deadhead miles are the number of miles driven without passengers, which account for 45% of ride-hail miles today. Autonomous vehicles could reduce deadhead miles by removing the human-in-the-loop and harnessing AI tools to predict demand and traffic patterns.



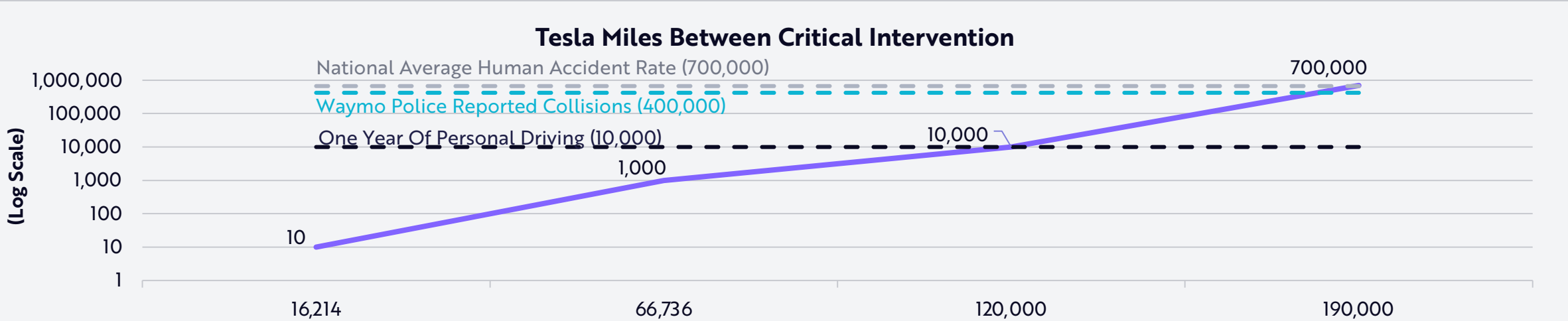


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Tesla Expects Its Autonomous Software To Outperform Human Drivers On Safety

Soon, Tesla expects more than 10,000 miles between critical interventions, or roughly one year's worth of human driving before the average person would need to touch the wheel in Full Self-Driving (FSD) mode. Later in 2025, Tesla plans to outperform the national accident rate—or ~700,000 miles between critical interventions—paving the way for conversations with regulators. In our view, Tesla could launch a robotaxi service with remote operators before hitting that milestone.

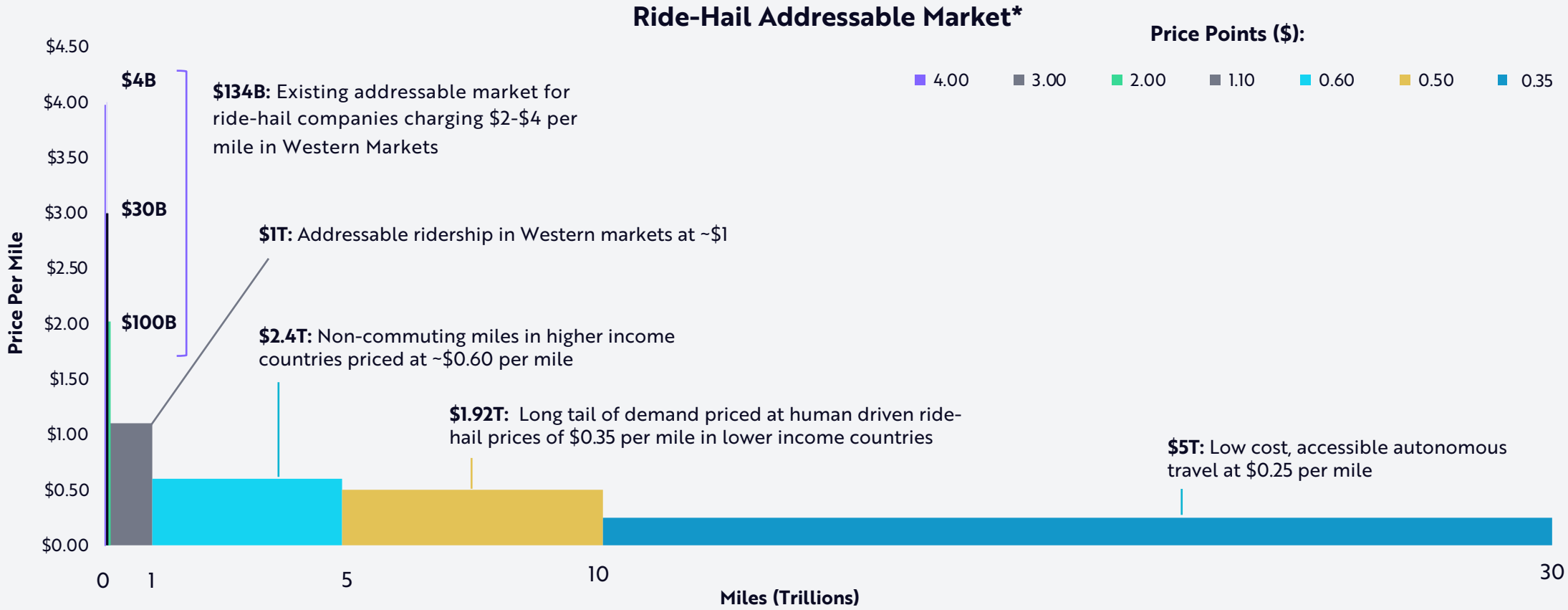
Waymo's commercial robotaxi service has surpassed 400,000 miles between police-reported collisions—impressive performance for a fleet of its size.



Note: "Miles Between Critical Intervention" measures the distance traveled before a human driver must take control to avoid an accident. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

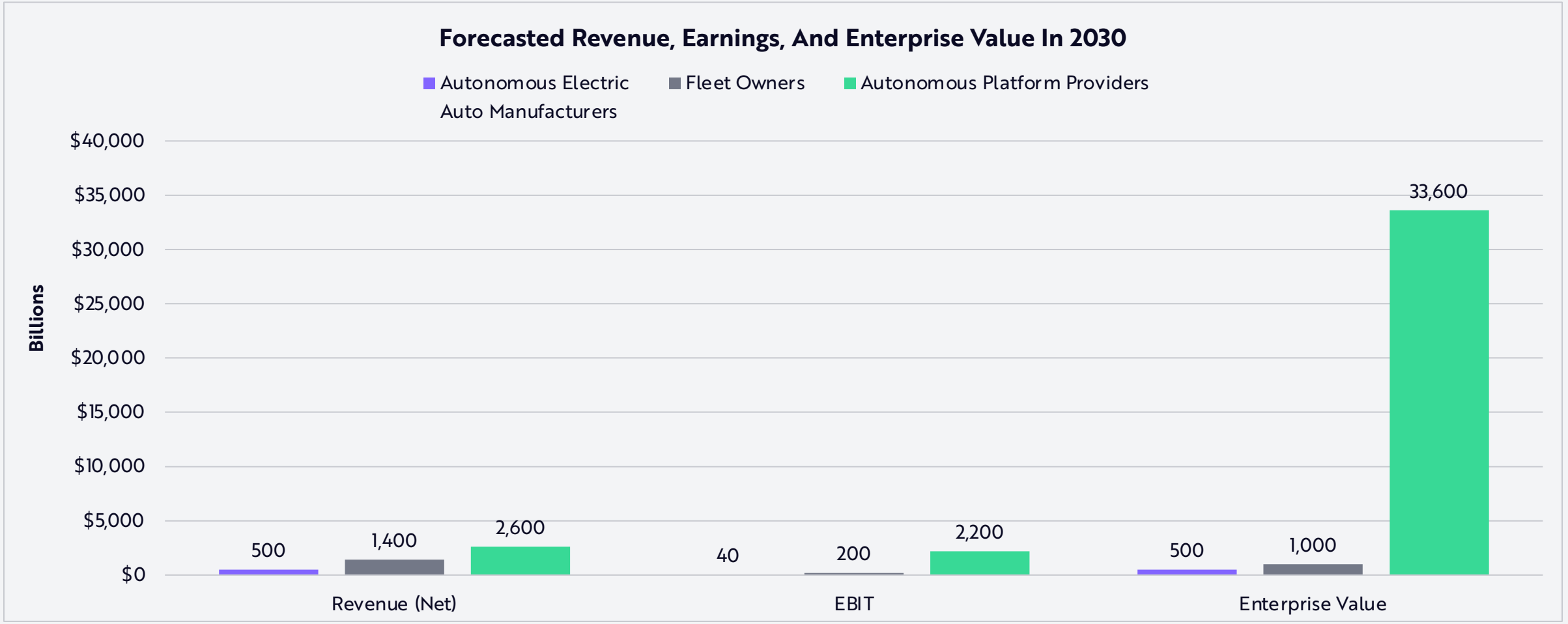
Ride-Hail Could Create A ~$10 Trillion Market

At $0.25 cents per mile, autonomous transportation could serve a much larger population than human-driven ride-hail does today. Meanwhile, based on how consumers value their time, demand could be significant even at higher price points.



*$10 trillion is the addressable market, not the revenue we expect in 2030, as we do not expect autonomy to penetrate all addressable miles. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Robotaxis Could Generate ~$34 Trillion In Enterprise Value By 2030



Note: Numbers are rounded. "EBIT": Earnings Before Interest and Tax. This slide depicts net revenue in 2030, the portion of gross revenue that the platform operator receives, while the previous slide depicts the total addressable market. Source: ARK Investment Management LLC, 2025This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Autonomous Logistics

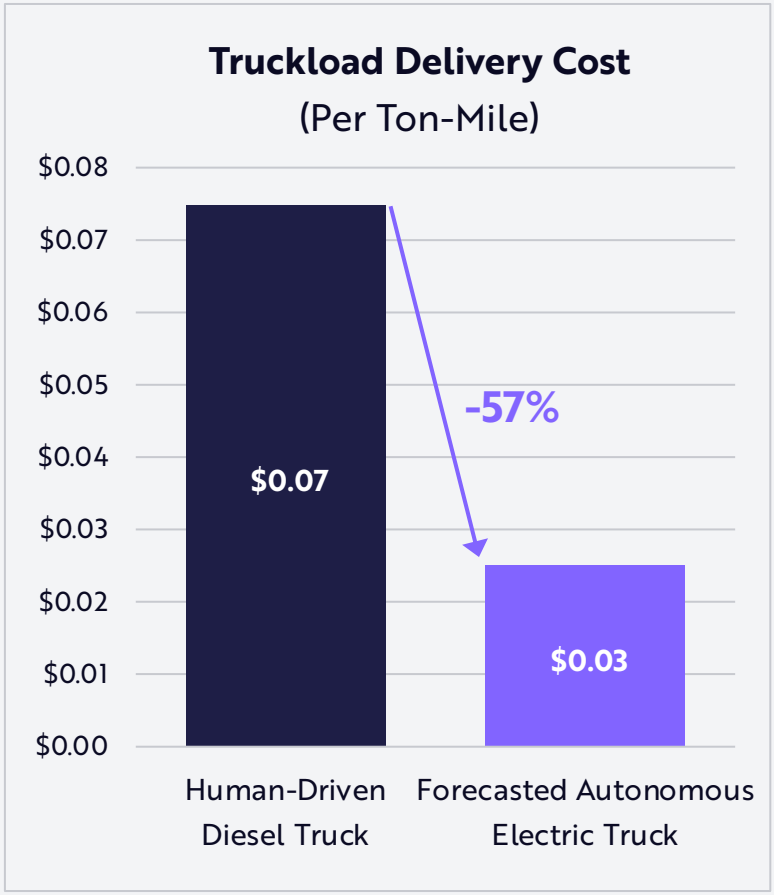
Cutting Costs, Revolutionizing Supply Chains, And Reshaping Consumer Behavior

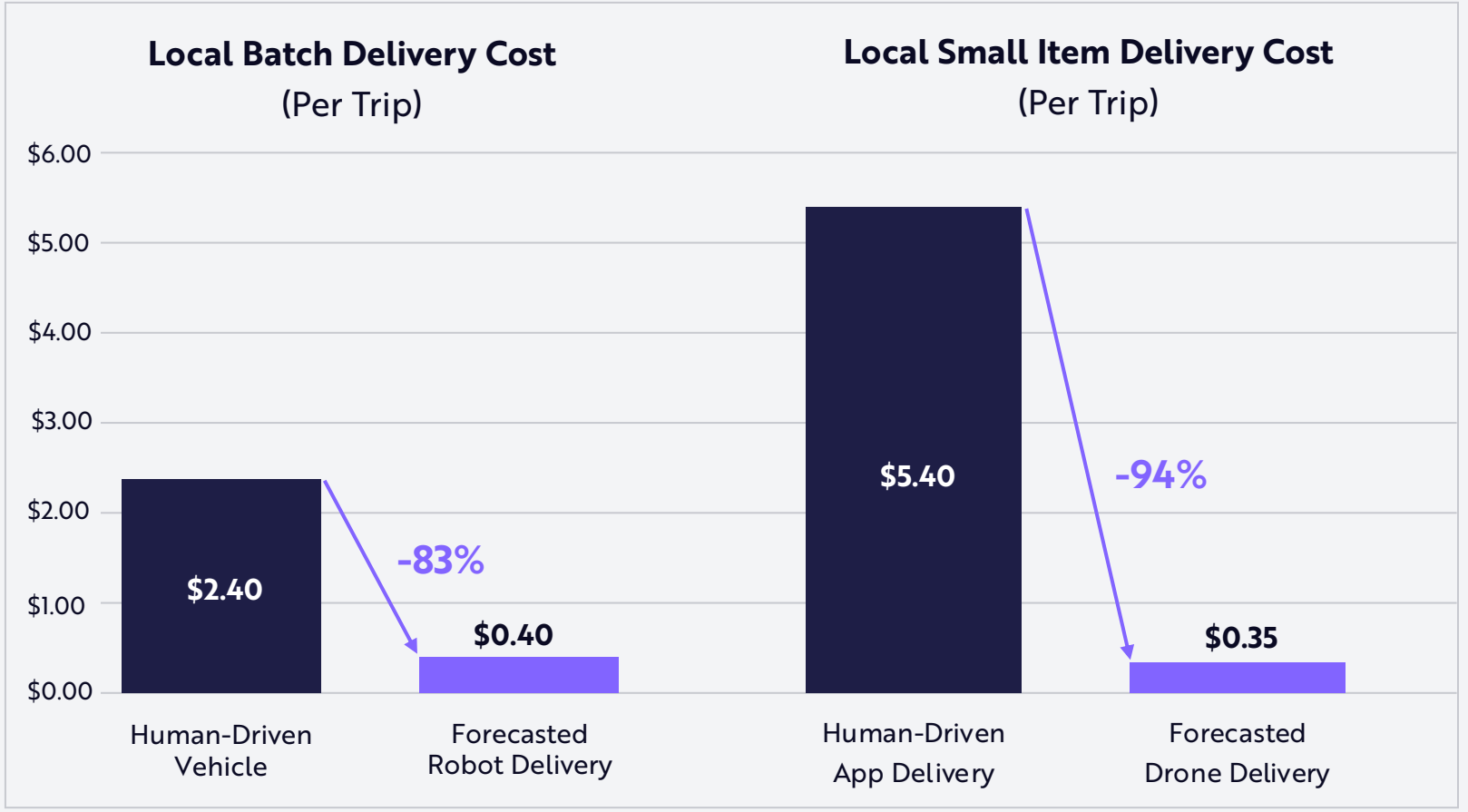
Tasha Keeney, CFA
DIRECTOR OF INVESTMENT ANALYSIS & INSTITUTIONAL STRATEGIES

Daniel Maguire, ACA
RESEARCH ANALYST, AUTONOMOUS TECHNOLOGY & ROBOTICS

Autonomous Vehicles That Roll And Fly Could Lower Supply Chain Costs Dramatically

Autonomous vehicles should operate at higher utilization rates than human-in-the-loop systems, creating more cost-effective last-mile delivery ecosystems.





Note: We have updated our drone price per mile with our latest assumptions for replacement costs, launching and charging infrastructure, insurance, and labor costs. Fees for drone and robot delivery are shown net of infrastructure costs (outside of charging and launch/land), which we believe either could be borne by the drone or robot delivery operators or shared with logistics or retail partners. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Robotrucks And Drones Face More Hurdles To Commercialization Than Robotaxis

	Robotaxis	Robotrucks	Drones
Technical Hurdles			
Regulatory Hurdles			
Customer Partnerships			
Manufacturing Partnerships			
Data Collection/ Testing/Validation			

Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Hurdles To Commercialization

Technical:

Robotaxis were first to commercialize, but most robotrucks still require a human operator, with a number of companies pushing to remove the driver this year. Meanwhile, drones have been able to fly autonomously for a number of years: the difficulty lies more in logistics than on the autonomous flight technology.

Regulation:

Waymo and Baidu have paved the regulatory path for robotaxis in the US and China, respectively. In the US, state regulators could give way to federal legislation in 2025. Trucking is influenced by lobbyists, while drones are regulated by the FAA, which historically has missed many of its own timelines for developing a framework for drone delivery.

Customer Partnerships:

Robotaxis sell rides to end consumers, while robotrucking and drone companies need to forge partnerships with retailers, food delivery providers, and other logistics operators.

Manufacturing Partnerships:

In the robotaxi industry, Tesla is vertically integrated while companies like Waymo and Baidu have partnered with Geely and Hyundai/BAIC, respectively. In the trucking space, players like Aurora have partnered both with OEMs* like Paccar and Volvo and with integrators like Continental. Meanwhile, many drone providers manufacture in-house but have not hit mass manufacturing scale.

Data/Testing/Validation:

While Tesla has generated billions of miles of customer data for training, Waymo and Baidu have access only to millions of miles. In trucking, autonomous players have taken a route-by-route approach, building their data libraries as they add more routes. For drones, while many flights have occurred in Africa, companies continue to test with partners in the US and Europe, with limited services offered, thus far.

* "OEM": Original Equipment Manufacturer. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request.

Logistics Drone Companies Are Beginning To Break Through Regulatory Barriers

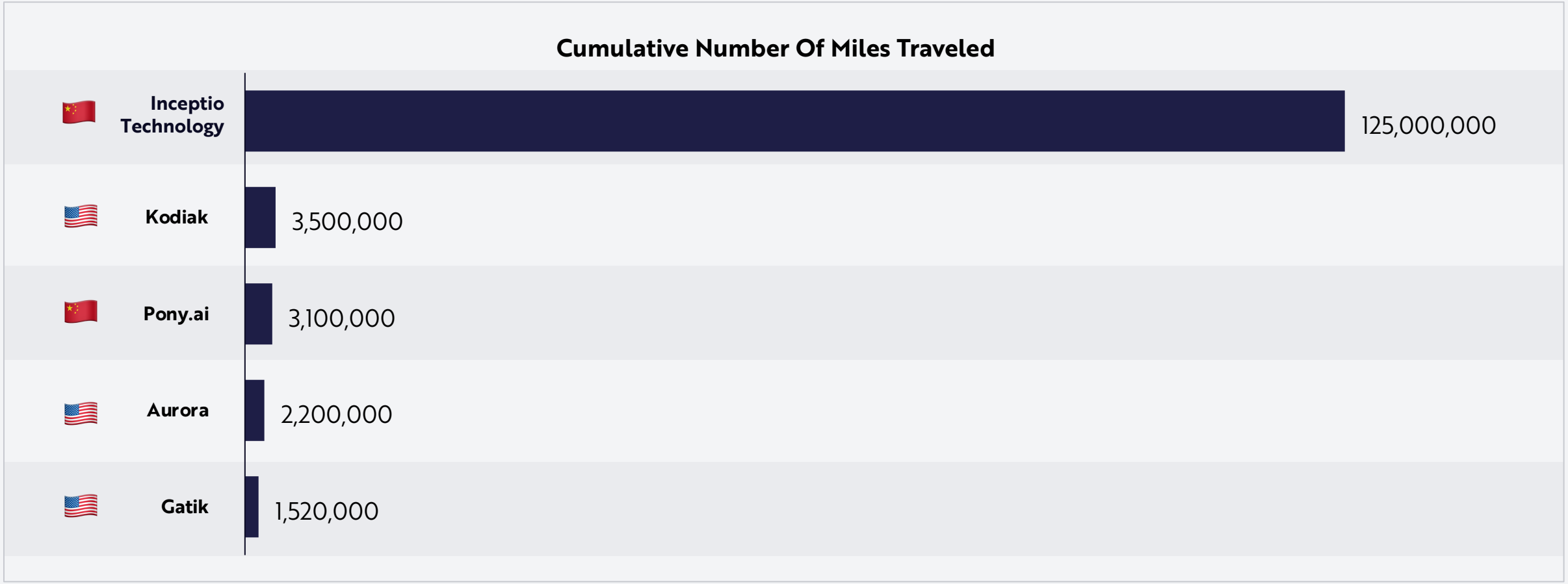
- Thus far, most drone deliveries have taken place in rural areas outside the US to serve unmet medical needs.
- Companies with more real-world data and regulatory approvals to fly beyond-visual-line-of-sight without observers will pull away from the competition.

Company	Region Of Operations	Customer	US Regulatory Approval*	Cumulative Number Of Commercial Flights
Zipline	US Africa	Hospital & Consumer	Part 135 (Paid)	1,320,000
Wing	US Australia EU UK	Hospital & Consumer	Part 135 (Paid)	400,000
Meituan	China UAE	Consumer	N/A	400,000
Manna	US EU	Hospital & Consumer	Part 107 (Unpaid)	280,000 e
FlyTrex	US	Consumer	Part 107 (Unpaid)^	100,000
Matternet	US EU UAE	Hospital & Consumer	Part 107 (Unpaid)^	50,000
Amazon	US	Consumer	Part 135 (Paid)	5,000 e

*In the US, paid drone delivery requires Federal Aviation Administration (FAA) Part 135 certification; Part 107 allows operation but prohibits compensation. That said, the FAA is working on updating drone regulation to standardize beyond visual line of sight operations for commercial drones in the US under Part 108. ^FlyTrex and Matternet have Part 135 partners. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 17, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Autonomous Trucking Companies With The Most Real-World Miles Should Be Best Equipped For Scale

- In the US, commercial autonomous trucking requires a safety driver today.
- China leads in generating real-world driving data, but companies in the US should advance considerably once regulators approve the removal of safety drivers in 2025.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Robot Delivery Companies With Broad-Based Experience Should Be In A Superior Competitive Position

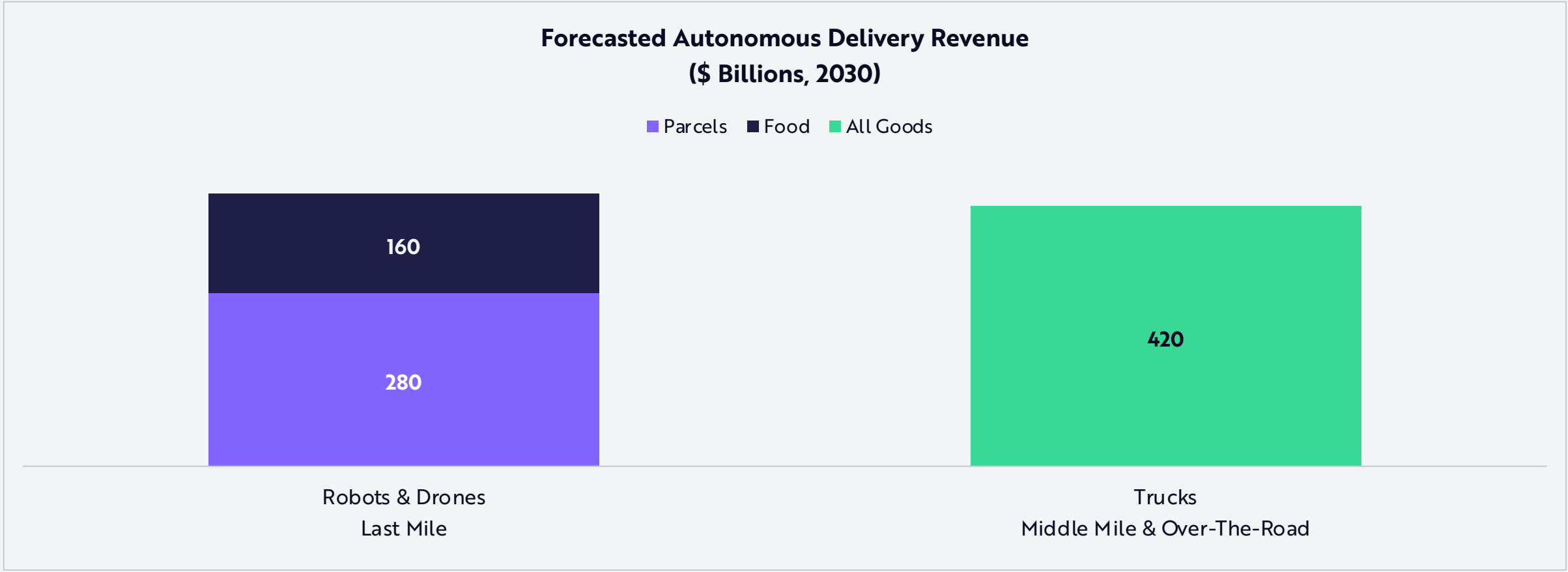
- In the US, most sidewalk deliveries are on college campuses, which do not seem to be productive training ground for urban and residential areas.
- In China, road robots are commonplace.

Company	Countries	Sidewalk Or Road?	College Campus Or Beyond?	Number Of Deliveries Completed
Starship Technologies	US GB DE FI EE	Sidewalk	Mostly Campus	7,000,000
Neolix	CN	Road	Beyond	6,000,000
Meituan	CN	Road	Beyond	4,000,000
Coco*	US FI	Sidewalk	Beyond	500,000
Avride	KR US UAE	Sidewalk	Beyond	200,000
Cartken	JP US	Sidewalk/ Indoor	Mostly Campus	200,000 e
Serve Robotics	US	Sidewalk	Beyond	50,000

*Coco has evolved from human-driven to hybrid robots and is more reliant on humans than are its competitors. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 17, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Autonomous Delivery Revenue Could Approach ~$900 Billion Globally In 2030

Technology-enabled delivery is likely to reshape consumer buying habits, as the cost of transporting goods falls. Our research suggests that robot/drone delivery fees and autonomous trucking revenues could reach ~$440 billion and ~$420 billion, respectively, in 2030.



The US Needs Low-Cost, AI-Powered Aircraft

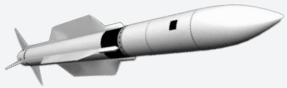
- The current state of warfare has proven that high-cost aircraft are unsustainable against low-cost internationally made drones.
- Meanwhile, AI is improving decision-making and efficiency, reducing the need for human troops.

Ukraine

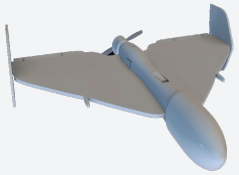
US F-16
~$30-60 million

Chinese DJI
~$2,000-20,000

Red Sea:



US SM-2 Missile
~$2 million



Iranian Shahed 136
~$20,000

> *"If we're shooting down a $50,000 one-way drone with a $3 million missile, that's not a good cost equation."*
>
> **Bill LaPlante,**
> Under Secretary of Defense for Acquisition and Sustainment

> *"Replicator will galvanize progress in the too-slow shift of U.S. military innovation to leverage platforms that are small, smart, cheap, and many."*
>
> **Kathleen Hicks,**
> Deputy Secretary of Defense

> *"Smaller And Cheaper AI-controlled Unmanned Jets Are The Way Ahead."*
>
> **Frank Kendall,**
> 26th Secretary of the Air Force

> *"I want to turn the Taiwan Strait into an unmanned hellscape..."*
>
> **Samuel Paparo,**
> US Indo-Pacific Command Chief
> Navy Admiral

> *"We need them potentially at very large scale and very quickly."*
>
> **Doug Bush,**
> Army Acquisition Chief, on buying drones in large quantities

> *"manned fighter jets are obsolete in the age of drones..."*
>
> **Elon Musk**

Energy

Powering The Artificial Intelligence Revolution

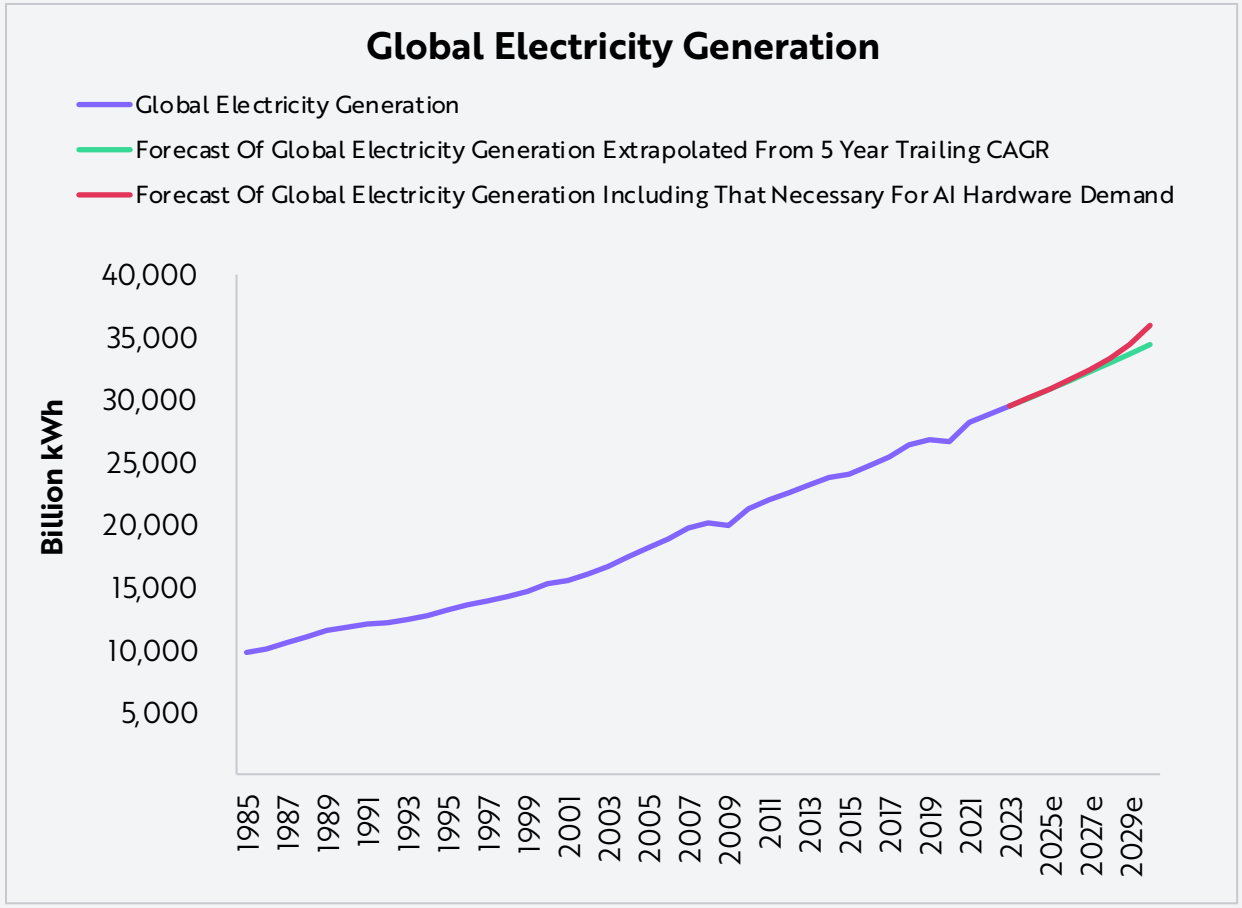
Sam Korus
DIRECTOR OF RESEARCH
AUTONOMOUS TECHNOLOGY
& ROBOTICS

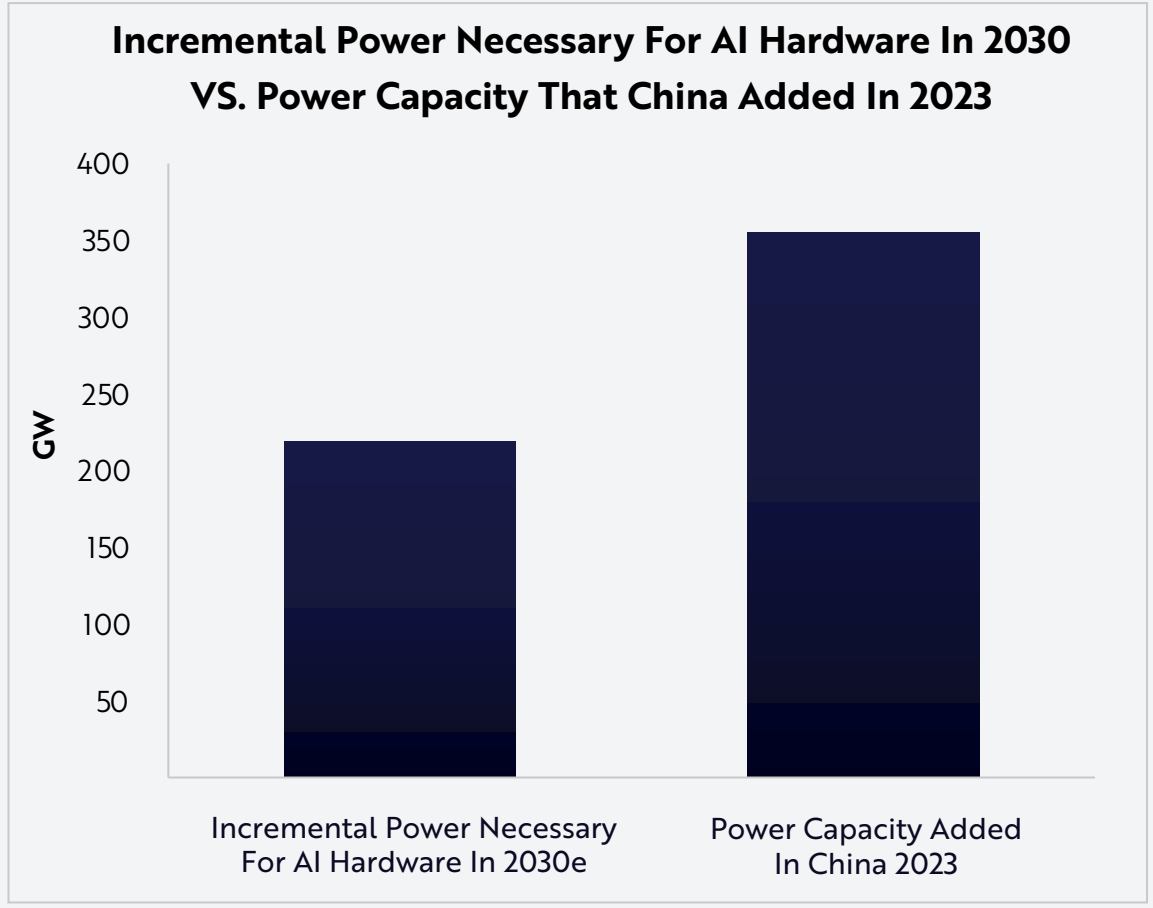
Daniel Maguire, ACA
RESEARCH ANALYST
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Akaash TK
RESEARCH ASSOCIATE
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Energy Production Is Important To Economic Growth

According to our research, China added more power capacity in 2023 than would be necessary to meet our estimate of incremental power demand from AI data centers through 2030. In other words, the buildout rate necessary to accommodate AI power demand is achievable.

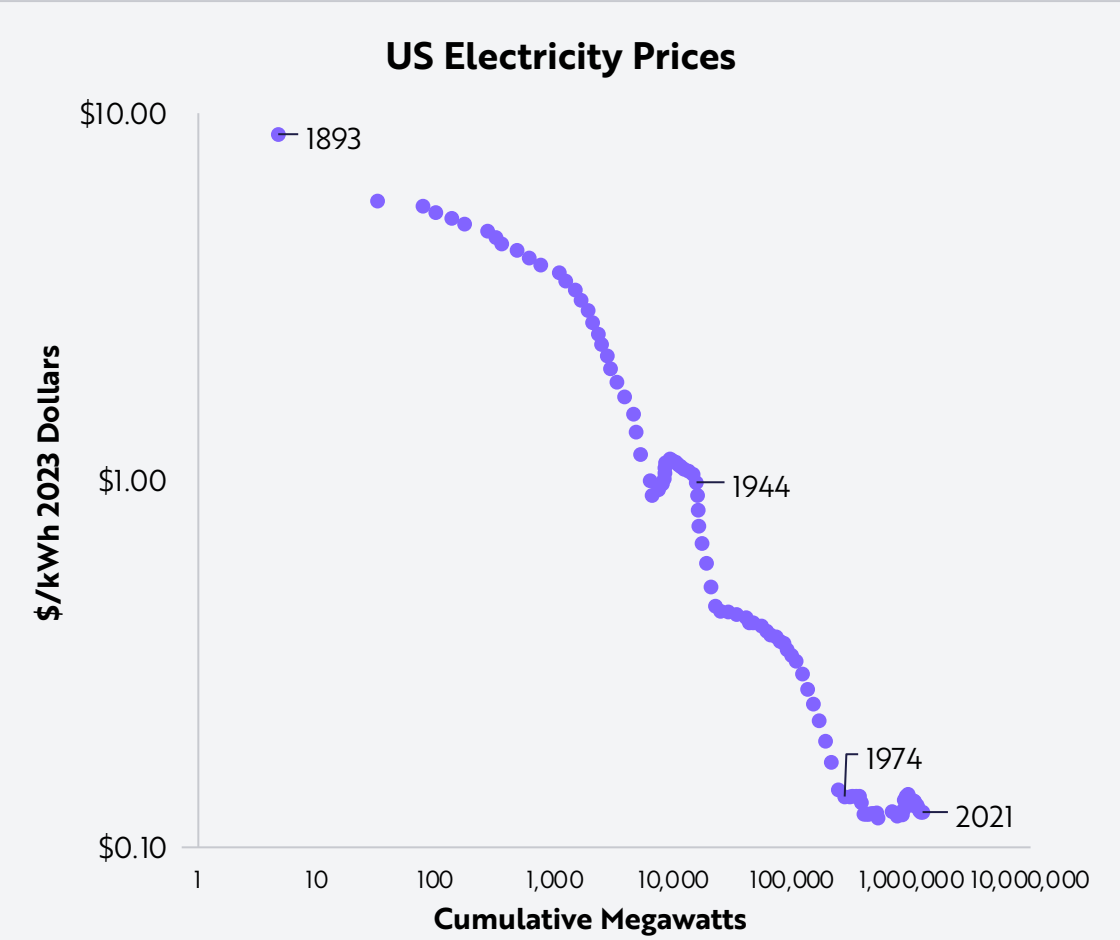


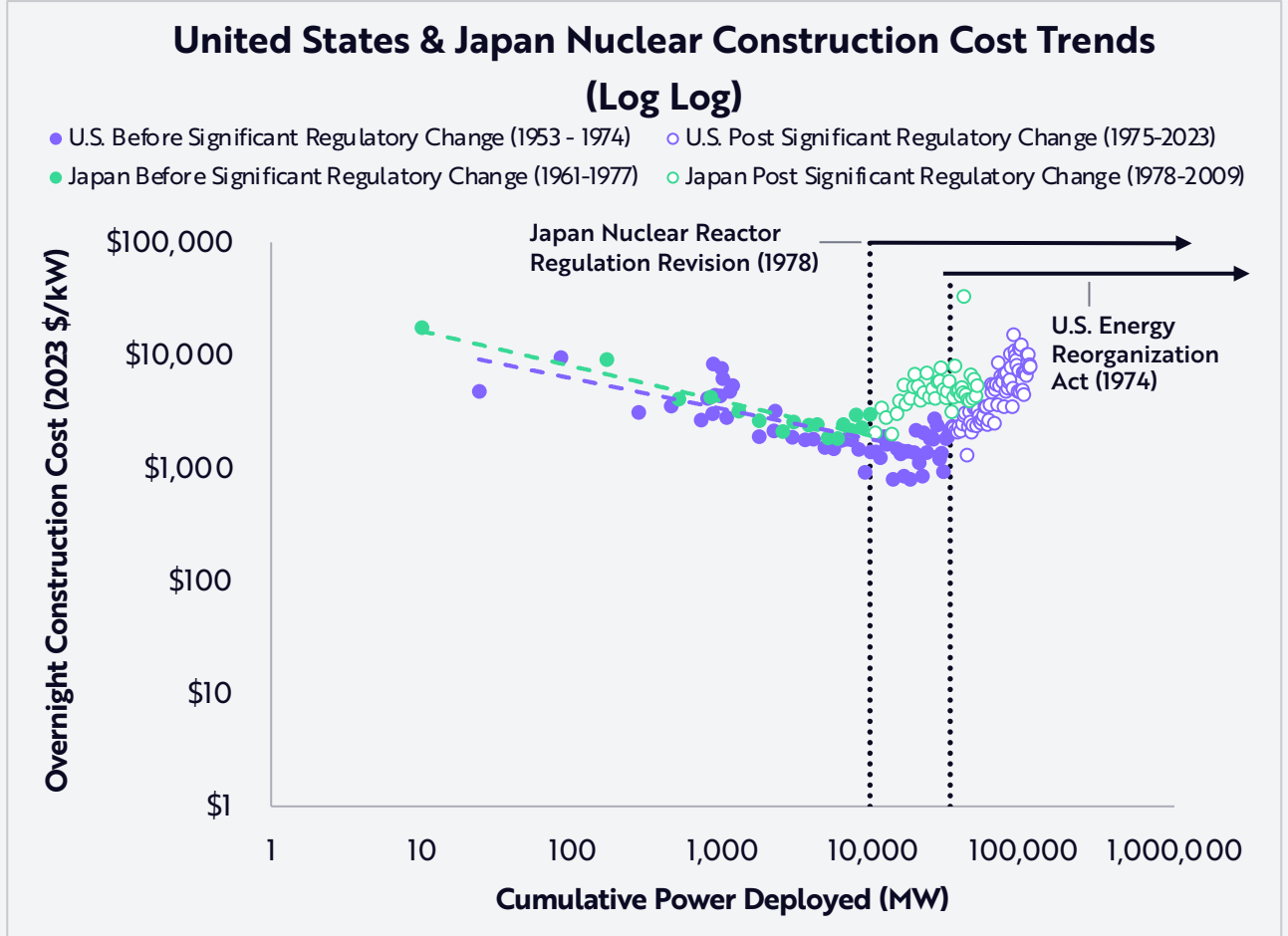


Note: "CAGR": Compound Annual Growth Rate. "kWh": Kilowatt-hour, a unit of energy, representing the use or generation of 1 kilowatt of power for 1 hour. "GW": Gigawatt, a unit of power equal to one billion watts. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Nuclear Energy Regulation Ended The Declines In Electricity Prices

Informed by Wright's Law,* ARK's research indicates that, apart from WWII, US electricity prices fell consistently from the late 1800s until 1974. The U.S. Energy Reorganization Act, enacted in 1974, reversed the drop in nuclear construction costs.





Note: "MW": Megawatt, a unit of power equal to one million watts. "kW": Kilowatt, a unit of power equal to one thousand watts. "kWh": Kilowatt-hour, a unit of energy, representing the use or generation of 1 kilowatt of power for 1 hour. *Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. See Winton 2019. Source: ARK Investment Management LLC, 2025, based on data from Smil 2000 and Cleveland 2023 (left chart) and Lovering et al. 2016 (right chart). For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

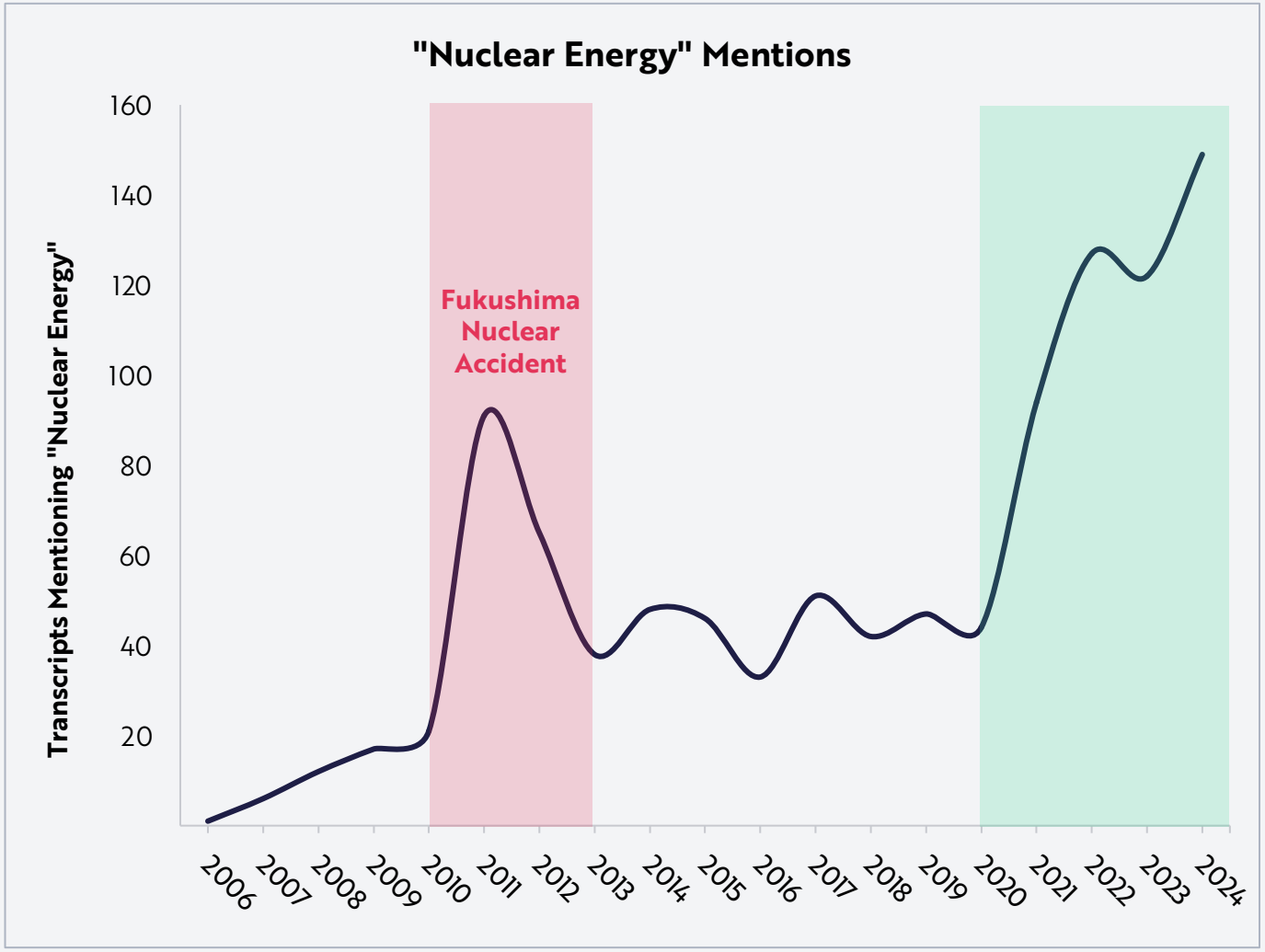
The Nuclear Tide Is Rising

Interest in nuclear energy is surging as companies seek a clean, reliable power source to sustain AI initiatives and meet ambitious net-zero carbon goals.

> *Microsoft in deal for Three Mile Island nuclear power to meet AI demand*
>
> - Financial Times, Sept 20, 2024

> *Google orders small modular nuclear reactors for its data centers*
>
> - Financial Times, Oct 14, 2024

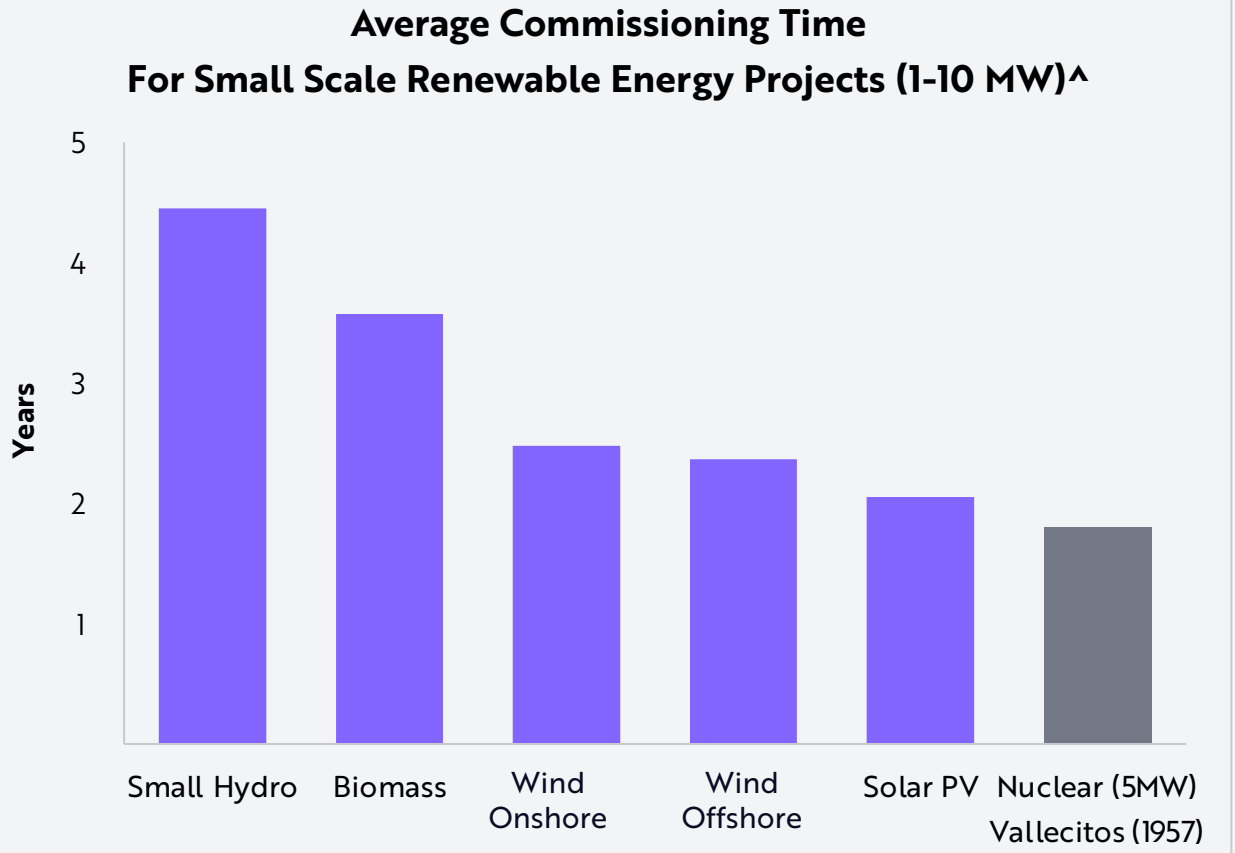
> *Amazon buys stake in nuclear energy developer in push to power data centers*
>
> - Financial Times, Oct 16, 2024

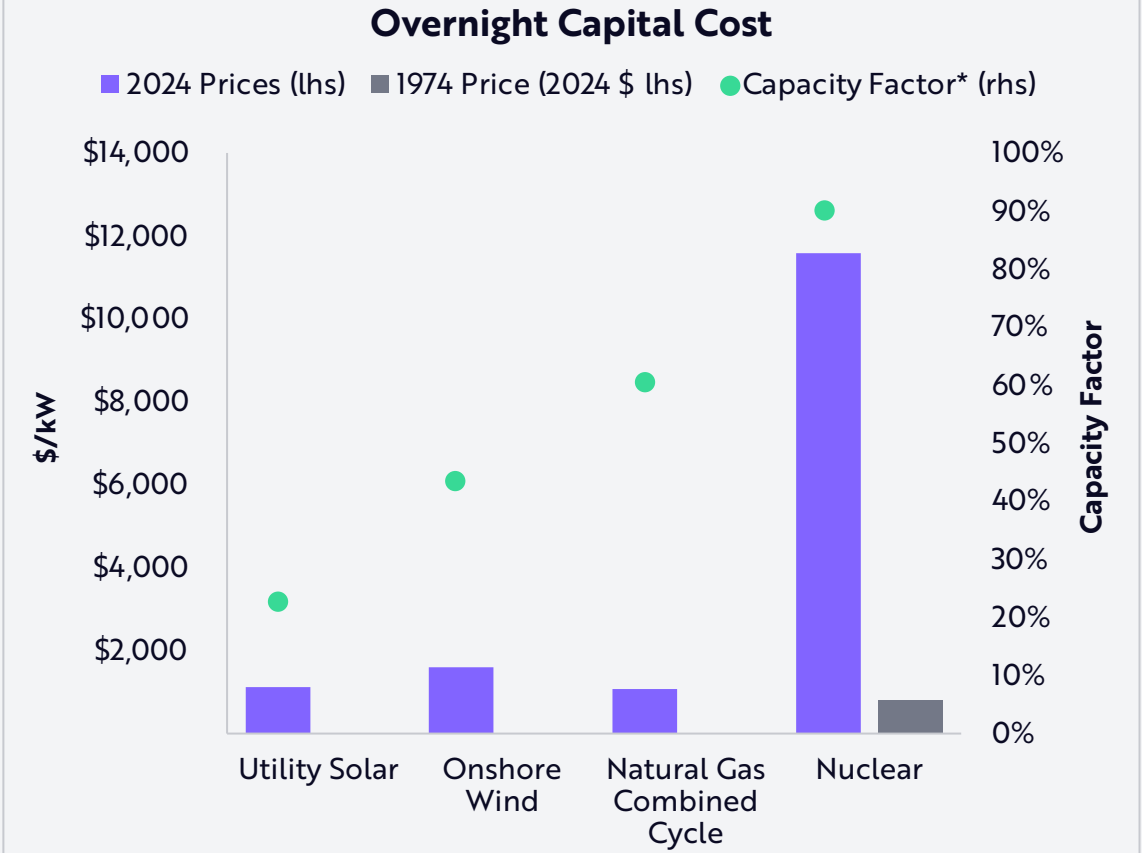


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Capital IQ Pro, as of December 18, 2024, which may be provided upon request.
For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.
Forecasts are inherently limited and cannot be relied upon.

Nuclear Fission Projects Could Deliver Economics Superior To Other Renewable Energy Projects

Supported by clear regulations, nuclear fission could be a cost-competitive, timely solution to increasing power demands globally.

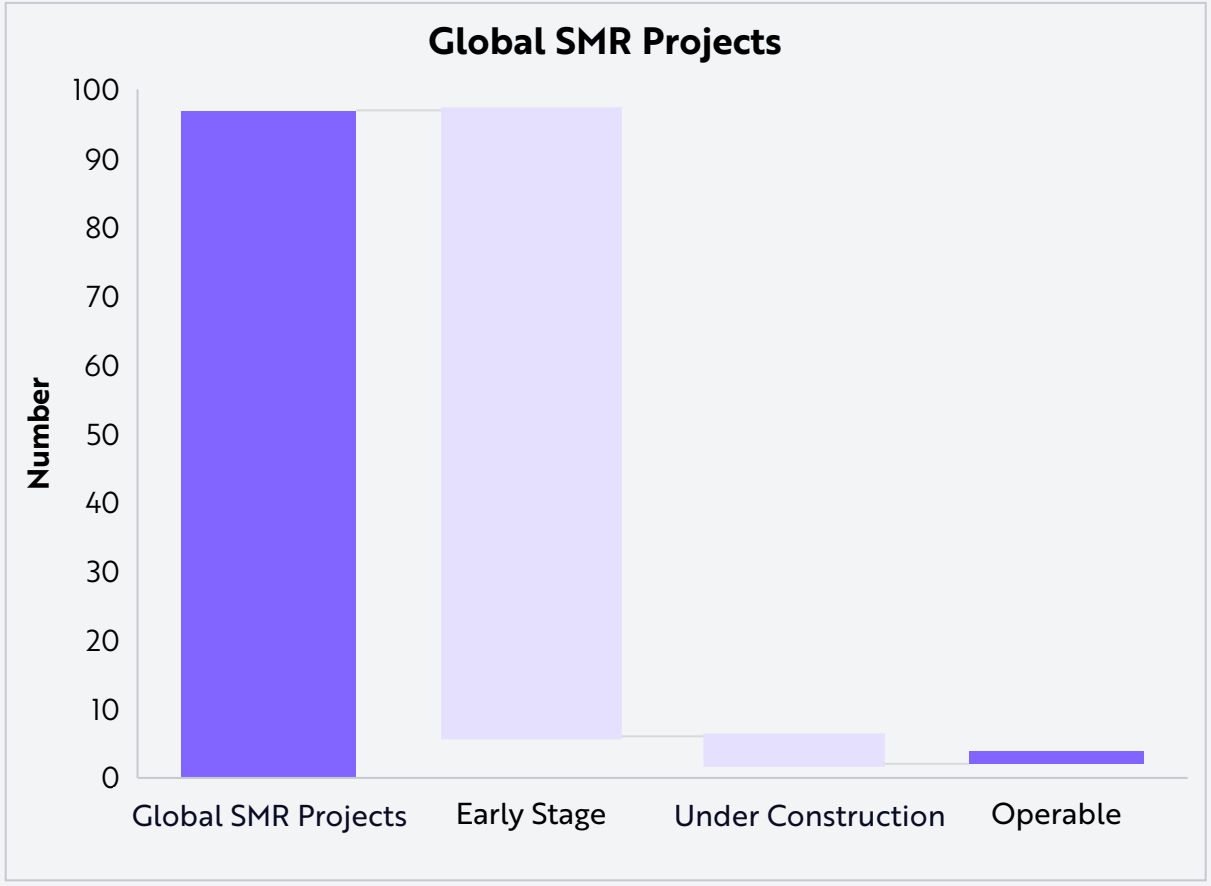


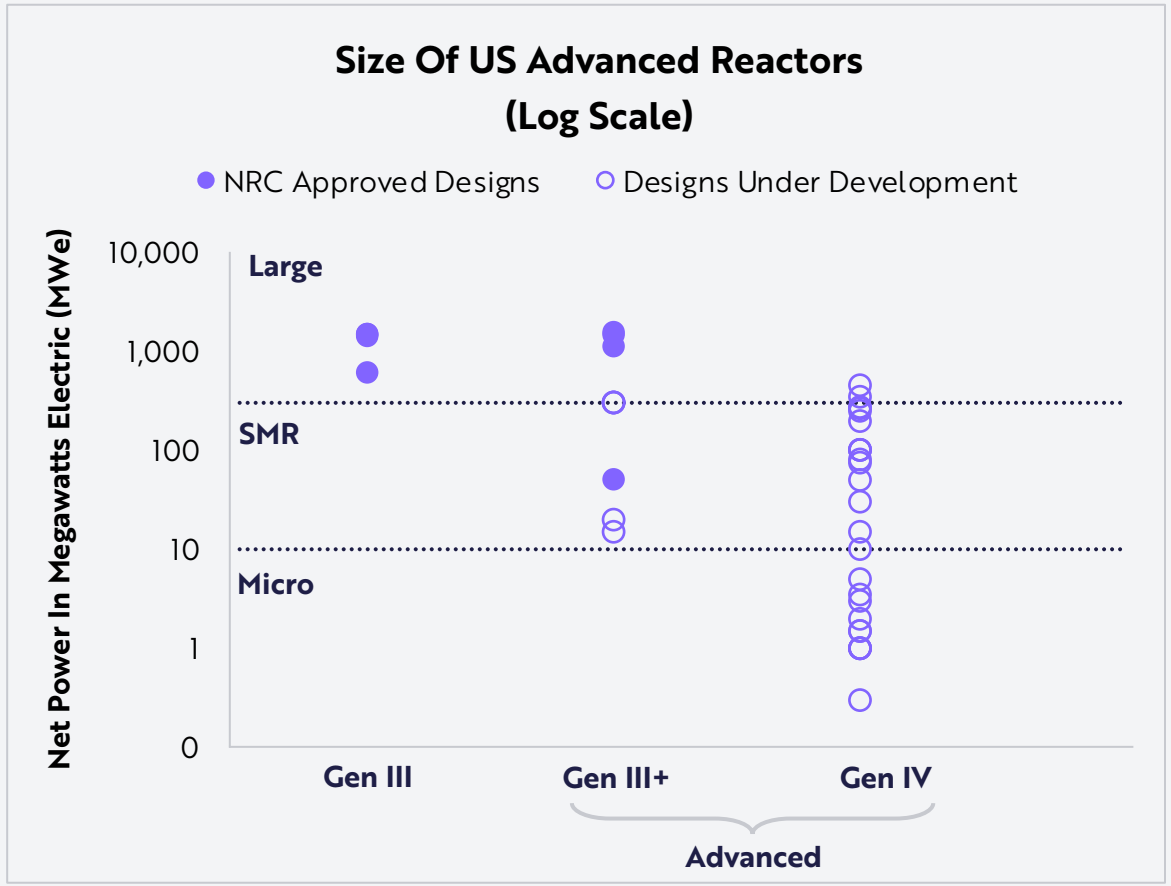


Note: In 1957, the Vallecitos Boiling Water Reactor (VBWR) in Sunol, California, was the first nuclear power plant privately owned and operated to supply electricity to a public utility grid. "MW": Megawatt, a unit of power equal to one million watts. "kW": Kilowatt, a unit of power equal to one thousand watts. ^Average across 48 countries between 2005-2022. *Capacity Factor is defined as the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including World Nuclear Association 2024, Gumber et al. 2023, and Lovering et al. 2016, as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

While Most Small Modular Reactor (SMR) Startups Will Fail, The Survivors Should Thrive

SMRs are early stage and face significant execution risks. To triple nuclear capacity by 2050, the US must build large reactors, SMRs, and microreactors. Shorter construction timelines, modular design, and scalability could enable smaller reactors to meet near-term demand. Selecting from more than 30 US designs will be important to reigniting Wright's Law and lowering electricity costs.





Note: "NRC": U.S. Nuclear Regulatory Commission. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Small Modular Reactor (SMR) Global Tracker as of November 14, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

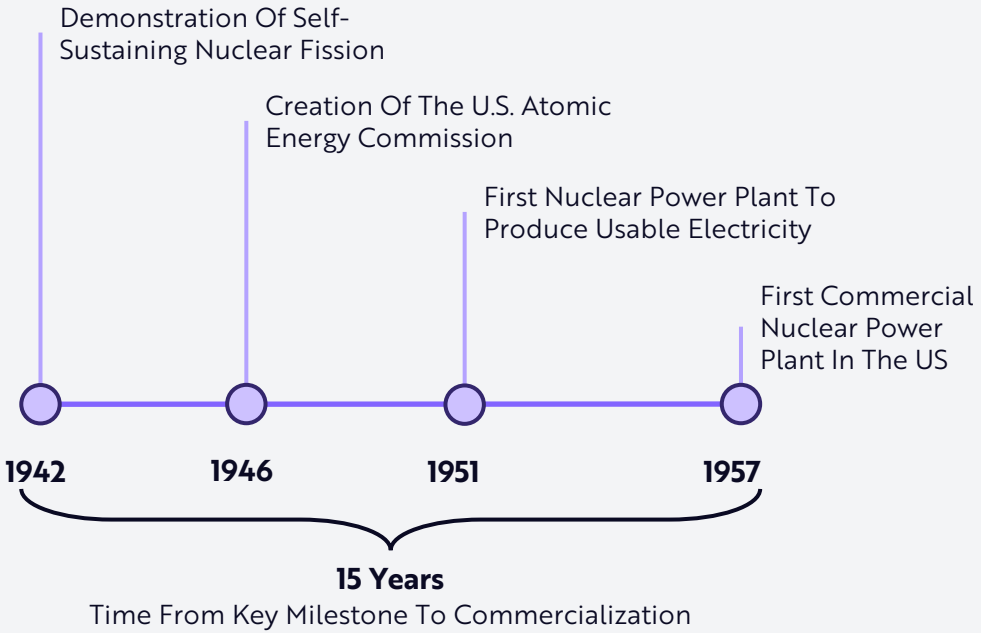
Nuclear Fusion Faces Significant Hurdles To Commercialization

Scientific Breakeven
The fusion reaction generates the same power as injected into the fuel.

Engineering Breakeven
The fusion reaction generates the same power as the reactor consumes.

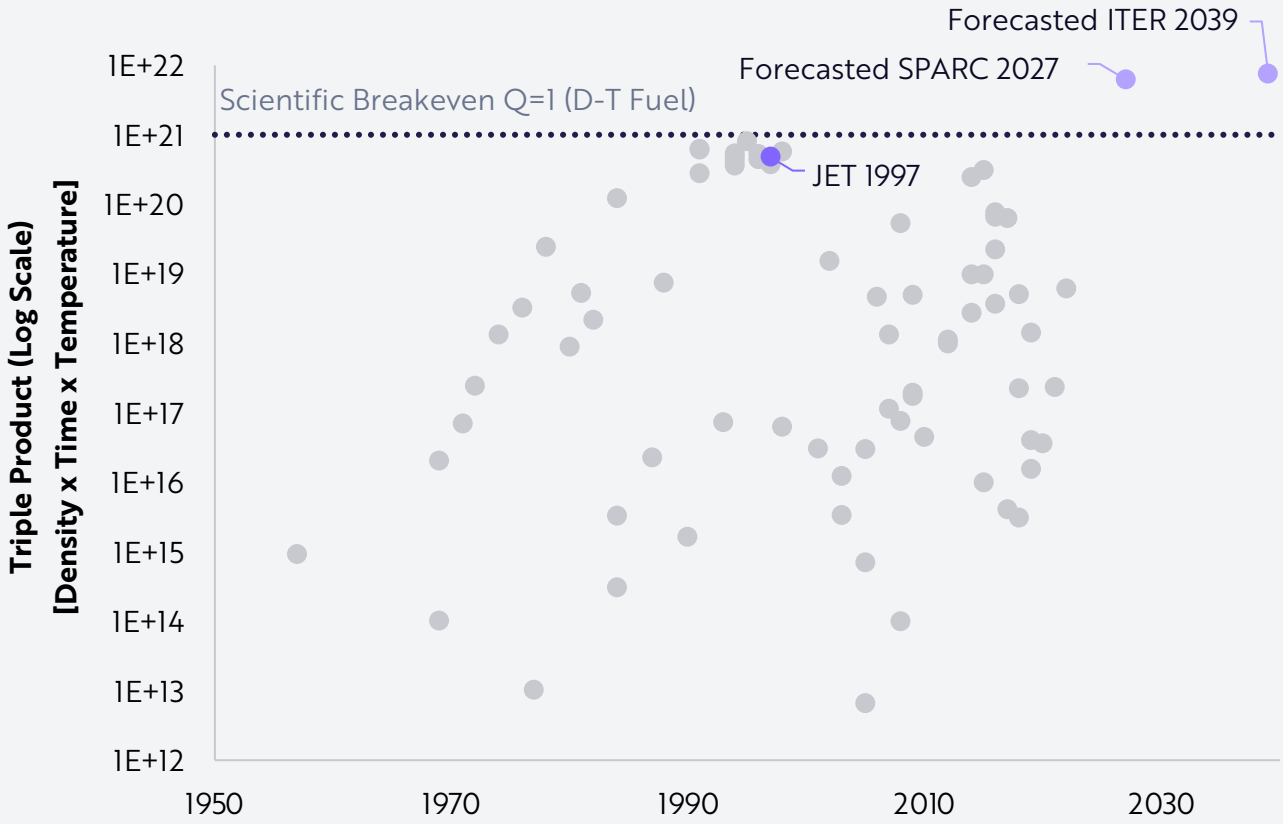
Commercial Breakeven
The fusion reaction generates surplus power to cover the cost of building and operating the plant.

Nuclear Fission Milestones



Despite ~75 years of research, nuclear fusion has not generated net energy in a meaningful way. While private fusion companies are promising breakthroughs as early as 2027, commercialization could take another ~15 years, if fission history is any guide.

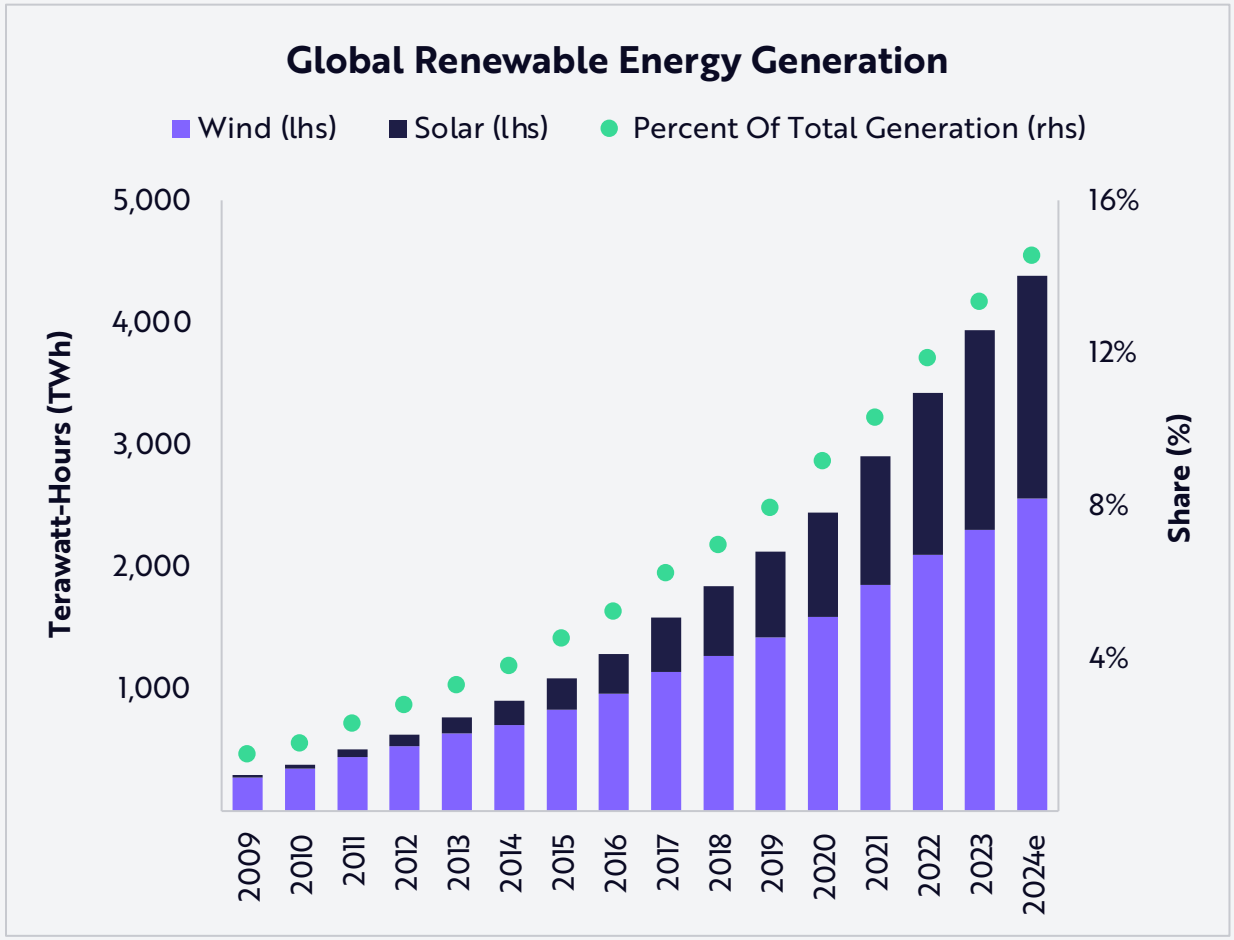
Fusion Project Progress Toward Scientific Breakeven*

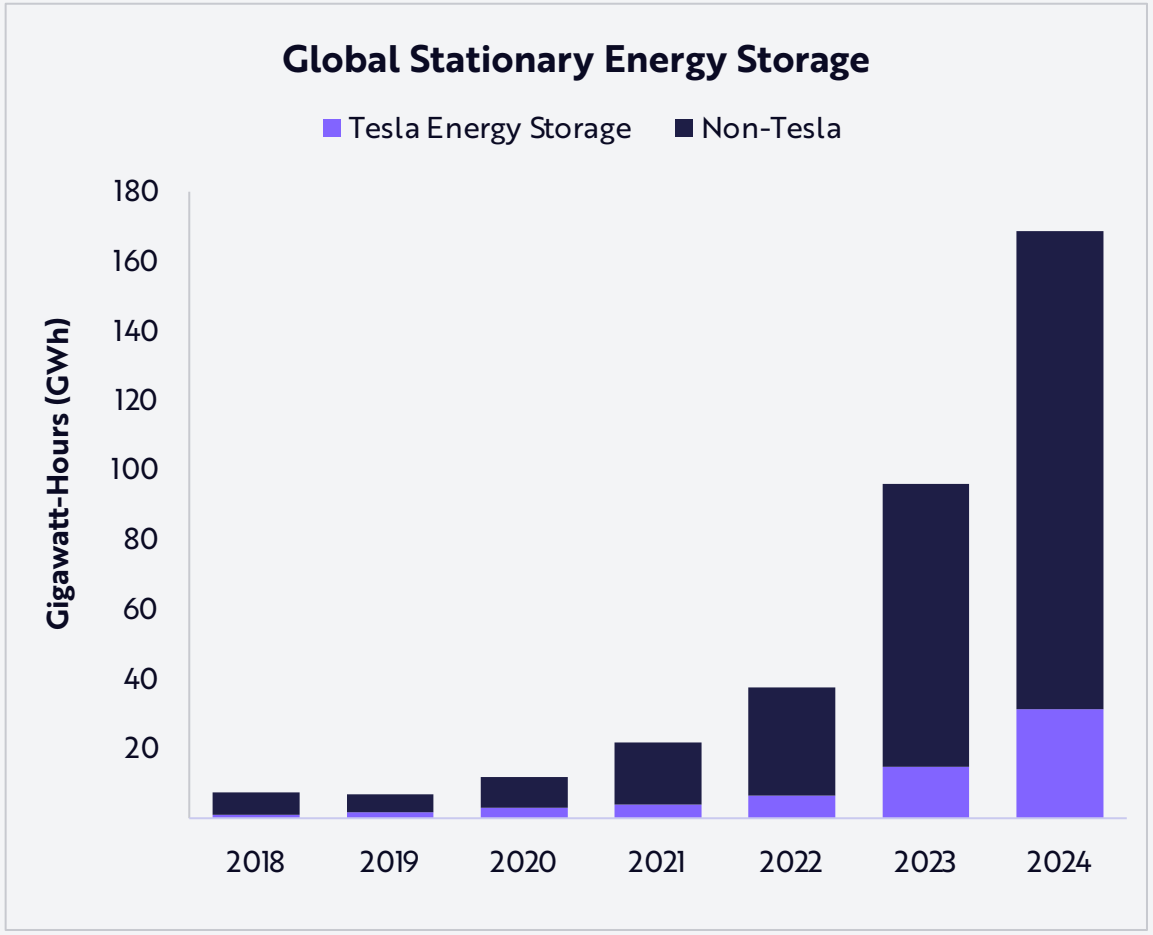


Note: The 'Triple Product" displayed on the Y axis above is a single metric that measures nuclear fusion progress by considering density, confinement time, and temperature. It's a very large number, so we use scientific notation, e.g., "1E+21," meaning 1 followed by 21 zeros. "SPARC": Smallest Possible Affordable Robust Compact reactor. SPARC is a Tokamak design. "ITER": International Thermonuclear Experimental Reactor. *Excluding Laser-Based Inertial Confinement. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Nuclear And Other Renewables Can Serve As Viable Solutions

Solar, wind, and stationary energy storage are just getting started. One solution will not meet all demands. Interestingly, Tesla accounts for ~19% of global energy storage today.

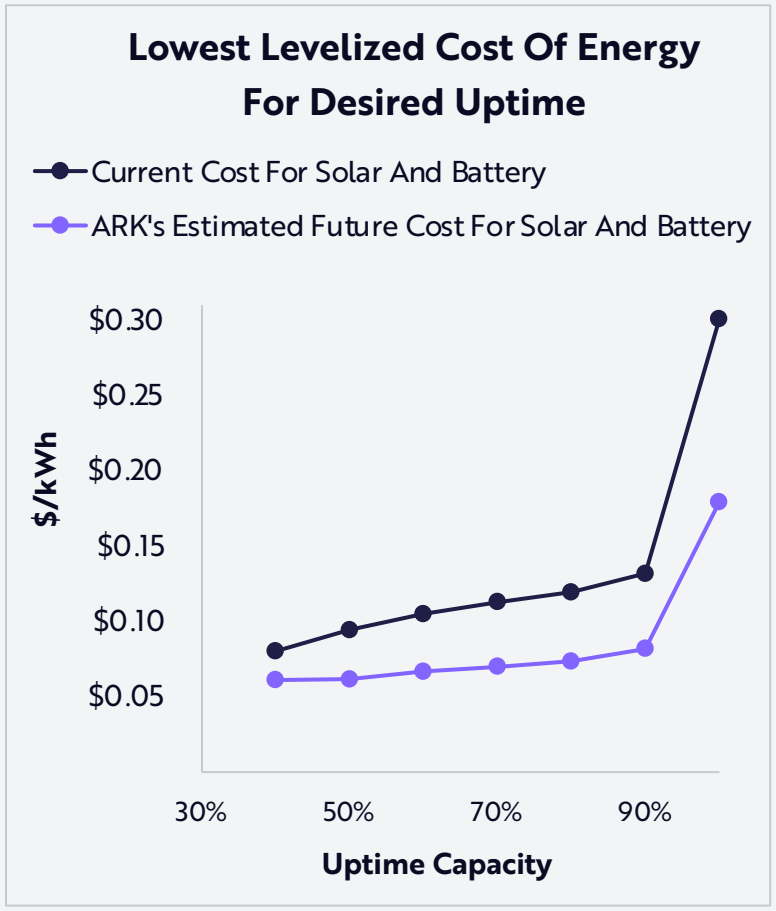


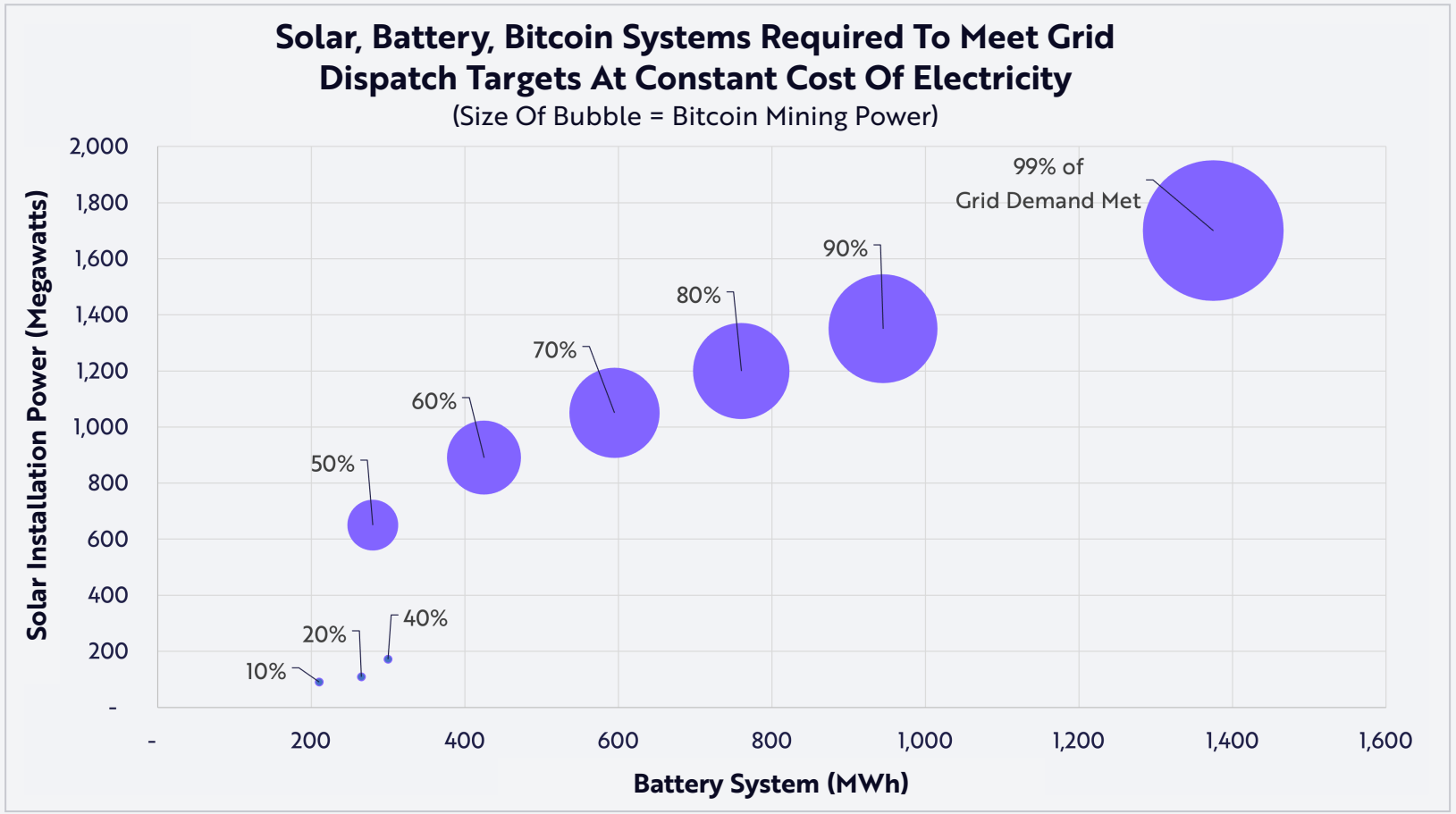


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

As Battery Costs Decline, Intermittent Energy Sources Become Less Problematic

Declining battery costs should make intermittent energy systems economically attractive with 100% uptime. ARK's modeling suggests that energy-intensive industries will accelerate the pairing of renewables with energy storage. Bitcoin mining is a prime example, showcasing how energy-intensive industries with business models orthogonal to power generation can accelerate the shift to 100% renewable grid integration.

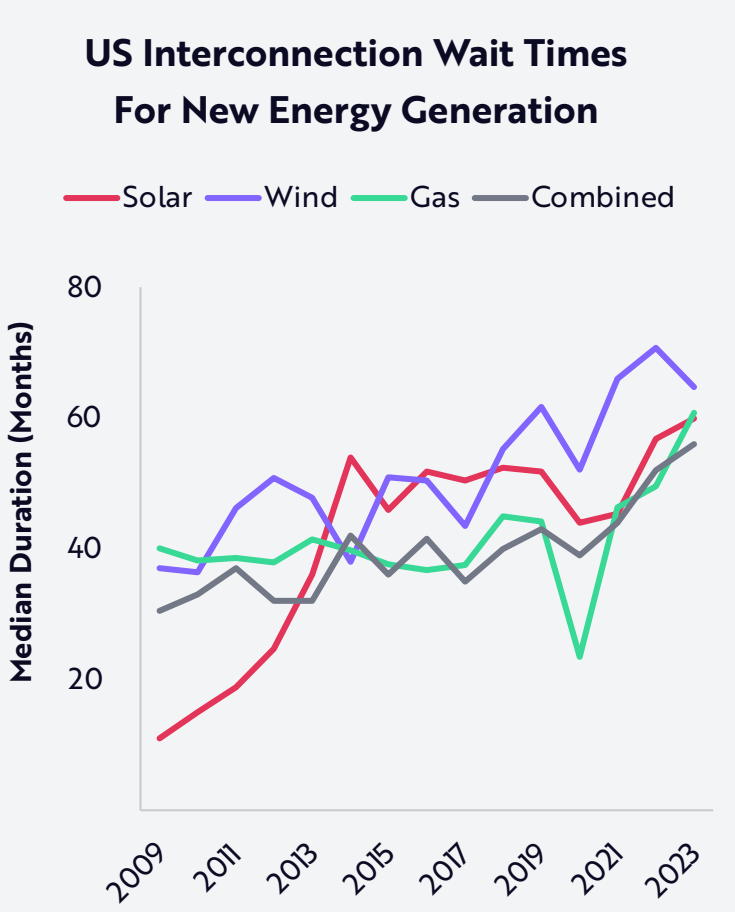


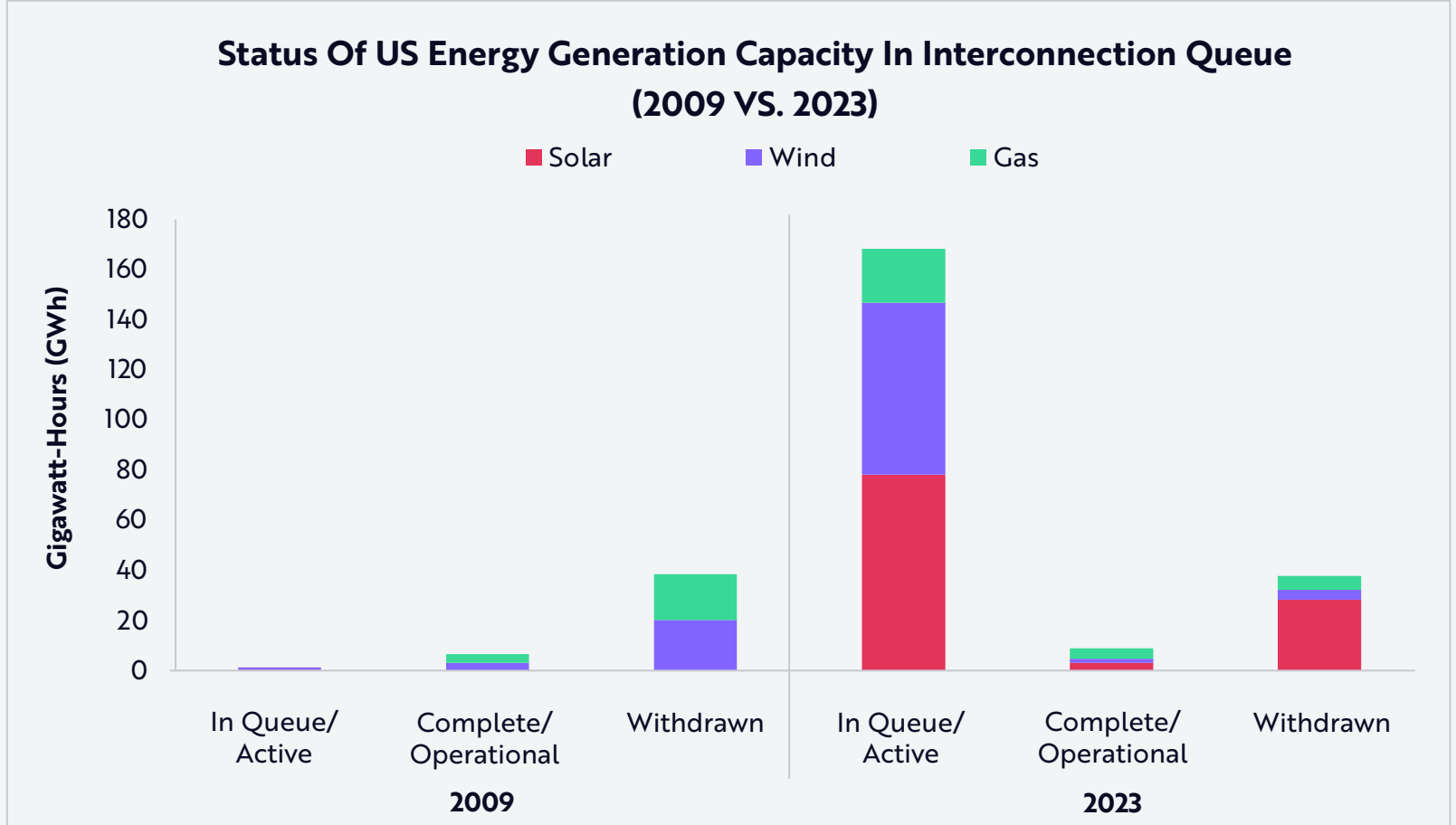


Note: "kWh": Kilowatt-hour, a unit of energy, representing the use or generation of 1 kilowatt of power for 1 hour. "MWh": Megawatt-hour, a unit of energy, equal to 1,000 kilowatt-hours, representing the use or generation of 1 megawatt of power for 1 hour. Source: ARK Investment Management LLC, 2025, based on data from National Renewable Energy Laboratory as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Regulatory Reform Should Boost All Renewables

Between 2009 and 2023, US interconnection approval wait times increased ~80%, from 31 months to 56 months. Quicker approvals could lower project costs and accelerate the scaling of energy-intensive projects.

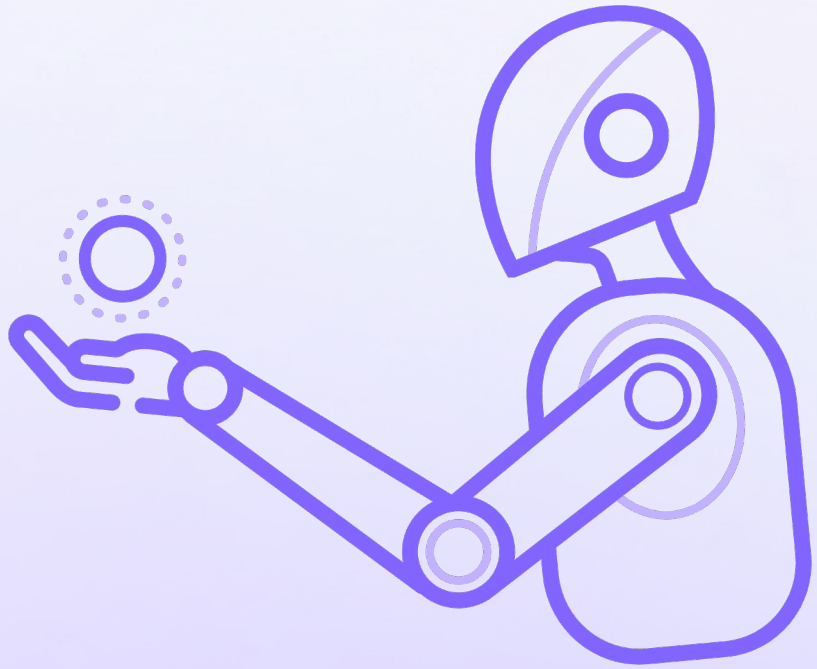




*An interconnection queue is a system used by grid operators to manage and prioritize requests from energy developers to connect new power generation projects to the electricity grid, involving assessments of each project's impact on grid reliability, planning for necessary infrastructure upgrades, and determining cost responsibilities for integrating new plants. Source: ARK Investment Management LLC, 2025, based on data from Lawrence Berkeley National Laboratory as of December 31, 2024. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Robotics

Decoupling Physical Labor From Output



Sam Korus

DIRECTOR OF RESEARCH
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Daniel Maguire, ACA

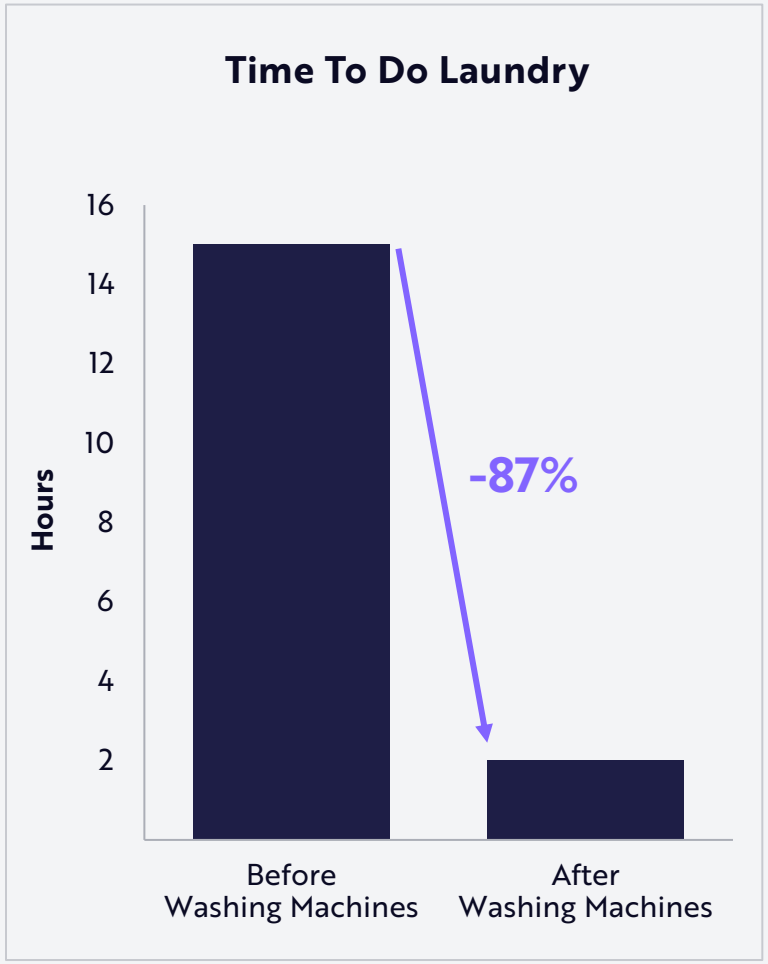
RESEARCH ANALYST
AUTONOMOUS TECHNOLOGY
& ROBOTICS

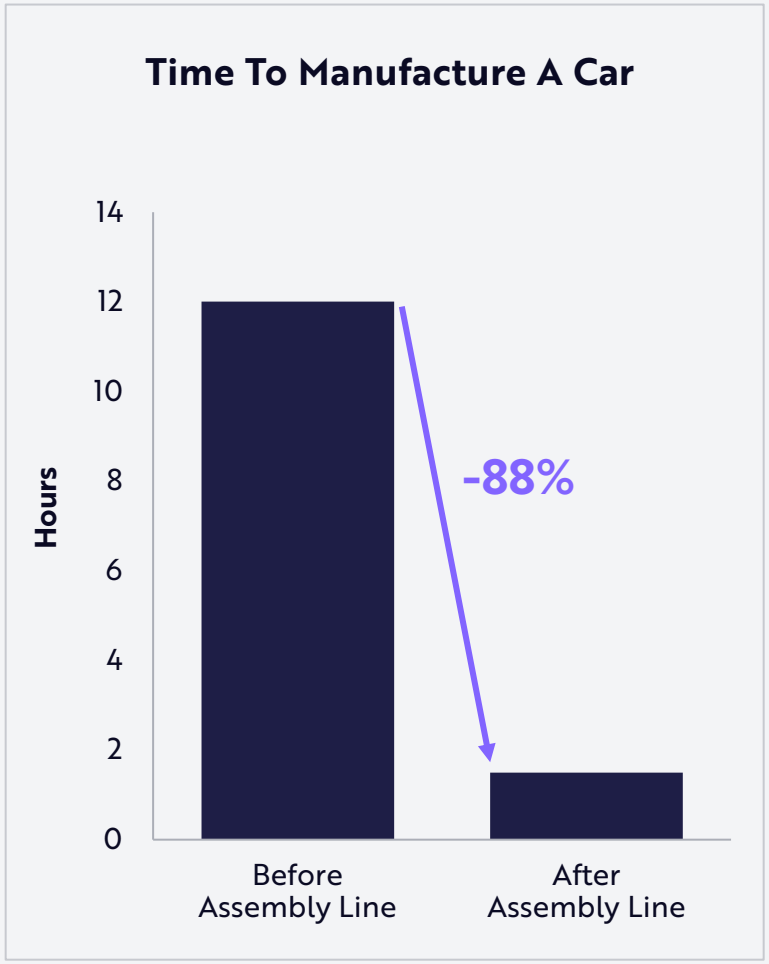
Akaash TK

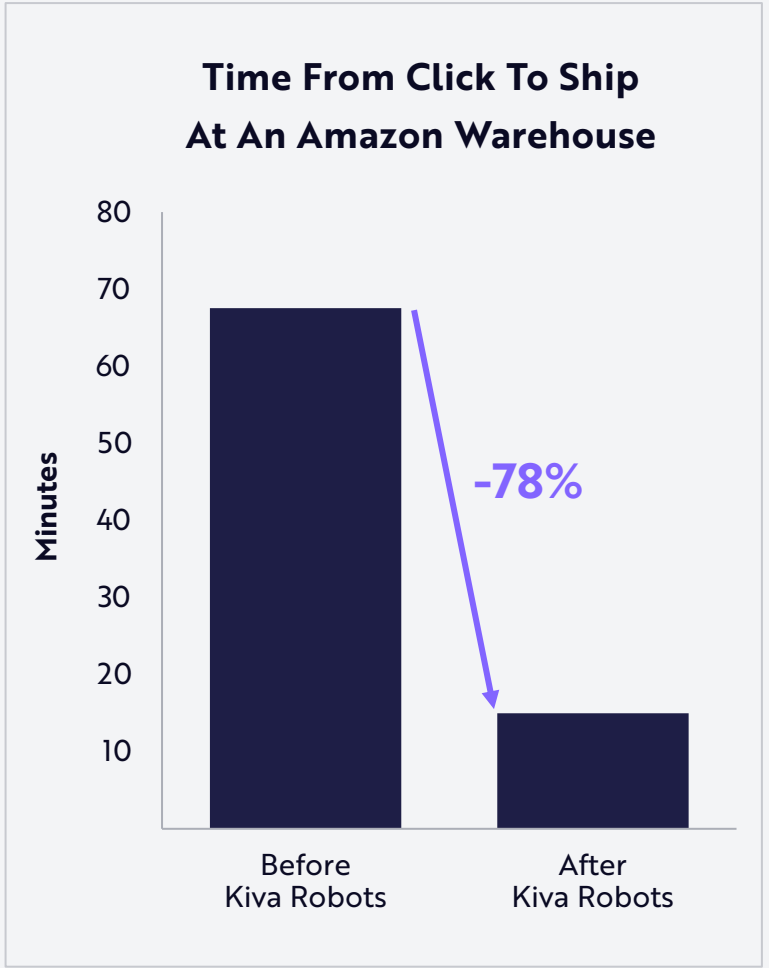
RESEARCH ASSOCIATE
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Robots Should Boost Productivity And Transform Industries

Automation's impact on productivity has transformed industries, with specialized robots as simple as washing machines reducing dramatically the time required for tasks.







Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Generalizable Robotics Represent A $26+ Trillion Global Revenue Opportunity

Household Robotics

~2.3 Hours Of Unpaid Work Per Day

×

~2.8 Billion Working Age Population

×

~$12 Weighted Average Hourly Wage

×

½ Value Attributed To Free Time VS. Paid Time

=

~$13+ Trillion Opportunity

Manufacturing Robotics

ARK Forecasts Global Manufacturing GDP
At ~$32 Trillion In 2030

		Productivity Uplift					
		10%	25%	50%	100%	200%	400%
Take Rate	10%	320	800	1,600	3,200	6,400	12,800
	20%	640	1,600	3,200	6,400	12,800	25,600
	50%	1,600	4,000	8,000	16,000	32,000	64,000

Revenue Opportunity*
($ Billions)

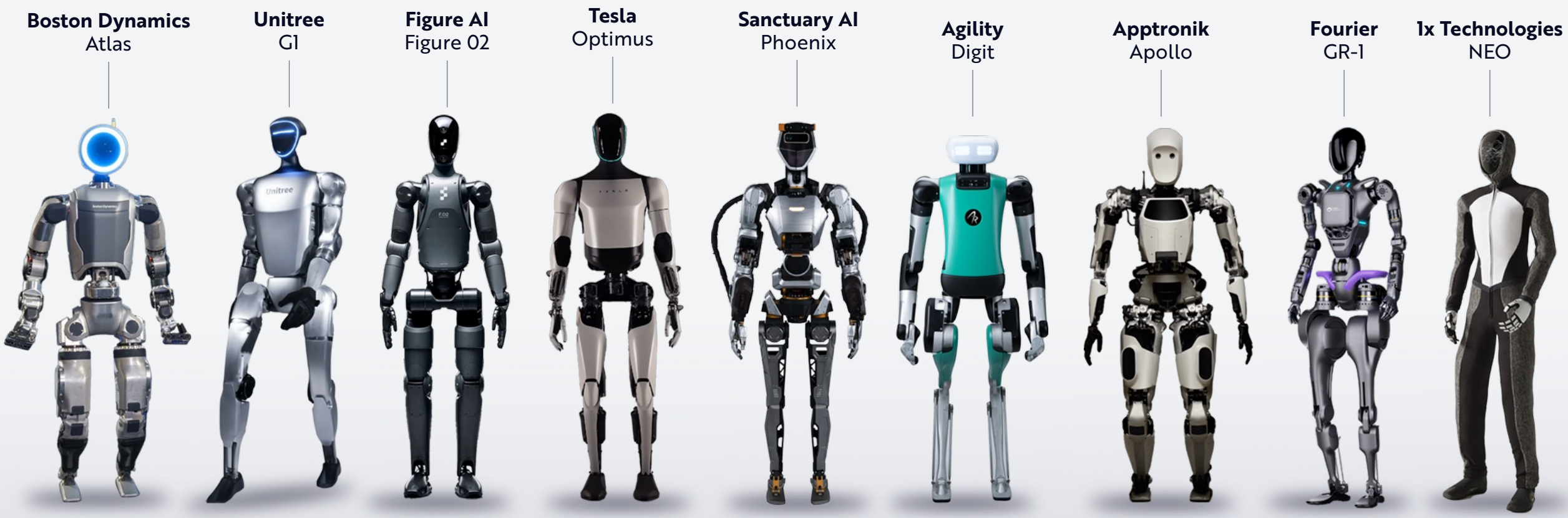
=

~$13+ Trillion Opportunity
(Average Of The Green Cells)

Note: The $12 hourly wage is an estimate of average global wage, not US wage + benefits. *The cells highlighted in green represent what ARK believes to be a reasonable or likely outcome. ^We define "Take Rate" as the percentage of a transactions value that the business keeps. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Humanoid Robots Are Debuting Around The World

Why the human form factor? Key is that a humanoid robot is generalizable. While a wrench can tighten nuts better than a human hand can, it is not a generalizable tool. The human hand is generalizable, particularly in an environment built by and designed for humans.

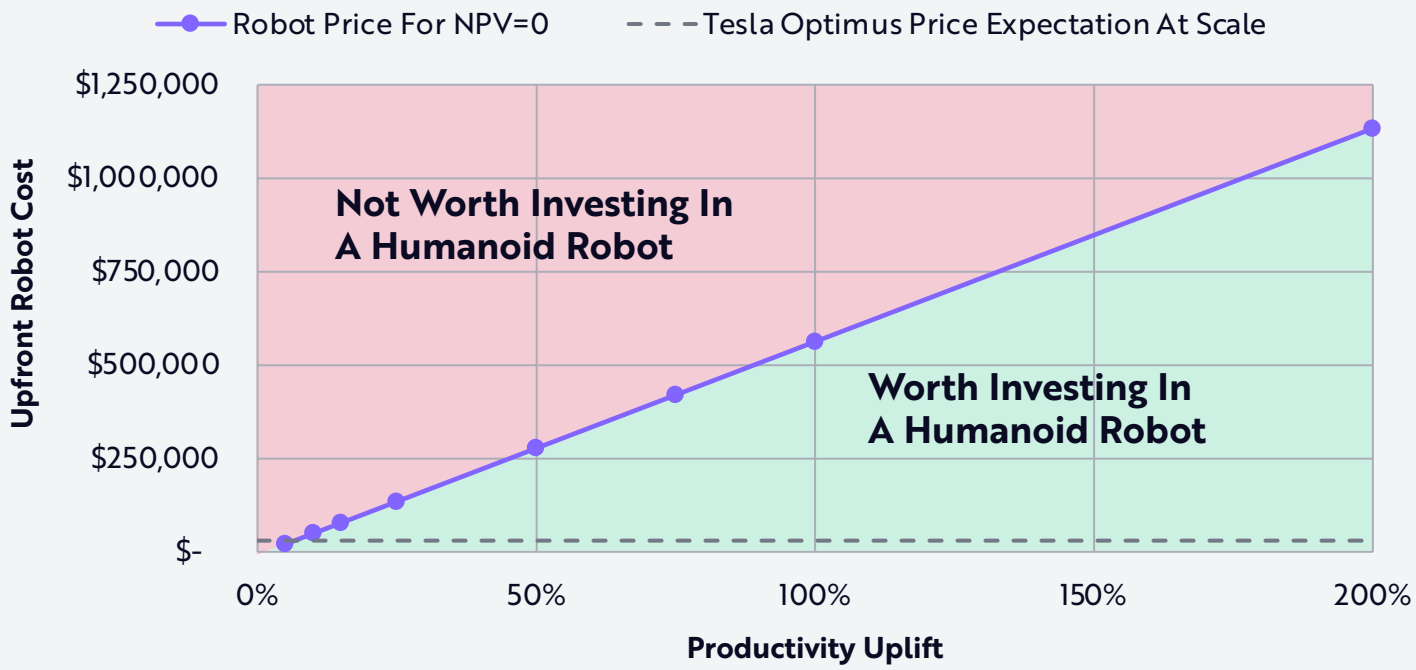


The Adoption Of Humanoid Robots Should Increase As Their Costs Fall And Their Productivity Increases

A 100% productivity uplift is equivalent to replacing a human working one shift over ten years.

Human Labor Costs On Average In The US

Hourly	$46, including benefits
Annually	$92,420
10-Year Cumulative	$924,200
Total Hours	~20,000
Net Present Value Of Costs	~$550,000, not including turnover



Note: Per hour salary based on Bureau of Labor Statistics Employer Costs For Employee Compensation press release on September 10, 2024: Average employer costs for all civilian workers = $46.21 per hour; Wages average = $31.80; average benefit costs = $14.41. We assume a 40-hour work week and a 50-week work year. A positive net present value in this calculation suggests that it would be worthwhile to invest in a humanoid robot at that upfront cost and productivity uplift. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

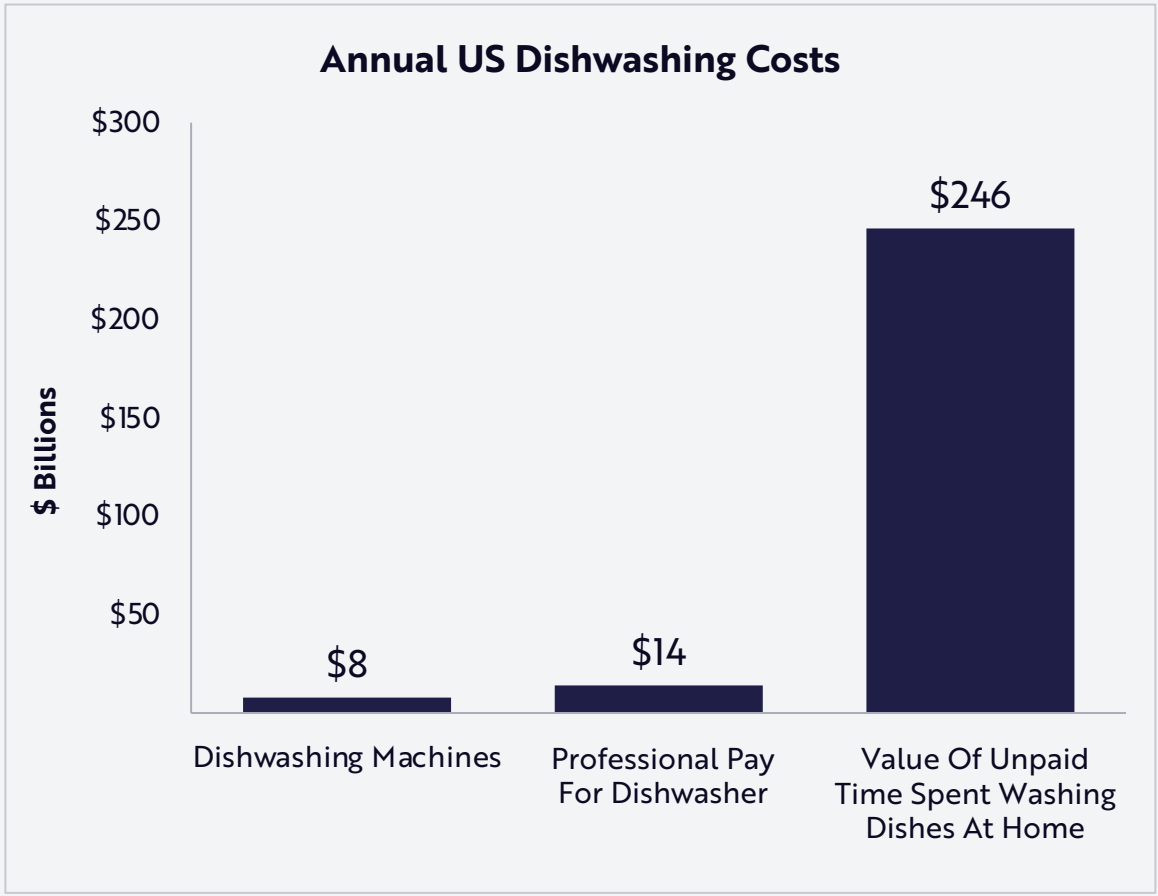
Jobs Are Bundles Of Tasks

In a restaurant with a dishwashing machine, washing dishes is one of thirteen tasks required of a "dishwasher." The home is not much different. The dishwasher is one of the most common "robots" in a house. According to our research, automating activities at home like loading and unloading dishes and cleaning countertops represents a $250 billion revenue opportunity in the US alone.

What does a professional dishwasher do?

Tasks:

- Wash dishes, glassware, flatware, pots, and pans, using dishwashers or by hand.
- Place clean dishes, utensils, and cooking equipment in storage areas.
- Sort and remove trash, placing it in designated pickup areas.
- Sweep and scrub floors.
- Maintain kitchen work areas, equipment, and utensils in clean and orderly condition.
- Clean garbage cans with water or steam.
- Receive and store supplies.
- Stock supplies like food and utensils in serving stations, cupboards, refrigerators, and salad bars.
- Transfer supplies and equipment between storage and work areas, by hand or using hand trucks.
- Clean and prepare various foods for cooking or serving.
- Prepare and package individual place settings.
- Load and unload trucks that deliver or pick up food and supplies.
- Set up banquet tables.



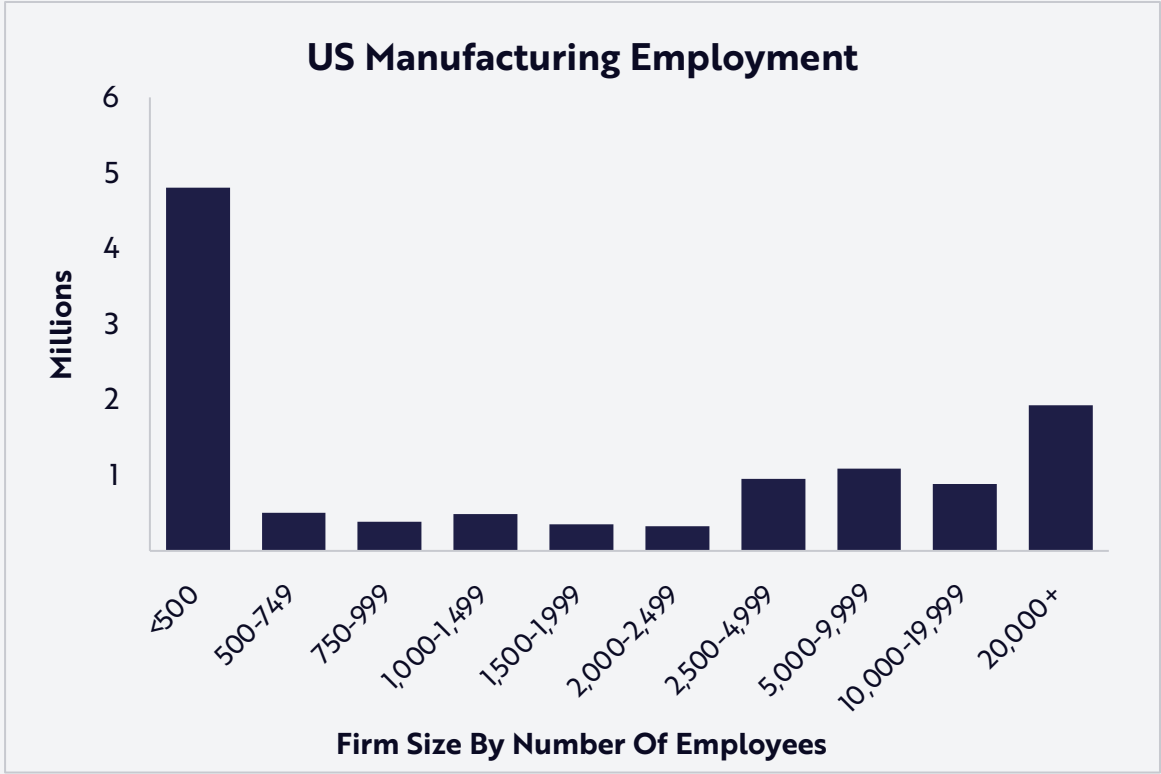
Note: For the value of unpaid time spent washing dishes, we assume, based on a study, that people value their free time at half their wage. From the Bureau of Labor Statistics, we take a median wage of ~$35. The Bureau of Labor Statistics reports that people spend 0.65 hours per day on food prep and cleanup. We assume .22 hours is spent on cleaning. We then multiply by the working age population. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Small Businesses Should Benefit Disproportionately From Humanoid Robots

Large manufacturing firms are organized by specialized and automated tasks. Specialization and automation give large firms the wherewithal to scale significantly and, in turn, lower labor costs as a share of revenue. Consequently, and somewhat counter-intuitively, large companies typically pay higher wages than small firms because automating specific tasks boosts productivity in large firms more than in small firms.

Because generalized automation solutions—those for multiple tasks—have not evolved as quickly as automation solutions for specific tasks, small firms typically have a disproportionate number of automatable-but-not-yet-automated tasks that would benefit from generalizable solutions like humanoid robots. Moreover, a high percentage of manufacturing employees in the US work in small firms.

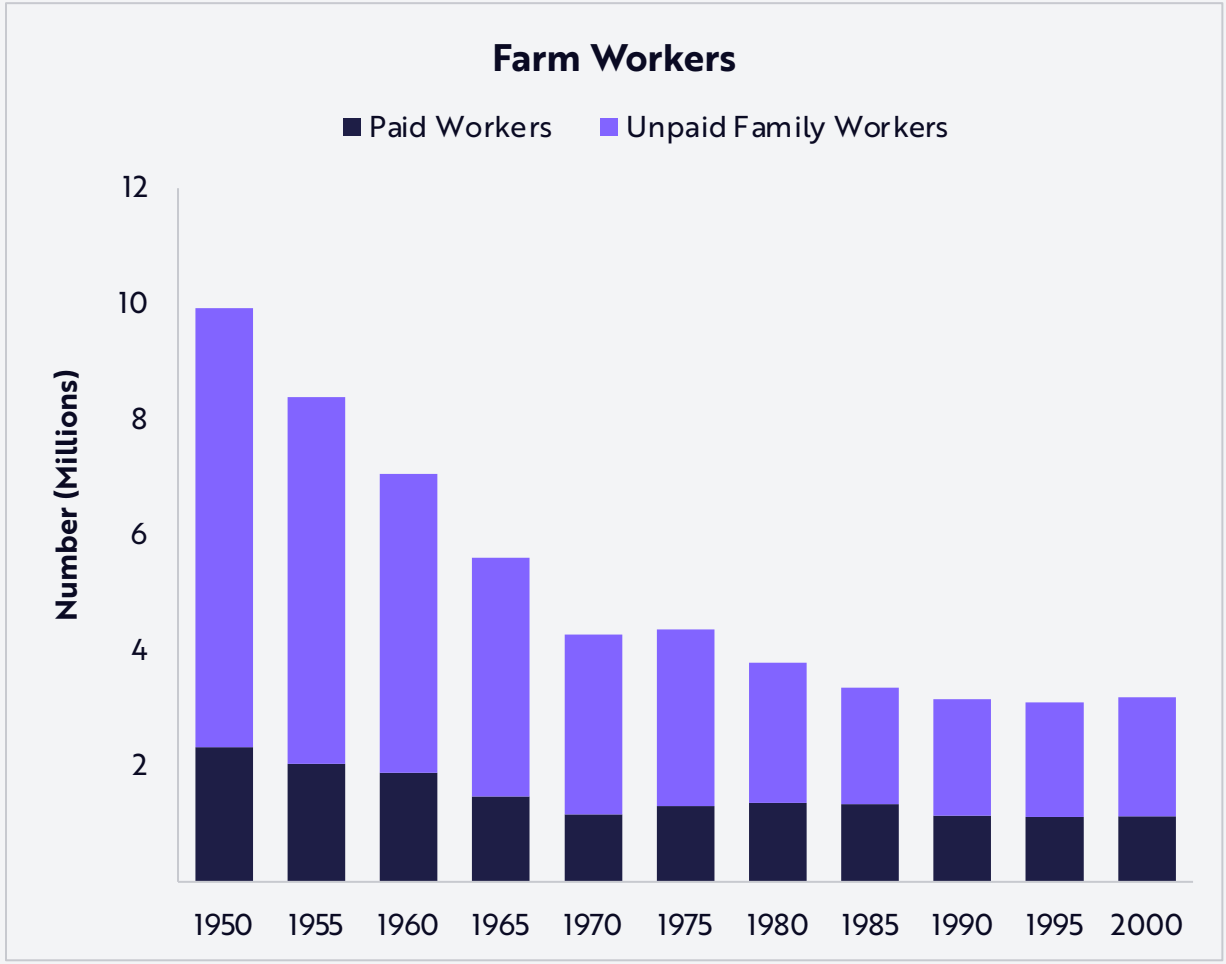
	Sample Small Firm	Sample Large Firm
Revenue	$1,000	$5,000
Labor Share Of Revenue	40%	20%
Number Of Employees	2	4
Wage Per Employee	$200 ($1,000 x 40%/2)	$250 ($5,000 x 20%/4)
Tasks Per Employee	4	2
Benefit Of Automating A Single Task	**$50 ($200 x (1/4 tasks))**	**$125 ($250 x (1/2 tasks))**
Valued Automation Solution	**Generalizable**	**Single Task**

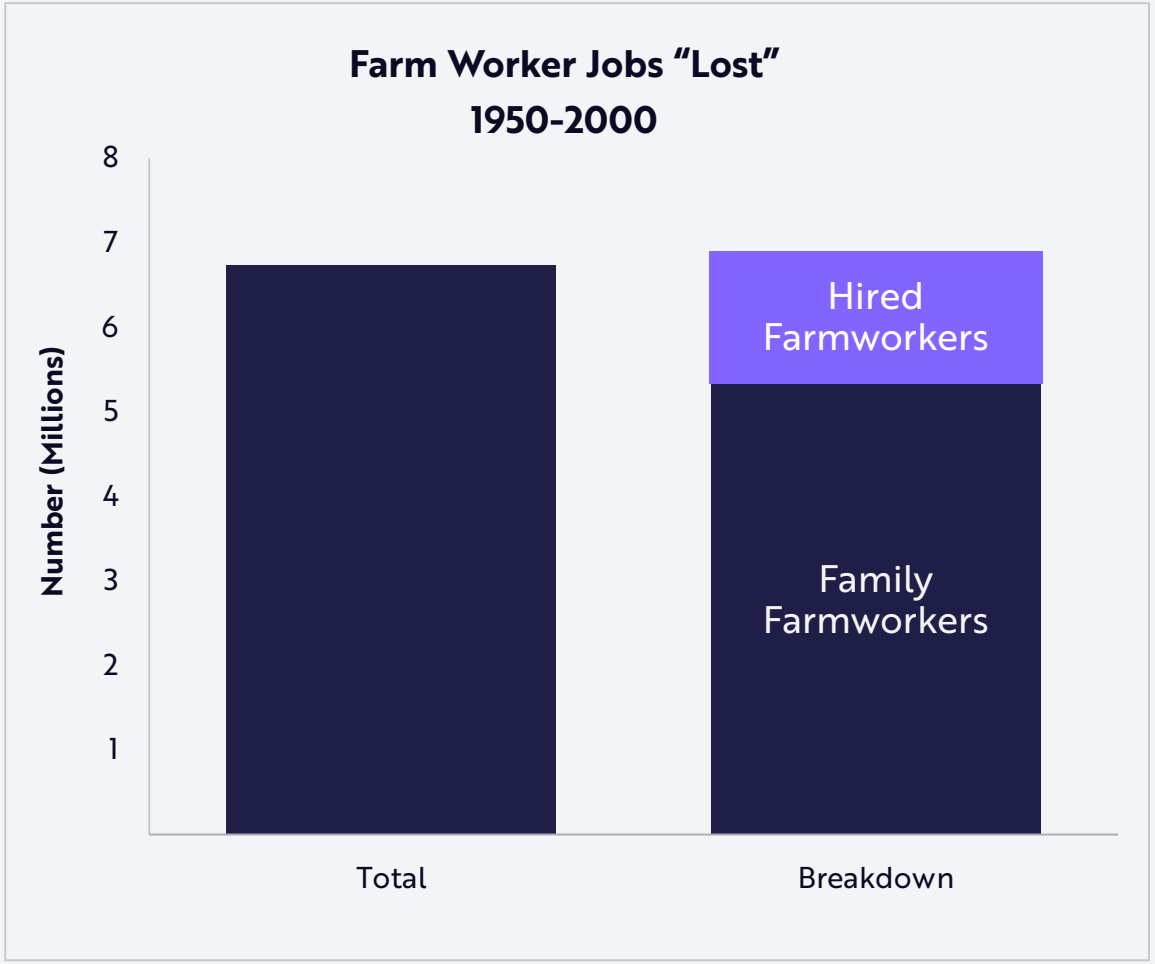


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including U.S. Census Bureau 2023, as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Automation Turns Non-Market Activity Into Revenue-Generating Activity And Gross Domestic Product (GDP)

Of the 82% who "lost" their jobs between 1950 and 2000, most farm workers were unpaid family members.

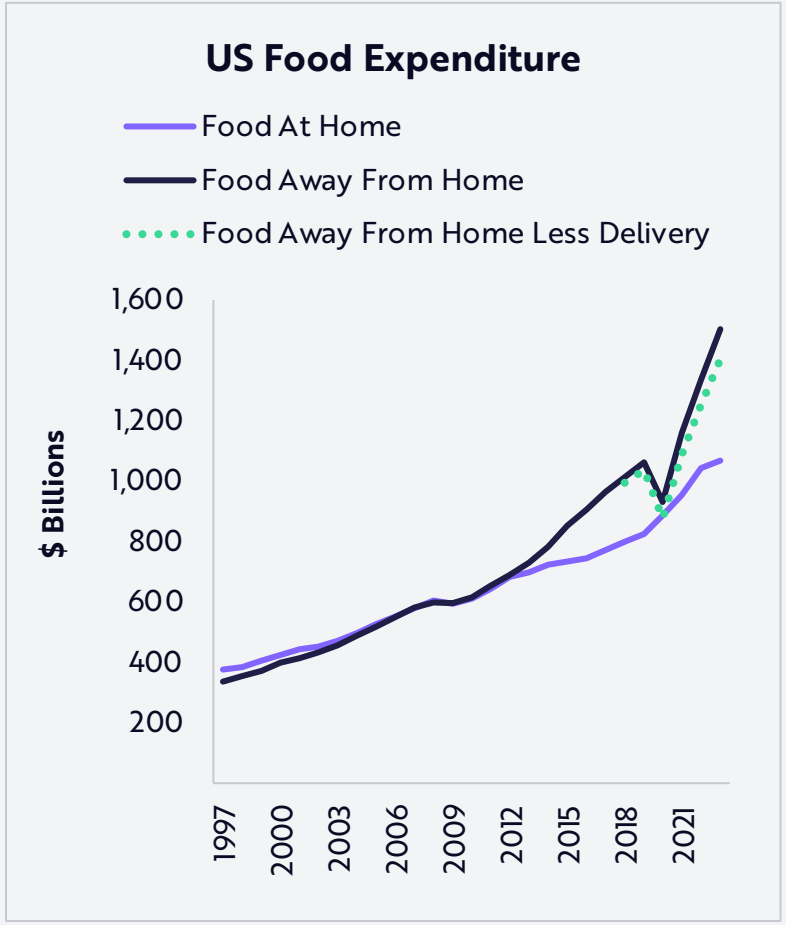


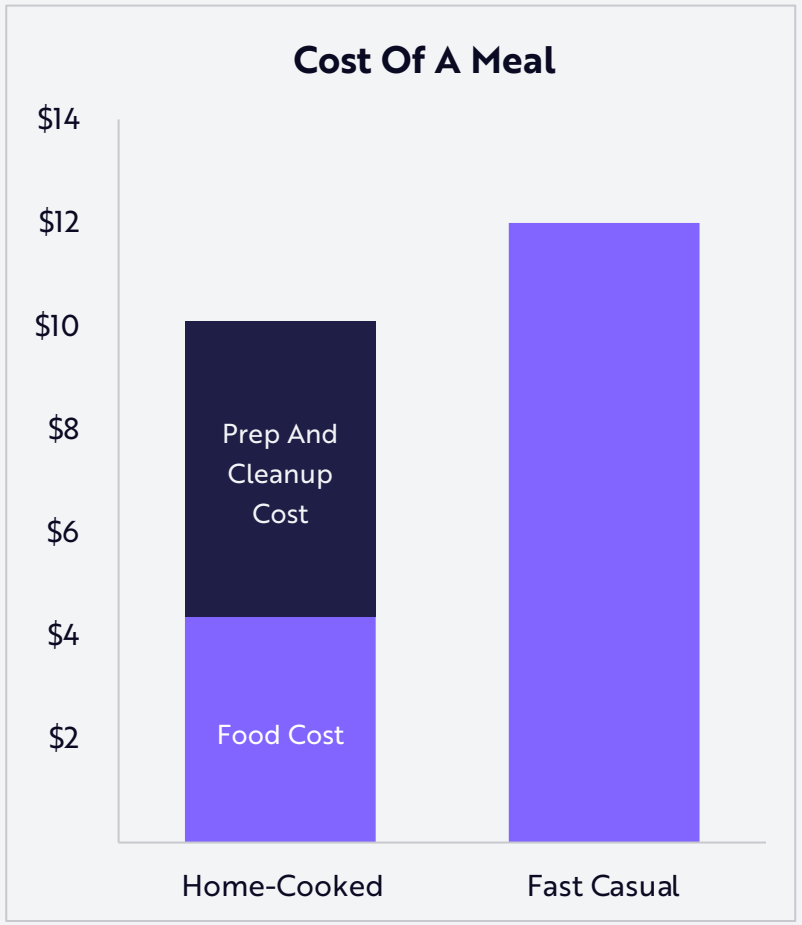


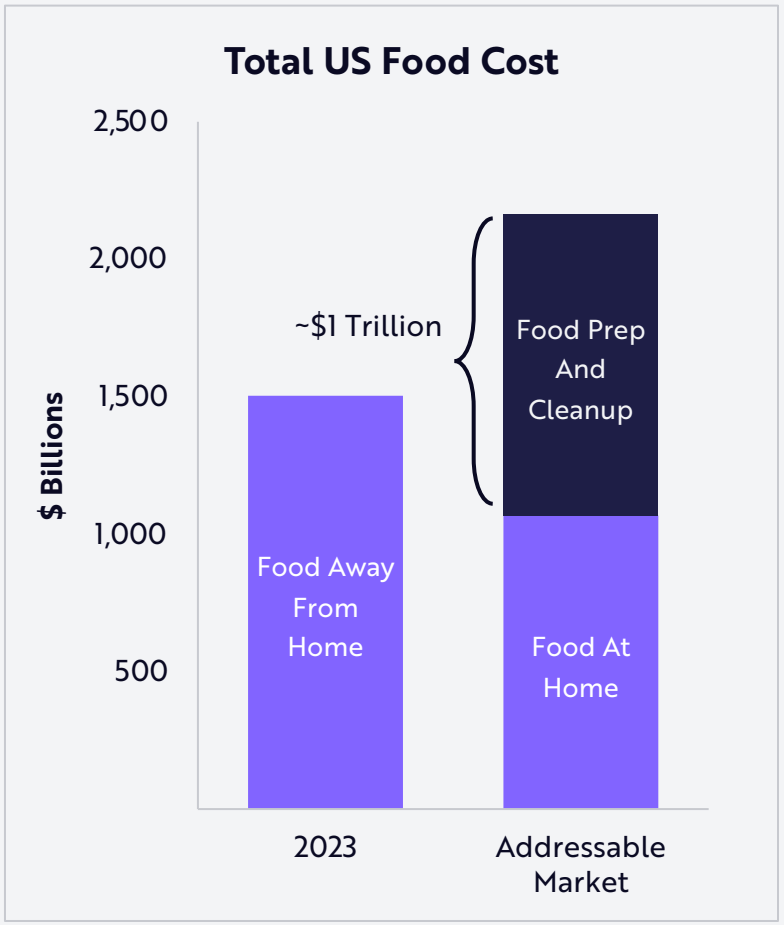
Source: ARK Investment Management LLC, 2025, based on data from U.S. Department of Agriculture 2025 as of January 10, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Consumers Continue To "Contribute" Unpaid Labor To The US Economy

If US consumers were to value their time at half their hourly wages, food preparation and cleanup would add ~$1 trillion to GDP annually.



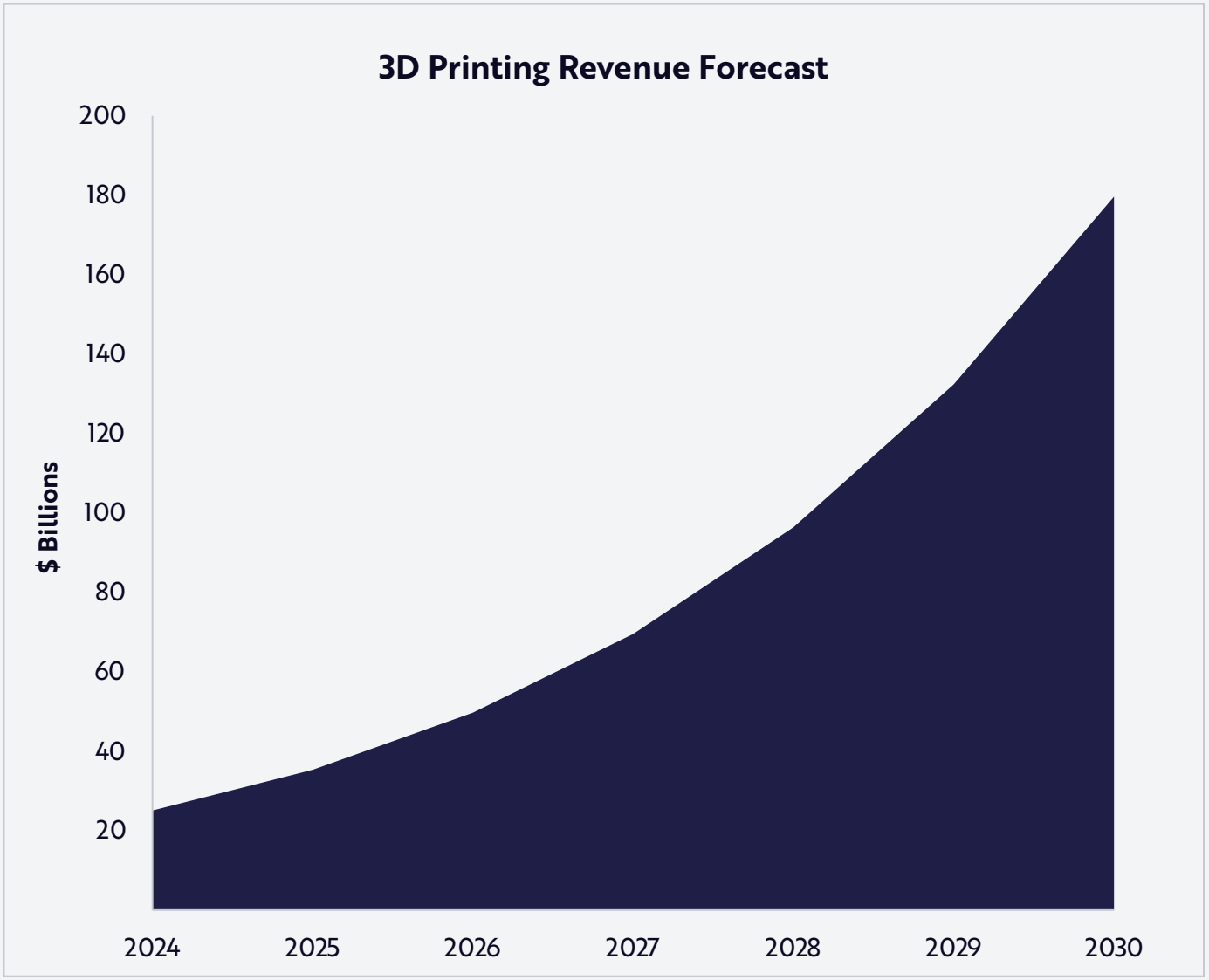




Note: The Food Prep and Cleanup Cost is based on the following: The Bureau of Labor Statistics (BLS) reports that time spent on food prep and cleanup is .65 hours per day. Based on a study, we assume people value their free time at half their hourly wage; for this, we use BLS data of ~$35. We use the population above 18 years old of ~260 million. Source: ARK Investment Management LLC, 2025, based on data from U.S. Department of Agriculture 2025 and Franchisee Resource Center 2021 as of January 10, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

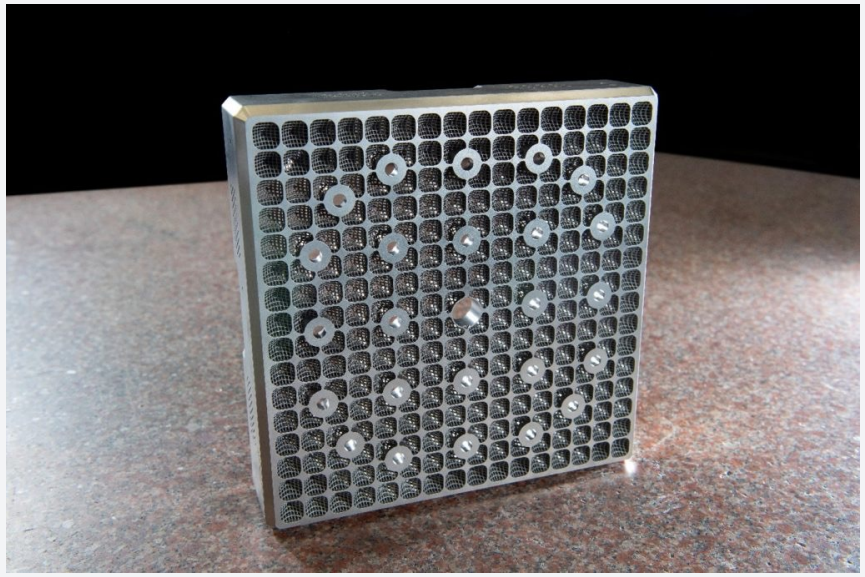
3D Printing Revenues Could Grow ~40% At An Annual Rate To $180 Billion By 2030

- The 3D printing industry consolidated significantly in 2024, highlighted by Nano Dimension's acquisition of Desktop Metal and Markforged.
- If manufacturers decide to bring the technology in house, as did General Electric, consolidation could continue.
- The Trump administration's efforts to bolster US manufacturing could benefit 3D Printing.
- Industries like drone manufacturing and nuclear power, which should scale rapidly, could use 3D printing to accelerate time to market.

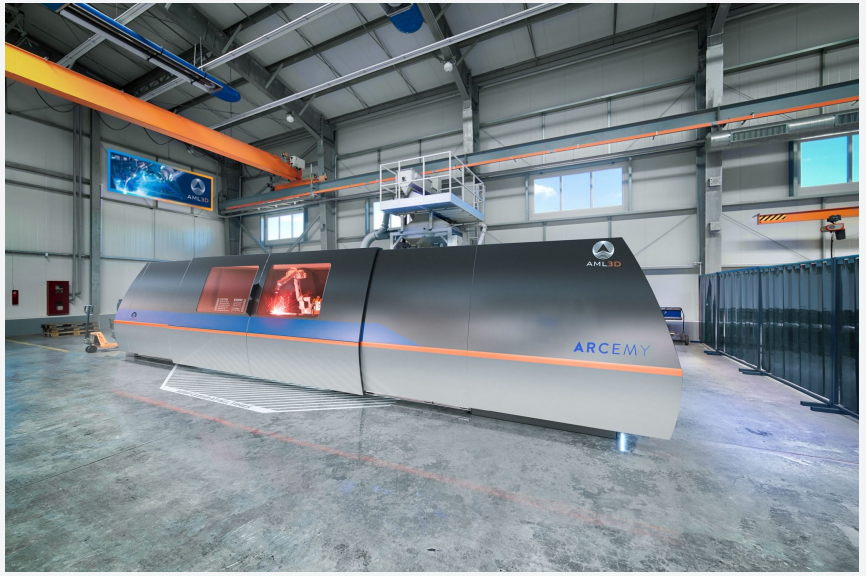


Slide by **Tasha Keeney**, Director of Investment Analysis & Institutional Strategies

3D Printing Makes Parts For Nuclear Applications More Efficiently



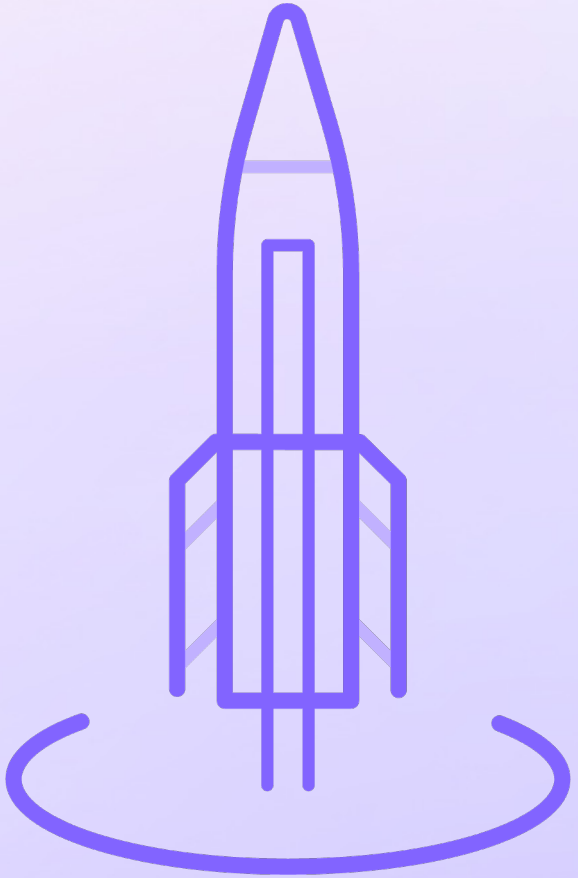
- Westinghouse uses 3D printing for nuclear debris filters.
- Those components improved on the measure of resistance to debris by 30%, thanks to the design flexibility offered by 3D printing.



- The US Navy engaged Australian additive manufacturing company AML3D to 3D-print tailpiece components for its nuclear submarine program.
- AML3D produced those parts in fewer than five weeks, ~15X more quickly than traditional manufacturers.

Source: ARK Investment Management LLC, 2025, based on data from Shaikhnag 2024 and Tyrer-Jones 2025 as of January 10, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Reusable Rockets



Sam Korus

DIRECTOR OF RESEARCH
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Daniel Maguire, ACA

RESEARCH ANALYST
AUTONOMOUS TECHNOLOGY
& ROBOTICS

Akaash TK

RESEARCH ASSOCIATE
AUTONOMOUS TECHNOLOGY
& ROBOTICS

SpaceX Has A Ten-Year Head Start On Reusable Orbital Rockets

> *"We don't have any plans to look at reusability at all right now...The reality is that, for the next ten years, other than for Falcon, I don't think any of us will look at this."*
> **-Phil Slack,**
> **President of International Launch Services, 2014**

> *"Past experience with launch vehicle reusability has been mixed at best in terms of achieving sustainable cost reductions. So I am a skeptic with regard to many of the claims that have been made for cost reductions."*
> **–David W. Thompson,**
> **CEO, Orbital ATK, 2016**

> *"We have not really changed our assessment over the last couple of years because we have yet to see the other forms of reusability—flyback or propulsive return to Earth—demonstrate economic sustainability on a recurring basis."*
> **–Tory Bruno,**
> **CEO, United Launch Alliance, 2020**

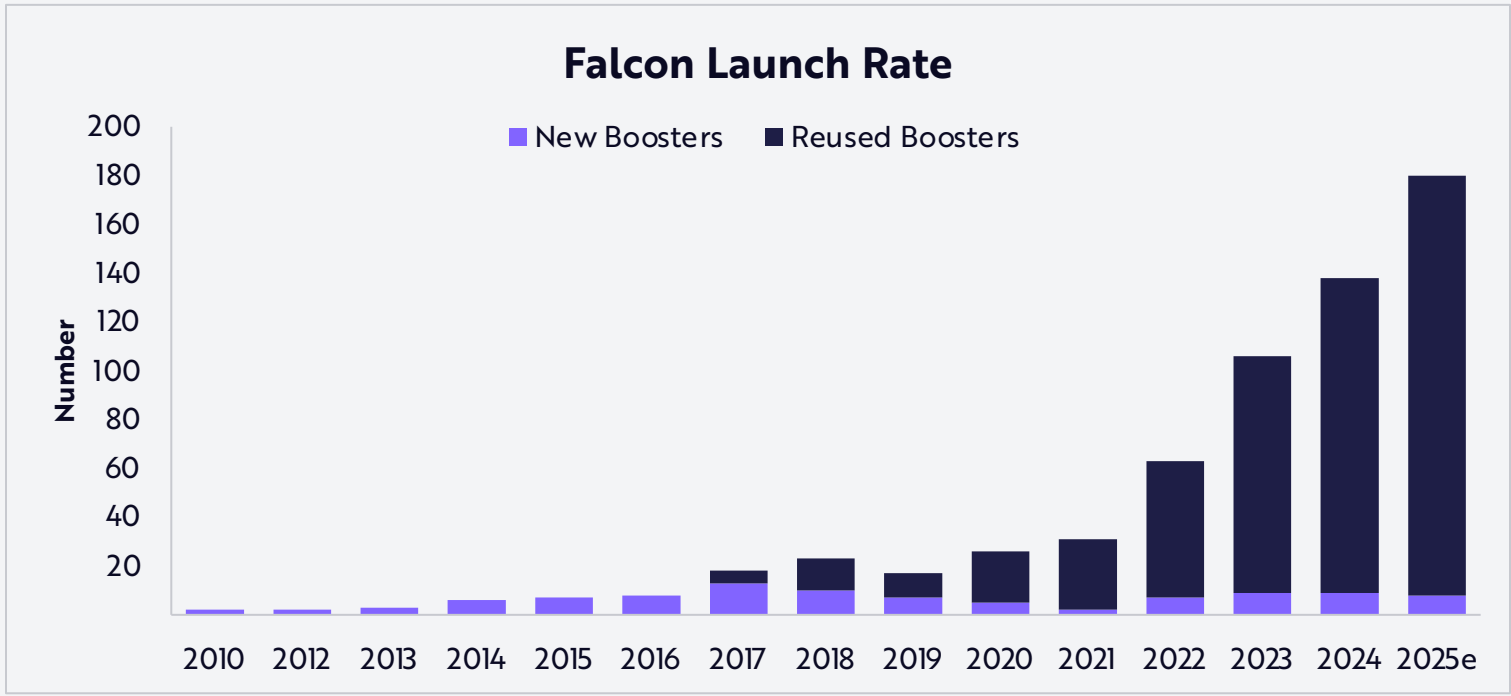
Forecast

2015
SpaceX Lands First Falcon 9

2017
SpaceX Launches 1st Flight Proven Booster

2024
No Orbital Reusable Rocket Besides SpaceX

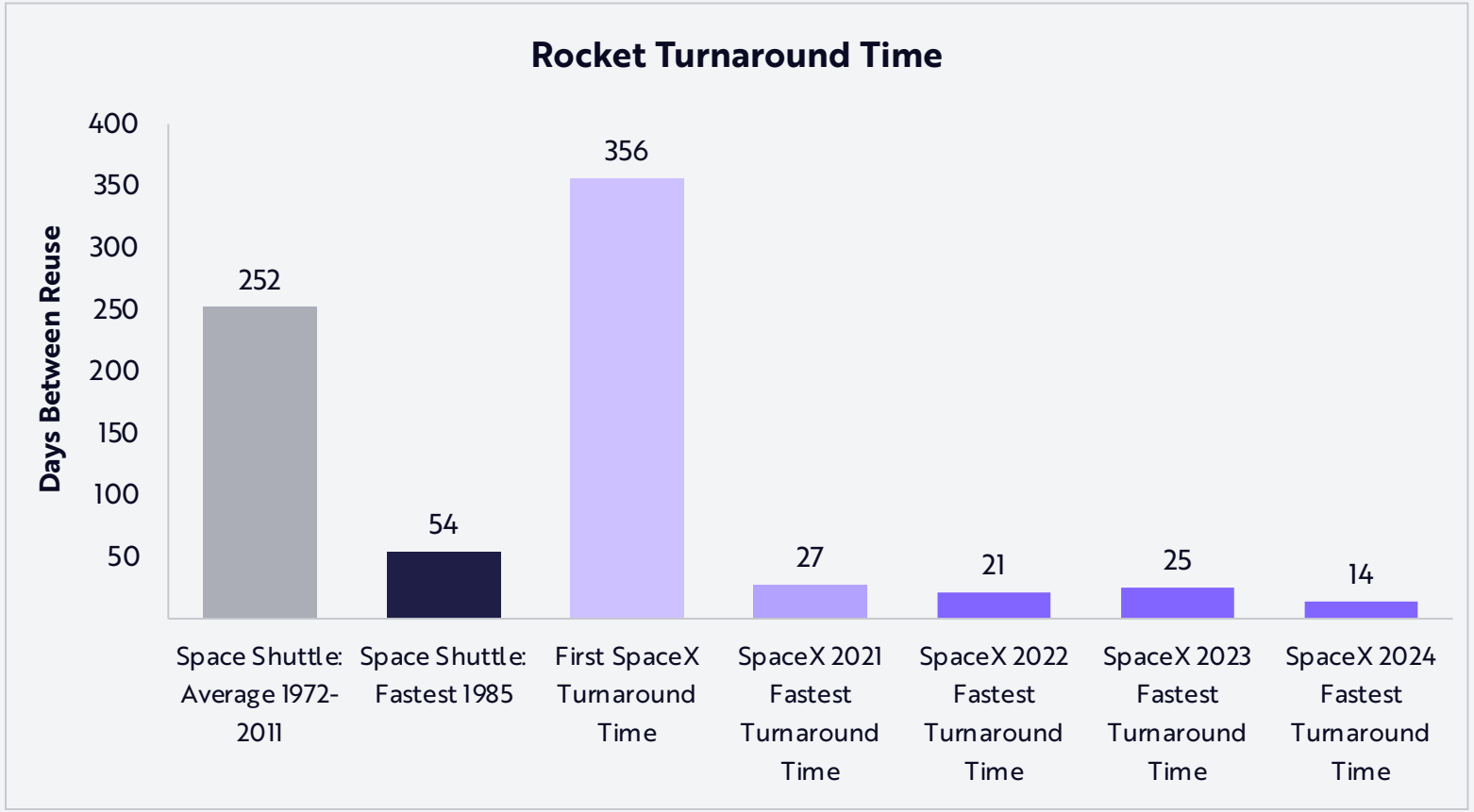
2025+
Blue Origin
Rocket Lab
China
Stoke Space
Firefly
Relativity

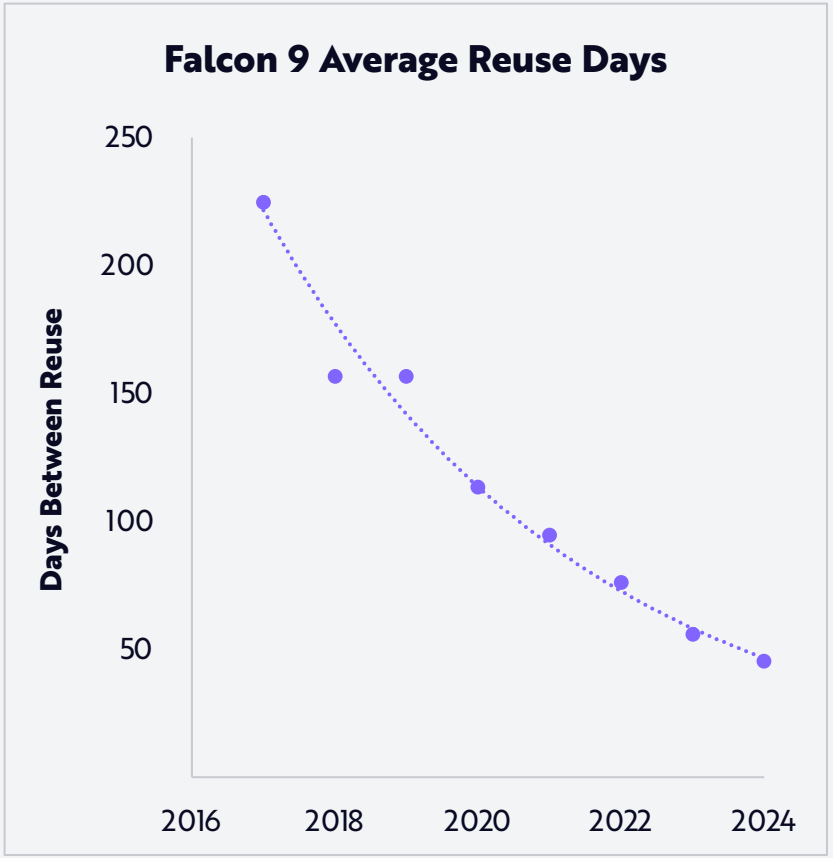


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Klotz 2020, de Selding 2016, and Faust 2014, as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

SpaceX Is Refurbishing Rockets In Record Time

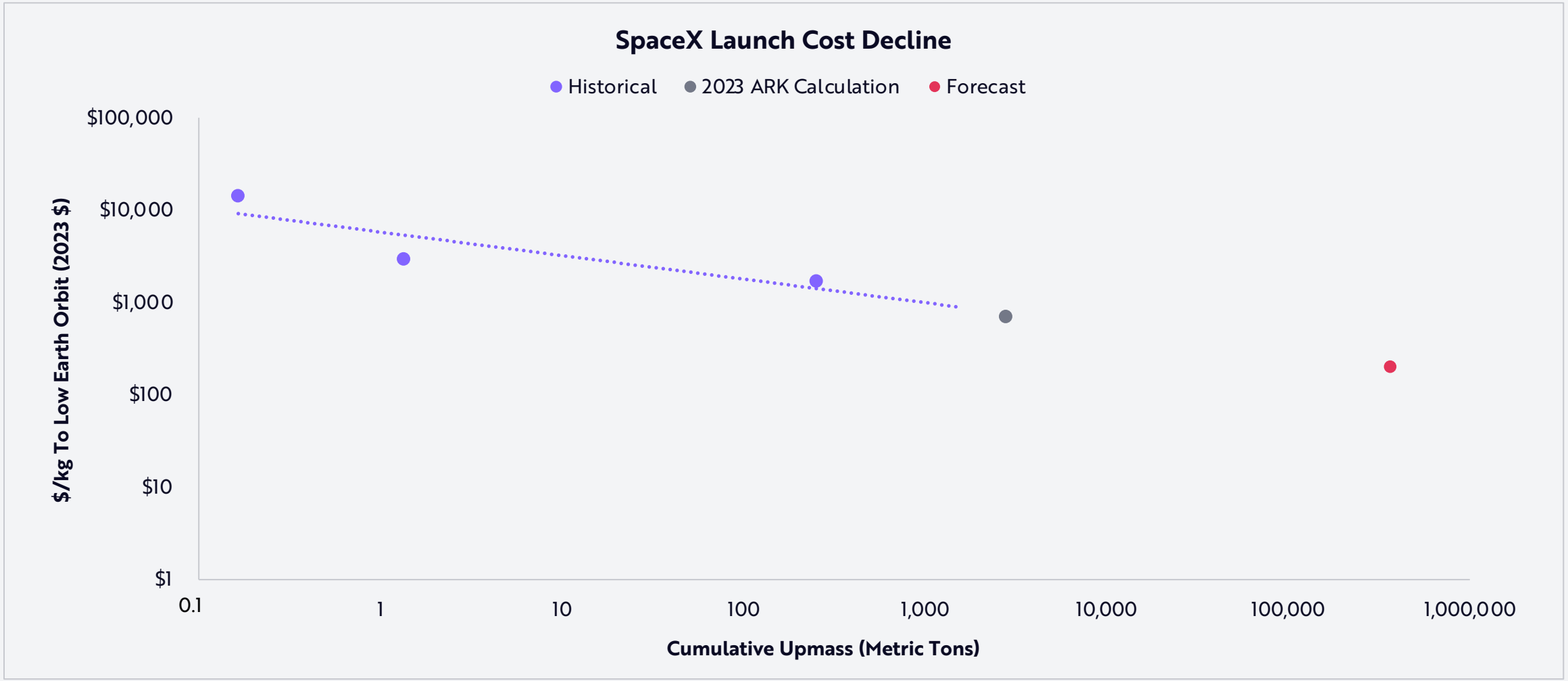
When the Space Shuttle cost ~$1.5 billion per launch, industry experts assumed that an economic reusable rocket would be impossible. SpaceX then flipped the script. According to ARK's research, the first stage of the Falcon 9 cost <$1 million to refurbish. Now, rocket turnaround time should be proportional to the cost required to refurbish a rocket booster, the key metric in tracking launch cost declines.





Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

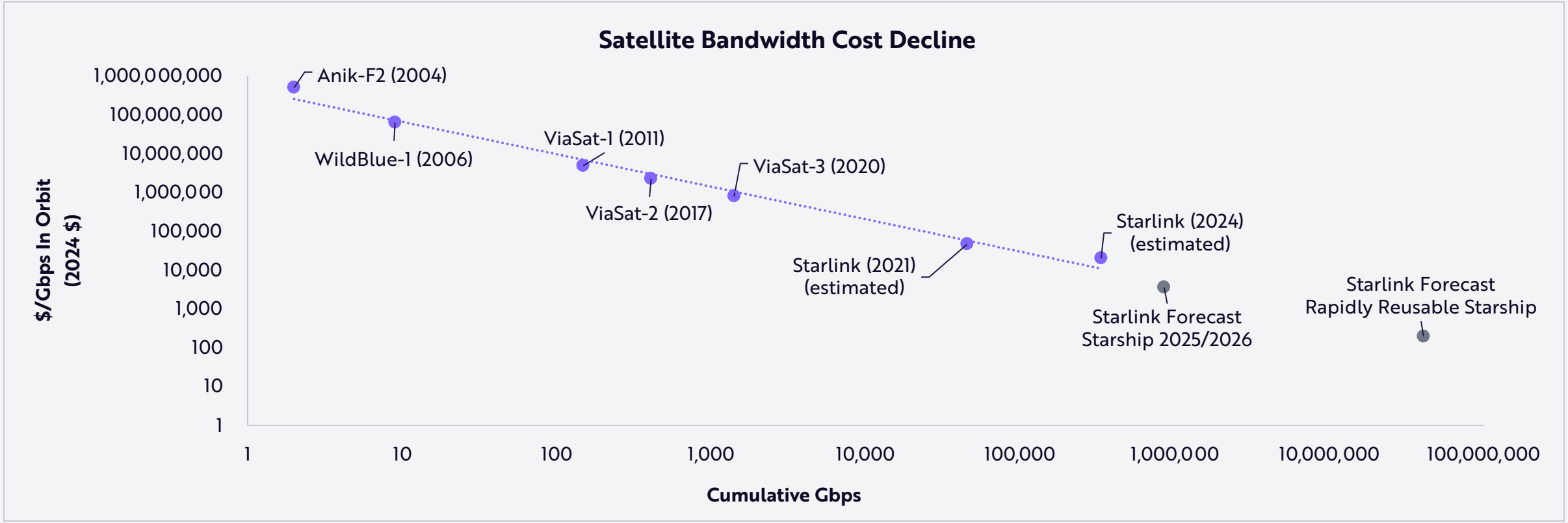
Rocket Reuse And Size Are Driving Rocket Launch Costs Down On A $/kg Basis



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

SpaceX Continues To Drive Satellite Bandwidth Costs Down In Line With Wright's Law

According to Wright's Law, satellite bandwidth costs should decline roughly ~45% for every cumulative doubling in gigabits per second (Gbps) in orbit. Since 2004, the cost of satellite bandwidth has dropped 15,000-fold from $300,000,000 to ~$20,000/Gbps. According to ARK's research, 1 Gbps can serve 200 customers. At a capital cost of ~$1,000/Gbps, SpaceX could recoup its Starship and satellite investment with a one-time charge of $5 per customer.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

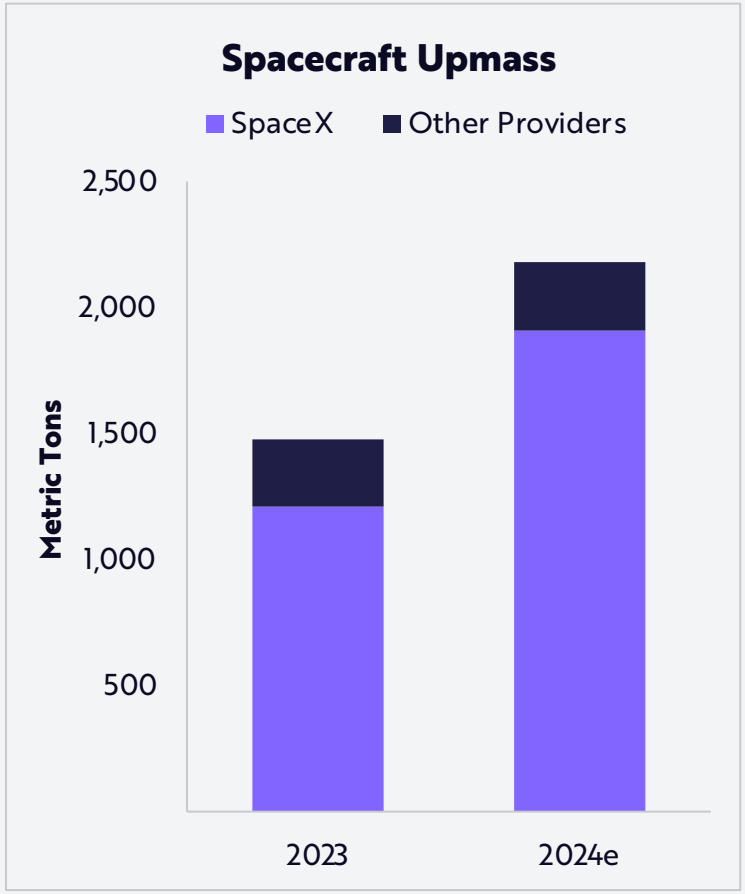
Lower Satellite Launch Costs Should Enable Continuous Global Coverage With Low Latency

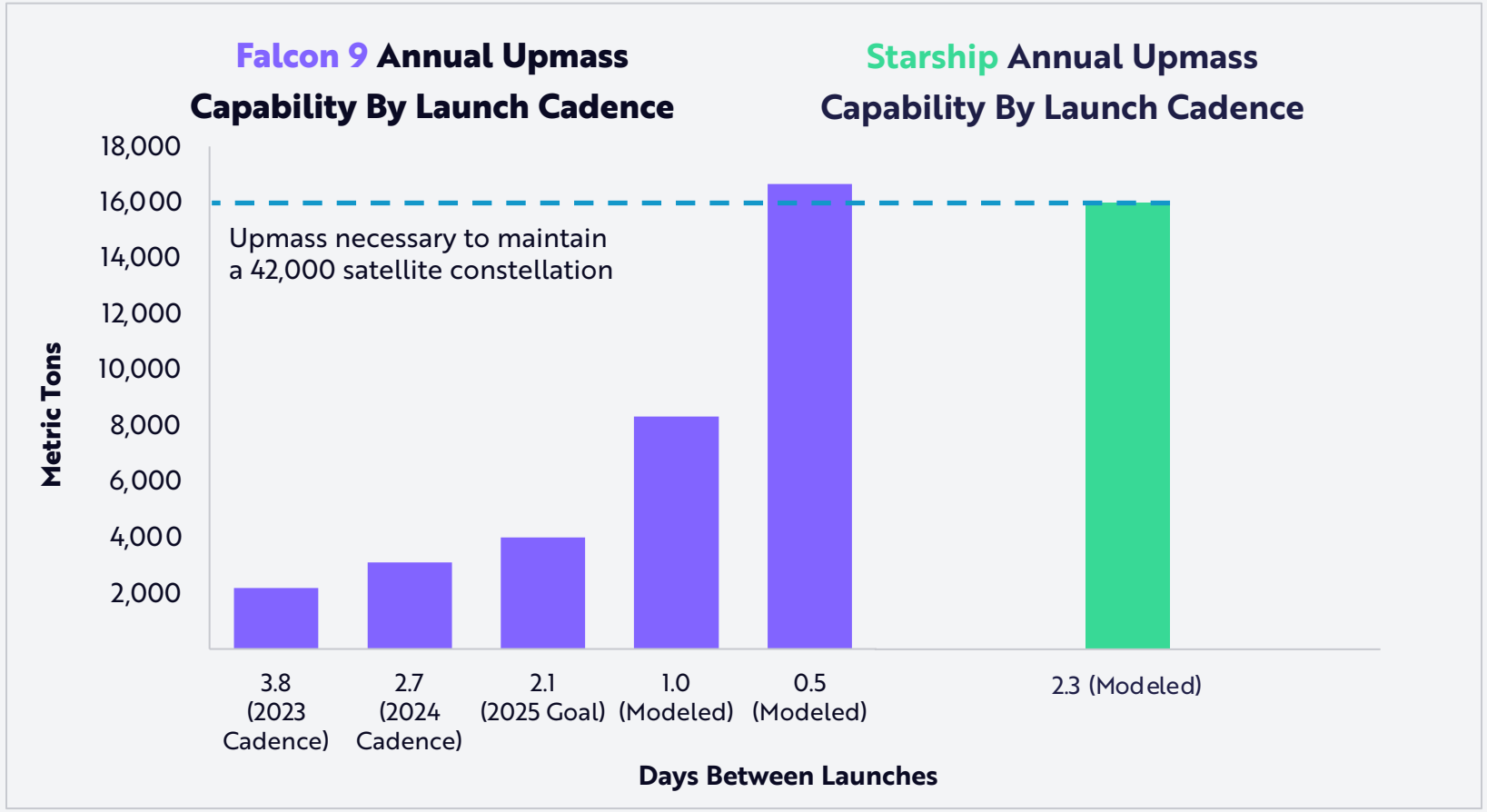
While latency precluded geostationary orbit (GEO) satellites from offering a compelling broadband internet solution, now thousands of low-cost, low earth orbit (LEO) satellites can provide service with low latency, continuous global coverage, and direct-to-mobile device connectivity.

Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Starship Will Help The Starlink Constellation Achieve Its Potential

Starship's payload capacity to LEO is ~5x that of the Falcon 9. While impressive, given the five-year life of its satellites, Starship still will have to fly every 2.3 days to maintain its target constellation of 42,000 Starlink satellites. As of January 2025, SpaceX has a constellation of over 7,000 satellites.

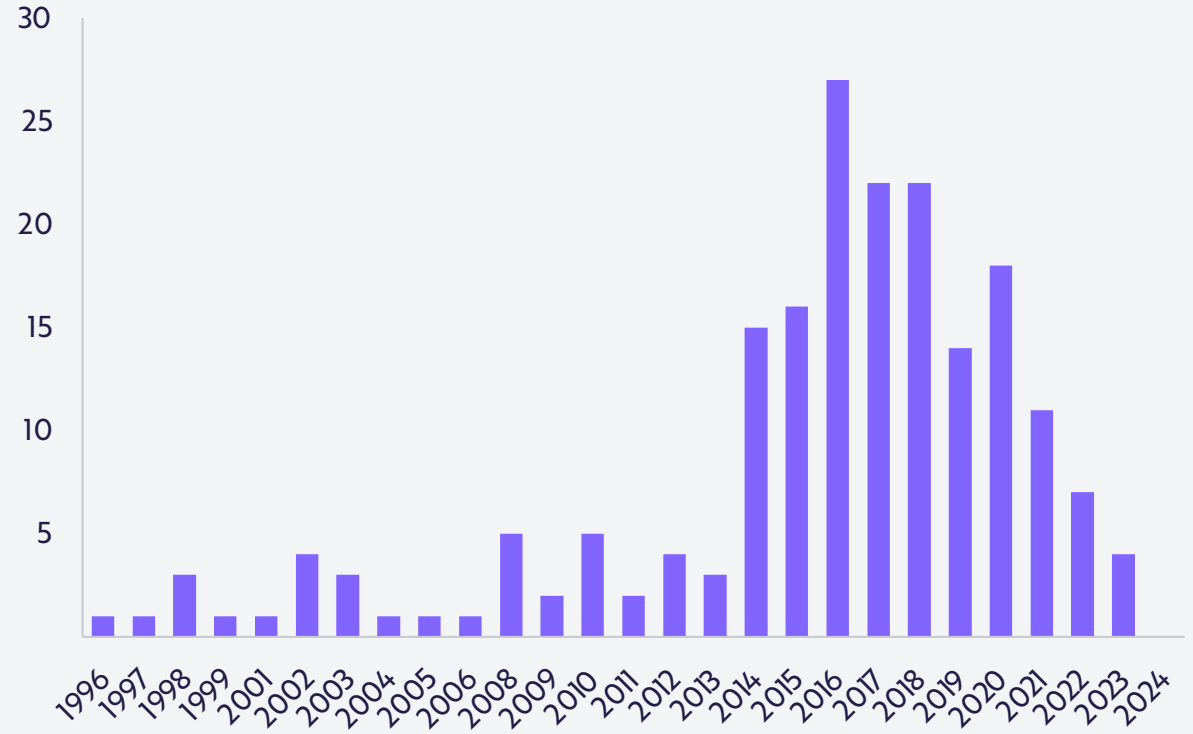




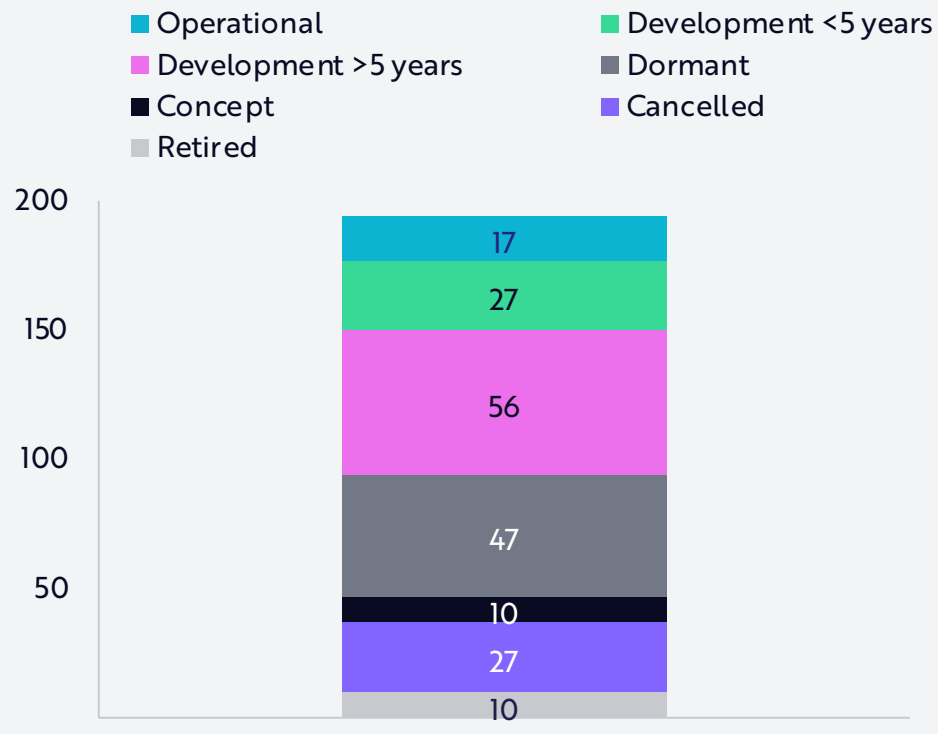
Despite A Proliferation In Company Creation, Small Launch Providers May Not Be The Winners

After capital spending booms, industries tend to consolidate. In the space industry, while launch capability is critical, the larger opportunity could be in the services enabled by low launch costs. Today, only 17 of the 194 small launch providers created since 1996 are operational.

Number Of New Small Launch Providers Founded

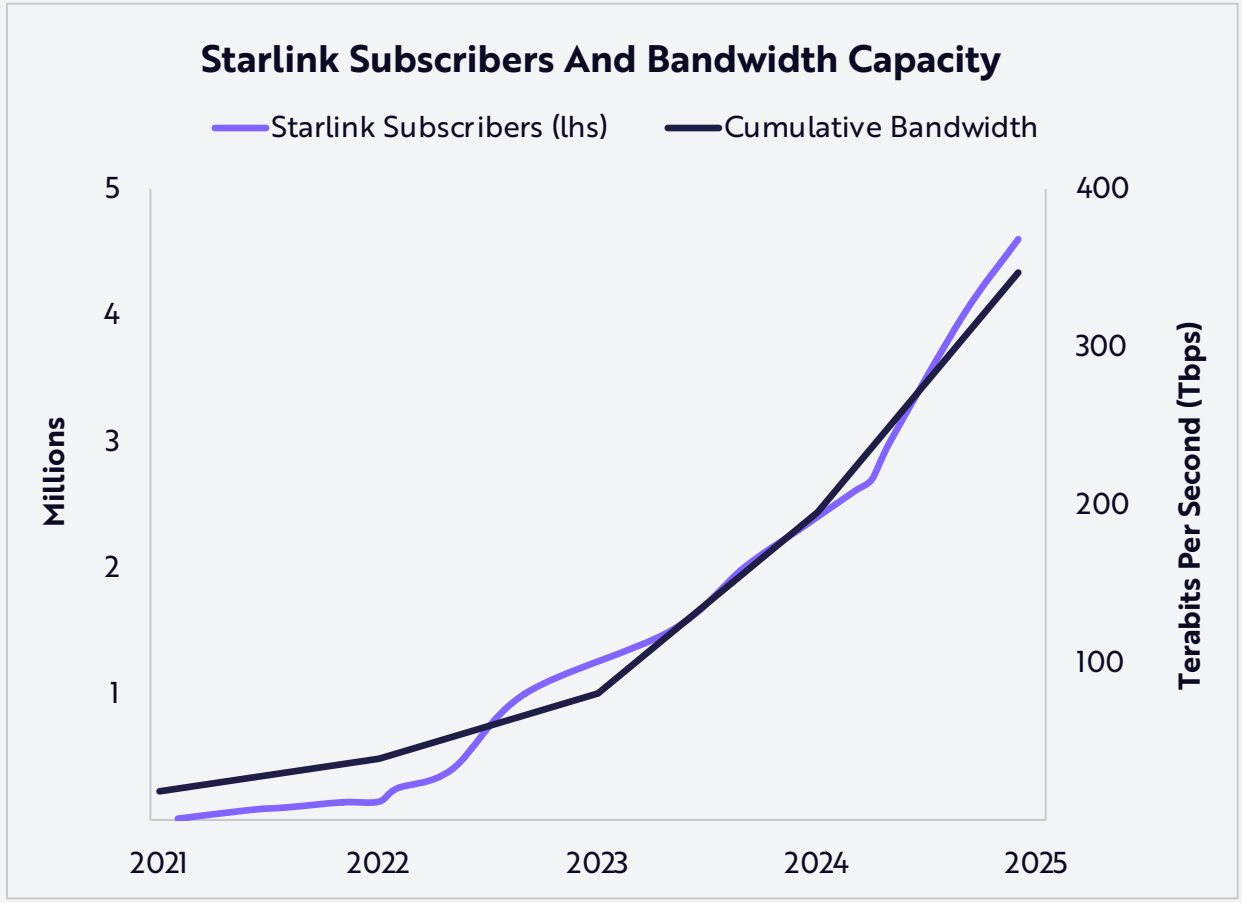


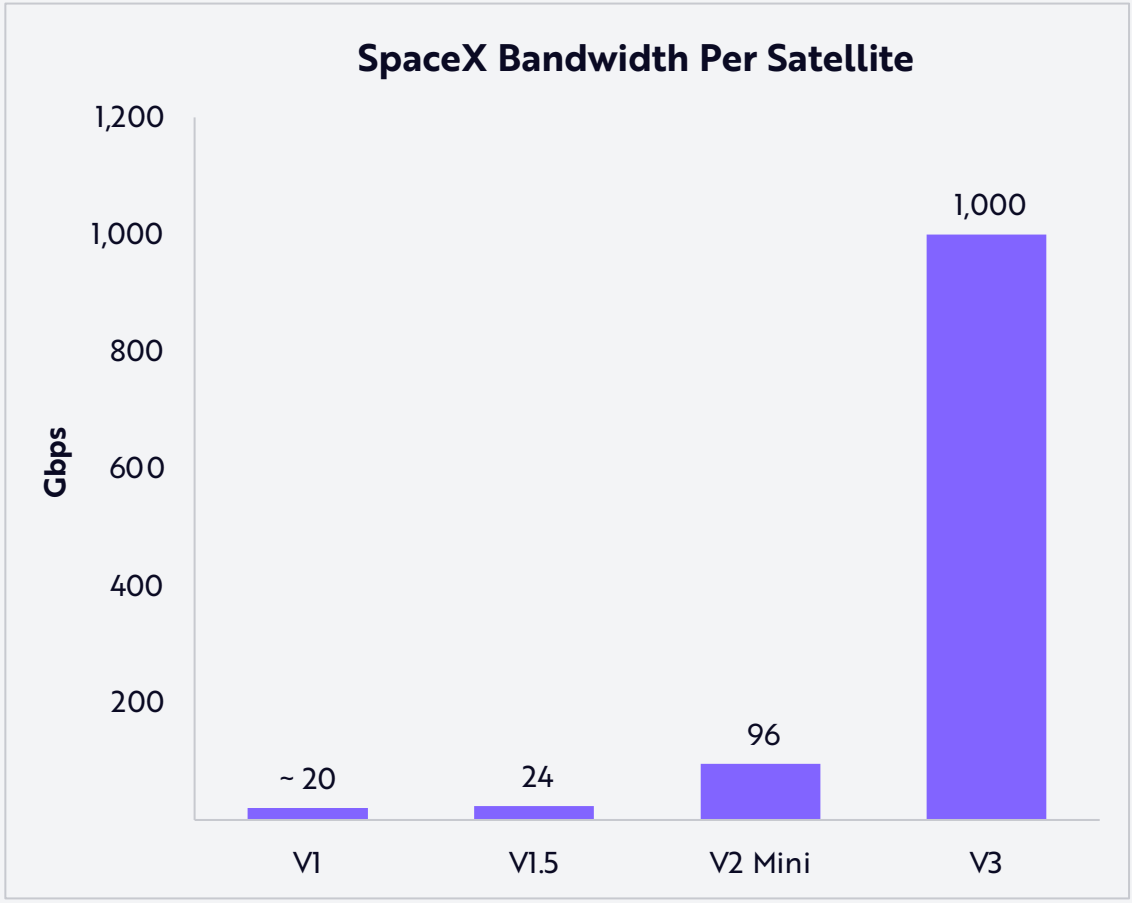
Stage Of Small Launch Providers Created Since 1996



Source: ARK Investment Management LLC, 2025, based on data from NewSpace Index as of January 10, 2025. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

SpaceX Has Converted The Addressable Market Into Revenue With Increased Starlink Capacity



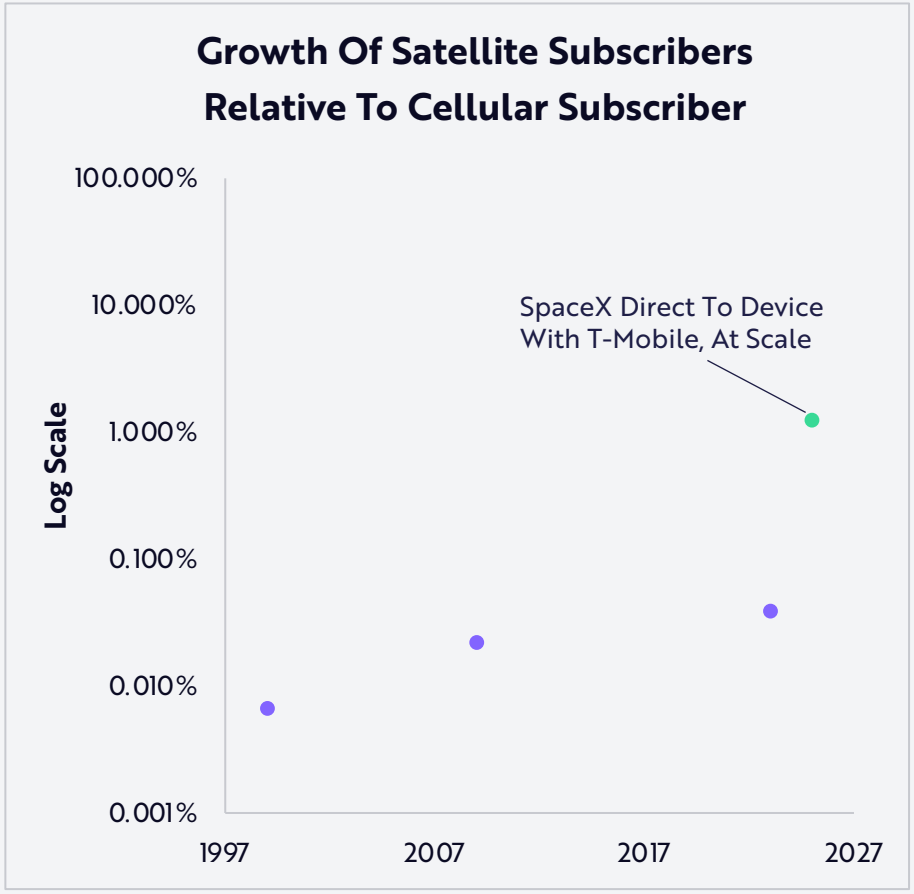


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including SpaceX 2024, as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Satellite Connectivity Revenues Could Exceed $130 Billion Per Year

Thanks to declining rocket launch costs, telecom operators could provide 100% of cellular subscribers satellite connectivity anywhere in the world.

	Addressable Subscribers*		Annual Revenue*		Annual Addressable Market*
Direct-To-Device	8 Billion	✖	$6	=	~$48 Billion
Global Households Without Access To Broadband	600 Million	✖	$60	=	~$40 Billion
RVs	11 Million	✖	$1,620	=	~$18 Billion
Recreational Boats	8.5 Million	✖	$1,620	=	~$14 Billion
Commercial Aircraft Fleet	25 Thousand	✖	$225,000	=	~$6 Billion
Cruise Ships, Warships, Commercial Ships	100 Thousand	✖	$60,000	=	~$6 Billion
				Total:	**~$132 Billion**



*Forecasts. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

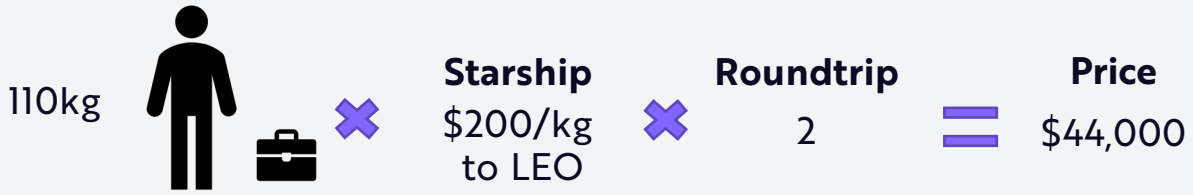
By 2030, Hypersonic Flight Could Be A ~$35 Billion Market, Ready To Scale To ~$350 Billion Longer Term

According to the US Department of Transportation, leisure travelers are willing to spend 60%-90% of their estimated hourly household income to save one hour.*

Compared to conventional flights that can take 28 hours roundtrip, ARK estimates that hypersonic flights could take just 6 hours, saving each traveler ~22 hours.

Given the typical cost and potential time savings, ARK's research suggests that a first-class passenger should be willing to spend $44,000 roundtrip for a hypersonic flight.

If launch costs decline in line with ARK's expectations, early adopters of hypersonic flight could generate $35 billion revenue by 2030.



Building Blocks Of Addressable Market Forecast

Total Number Of Airline Passengers Worldwide: 6.7 Billion

↓ 5% Of Flights Are Long-Haul

Number Of Passengers On Long-Haul Flights: ~335 Million

↓ 5% Of Passengers Are First-Class

Number Of Passengers Flying First-Class: ~16 Million

↓ 50% Adoption At Maturity

Number Of Passengers Flying Hypersonic: ~8 Million

↓ $44,000 Roundtrip Ticket

Annual Addressable Market: ~$350 Billion

*Forecasts. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of January 10, 2025, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Multiomics

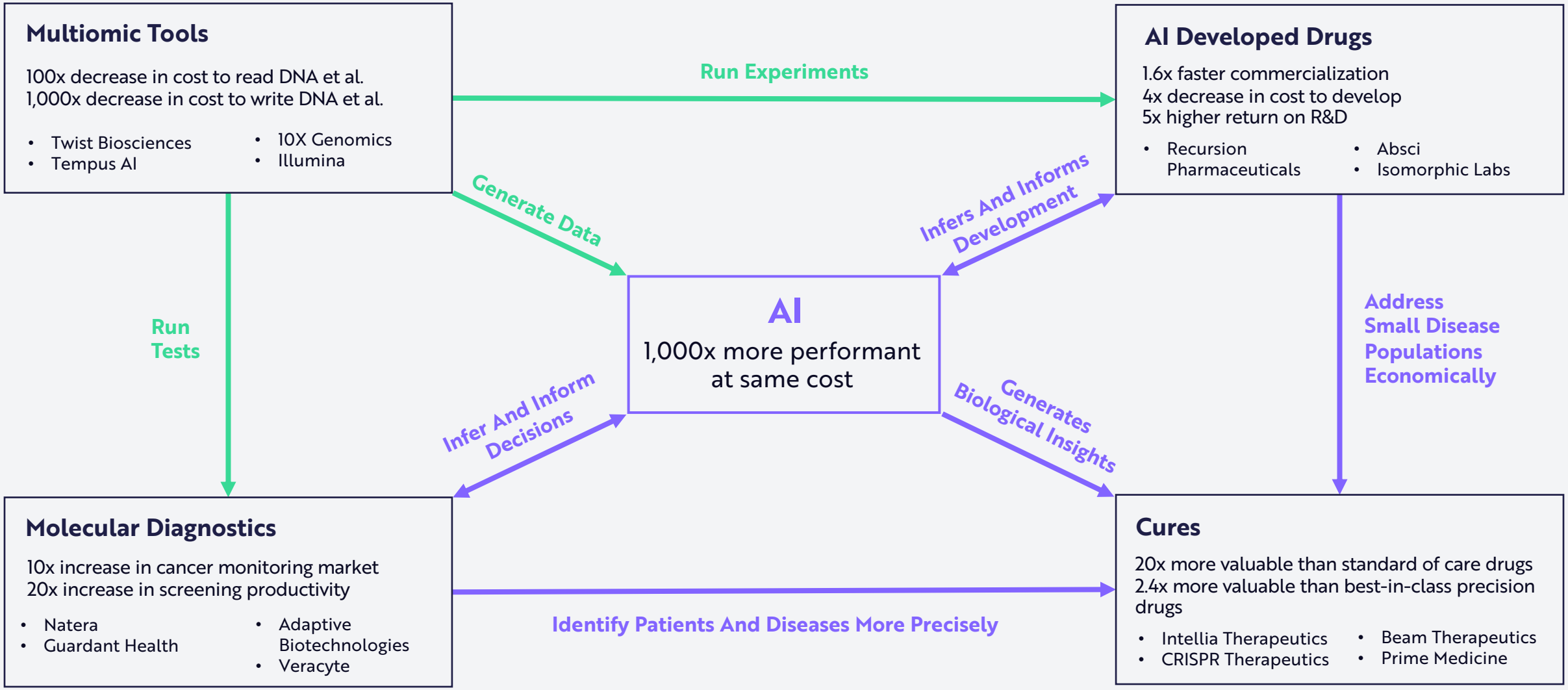
Operationalizing Data With AI To Transform Diagnostics, Drug Discovery, And Therapies

Nemo Despot Marjanovic, PhD
ANALYST, MULTIOMICS

Brett Winton
CHIEF FUTURIST

Rong Guo, PhD
RESEARCH ASSOCIATE, MULTIOMICS

Multiomics Performance Should Improve By Orders Of Magnitude By 2030*



*The multiomics performance statistics provided on this slide represent ARK's research-based forecasts for 2030, which may not be realized. The companies listed represent companies that are currently working toward achieving the forecasted results, but the list does not include all companies that may be pursuing the same goals, and which may do so more successfully. The companies listed may or may not be held in ARK portfolios. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment in any of the companies listed was or will be profitable. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Biological Information Is Encoded In Three Layers

Advances in sequencing, AI, and single-cell technologies enable us to read, model, and predict complexity. Biological information is organized by three interconnected layers that drive life processes.

STATIC

DYNAMIC

Biological Information		Measuring Tools*	
The linear arrangement of nucleotides in DNA or amino acids in proteins Examples: • DNA sequences store genetic information, determining an organism's primary traits. • Protein sequences define structure and function in cellular processes.	**Sequence**	**DNA/Protein Sequencing**	Illumina Oxford Nanopore PacBio QuantumSi
The three-dimensional organization of biomolecules like proteins and nucleic acids Examples • Protein structures determine binding sites and catalytic activity. • Nucleic acid structures affect stability, replication, and transcription.	**Structure**	**AlphaFold**	Bruker DeepMind Isomorphic Labs ThermoFisher
Agglomeration of molecules Examples • Gene regulation: mRNA and protein abundance vary, controlling gene expression.	**Systems**	**Single Cell Genomics**	10X Genomics Akoya ScaleBio Vizgen

Sequence Layer
The static genetic blueprint within DNA, RNA, and proteins.

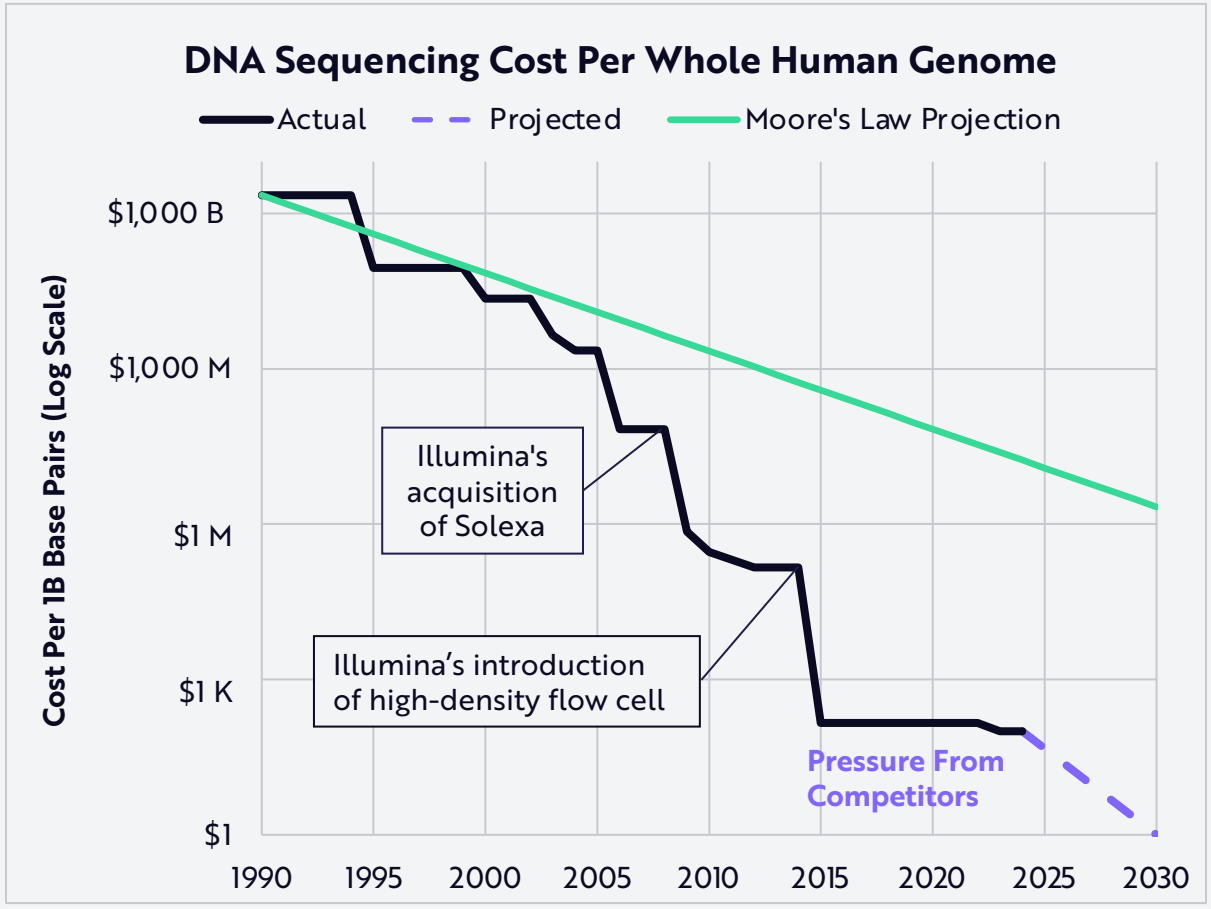
Structure Layer
The 3D folding of biomolecules, defining their function.

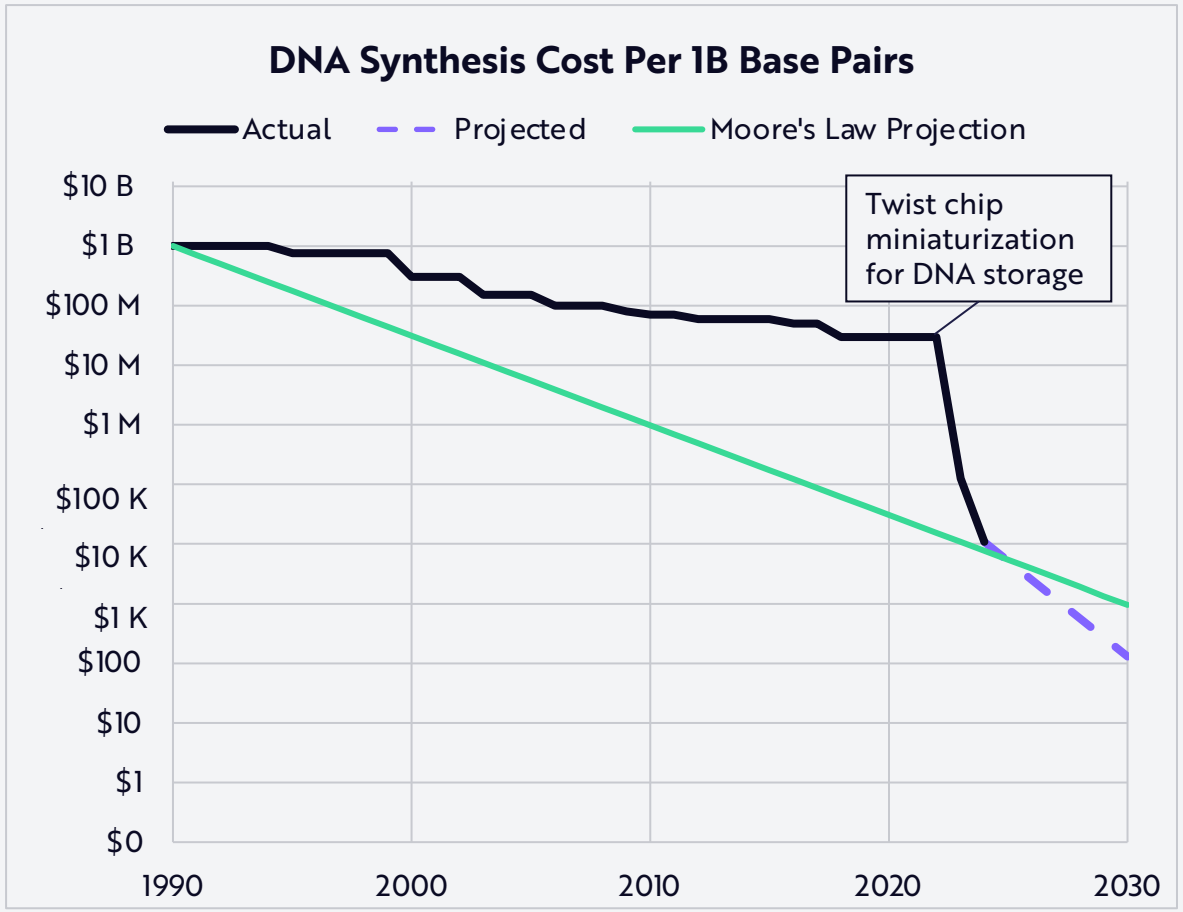
Systems Layer
The dynamic abundance of biomolecules responding to cellular and environmental cues.

*The companies listed are examples of companies that employ the measuring tools described, but the list does not include all companies that may be utilizing those tools, and which may do so more successfully. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment any of the companies listed was or will be profitable. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

The Costs Of DNA Sequencing And Synthesis Are Falling Precipitously

DNA sequencing and synthesis costs are declining faster than Moore's Law* predicted. The cost of reading biology through multiomics tools like DNA sequencing has plummeted by 10 billion-fold (10^{10}) in its 35-year history. DNA synthesis costs have dropped 100,000-fold (10^5) and could continue to fall 10 million-fold (10^7) by 2030. Twist Bioscience's silicon-based DNA synthesis, combined with miniaturization and parallelization, has reduced costs by increasing efficiency, reducing reagent usage, and scaling production.

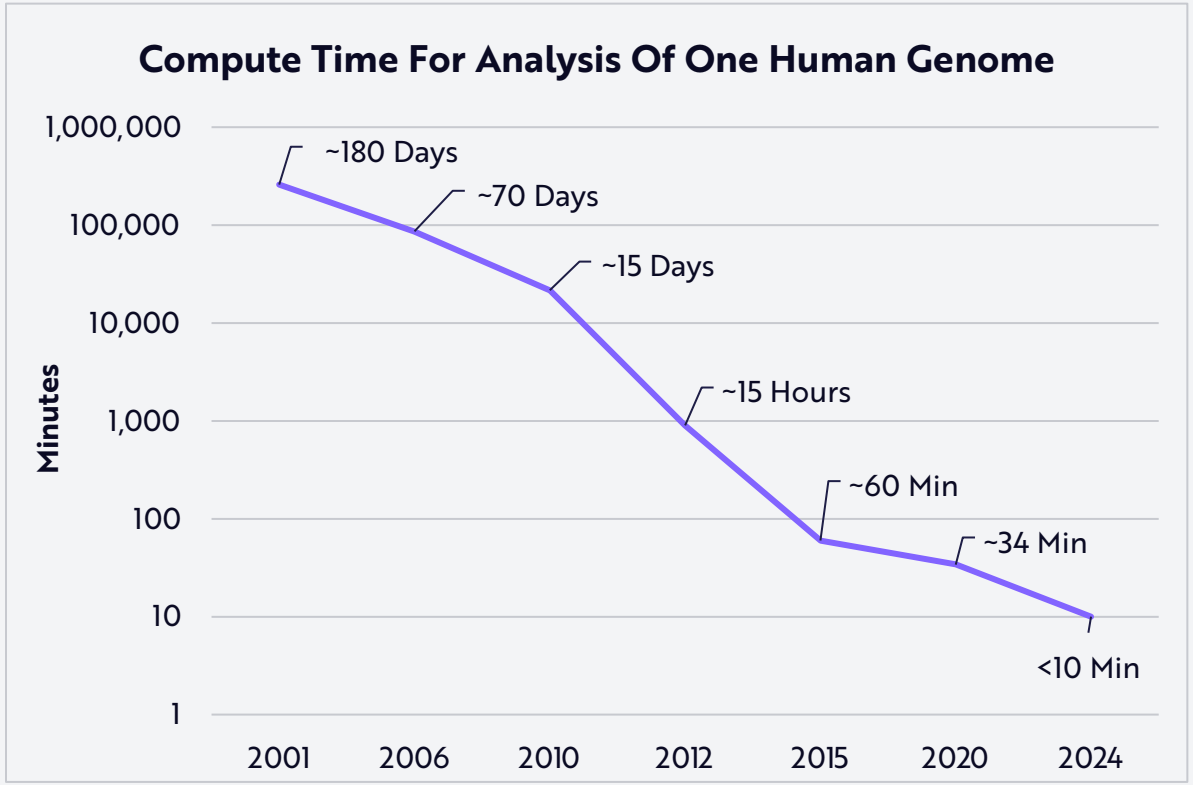


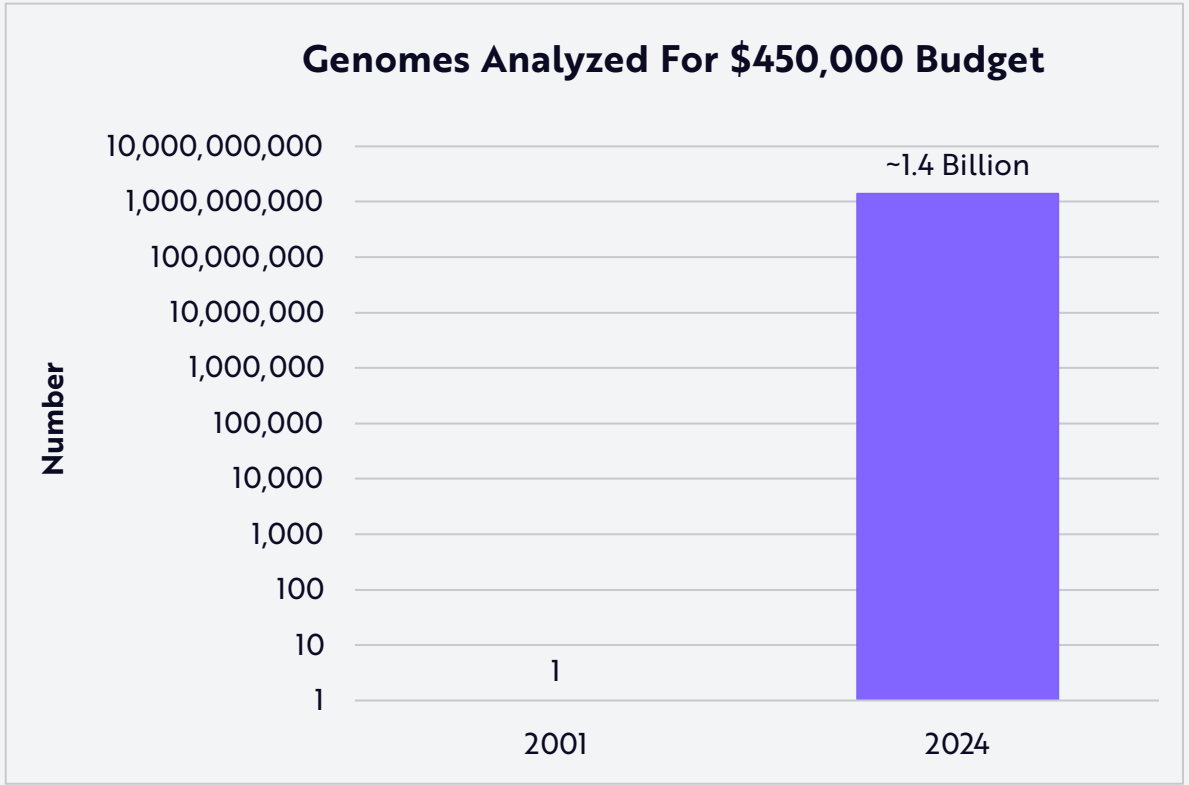


*Moore's Law predicts that the number of transistors on a chip doubles every 18 months to two years. See Winton 2019. Note: The total price of sequencing the first human genome was estimated at ~2.7B, which included all the costs of developing and improving sequencing tools, actual sequencing, and all analysis. In the above graph, we are calculating only actual sequencing cost per base pair. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including BusinessWire 2024 and Carlson 2022 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

The Productivity Of Genomics Analysis Has Skyrocketed

Since 2001, the compute time required to analyze a human genome has plummeted from 180 days to 10 minutes. Today we can analyze ~1.4 billion genomes for the cost of analyzing a single genome in 2001. Alongside the plummeting costs of sequencing and synthesis, as noted on the previous slide, genome analysis is commoditizing, driving a revolution in biological research and applications, from personalized medicine to global-scale genomics.

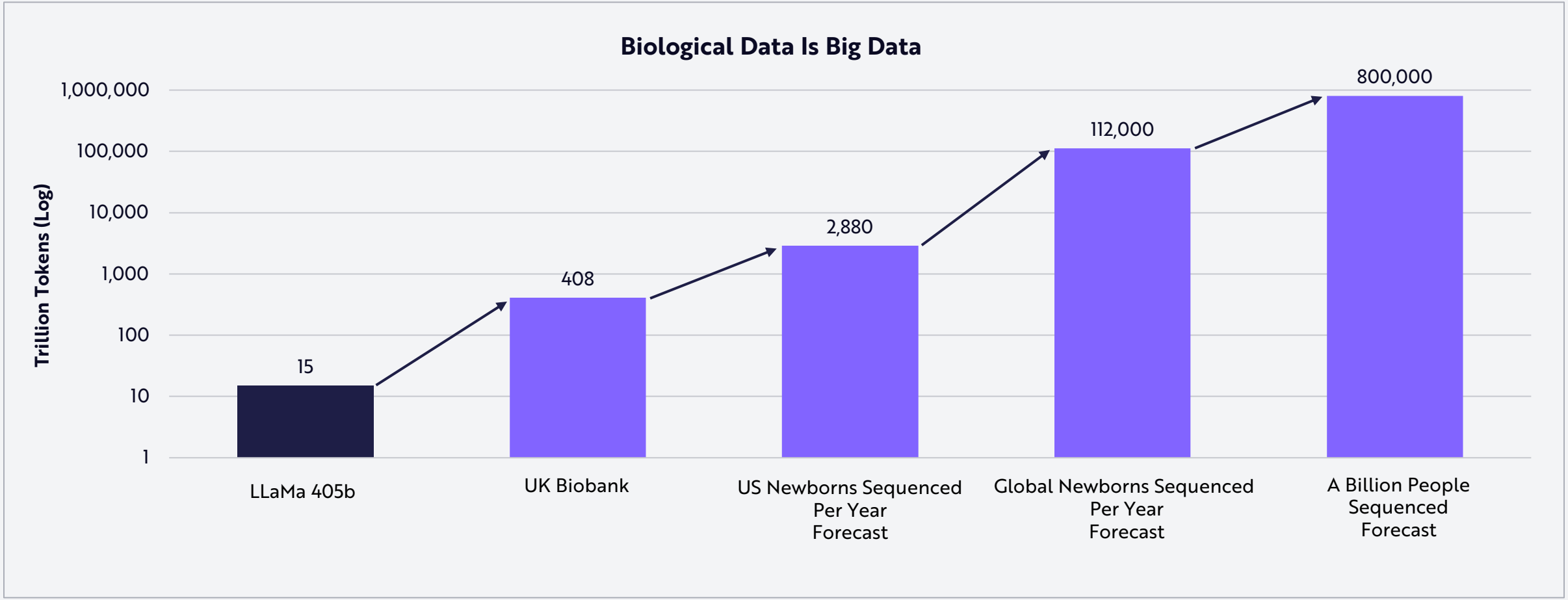




Note: 2001 marks the publication of the first draft of the human genome, covering approximately 90% of the genome. In 2003, a near-complete sequence (99.99%) was published, while the fully complete genome was finalized in 2022. Although sequencing the first human genome took about 13 years in total, this slide focuses solely on the time required for the computational analysis, excluding the experimental phase, which was a significantly larger bottleneck. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Saunders et al. 2021, Miller et al. 2015, Gorzynski et al. 2022, and Clifford 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Data Volumes Should Explode As Measurement Costs Decline

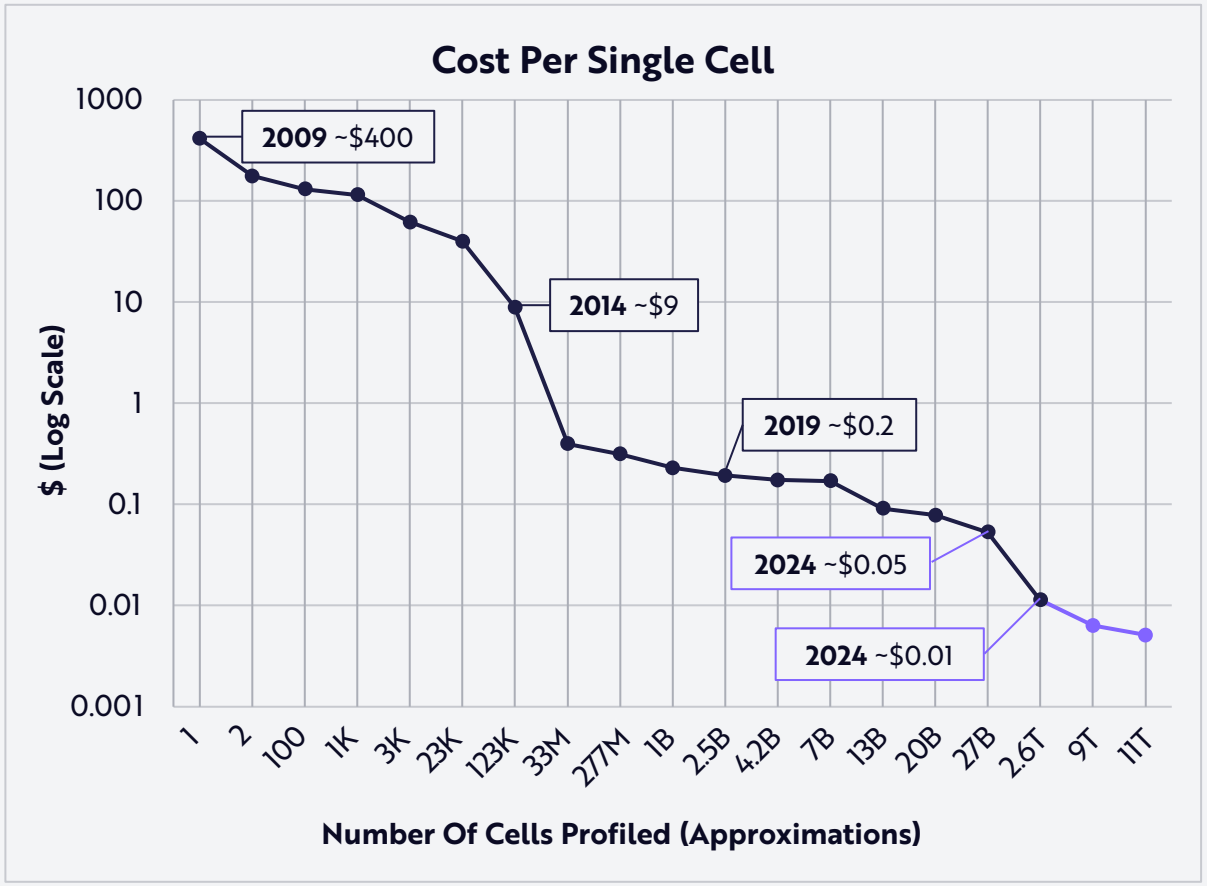
Multiomics tools create volumes of data. The largest publicly-available genomics database, the UK Biobank, includes a half-million patients with 27x more data than the 15 trillion tokens of text powering large AI language models. If newborn sequencing were to become the standard globally, as we expect, data volumes would explode by 1,000x or more.

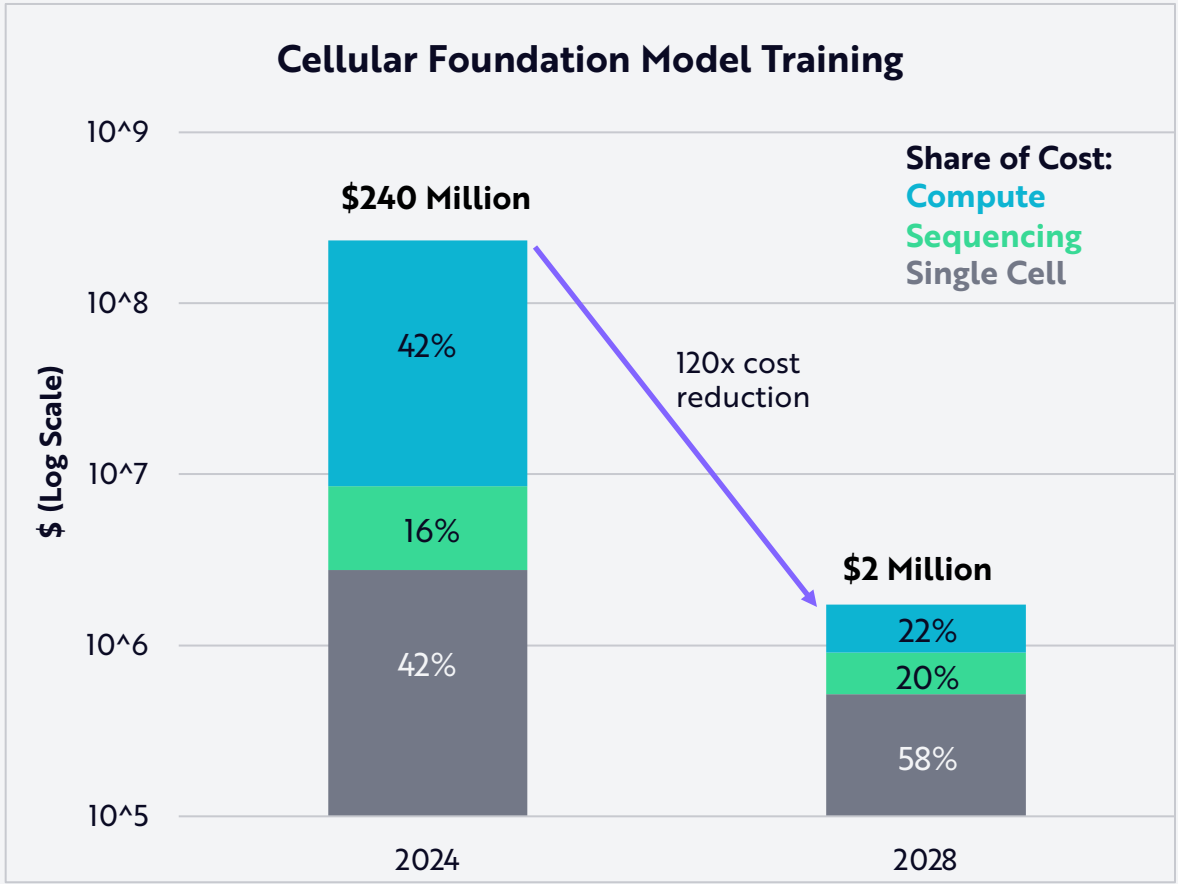


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources , including UK Biobank as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Virtual Cell Foundation Models Are Collapsing The Cost Of Single-Cell Genomics

Single-cell genomics costs are dropping exponentially, in line with Wright's Law.* According to ARK's research, trillion-cell experiments are feasible now that single-cell sequencing costs have dropped to $0.01 per cell. Virtual cell foundation models are likely to become the killer AI application in drug discovery and precision medicine. By 2028, virtual cell costs could drop ~120x. Companies like 10x Genomics and Scale Bio are leading the way.

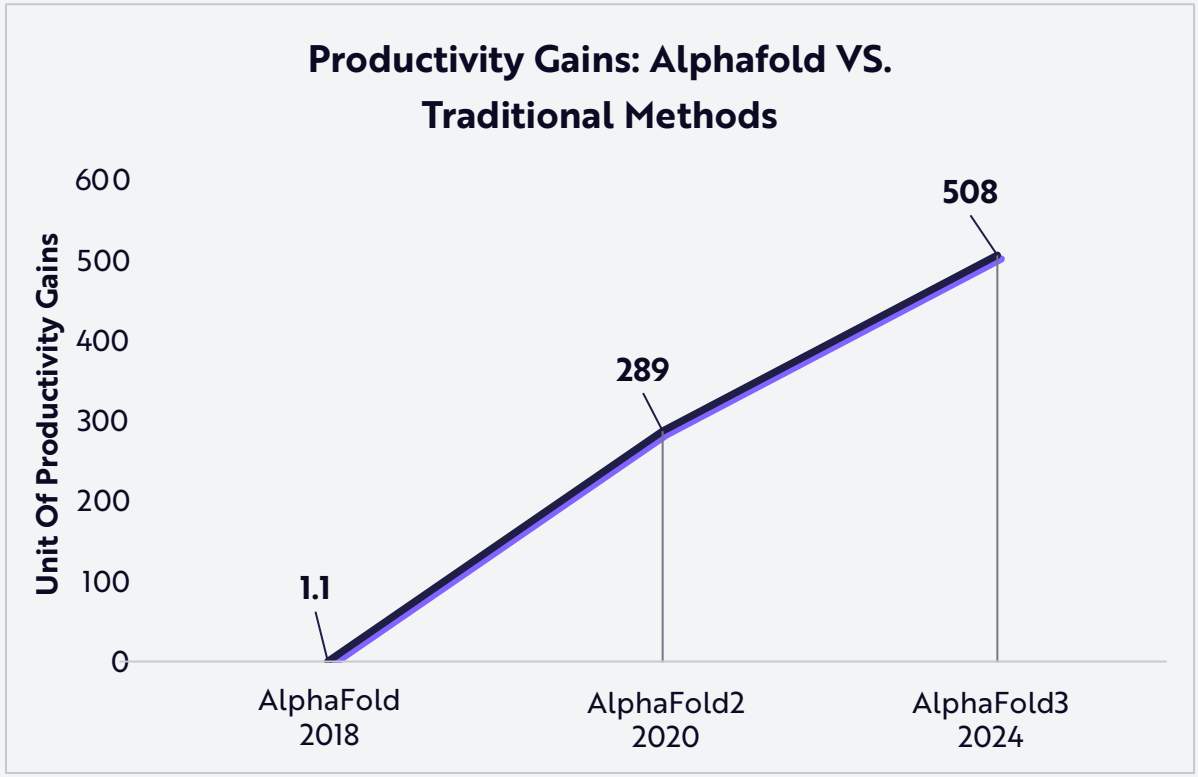


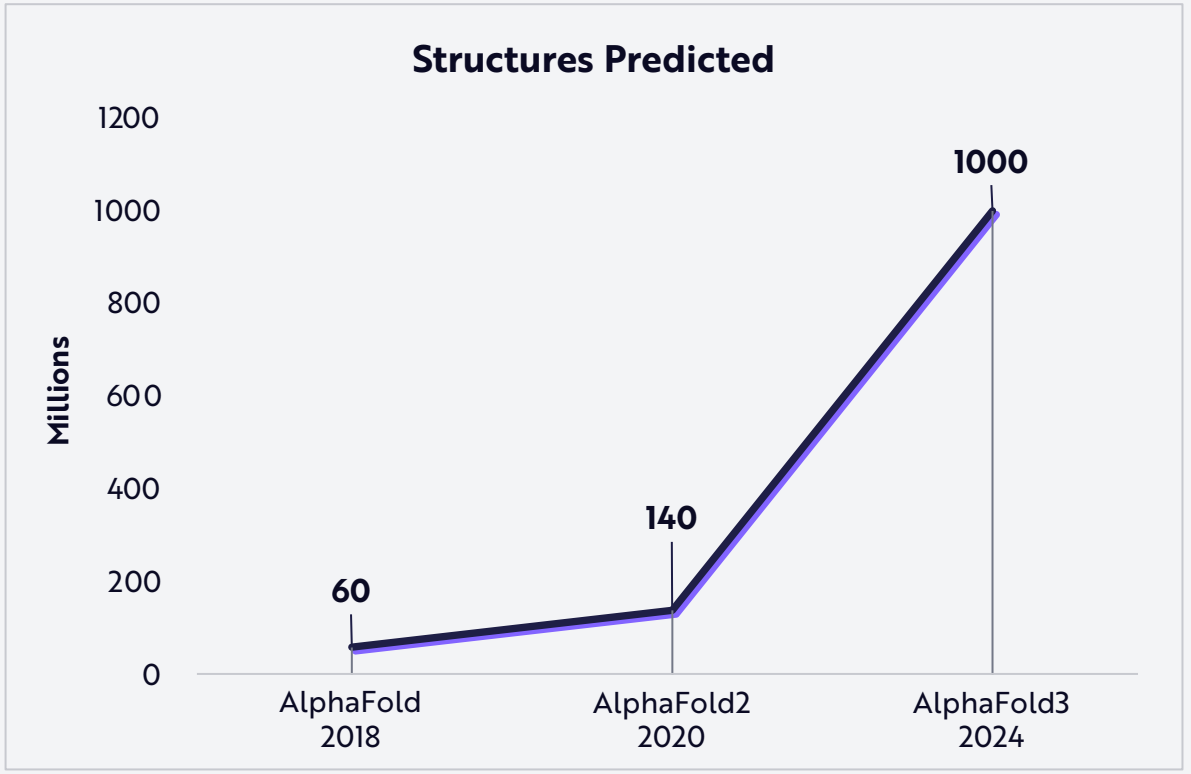


Note: The companies mentioned are examples of companies developing virtual cell models, but the list does not include all companies that may be developing these models, and which may do so more successfully. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment any of the companies mentioned was or will be profitable. *Wright's Law states that for every cumulative doubling of units produced, costs will fall by a constant percentage. See Winton 2019. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Tang et al. 2009, Jovic et al. 2022, Ding et al. 2020, and Rood et al. 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AlphaFold Is Redefining The Prediction Of Molecular Structures

AlphaFold has transformed the prediction of protein structures, surpassing traditional methods like X-ray crystallography and Cryo-EM in both productivity* and scope.** Each version of AlphaFold has delivered exponential gains, not only improving efficiency, but also unlocking entirely new structural predictions. AlphaFold1, for example, predicted single-chain proteins (~60M structures), but AlphaFold3 can predict more than 1 billion structures, including multi-chain complexes, protein-ligand, protein-DNA/RNA interactions, and post-translational modifications.

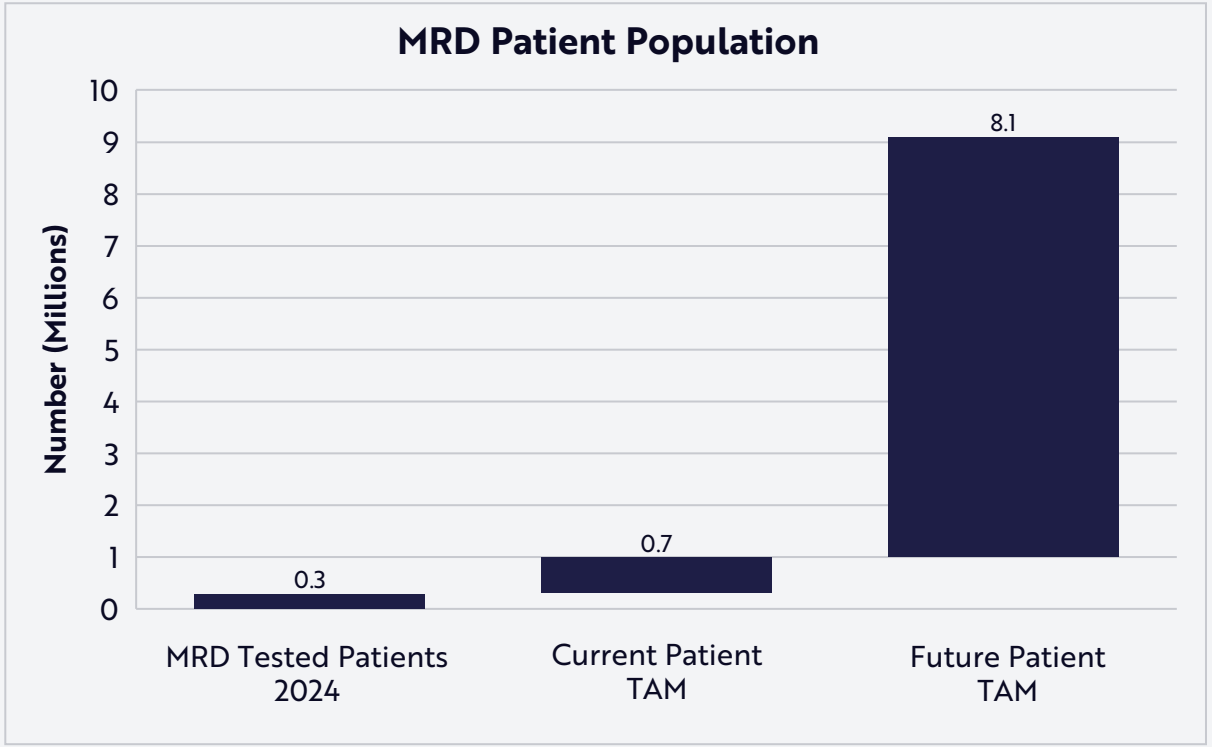


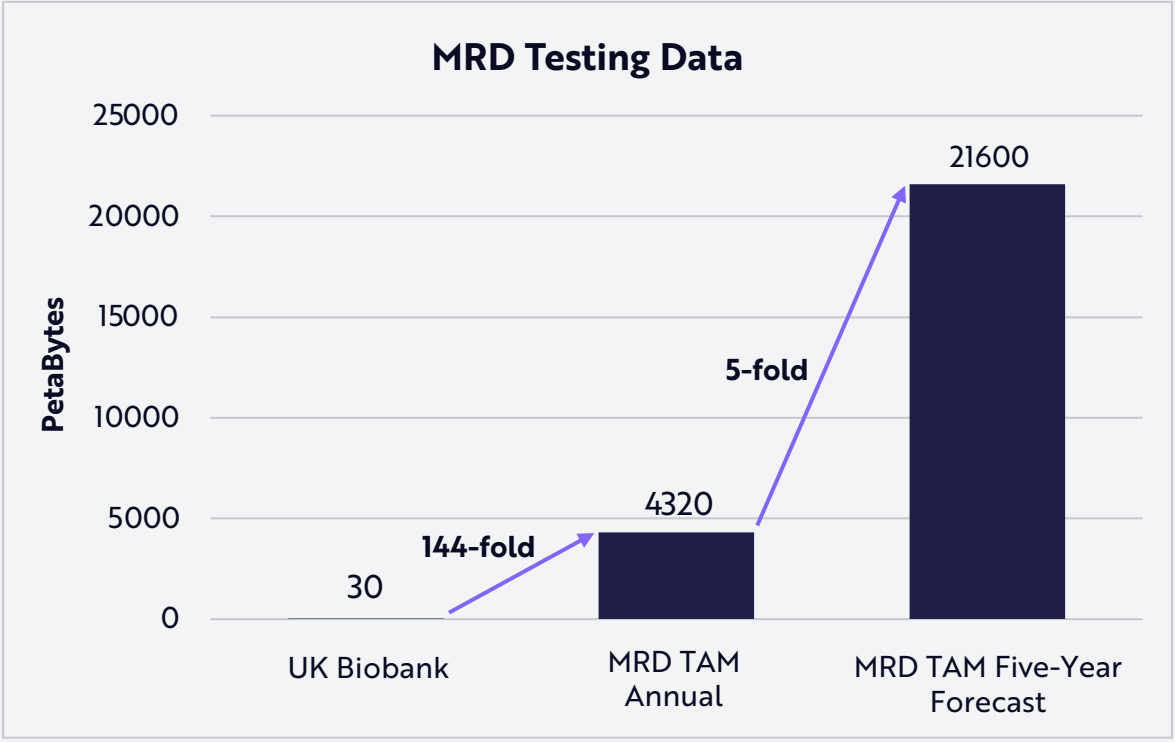


*Productivity gains are defined as the ratio of AlphaFold's Efficiency Metric—accuracy per cost per speed—to the average efficiency of traditional methods. **Scope is calculated as the Efficiency Metric × Number of Structures Predicted. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Jumper et al. 2021, CASP13 2019, and Liu et al. 2024, as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

MRD Testing Is Catalyzing The Generation Of Genomics Data

Minimal residual disease (MRD) testing can detect the recurrence of cancer up to 20 months earlier than traditional imaging. Yet, more than eight million suitable cancer patients in the US currently are not reimbursed for MRD testing. Now, at only 10% penetration, MRD testing should become the standard of care for every cancer patient, with multiple tests per year and follow-ups for five years. ARK's research suggests that MRD testing could produce 700x more data than the largest genomics project to date, the UK Biobank, enabling advanced predictive and prescriptive analytics that could revolutionize how we understand, monitor, and manage cancer.

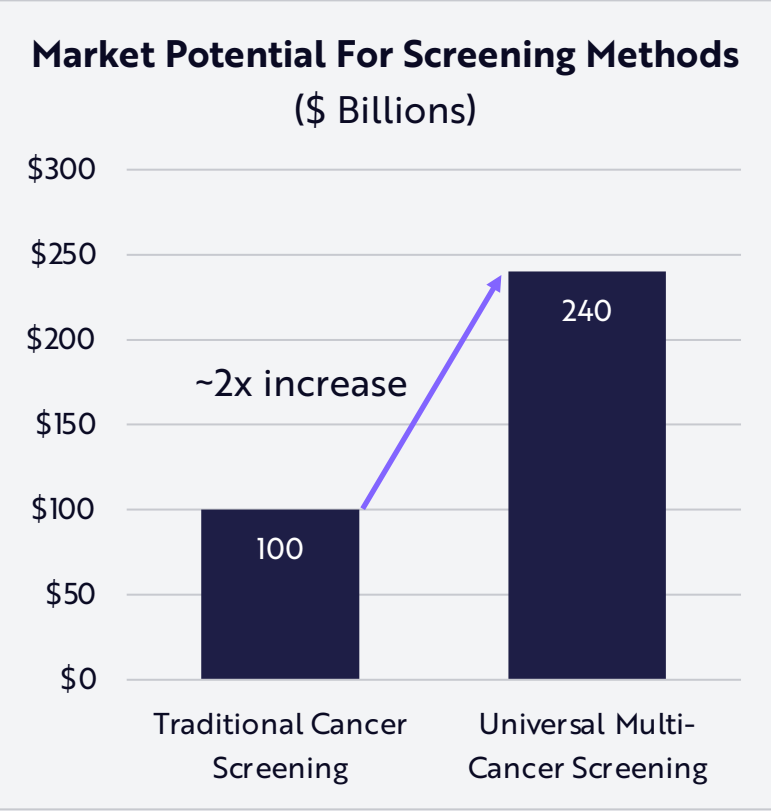


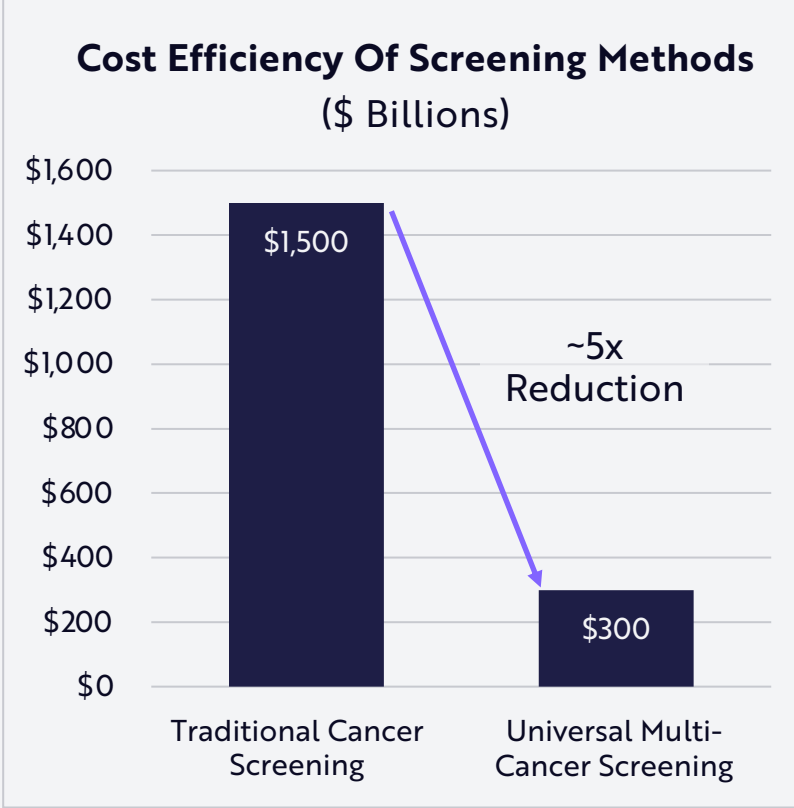


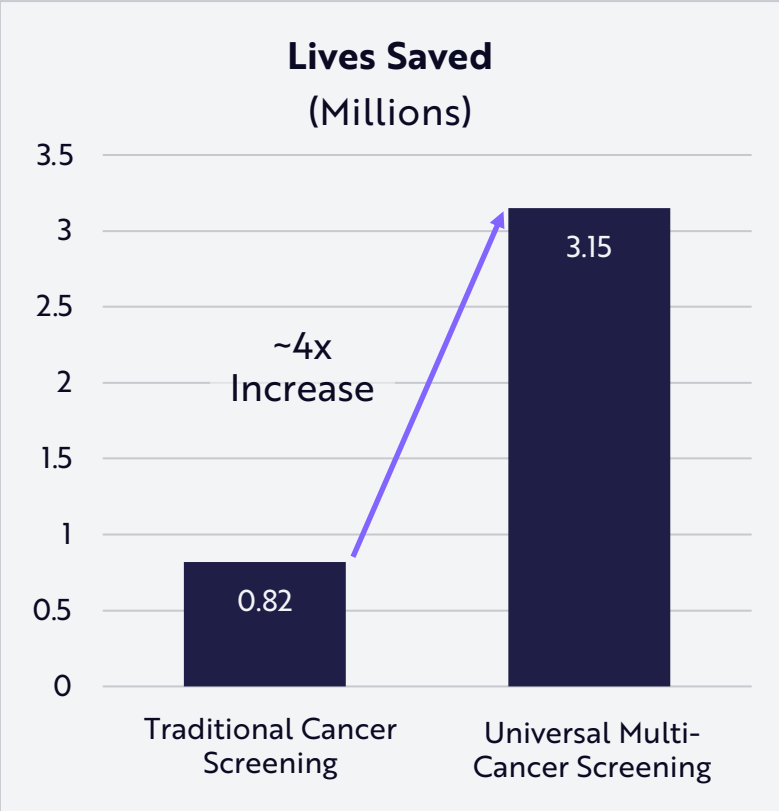
Note: "TAM": Total addressable market. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Wan et al. 2017, Luskin et al. 2017, and Borfitz 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Multi-Cancer Screening Could Save Lives And Cut Costs

Powered by liquid biopsy technology, multi-cancer screening is a revolutionary approach to early cancer detection. Unlike traditional methods, a single blood test can screen for multiple cancers simultaneously, streamlining screening and expanding its scope. The FDA's recent approval of Guardant Health's "Shield" colorectal cancer screening test suggests that the technology is proving its potential. Pending resolution of regulatory and reimbursement paths, universal multi-cancer screening could more than double the Total Addressable Market (TAM) in the US.







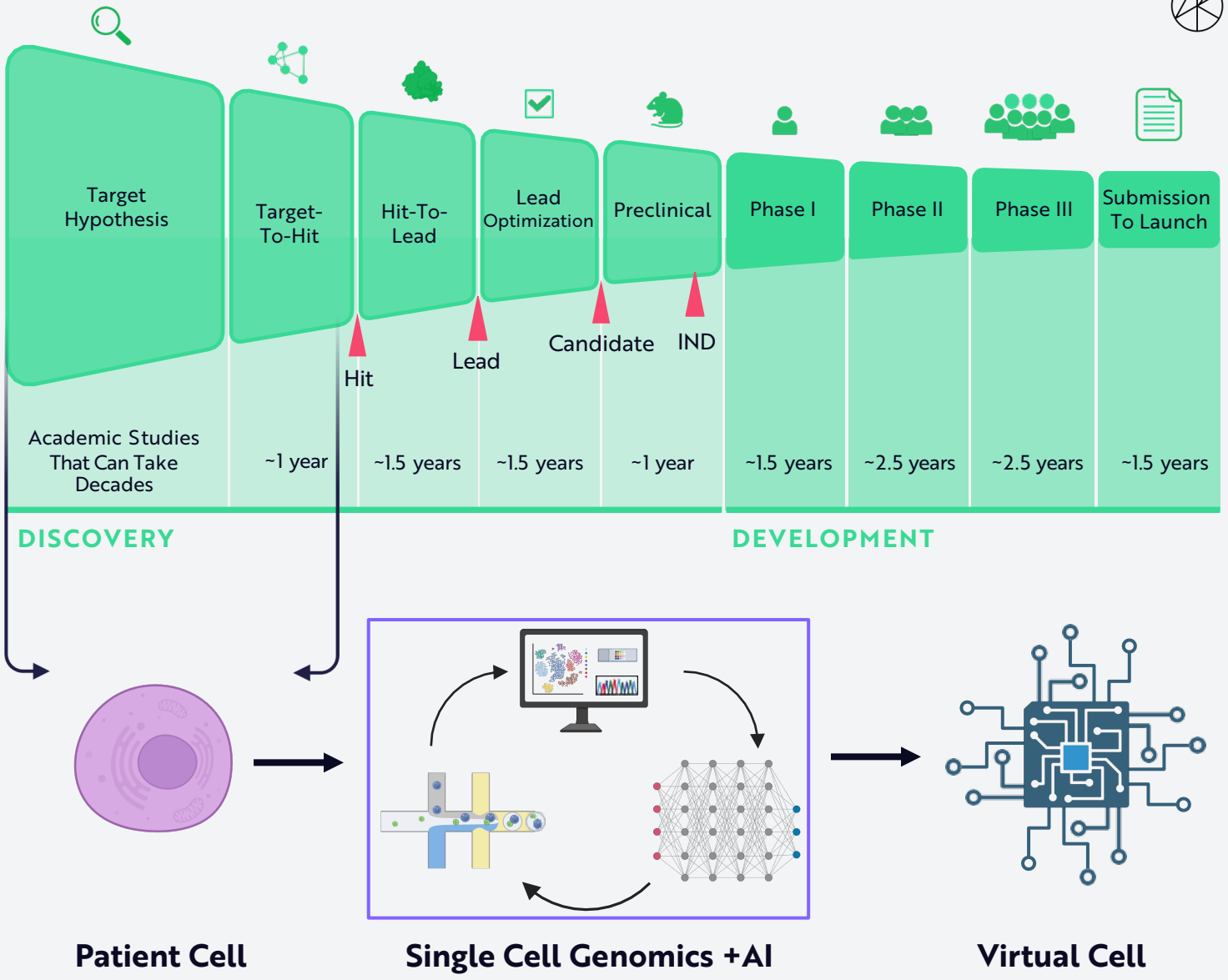
Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Philipson et al. 2023, Goddard et al. 2024, and Mannucci and Goel 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Single-Cell Genomics And AI Are Creating Virtual Cells And Transforming Drug Discovery

The "virtual cell" is a cutting-edge achievement that integrates artificial intelligence and single-cell genomics. By leveraging multi-modal, multi-scale data, virtual cells use foundation models to simulate cellular functions and predict responses to perturbations across various biological states.

A transformative leap in drug discovery—particularly target identification and validation—virtual cells enable in-silico experiments to test hypotheses, simulate perturbations, and identify viable targets efficiently and cost-effectively. They also predict how specific mutations or drugs influence cellular pathways, potentially accelerating the pipeline from target discovery to validation and reducing reliance on costly and time-consuming wet-lab experiments. We expect the same timeline reductions as AlphaFold achieved in the prediction of molecular structure.

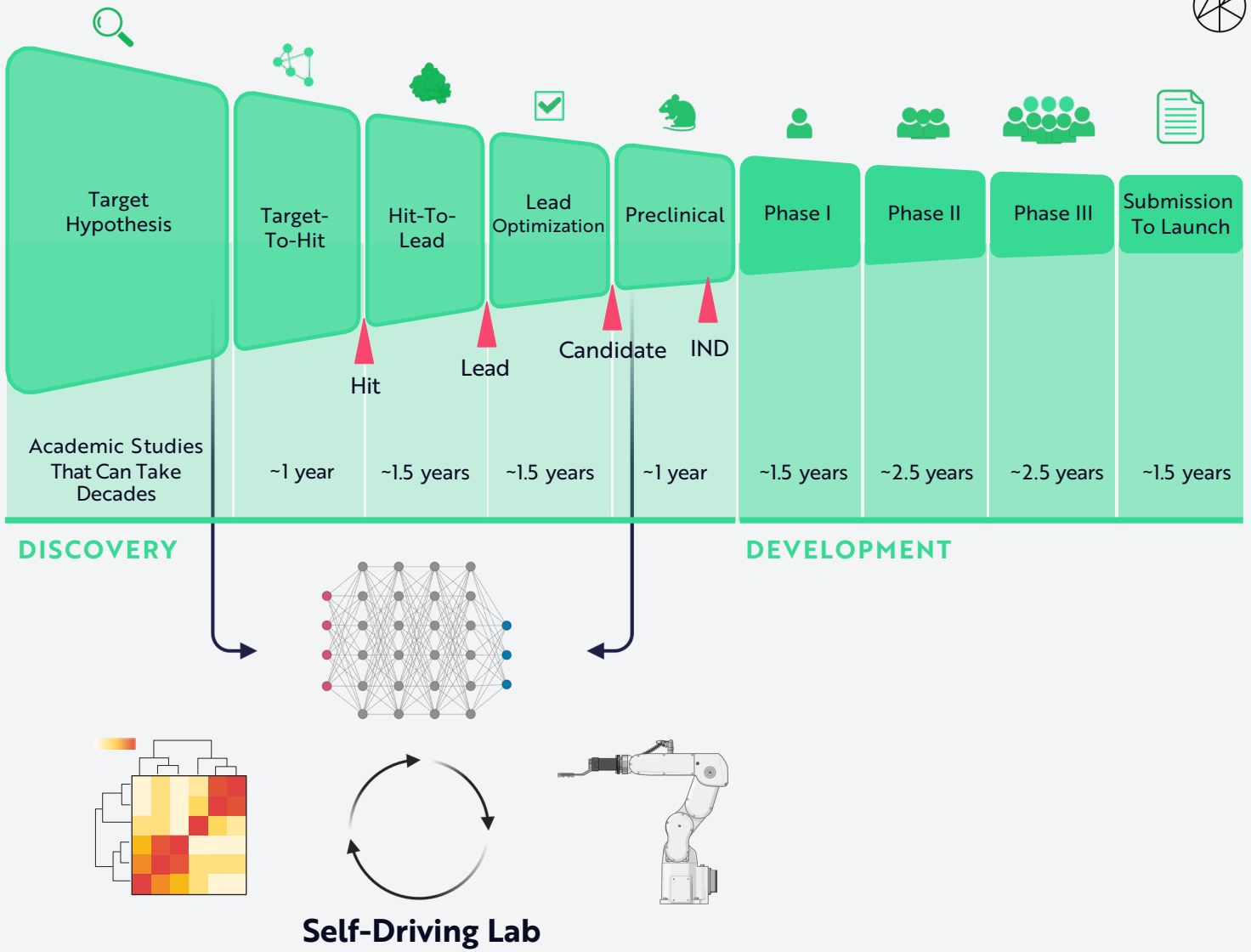
Companies like 10X Genomics, Illumina's FluentBio, ScaleBio, and ParseBio are providing technologies that build Virtual Cells.



Note: The companies mentioned are examples of companies developing virtual cell models, but those examples do not include all companies that may be developing these models, and which may do so more successfully. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment any of the companies mentioned was or will be profitable. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Bunne et al. 2024 and Rood et al. 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Self-Driving Labs Are Using Scalable Biology And AI To Revolutionize Drug Discovery

A self-driving lab (SDL) combines not only multiomics tools that read biology at scale, but also automation that enables high-throughput experimentation and large language models (LLMs) that analyze data and design the next set of experiments. The SDL's integrated approach should enable the transition from automated to autonomous drug discovery and research, potentially accelerating the cycle of discovery and reducing costs/time while increasing efficiency. According to our research, SDLs could save up to two years and hundreds of millions of dollars in the discovery process. Currently achieving ~200x productivity gains, Recursion Pharmaceuticals is pioneering this approach.

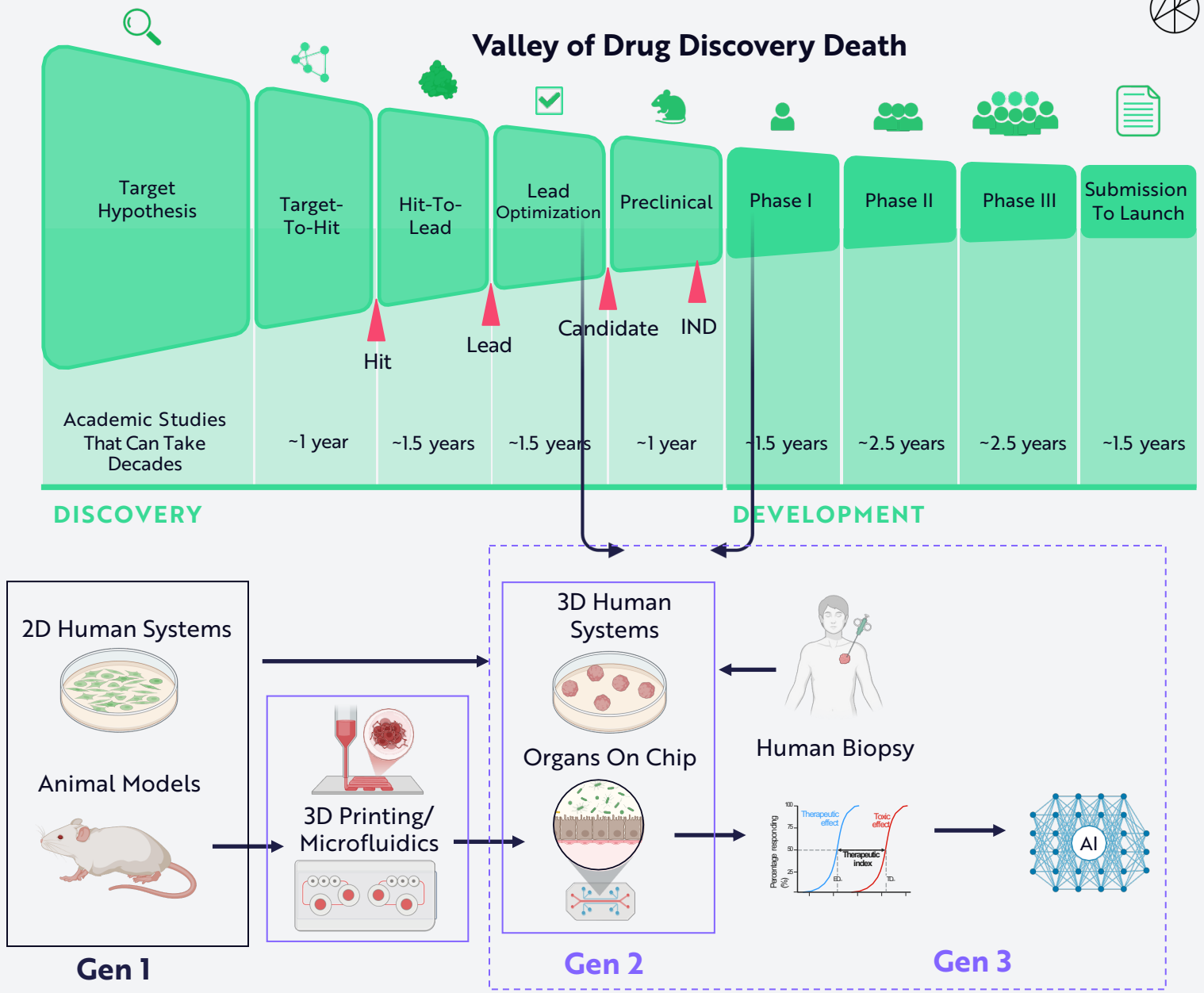


Note: Recursion Pharmaceuticals is the company currently pioneering the use of SDLs, but there may be other companies that utilize SDLs and which may ultimately do so more successfully. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment in the company mentioned was or will be profitable. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Recursion 2024, Abolhasani and Kumacheva 2023, and Martin et al. 2023 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Organs-On-Chips And AI Are Rescuing Drug Discovery From The Valley Of Death

Often called the "valley of death" in drug discovery, preclinical studies are prone to high failure rates that stem from predictive models like 2D cell systems and animal testing. Thanks to advances in microfluidics, 3D bioprinting, and organoids, next-generation preclinical models like organs-on-chips are evolving. The new systems are more physiological, scalable, and capable of supporting higher-throughput testing. Integrating Gen 2 models—grown from patient-derived biopsies—with AI-powered analyses of vast datasets could lead to precise, patient-specific predictions that improve drug discovery outcomes dramatically.

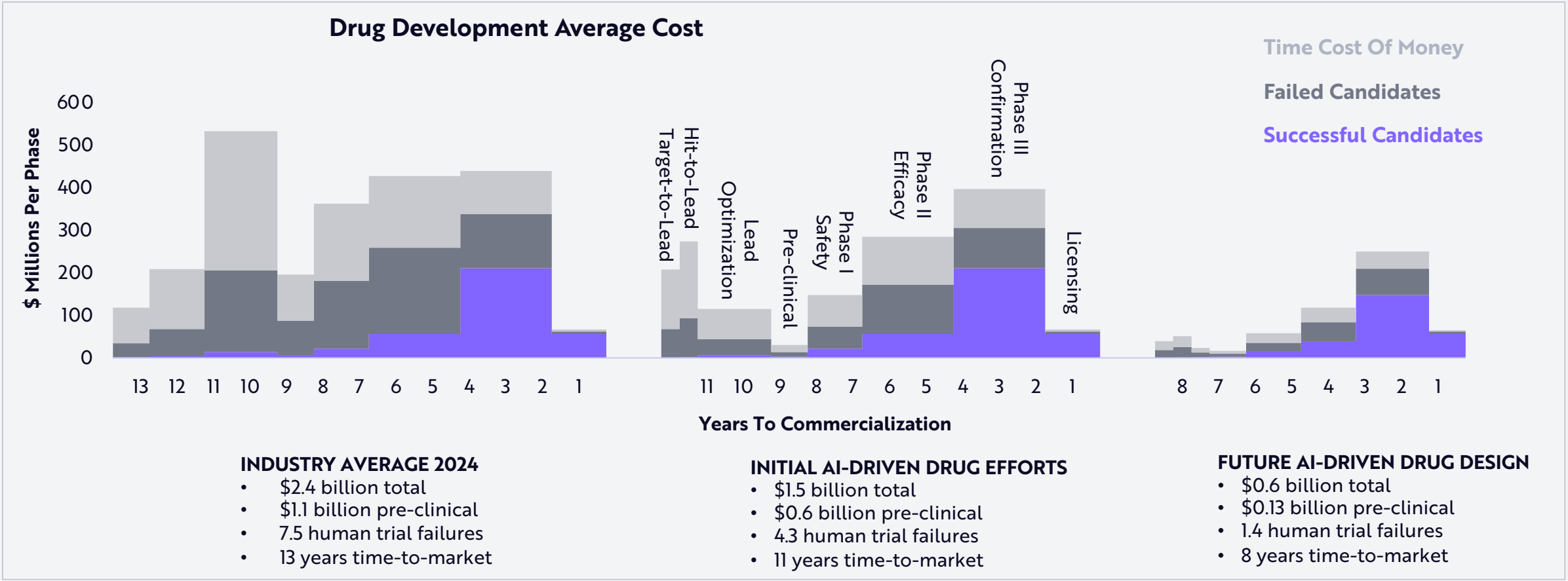
Large Language Models are beginning to impact and accelerate clinical trials by optimizing regulatory filings, patient selection, trial designs, and data analysis.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources, including Zhou et al. 2023, Tong et al. 2024, and Thng et al. 2024 as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI Is Transforming The Economics Of Drug Development

Biotech valuations include little-to-nothing for the preclinical and Phase 1 stages of development, but increasingly they are likely to incorporate the higher probability of longer patent lives. AI-driven drug development could reduce time-to-market nearly 40%, from 13 years to 8 years, while reducing total drug costs 4-fold, from $2.4 billion to $0.6 billion.



INDUSTRY AVERAGE 2024
- $2.4 billion total
- $1.1 billion pre-clinical
- 7.5 human trial failures
- 13 years time-to-market

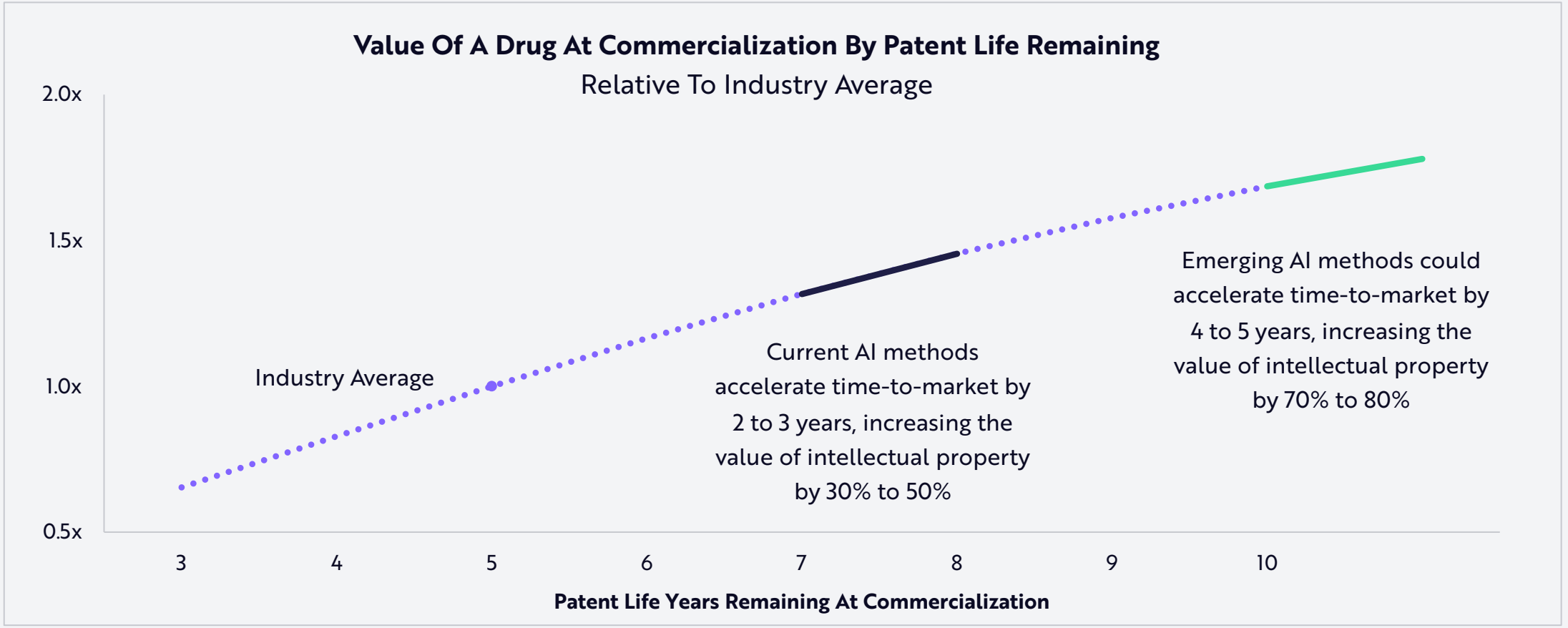
INITIAL AI-DRIVEN DRUG EFFORTS
- $1.5 billion total
- $0.6 billion pre-clinical
- 4.3 human trial failures
- 11 years time-to-market

FUTURE AI-DRIVEN DRUG DESIGN
- $0.6 billion total
- $0.13 billion pre-clinical
- 1.4 human trial failures
- 8 years time-to-market

Note: 10% discount rate, 2024 dollars. For initial AI-driven drug efforts, assumes 70+% failure reduction in phase I that moderates to 20% in phase II and phase III. For future AI-driven drug design, assumes demonstrated 70+% reduction in phase I failure rates that moderates to a 50% failure reduction in phase II and 25% failure reduction in phase III. Assumes that pre-clinical efficiency is similar to what Absci has indicated is achievable. Also assumes that licensing timeframe reduces to 12 months from 18 months for future drugs. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Reducing Development Timelines Should Increase The Value Of Patents And Commercialization

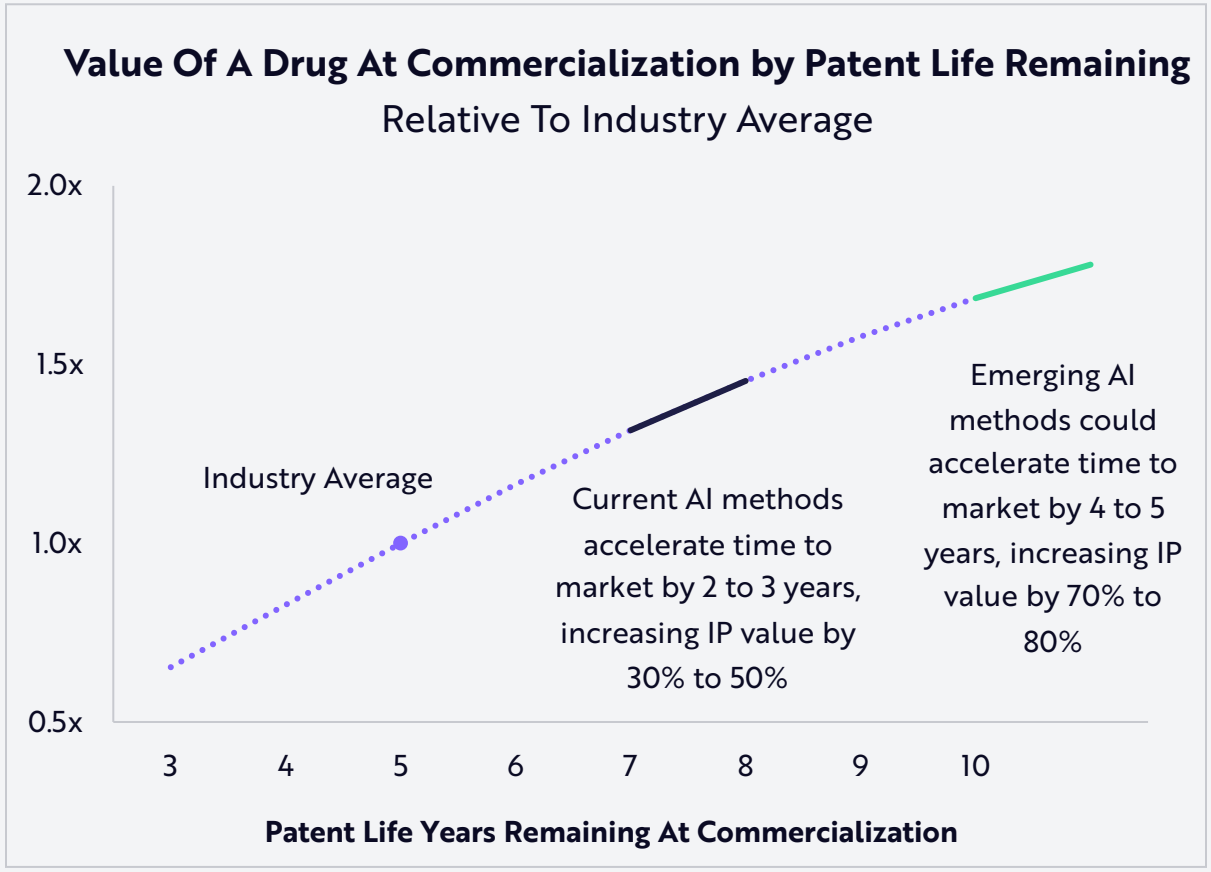
Faster commercialization extends patent-protected revenue, allowing companies to generate higher returns for longer. Current AI efforts shorten development timelines by 2-3 years, increasing a drug's lifetime value by 30-50% compared to the industry average of five years. Emerging AI designs could accelerate time-to-market by 4-5 years and boost the value by 70-80%.

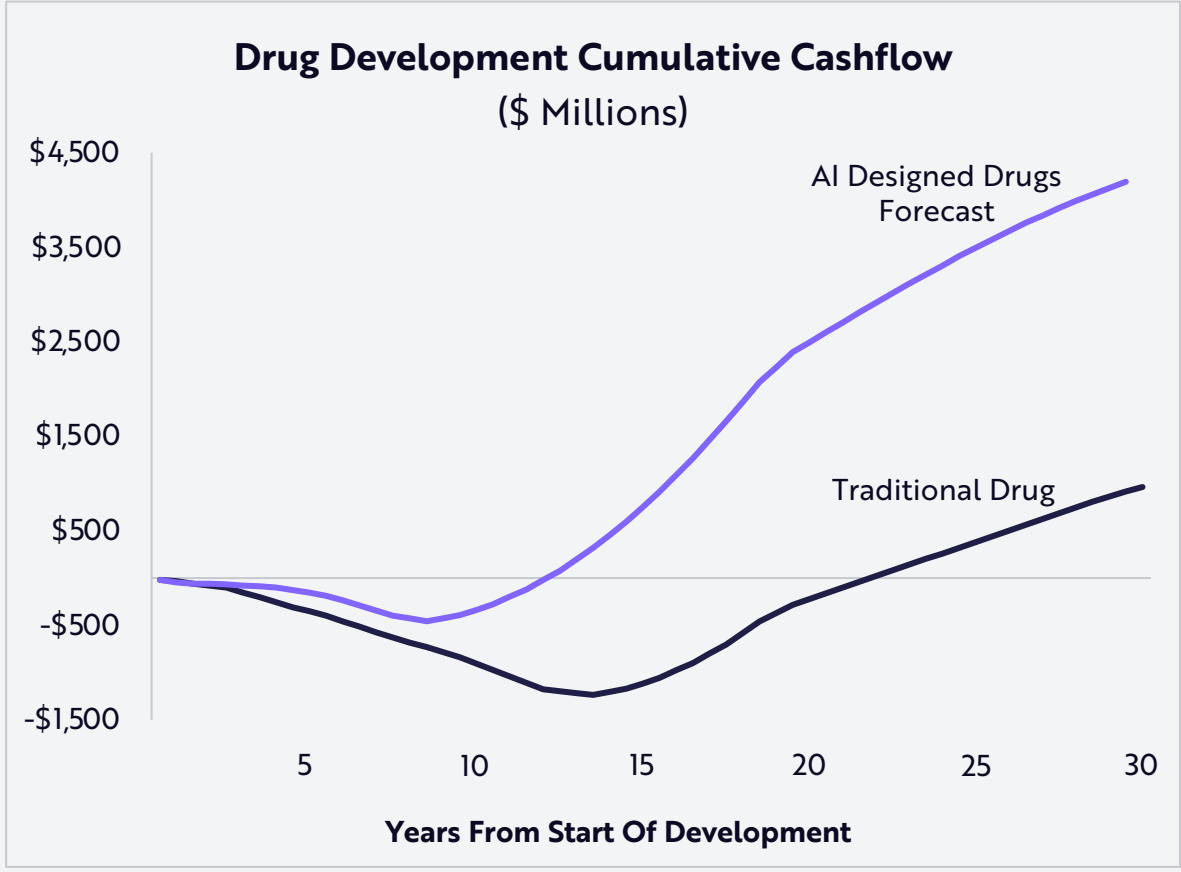


Note: 10% discount rate. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Drug Development Cost Efficiencies Could Boost Cash Flow Significantly

The value of AI-driven drug development should compound thanks to lower costs, an acceleration in time-to-market, and a longer timeline of patent-protected revenue. Over a 30-year period, the cumulative cashflow for the average AI-designed drug could reach **$4 billion**, compared to less than $1 billion for traditional drug models. Even before a traditional drug breaks even, an AI-developed drug could generate $2.5 billion in cashflow.

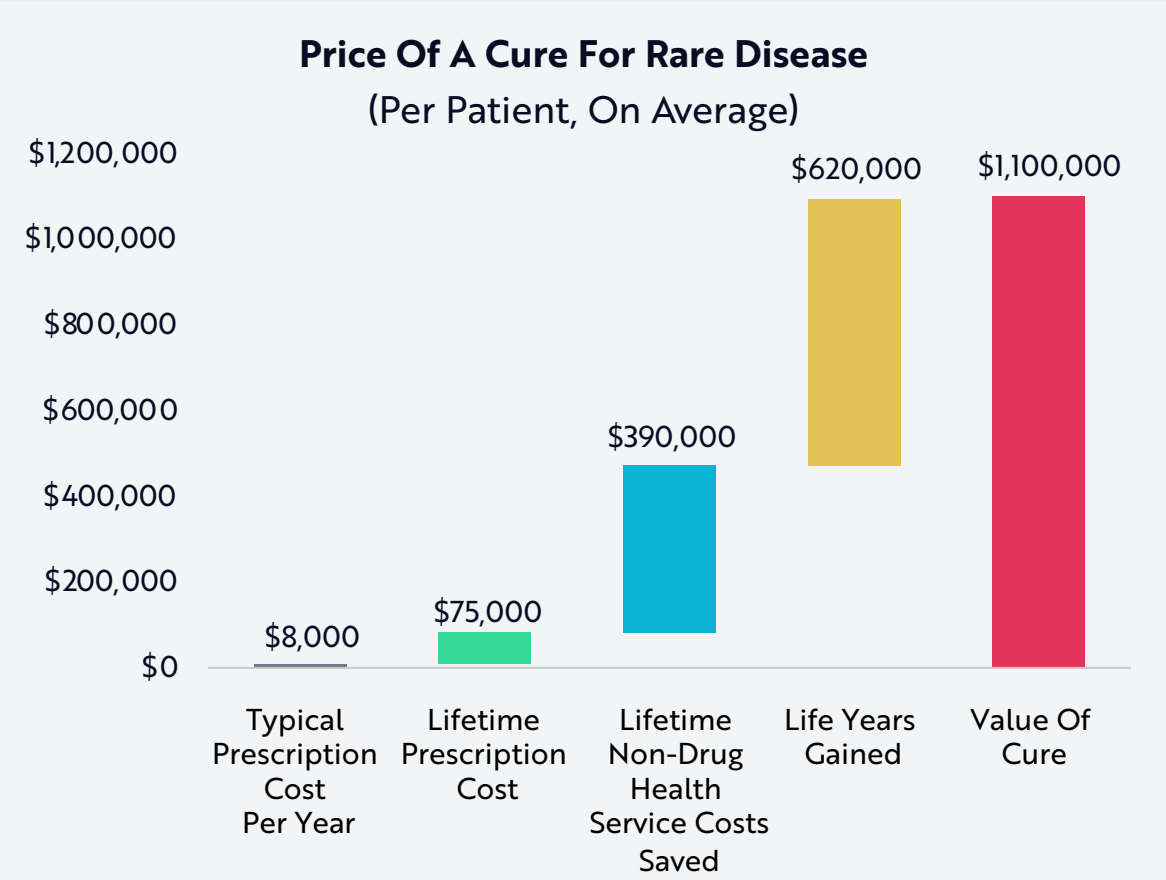


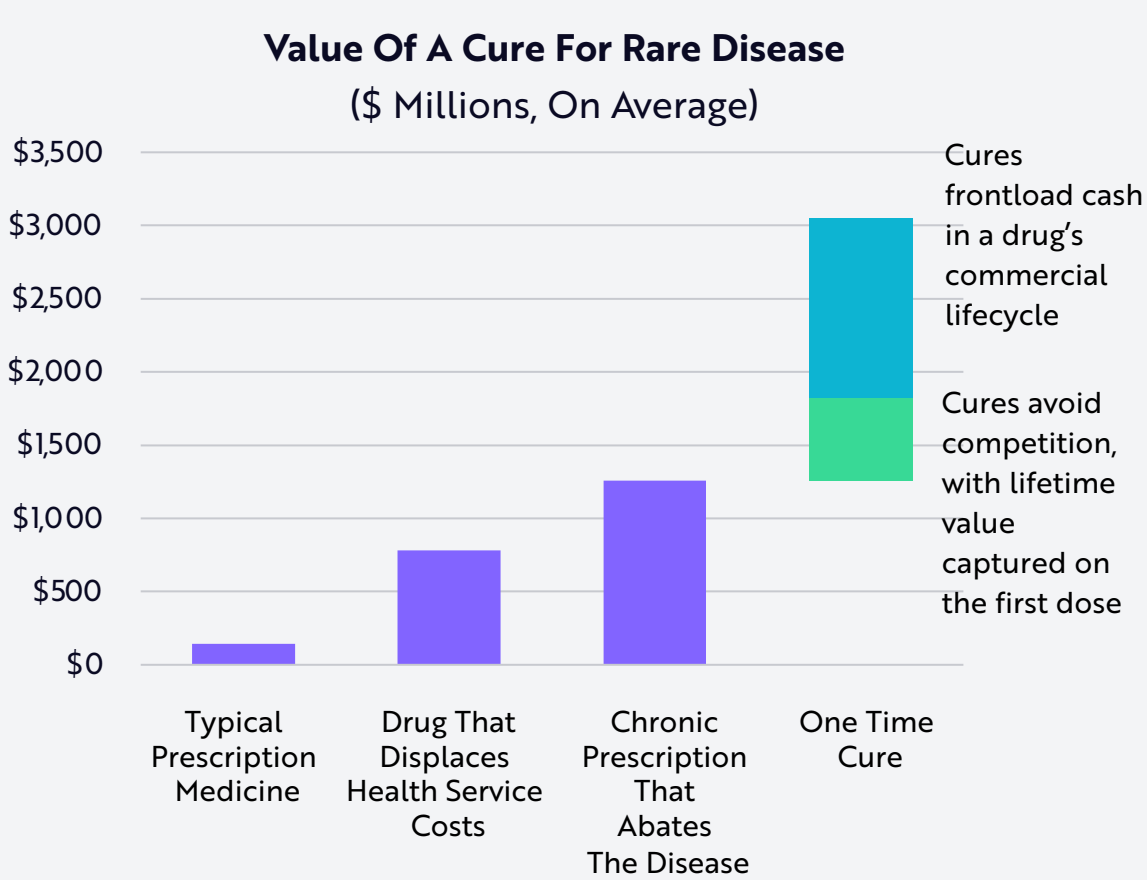


Note: 10% discount rate, 2024 dollars. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Biological Cures Could Become Quite Valuable

Cures for diseases can command much higher prices than traditional treatments. The average price of a cure today exceeds $1 million, nearly 15x the the lifetime prescription cost that would be necessary to manage the disease. Capturing revenue upfront and addressing much of the patient population well before patent expiration suggests that cures could become more valuable—potentially 20x more valuable—than a typical drug and 2.4x more valuable than a chronic prescription that abates the disease.



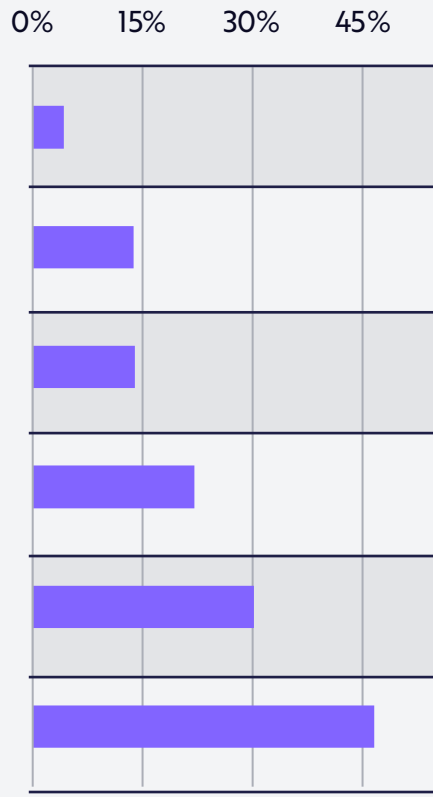


Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Cures And Accelerated Development Should Transform The Economics Of Drug Development

The combination of AI-accelerated drug development and the value of cures for disease could boost returns on research and development (R&D) and improve the value of pre-clinical pipeline assets materially. According to our research, an AI-accelerated cure in the first phase of human testing could be worth more than $2 billion. Traditional assets typically pay back only the cost of capital for Phase 1 pipelines.

Drug Development Return On Invested Capital



Value Of Assets at Different Clinical Phases ($ Millions)

	At inception	Preclinical	Phase I	Phase II	Phase III	Commercial	Representative Companies*
Traditional Drug, Traditional Development	(300)	(200)	**0**	200	500	1,000	Industry Average
Cure, Traditional Development	200	600	1,000	1,400	2,000	3,000	Beam, Crispr Tx, Editas, Intellia, Prime
Traditional Drug, AI Speedup, Traditional Fail Rate	300	500	600	800	1,200	1,800	Abcellera , Absci, Generate Bio, Isomorphic Lab, Lantern Pharma, Recursion, Relation, Roivant Sciences, Xtalpi
Traditional Drug, AI Speedup And AI Success Rate	600	700	900	1,000	1,300	1,800	
Cure, AI Speedup, Traditional Fail Rate	1,500	1,800	**2,300**	2,500	3,400	4,400	In Development
Cure, AI Speedup And AI Success Rate	1,800	2,000	**2,500**	2,700	3,500	4,400	

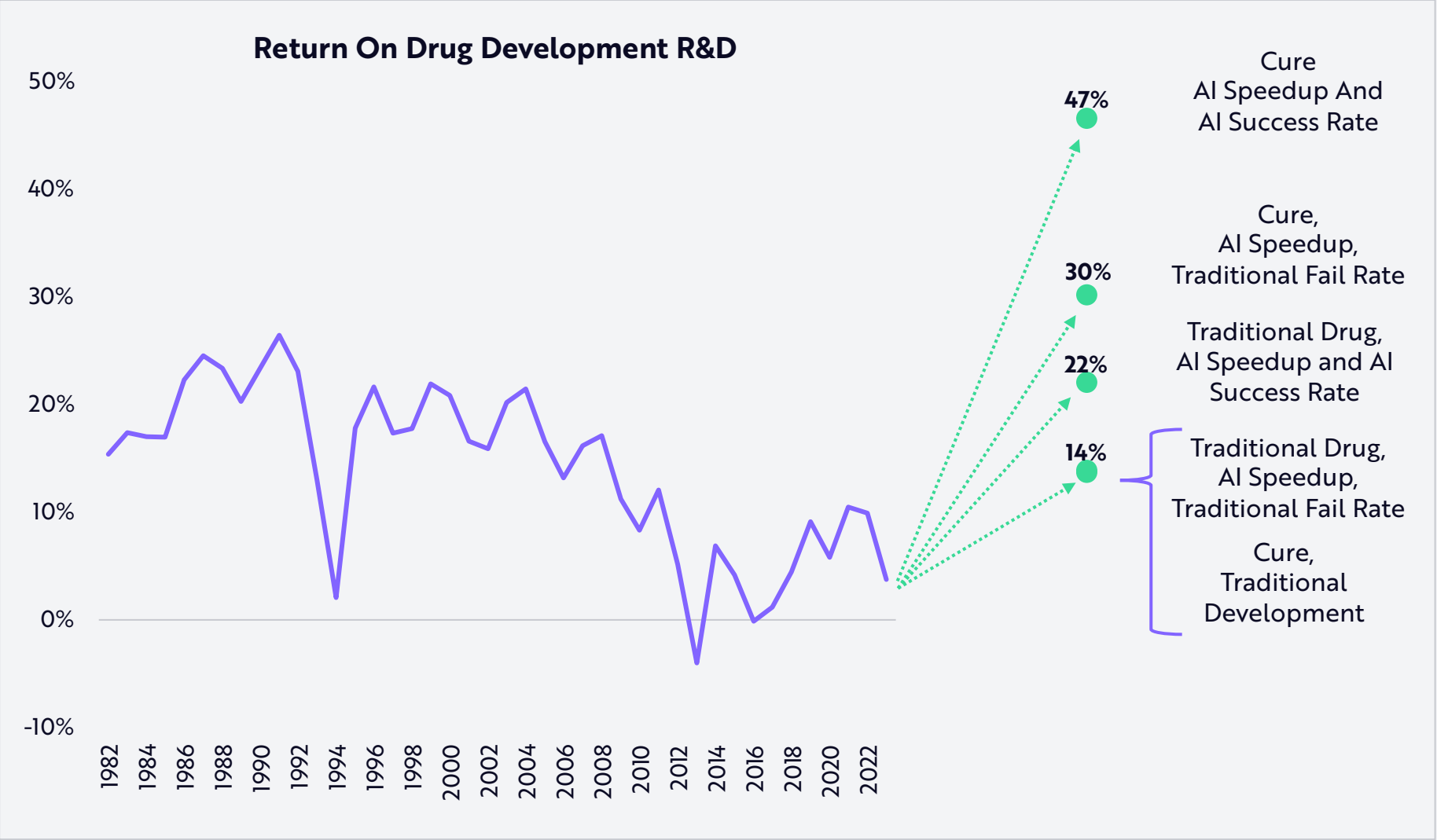
Note: 10% discount rate. *Companies pursuing this strategy for drug development, though this does not imply that every asset the company has at that particular stage is worth that amount or that company return on R&D dollars will meet the modeled value. The information provided should not be used as the basis for any investment decision, and it should not be assumed that an investment any of the companies mentioned was or will be profitable. Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

AI-Driven Drug Development And Cures For Disease Could Reverse A Multi-Decade Decay In Pharma/Biotech Returns

As AI and other technologies impact the drug development pipeline, industry-wide returns should turn around.

Meanwhile, many development projects in place today could become sunk costs as more nimble AI drug development platforms beat them to market with cures that eliminate disease.

A bifurcation could grow between the returns generated by AI driven, cure-seeking firms and those traditional pharma/biotech companies that do not adapt.



Source: ARK Investment Management LLC, 2025. This ARK analysis draws on a range of external data sources as of December 31, 2024, which may be provided upon request. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results. Forecasts are inherently limited and cannot be relied upon.

Works Cited

Abolhasani, M. and E. Kumacheva. 2023. "The Rise of Self-driving Labs in Chemical and Materials Sciences." Nature Synthesis.

American Automobile Association. 2050. "Your Driving Costs."

American Automobile Association. 2024. "How Much Does it Really Cost to Own a New Car?"

Artemis Terminal. 2024.

Bitcoin Treasuries. 2024.

Borfitz, D. 2024. "UK Biobank Pivoting to Platform-Only Model For Big Data Sharing." Bio IT World.

Bunne, C. et al. 2024. "How to Build the Virtual Cell with Artificial Intelligence: Priorities and opportunities." Cell.

BusinessWire. 2024. "Ultima Announces UG 100™ and Reveals Disruptive Cost and Accuracy Profile to Enable the Era of the $100 Genome and Beyond."

Calma, J. 2024. "Google Orders Small Nuclear Reactors for its Data Centers." Financial Times.

Carlson, R. 2022. "DNA Cost and Productivity Data, aka 'Carlson Curves.'" Synthesis.

Capital IQ Pro. 2024.

CASP13. 2019. "13th Community Wide Experiment on the Critical Assessment of Techniques for Protein Structure Prediction."

Circle. 2024.

Cleveland, C. 2023. "United States Electricity History in Four Charts." Boston University Institute for Global sustainability.

Clifford, J. 2024. "Boost Multi-Omics Analysis with GPU-Acceleration and Generative AI." Nvidia Developer.

CoinGecko. 2024.

Dediu, H. 2017. "Share of United States Households Using Specific Technologies." Our World in Data.

DeLong, B. 1998. "Estimating World GDP, One Million B.C. — Present." Brad De Long's homepage. Department of Economics, University of California, Berkeley.

de Selding, P.B. "Orbital ATK Believes in Satellite Servicing, but Not Rocket Reusability." Space News.

Ding, J. et al. 2020. "Systematic Comparison of Single-cell and Single-nucleus RNA-sequencing methods." Nature Biotechnology.

Dune Analytics. 2024.

Electric Capital. 2024. "Developer Report 2023."

EV Volumes. 2025.

Foust, J. 2014. "Reusability and Other Issues Facing the Launch Industry." The Space Review.
Franchisee Resource Center. 2021. "Fast Casual Industry Analysis 2020 - Cost & Trends." Franchise Help.

Glassnode. 2024.

Goddard, K. et al. 2024. "Estimation of Cancer Deaths Averted From Prevention, Screening, and Treatment Efforts, 1975-2020." JAMA Oncology.

Goddard, T. 2024. "AlphaFold Performance: Molecule Size, Speed, Memory, and GPU." UCSF Resource for Biocomputing, Visualization, and Informatics.

Gorzynski, J. et al. 2022. "Ultrarapid Nanopore Genome Sequencing in a Critical Care Setting." The New England Journal of Medicine.

Gumber, A. et al. 2024. "A Global Analysis of Renewable Energy Project Commissioning Timelines." Applied Energy.

Hartig, K. 1998. "TUNING IN: Communications Technologies Historically Have Had Broad Appeal for Consumers," The Wall Street Journal.

Jiminez, C. et al. 2024. "SWE-bench: Can Language Models Resolve Real-World GitHub Issues?" arXiv.

Jovic, D. et al. 2022. "Single-cell RNA Sequencing Technologies and Applications: A Brief Overview." Clinical and Translational Medicine.

Jumper, J. et al. 2021. "Highly Accurate Protein Structure Prediction with AlphaFold." Nature.

Jurvetson, Steve 2024. "The Moore's Law Update." X.

Klotz, I. 2020. "Economics Of Rocket Reuse Still Up In The Air." Aviation Week.

Kurzweil, R. 2006. "The Singularity Is Near: When Humans Transcend Biology." Duckworth.

Lawrence Berkeley National Laboratory. 2024. "Energy Markets & Policy."

Liu, L. et al. 2024. "Technical Report of HelixFold3 for Biomolecular Structure Prediction." arXiv.

Lovering, J. et al. 2016. "Historical Construction Costs of Global Nuclear Power Reactors." Energy Policy.

Luskin, M. et al. 2018. "Targeting Minimal Residual Disease: A Path to Cure?" Nature Reviews Cancer.

Mannucci, A. and A. Goel. 2024. "Stool and Blood Biomarkers for Colorectal Cancer Management: An Update on Screening and Disease monitoring." Molecular Cancer.

Martin, H.G. et al. 2023. "Perspectives for Self-driving Labs in Synthetic Biology." Current Opinion in Biotechnology.

McCormick, M. and J. Smith. 2025. "Microsoft in Deal for Three Mile Island Nuclear Power to Meet AI Demand." Financial Times.

Miller, N.A. et al. 2015. "A 26-hour System of Highly Sensitive Whole Genome Sequencing for Emergency Management of Genetic Diseases." Genome Medicine.

Model T Ford Forum. 2010. "How Many Miles Can a T Drive Down, Before it Needs a Rebuild?"

Morningstar Direct. 2024.

National Renewable Energy Laboratory (NREL). 2024. "Solar Resource Data."

NewSpace Index. 2025. "Small Satellite Launchers."

OpenAI. 2024.

OpenPhilanthropy. 2025.

Philipson, T. et al. 2023. "The Aggregate Value of Cancer Screenings in the United States: Full Potential Value and Value Considering Adherence." BMC Health Services Research.

Pitchbook. 2024.

Recursion. 2024. "Recursion Unveils LOWE Drug Discovery Software at the J.P. Morgan Healthcare Conference."

Rood, J. et al. 2024. "Toward a Foundation Model of Causal Cell and Tissue Biology with a Perturbation Cell and Tissue Atlas." Cell.

Rwa.xyz. 2024

Saunders, C.J. et al. 2021. "Rapid Whole-genome Sequencing for Genetic Disease Diagnosis in Neonatal Intensive Care Units." Science and Translational Medicine.

Shaikhnag, A. 2024. "Westinghouse Facilitates Improved Nuclear Power with Its 3D Printed Nozzles." 3D printing Industry.

Sidoti, O. et al. 2024. "Mobile Fact Sheet." Pew Research Center.

Small Modular Reactor (SMR) Global Tracker. 2024.

Smil, V. 2000. "Energy in the Twentieth Century: Resources, Conversions, Costs, Uses, and Consequences." Annual Review of Energy Environment.

Smyth, J. 2024 "Amazon Buys Stake in Nuclear Energy Developer in Push to Power Data Centres." Financial Times.

SpaceX. 2024. "STARSHIPS ARE MEANT TO FLY—2024 PROGRESS REPORT."

Tang, F. et al. 2009. "mRNA-Seq Whole-transcriptome Analysis of a Single Cell." Nature Methods.

Tether. 2024.

The Block. 2024.

Thng, D. et al. 2024. "A Functional Personalised Oncology Approach Against Metastatic Colorectal Cancer in Matched Patient Derived Organoids." NPJ Precision Oncology.

TicData Treasury. 2024. "Table 5: Major Foreign Holders of Treasury Securities."

Token Terminal. 2024.

Tong, L. et al. 2024. "Patient-derived Organoids in Precision Cancer Medicine." MED.

TradingView. 2024.

Tyrer-Jones, A. 2025. "3D Printer Nuclear Submarine Components from AML3D Delivered to US Navy." 3D PRINTING INDUSTRY.

Ulvog, J. 2012. "Travel Cost by Stagecoach in 1870s – Part One." Outrun Change.
UK Biobank. 2024.

U.S. Department of Agriculture. 2025. "Food Expenditure Series."

U.S. Department of Agriculture. 2025. "Farm Labor."

U.S. CENSUS BUREAU. 2023. "2021 SUSB Annual Data Tables by Establishment Industry."

Visa OnChain Analytics. 2024.

Wallstreet Zen. 2024.

Wan, J. et al. 2017. "Liquid Biopsies Come of Age: Towards Implementation of Circulating Tumour DNA." Nature Reviews Cancer.

Winton, B. 2019. "Moore's Law Isn't Dead: It's Wrong—Long Live Wright's Law." ARK Investment Management LLC.

World Nuclear Association. 2024. "Small Modular Reactor Global Tracker."

Worldpay Inc. 2018. "2018 Global Payments Report."

Worldpay Inc. 2019. "2019 Global Payments Report."

Worldpay Inc. 2020. "2020 Global Payments Report."

Worldpay Inc. 2021. "2021 Global Payments Report."

Worldpay Inc. 2022. "2022 Global Payments Report."

Worldpay Inc. 2023. "2023 Global Payments Report."

World Gold Council. 2024. "Gold ETFs, holdings and flows."

World Nuclear Association. 2024. "United State of America Vallecitos Permanent Shutdown."

Zhou, Z. et al. 2023. "Harnessing 3D In Vitro Systems to Model Immune Responses to Solid Tumours: A Step Towards Improving and Creating Personalized Immunotherapies." Nature Reviews Immunology.

ZipRecruiter. 2024.

For more research on disruptive innovation visit www.ark-invest.com

Please note, companies that ARK believes are capitalizing on disruptive innovation and developing technologies to displace older technologies or create new markets may not in fact do so and/or may face political or legal attacks from competitors, industry groups, or local and national governments.

ARK aims to educate investors and to size the potential opportunity of Disruptive Innovation, noting that risks and uncertainties may impact our projections and research models. Investors should use the content presented for informational purposes only, and be aware of market risk, disruptive innovation risk, regulatory risk, and risks related to Deep Learning, Digital Wallets, Battery Technology, Autonomous Technologies, Drones, DNA Sequencing, CRISPR, Robotics, 3D Printing, Bitcoin, Blockchain Technology, etc. Cryptocurrency Risk. Cryptocurrencies (also referred to as "virtual currencies" and "digital currencies") are digital assets designed to act as a medium of exchange. Cryptocurrency is an emerging asset class. There are thousands of cryptocurrencies, the most well-known of which is bitcoin. Cryptocurrency generally operates without central authority (such as a bank) and is not backed by any government. Cryptocurrency is not legal tender. Federal, state and/or foreign governments may restrict the use and exchange of cryptocurrency, and regulation in the U.S. is still developing. The market price of bitcoin and other cryptocurrencies have been subject to extreme fluctuations. Similar to fiat currencies (i.e., a currency that is backed by a central bank or a national, supra-national or quasi-national organization), cryptocurrencies are susceptible to theft, loss and destruction. Cryptocurrency exchanges and other trading venues on which cryptocurrencies trade are relatively new and, in most cases, largely unregulated and may therefore be more exposed to fraud and failure than established, regulated exchanges for securities, derivatives and other currencies. Cryptocurrency exchanges may stop operating or permanently shut down due to fraud, technical glitches, hackers or malware, which may also affect the price of cryptocurrencies. Cryptocurrency Tax Risk. Many significant aspects of the U.S. federal income tax treatment of investments in bitcoin and other cryptocurrencies are uncertain and still evolving.

The content of this presentation is for informational purposes only and is subject to change without notice. This presentation does not constitute, either explicitly or implicitly, any provision of services or products by ARK and investors are encouraged to consult counsel and/or other investment professionals as to whether a particular investment management service is suitable for their investment needs. All statements made regarding companies or securities are strictly beliefs and points of view held by ARK and are not endorsements by ARK of any company or security or recommendations by ARK to buy, sell or hold any security. Historical results are not indications of future results. Certain of the statements contained in this presentation may be statements of future expectations and other forward-looking statements that are based on ARK's current views and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in such statements. The matters discussed in this presentation may also involve risks and uncertainties described from time to time in ARK's filings with the U.S. Securities and Exchange Commission. ARK assumes no obligation to update any forward-looking information contained in this presentation. Certain information was obtained from sources that ARK believes to be reliable; however, ARK does not guarantee the accuracy or completeness of any information obtained from any third party. ARK and its clients as well as its related persons may (but do not necessarily) have financial interests in securities or issuers that are discussed.

ARK Investment Management LLC