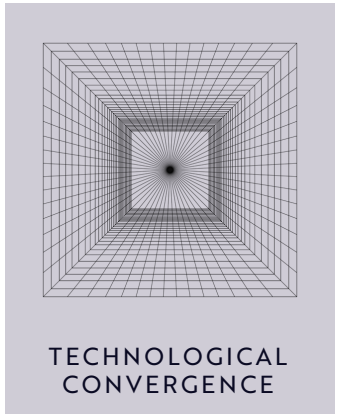
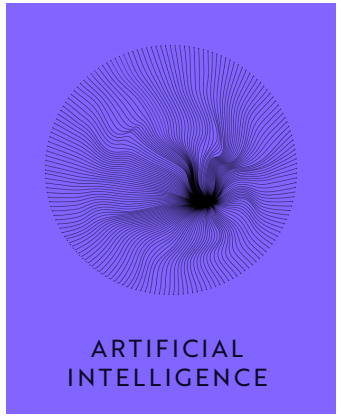
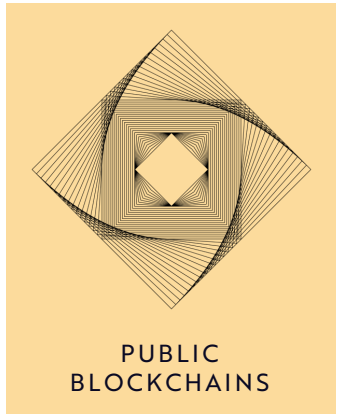
BIG IDEAS 2023

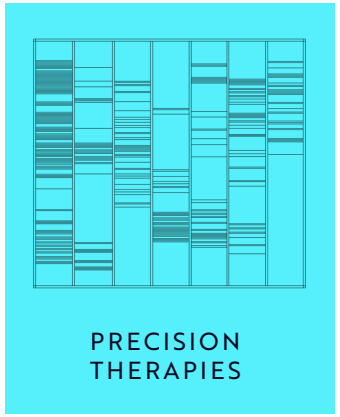
ARK INVEST

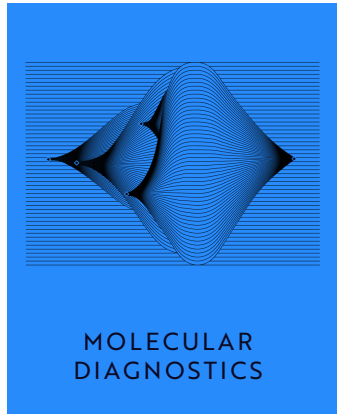
January 31, 2023 ARK Investment Management LLC www.ark-invest.com

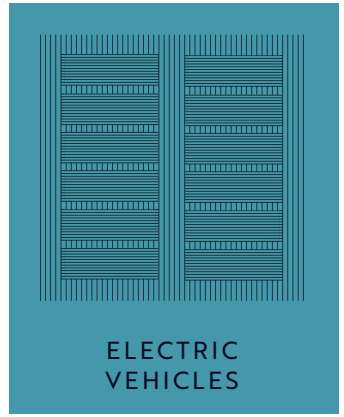


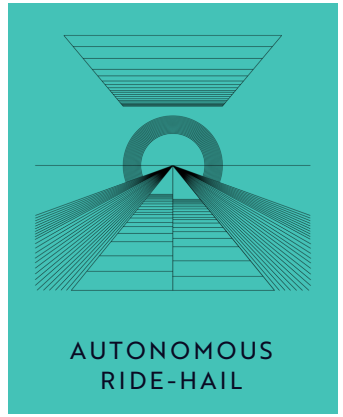


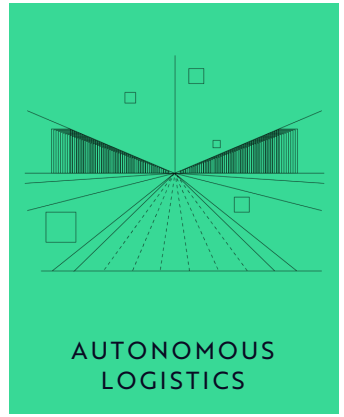


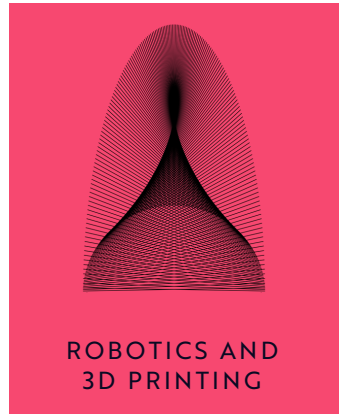


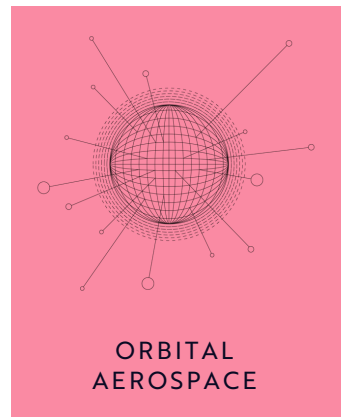










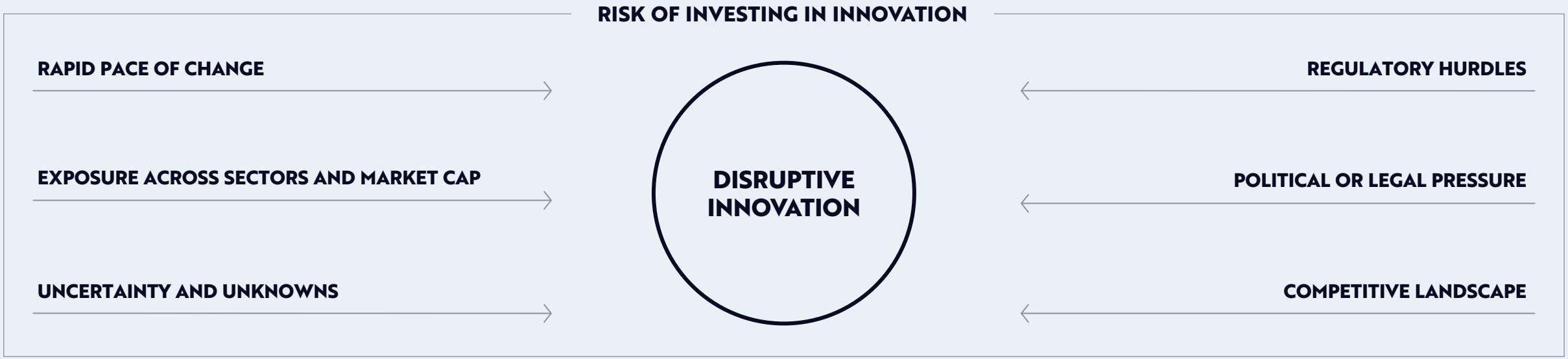


For Informational Purposes Only

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.



→ **Aim for a cross-sector understanding of technology and combine top-down and bottom-up research.**

→ **Aim to understand the regulatory, market, sector, and company risks. (See Disclosure Page)**

Sources: ARK Investment Management LLC, 2023.

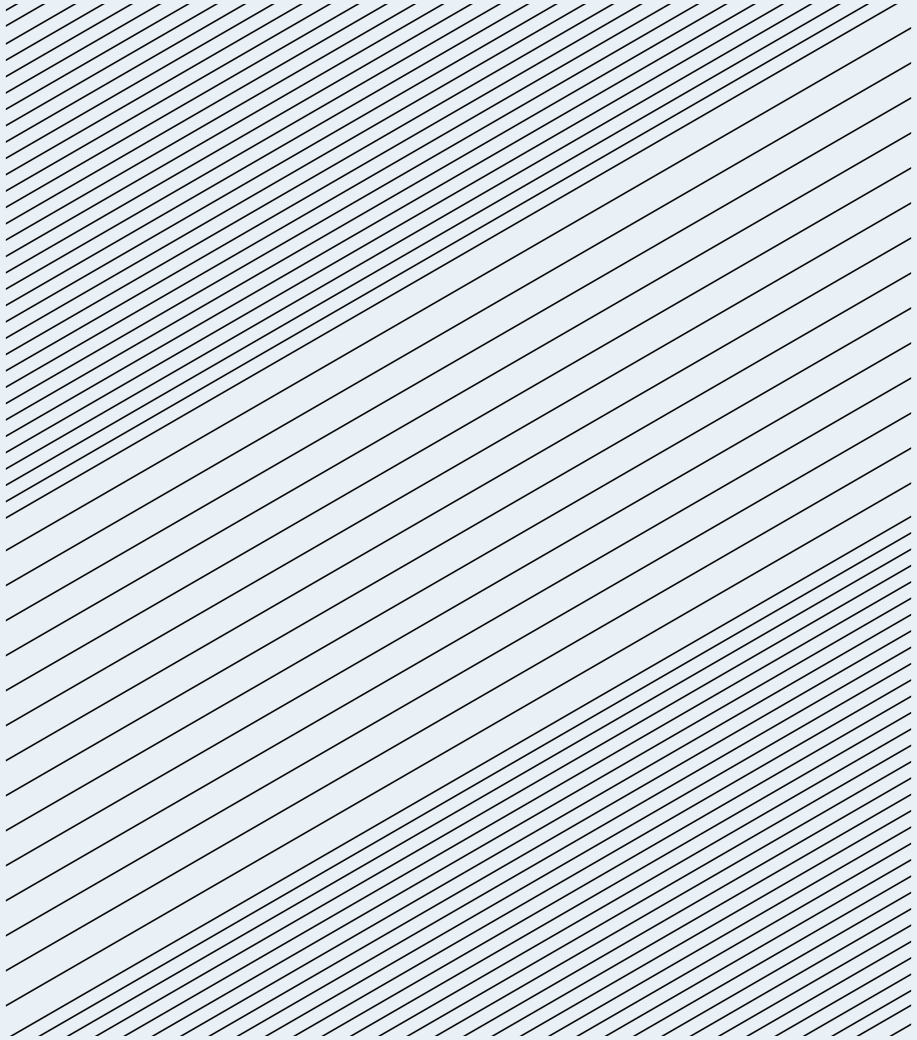
Big Ideas 2023

Innovation is Taking Off

ARK aims to deliver long-term capital appreciation by investing in the leaders, enablers, and beneficiaries of disruptive innovation. We believe every investor should have a strategic allocation to innovation, not only to access potential exponential growth opportunities typically absent from broad-based indices, but also to hedge against the increasing risk that incumbents will be disrupted.

To enlighten investors on the long-term impact of innovation, we began publishing Big Ideas in 2017. This annual research report seeks to highlight the technological breakthroughs evolving today and creating the potential for super-exponential growth tomorrow.

We believe that innovation is taking off now, corroborating our original research and boosting our confidence that ARK's strategies are on the right side of change. We hope you enjoy Big Ideas 2023!



Technological Convergence

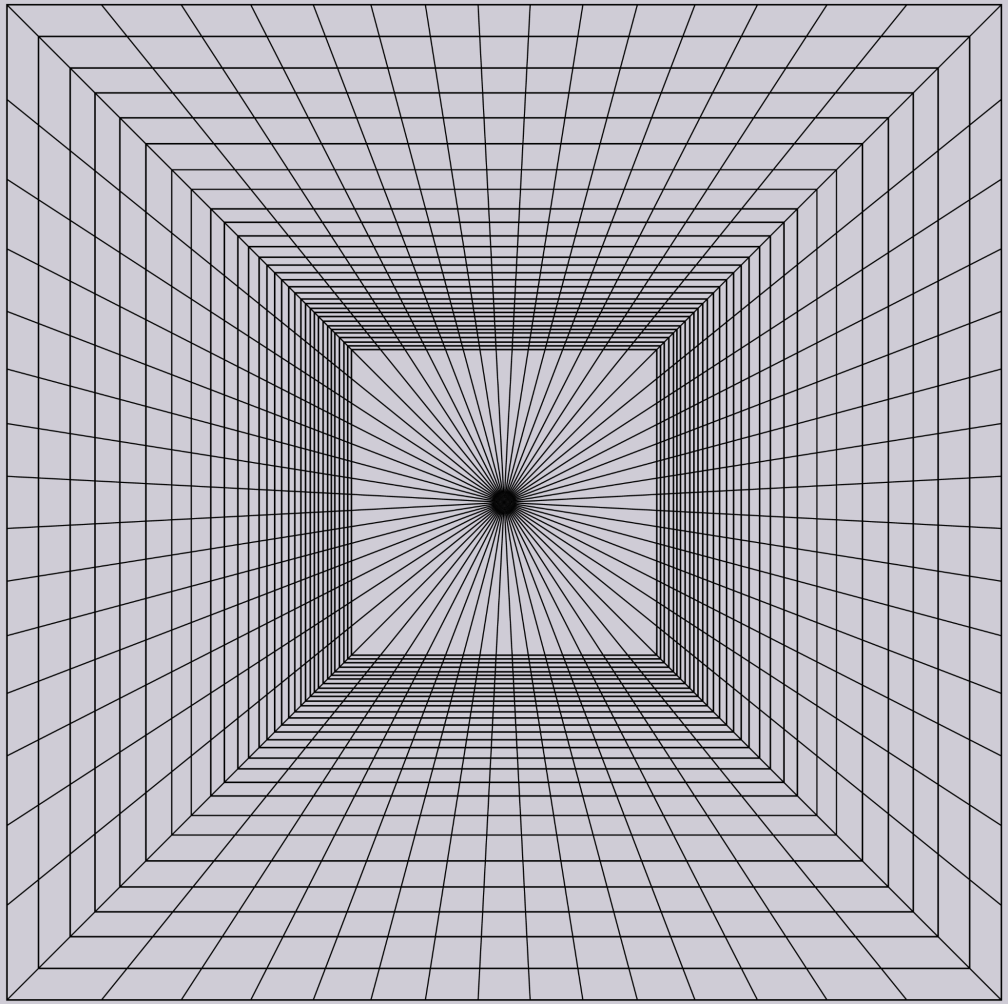
Creating The Potential For Super-Exponential Growth

According to ARK's research, five innovation platforms are converging to create unprecedented growth trajectories.

Artificial Intelligence is the most important catalyst, its velocity cascading through all other technologies.

The market value of disruptive innovation platforms could scale 40% at an annual rate during this business cycle, from $13 trillion today to $200 trillion by 2030.

In 2030, the market value associated with disruptive innovation could account for the majority of the global equity market capitalization.



Research by Brett Winton, Chief Futurist & ARK Venture Investment Committee Member

Sources: ARK Investment Management LLC, 2023. As of year end 2022. Numbers are rounded. ARK estimates that $13.4 trillion of market value is attributable to the disruptive technologies it covers today. By 2030 ARK estimates that market value attributable to these technologies will exceed $206 trillion. Market value includes public companies, private companies, cryptocurrencies and smart contract protocols. Forecasts are inherently limited and cannot be relied upon. 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.

Five Converging Innovation Platforms Define This Technological Era

Public Blockchains

Upon large-scale adoption, all money and contracts will 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 contract execution costs. 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 themselves may be called into question.

Artificial Intelligence

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 the introduction of the internet and create 10s 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 pervade 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.

Multiomic Sequencing

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. Multiomic data should feed into novel **Precision Therapies** using emerging gene editing techniques that target and cure rare diseases and chronic conditions. Multiomics should unlock entirely new **Programmable Biology** capabilities, including the design and synthesis of novel biological constructs with applications across industries, particularly agriculture and food production.

Energy Storage

Declining costs of **Advanced Battery Technology** should cause an explosion in form factors, enabling **Autonomous Mobility** systems that collapse the cost of getting people and things from place to place. Electric drivetrain cost declines should unlock micro-mobility and aerial systems, including flying taxis, enabling business models that transform the landscape of 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 should cause a transformation in energy, substituting electricity for liquid fuel and pushing generation infrastructure towards the edge of the network.

Robotics

Catalyzed by artificial intelligence, **Adaptive Robots** can operate alongside humans and navigate legacy infrastructure, changing the way products are made and sold. **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. A nascent innovation platform, robotics could collapse the cost of distance with hypersonic travel, the cost of manufacturing complexity with 3D printers, and the cost of production with AI-guided robots.

Node size: Log prospective 2030 Market Value

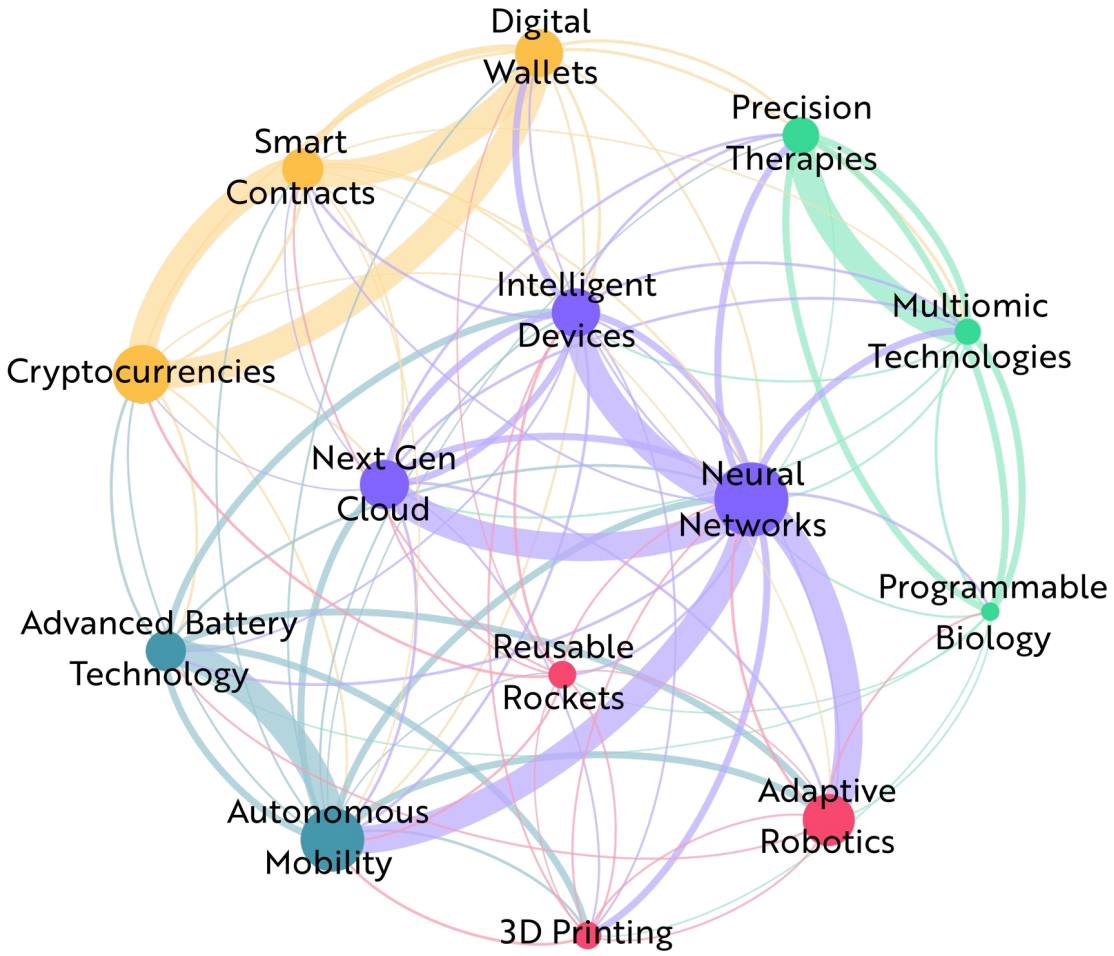
Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Convergence

The converging innovation platforms involve 14 investable technologies undergoing steep cost declines, impacting multiple sectors, and serving as launching pads for more innovation.

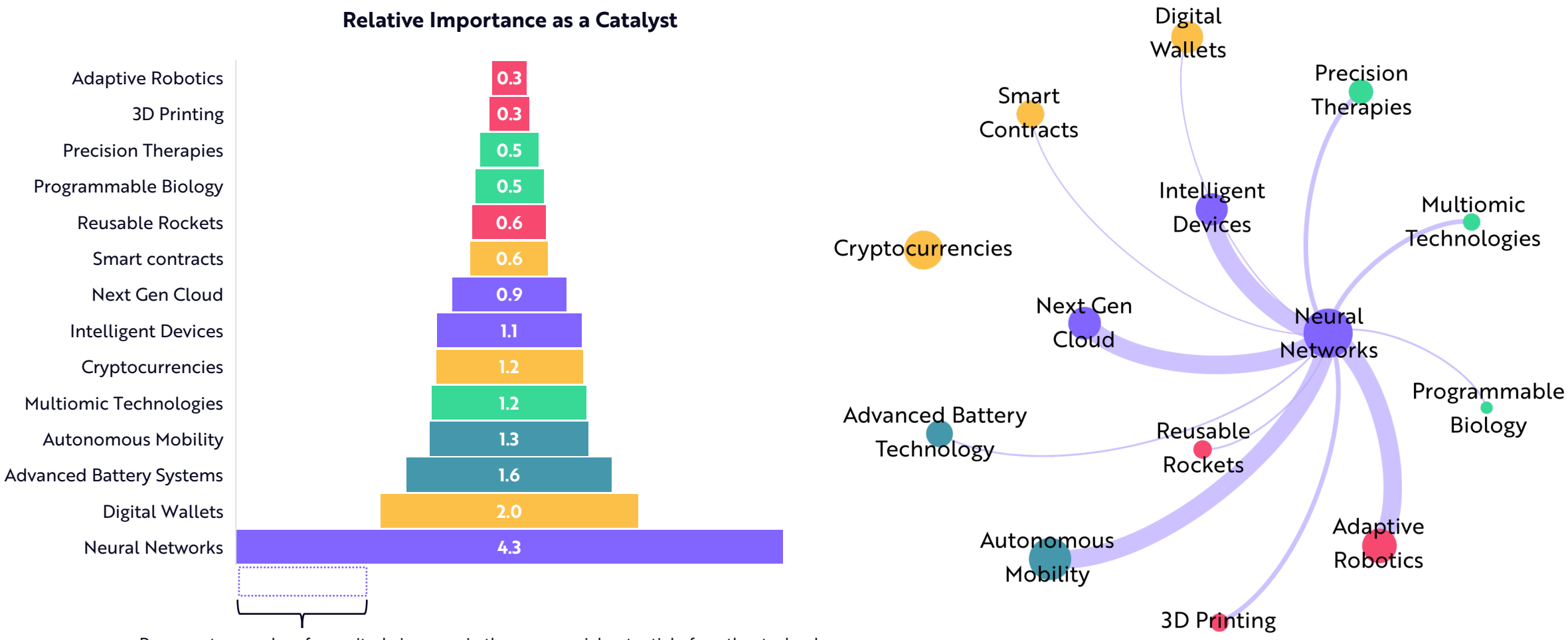
ARK's Convergence Scoring Framework And Network Graph:

- Technology scores are a function of their potential to generate super-exponential growth as they catalyze other technologies.
- The thickest lines correspond to expectations for an order of magnitude increase in another technology's potential.
- Edges are directional. Neural networks should catalyze autonomous mobility (thick purple line), for example, and the data generated by autonomous mobility systems should improve neural network capability (thin teal line).
- Node size corresponds to estimate of 2030 enterprise value attributable to the technology on a log scale.
- The innovation platform taxonomy emerges organically from this network graph.



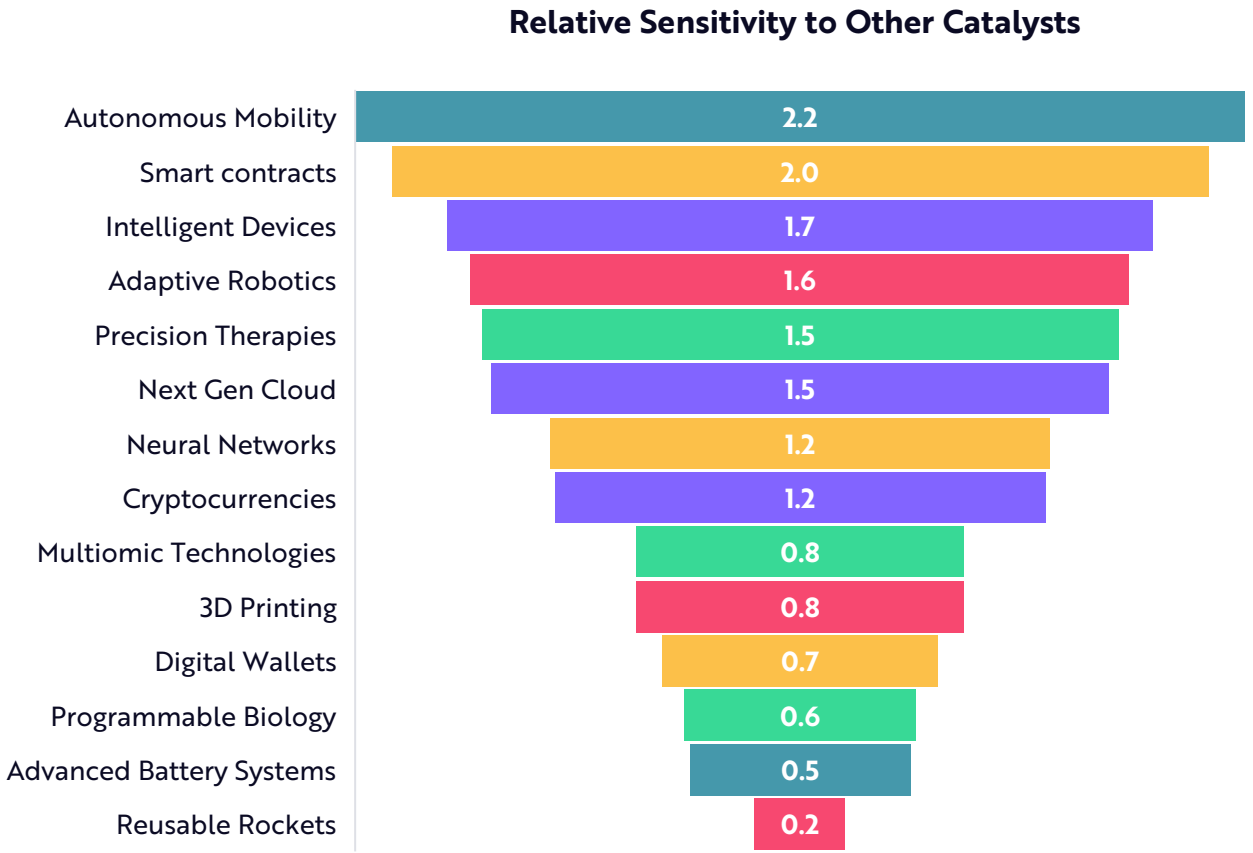
Node size: Log prospective 2030 Market Capitalization
Edge size:: Estimated catalyzing impact
Edge color coded to the catalyzing technology

Neural Networks Are The Most Important Catalyst

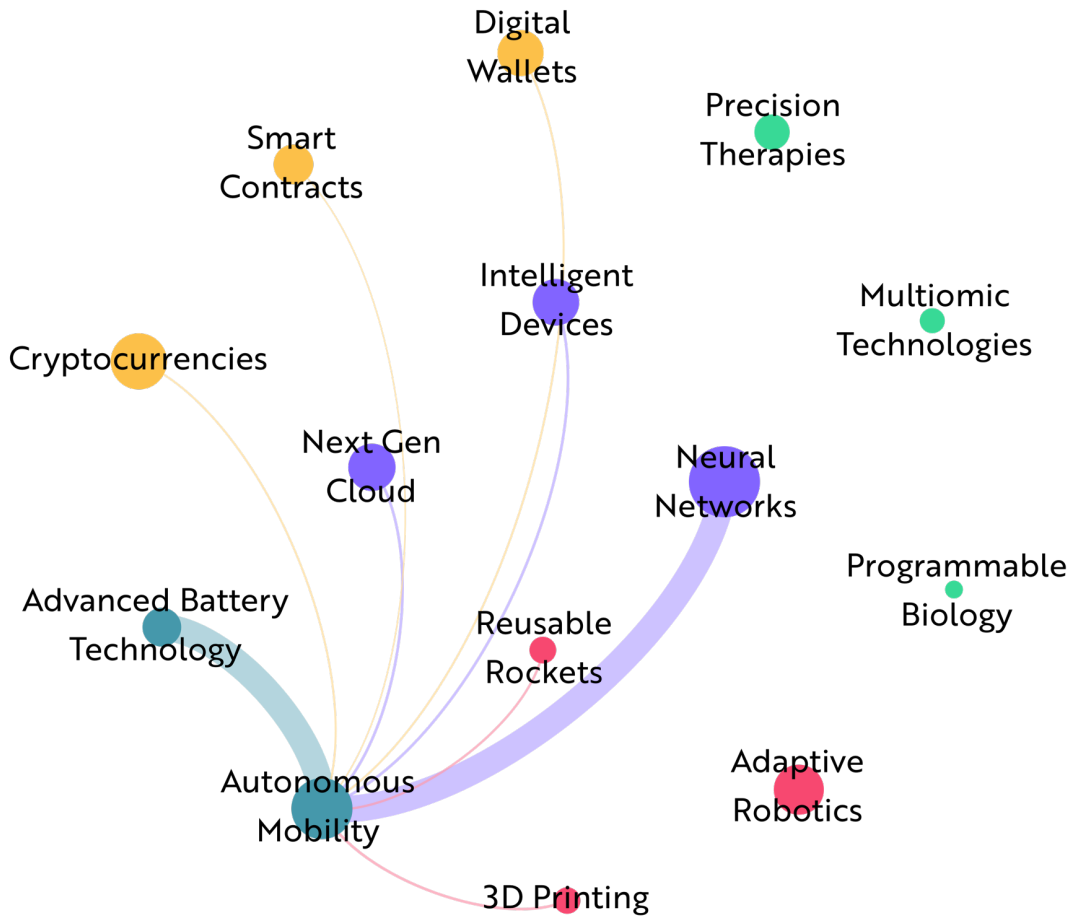


Sources: ARK Investment Management LLC, 2023. ARK's convergence scoring framework measures the scale of impact that advances in one technology are likely to have on the potential market value of another. "Relative importance as a catalyst" measures the sum of convergence scores for each technology. Scoring is tuned such that a score of 1 corresponds to the potential to increase another technology's market value by an order of magnitude. Scores are subject to ARK's views and research and are subject to change. Forecasts are inherently limited and cannot be relied upon. 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.

Autonomous Mobility Epitomizes The Convergence Among Technologies



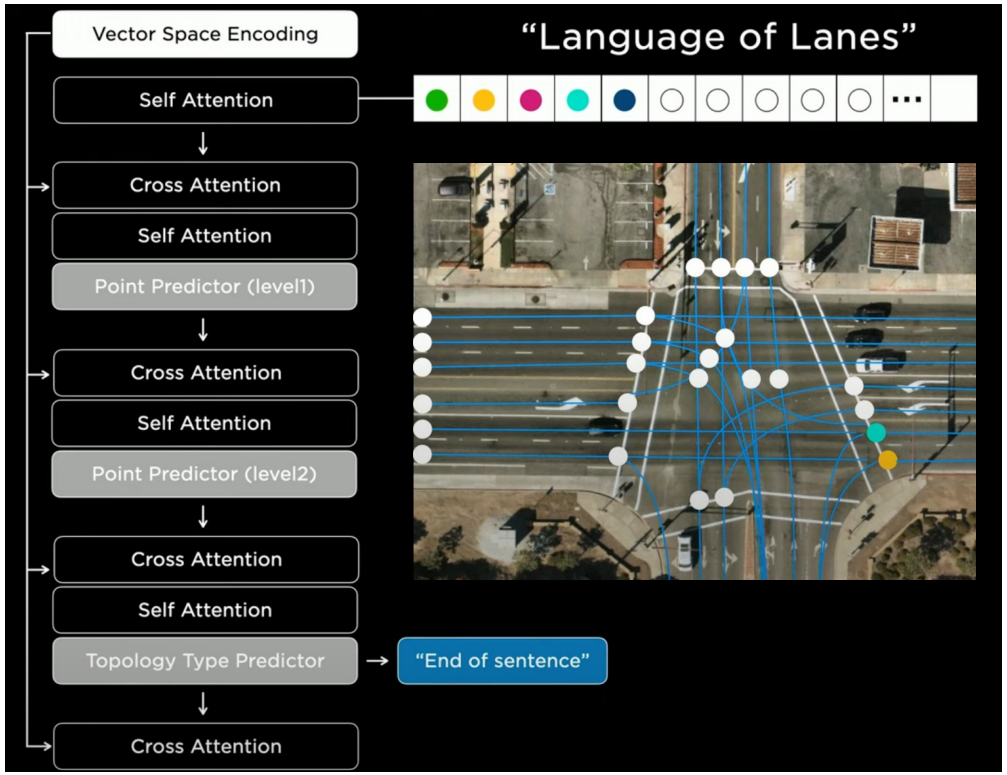
Log of potential increase in addressable market based on other technological advances.



Sources: ARK Investment Management LLC, 2023. ARK's convergence scoring framework measures the scale of impact that advances in one technology are likely to have on the potential market value of another. "Relative sensitivity to other catalysts" measures the inbound sum of convergence scores for each technology. Scoring is tuned such that a score of 1 corresponds to an order of magnitude potential increase in the technology's market value. Scores are subject to ARK's views and research and are subject to change. Forecasts are inherently limited and cannot be relied upon. 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.

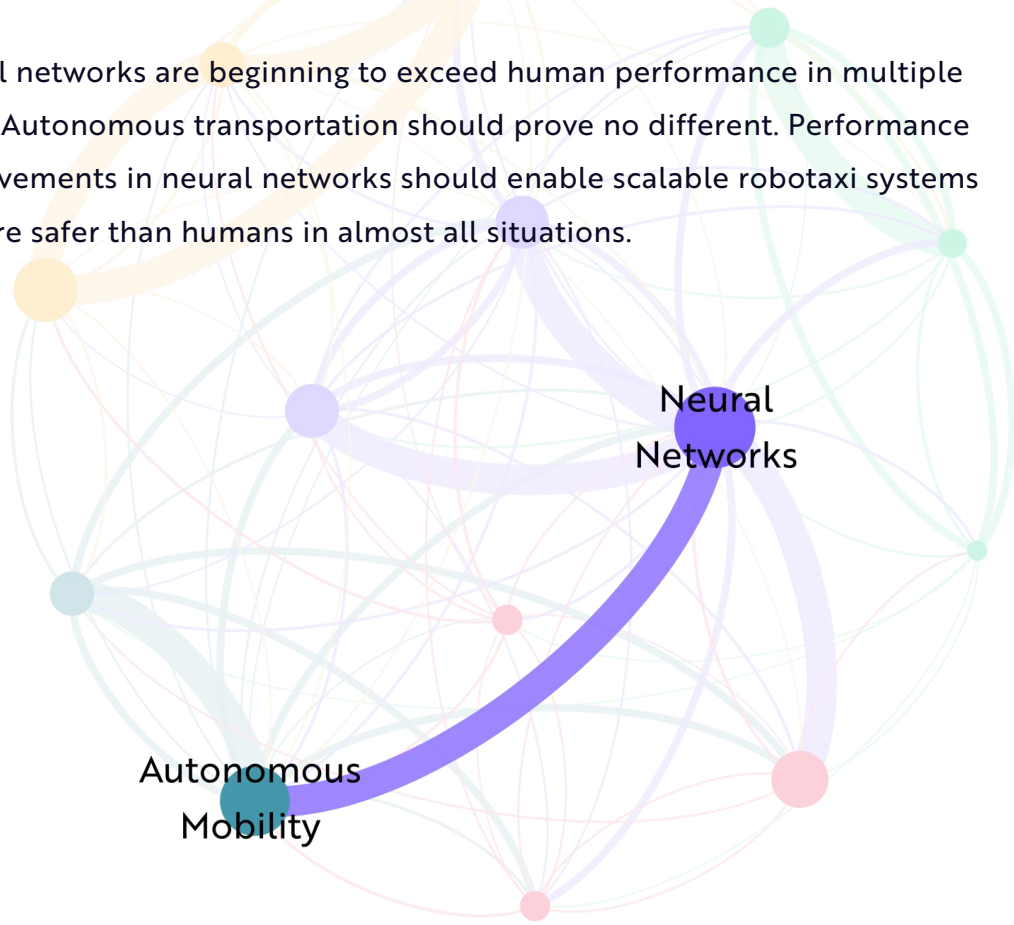
AI Chatbots Will "Drive" Robotaxis

Tesla applies transformer neural networks—introduced as a solution for language translation—to help its vehicles understand complicated intersections and drivable pathways.



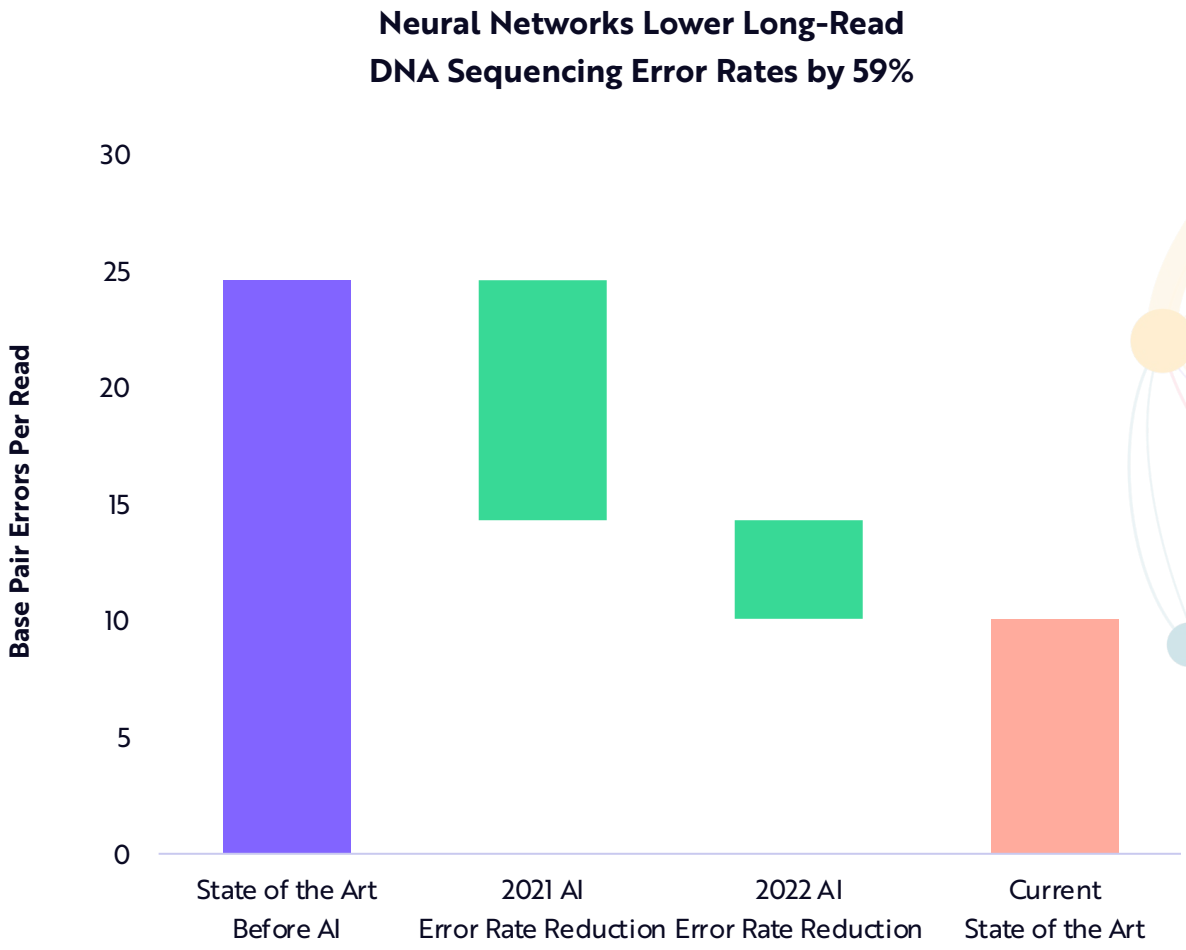
The pace of AI innovation has increased our confidence in the commercial viability of robotaxis and other autonomous mobility systems.

Neural networks are beginning to exceed human performance in multiple areas. Autonomous transportation should prove no different. Performance improvements in neural networks should enable scalable robotaxi systems that are safer than humans in almost all situations.

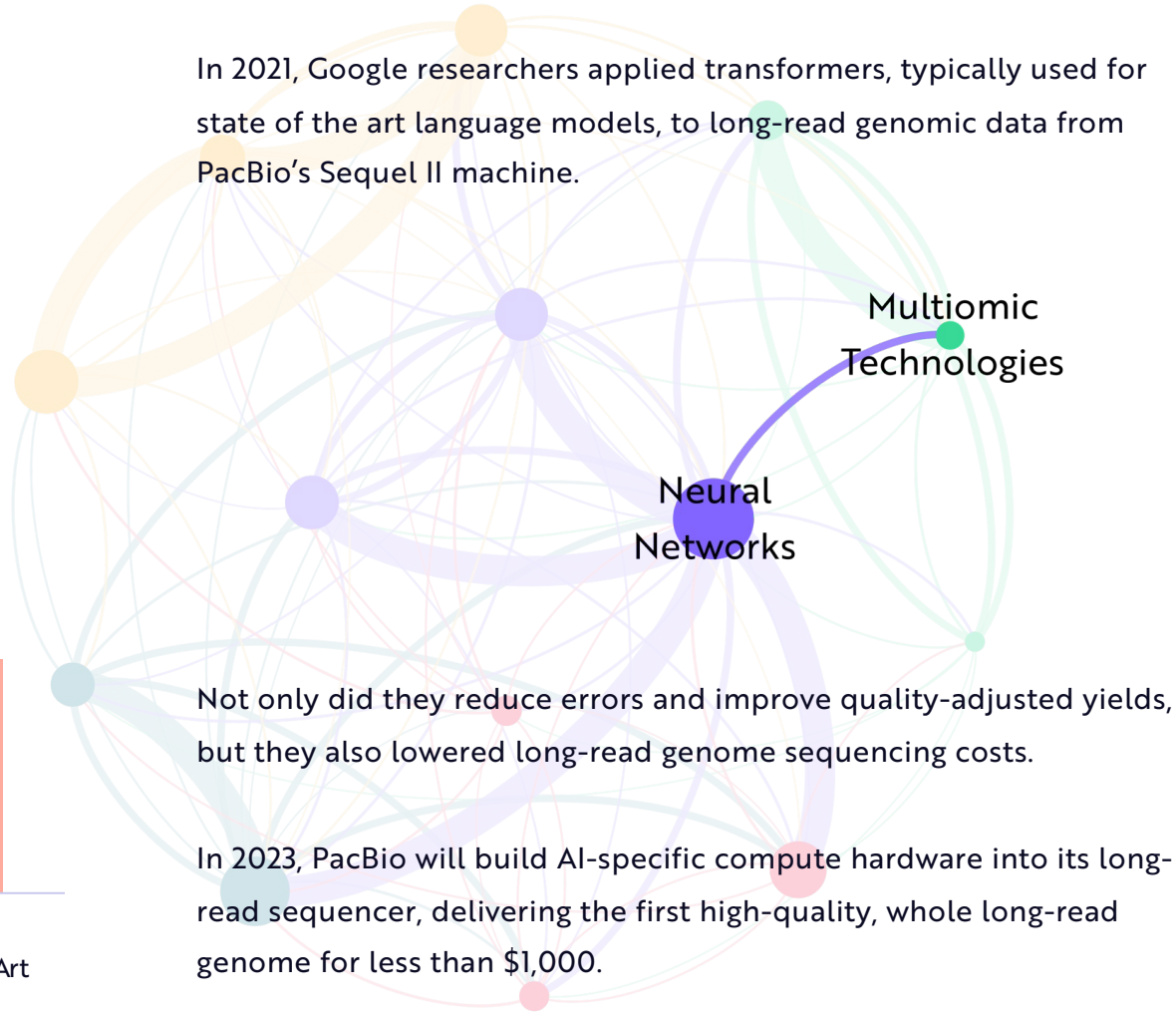


Sources: ARK Investment Management LLC, 2023. Tesla 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Deep Neural Networks Enable More Accurate Long-Read DNA Sequencing



In 2021, Google researchers applied transformers, typically used for state of the art language models, to long-read genomic data from PacBio's Sequel II machine.

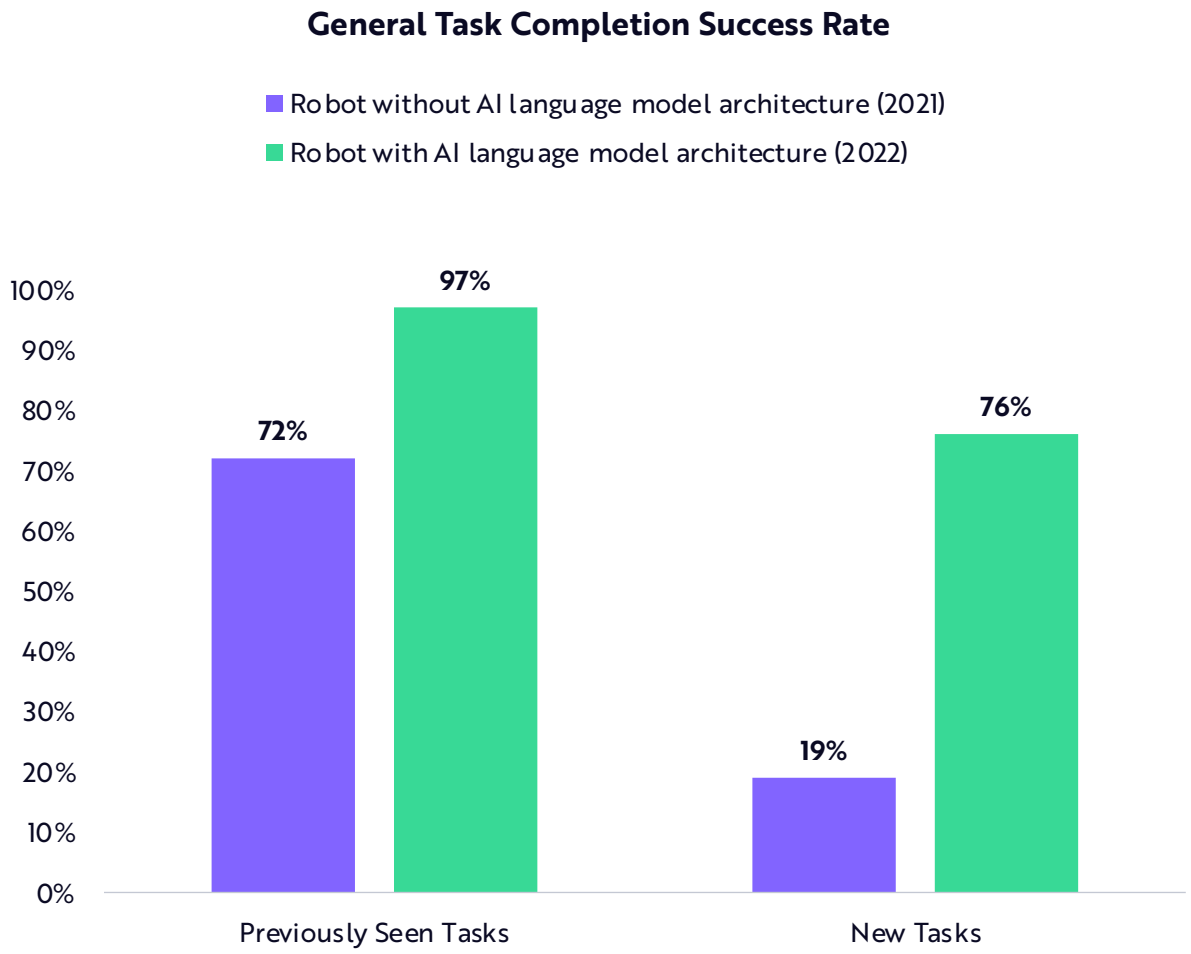


Not only did they reduce errors and improve quality-adjusted yields, but they also lowered long-read genome sequencing costs.

In 2023, PacBio will build AI-specific compute hardware into its long-read sequencer, delivering the first high-quality, whole long-read genome for less than $1,000.

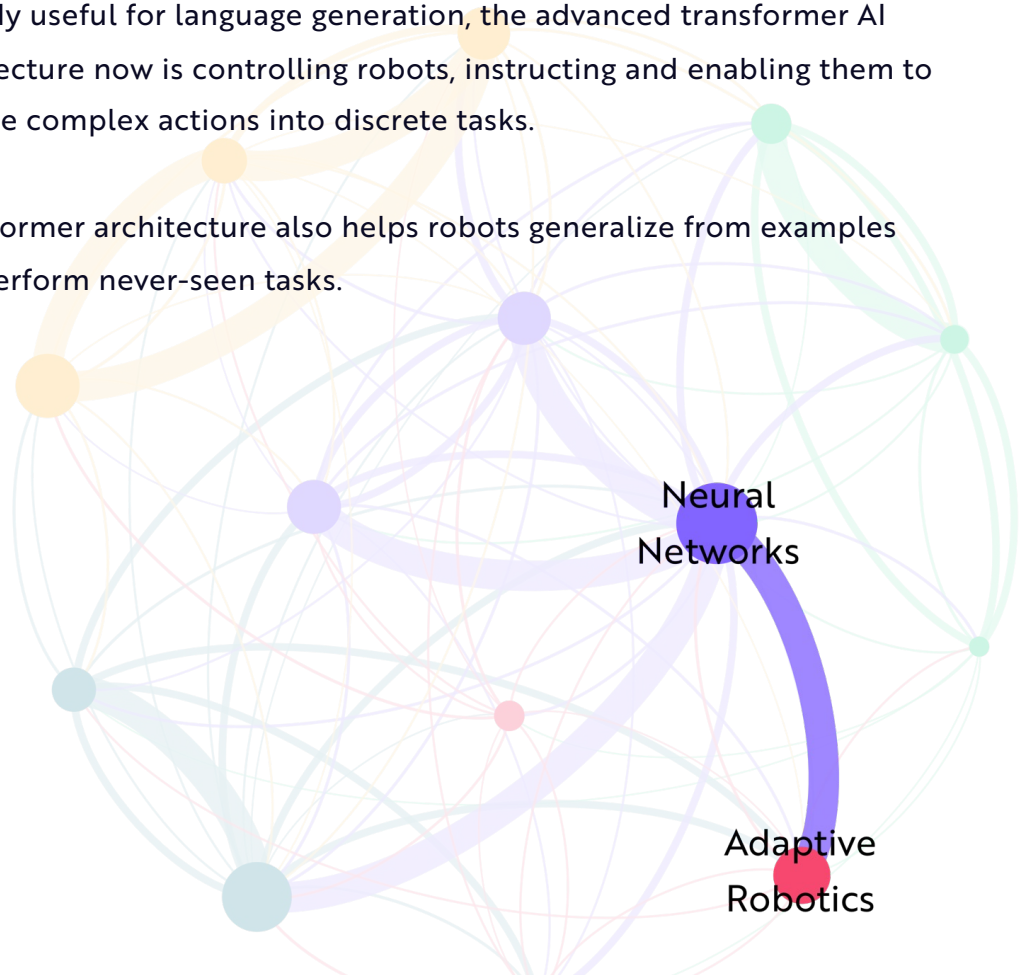
Sources: ARK Investment Management LLC, 2023. Baid, G. et al. 2022; Carroll, A. 2022; Lopez, L. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Robots Learn From Experience Thanks To Advances In AI Language Models



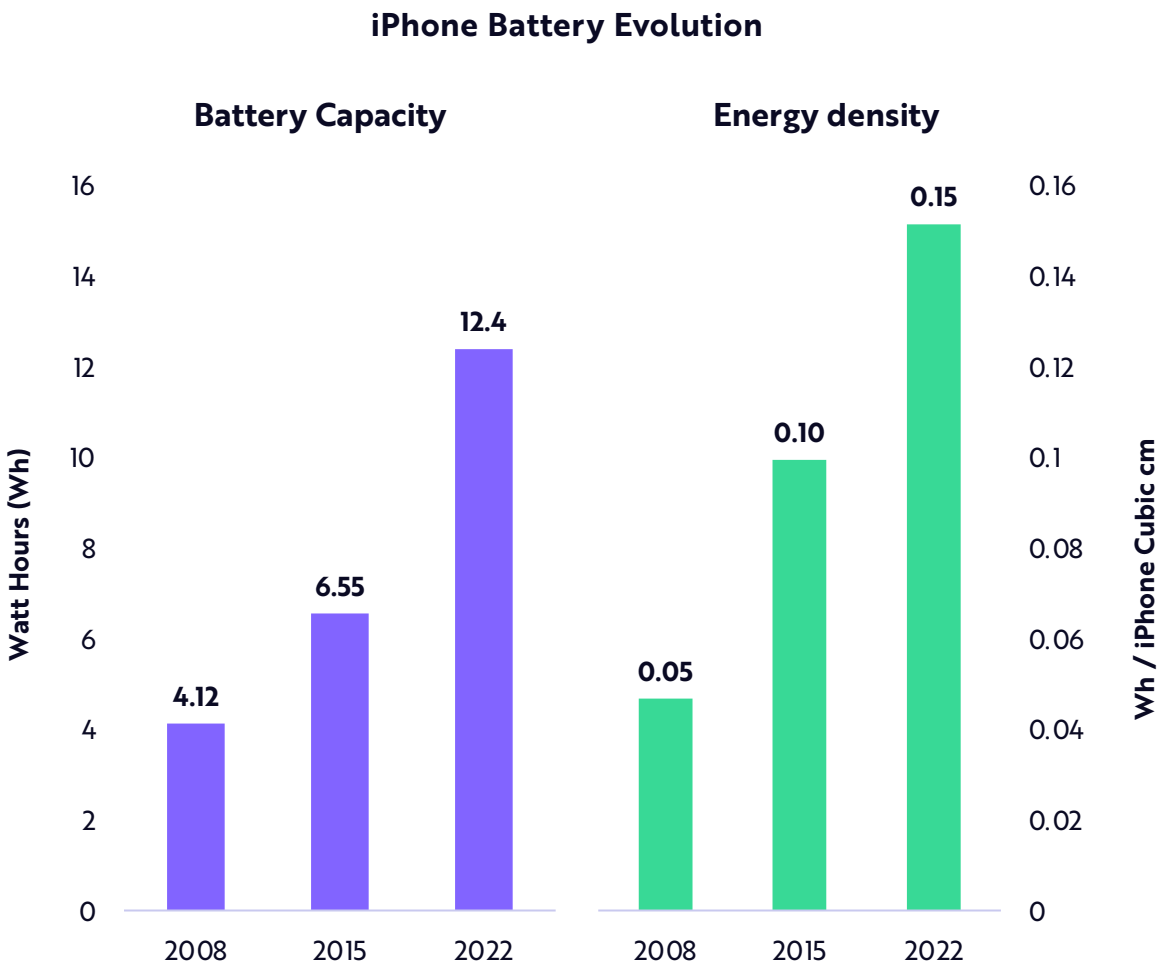
Already useful for language generation, the advanced transformer AI architecture now is controlling robots, instructing and enabling them to encode complex actions into discrete tasks.

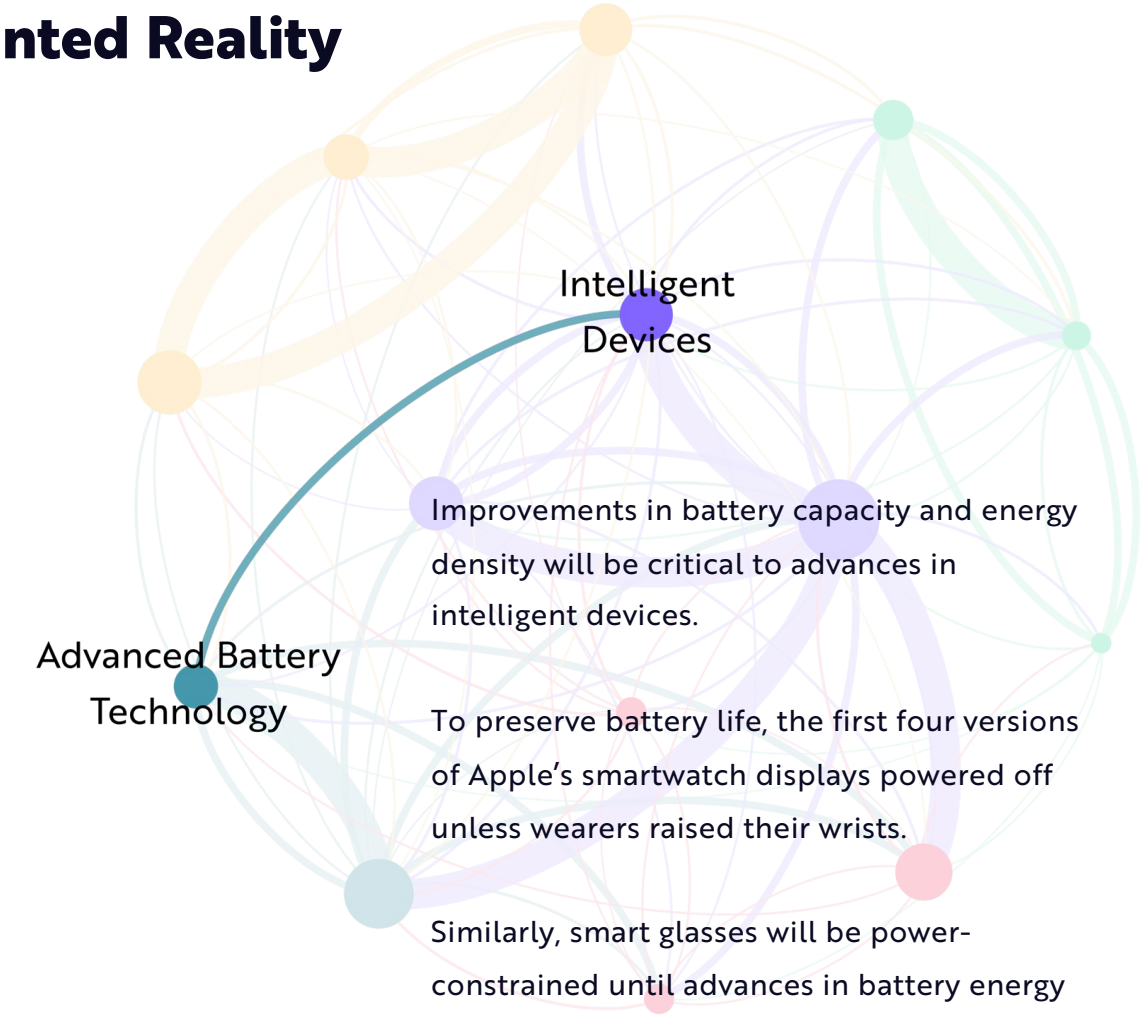
Transformer architecture also helps robots generalize from examples and perform never-seen tasks.



Sources: ARK Investment Management LLC, 2023. Gopalakrishnan, K. et al. 2022; Brohan, A. et al. 2022; Jang, E. et al. 2022. Compares performance of RT-1, the robotics transformer architecture to BC-Z, based on a recurrent neural net architecture. Forecasts are inherently limited and cannot be relied upon. 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.

Battery Advances Will Be Critical To Augmented Reality





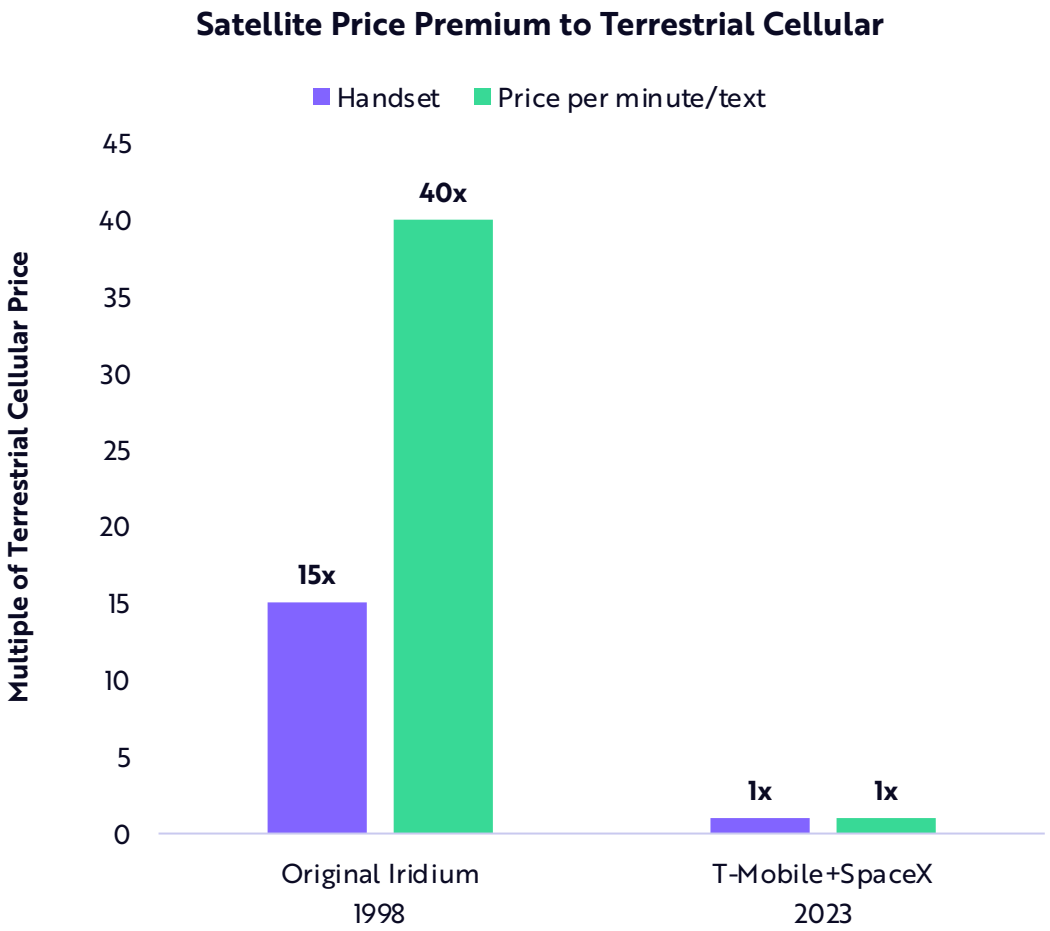
Improvements in battery capacity and energy density will be critical to advances in intelligent devices.

To preserve battery life, the first four versions of Apple's smartwatch displays powered off unless wearers raised their wrists.

Similarly, smart glasses will be power-constrained until advances in battery energy density increase their utility.

Sources: ARK Investment Management LLC, 2023. Apple, data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. 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.

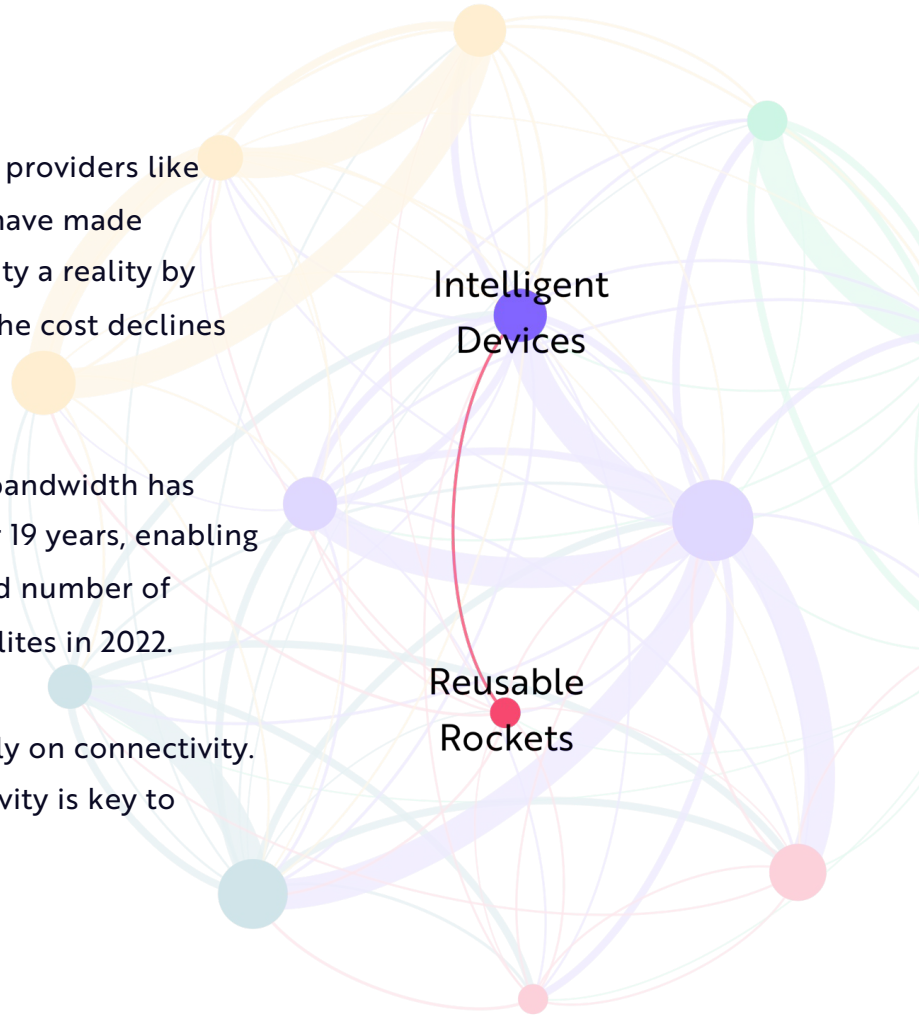
Reusable Rockets Deliver Satellite Power To Traditional Smartphones



Satellite connectivity providers like Iridium and Starlink have made worldwide connectivity a reality by taking advantage of the cost declines in re-usable rockets.

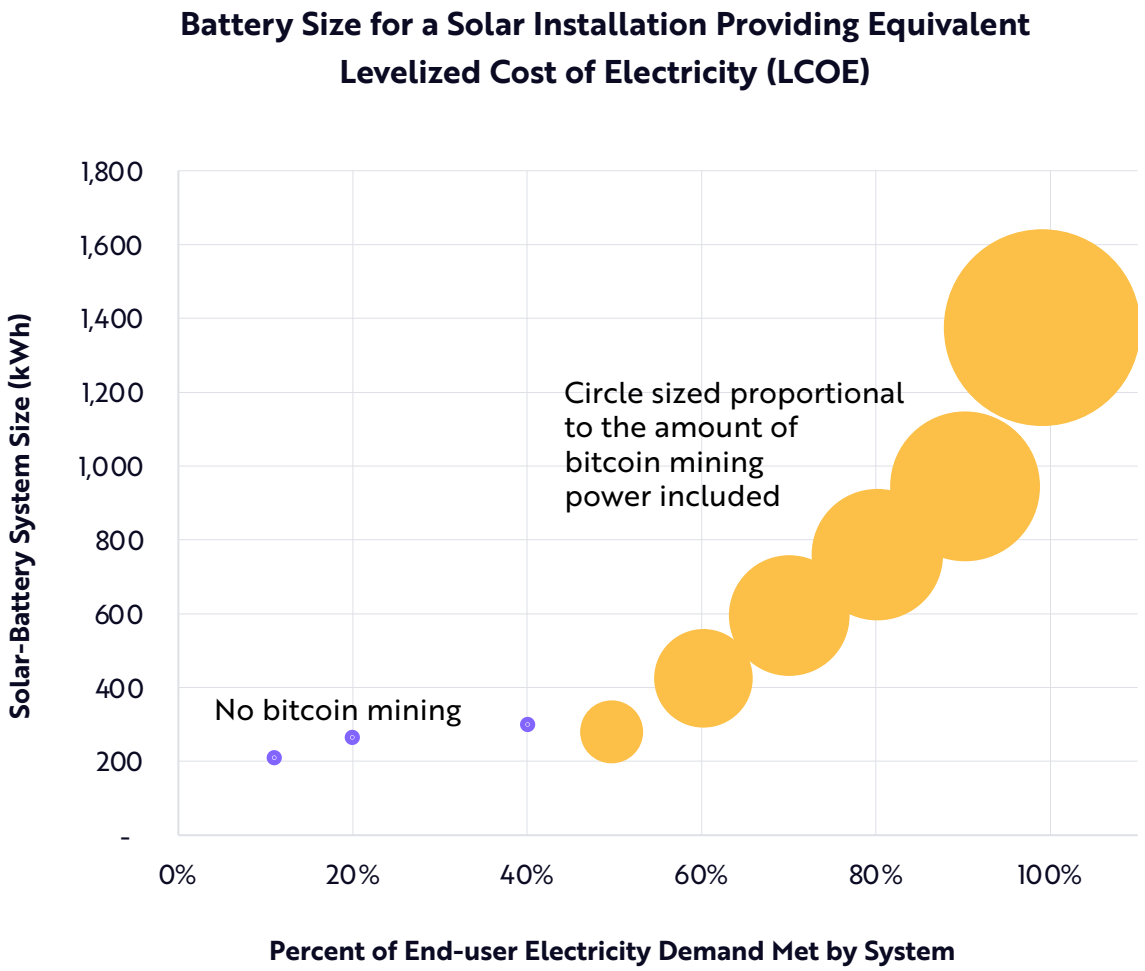
The cost of satellite bandwidth has fallen 7,500-fold over 19 years, enabling the launch of a record number of communication satellites in 2022.

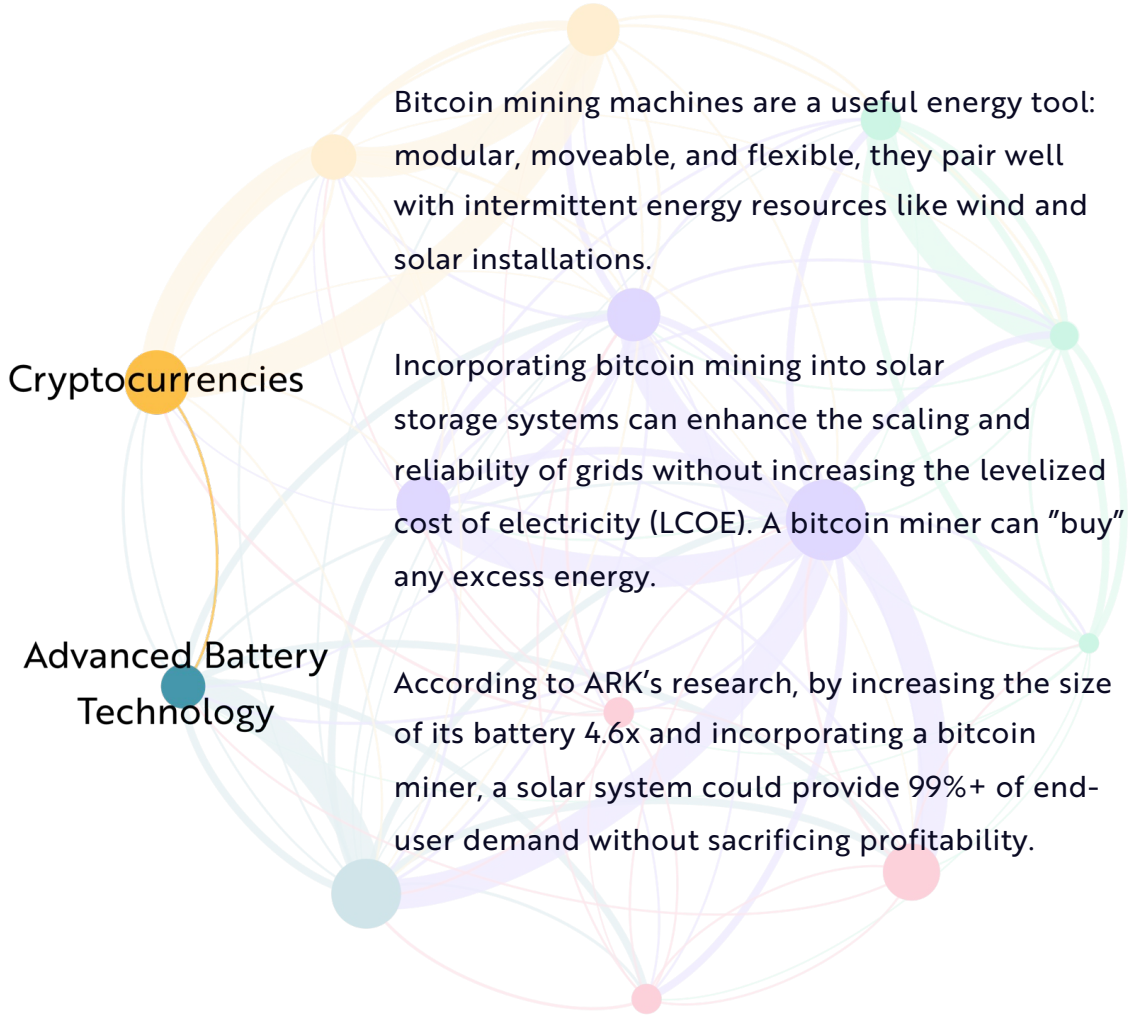
Intelligent devices rely on connectivity. Inexpensive connectivity is key to universal access.



Sources: ARK Investment Management LLC, 2023. Gregson, R. 1999; Glasner, J. 1999; Hasenstab, B. 1998. Forecasts are inherently limited and cannot be relied upon. 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.

Cryptocurrency Mining Can Support Larger Solar-Battery Installations





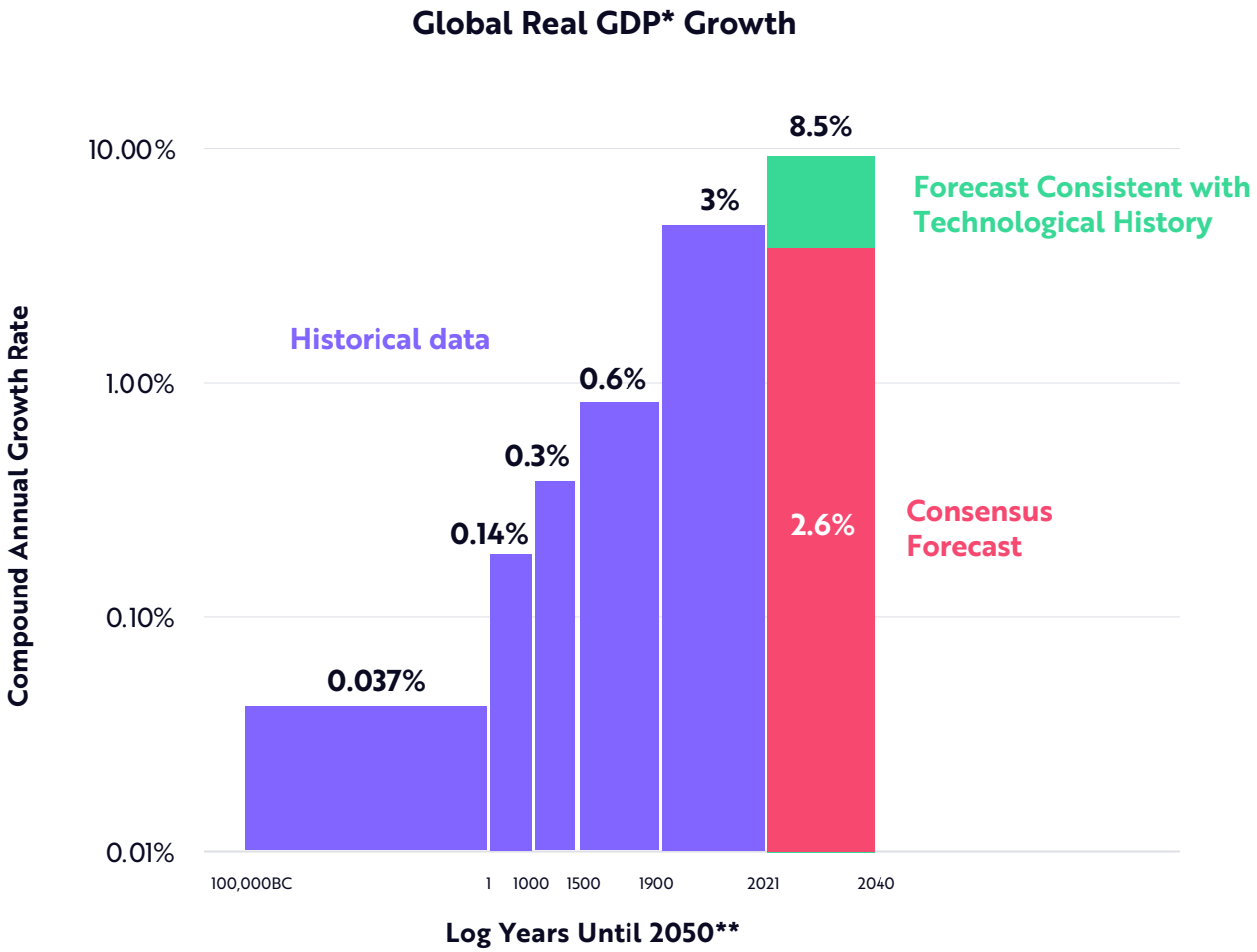
Bitcoin mining machines are a useful energy tool: modular, moveable, and flexible, they pair well with intermittent energy resources like wind and solar installations.

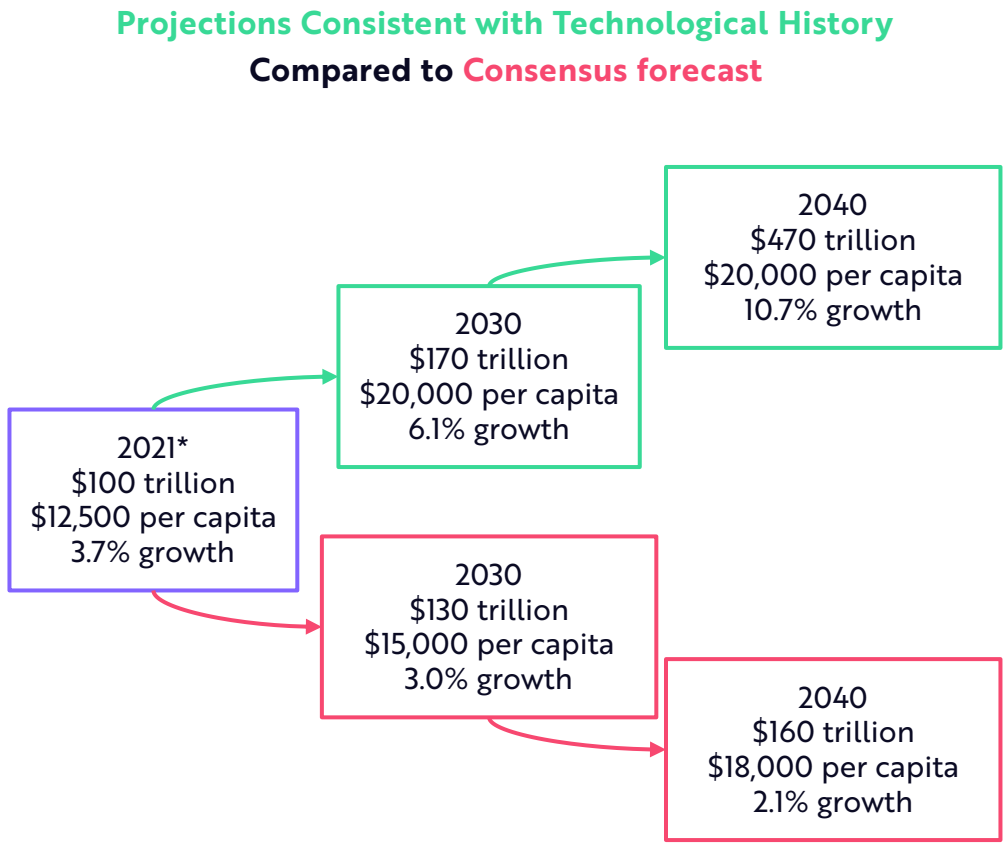
Incorporating bitcoin mining into solar storage systems can enhance the scaling and reliability of grids without increasing the levelized cost of electricity (LCOE). A bitcoin miner can "buy" any excess energy.

According to ARK's research, by increasing the size of its battery 4.6x and incorporating a bitcoin miner, a solar system could provide 99%+ of end-user demand without sacrificing profitability.

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Discontinuous Changes In Macroeconomic Growth Are The Norm, Thanks to Technology



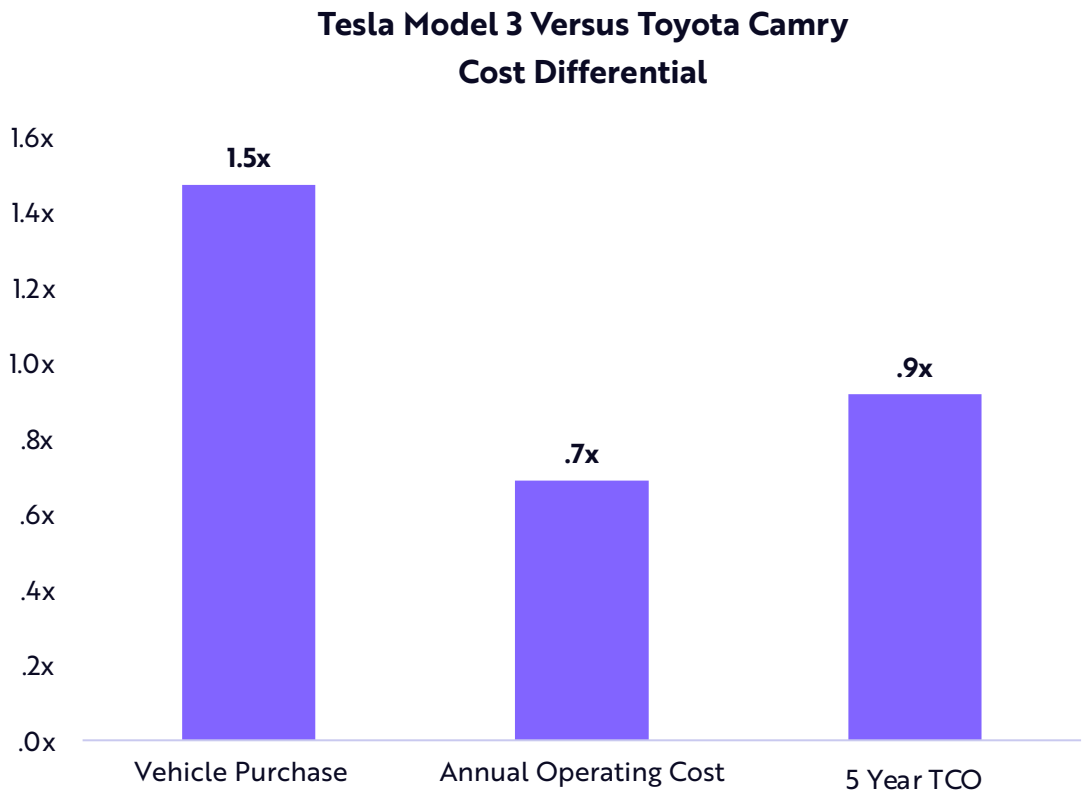


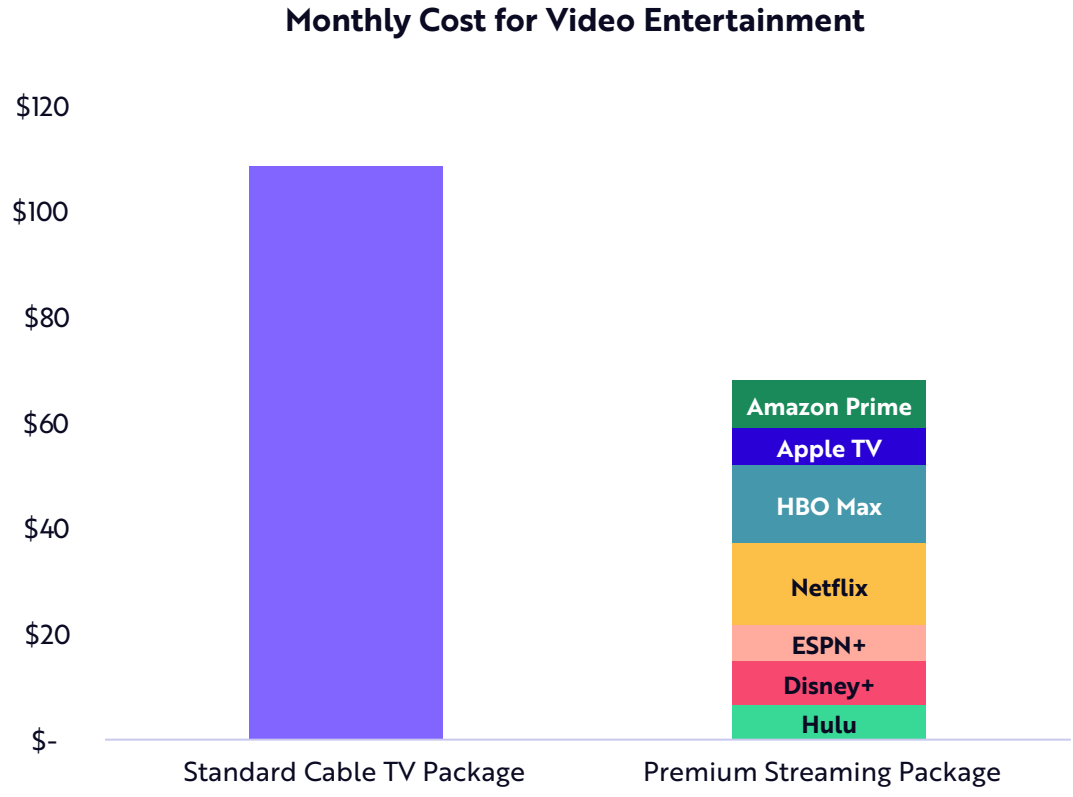
*Gross Domestic Product. **X-axis scaled by log years until 2050. Sources: ARK Investment Management LLC, 2023. Bolt, J. et al. 2022; The World Bank Group, data as of 01/27/23; Nalley, S. et al. 2021; DeLong, B. 1998. Numbers are rounded. Consensus forecast is the reference economic case for the EIA's International Energy Outlook. X-axis of log years until 2050 is tuned to the best fit against the historical data. Forecasts are inherently limited and cannot be relied upon. 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.

Disruptive Innovations Complicate The Meaning Of Economic Statistics

Consumers paying up for an electric vehicle are lowering future costs for better performing vehicles at a lower total cost of ownership (TCO). An EV purchase today leads to lower "output" in the future.

Cutting the cord from a cable package and shifting to streaming services could hurt economic measures but boost the value of entertainment.

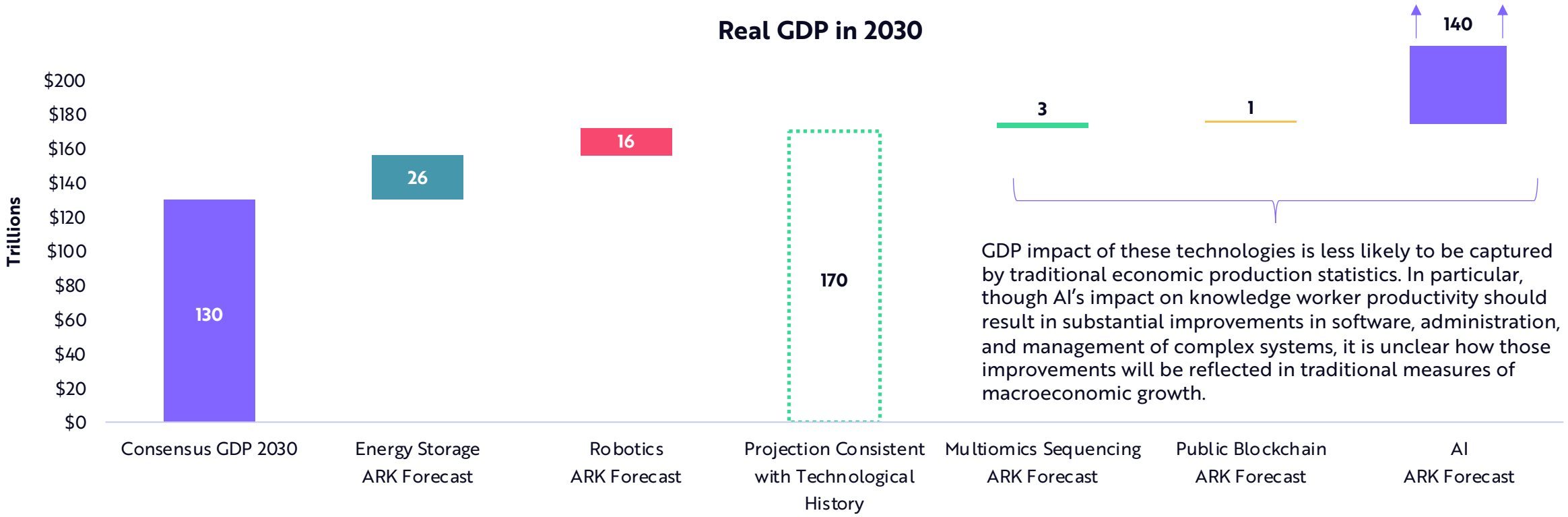




Sources: ARK Investment Management LLC, 2023. Edmunds.com, Inc., data as of 01/27/23; Afonso, C. 2022. Cost of ownership as measured over 5 years at 15,000 miles per year. Assumes IRA tax credit. Assumes same depreciation rate for Model 3 versus Camry. Assumes EV maintenance costs at 45% of internal combustion. Forecasts are inherently limited and cannot be relied upon. 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.

Today's Innovation Platforms Could Lift Consensus GDP* Growth Toward GDP Growth Suggested By Technological History

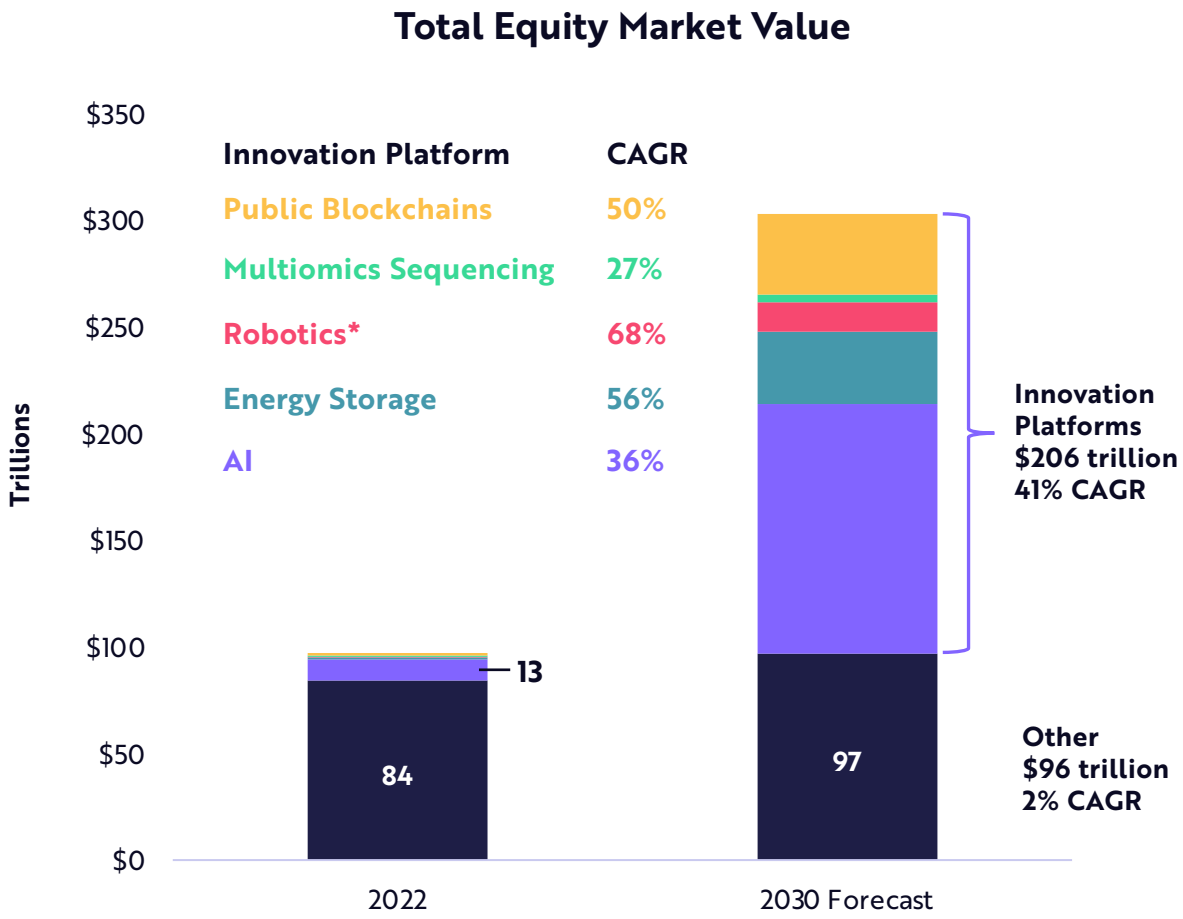
According to ARK's research, breakthroughs associated with Energy Storage and Robotics alone could add 30% to real GDP by 2030, and AI could dwarf both their contributions.



GDP impact of these technologies is less likely to be captured by traditional economic production statistics. In particular, though AI's impact on knowledge worker productivity should result in substantial improvements in software, administration, and management of complex systems, it is unclear how those improvements will be reflected in traditional measures of macroeconomic growth.

*Gross Domestic Product. Sources: ARK Investment Management LLC, 2023. Nalley, S. et al. 2022. Energy storage forecast is primarily driven by expectations for robotaxi service penetration. Robotics forecast assumes 1 robot per manufacturing employee delivering a 15% productivity uplift and imbeds the indirect benefit of household robots reducing housework burdens for consumers by 16%. Multiomics sequencing GDP impact corresponds to a 2% increase in working populations above expectations due to health advances. Public blockchain forecast assumes that the rent charged by intermediaries falls 2/3rds for public blockchain assets as compared to traditional financial assets, and that the GDP impact of digital wallet penetration in emerging markets continues to yield incremental GDP growth. AI GDP forecast assumes that AI software increases knowledge-worker productivity by 4.5x by 2030. Forecasts are inherently limited and cannot be relied upon. 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.

Disruptive Innovation Platforms Could Constitute The Majority Of The Global Equity Market Value By 2030



- AI, Energy Storage, Robotics, Multiomics Sequencing, and Public Blockchains could scale ~15-fold to ~$200 trillion in equity value over the course of this business cycle.
- Even if non-innovation exposures to the market continue to accrue value, disruptive innovation is likely to dominate equity market values by 2030.
- Including cryptoassets, disruptive innovation exposures could constitute roughly 68% of risk asset value by 2030.

*CAGR: Robotics including home robots as opposed to industrial robots. Sources: ARK Investment Management LLC, 2023. Equity market value includes the value of public blockchain protocols. Forecasts are inherently limited and cannot be relied upon. 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. In this specific estimation, 2022 and 2030 total equity market values and CAGRs for Public Blockchains are inclusive of three technology platforms: Cryptocurrencies, Smart Contracts, and Digital Wallets.

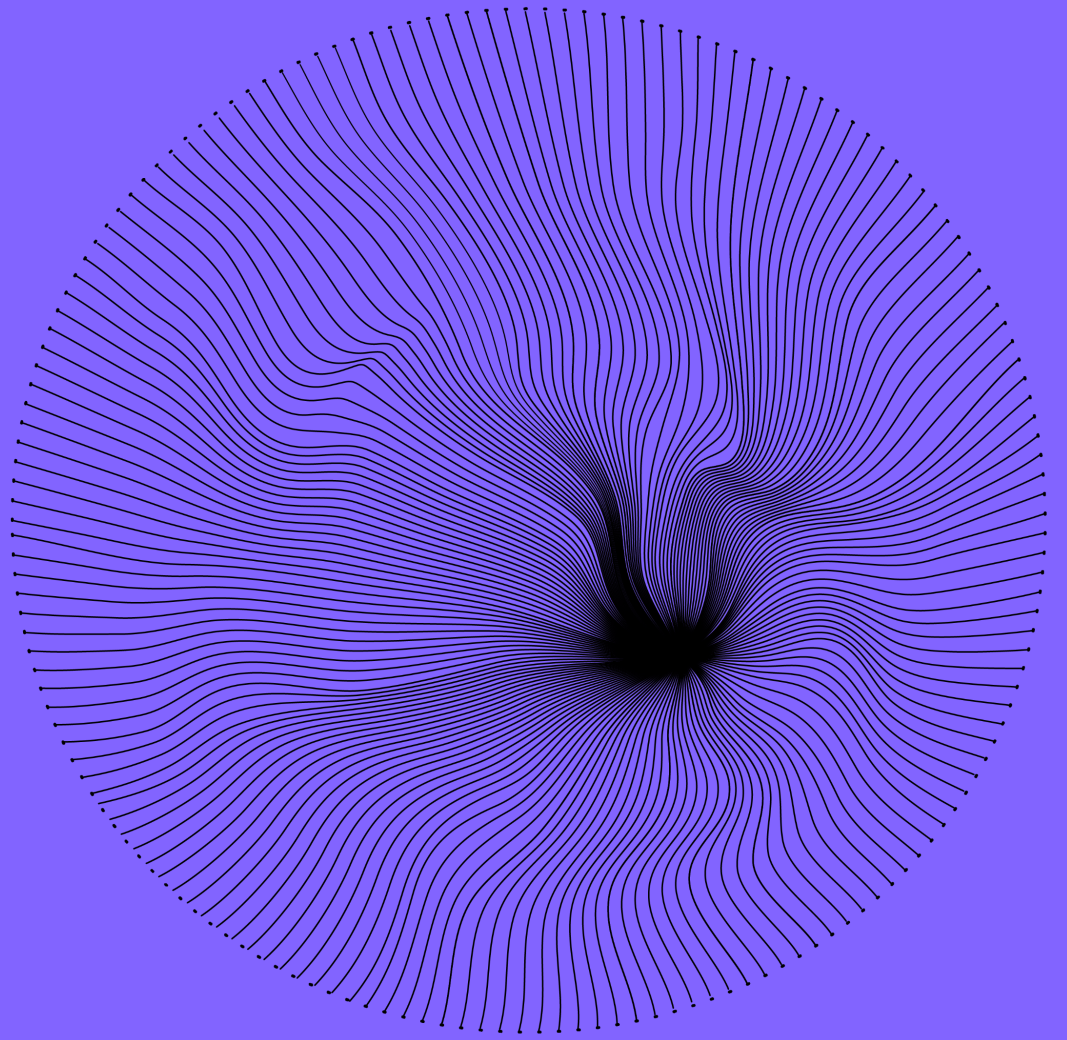
Artificial Intelligence

Creating The Assembly Line For Knowledge Workers

Generative AI made waves this year, from DALL-E-2 to ChatGPT. These tools are improving the productivity of knowledge workers—~2x in the case of AI coding assistants.

AI training cost declines continued at an annual rate of 70%, the cost to train a large language model to GPT-3 level performance collapsing from $4.6 million in 2020 to $450,000 in 2022. We expect cost declines to continue at a 70% rate through 2030.

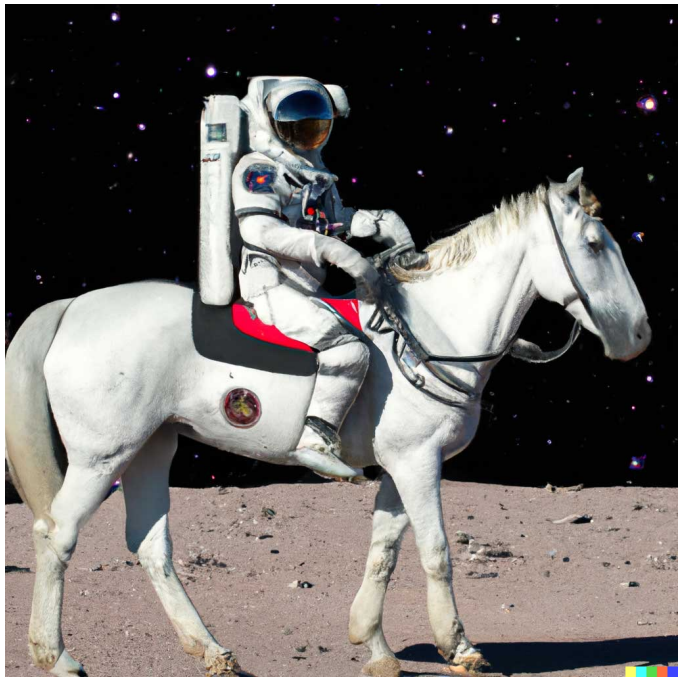
AI should increase the productivity of knowledge workers more than 4-fold by 2030. At 100% adoption, AI could increase global labor productivity ~$200 trillion, dwarfing the ~$32 trillion in total knowledge worker salaries.



Research by William Summerlin, Co-Lead, ARK Venture & Analyst
Frank Downing, Director of Research, Next Generation Internet

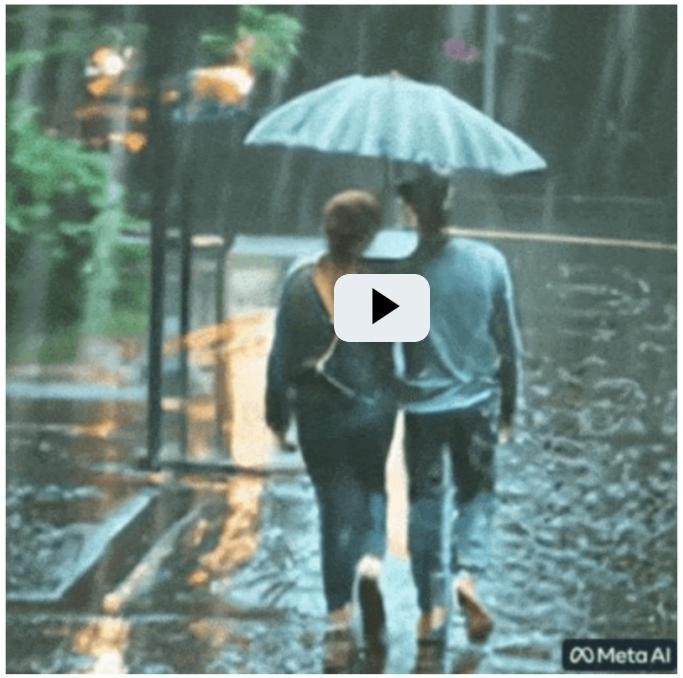
2022 Was The Year Of Generative AI

Prompted by a short text, generative AI models can produce images, code, text, audio, and video. In less than one year, dozens of generative AI projects created models that progressed from grainy images to high-quality 3D models and videos.



DALL-E 2: "An astronaut riding a horse"

Publicly available September 2022



Meta Make-A-Video

Announced September 2022

Open-Source Stable Diffusion 2.0:

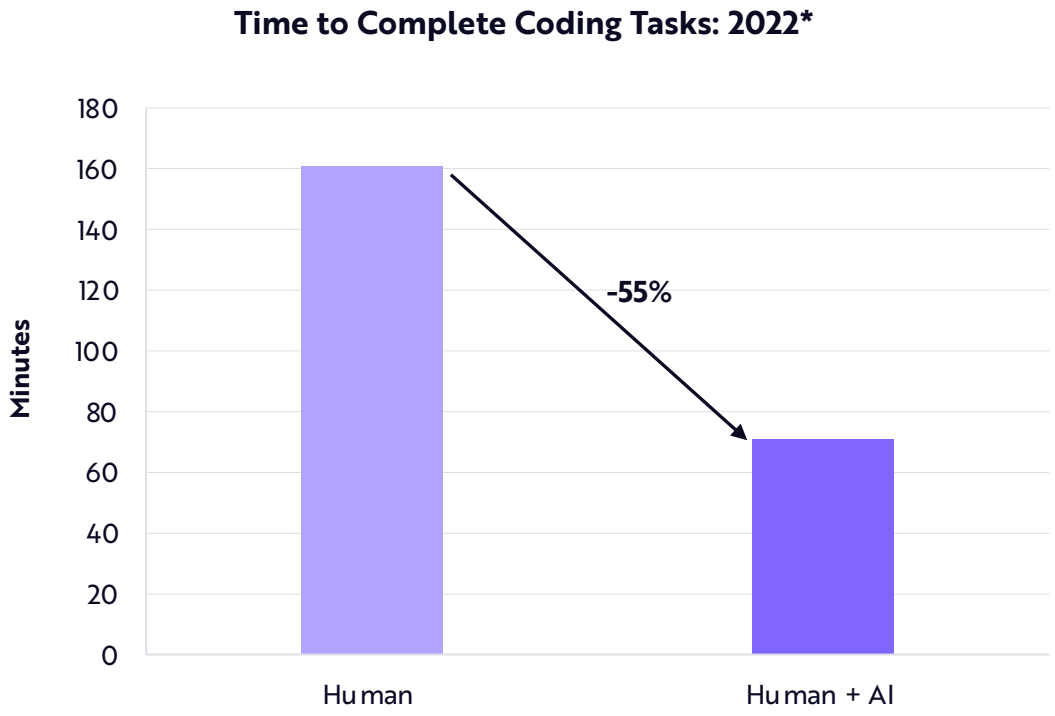
Released November 2022

Sources: ARK Investment Management LLC, 2023. Bleeding Edge, data as of 01/23/23; Stability 2023; Singer, U. et al. 2022; OpenAI, data as of 01/23/23. Forecasts are inherently limited and cannot be relied upon. 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.

AI Is Increasing The Productivity Of Knowledge Workers

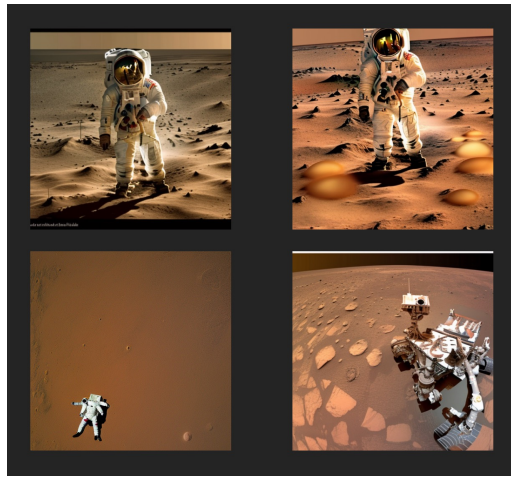
Coding Assistants

Software engineers completed a coding task in less than half the time with AI coding assistant GitHub Copilot.



Generative Image Models

According to our research, AI can create a graphic design for just $0.08** in minutes — a *di minimis* cost compared to $150 for human labor.



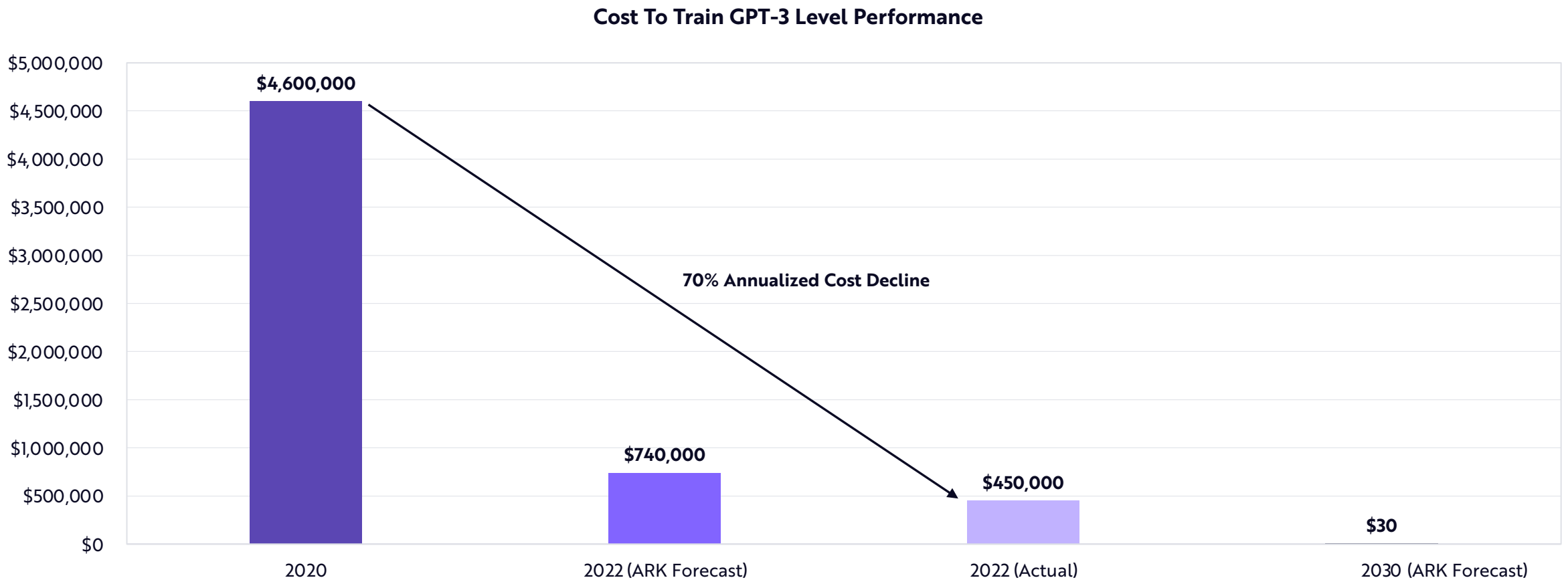
Human	
Cost	$150
Time	5 Hours

Generative AI	
Cost	$0.08
Time	< 1 Minute

*Based on data from GitHub. **Generative AI models translated " a picture of an astronaut on Mars" into multiple images in just a few seconds. Sources: ARK Investment Management LLC, 2023. Kalliamvakou, E. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

AI Training Costs Continue To Plummet

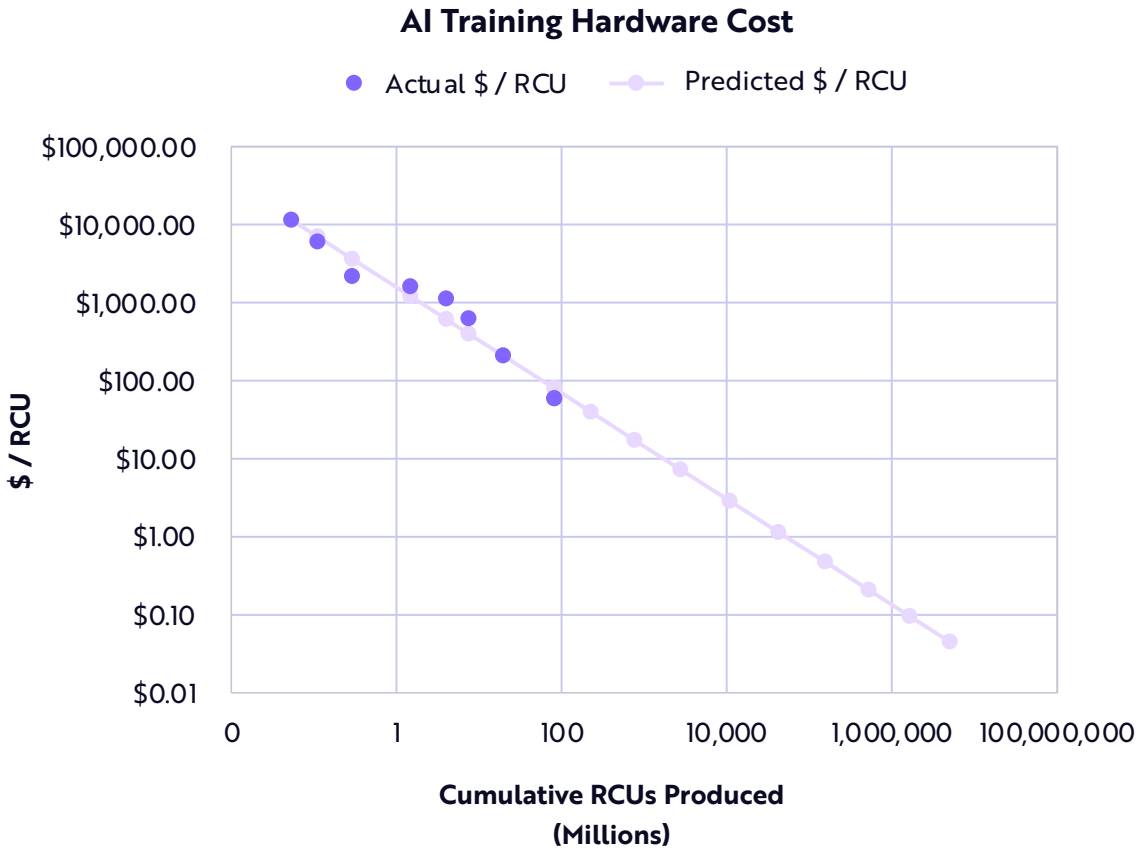
Mosaic[ML] recently released AI training tools that can train language models to GPT-3 level performance for just $450,000, roughly one-tenth the $4.6 million just two years ago. AI training costs are dropping ~70% per year, even faster than the 60% estimate based on research presented in ARK's Big Ideas 2022.

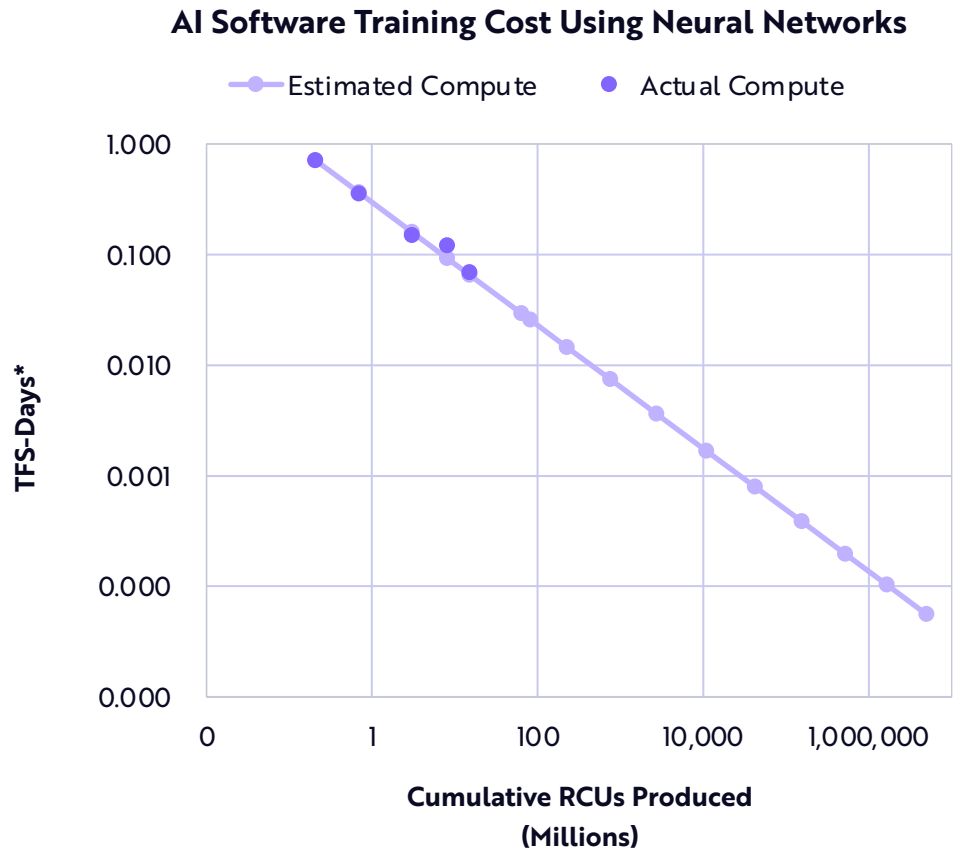


Sources: ARK Investment Management LLC, 2023. Venigalla, A. et al. 2022; Li, C. 2020. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

AI Hardware And Software Costs Should Continue To Decline 70% At An Annual Rate

According to Wright's Law, AI-relative compute unit (RCU) production costs and software costs should decline 57% and 47% at annual rates, respectively. In other words, the convergence of hardware and software could drive AI training costs down by 70% at an annual rate through 2030.



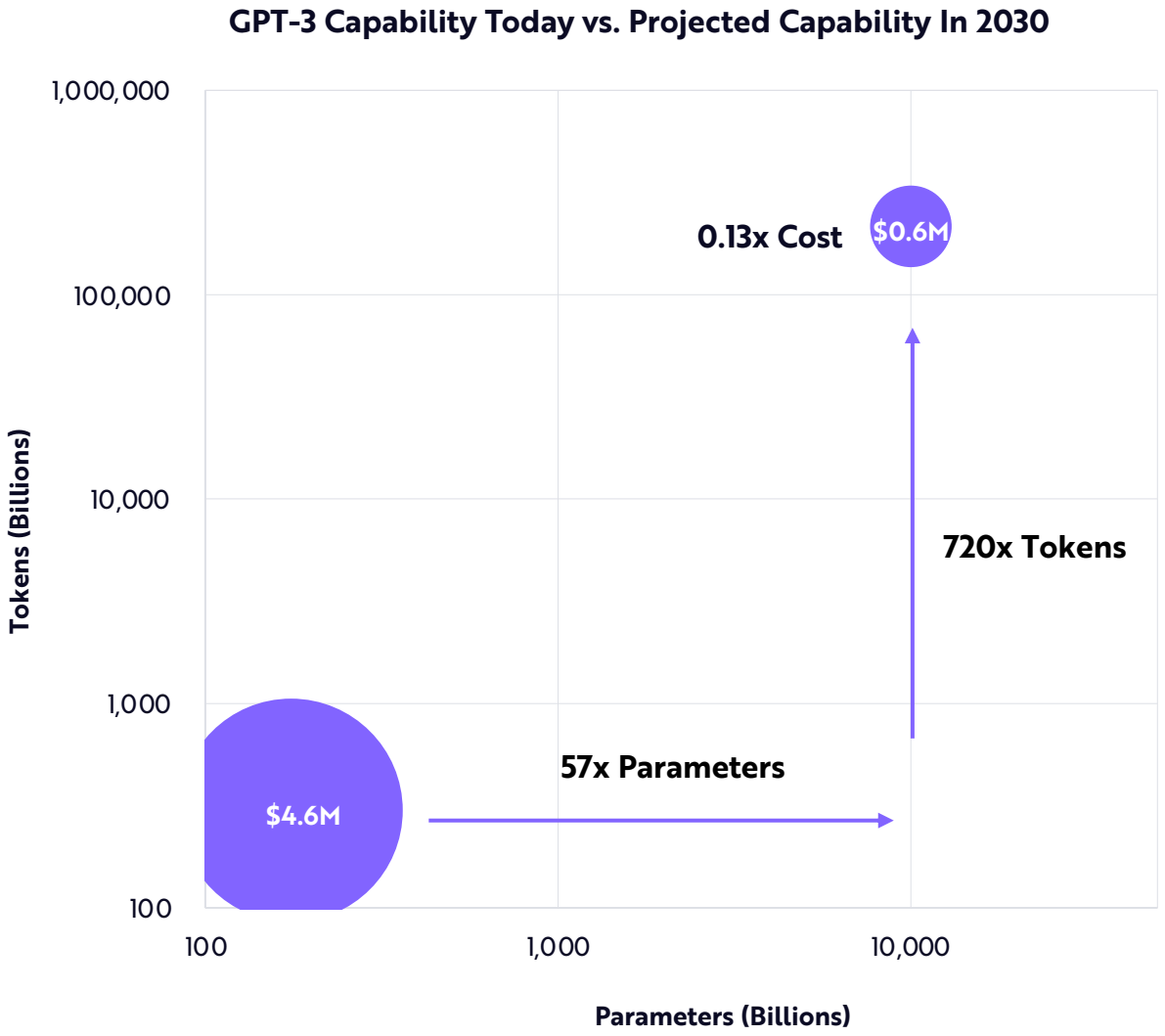


*TFS-Days is a measure of compute required to train a model. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

AI Is Creating Explosive Demand For Training Data

The cost to train the state-of-the-art GPT-3 in 2020 was $4.6 million. Based on our modeling, the cost of training an AI model with 57x more parameters and 720x more tokens than GPT-3 would drop from $17 billion today to $600,000 by 2030.

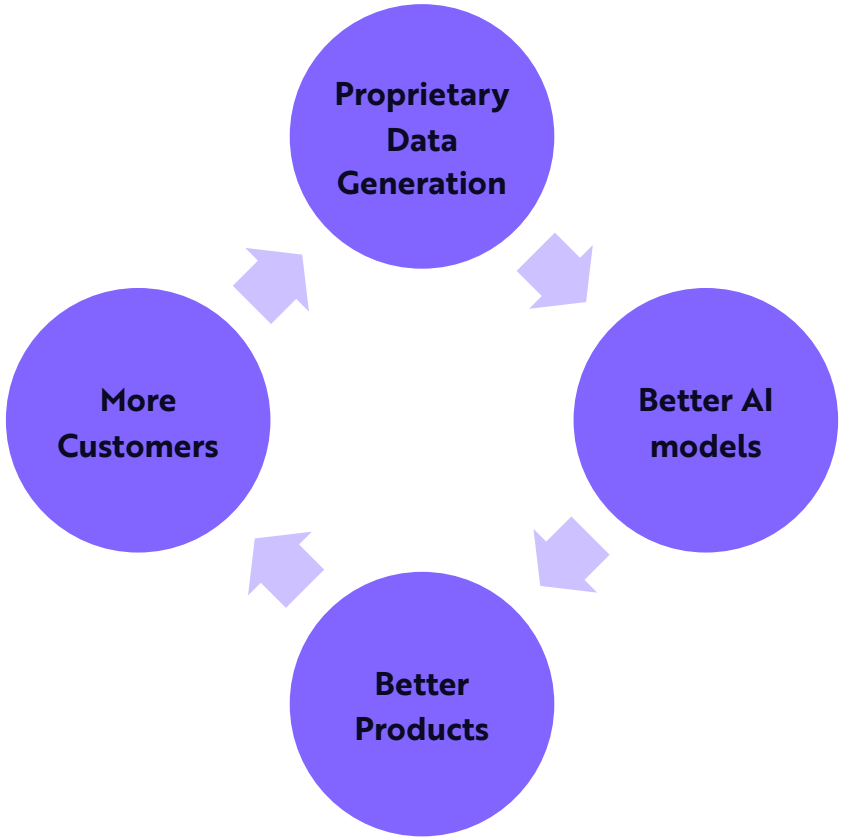
For perspective, Wikipedia's 4.2 billion words today represent roughly 5.6 billion tokens. Training a model with 162 trillion words, or 216 trillion tokens, should be possible in 2030. In a world of low-cost compute, data will become the primary constraint.



Sources: ARK Investment Management LLC, 2023.. Wikipedia 2023; Hoffmann, J. et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

Proprietary Data Could Create Moats

High-quality domain-specific AI training data could result in winner-takes-most outcomes across vertical applications.



Domain	Autonomous Driving	Software Development	Dialogue
Data Metric	Recorded real-world driving miles	Lines of code	Logged conversations
Feedback Loop	Autonomous disengagements	Rejected code	Rephrased questions
Company Example	Tesla	Replit	Twilio

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

AI Could Lead To A 10-Fold Increase In Coding Productivity

Based on a 70% annualized drop in training costs and feedback loops, AI coding assistants like Copilot could increase the output of software engineers ~10-fold by 2030.

Github Copilot Example

Human Input

sentiments.ts | write_sql.go | parse_expenses.py | addresses.rb

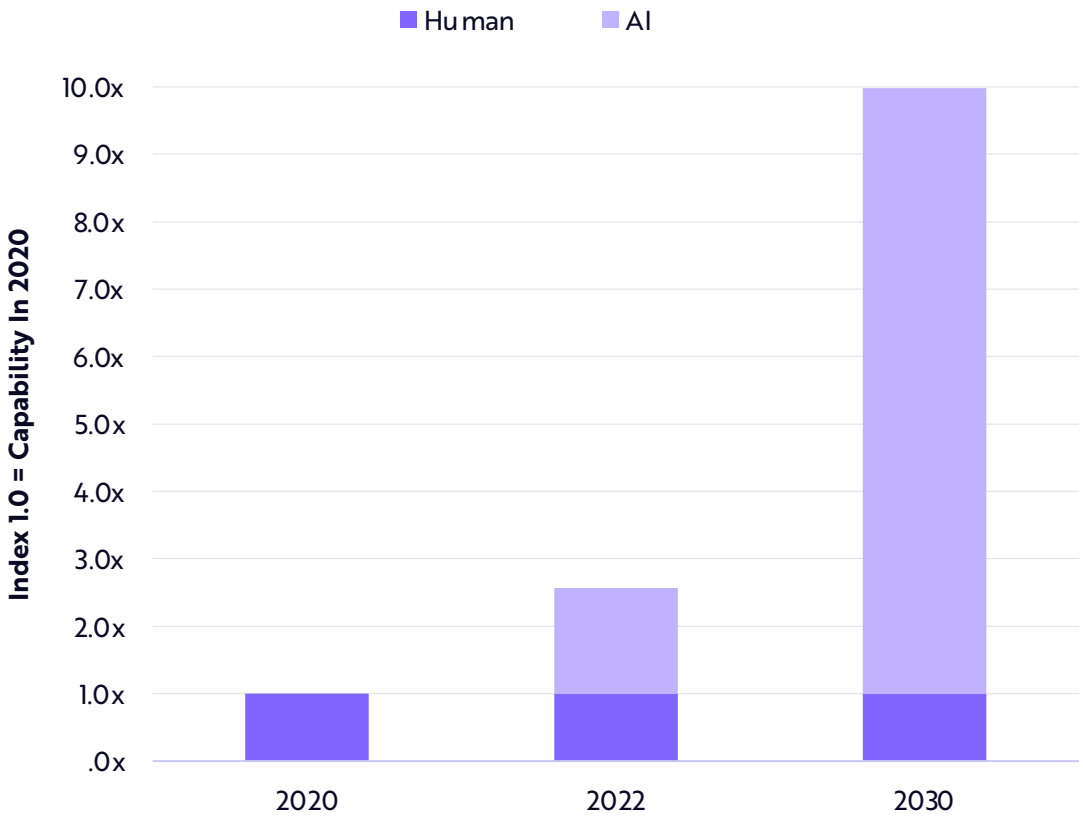
```
#!/usr/bin/env ts-node

import { fetch } from "fetch-h2";

// Determine whether the sentiment of text is positive
// Use a web service
async function isPositive(text: string): Promise<boolean> {
  const response = await fetch(`http://text-processing.com/api/sentiment/`, {
    method: "POST",
    body: `text=${text}`,
    headers: {
      "Content-Type": "application/x-www-form-urlencoded",
    },
  });
  const json = await response.json();
  return json.label === "pos";
}
```

Copilot

Output of Human + AI: Coding Tasks



Sources: ARK Investment Management LLC, 2023. GitHub 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Cost Declines Should Enable Mass Adoption Of Sophisticated AI Chatbots

Released by OpenAI in November 2022, ChatGPT uses large-language models to generate text in response to user prompts. Within five days of launch, the number of users reached 1 million. While the inference costs to run the model at scale are ~$.01 per query, Wright's Law suggests that by 2030 ChatGPT-style applications will be deployable at the scale of Google Search, processing 8.5 billion searches per day.

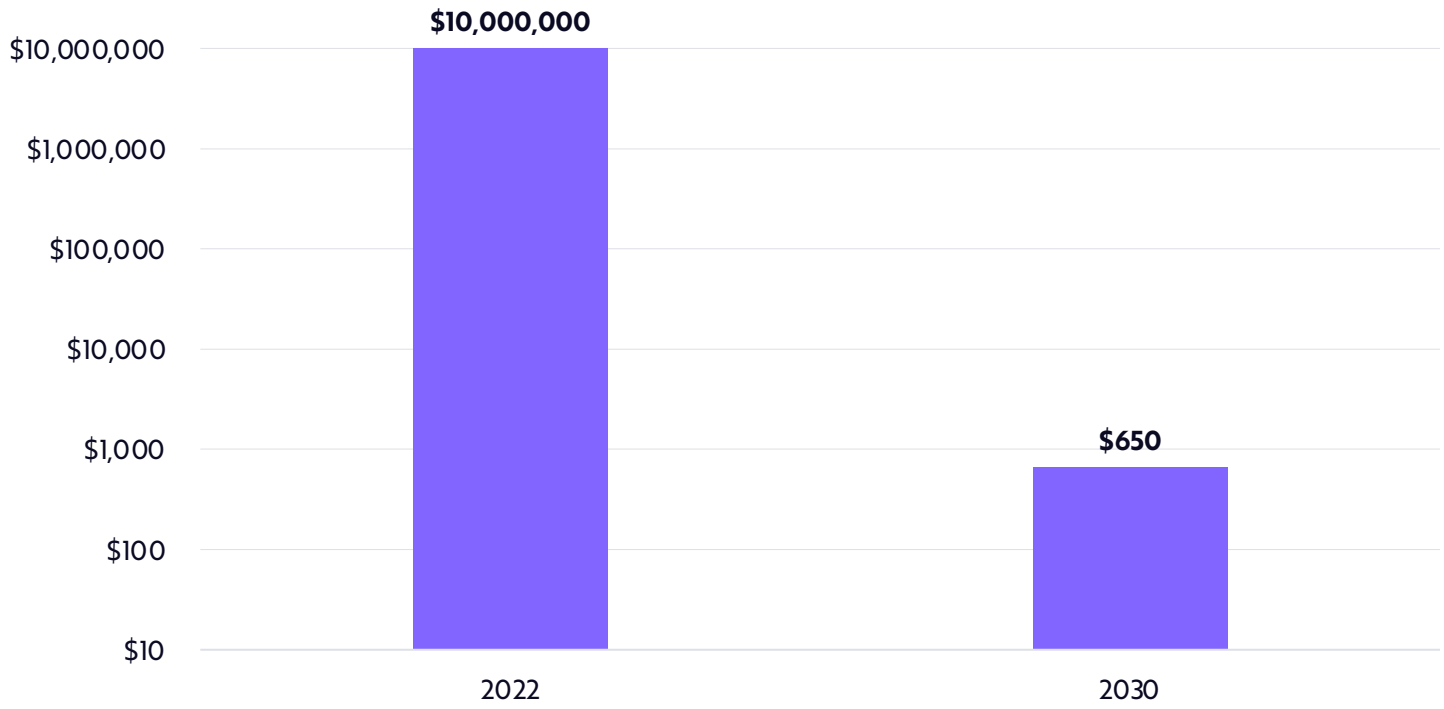
ChatGPT Example

ES

Briefly explain chatGPT using a metaphor that would resonate with an audience of stock-market investors and avoiding AI jargon.

One way to explain chatGPT to stock-market investors is to compare it to a financial advisor who uses past performance data and market trends to make predictions about future investments. Just like a skilled financial advisor, chatGPT uses large amounts of training data to generate intelligent and informed responses to questions, providing valuable insights and suggestions to users.

Cost Per Billion Inferences

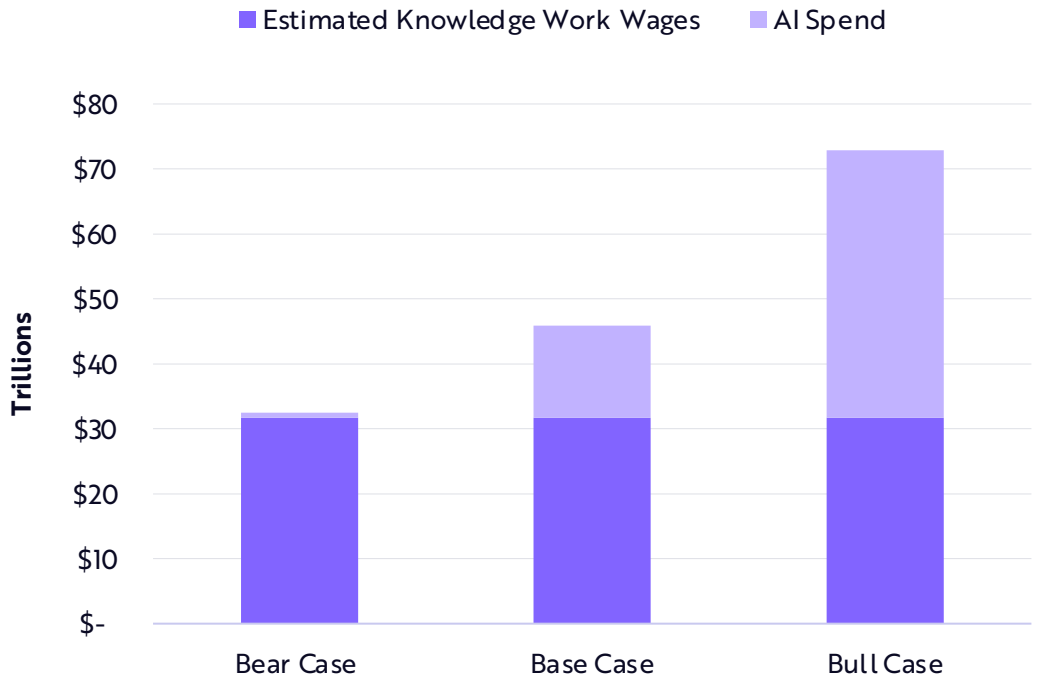


Sources: ARK Investment Management LLC, 2023. Goldstein, T. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

AI Should Increase Knowledge Worker Productivity Dramatically

According to ARK's research, AI should increase the productivity of knowledge workers more than 4-fold by 2030. At 100% adoption, AI spend of ~$41 trillion could increase labor productivity ~$200 trillion, dwarfing the ~$32 trillion in knowledge worker salaries and rivaling current projections of global GDP* in 2030. If vendors were to capture 10% of value created by their products, AI software could generate up to $14 trillion in revenue and $90 trillion in enterprise value in 2030.

Estimated Human Knowledge Work Wages Relative To AI Spend In 2030

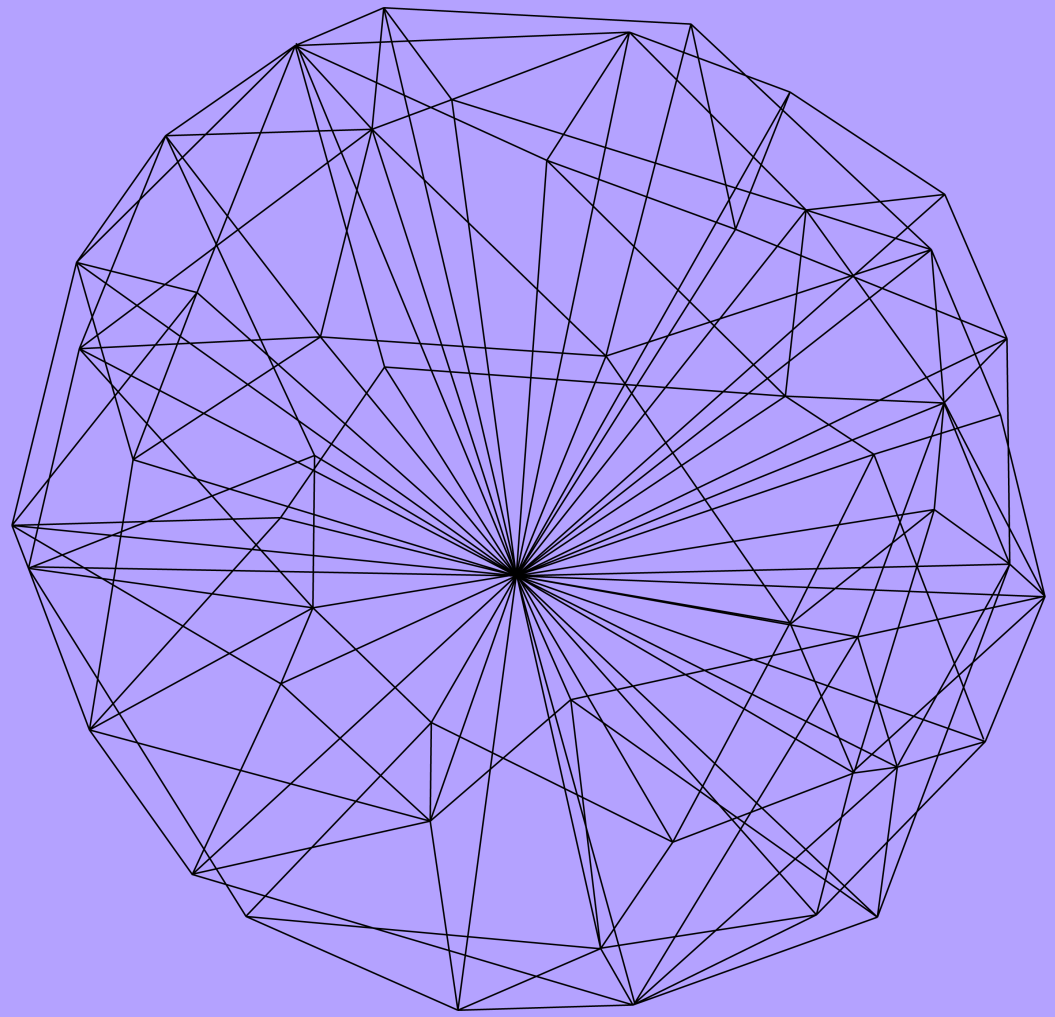


AI Total Addressable Market (TAM) Forecast In 2030

Productivity Uplift	Software Vendor Value Capture Of Productivity Gain: 1%	10%	20%
2.5	$0.8T	$8T	$16T
4.5	$1T	**$14T**	$29T
6.5	$2T	$21T	$41T

*Gross Domestic Product. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Consumers



Transitioning To Online Leisure

In 2022, digital leisure spending* totaled $6.6 trillion and, during the next eight years, should grow 17% at a compound annual rate to $22.5 trillion adjusted for inflation. Four trends should contribute to its growth:

Connected TV (CTV): Roughly 85% of US households have access to at least one CTV, but the CTV ad market is only 23% the size of total US TV ad budgets. In our view, CTV is at an inflection point and will take share from both linear TV and other digital ad budgets.

New Social Platforms: Nearly 40% of Gen Z consumers prefer to search on TikTok and Instagram over Google Search and Maps. Social platforms with the best recommendation engines should command the majority of ad budgets, with content-based social media likely outperforming follow-and-feed social media.

Sports Betting: Despite macro headwinds, consumer demand for sports betting remains strong. Legalization of online/mobile sports betting should continue to catalyze growth.

Gaming: The convergence of video games and social media should sustain gaming revenue growth. Video games should provide end-to-end virtual entertainment that rivals physical experiences.

Research by Nicholas Grous, Associate Portfolio Manager & Andrew Kim, Research Associate

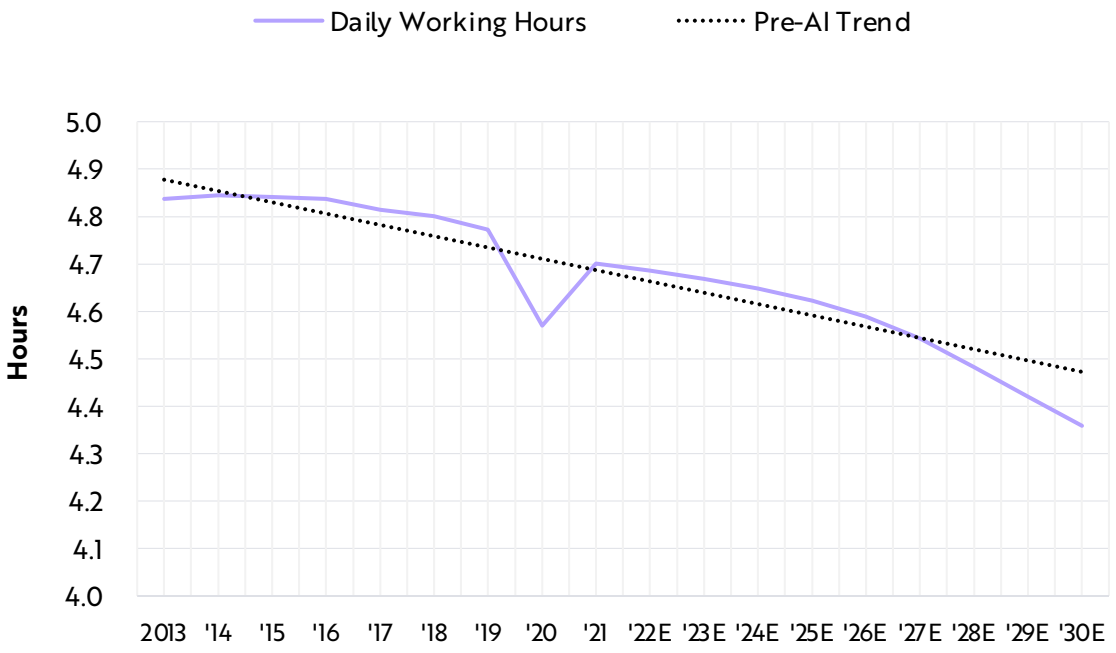
*We define digital leisure spending as the sum of consumer expenditures on leisure-related goods and services purchased online, NFTs, online sports betting, video game software and services, streamed video, and streamed audio. We only estimate online sports betting volume generated in Canada and the US. Sources: ARK Investment Management LLC, 2023. Altruda, C. 2022; Roblox, data as of 12/30/22; S&P Global Market Intelligence, data as of 01/25/23. The World Bank, data as of 12/30/22; Insider Intelligence, data as of 01/02/23; S&P Global Market Intelligence, data as of 01/25/23; Perez, S. 2022; Statista, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. 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.

Artificial Intelligence Should Increase Time Spent On Digital Entertainment

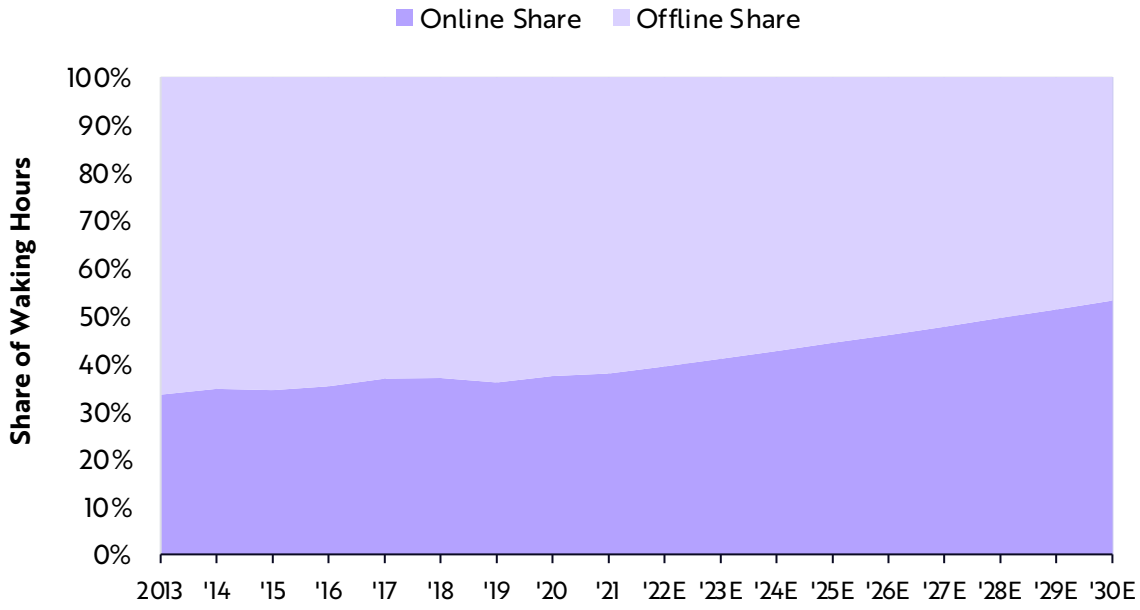
Thanks to the productivity gains associated with generative AI, daily hours worked globally could decline 0.9% on average at an annual rate during the next five years, from 4.7 hours in 2022 to 4.4 hours in 2030, an accelerated decline from the -0.4% prior rate as of 2013.

In our view, consumers will reallocate extra time to online instead of offline activities, increasing the share of total waking hours spent online from 39% in 2022 to 53% in 2030.

Average Hours Worked Per Day Globally*



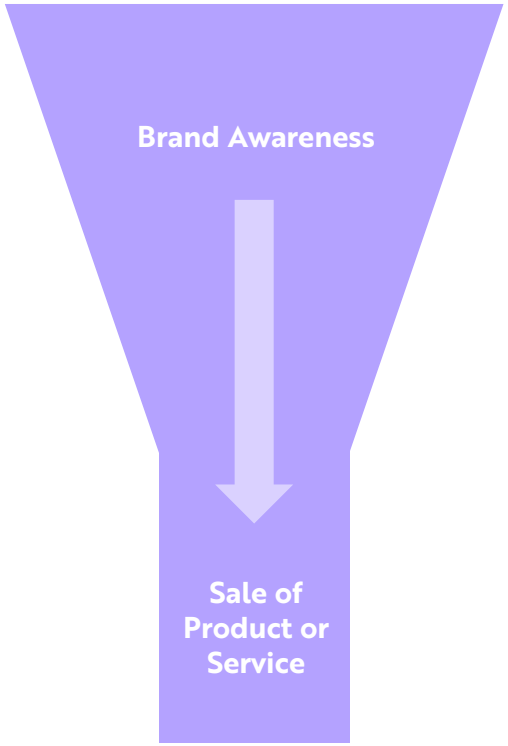
Daily Allocation of Time Online vs. Offline Global Internet Users**



*To calculate global daily working hours, we take the total annual hours of labor per worker as published by the OECD and divide the figure by the total days of the year. **The chart illustrating daily allocation of online vs. offline time captures total daily waking hours, including those allocated to labor or education. Sources: ARK Investment Management LLC, 2023. OECD Data, data as of 12/28/22; Kemp, S. 2022 – 2012. Forecasts are inherently limited and cannot be relied upon. 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.

Advertisers Have Yet To Unlock The Potential Of CTV

CTV provides advertisers with the targeting and attribution measurement once reserved for traditional digital advertisers. Combining the advantages of linear TV and digital advertising, CTV could capture share of both brand and performance ad budgets.* A meaningful disconnect exists between viewership and advertising budgets in the US. In our view, advertisers will close the gap within the next five years.



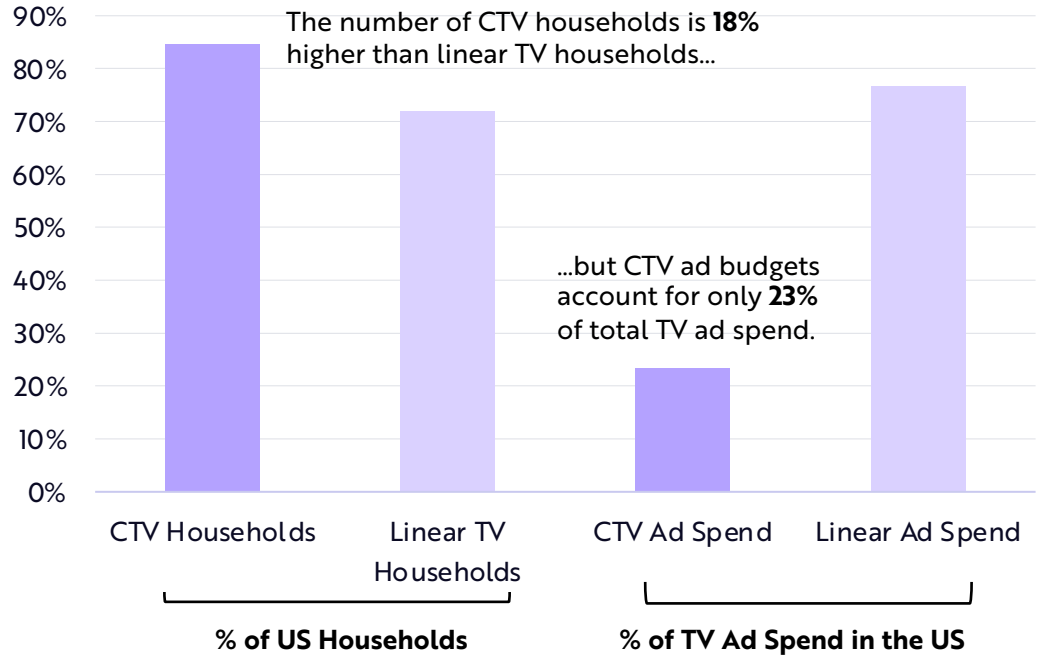
Linear TV Ads

Digital Ads

Connected TV

- Advertisers believe CTV ads deliver brand perception **46%** more effectively than linear TV.
- Advertisers believe CTV delivers website and sales actions **57%** more effectively than linear TV.

Viewership vs. Ad Spend
US CTV vs. Linear TV, 2022

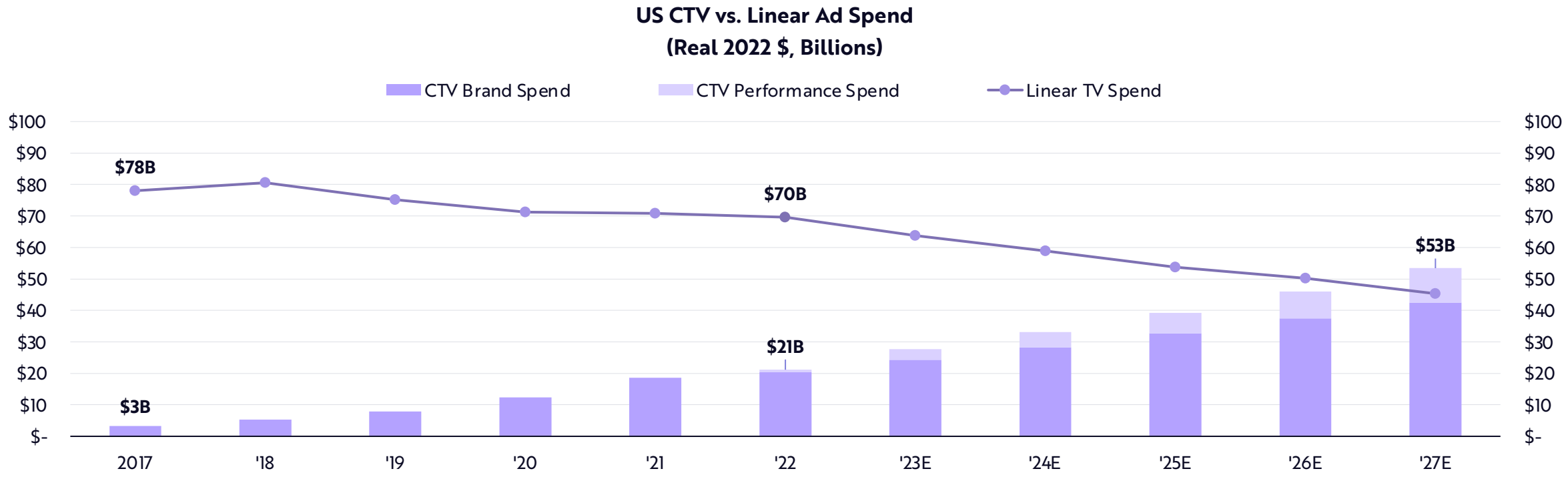


*We view a connected TV household as any household owning at least one large-screen display that can stream over-the-top (OTT) content natively through a built-in operating system (OS), external streaming media devices, video game consoles, etc. We define a linear TV household as any household that views TV via traditional pay TV subscriptions and/or free over-the-air broadcast. A single household may both be a connected TV household and a linear TV household. Sources: ARK Investment Management LLC, 2023. IAB 2022; Insider Intelligence, data as of 01/12/23; Insider Intelligence, data as of 01/12/23; S&P Global Market Intelligence, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. 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.

CTV Should Take Share From Other Digital Ad Budgets And Linear TV

As it displaces linear TV's once-dominant role in the US, total CTV ad spend should grow 20% in real terms at a compound annual rate, from $21 billion in 2022 to more than $50 billion in 2027.

After declining 2% at an annual rate for the past five years, US linear TV ad spend should decline 8% at an annual rate during the next five years, from $70 billion to $45 billion by 2027. With improved ad targeting and measurement, CTV advertising should overtake linear TV advertising in the next five years.

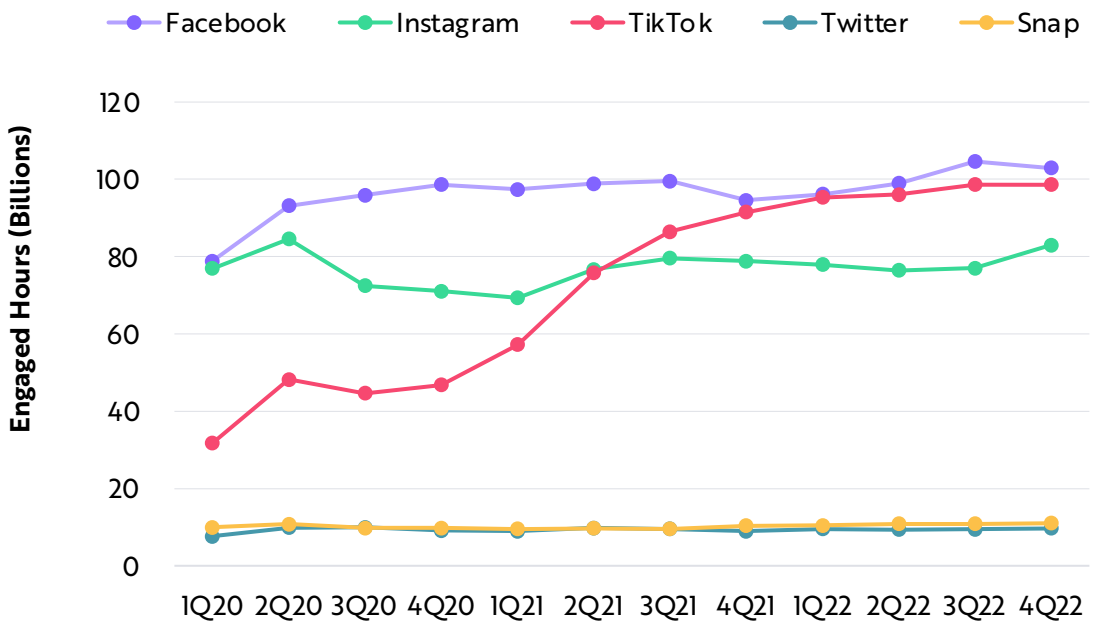


Sources: ARK Investment Management LLC, 2023. Insider Intelligence, data as of 12/22/22; S&P Global Market Intelligence, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

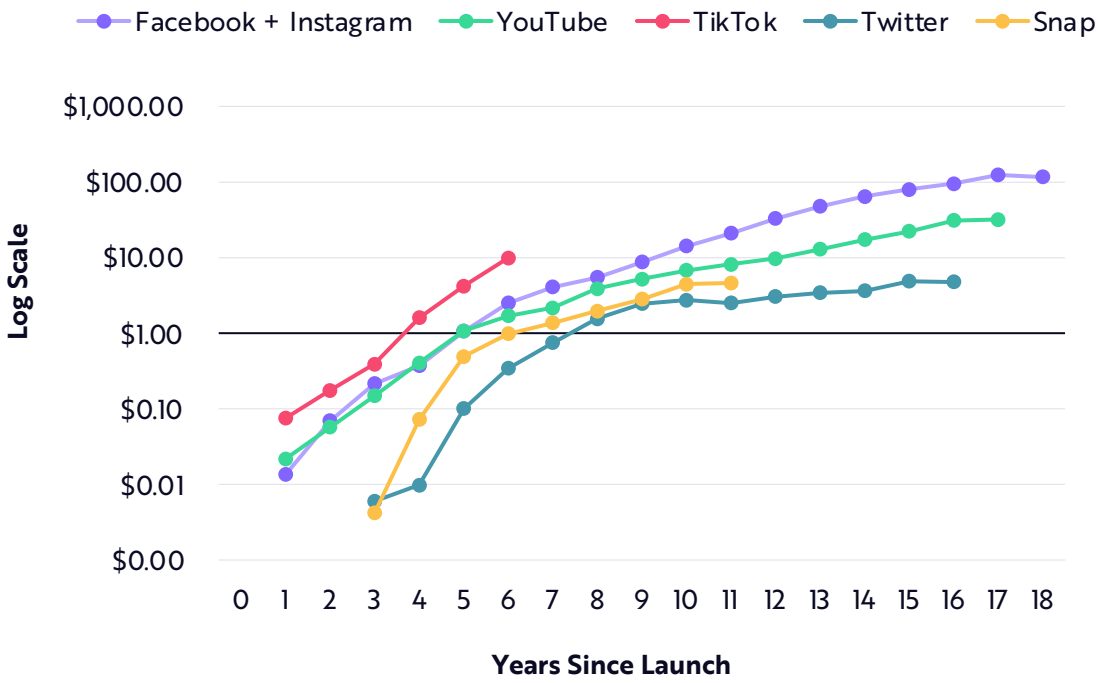
Short-Form Video And Recommendation Engines Are Displacing Incumbent Social Media

In 2022, TikTok and Facebook were roughly equal in engagement hours, which could mark the peak in traditional follow-and-feed social media. Despite scaling faster than other social media platforms, TikTok* accounted for only $10 billion, or 2% market share, of the estimated $470 billion spent on search, video, and social ads in 2022. Content-based social media is likely to capture advertising share more in line with its engagement hours.

Global Hours Spent on Mobile Social Apps* (iOS and Android)



Social Platform Ad Revenues* (Annual Real 2022 $, Billions)

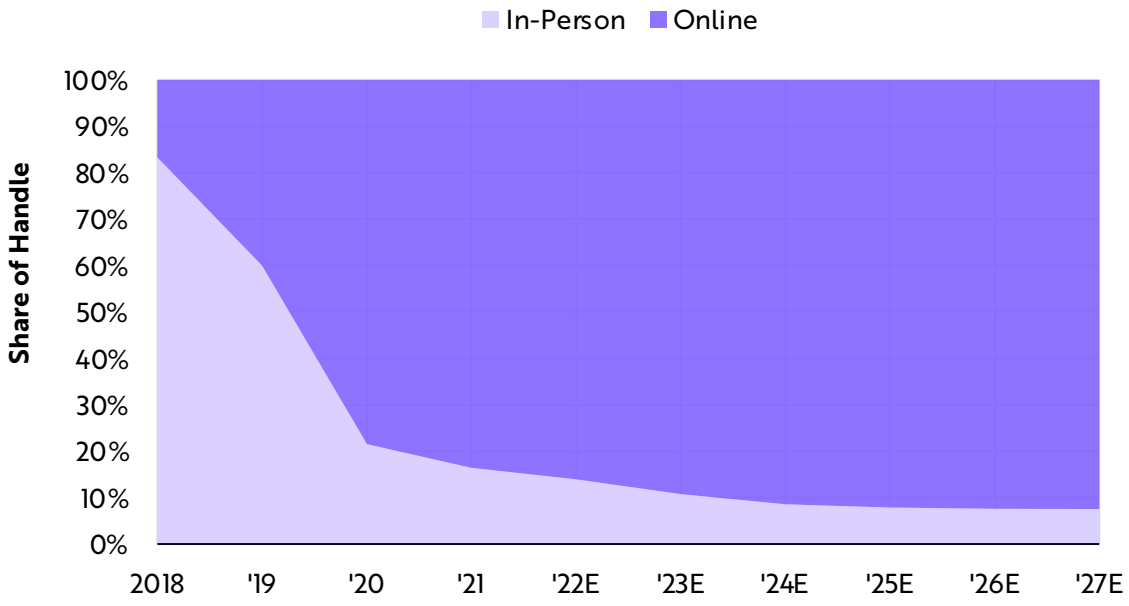


*Estimates for TikTok's engagement hours do not include Douyin. Sources: ARK Investment Management LLC, 2023. Unified, data as of 01/02/23; Tsotsis, A. 2012; Meta Platforms, Inc., data as of 12/30/22; Arrington, M. 2007; Insider Intelligence, data as of 12/22/22; Alphabet, data as of 12/30/22; Iqbal, M. 2022; Twitter, Inc., data as of 12/30/22; Wilhelm, A. 2013; Colao, J. 2012; Snap Inc., data as of 12/30/22. Forecasts are inherently limited and cannot be relied upon. 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.

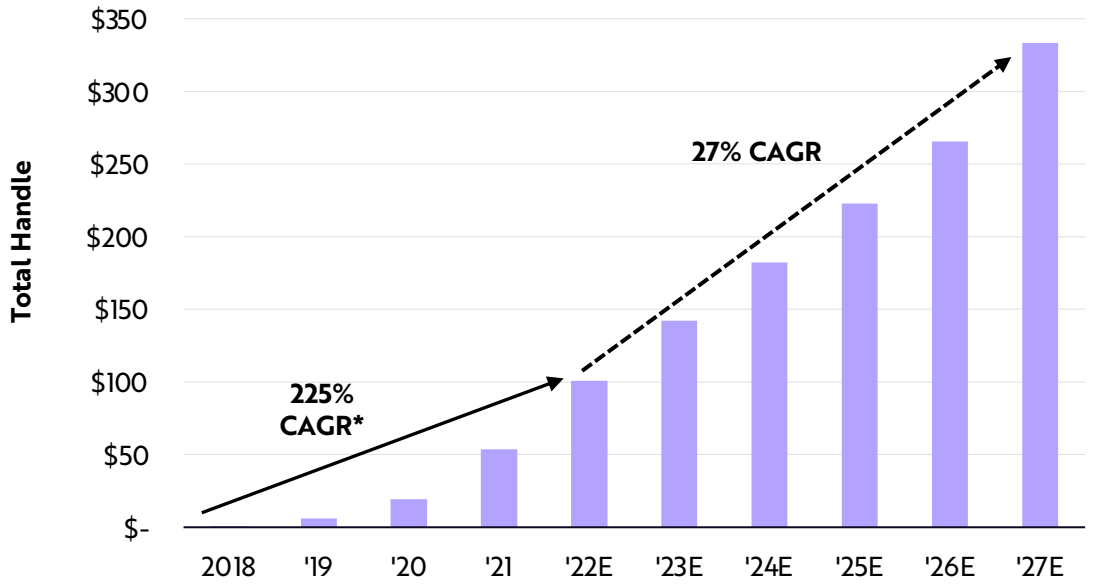
Demand For Sports Betting Remains Strong, Even In A Tough Economy

In the first NFL season without COVID-19 protocols, total sports betting in the US and Canada increased an estimated 83% year-over-year to ~$117 billion in 2022. As a percent of total sports betting volume, online has soared from 17% in 2018 to 86% in 2022. Based on ARK's research, online sports betting in the US and Canada is likely to grow 27% in real terms at an annual rate during the next five years, from ~$100 billion in 2022 to ~$330 billion in 2027. During the same time, in-person betting is likely to grow 11% at an annual rate, from $16 billion to $27 billion.

US and Ontario Sports Betting Volume, In-Person Vs. Online (Real 2022 $)



US and Ontario Online Sports Betting Volume (Real 2022 $, Billions)

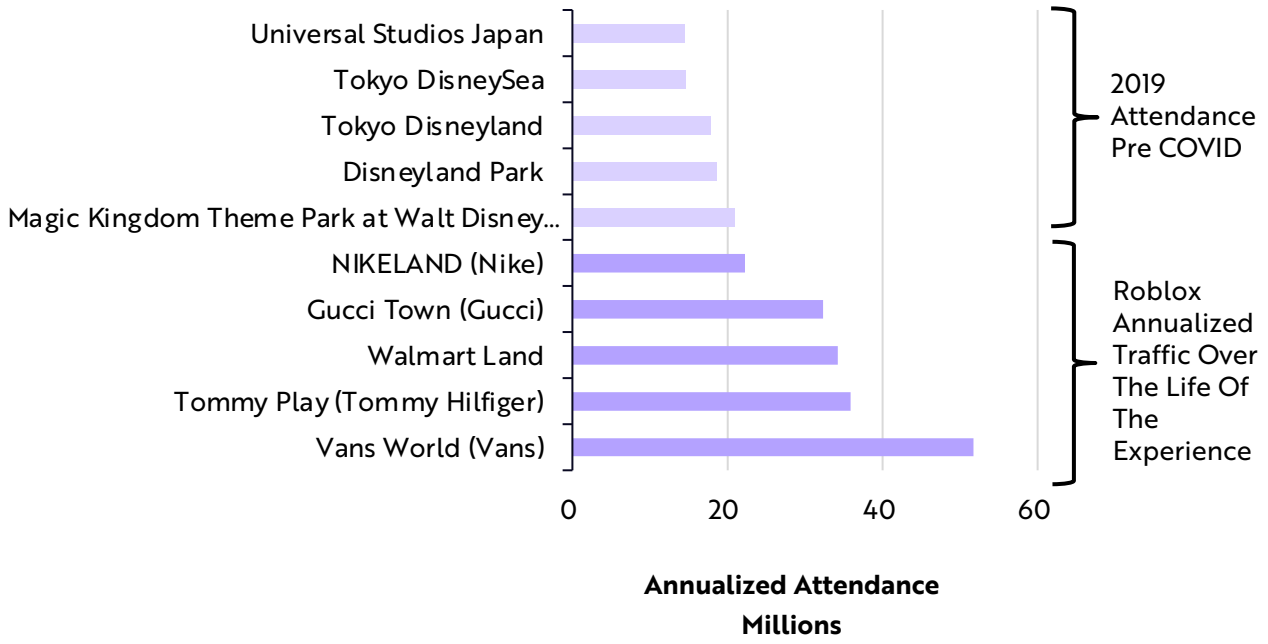


*Compound Annual Growth Rate (CAGR). Sources: ARK Investment Management LLC, 2023. Altruda, C. 2022; Arizona Department of Gaming, data as of 01/25/23; State of Colorado, data as of 01/25/23; New Hampshire Lottery Commission, data as of 01/25/23; PA Gaming Control Board, data as of 01/25/23; Virginia Lottery, data as of 12/30/22; PLAYWV, data as of 12/30/22; Wyoming Gaming Commission, data as of 12/30/22. Forecasts are inherently limited and cannot be relied upon. 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.

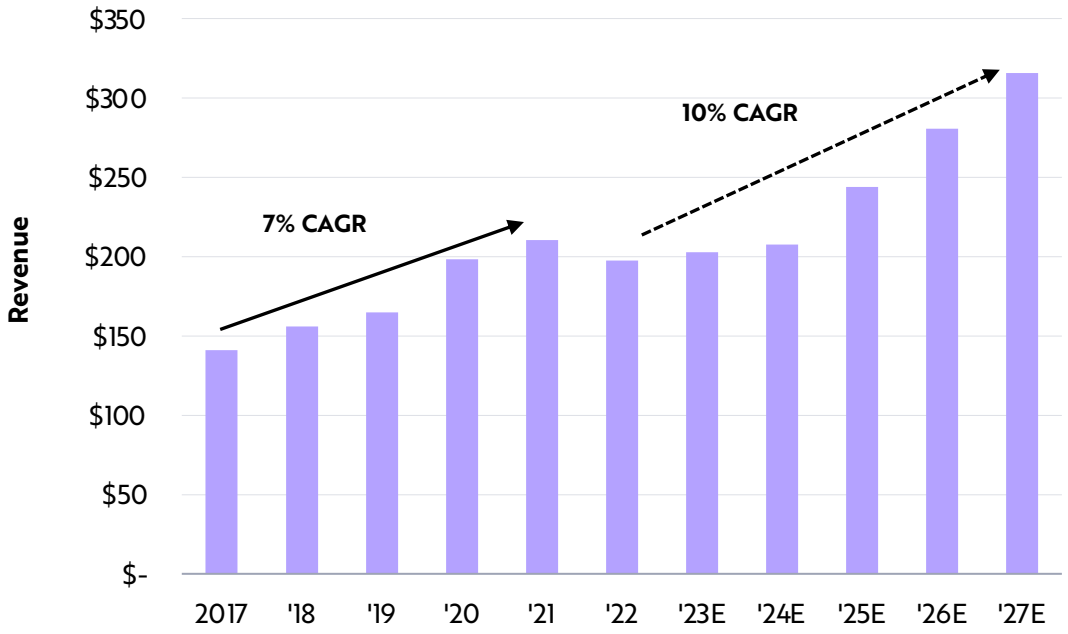
Immersive Virtual Experiences Should Galvanize The Next Wave Of Gaming

As the gaming industry transitions to full-service virtual worlds, video games and social media could merge as consumers socialize and entertain in game-supported virtual spaces, at the expense of physical environments. According to ARK's research, the convergence between gaming and social media should boost the growth in gaming revenue from 7% at a compound annual rate during the past five years to 10% during the next five years.

Attendance At Physical Amusement Parks vs. Branded Virtual Worlds



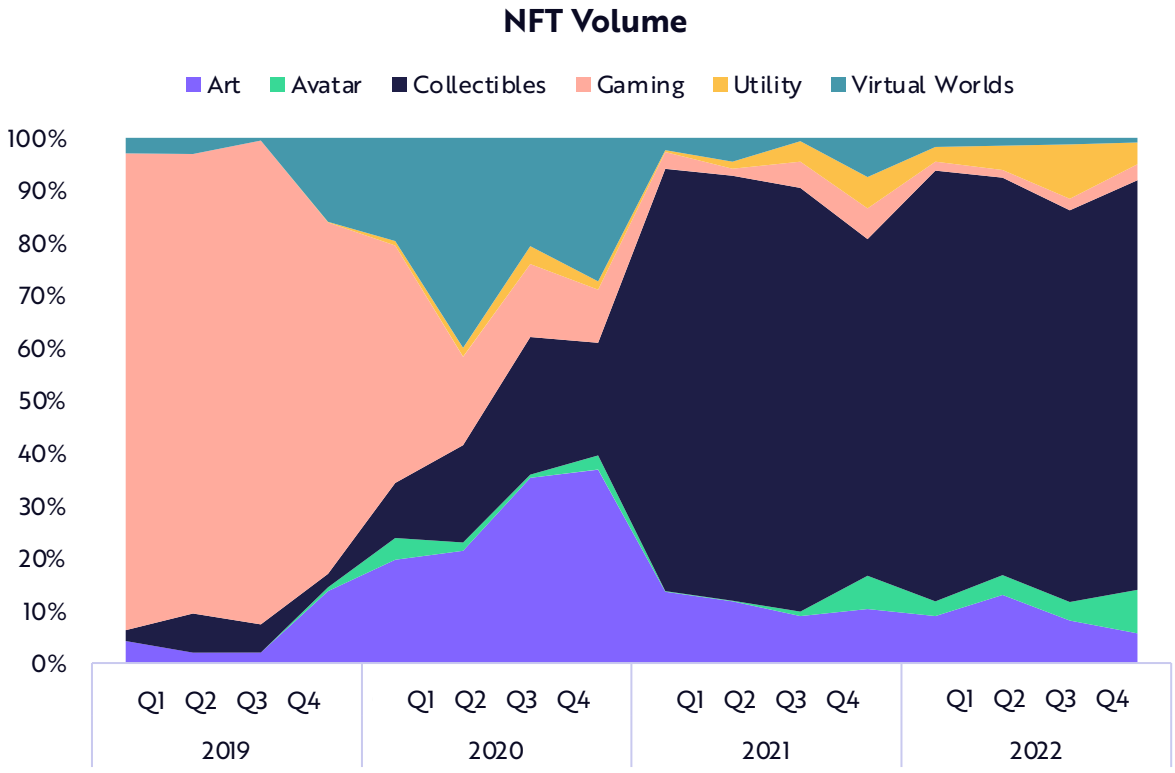
Global Gaming Software and Services (Real 2022 $, Billions)

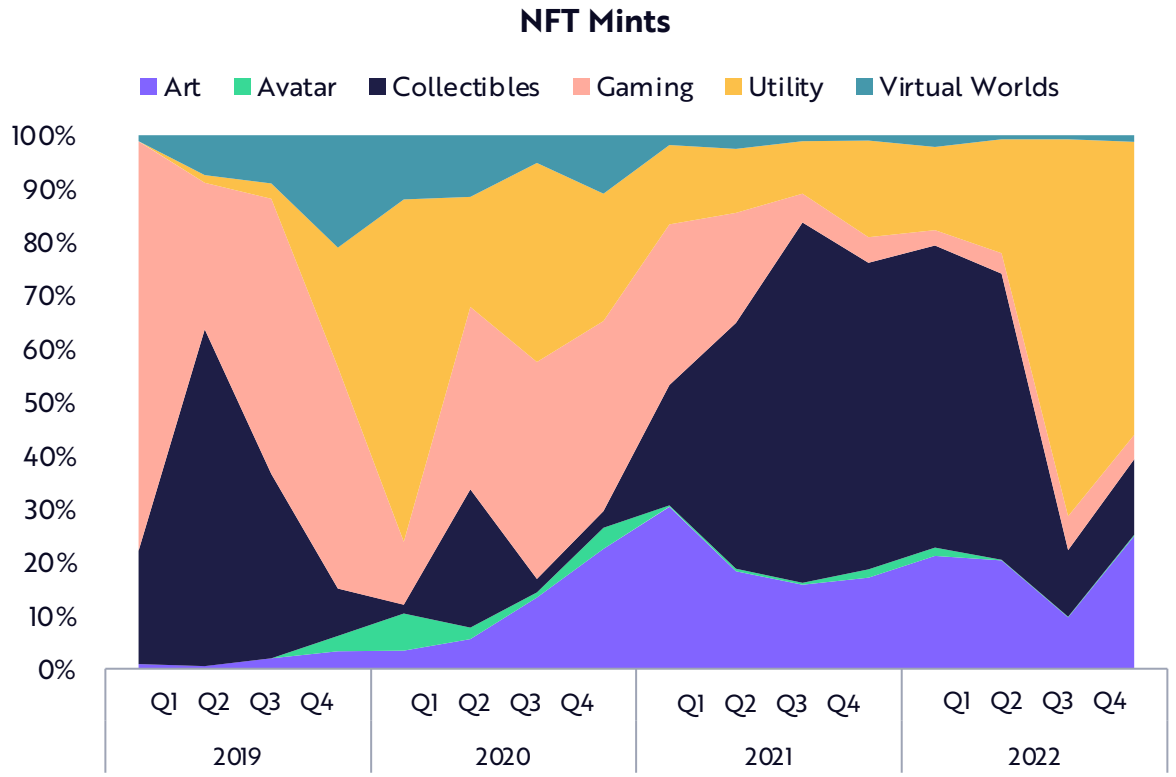


*Compound Annual Growth Rate (CAGR). Note: We annualize Roblox traffic by taking all-time traffic data as provided by Roblox and take the difference between the date pulled and the experience's launch date. We then calculate the average traffic per day for each experience to ultimately gross up the daily traffic estimate to an annualized figure. Sources: ARK Investment Management LLC, 2023. Altruda, C. 2022; Roblox, data as of 12/30/22; S&P Global Market Intelligence, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. 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.

Trading And Creation Of Digital Assets Diverged During The Bear Market

In 2022, NFT* trading volume increased 15% year-over-year, dominated by high-profile collectible projects like Bored Ape Yacht Club and Crypto Punks. The share of NFTs minted, however, shifted toward utility-based projects like on-chain domain names and digital memberships. Focused on underlying value instead of speculation, the shift toward utility is a healthy development.

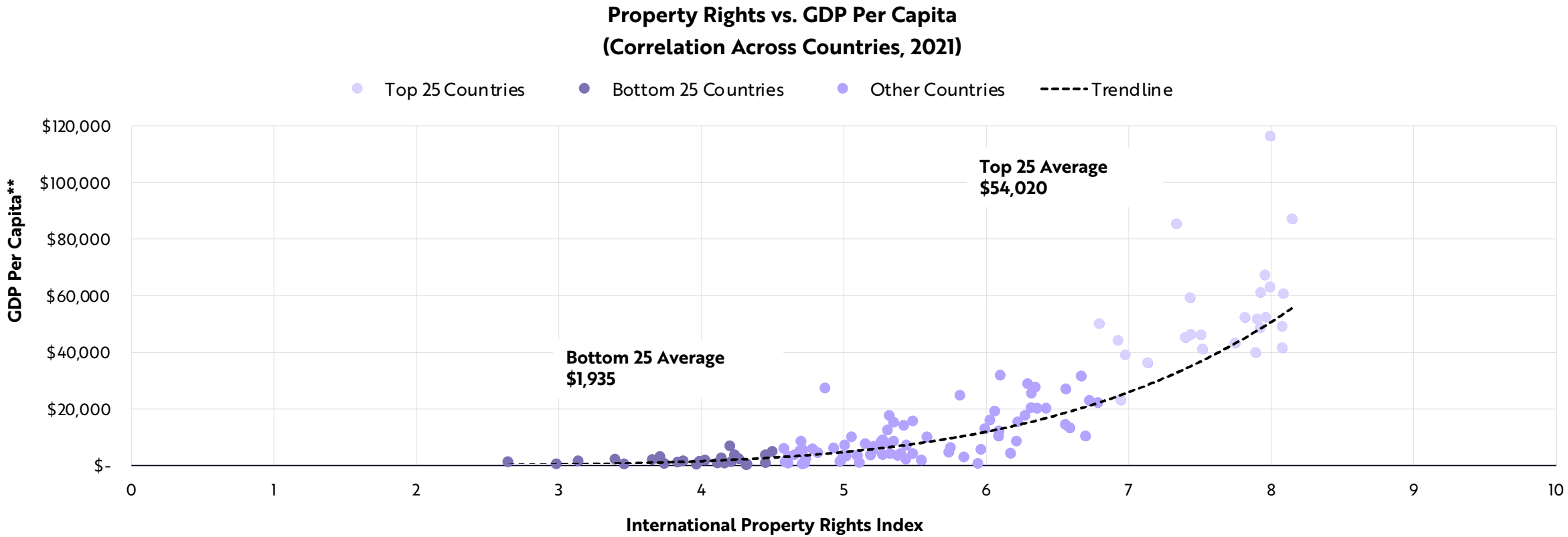




*Non-fungible token (NFT), a unique, programmable blockchain-based digital object that proves ownership of digital assets. Sources: ARK Investment Management LLC, 2023. Dune Analytics, data as of 01/23/23; CryptoSlam, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. For 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.

Based On The Introduction Of Property Rights, Digital Assets Should Accrue Significant Value

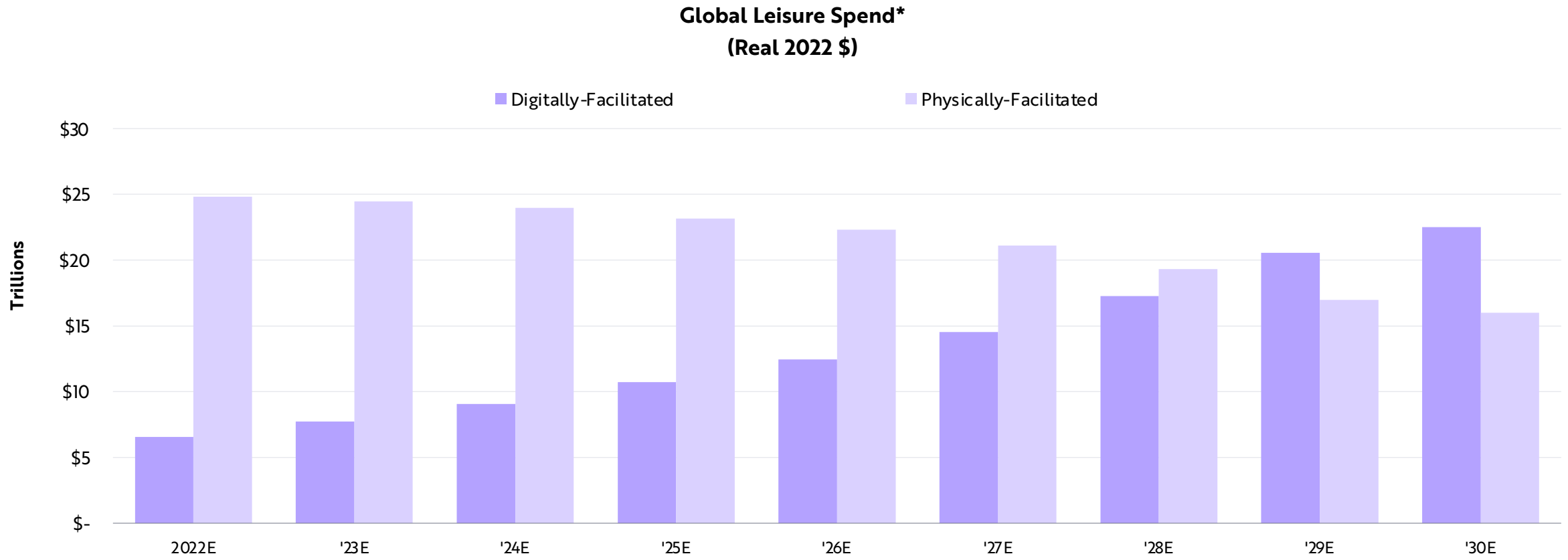
Physical and intellectual property rights correlate positively to GDP* per capita, a common proxy for quality of life. In our view, thanks to decentralized proof-of-ownership, digital assets are likely to increase online spending per capita. ARK forecasts that global NFT transaction volume will grow more than five-fold from $22 billion today to $120 billion by 2027.



*Gross domestic product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period. **Real 2022 $. Sources: ARK Investment Management LLC, 2023. Property Rights Alliance, data as of 01/25/23; The World Bank, data as of 12/30/22; CryptoSlam, data as of 01/02/23. Forecasts are inherently limited and cannot be relied upon. 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 Leisure Is In Early Innings

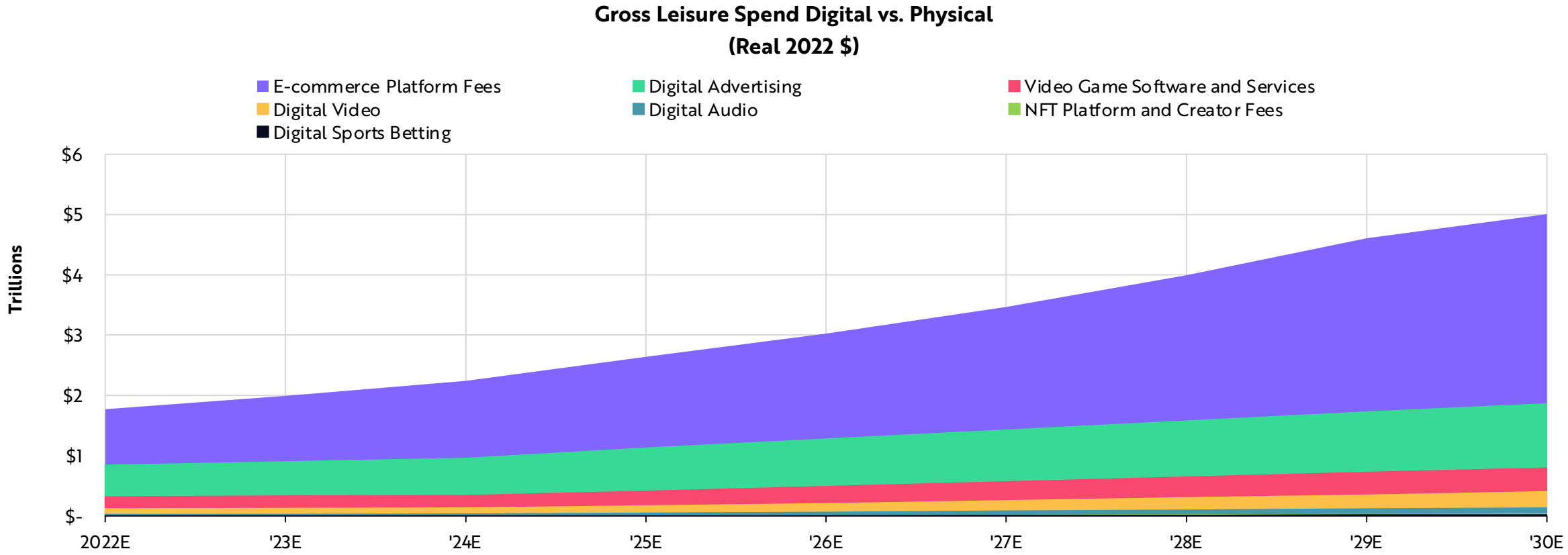
According to ARK's research, global consumers spent 21% of their $31 trillion leisure budget on digitally-facilitated goods and services in 2022. Demand for digital goods and services is likely to grow 17% at an annual rate in real terms, surpassing demand for physically-facilitated goods and services in 2029.



*We define digital leisure spending as the sum of consumer expenditures on leisure-related goods and services purchased online, NFTs, online sports betting, video game software and services, streamed video, and streamed audio. We only estimate online sports betting volume generated in Canada and the US. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Leisure Revenue Could Reach $5 Trillion Globally In 2030

Based on the shift toward digital leisure and digital property rights, real digital revenue* should grow 14% at an annual rate during the next eight years, from ~$2 trillion in 2022 to $5 trillion in 2030.



*We define digital leisure revenue as the revenue accrued to platforms and creators from digitally-facilitated leisure spending. We sum e-commerce marketplace fees related to leisure-related goods and services, total digital ad expenditures, gross video game software and services revenue, gross streamed video revenue, gross streamed audio revenue, gross gaming revenue attributable to online sportsbook operators in Canada and the US, and NFT platform and creator fees. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Wallets

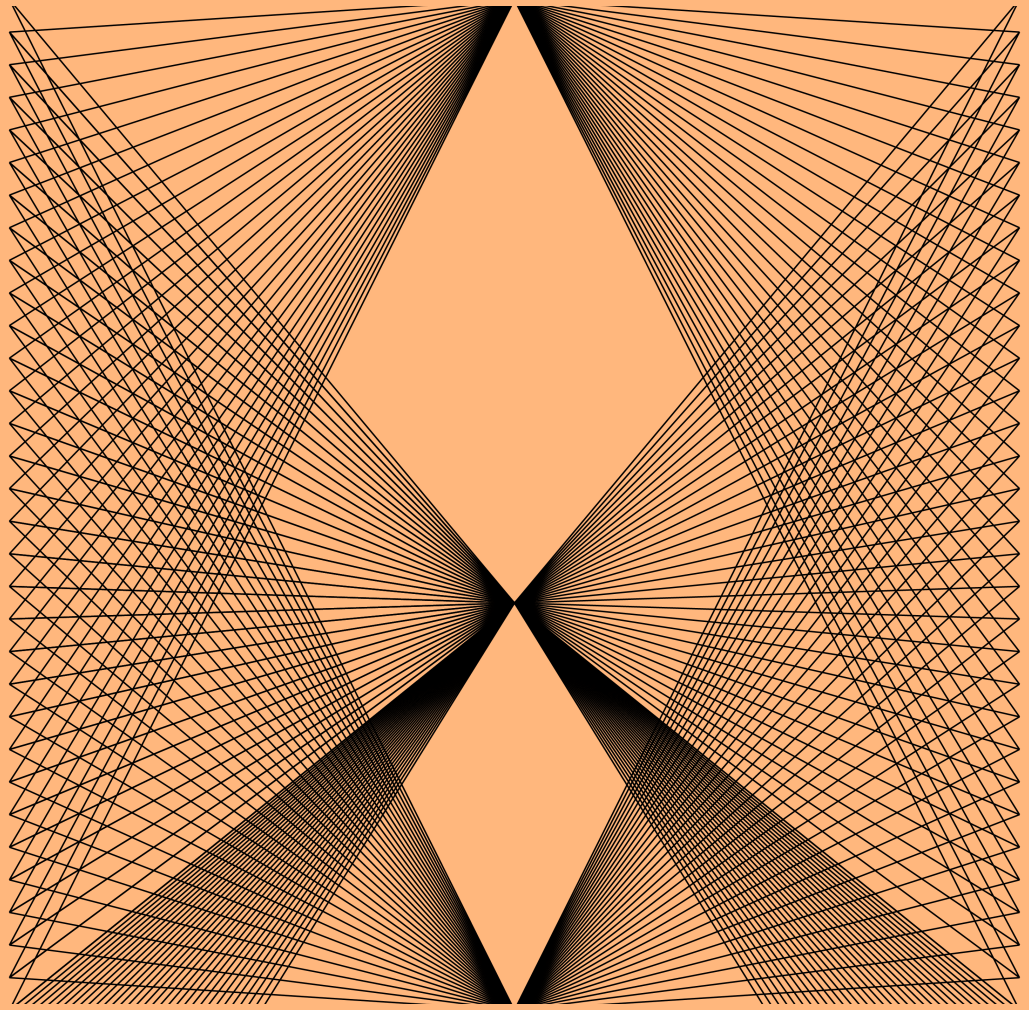
Disintermediating Traditional Banking

Having onboarded billions of consumers and millions of merchants, digital wallets could transform the economics associated with traditional payment transactions, saving them nearly $50 billion in costs.

With 3.2 billion users, digital wallets have penetrated 40% of the global population. ARK research suggests that the number of digital wallet users will increase 8% at an annual rate, penetrating 65% of the global population by 2030.

As consumers and merchants adopt digital wallets, the usage of traditional checking accounts, credit and debit cards, and direct merchant accounts should decline, disrupting traditional payment intermediaries.

Cutting out middlemen, digital wallets could facilitate closed-loop transactions for more than 50% of their payment volumes, potentially adding $450 billion to the current $1 trillion in digital wallet enterprise value by 2030.



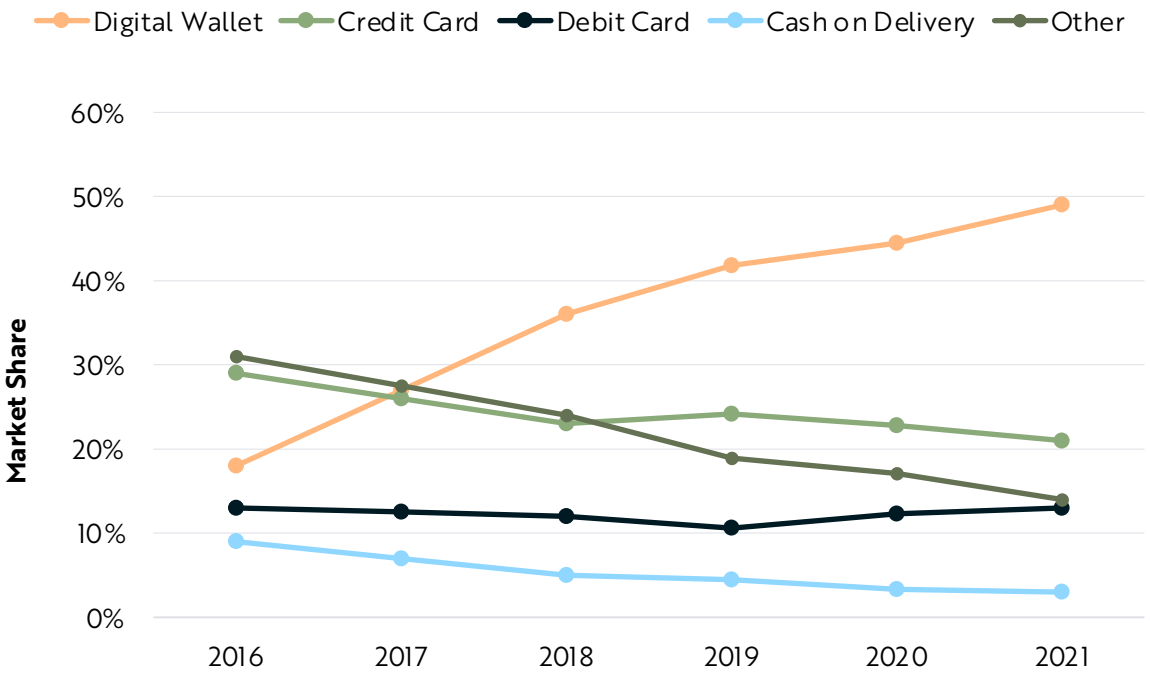
Research by Maximilian Friedrich, Co-Lead, ARK Venture & Analyst
Andrew Kim, Research Associate

Digital Wallets Are Gaining Share In Online And Offline Transactions

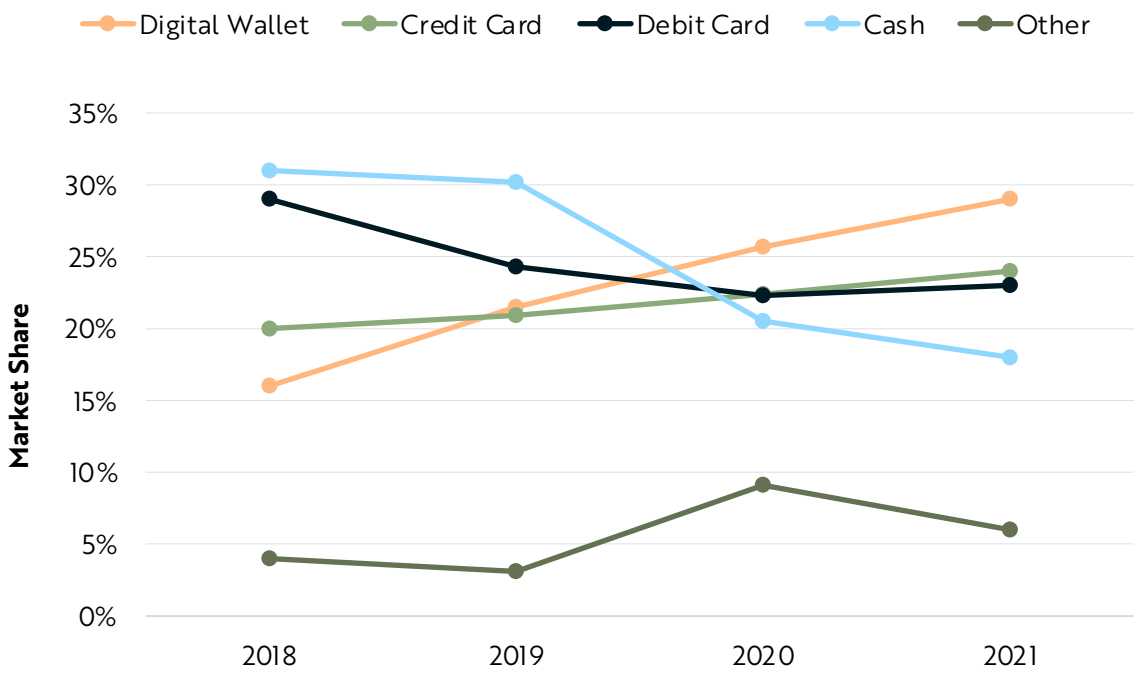
In 2021, digital wallets facilitated 49% of e-commerce transactions, up from 18% in 2016. Since 2016, digital wallets have been gaining share at the expense of credit cards, bank transfers, and cash.

In 2021, digital wallets facilitated 29% of offline transactions, nearly double the 16% in 2018. Overtaking cash as the primary means of offline transactions during the COVID pandemic in 2020, digital wallets continue to gain share.

Payment Methods As Share Of Global E-Commerce Volume



Payment Methods As Share Of Global Point-Of-Sale (POS) Volume

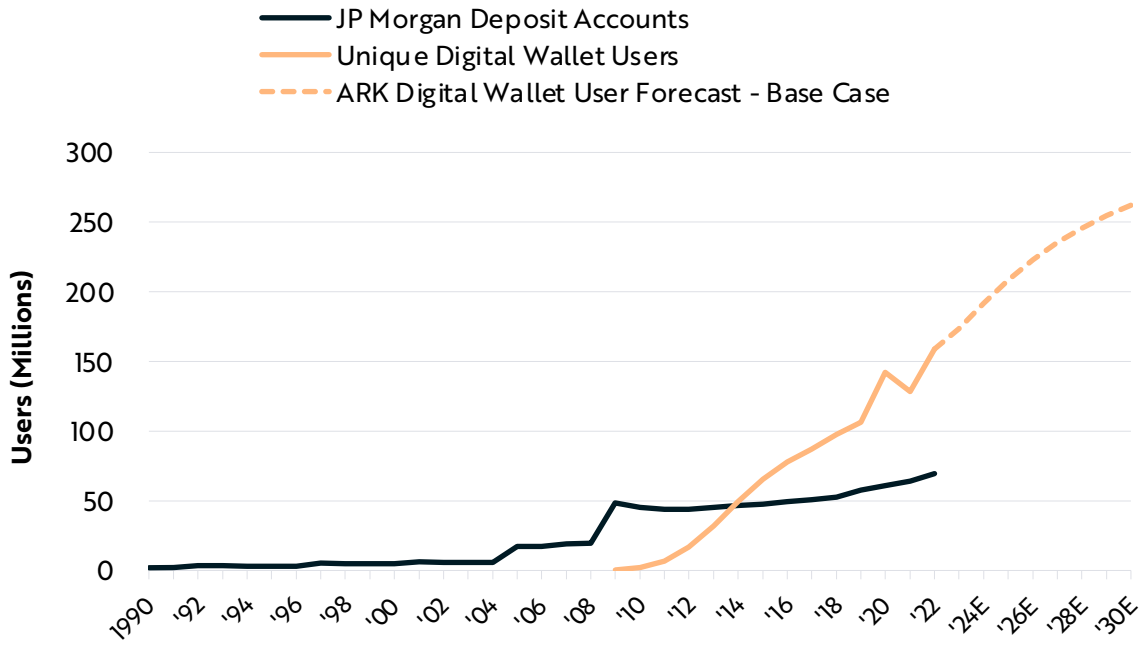


Sources: ARK Investment Management LLC, 2023. Worldpay, LLC 2017; Worldpay, LLC 2018; FIS 2020; FIS 2021; FIS 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

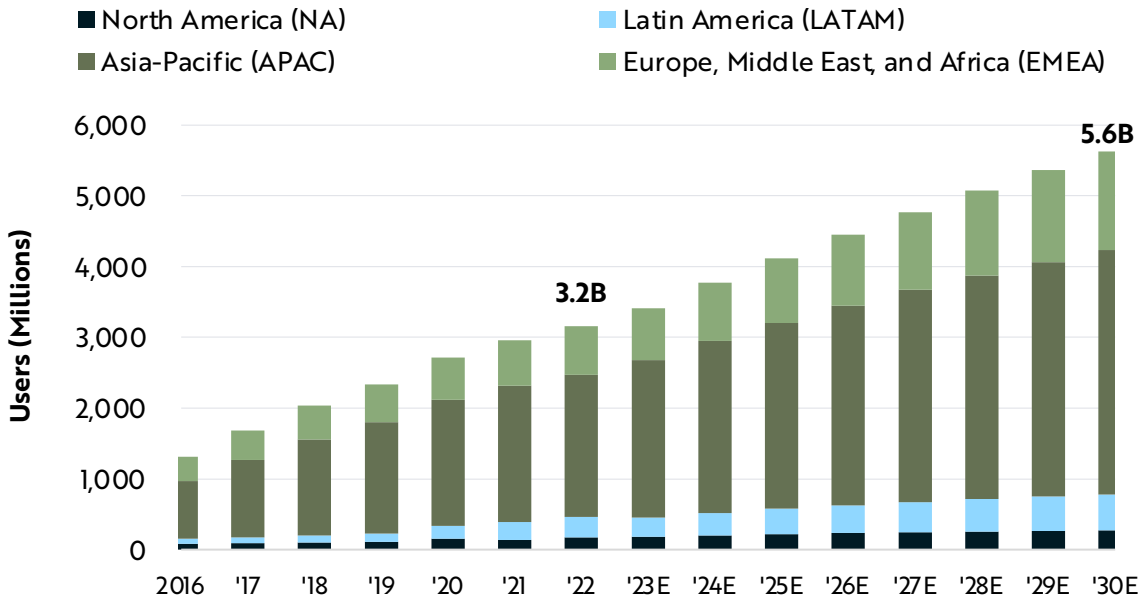
Digital Wallets Are Scaling Faster Than Accounts At Traditional Financial Institutions

The network effects associated with low customer acquisition costs and a superior user experience are powering digital wallet adoption. After the COVID-induced acceleration and subsequent churn, US digital wallet adoption rebounded in 2022, surpassing previous highs. According to our estimates, US digital wallet users will increase 7% at an annual rate during the next eight years, from ~160 million in 2022 to more than 260 million, while the number of global digital wallet users increases 8% at an annual rate, hitting 5.6 billion, 65% of the global population, by 2030.

US Unique Digital Wallet Users
ARK Estimate And Forecast*



Global Unique Digital Wallet Users
ARK Estimate And Forecast



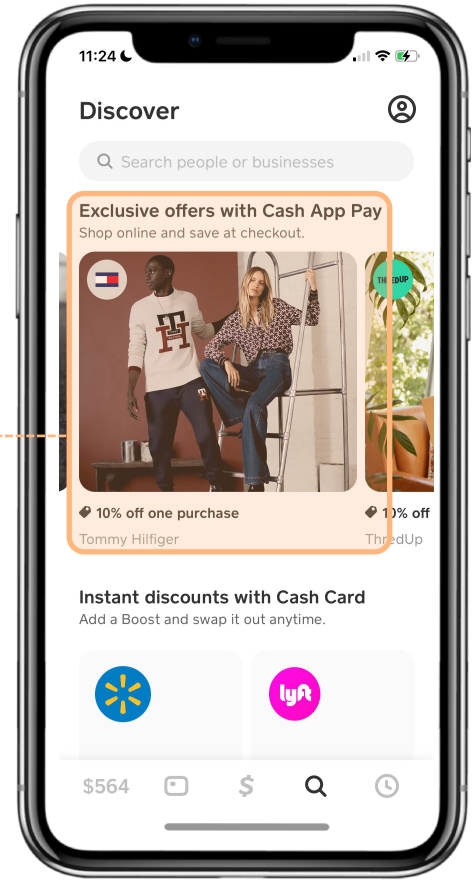
*Due to a regulatory reporting change, JP Morgan publicized the number of deposit accounts of $100,000 or less until 2010. From 2010 onwards, JP Morgan has since publicized the number of deposit accounts excluding retirement accounts of $250,000 or less. Data from 1990 to 2009 reflect the number of accounts as of June 30th of each calendar year, while subsequent data reflect the number of accounts as of calendar year end. Sources: ARK Investment Management LLC, 2023. FDIC, data as of 01/17/23; FFIEC, data as of 01/17/23; The World Bank, data as of 01/20/23; Anan, L. et al. 2020; Anan, L. et al. 2022; Forecasts are inherently limited and cannot be relied upon. 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 Wallets Create Closed-Loop Ecosystems For Consumers and Merchants

After acquiring billions of users, digital wallets are onboarding millions of merchants to platforms that enable direct consumer-merchant transactions that disintermediate traditional financial institutions.*

1.3 Billion Consumers	**Alipay**	80 Million Merchants
84 Million Consumers	**Block**	7 Million Merchants
51 Million Consumers	**PayPay**	3.9 Million Merchants
12 Million Consumers	**Kaspi**	413,000 Merchants

Block encourages its 86 million Cash App users to shop in Cash App's merchant network with Cash App Pay.



*We estimate Cash App's annual active users in 2022 using public filings, public investor presentations and conferences, and third-party mobile app data. We estimate the number of merchants within Block's ecosystem by taking the average total payment volume (TPV) per annual active merchant account as disclosed in PayPal's public filings and divide the figure by our estimate for Block's consolidated TPV in 2022. Alipay's consumer and merchant count source citations published in 2021 and 2020, respectively. PayPay and Kaspi's consumer and merchant estimates are from each company's second fiscal quarter and third fiscal quarter filings, respectively. Sources: ARK Investment Management LLC, 2023. Block, Inc, data as of 12/29/22; Sensor Tower Inc, data as of 01/25/23; Kaur , D. 2022; China Internet Watch 2022; Z Holdings, data as of 01/17/23; Kaspi, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

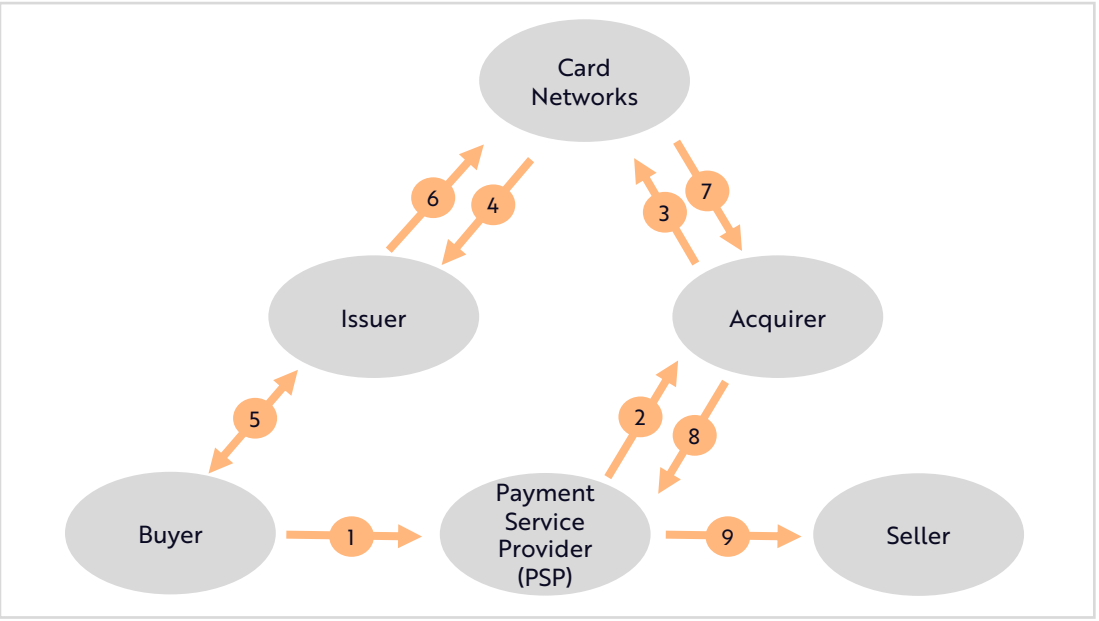
Digital Wallets Eliminate Middlemen By Enabling Direct Payments Between Consumers And Merchants

In the traditional payment chain, several intermediaries take tolls on payments* between consumers and merchants. By enabling in-network transactions, digital wallet providers capture more value per transaction and can share the savings with merchants and consumers.

Traditional Open-Loop Credit And Debit Card Transaction

Steps Between Buyer and Seller: 9

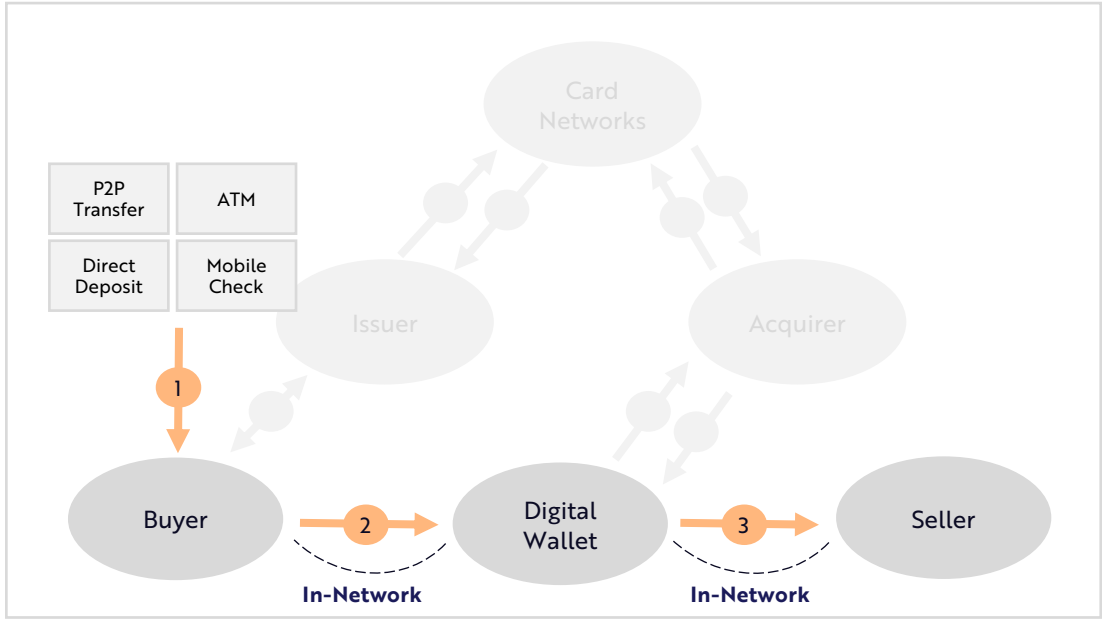
Estimated Intermediary Fees: 2.6%



Closed-Loop Balance-Funded Transaction

Steps Between Buyer and Seller: 3

Estimated Savings: 2.4%

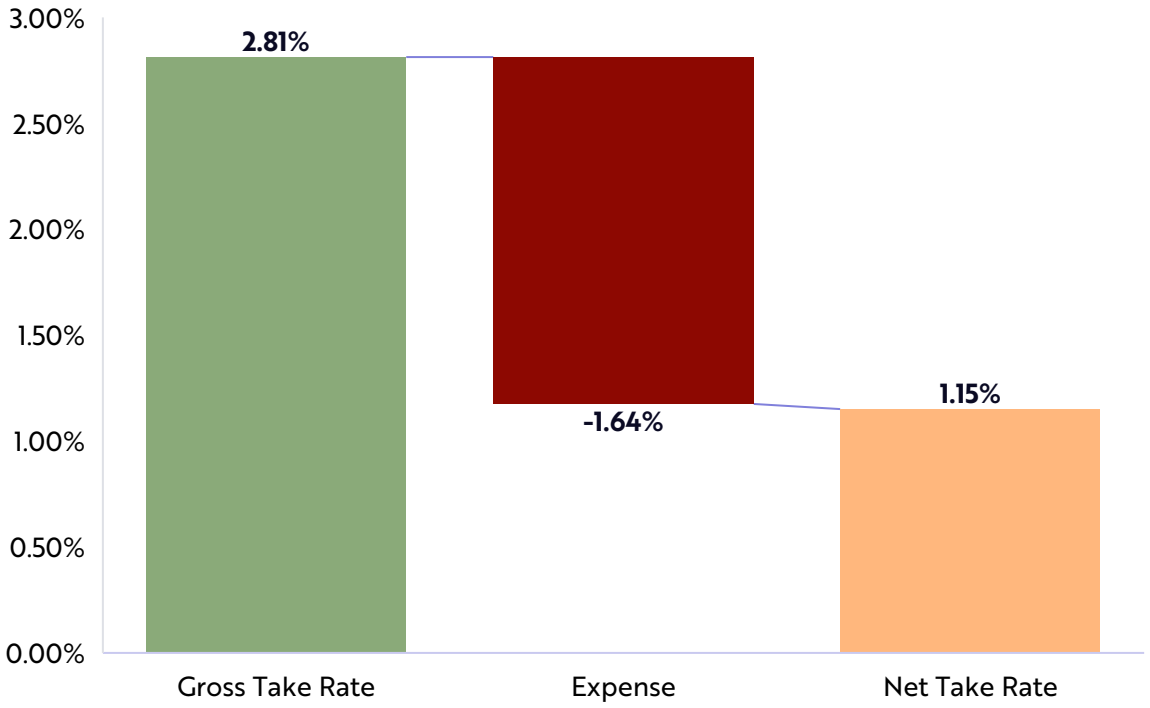


*Estimated fees and payment processes are rendered for illustrative purposes only and are based on sources specific to payment infrastructure in the United States. To estimate intermediary fees under the current payment value chain in the US, we embed our estimate for interchange, card network, issuer, acquirer, and PSP fees. We assume that a closed-loop transaction can eliminate interchange, card network, issuer, and legacy acquirer fees, but we add back estimated costs associated with topping up digital wallet balances and usage of modern payment facilitators. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

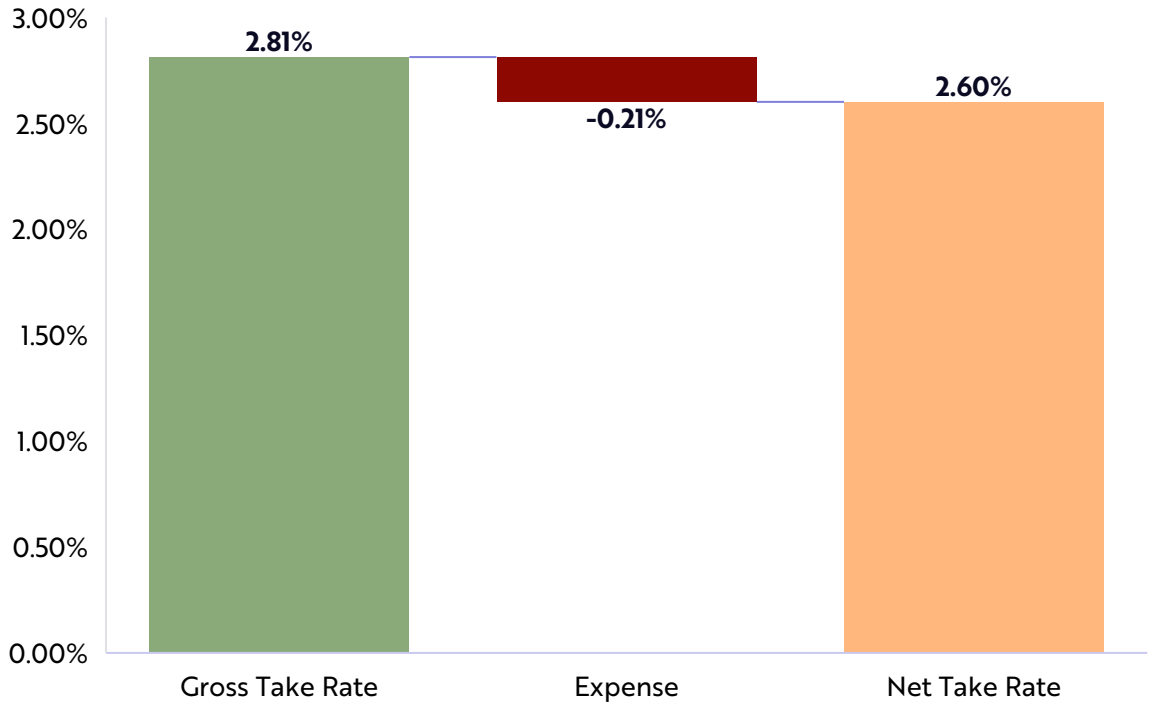
Closed-Loop Transactions Could Boost The Margin Structure Of Digital Wallet Providers

In 2022, Block paid ~60% of customer transaction fees to third parties for interchange, assessment, processing, and bank settlement fees. If Cash App customers were to use their balances to transact with Block merchants, Block's net take rate could more than double.*

Block's Current Unit Economics (Percent of Transaction)



Block's Potential Closed-Loop Unit Economics (Percent of Transaction)

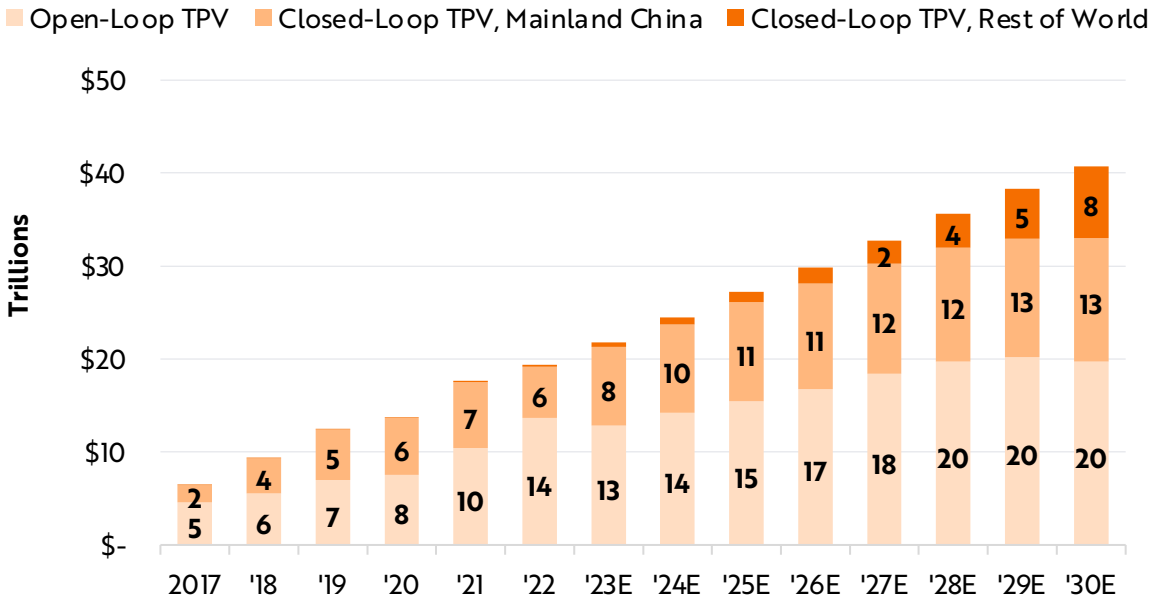


*In the above exercise, we illustrate a scenario in which Block captures 100% of the cost savings associated with the implementation of closed-loop transactions. In reality, we believe the benefits of such cost savings will be shared across PSPs, consumers, and merchants. To calculate Block's gross take rate, we divide consolidated gross payment volume (GPV) by total transaction revenue. To calculate Block's net take rate, we divide total transaction gross profit by total GPV. We use the summed data disclosed by Block through the first three fiscal quarters of 2022. We embed 0.21% in costs associated with closed-loop transactions, attributable to ACH transactions and usage of third-party payment facilitators that help distribute the payment method to merchants. Sources: ARK Investment Management LLC, 2023. Block, Inc., data as of 01/19/23. Forecasts are inherently limited and cannot be relied upon. 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.

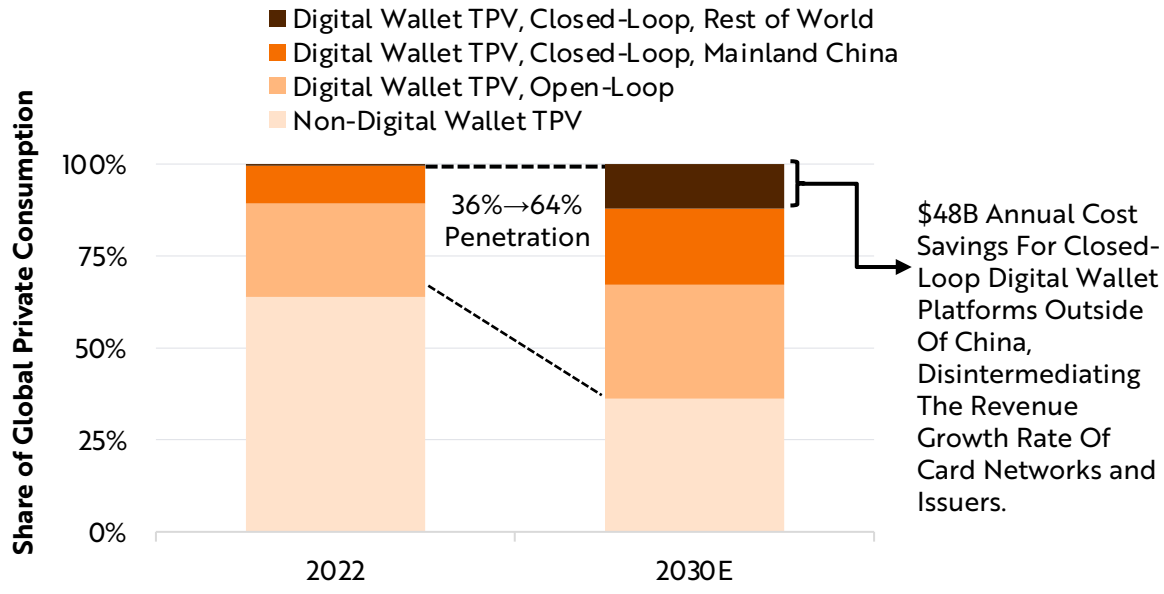
Closed-Loop Transactions Could Account For More Than 50% Of Digital Wallet Payments By 2030

Commonplace in mainland China, closed-loop transactions could disintermediate third-parties and generate nearly $50 billion in cost savings for digital wallet platforms, consumers, and/or merchants outside of mainland China, potentially adding $450 billion to the $1 trillion in total enterprise value of digital wallet platforms by 2030.

Global Digital Wallet TPV*
(Real 2022 $)



Closed-Loop Cost Savings Relative To Global Credit And Debit Transaction Revenue, Real $2022



*Total processed volume (TPV) only refers to consumption-related payments online or at the point-of-sale. To calculate closed-loop TPV, we assume that digital wallet platforms capture most of the cost savings associated with closed-loop transactions and that these platforms will incentivize users to transact with in-network merchants in the form of rewards. We regress total payment volumes by major credit card issuers, such as American Express, Capital One, and Discover, on their credit card reward expenses to project how incremental reward spend by digital wallet platforms can generate additional TPV in the form of closed-loop transactions. We assume that incremental cost savings from increased adoption of closed-loop payments in mainland China will be negligible, as we estimate that 1) PSP gross and net take rates for consumption transactions are already low and may remain low due to competitive and regulatory pressures, and 2) the penetration of balance-funded transactions has already reached maturity and will not meaningfully increase throughout the next decade. To calculate the incremental cost savings accrued to digital wallet platforms, we forecast open-loop and closed-loop net PSP take rates outside of mainland China out to 2030 and take the difference in revenue implied by the two metrics after accounting for other closed-loop transaction costs. We do not include additional cost savings from the potential decline in overdraft, checking account maintenance, and ATM fees, as well as interest income lost from churned deposits. Finally, to calculate the $450 billion in incremental enterprise value, we apply a 9.5x gross profit multiple to our 2030 TPV estimates, then take the difference in enterprise value between our forecast and a scenario in which 100% of digital wallet transactions outside of mainland China remain open-loop. Sources: ARK Investment Management LLC, 2023. Ant Group 2023; McKinsey & Company 2022; MPayPass 2020-2022. Forecasts are inherently limited and cannot be relied upon. 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.

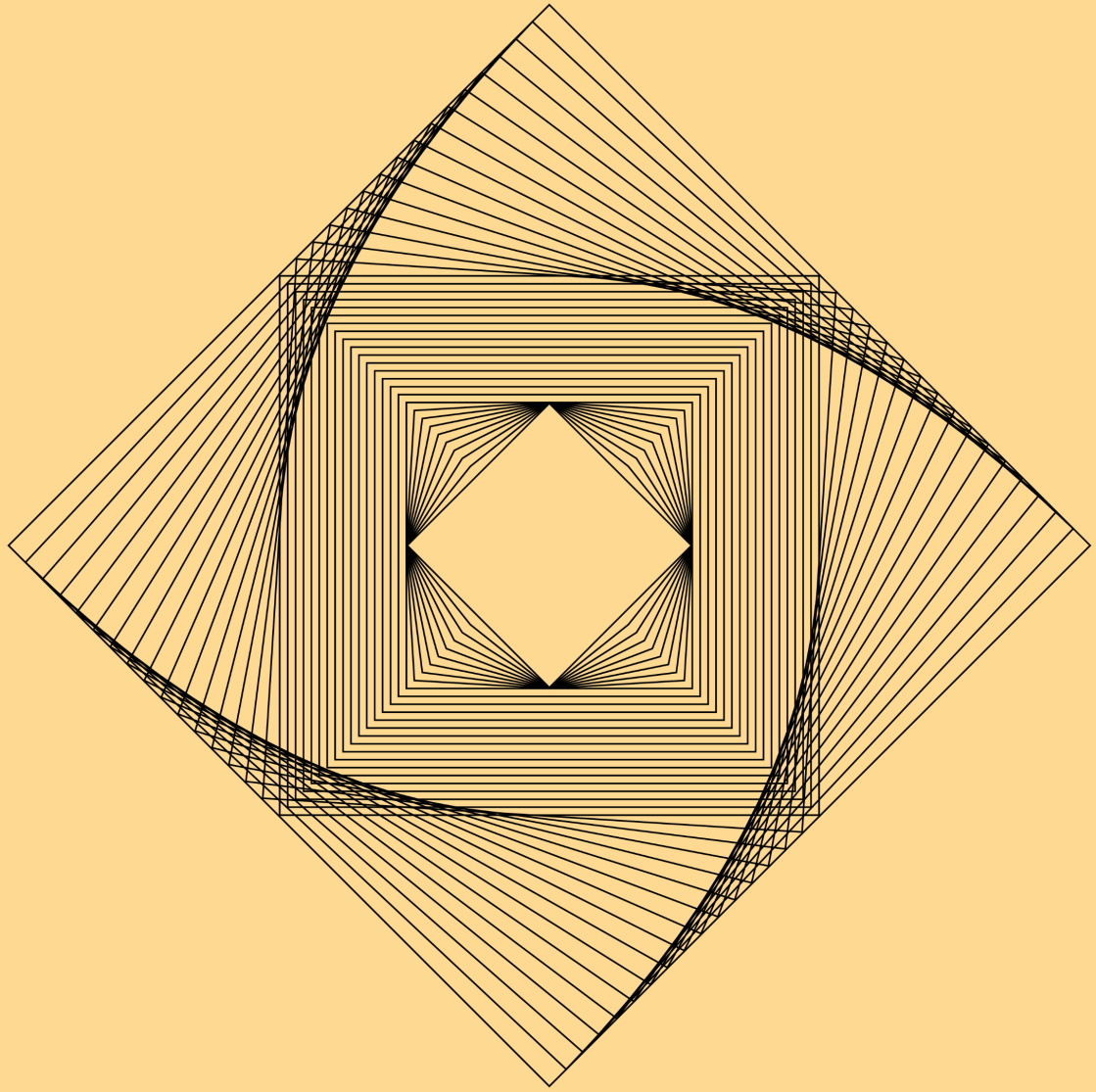
Public Blockchains

Gaining Traction In The Midst Of Crisis

In 2022, the contagion from Terra/LUNA, Three Arrows Capital, Celsius, and FTX/Alameda wiped out ~$1.5 Trillion in crypto market capitalization.

Despite the severe downturn, public blockchains continue to foster The Monetary, Financial, And Internet Revolutions. The long-term opportunity for Bitcoin, DeFi, and Web3 is strengthening.

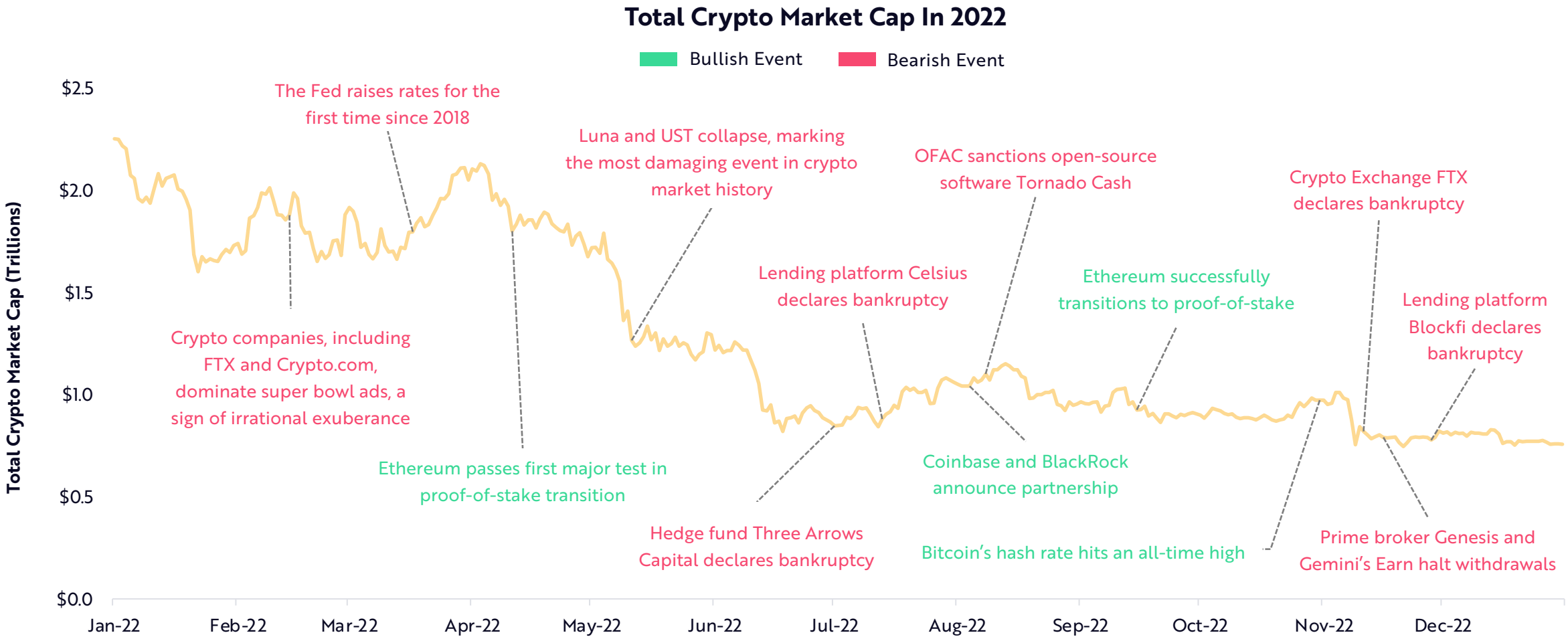
Cryptocurrencies and smart contracts could command $20 trillion and $5 trillion in market value, respectively, during the next ten years.



Research by Yassine Elmandjra, Crypto Lead
Frank Downing, Director of Research, Next Generation Internet
David Puell, Research Associate

Sources: ARK Investment Management LLC, 2023. CoinMarketCap, data as of 12/31/2022. Forecasts are inherently limited and cannot be relied upon. 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.

Contagion Wiped Out ~$1.5 Trillion In Crypto Market Capitalization In 2022



Sources: ARK Investment Management LLC, 2023. Ponnezhath, M. et al. 2022; Choo, L. 2022; Tepper, T. 2022; TechnoPixel 2022; Sandor, K. et al. 2022; De, N. et al. 2022; Tejpaul, B. et al. 2022; US Department of the Treasury 2022; O'Neill, A. 2022; Sigalos, M. 2022; Ponciano, J. 2022; Sigalos, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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 Severe Downturn, Public Blockchains Continue To Foster Multiple Revolutions

Public Blockchain Infrastructure

The Money Revolution

Coordination of value transfer and property rights outside the purview of centralized authorities, governments, and top-down control

Fiat Currencies & Central Banking → Global, Decentralized, Non-State Money

- Bitcoin has settled ~$100 trillion of value in ~791 million transactions since its inception.
- Independent of price, miners continued to validate transactions, mining ~53,000 blocks and generating ~$10 billion of revenue in 2022.

The Financial Revolution

Coordination of financial services and contracts outside the purview of traditional financial institutions

Traditional Finance (TradFi) → Decentralized Finance (DeFi)

- In 2022, decentralized financial services demonstrated resilience relative to their centralized counterparts in 2008-09.
- In the face of fraud, undisciplined risk, and non-transparent operators, demand for decentralized, auditable and transparent financial services is stronger than ever.

The Internet Revolution

Coordination of identity, reputation, and data outside the purview of traditional media conglomerates and big tech

Corporate-Owned Platforms → Interoperable, User-Owned Web

- NFTs[1] highlight the potential for mainstream crypto demand and could put private key cryptography in the hands of millions.
- Dozens of companies and publishers have announced web3 ambitions.

[1] Non-fungible token (NFT), a unique, programmable blockchain-based digital object that proves ownership of digital assets. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23, figures not entity-adjusted. Forecasts are inherently limited and cannot be relied upon. 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.

Monetary Revolution | Bitcoin's Long-Term Opportunity Is Strengthening

THE PROBLEM

Centralized Monetary Systems Have Failed To Provide Strong Economic Assurances.

- > 4 billion people live under authoritarian regimes.
- > 2 billion people suffer from double-digit inflation.
- > 1 billion people cannot use traditional payment transfer apps.
- > 1 billion people rely on remittances.

THE DATA

Bitcoin Network Stats	2022	Cumulative[1]
Transfer Volume ($ Trillions)	+$38.7	$105.3
Transaction Count (Millions)	+95.4	791.4
Total Addresses (Millions)	+147.5	1,100
Addresses With A Balance (Millions)	+3.75	43.2
Miner Revenue ($ Billions)	+$9.5	$47.4

THE REVOLUTION

Bitcoin is censorship-resistant.

The barriers to transacting on Bitcoin are low, the only requirement being possession of a private key.

Bitcoin is inflation-resistant.

The number of bitcoin created is mathematically metered and predictable, according to a predefined schedule. The supply of bitcoin outstanding is 19 million now and capped at 21 million units.

Bitcoin is seizure-resistant.

Bitcoin combines elliptic curve cryptography and secure custody to ensure independent property rights.

Bitcoin is auditable and transparent.

Bitcoin decision making is transparent and decentralized. Running a full node, a user is free to validate transactions and audit supply.

[1] Cumulative since inception in January 3, 2009. Sources: ARK Investment Management LLC, 2023. Kasparov, G. et al. 2017; Hall, J. 2022; The World Bank 2021; International Fund for Agricultural Development 2022; Glassnode, data as of 01/20/23, figures not entity-adjusted. Forecasts are inherently limited and cannot be relied upon. 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.

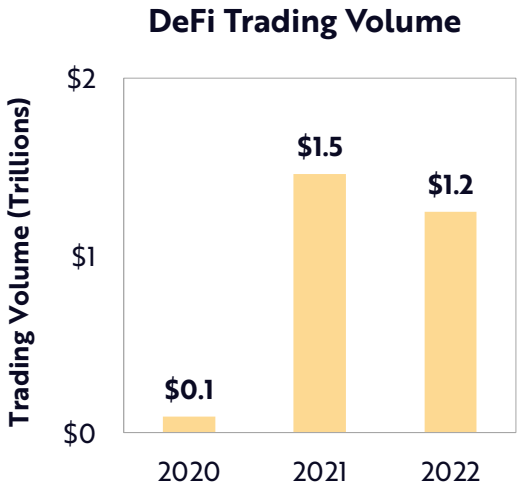
Financial Revolution | Decentralized Finance Powered Through The Crypto Crisis

THE PROBLEM

- More than 2 billion people lack access to basic banking services, including account management and credit.
- The opacity of traditional financial institutions has caused catastrophic financial collapses.
- Counterparty risk among traditional financial institutions results in single points of failure, and centralized decision making enables rampant rent-seeking.

THE DATA

- ~$1.2 trillion in DeFi trading volume, up 12x from 2020 to 2022.
- ~52% increase in DeFi trading volume relative to total crypto trading volume after the FTX collapse.
- ~$9 trillion in on-chain stablecoin transfers, more than card networks Mastercard, Amex, and Discover combined in 2022.
- ~$32 billion in withdrawals and nearly $1 billion in liquidations in 2022.



THE REVOLUTION

DeFi eliminates traditional intermediaries.

Automated smart contracts guarantee execution without the need for trusted toll-takers.

DeFi is global.

Financial services deployed on open protocols enable anyone with an internet connection access to custody, trading, and lending facilities.

DeFi is interoperable.

Financial services are open-source and interoperable, allowing for rapid innovation and experimentation.

DeFi is auditable and transparent.

Users govern risk and functions, while collateralization and asset flows are open for inspection.

Sources: ARK Investment Management LLC, 2023. The World Bank 2016; The Block, data as of 01/17/23; Johnson, P. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

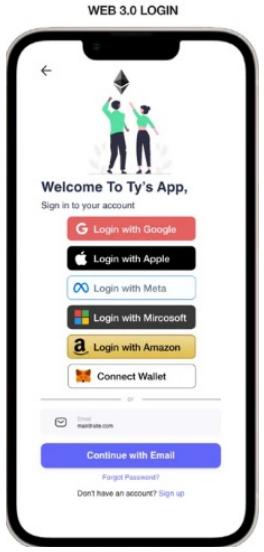
Internet Revolution | The Case For Web3 Is Reaching A Tipping Point

THE PROBLEM

- The Internet relies on tech monopolies that exploit, own, and monetize user data.
- Online identity and reputation are not interoperable.
- Centralized decision makers dictate the discovery of information, subjectively moderating content and communication.

THE DATA

- 5 million unique IDs issued across the Ethereum Name Service and Unstoppable Domains.
- $22 billion in annual NFT[1] trading volume, up 15% in 2022.
- 127 million in cumulative NFT creations.
- Major brands, including Starbucks, Adidas, Nike, Coca-Cola, and the NBA, partnering with Web3 protocols.
- Major social platforms including Instagram, Twitter, Reddit launching NFT-powered capabilities.



THE REVOLUTION

Web3 is user owned.

Web3 introduces digital property rights for the first time.

Web3 relies on protocols, not platforms.

Decentralized protocols enable the governance of—and open access to — distributed data, limiting central aggregator control.

Web3 enables new monetization paradigms.

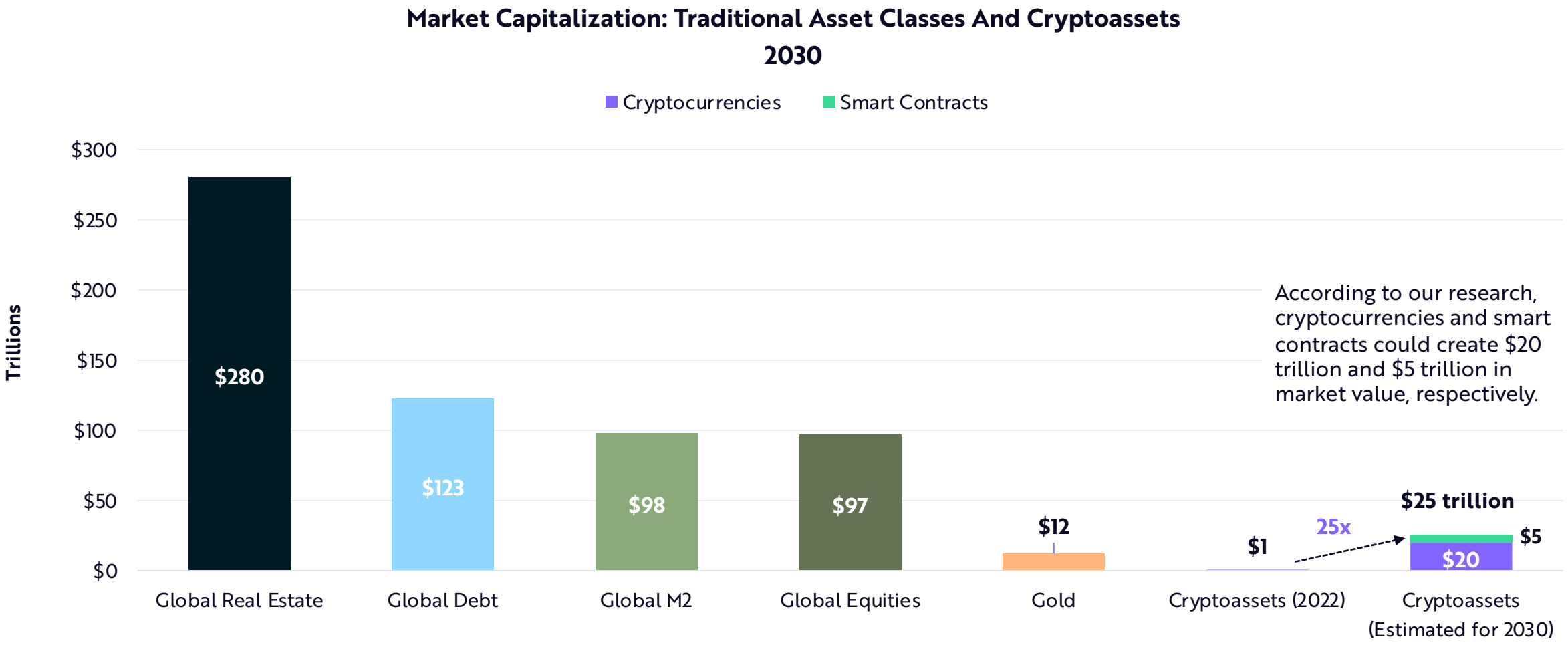
Web3 embeds economics into software, enabling users to monetize and participate in network development.

Web3 enables the convergence between consumption and investment.

Consumer behavior is shifting as the economy becomes digitally native, enabling a new paradigm for purchasing, owning, and using goods and services.

[1] Non-fungible token (NFT), a unique, programmable blockchain-based digital object that proves ownership of digital assets. Sources: ARK Investment Management LLC, 2023. Malwa, S. 2023; Unstoppable Domains, data as of 01/16/23; CryptoSlam, data as of 01/17/23; Dune Analytics, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

Cryptoassets Could Rival And Redefine Traditional Asset Classes



Sources: ARK Investment Management LLC, 2023. Bank for International Settlements, data as of 01/25/23; Bloomberg, data as of 01/25/23; 8MarketCap, data as of 01/17/23; TradingView, data as of 01/17/23; Desjardins, J. 2020. Forecasts are inherently limited and cannot be relied upon. 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.

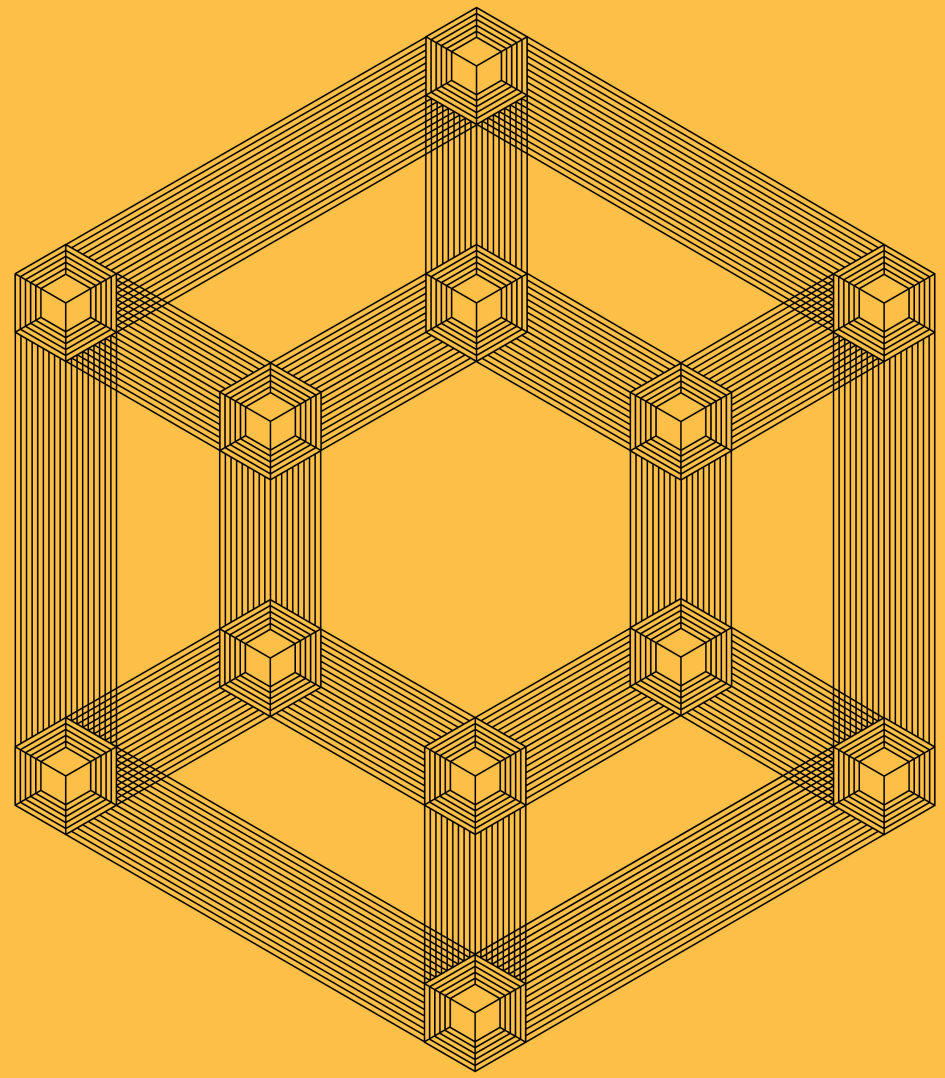
Bitcoin

A Durable Network

We believe Bitcoin's long-term opportunity is strengthening. Despite a turbulent year, Bitcoin has not skipped a beat. Its network fundamentals have strengthened and its holder base has become more long-term focused.

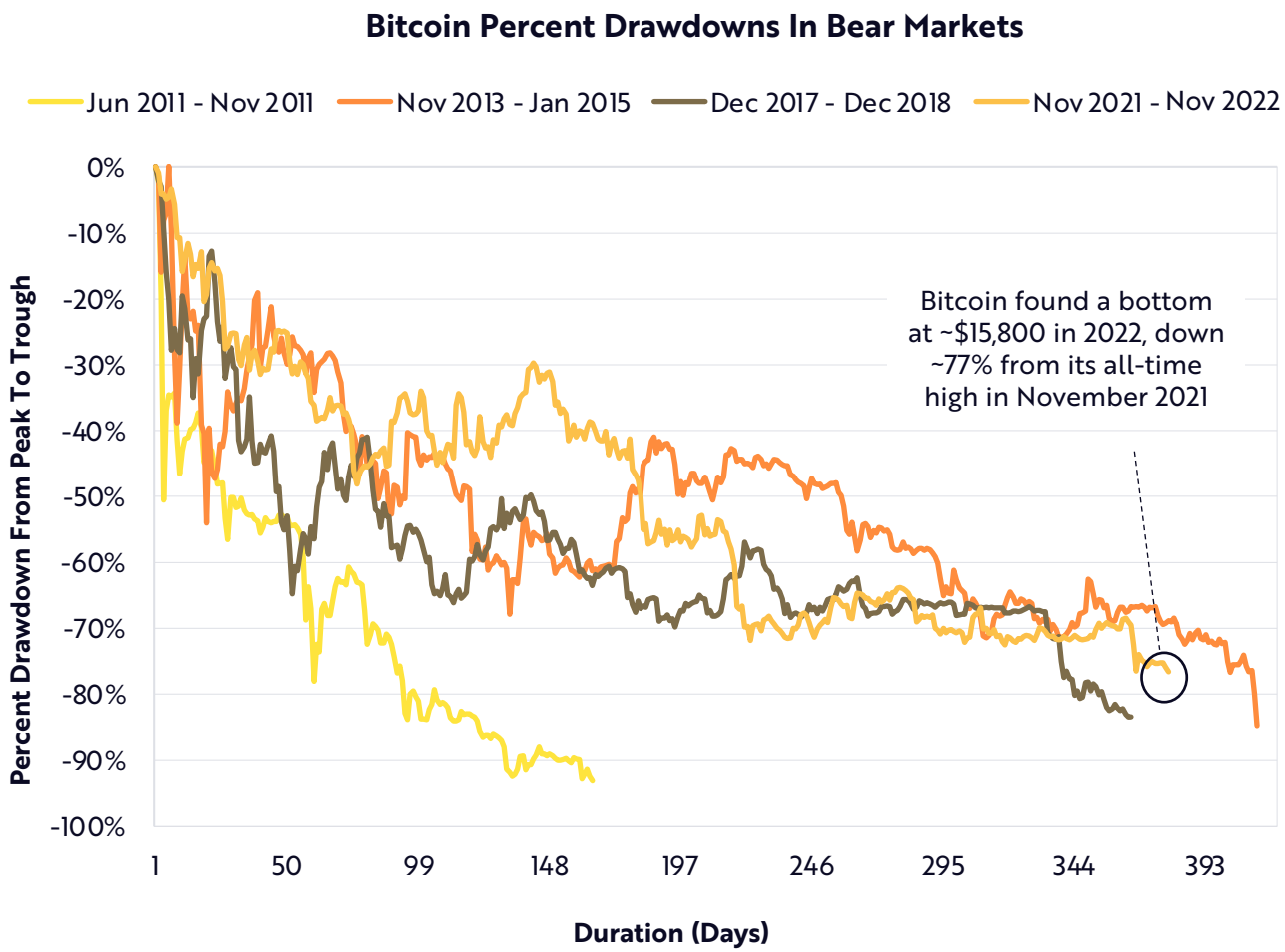
Contagion caused by centralized counterparties has elevated Bitcoin's value propositions: decentralization, auditability, and transparency.

The price of one bitcoin could exceed $1 million in the next decade.



Research by Yassine Elmandjra, Crypto Lead
Frank Downing, Director of Research, Next Generation Internet
David Puell, Research Associate

The Drawdown From Bitcoin's All-Time High Was The Fifth Largest And Second Longest In History



Bitcoin's Bear Market Drawdowns

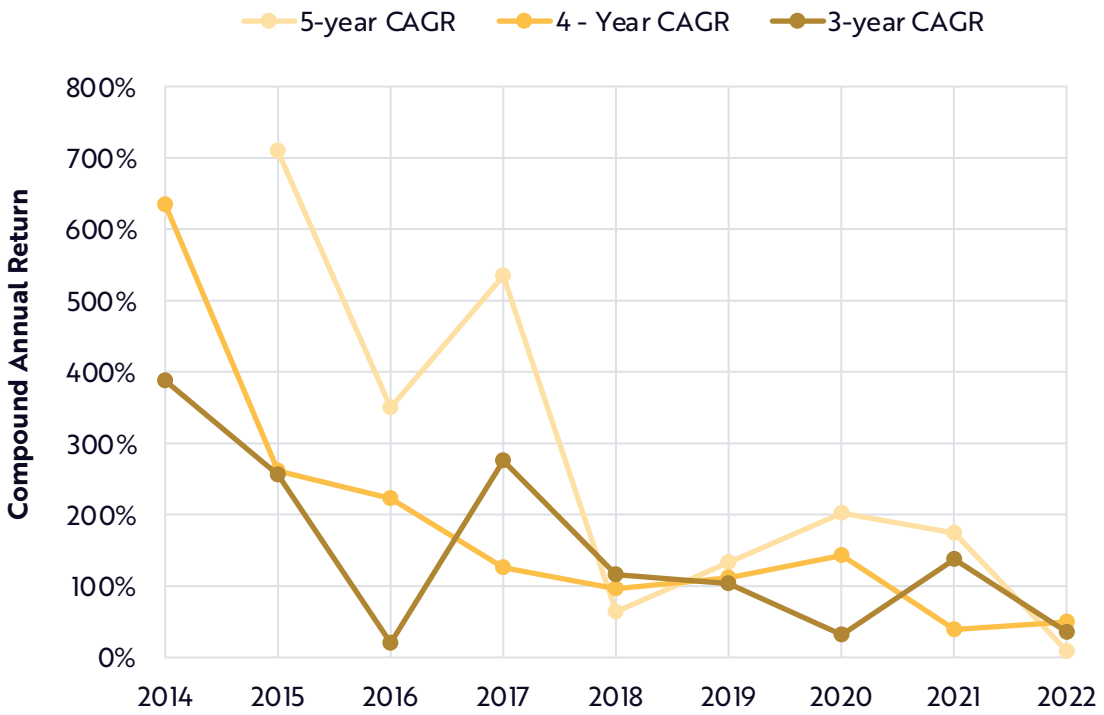
Peak		Trough		
Date	Price	Date	Price	Drawdown
June 2011	$31.91	November 2011	$2.00	-93.7%
November 2013	$1,242	January 2015	$152	-87.7%
December 2017	$19,891	December 2018	$3,128	-84.3%
November 2021	$69,000	November 2022[1]	$15,797	-76.7%
Peak-to-Peak Average CAGR	157.9%	Trough-to-Trough Average CAGR	153.6%	

Note: Bitcoin experienced an 81% drawdown in April 2013 that is not included in the chart or table given the duration lasted only 6 days and, in this context, is considered an outlier. [1] The trough in November 2021 is assumed to be the lowest mark in price as of December 31, 2022. Lower price levels may develop during 2023 or after. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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 Severe Drawdowns, Bitcoin Has Outperformed Every Major Asset Class Over Longer Time Horizons

Bitcoin's volatility has obscured its long-term returns. Despite five drawdowns greater than 75% since its inception in 2009, bitcoin has delivered positive annualized returns over 3-, 4-, and 5-year time horizons.

Bitcoin's Compound Annual Returns (CAGR) Are Positive Over 3-, 4-, and 5-Year Time Horizons*

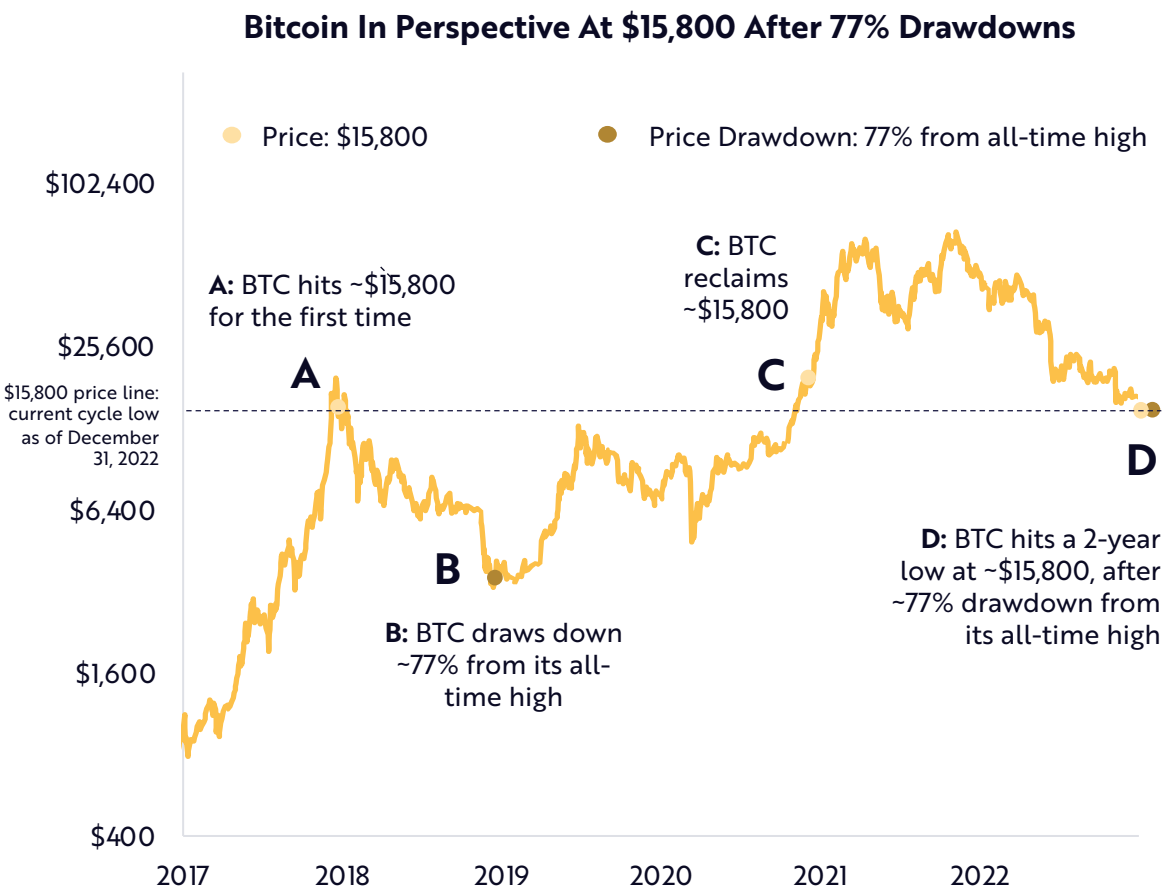


Bitcoin Has Outperformed Traditional Asset Classes Since Its Inception

	3–Year CAGR		4–Year CAGR		5–Year CAGR	
Asset Classes	Average[1]	2022	Average[1]	2022	Average[1]	2022
Global Equities	10.6%	4.9%	10.1%	10.2%	6.1%	6.1%
Global Debt	1.5%	-4.5%	1.5%	-1.8%	1.4%	-1.7%
Gold	2.4%	6.3%	2.5%	9.2%	2.2%	7.0%
Bitcoin	**152%**	**35.6%**	**187%**	**49.4%**	**272%**	**8.7%**

*Average CAGRs are calculated since bitcoin's price inception. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23; Bloomberg, data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. 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 Fundamentals Are Stronger Today Than In Past Drawdowns



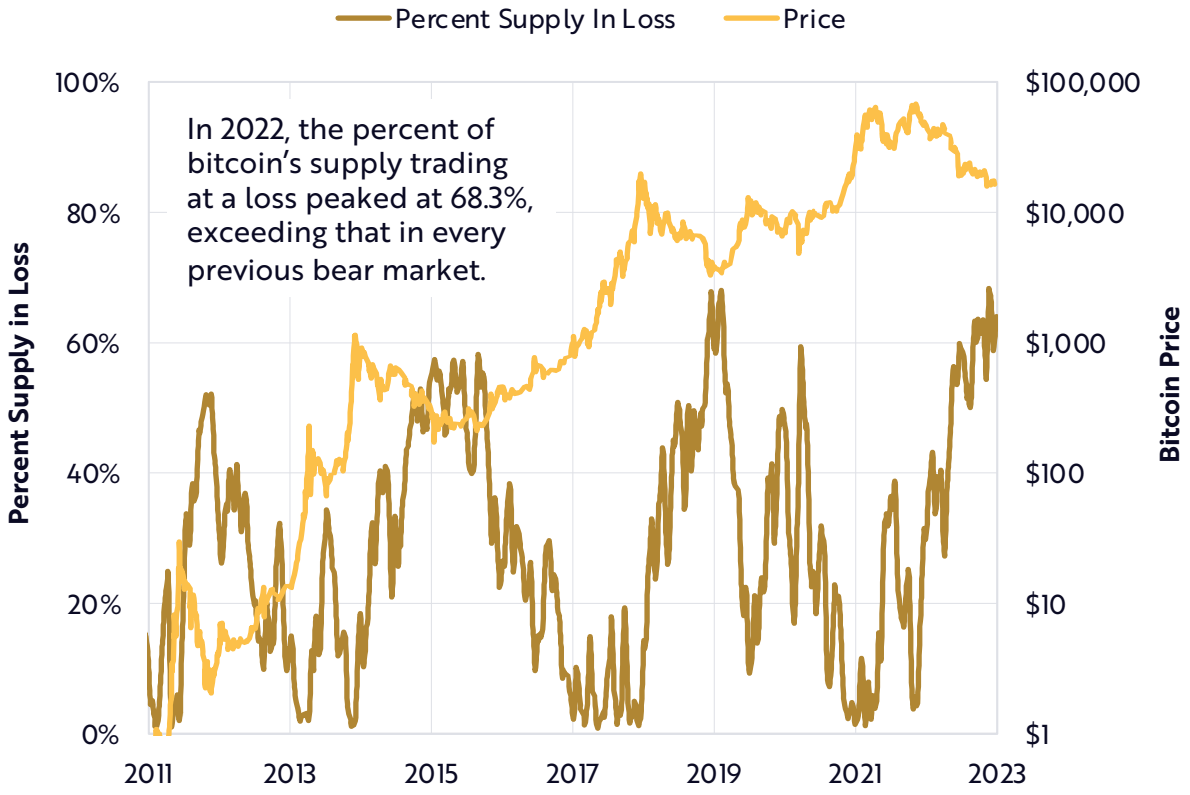
Bitcoin Metrics	A Dec. 10, 2017	B Nov. 20, 2018	C Nov. 11, 2020	D Nov 21, 2022
Market Cost Basis (Realized Cap, $, Billions)[1]	$58.2	$85.1	$126.3	**$393**
Cost Basis Per BTC (Realized Price, $)[2]	$3,485	$4,713	$6,811	**$20,459**
Hash Rate (EH/s)[3]	12.6	44.5	127.8	**262.4**
Supply Of BTC Last Moved >1 Year Ago (%)	44.1%	51.8%	61.8%	**66.5%**
BTC Addresses With Non-Zero Balance (Millions)	24.0	22.5	32.6	**43.5**
Long-Term Holder Supply (%)[4]	51.9%	67.5%	66.3%	**71.8%**
Lightning Network Capacity (BTC)[5]	N/A	340	1,040	**4,700**

[1] Market cost basis: The on-chain volume-weighted average price of the market, calculated by aggregating the value of all bitcoins in circulation at the time when they last moved. Also known as realized cap. [2] Cost basis per BTC: The market cost basis divided by total outstanding supply. Also known as realized price. [3] Hash rate: The number of computations per second produced by miners and a proxy for network security. [4] Long-term holder supply: The number of coins that last moved 155 days or longer. 155 days is the threshold when the probability of a bitcoin being spent in the future diminishes substantially. [5] Lightning Network capacity: The number of bitcoins locked in the Lightning Network. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

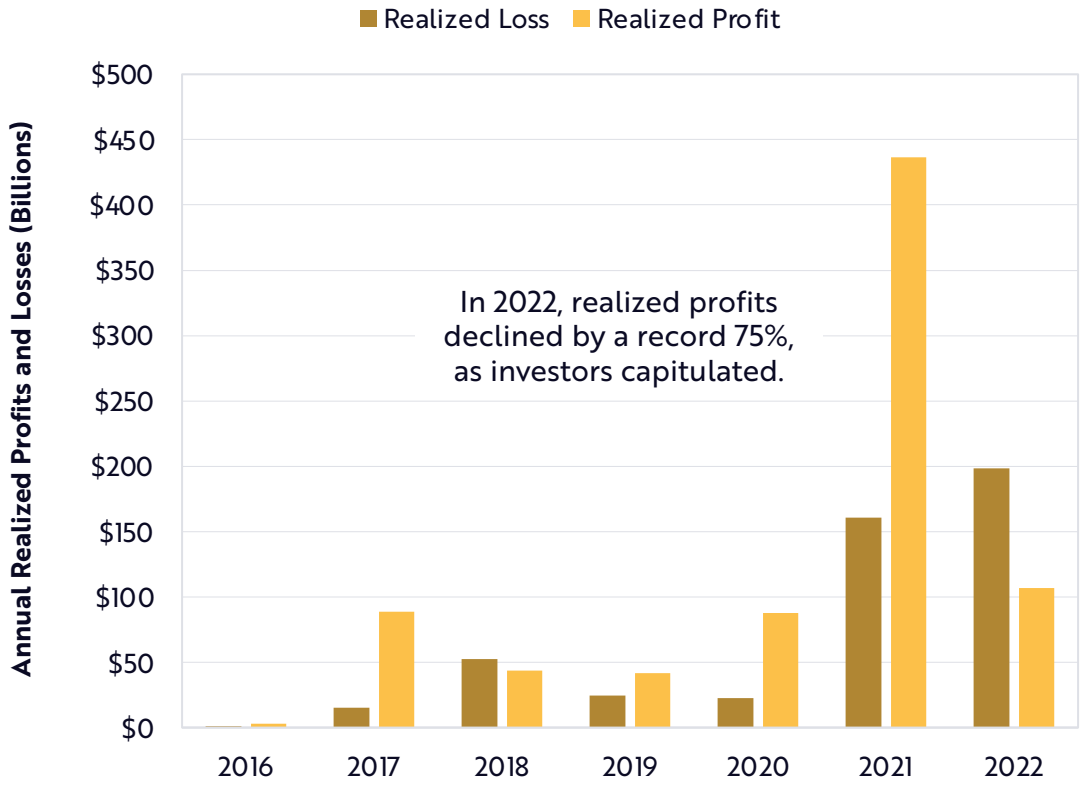
Bitcoin Capitulation Has Hit Levels Associated With Price Troughs In The Past

In 2022, bitcoin holder capitulation was proportionate to that at previous cycle lows.

The Percentage Of Bitcoin Trading At A Loss Reached An All Time High in 2022[1]



Bitcoin Holders Realized Record Losses Of ~$200 Billion In 2022[2]

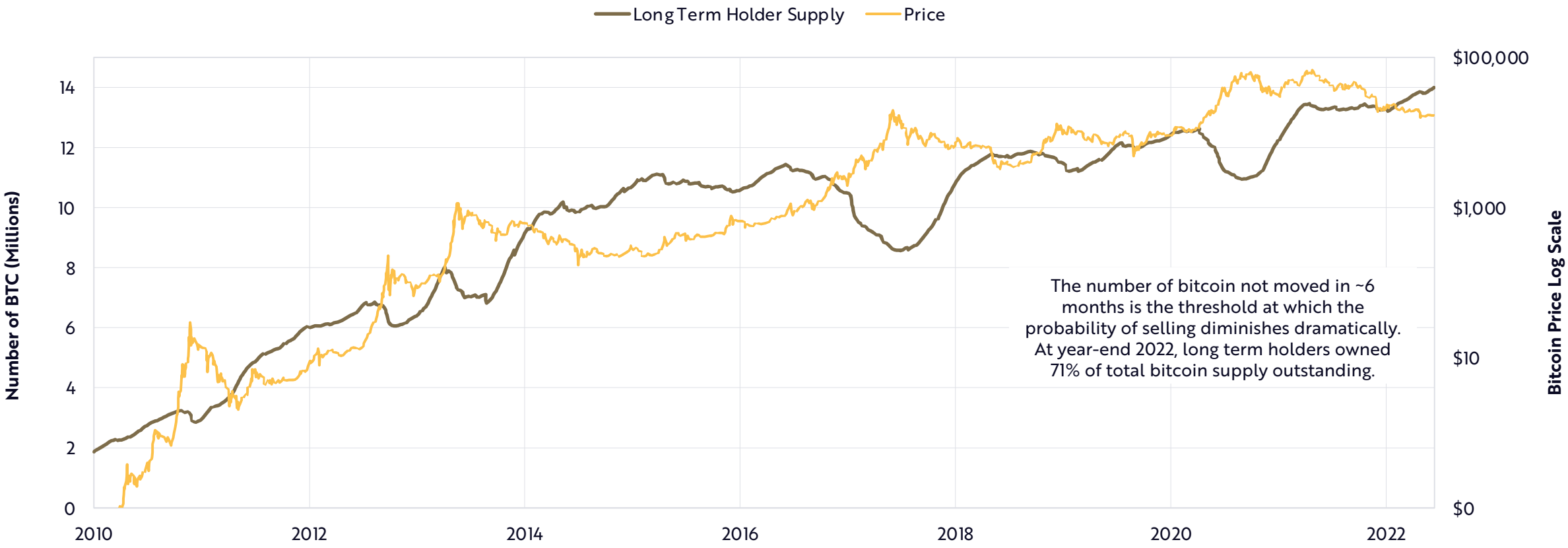


[1] The percent of bitcoin at loss is adjusted by discounting coins that have not moved in 7 years or longer. This serves as a heuristic to remove potentially lost coins from calculation. [2] Realized losses: The number of coins moved on-chain at a price lower that when they last moved. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23. Forecasts are inherently limited and cannot be relied upon. 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 Holders Are More Long-Term Focused Than At Any Point In History

Despite extreme market fear fueled by the collapse of several major crypto entities, on-chain data suggest that bitcoin holders remained focused on long-term fundamentals.

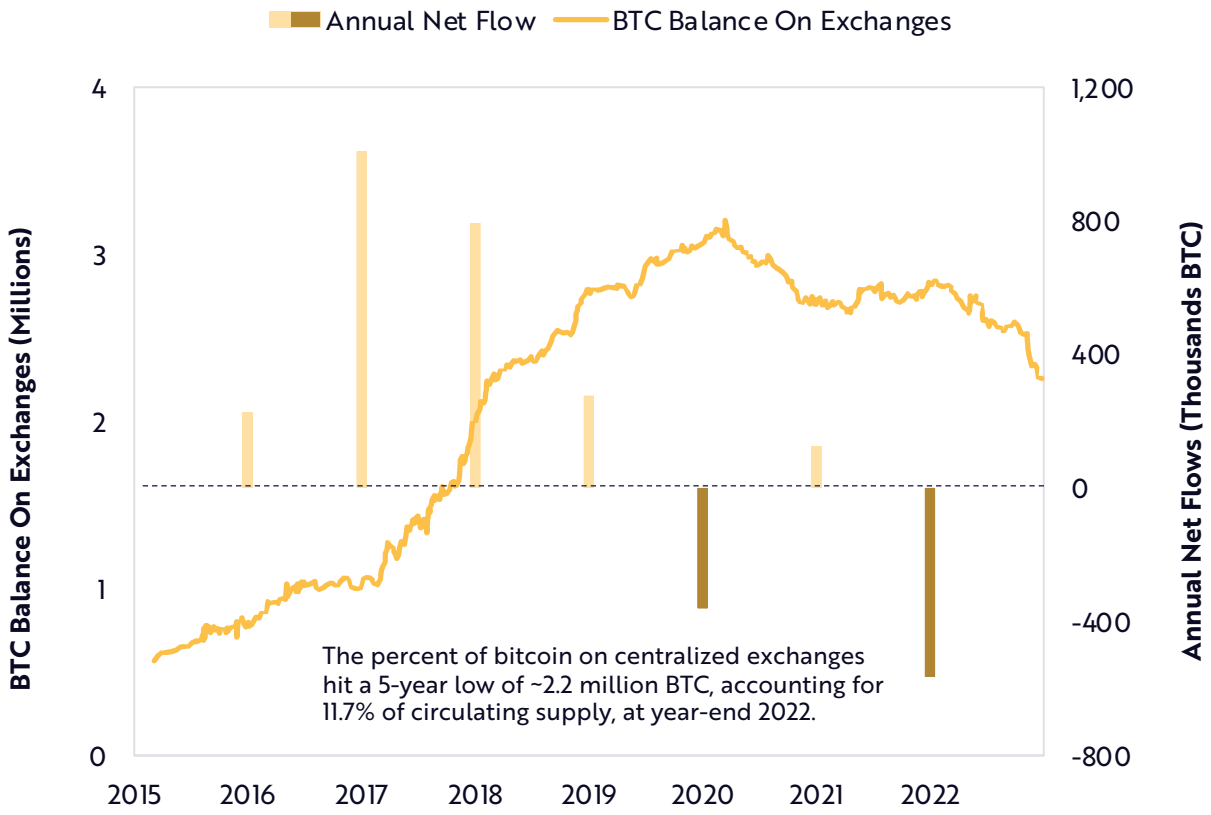
Bitcoin Supply Held By Long-Term Holders Hit An All Time High in 2022[1]



[1] Long-term holder supply: The number of coins that last moved 155 days or longer. 155 days is the threshold when the probability of a bitcoin being spent in the future diminishes substantially. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23. Forecasts are inherently limited and cannot be relied upon. 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.

Exchanges Have Increased Transparency In Response To The Collapse Of Trust In Centralized Crypto Entities

In 2022, Net Outflows From Centralized Exchanges Totaled 560,000 BTC, The Largest In History[1]



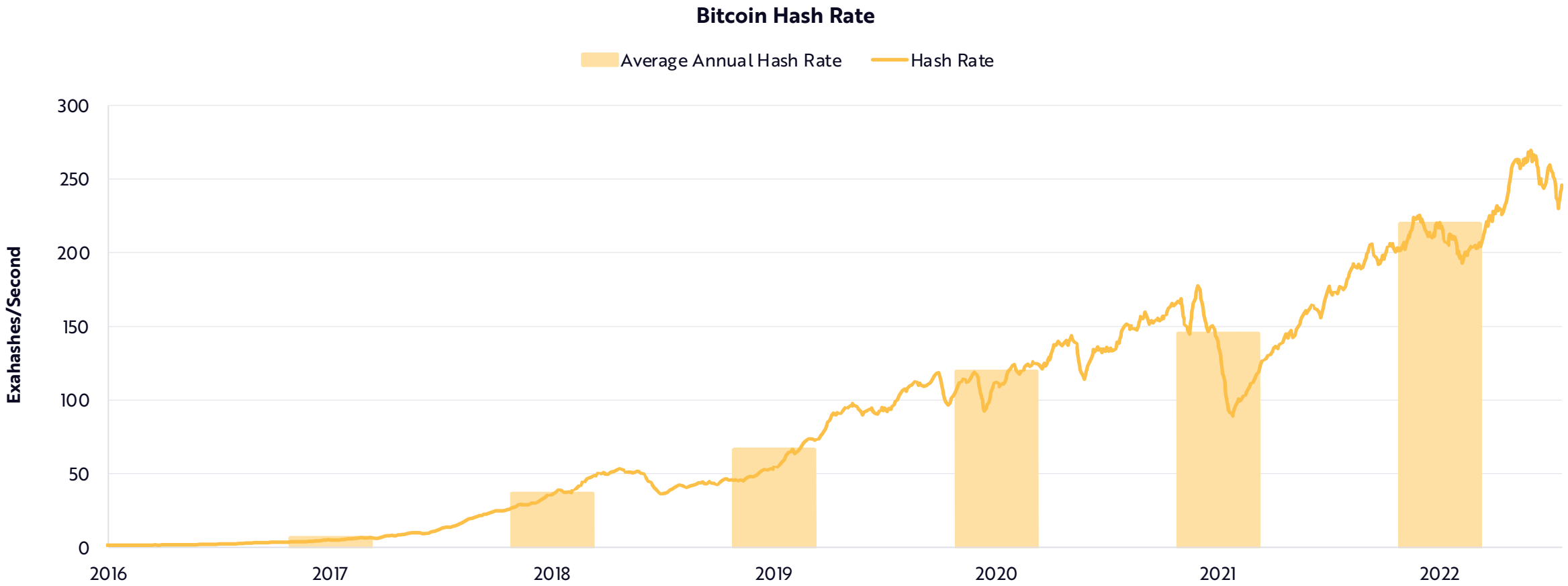
A "run on the bank" forced a record number of exchanges to publish auditable financials and cryptographically verifiable attestations of solvency, otherwise known as "proof-of-reserves" (PoR).

Exchange	"PoR" Publication Year[2]
Binance	2022
BitMEX	2021
ByBit	2022
Coinbase[3]	2021
Crypto.com	2022
Deribit	2022
Gate.io	2020
Kraken	2014
Kucoin	2022
Luno	2021
OKX	2014

[1] Outflows from exchanges saw historical values in 2022 and so did the market share between these. For instance, Coinbase saw an increase of 11 percentage points in market share amongst fiat exchanges during 2022, from 29% to 40% (as per The Block), remaining as the premier regulated retail on-ramp in the US. [2] The proofs-of-reserves herein vary in quality and standard. [3] While Coinbase has not conducted a cryptographic proof of reserves, its status as a public company requires it to publish extensive "proof of solvency" reporting. Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/20/23; Carter, N. 2022. Forecasts are inherently limited and cannot be relied upon. 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 Hash Rate Hit An All-Time High In 2022

Bitcoin's hash rate—the number of computations per second produced by miners and a proxy for network security—has increased for twelve consecutive years, hitting an all-time high of 272 exahashes/second in 2022.

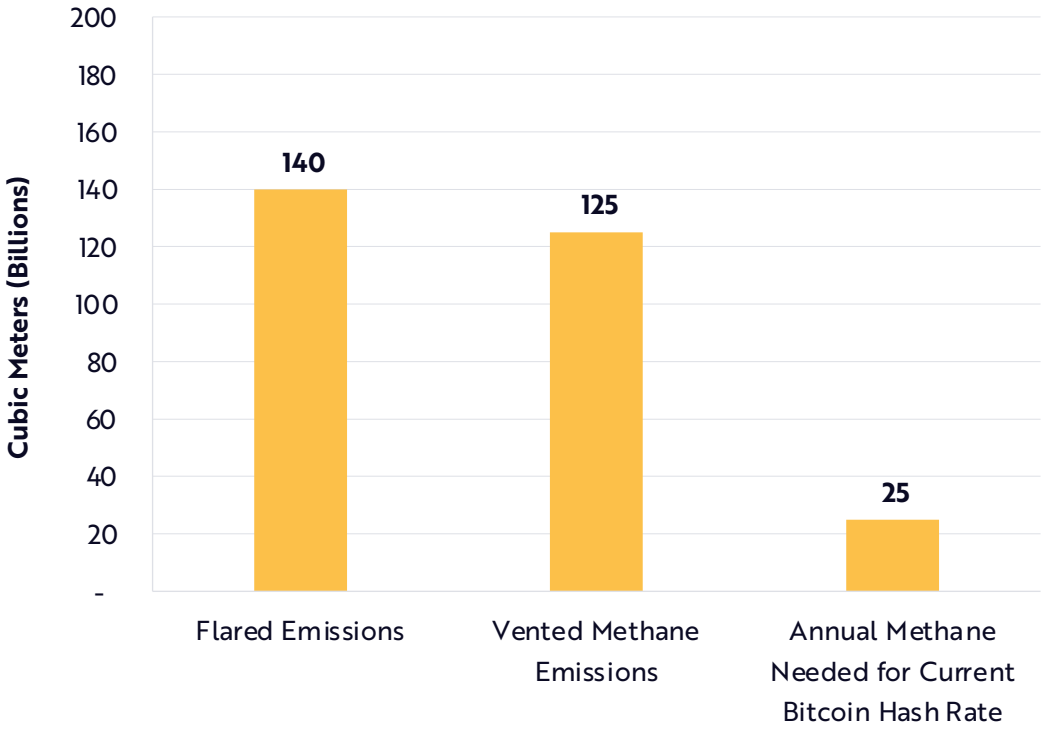


Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

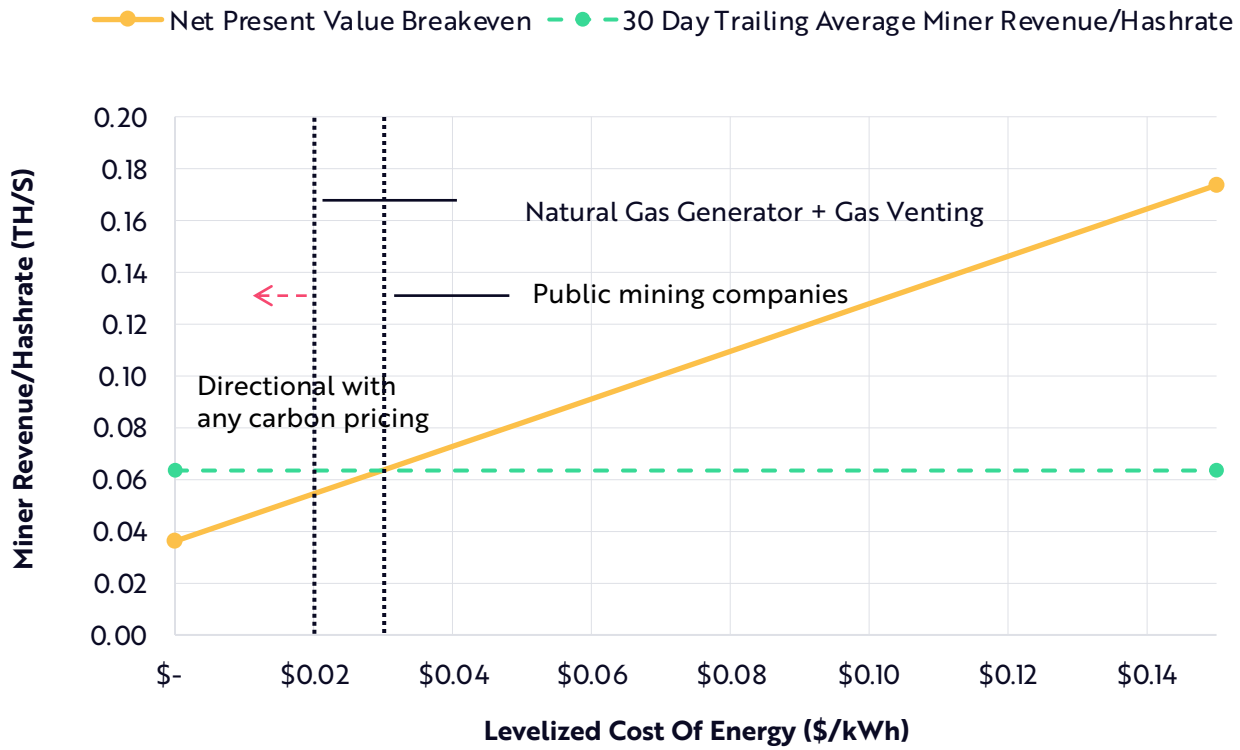
Bitcoin Mining Is Harnessing And Containing Natural Gas Emissions

Bitcoin mining is ideal for oil and gas well sites: it is distributed and highly scalable with modular hardware that can be transported to and shifted among operating well sites. Because oil and gas well lifespans often are limited, bitcoin mining could make the difference between high and low returns on investment.

Over 265 Billion Cubic Meters Of Natural Gas[1] Are Wasted Each Year



With The Introduction Of Bitcoin Mining At Oil And Gas Well Sites, Independent Bitcoin Miners[2] Could Become Unprofitable



[1] Flared emissions: The wasteful burning of excess gas released during oil production. Vented methane: The intentional and controlled release of gases containing alkane hydrocabrons, predominately methane, into the earth's atmosphere. [2] Independent bitcoin miners: Refers to mining operations that solely mine bitcoin as business model and revenue source. Forecasts are inherently limited and cannot be relied upon. Sources: ARK Investment Management LLC, 2023. Chen, Y. et al. 2022; Glassnode, data as of 01/17/23. 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.

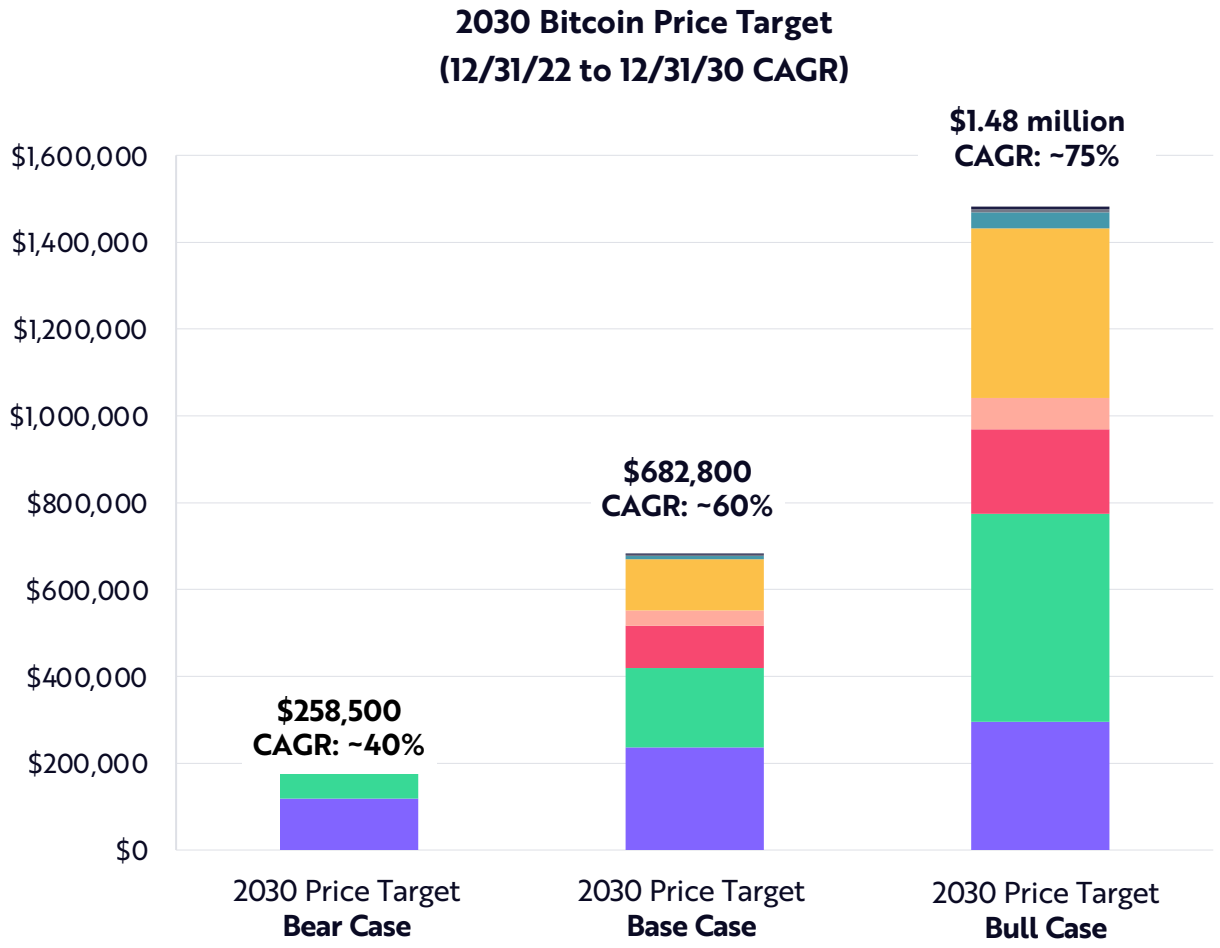
Institutions Are Committing To Bitcoin During A Bear Market

Entity	Market Validation
BlackRock	**June 2022:** BlackRock's Aladdin partnered with Coinbase Prime to provide institutional clients with direct access to crypto, starting with bitcoin. Connecting to Coinbase Prime, Blackrock's Aladdin could usher trillions of dollars into the asset class in the coming years.
BNY Mellon	**October 2022:** BNY Mellon launched a cryptoasset custody platform to safeguard assets for institutional investors. Touching more than 20% of the world's investable assets, BNY Mellon could use bitcoin to scale financial services cost-effectively.
Eaglebrook Advisors	**October 2022:** Eaglebrook Advisors and ARK Investment Management partnered to offer financial advisors access to actively-managed crypto strategies, including direct cryptoasset ownership, low minimums, and portfolio reporting integration.
Fidelity	**November 2022:** Fidelity officially launched retail bitcoin and ether trading accounts enabling investors to trade and custody them on its platform.

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Is Likely To Scale Into A Multi-Trillion Dollar Market

ARK's research estimates that the price of one bitcoin could exceed $1 million by 2030[1]



Price Target Assumptions

Bitcoin Use Case	Penetration Rate		
	Bear	Base	Bull
Corporate Treasury TAM: Cash & Equivalents	0%	2.5%	5%
Remittance Asset TAM: Global Remittance Volume	5%	10%	25%
Nation State Treasury TAM: Global Treasury Reserves	0%	1%	5%
Emerging Market Currency TAM: M2 Base Outside of Top 4	0.5%	3%	10%
Economic Settlement Network TAM: US Bank Settlement Volumes	1%	5%	10%
Seizure-Resistant Asset TAM: Global HNWI Wealth	1%	3%	5%
Institutional Investment TAM: Institutional Asset Base	1%	2.5%	6.5%
Digital Gold TAM: Gold Market Cap	20%	40%	50%

[1] In this year's presentation of bitcoin price target, ARK has added bear, base, and bull price targets as opposed to the single price target given in 2022's Big Ideas report. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

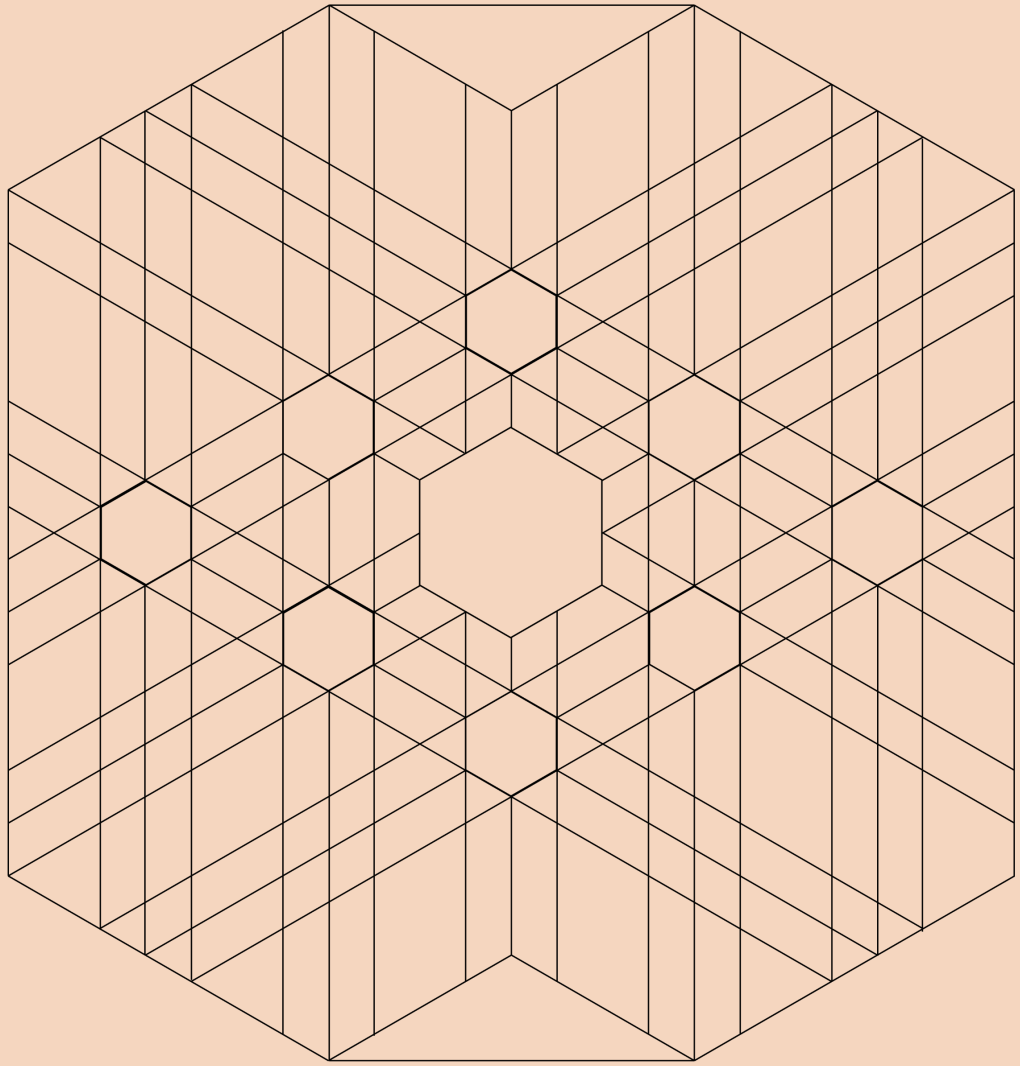
Smart Contract Networks

Enabling Financial And Internet Revolutions

In the aftermath of catastrophic failures of centralized crypto intermediaries last year, automated self-executing contracts on decentralized public blockchains offer the alternative of transparent and non-custodial financial services.

Decentralization is proving more critical to maintaining the original value proposition of public blockchain infrastructure.

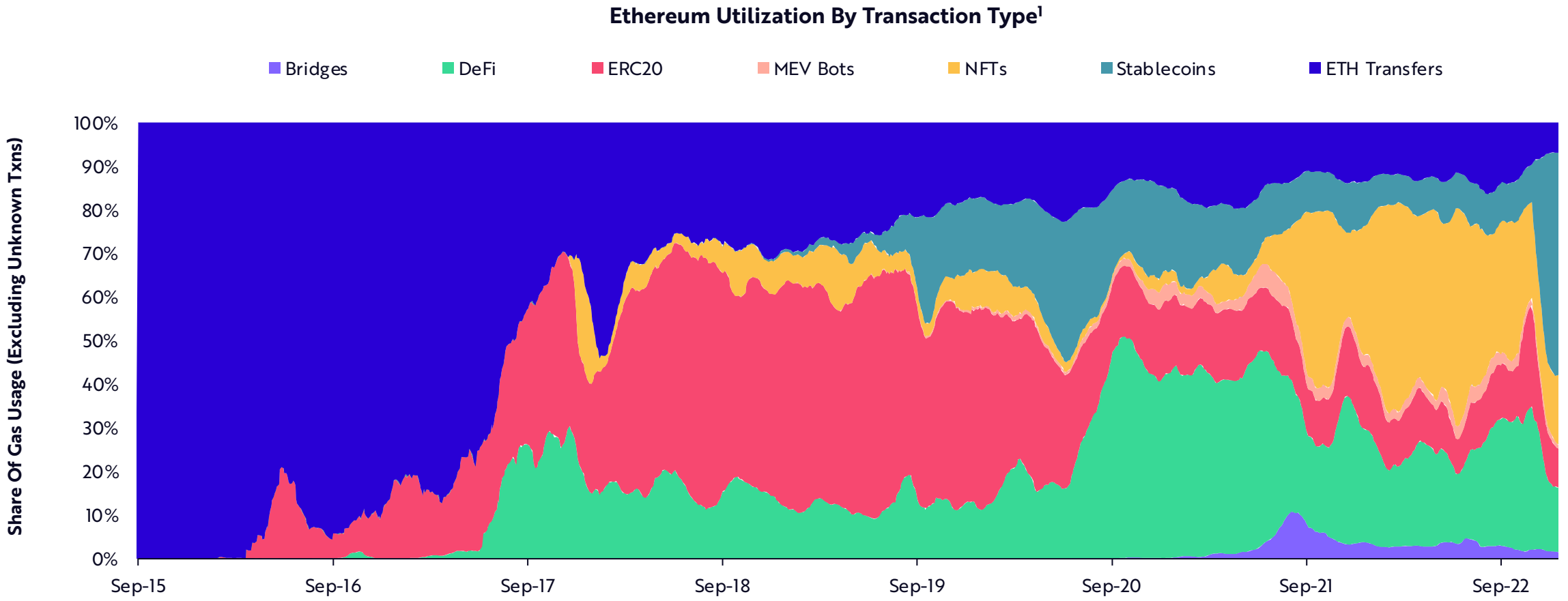
According to ARK's research, as the value of tokenized financial assets grows on-chain, decentralized applications and the smart contract networks that power them could generate $450 billion in annual revenue and reach $5.3 trillion in market value by 2030.



Research by Frank Downing, Director of Research, Next Generation Internet
Yassine Elmandjra, Crypto Lead
David Puell, Research Associate

The Utility Of Smart Contract Networks Is Expanding And Diversifying

Once dominated by simple asset transfers, activity on public blockchains like Ethereum has diversified into decentralized financial services (DeFi) and the NFT-based creation and ownership of digital goods, among other applications.



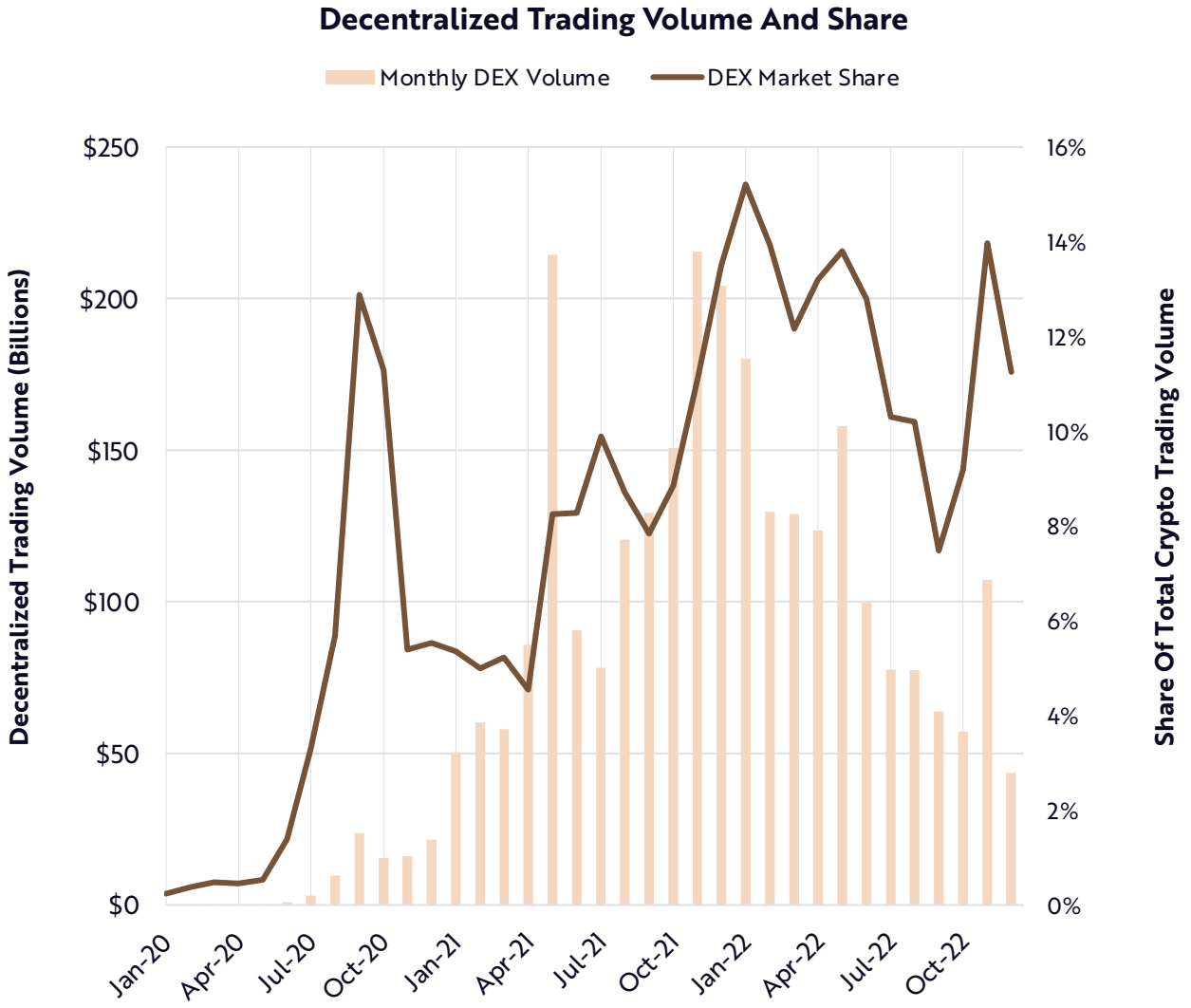
[1] 30-day Simple Moving Average (SMA). Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Decentralized Finance Is A Promising Alternative To Centralized Intermediaries

Abandoning centralized intermediaries and moving to self-custody solutions, traders increasingly favor the transparency of decentralized exchanges.

Since 2020, decentralized exchange (DEX) trading volume as a percentage of total crypto trading volume has been rising.

The ratio fell during the summer, perhaps as speculative trading around long-tail assets limited to DEX's died down after the collapse of Terra / Luna, Celsius, and Three Arrows Capital. After FTX collapsed in November, however, DEX market share shot up 52%, from 9% to 14% of total trading volume.



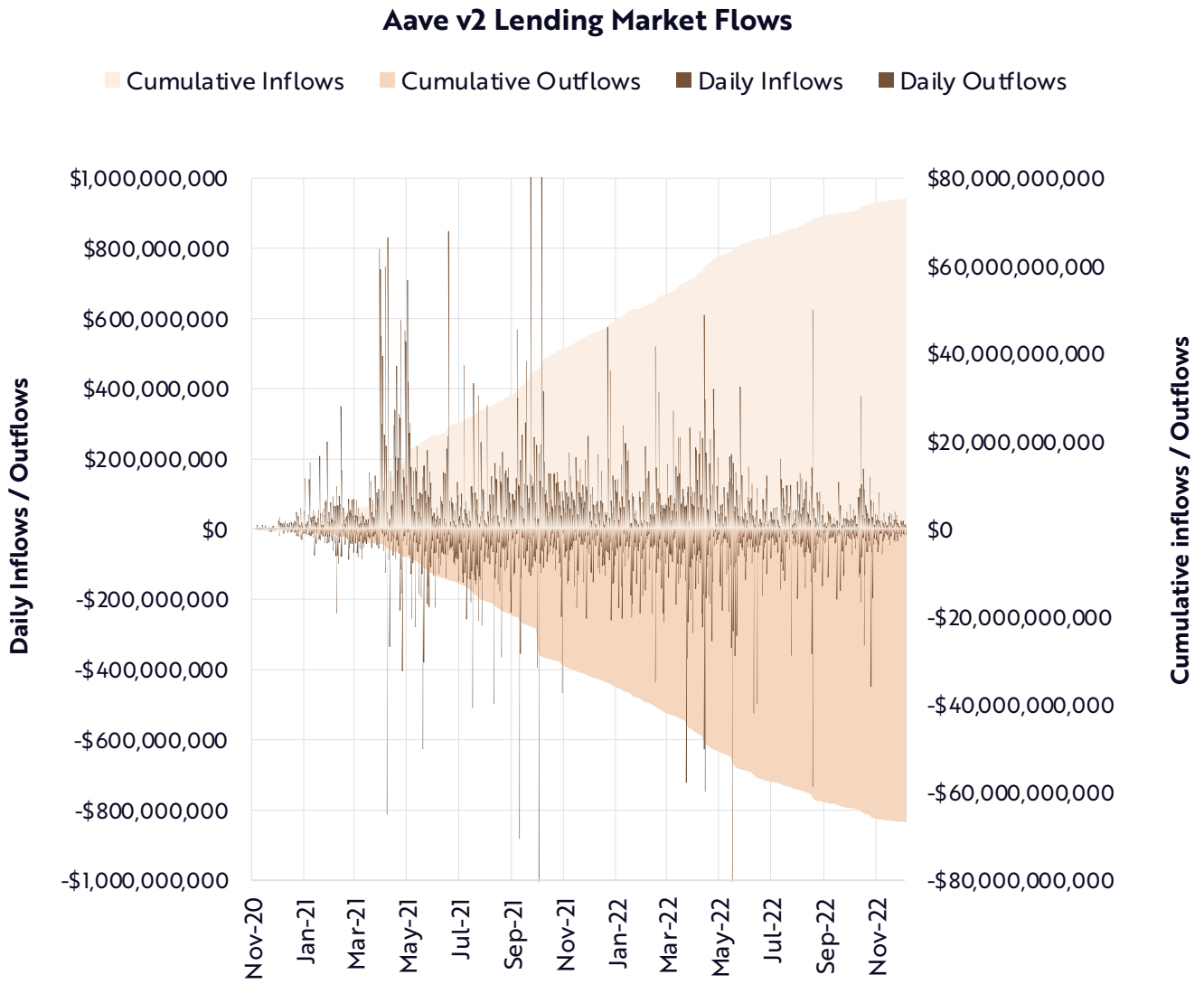
Sources: ARK Investment Management LLC, 2023. The Block, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

As Centralized Crypto Lenders Failed, DeFi Lending Protocols Functioned As Designed

As insolvencies mounted across crypto lending businesses like Celsius and Voyager, decentralized lending markets like Aave continued to operate as designed. They processed deposits, withdrawals, originations, and liquidations without service interruption.

Since November 2020, Aave has processed more than $75 billion in inflows and $66 billion in outflows, all autonomously via smart contracts.

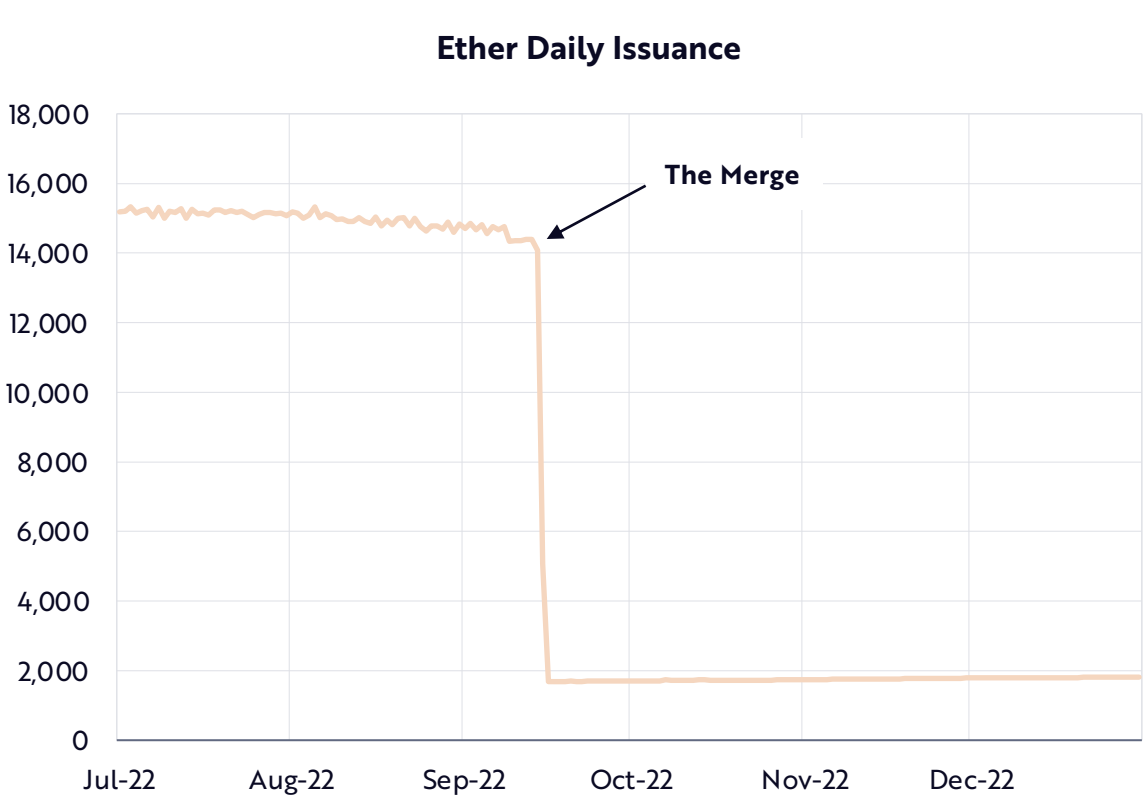
Risk controls and full transparency of deposits, loans, and collateralization ratios have contributed to DeFi's stability.

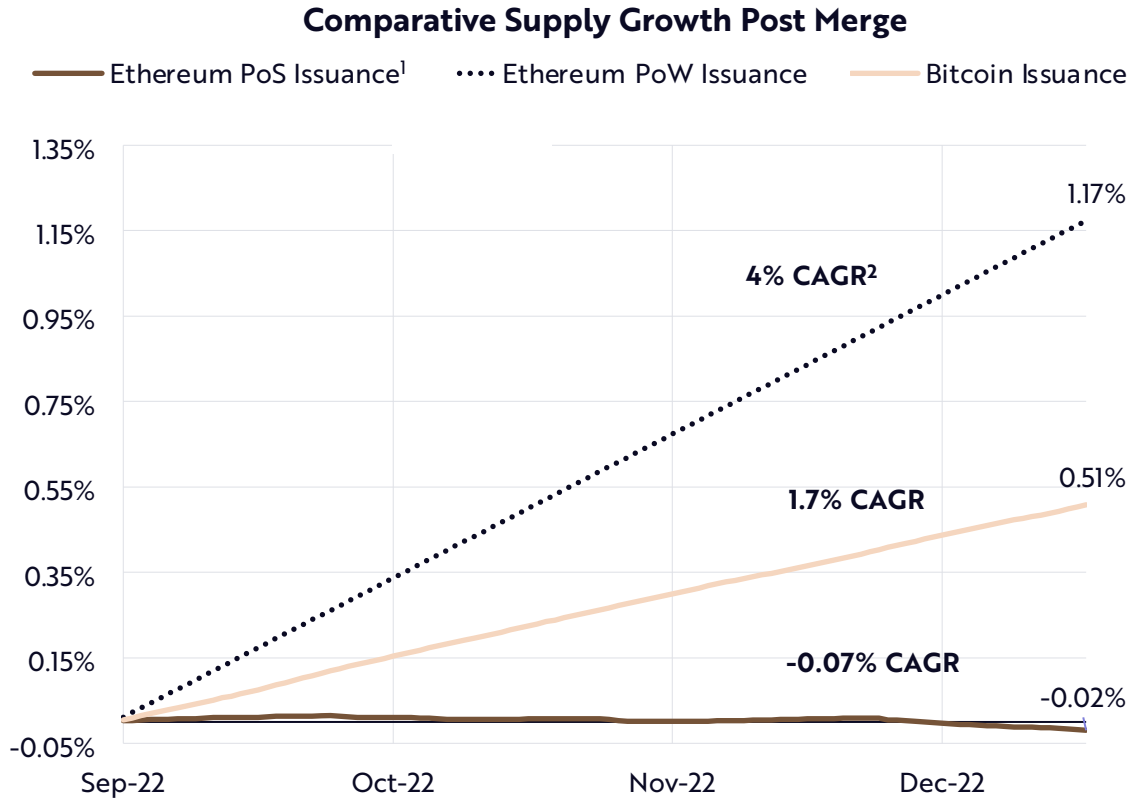


Sources: ARK Investment Management LLC, 2023. DefiLlama, data as of 01/03/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

The Merge Ushered Ethereum Into A New Era

During the Merge in September 2022, Ethereum transitioned from Proof-of-Work (PoW) to Proof-of-Stake (PoS). No longer required to pay energy-intensive miners for security, Ethereum strengthened its monetary policy and reduced new token issuance. With its new token model, Ethereum's net annual issuance has flattened and is now lower than Bitcoin's 1.7% and the 4% in Ethereum's prior PoW model. With the sustained network, the supply of ether will fall.



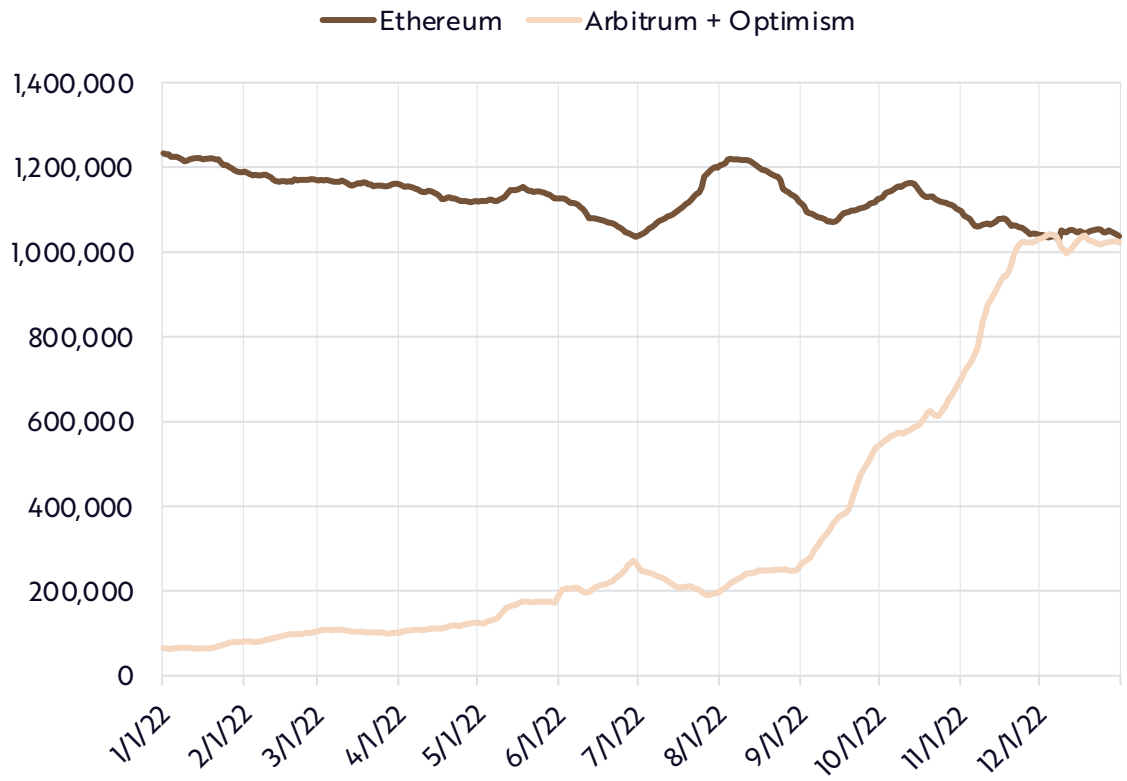


[1] Token issuance is the process of creating new tokens that then are added to the total supply of the cryptocurrency. [2] Compound Annual Growth Rate (CAGR). Sources: ARK Investment Management LLC, 2023. Glassnode, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For 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.

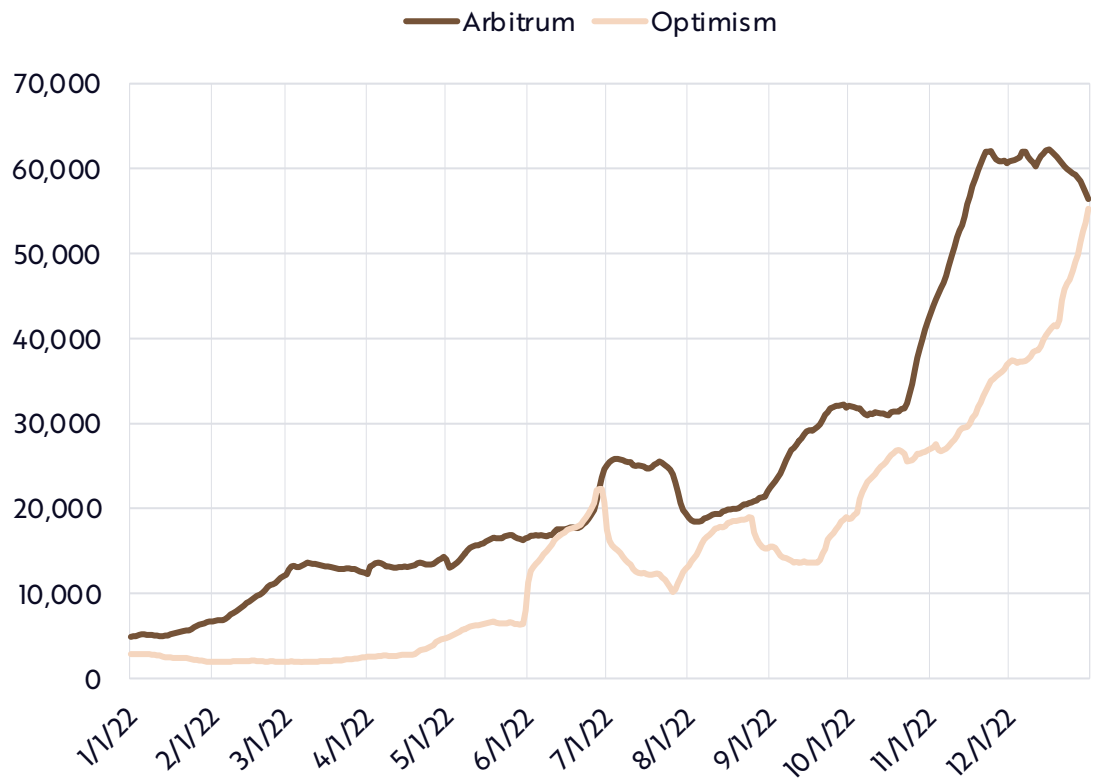
Still In Early Days, Ethereum's Layer 2 Networks Are Beginning To Scale

Once challenged by significant congestion, Ethereum has developed a solution to scaling—"layer 2" networks—that is gaining meaningful traction. The number of transactions on Arbitrum and Optimism, two popular layer 2 networks, now matches that on Ethereum's base layer, and the number of active addresses on each grew 11x and 19x, respectively, in 2022.

Average Daily Transactions[1]



Average Daily Active Addresses[1]



[1] 30-day Simple Moving Average (SMA). Sources: ARK Investment Management LLC, 2023. Dune Analytics, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

Concerns About Network Censorship Intensified After The Merge

Validator Concentration

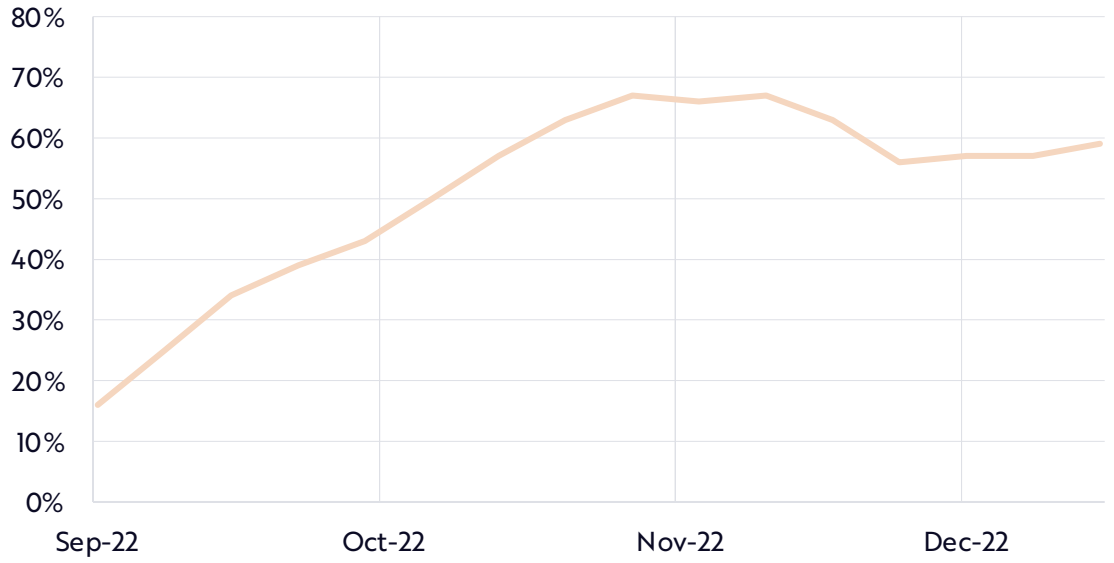
As stakers prioritize convenience over decentralization, the top three staking services now account for roughly two thirds of total Ether staked.

Provider	Staked ETH	Share
Lido Finance	4,642,432	29%
Unknown	3,844,579	24%
Coinbase	2,066,976	13%
Kraken	1,205,536	8%
Binance	1,012,864	6%
Staked.us	561,408	4%
Bitcoin Suisse	459,488	3%
Rocket Pool	410,560	3%
Figment	396,032	2%
Other	1,270,032	8%
Total	14,730,023	100%

Transaction Censorship

As financial incentives to maximize rewards begin to outweigh censorship resistance, Flashbots and other services that censor transactions are growing as a share of new blocks.

Share Of New Blocks Proposed By Flashbots In 2022



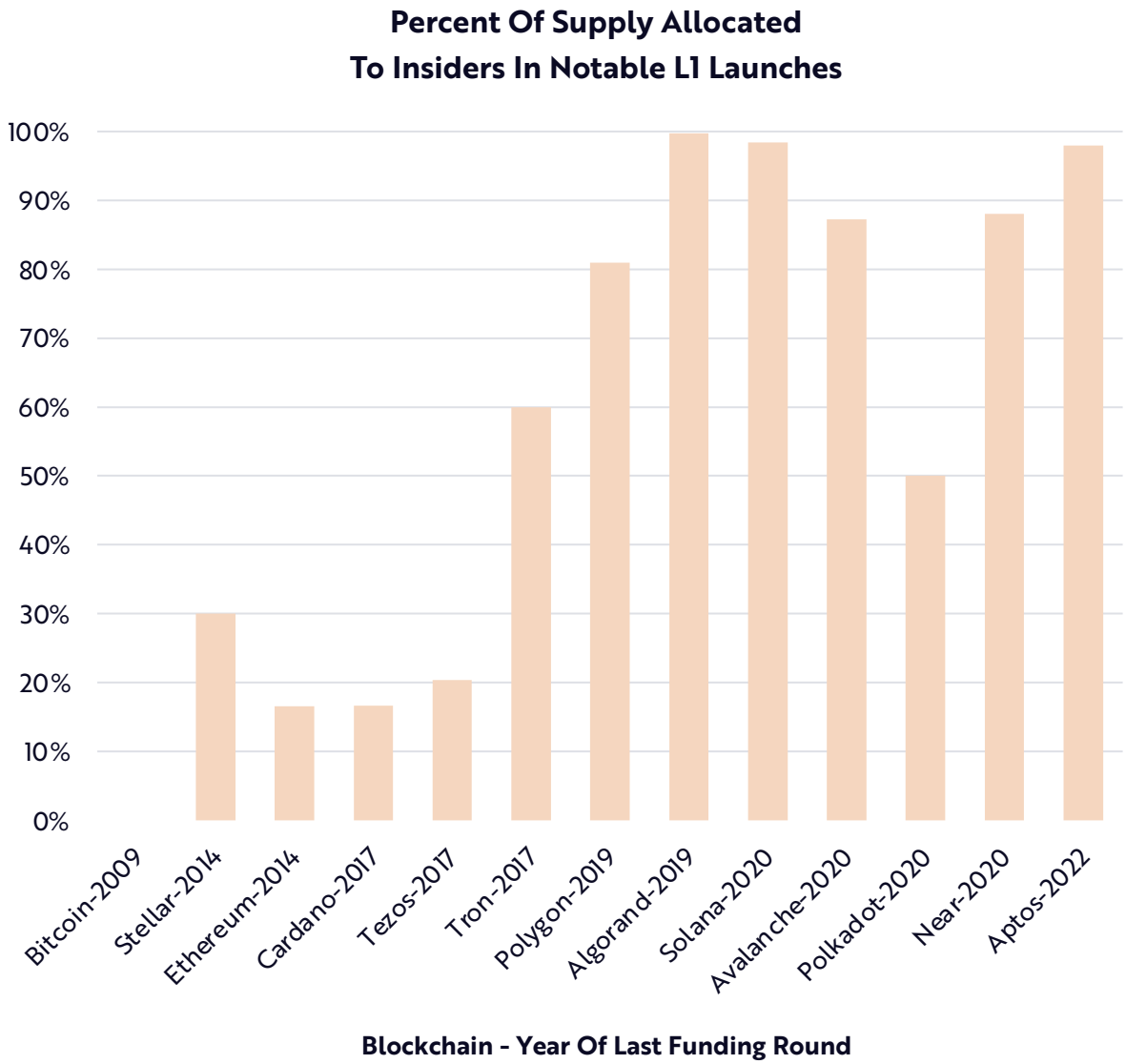
Sources: ARK Investment Management LLC, 2023. Nansen, data as of 01/17/23; Flashbots, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

True Decentralization Is More Difficult For New Networks

On layer 1 blockchains, the percentage of token supply allocated to insiders—founding teams, private investors, and privately controlled foundations and ecosystem funds—has been increasing.

Since 2017, founders have been increasing war chests to compete with incumbents, and venture capital has been investing aggressively in base layer protocols. Additionally, regulatory concerns have hindered the Initial Coin Offering as an open distribution model.

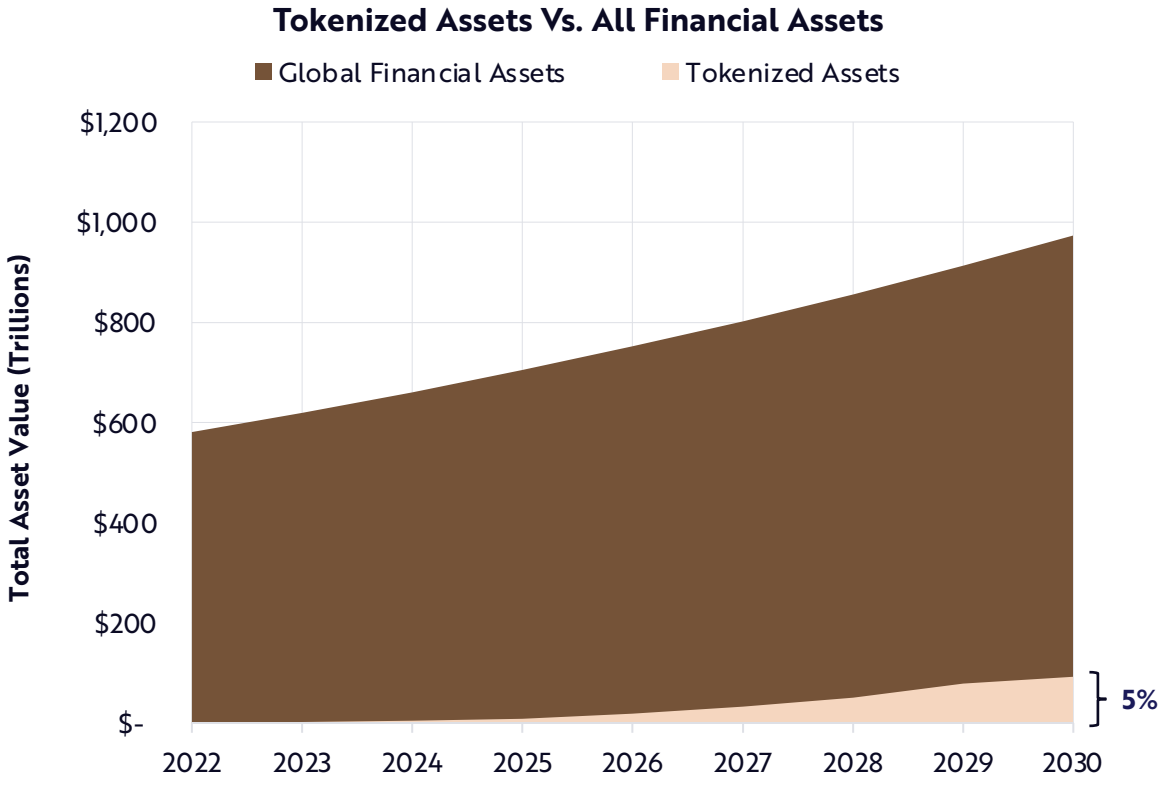
Consequently, new networks cannot claim they are sufficiently decentralized on a token holder basis and could be susceptible to pressure by insiders.

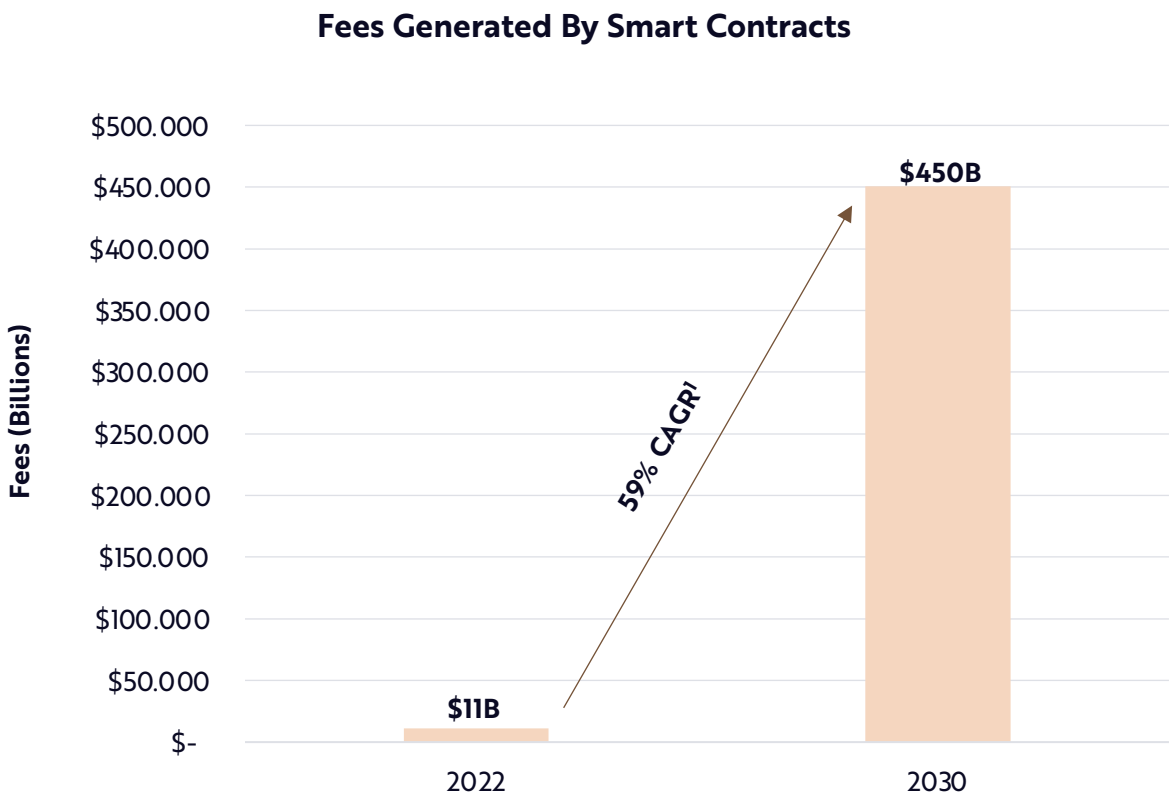


Sources: ARK Investment Management LLC, 2023. Messari, data as of 01/25/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security or cryptocurrency. Past performance is not indicative of future results.

Smart Contract Networks Could Facilitate $450 Billion In Annual Fees By 2030

Smart contracts could facilitate the origination, ownership, and management of tokenized assets for a fraction of the cost of traditional financial services. If financial assets were to migrate to blockchain infrastructure at a rate similar to the adoption of the early internet, and decentralized financial services charged a third of traditional financial services take rates, smart contracts could generate $450 billion in annual fees and create $5.3 trillion in market value by 2030.





[1] Compound Annual Growth Rate (CAGR). Sources: ARK Investment Management LLC, 2023. Token Terminal, data as of 01/03/22; McKinsey & Company 2021. Forecasts are inherently limited and cannot be relied upon. 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.

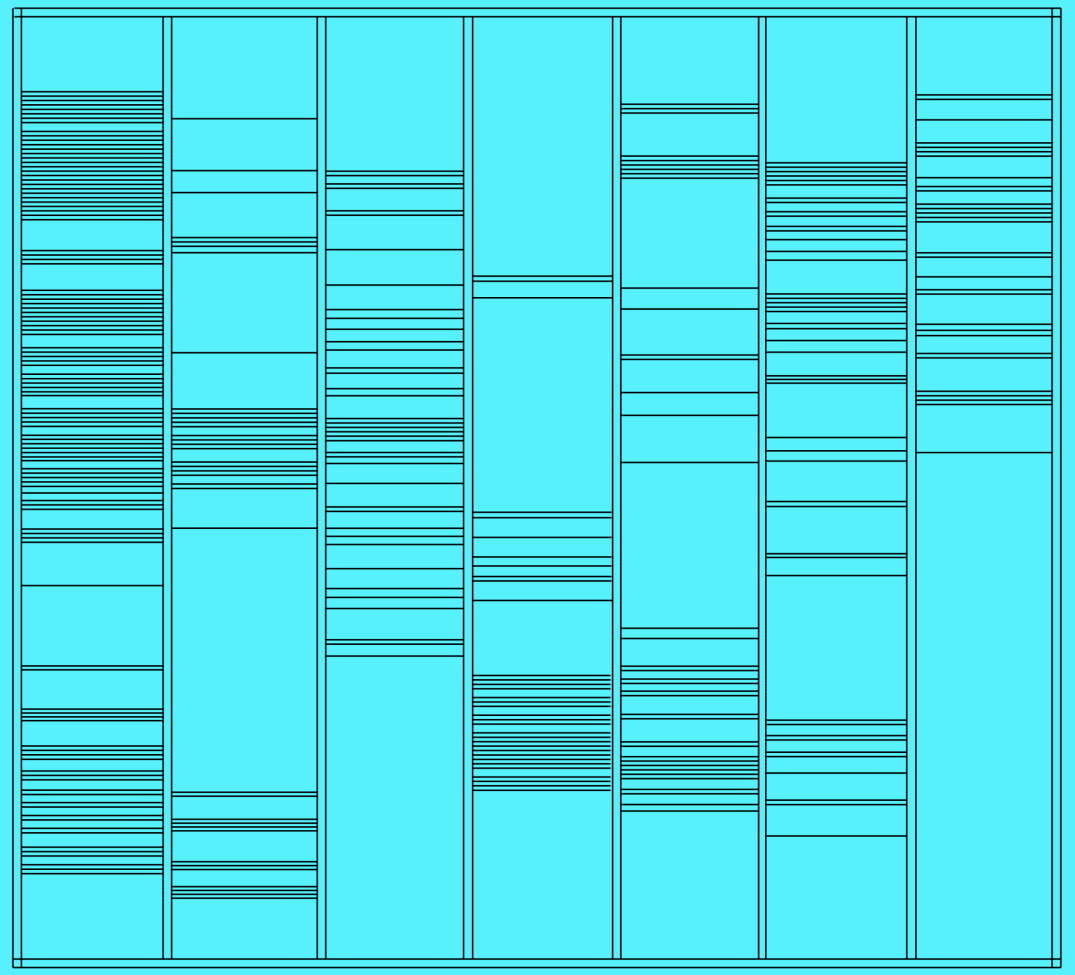
Precision Therapies

Expanding Medicine To Treat And Cure Disease

Precision therapies are patient-centric and target the root cause of disease, not symptoms. Designed using novel experimental and computational methods, precision therapies could develop faster and more cost-effectively than traditional therapies.

Rapid advances in technologies like artificial intelligence (AI), DNA and RNA sequencing, CRISPR gene editing, and laboratory automation have spawned new therapies, enabling the treatment of diseases previously considered intractable. Increasingly, precision therapies are becoming multiomic, with mechanisms of action spanning DNA, RNA, proteins, and more.

Based on ARK's research, the enterprise value of companies focused on precision therapies could appreciate 29% at an annual rate from ~$500 billion in 2022 to ~$3 trillion by 2030.[1]



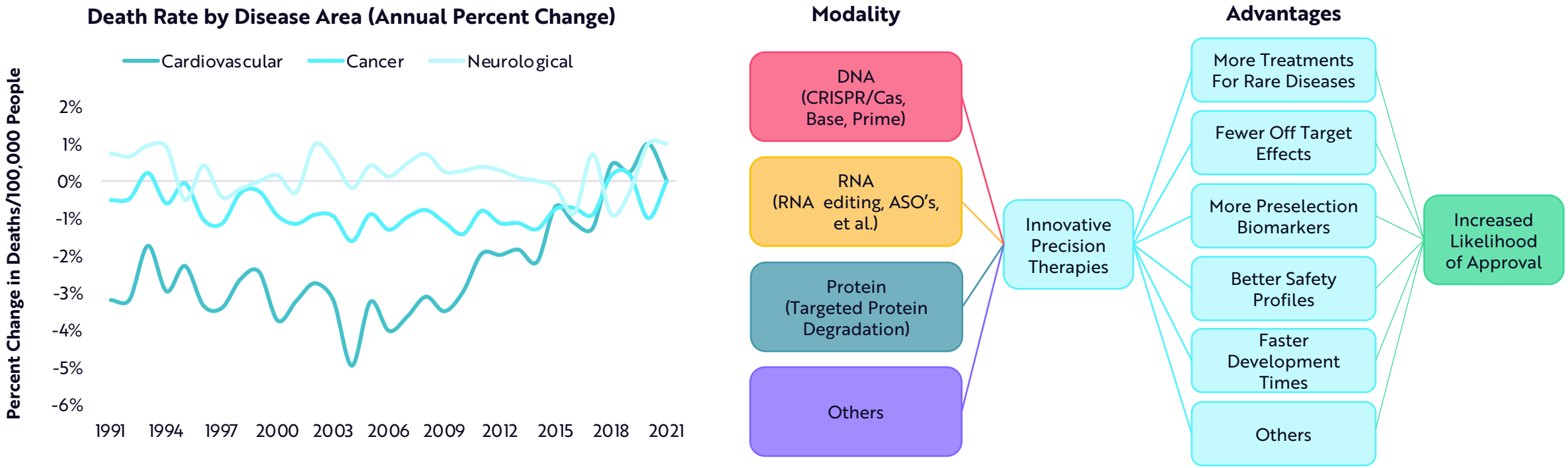
Research by Ali Urman, Analyst & Pierce Jamieson, Research Associate

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Pharmaceuticals Need Innovation

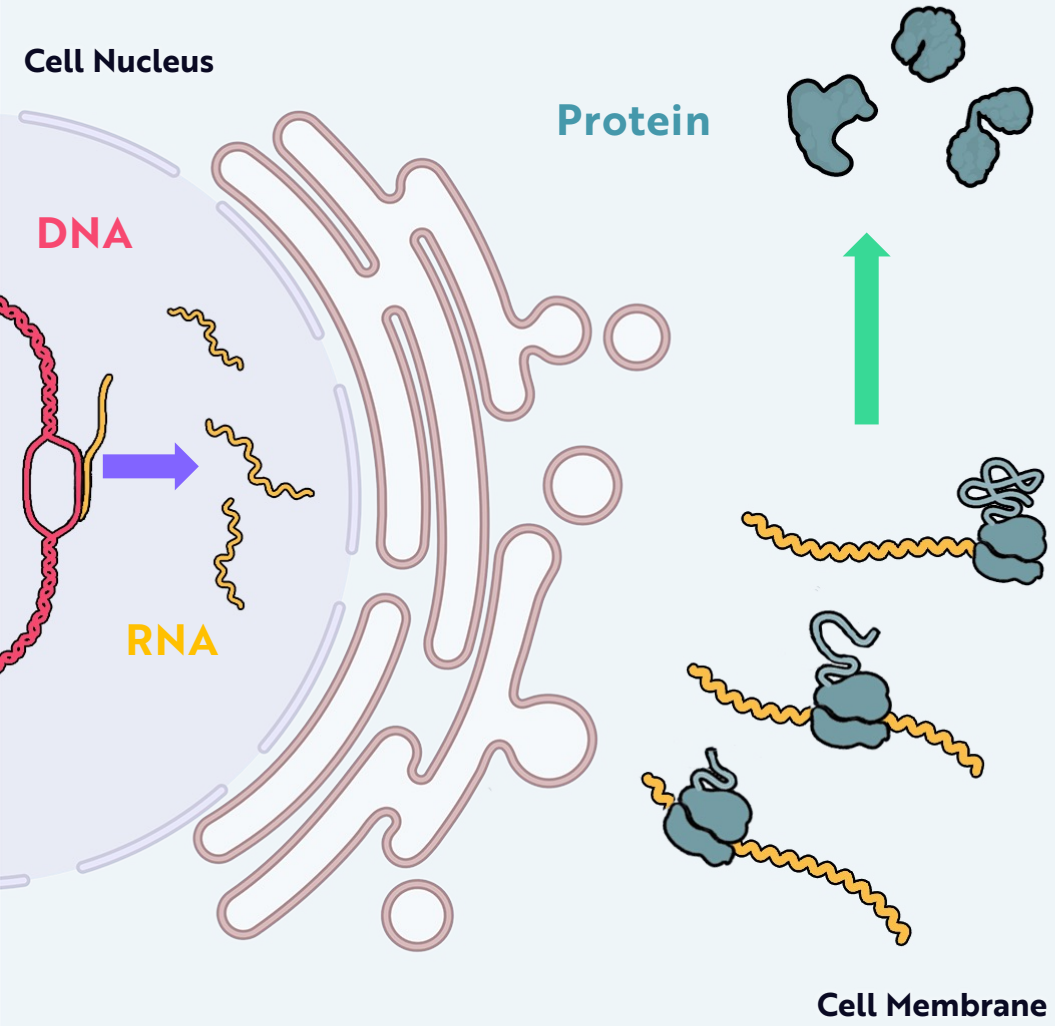
Unlike the last 30 years, the change in death rates associated with cancer and cardiovascular diseases during the past five years has not improved significantly, suggesting that existing approaches have reached diminishing returns, as shown on the left below. Emerging precision therapy modalities could become best-in-class, lowering death rates across many diseases, including neurological, as shown on the right below.

Compared to older pharmaceuticals, innovative precision therapies have advantages that could cause significant shifts in market share. Precision therapy toolkits are broadening with techniques that target DNA, RNA, proteins, and more—giving researchers unprecedented flexibility to tackle different diseases.

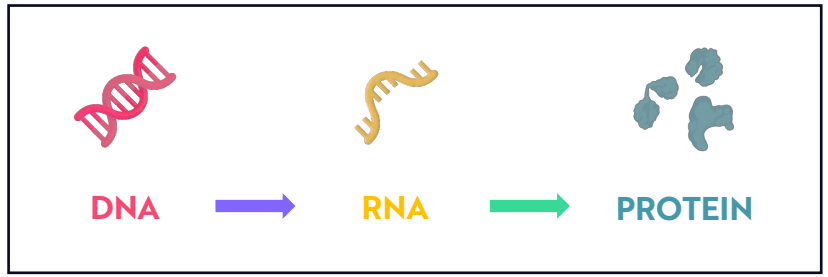


Sources: ARK Investment Management LLC, 2023. World Health Organization, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

The Central Dogma Of Biology



The central dogma describes the flow of information through biological systems. With DNA as the template, our cells transcribe RNA molecules, which translate into proteins. DNA mutations migrate through this process, sometimes producing dysfunctional proteins. Although proteins are the main causes of disease, scientists can target any molecule—DNA, RNA, or proteins—with precision therapies.



We believe that more therapeutic targets could result in better health outcomes for patients.

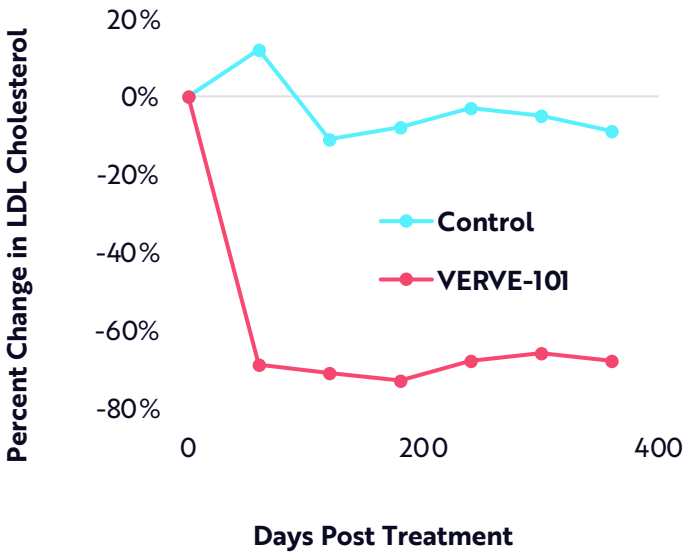
Sources: ARK Investment Management LLC, 2023. Malone, C. 2007. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Innovative Therapies Are Targeting Each Part Of The Central Dogma

Researchers can target DNA[1] using gene editing to cure or prevent heart disease, silence RNA[2] to control polyneuropathy, and degrade proteins[3] to limit the growth of tumors.

DNA

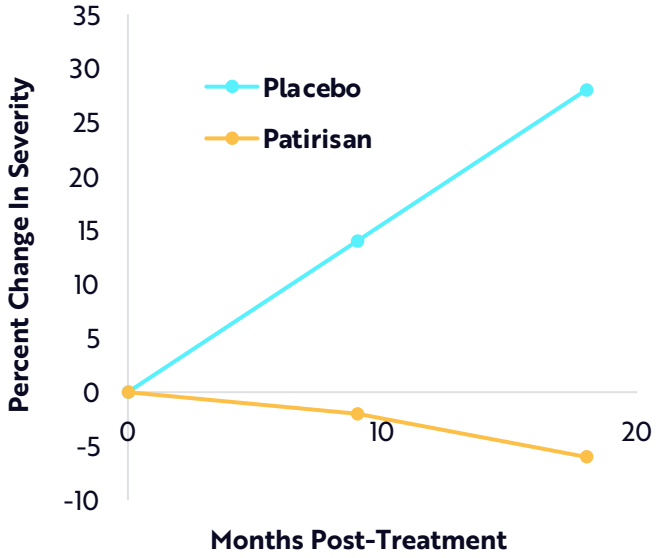
DNA Editing Is Preventing Cardiovascular Disease in Non-Human Primates (NHPs)



VERVE-101 is a gene editing therapy for the treatment of hypercholesterolemia under clinical investigation by Verve Therapeutics.

RNA

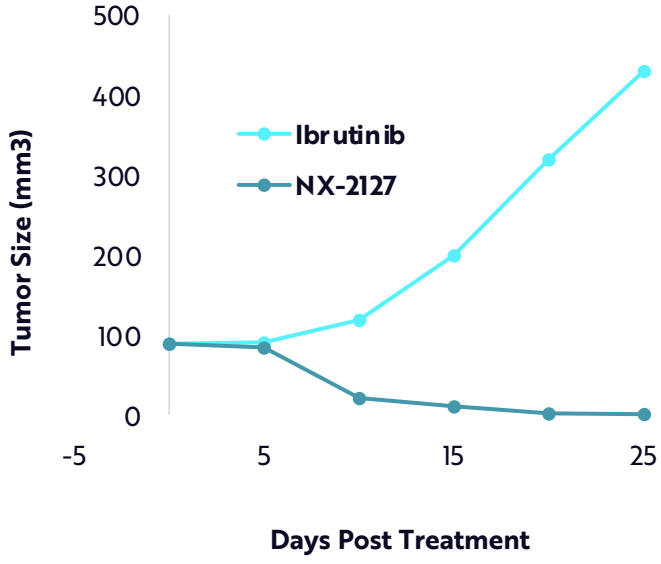
RNA Silencing Is Reversing Neurological Diseases



Developed by Alnylam Pharmaceuticals, Patirisan was approved recently by the FDA for hATTR Amyloidosis leading to polyneuropathy.

PROTEIN

Targeted PROTEIN Degraders Inhibit Tumor Growth



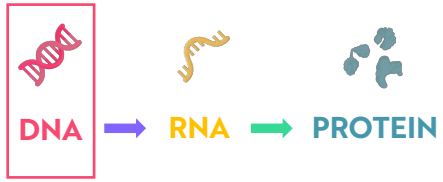
Ibrutinib is a small molecule drug for treatment of several cancer types.

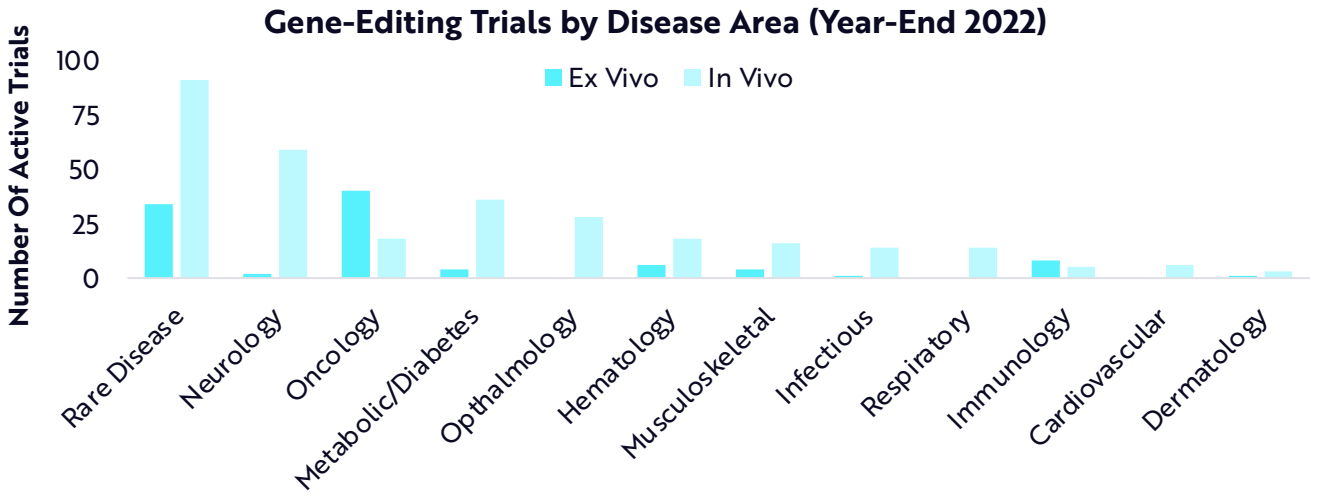
NX-2127 is Nurix Therapeutics' targeted protein degrader currently under clinical investigation.

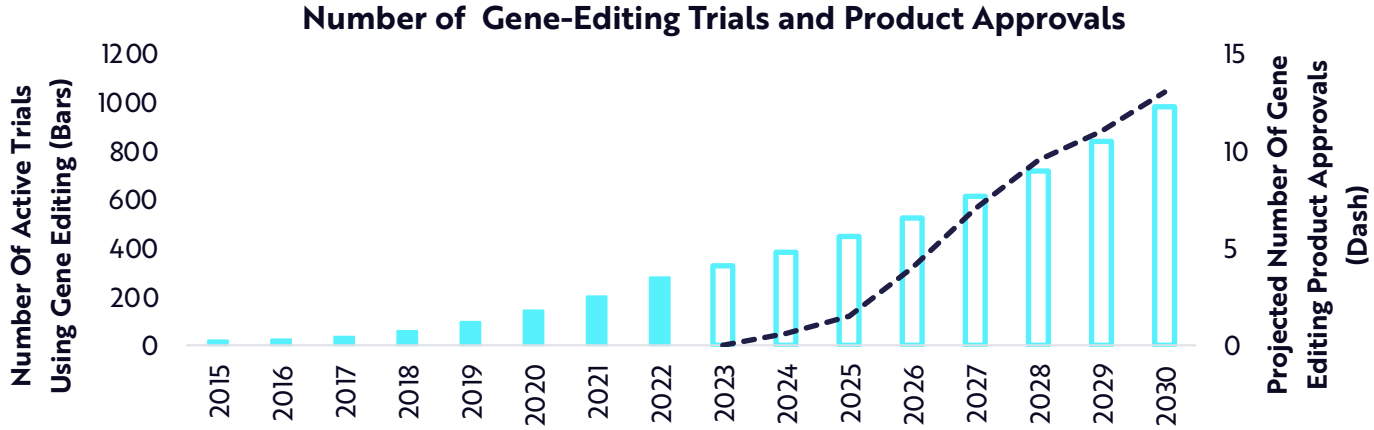
Sources: ARK Investment Management LLC, 2023. [1] Musunuru, K. et al. 2021; [2] Adams, D. et al. 2018; [3] Robbins, D. et al. 2020.

Gene Editing Is Close To Commercialization

- Gene editing—the ability to modify, insert, or delete genes—could stop disease at its source.
- Gene editing-based therapies are in the clinic for rare diseases, neurology, oncology, ophthalmology, among others.
- For some diseases, an ex-vivo approach modifying a patient's cells outside the body and then transplanting them back is sufficient. More versatile, an in-vivo approach modifies a patient's cells inside the body. In-vivo gene editing should be more cost-effective and easier to manufacture and scale and will expand access to the liver, eye, central nervous system (CNS), and muscles.
- Gene-editing clinical trials could triple by the end of the decade, accelerating the first product approvals, as shown in the lower chart.

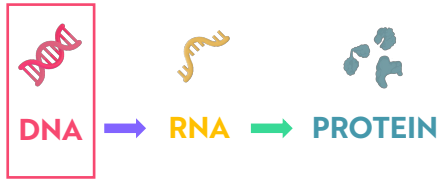






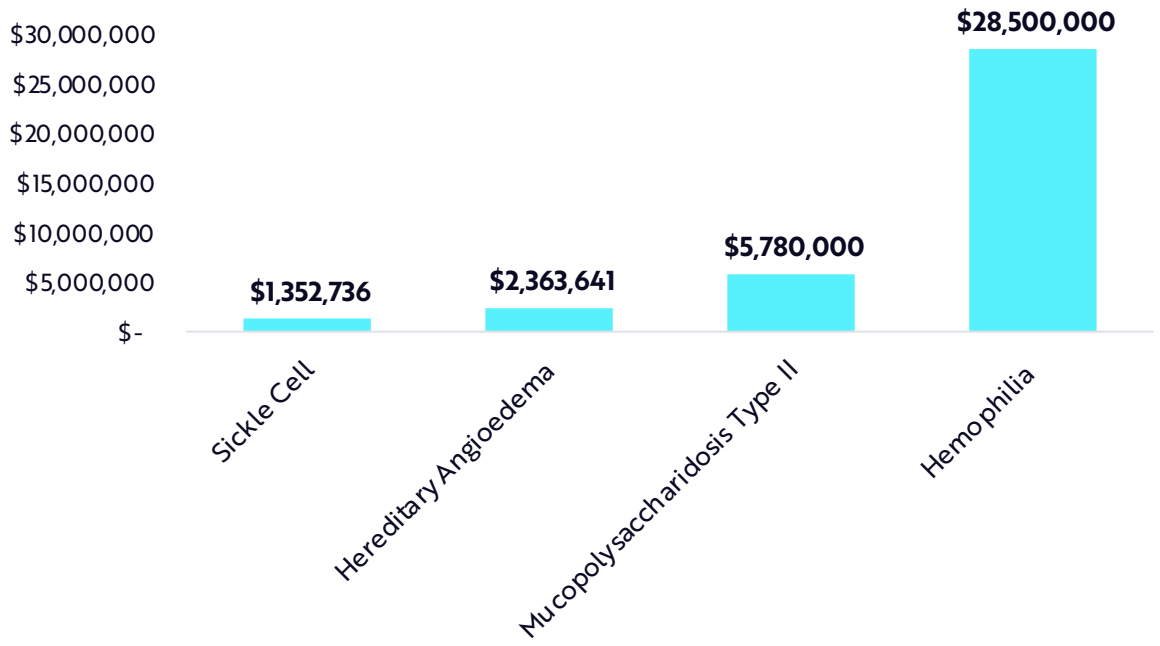
Sources: ARK Investment Management LLC, 2023. Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Gene-Editing Therapies Could Command Premium Pricing

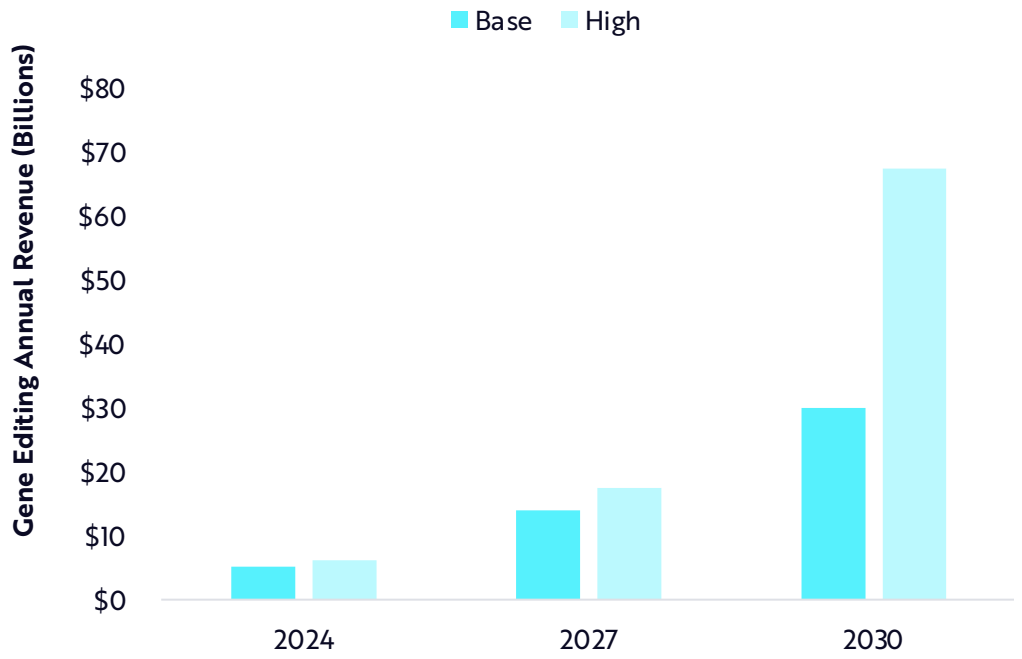


Gene editing therapies could command a median price of ~$2.5 million dollars, and much more for certain indications. Indeed, a recently approved gene therapy for Hemophilia B costs $3.5 million per dose. ARK's base case forecast for gene editing revenue is ~$30 billion, though approvals for diseases like Type 1 diabetes could scale the category to $60 billion by 2030.

Lifetime Direct Cost of Treatment for Hereditary Disorders

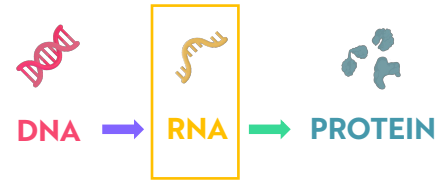


Gene Editing Revenue Projections*



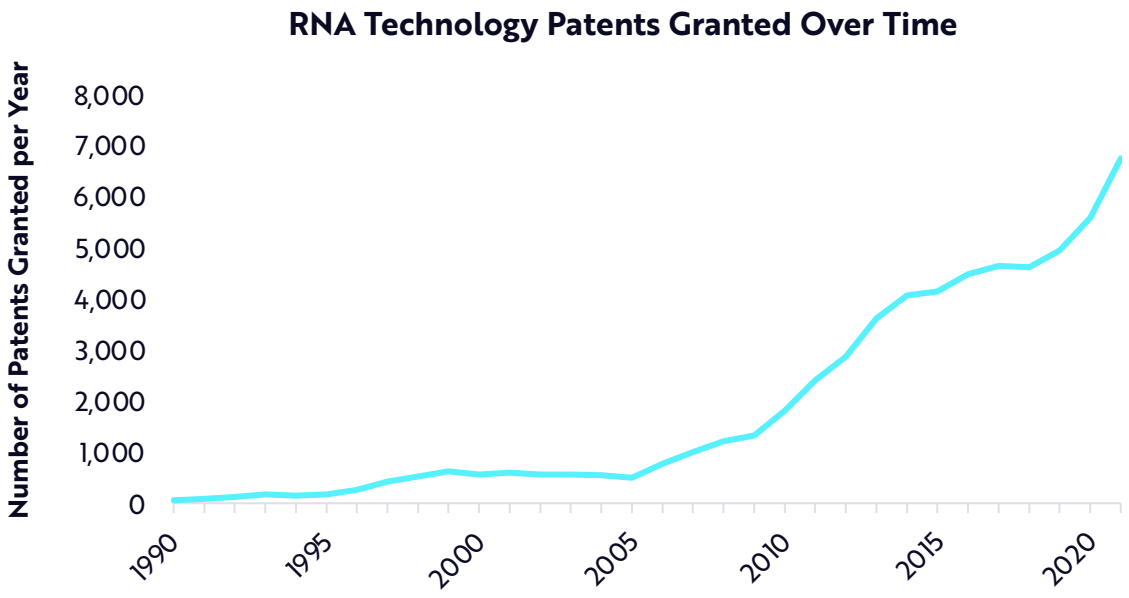
*Forecast assumes that the annual direct cost associated with treating these diseases is between $15,000- $34,000 and the age range of patients is 20 - 50 years. Payers may consider indirect costs, such as quality of life and/or lost labor, which could drive reimbursement higher. To arrive at the total cost of treatment, we average annual direct costs of treatment by the years treated. For a potential cure we assume a median of the approved drugs. Sources: ARK Investment Management LLC, 2023. Irvine, A. 2019. Forecasts are inherently limited and cannot be relied upon. 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.

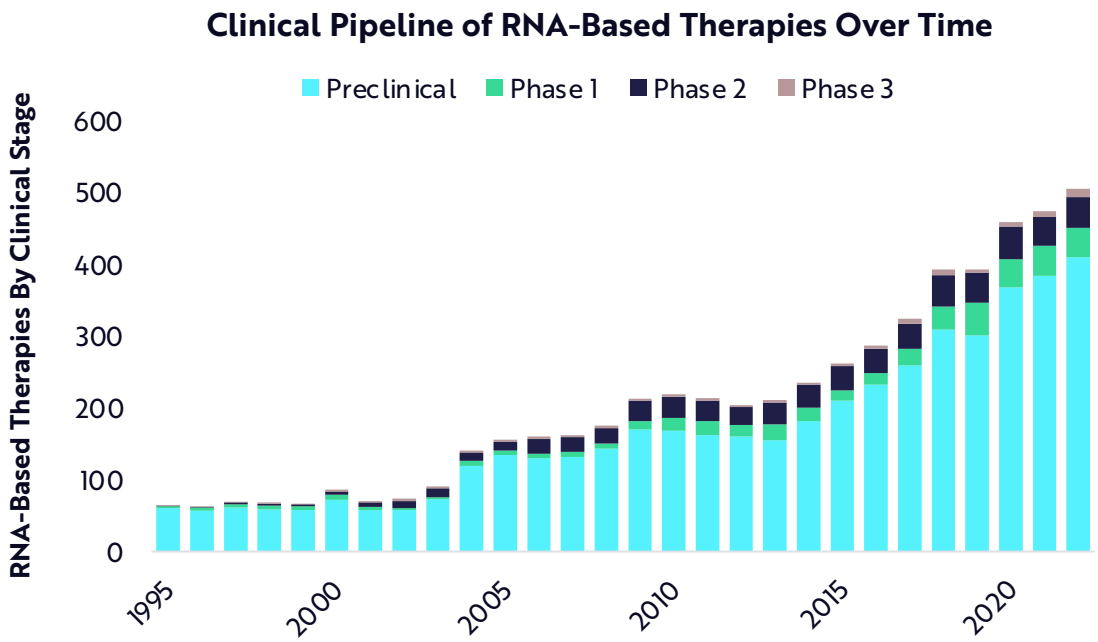
RNA-Based Therapeutics Are Gaining Traction



RNA-based medicines alter the structure, function, quantity, or localization of **RNA** and/or other molecules. This class of medicine can treat "undruggable" targets. While traditional small molecule therapies target the active binding site of a **protein**, only 14% of **proteins** have such sites. RNA-based medicines could help close this gap.[1]

During the past 20 years, the number of annual **RNA** patent grants has increased 10-fold and the number of **RNA-based** therapies in clinical pipelines has more than quintupled to ~500.

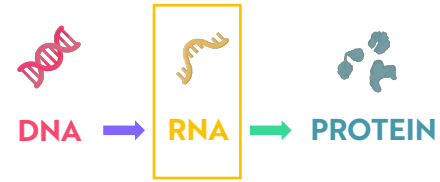




Sources: ARK Investment Management LLC, 2023. Clarivate, data as of 01/17/23; Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

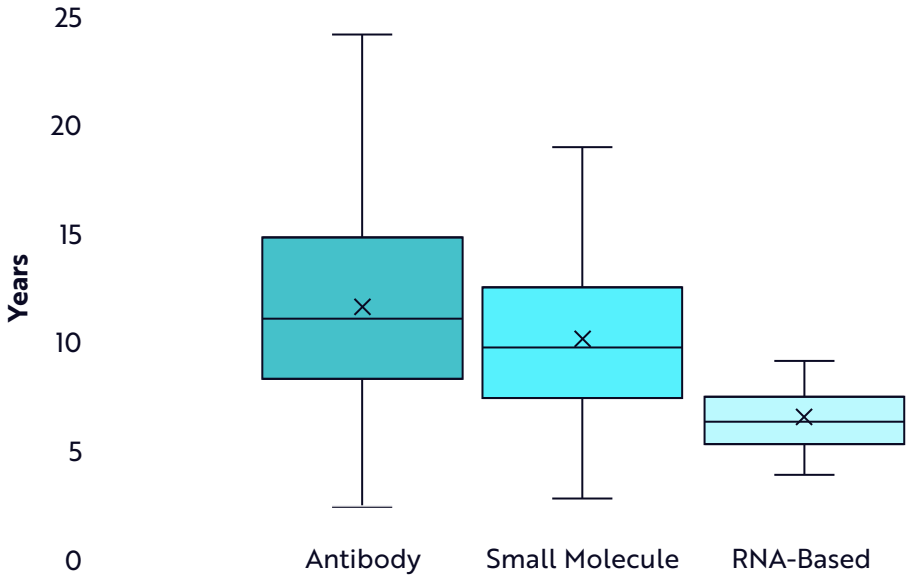
RNA-Based Therapeutics Should Lower Costs and Improve Time To Market

Traditional clinical development costs, including the cost of failures, have averaged $2 billion over ten years, before any commercialization costs. Thanks to recent multiomic breakthroughs like next generation sequencing, CRISPR gene editing, and artificial intelligence, drug failure rates and commercialization timelines are likely to decline.

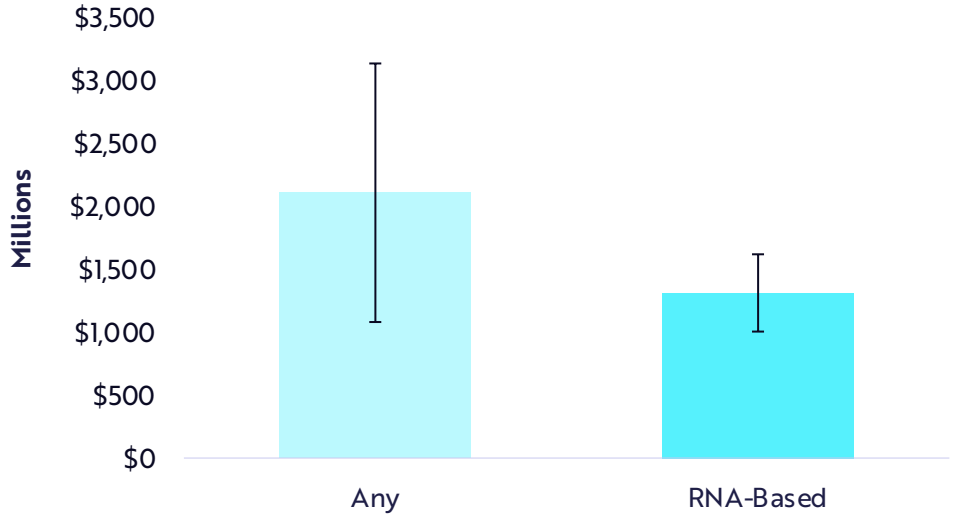


Compared to other modalities, the production of RNA-based therapeutics is faster and less expensive. RNA-based development, including failures, averages five years and costs $1.25 billion, compared to small molecule and antibody trials that average 10 years and cost more than $2 billion.

Clinical Development Time by Therapeutic Class*

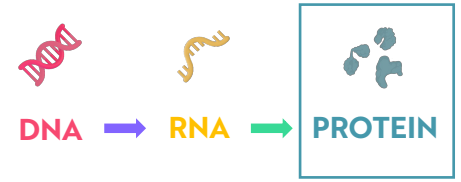


Cost of Clinical Development



*This is a box and whisker plot used to display data that includes error bars. Sources: ARK Investment Management LLC, 2023. Wouters, O. et al. 2020; Brown, D. et al. 2021; Lindeborg, R. et al. 2021. Forecasts are inherently limited and cannot be relied upon. 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.

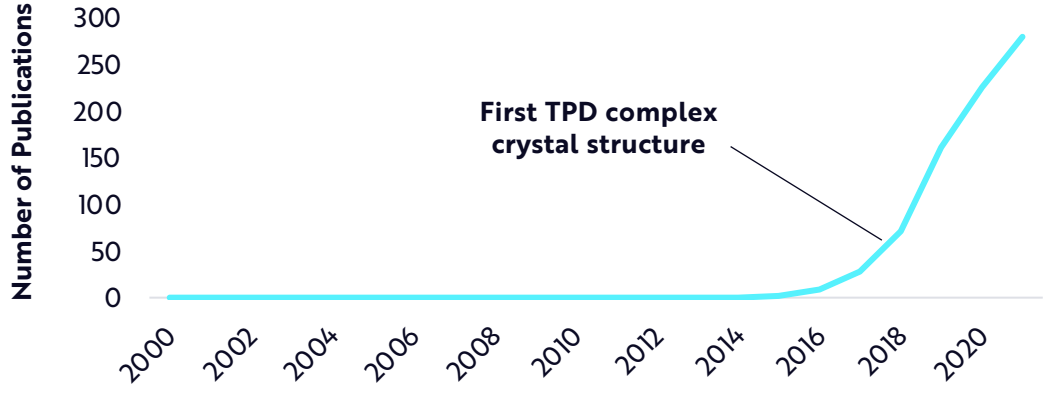
Targeted Protein Degraders (TPD) Could Treat Many Diseases



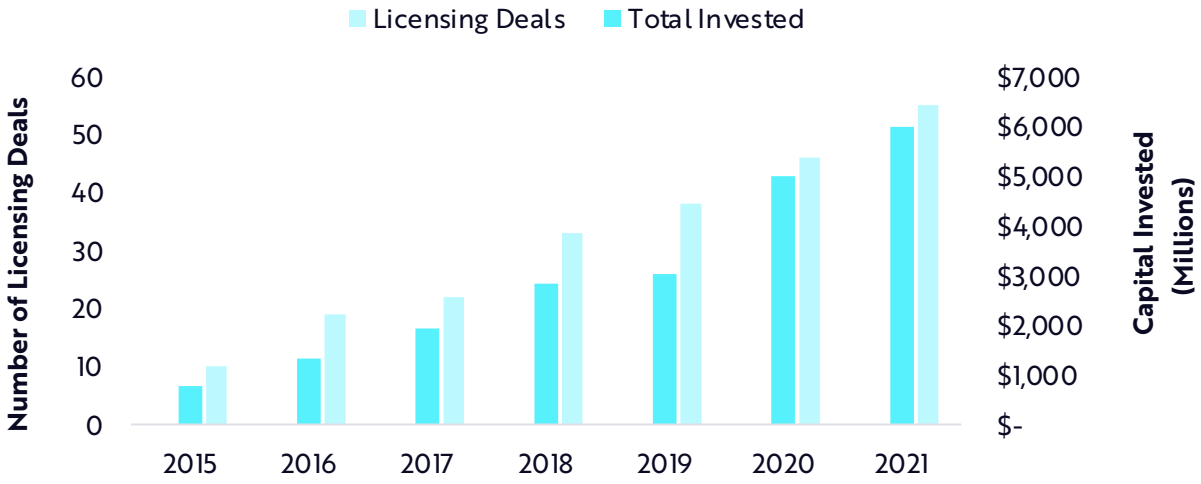
Targeted **Protein** Degraders (TPDs) leverage the body's system to lower the number of disease-causing misfolded **proteins**. TPDs have doubled the number of druggable **proteins** and are in the clinic for oncology, autoimmune, and fibrotic diseases, sometimes in combination with cell therapies.

During the period of 2015-2020, the number of TPD patent publications increased ten-fold. According to our research, 88% of TPD trials are in early phases, and the number of TPD licensing deals has increased more than 10-fold to 50+.

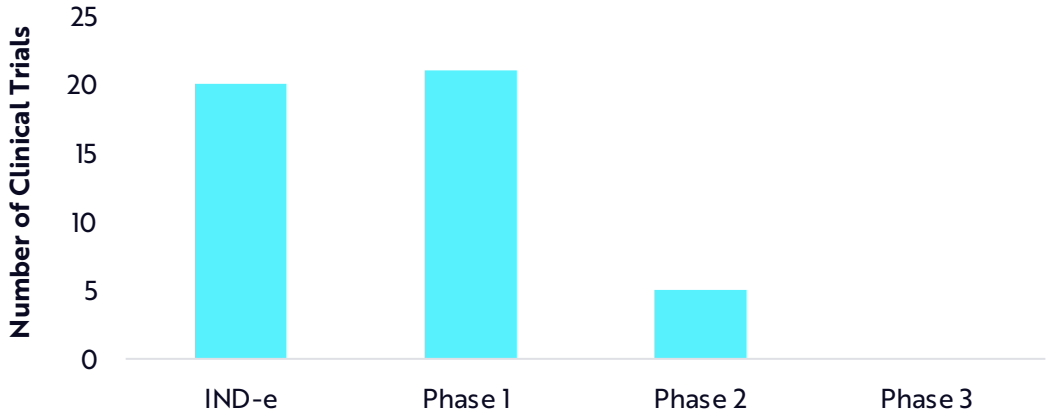
TPD Patent Publication



Cumulative Investment in the Targeted Protein Degrader Space

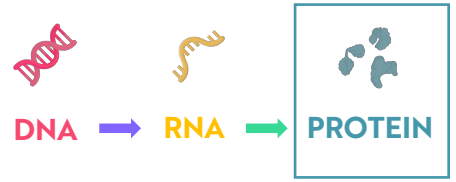


Maturity of TPD Clinical Landscape



Sources: ARK Investment Management LLC, 2023. Koppal, T. 2020; Nasir, M. et al. 2022; Biomedtracker, data as of 01/17/23; Samarasinghe, K. et al. 2021; Békés, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

TPD Therapy Could Address The “Undruggable" Proteome



More Than Half of Protein Targets Under Investigation Are TPD-Enabled

Benefit of Therapeutic Modality	Small-Molecule Inhibitors	TPDs
Potential to Treat Undruggable Proteins	No	Yes
Iterative Mechanism of Action	No	Yes
Orally Bioavailable	Yes	Yes
Ease of Manufacturing	Yes	Yes
Preclinical Validation	Yes	Yes
Clinical Validation	Approved	Phase 2

Targeted **Protein** Degraders (TPDs) have more than doubled the number of druggable human protein targets.

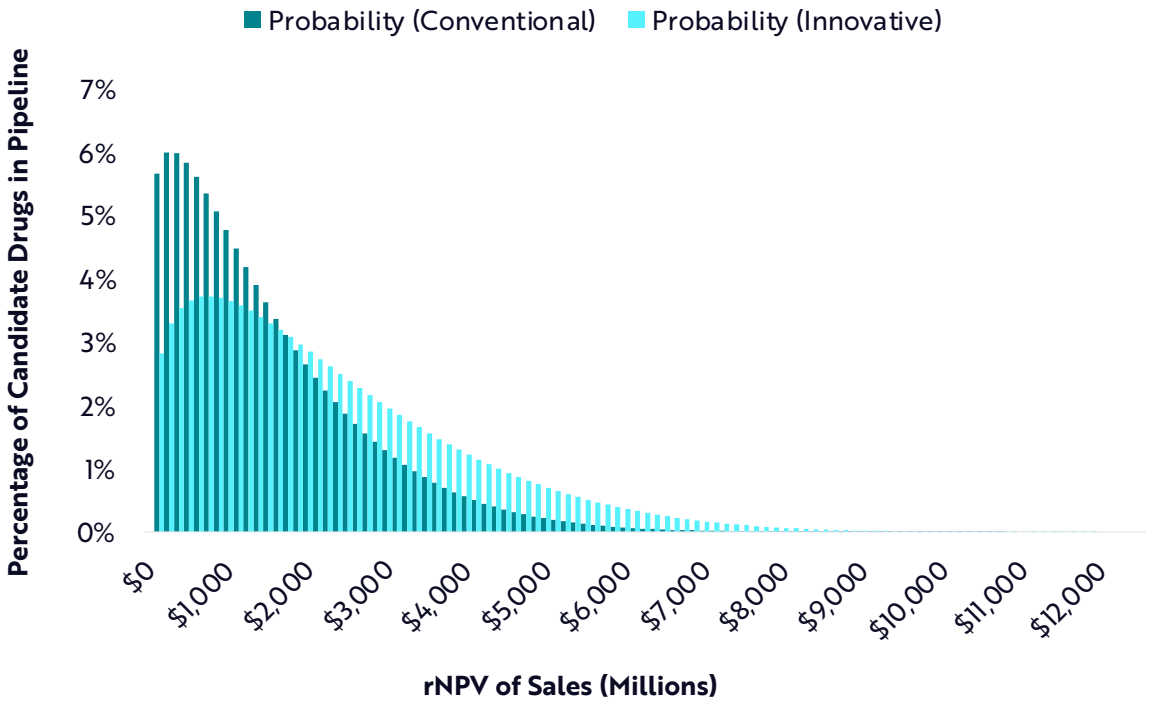
One TPD molecule can degrade hundreds of target **proteins** (iterative mechanism of action) over its lifetime, whereas traditional small molecule inhibitors can target only one. As a result, TPD's have a very attractive safety profile relative to small molecules.

Sources: ARK Investment Management LLC, 2023. Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

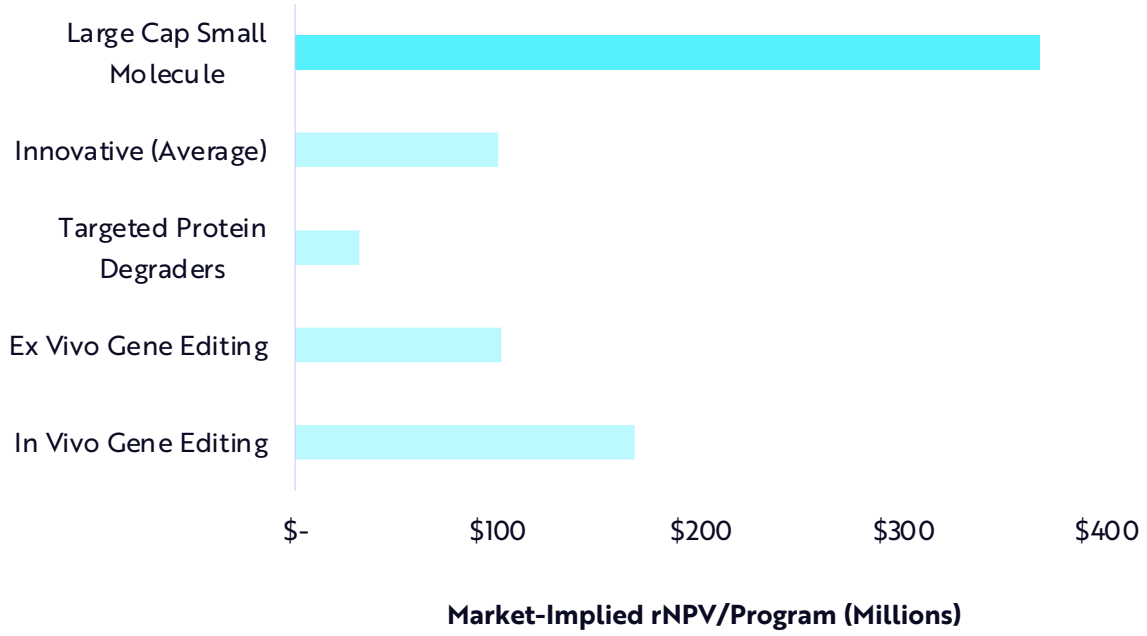
Innovation Is Key To The Efficiency Of Research And Development

In our view, innovative precision therapies are undervalued, with a more attractive risk-adjusted net present value (rNPV) relative to large pharmaceutical companies that focus on traditional therapeutics like small molecules. Based on our research, the total enterprise value of innovative precision therapy companies should appreciate at a 29% compound annual growth rate (CAGR) from ~$500 billion in 2022 to ~$3 trillion by 2030.

Innovative Drugs Offer More Attractive Risk-Adjusted NPVs



The Market Ascribes Little Value to Innovative Therapeutics Relative to Traditional Medicines



*Progress-Normalized. Sources: ARK Investment Management LLC, 2023. Biomedtracker, data as of 01/17/23. Forecasts are inherently limited and cannot be relied upon. 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.

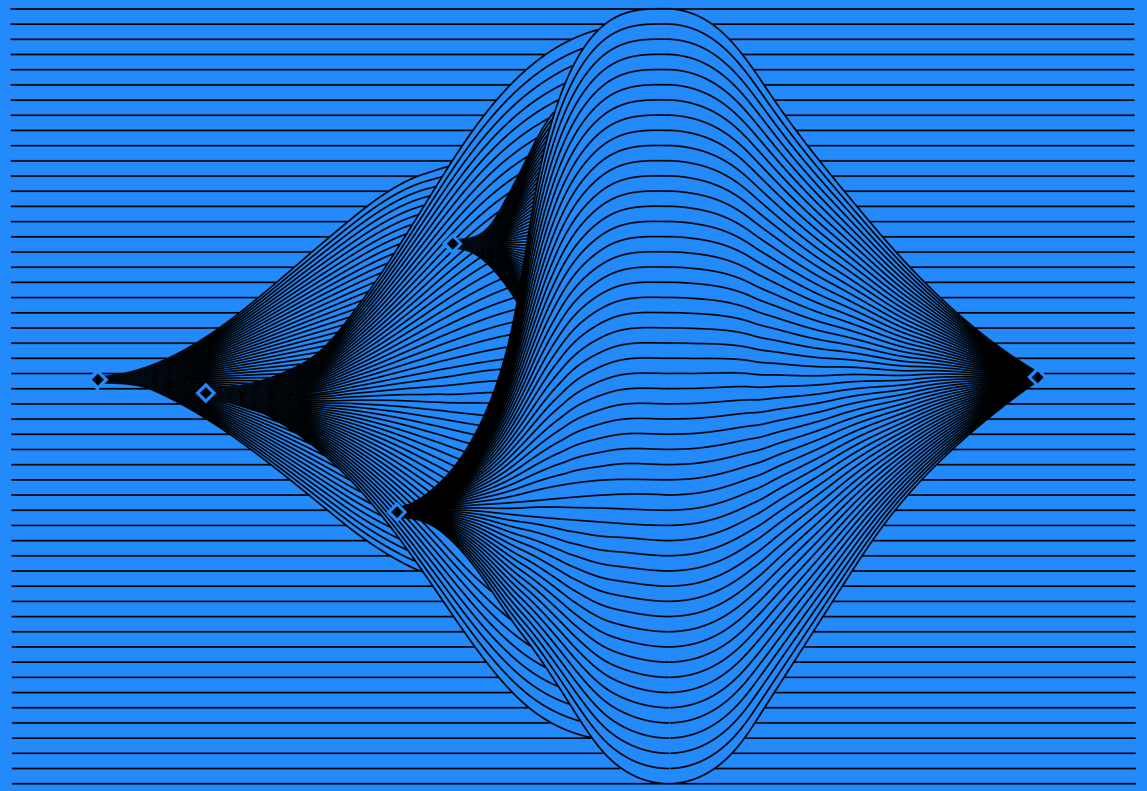
Molecular Cancer Diagnostics

Transforming Biological Signals Into Better Patient Outcomes

Next-generation sequencing (NGS) costs have collapsed, making molecular diagnostic tests more feasible and turbocharging our understanding of tumor biology.[1]

By leveraging artificial intelligence (AI), cancer diagnostics labs have created less invasive tests like liquid biopsies to supplement tissue biopsies.[2]

As proof of clinical utility accumulates, ARK estimates that the total addressable market (TAM) for molecular cancer diagnostic tests in the US is ~$95 billion, its revenue increasing more than 20% annually during the next five to ten years, from ~$5 billion in 2022 to $24 billion in 2030. Moreover, the collective enterprise value of molecular cancer testing companies should expand at a similar rate from ~$30 billion in 2022 to $145 billion in 2030.



Research by Simon Barnett, Director of Research, Life Sciences

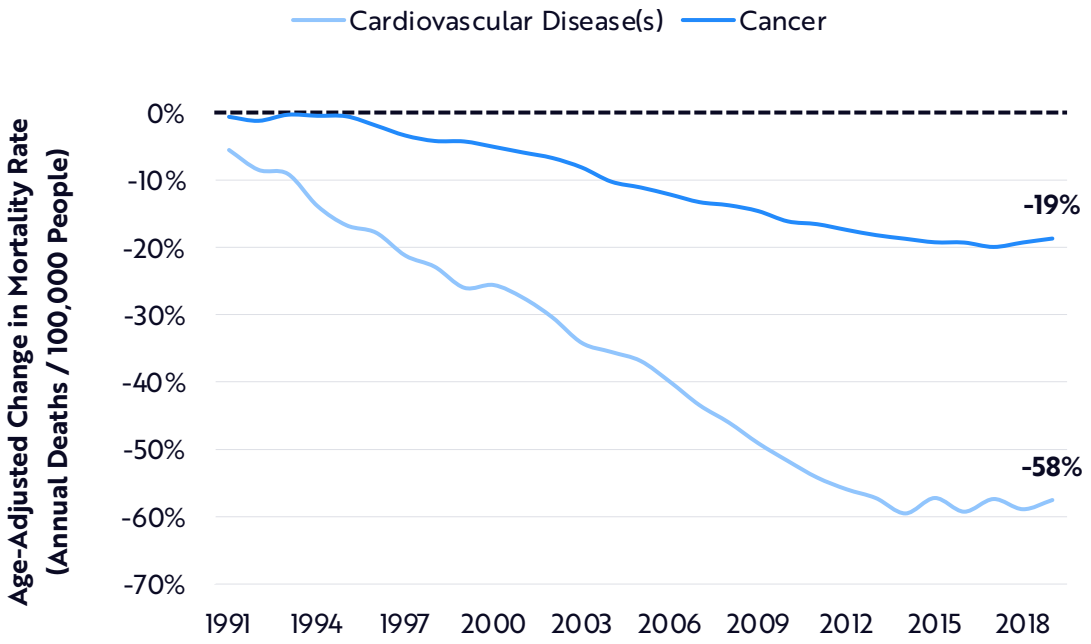
Sources: ARK Investment Management LLC, 2023. [1] Wetterstrand, K. 2021; [2] ASCO, data as of 01/19/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Cancer Could Be The Next Victory In Public Health

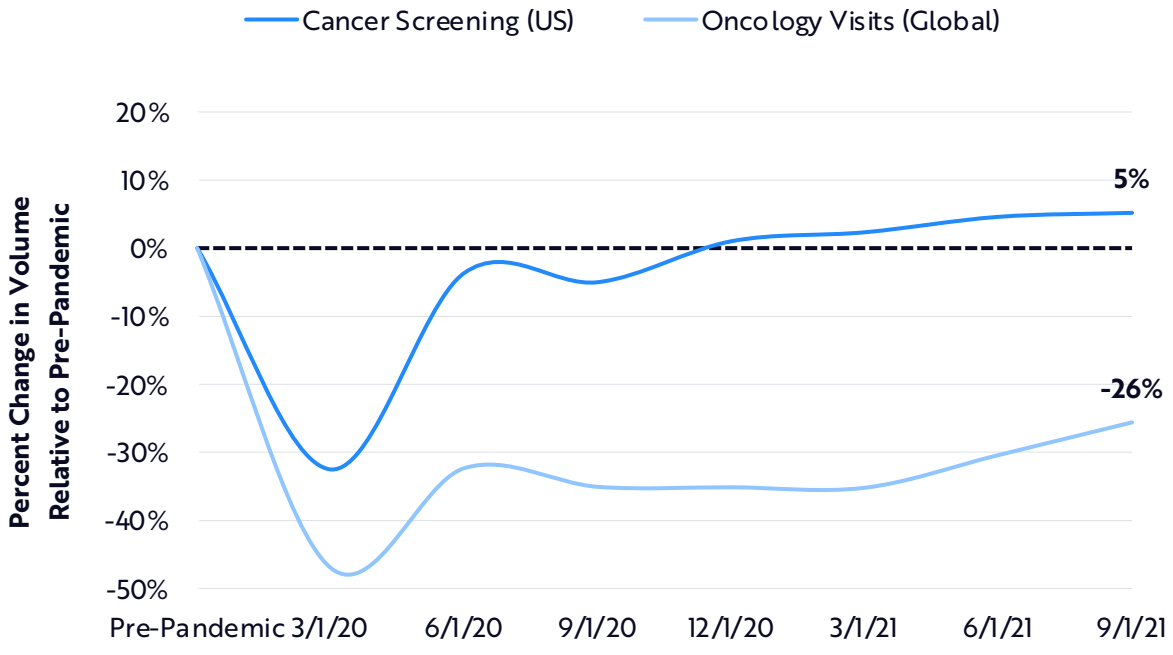
Since 1990, while the age-adjusted mortality rate for cardiovascular diseases has dropped more than 50%,[1] that for cancer has declined only ~19%.[2] Alongside improved therapies, emerging diagnostics could result in a dramatic drop in cancer mortality.

The need to focus on cancer has never been greater, especially because the COVID-19 pandemic severely disrupted cancer care, causing patients to miss more than 30 million screenings and ~60,000 diagnoses.[3]

Progress Fighting Cardiovascular Diseases and Cancer[1,2]



COVID's Impact on Global Oncology Practices[3]



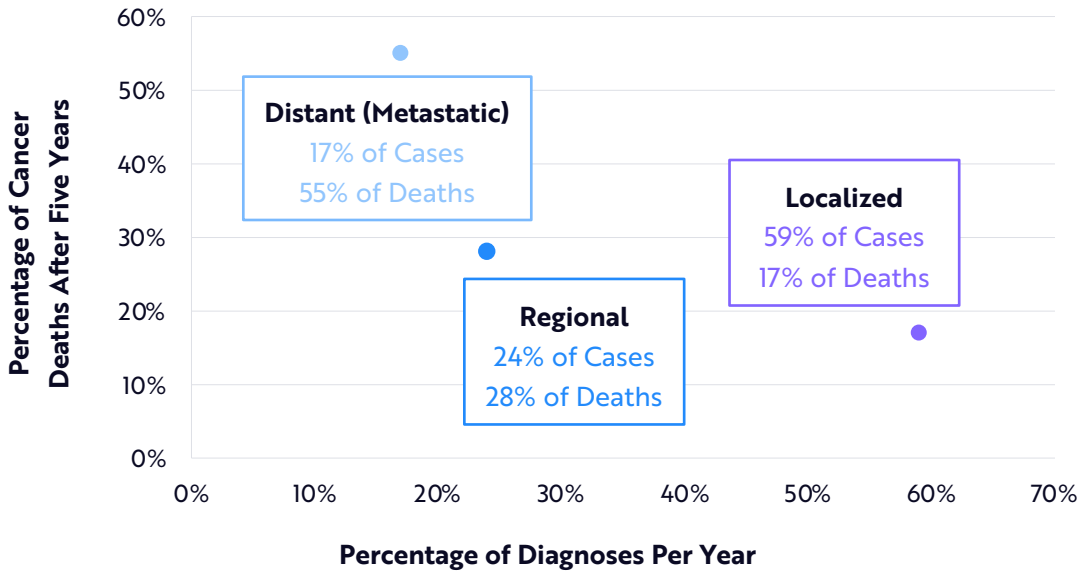
Sources: ARK Investment Management LLC, 2023. [1] Mensah, G. et al. 2017; [2] Roser, M. et al. 2019; [3] IQVIA Inc 2022. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Diagnostics + Therapeutics Should Reduce Cancer Mortality

We believe next-generation diagnostics and therapeutics will work together to lower cancer mortality.[1]

Advanced cancers account for only 17% of new diagnoses each year but 55% of deaths after five years. The importance of early detection is clear.[2]

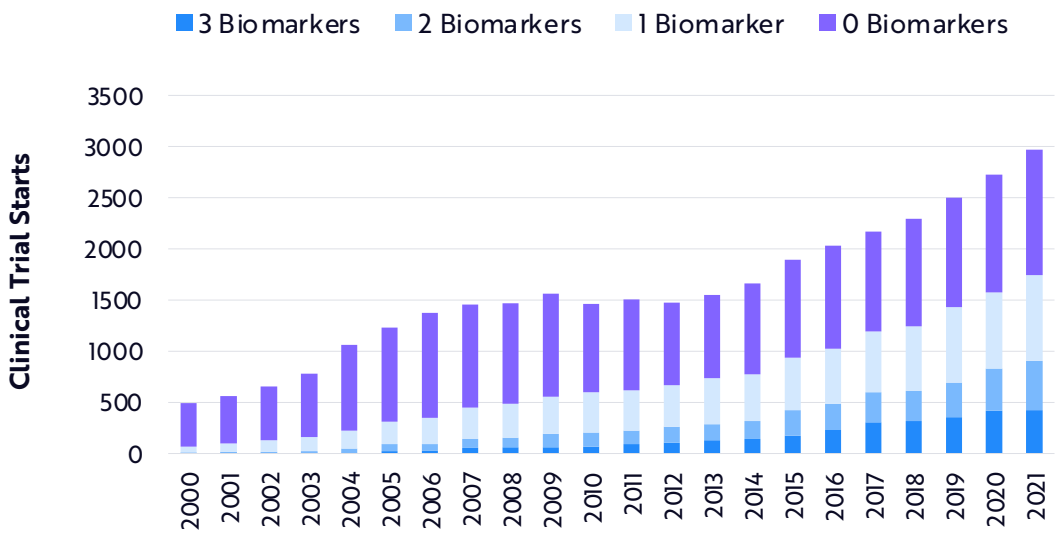
Advanced Cancers Account For The Minority of New Cases But Cause the Majority of Deaths[2]



Molecular testing is a prerequisite for precision therapy. The tests surface tumor-specific mutations, also called biomarkers, which point oncologists towards specific treatments.

Evidence suggests that biomarkers improve trial success rates,[3] so most oncology clinical trials now include molecular biomarkers.[4]

The Majority of Oncology Clinical Trials Use Molecular Biomarkers[4]

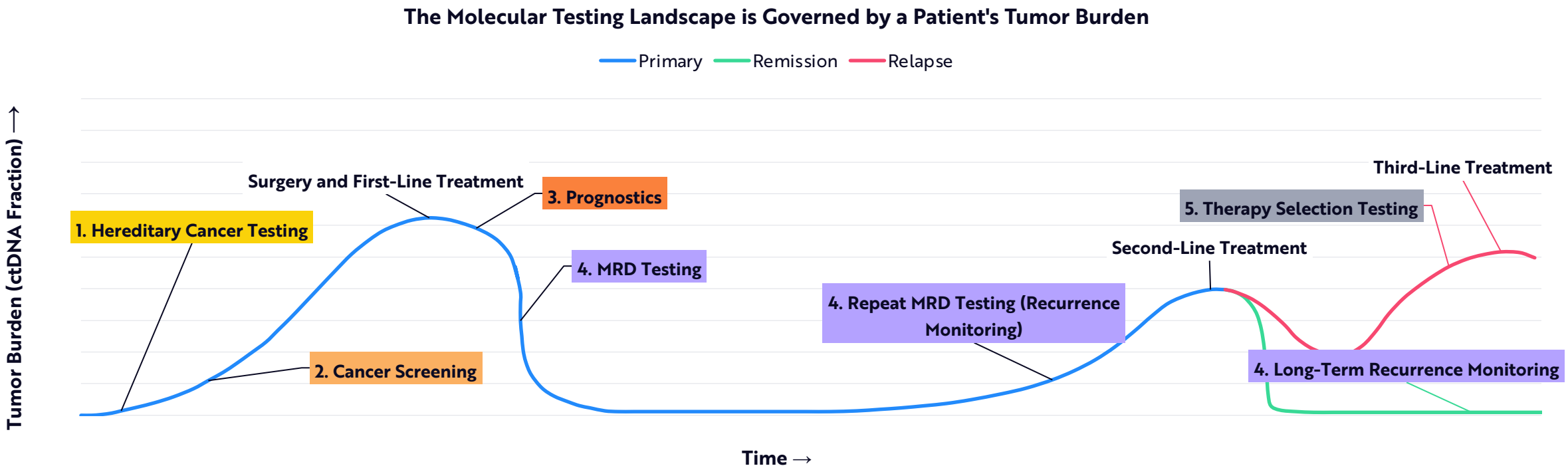


Sources: ARK Investment Management LLC, 2023. [1] Mensah, G. et al. 2018; [2] National Cancer Institute, data as of 01/19/23; [3] Parker, J. et al. 2021; [4] Vadas, A. et al. 2021. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

The Molecular Cancer Testing Market Segments By "Tumor Burden"

Molecular cancer tests examine biological samples like blood or tissue and use techniques like next-generation sequencing to transform biological information into digital information. Among the categories of molecular cancer testing are: (1) hereditary cancer testing, (2) screening, (3) prognostics, (4) minimal residual disease (MRD), and (5) therapy selection.

Tumor burden is a rough proxy for cancer's severity, typically quantified by the amount of circulating tumor DNA (ctDNA) in a patient's bloodstream. Using this framework, we segment the cancer testing market, as shown below.



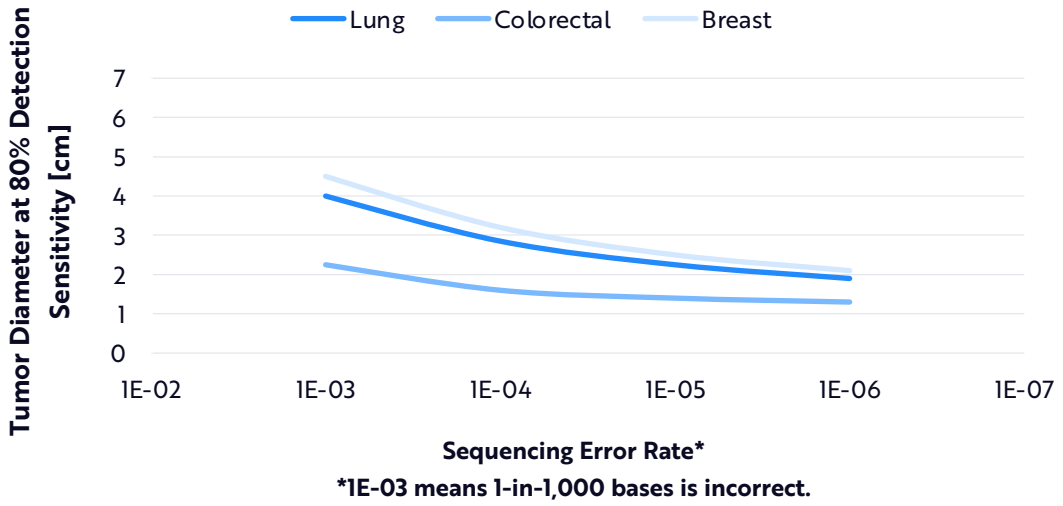
This image is not drawn to scale. The relationship between tumor burden and time is meant to be purely illustrative, not representative of a specific data set.

Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Multiomics Is Powering Screening Tests For The Deadliest Cancers

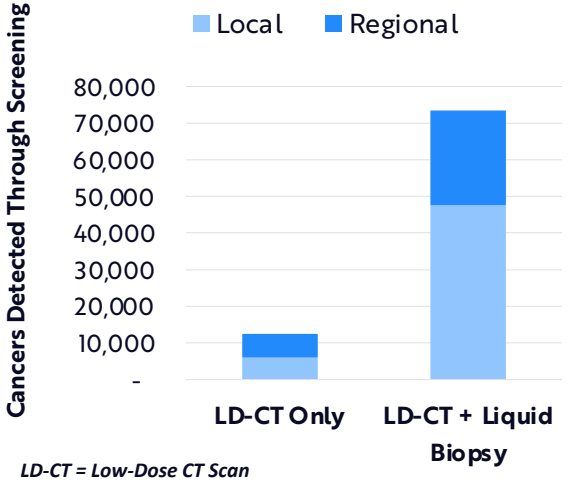
Non-invasive tests like Cologuard are supplementing standard-of-care screening technologies, a trend that should accelerate. Sequencing ctDNA mutations alone does not detect early-stage cancers reliably.[1] Even extremely accurate ctDNA sequencing methods struggle to find cancers until they are 1-2 cm in diameter, as shown below.[1] Multiomics tests incorporating other circulating cancer signals—like DNA fragmentation patterns—enable better performance.

DNA Mutations Alone are Insufficient to Screen for Most Stage 1 Cancers Economically[1]

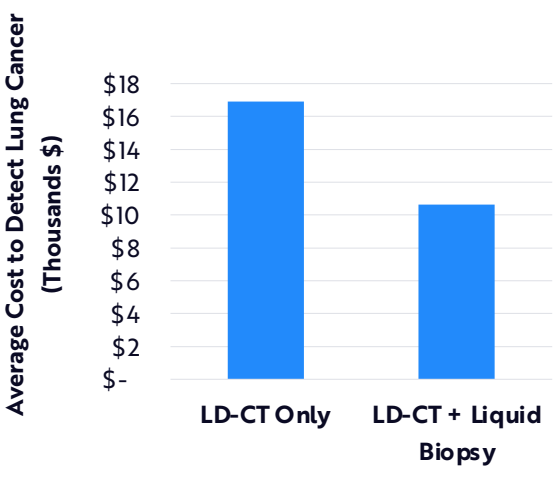


*1E-03 means 1-in-1,000 bases is incorrect.

Blood-Based Tests Could Improve Lung Cancer Screening[3]



Blood-Based Tests Could Lower the Average Cost of Detecting Lung Cancer[3]



LD-CT = Low-Dose CT Scan

Blood-based testing should improve patient adherence to cancer screening guidelines.[2] Powerful tests focused on lethal cancers, like pancreatic, are likely to proliferate during the next five years.

With currently available data, blood-based screening should increase early-stage lung cancer detection by six-fold.[3,4] Improved cancer detection, in turn, should lower average detection costs.

Sources: ARK Investment Management LLC, 2023. [1] Avanzini, S. et al. 2020; [2] Bokhorst, L. et al. 2015; [3] Mathios, D. et al. 2021; [4] Zhao, Y. et al. 2011.

Multicancer Earlier Detection (MCED) Tests Are Cancer Moonshots

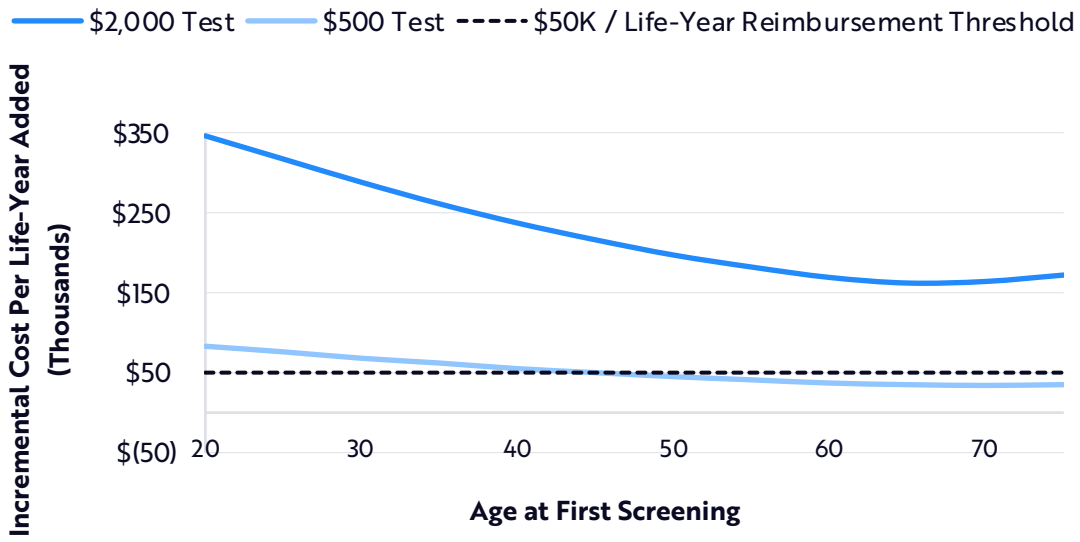
Unlike single-cancer tests, multi-cancer earlier detection (MCED) tests detect many forms of cancer from a single blood draw. Based on current performance data, payors could reimburse MCED tests at $500 for adults aged 45-75.[1]

A prerequisite for broad adoption, national reimbursement could take nearly a decade.[2] At full adoption today, MCED could reduce cancer mortality by 15%.

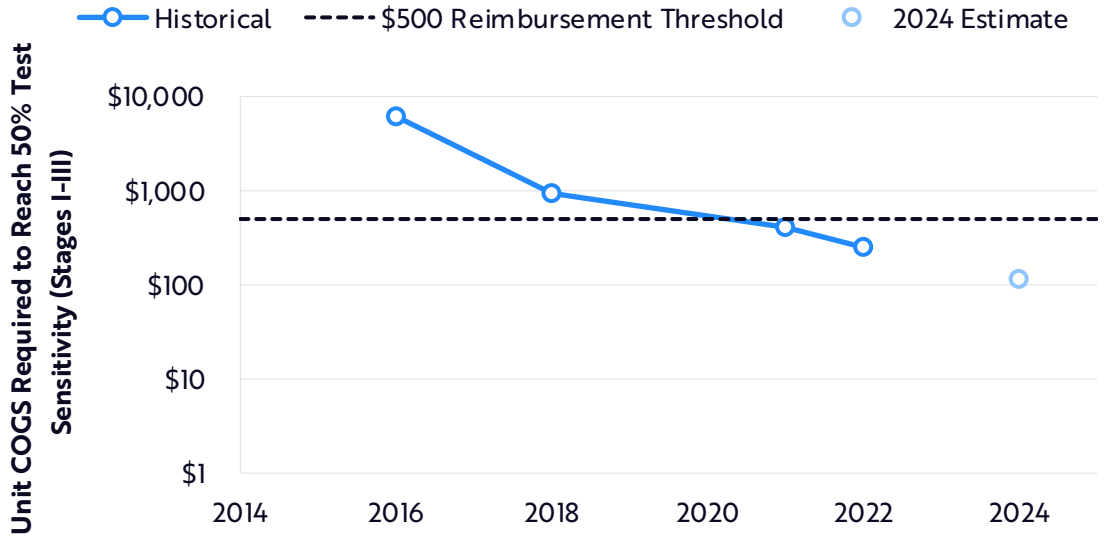
The cost-of-goods-sold (COGS) for an MCED test has fallen >90% over the past five years, resulting in positive gross profit at a $500 reimbursement price.

Test designs are becoming more efficient, giving MCED companies the ability to add more sensitivity and/or profitability for each incremental dollar in cost. In our view, vendors will opt for the former.

$500 MCED Tests Could Be Cost-Effective For Adults Aged 45—75



Already Profitable, MCED Tests Are Becoming More Cost-Efficient



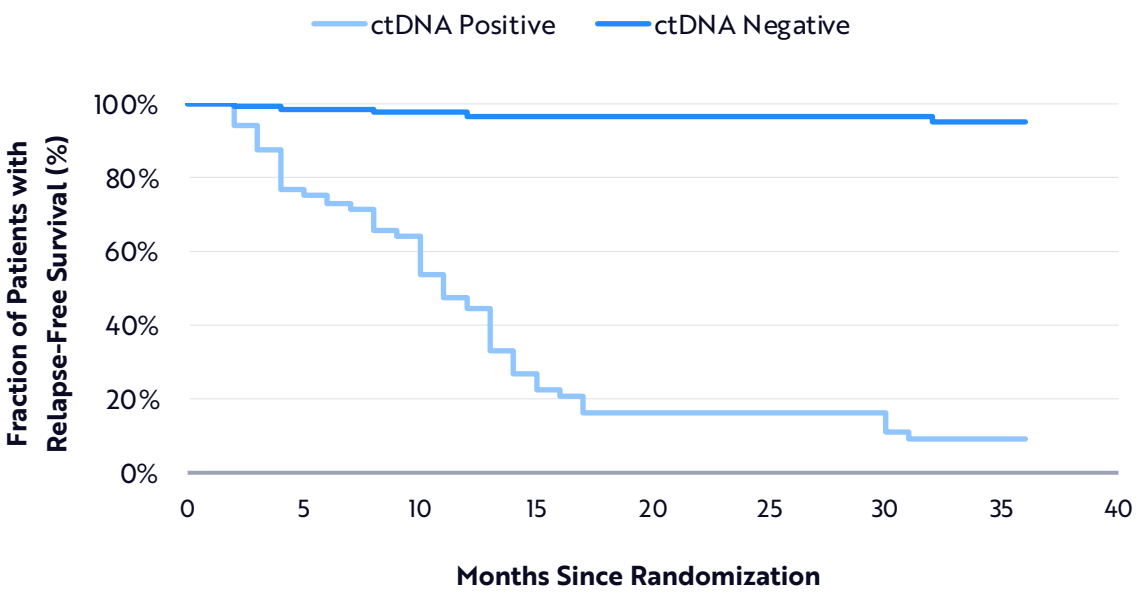
Sources: ARK Investment Management LLC, 2023. [1] Rowland, T. et al. 2022; [2] Grail, data as of 01/19/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Blood-Based Testing Could Revolutionize The Treatment Of Early-Stage Cancer

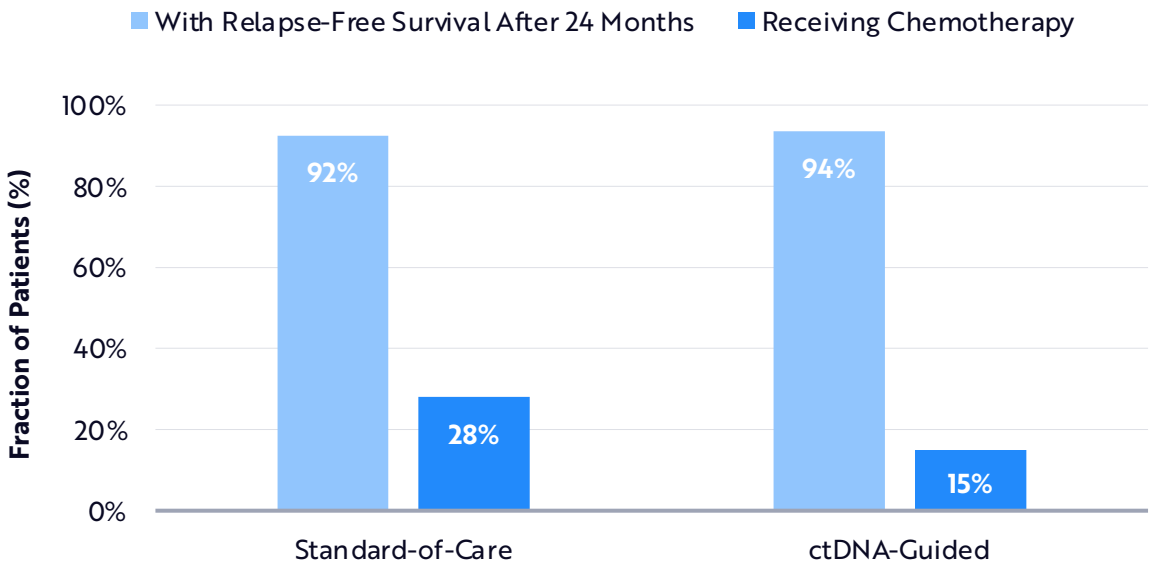
Historically, oncologists have used a metric called minimal residual disease (MRD)—the amount of cancer remaining in the body after treatment—to guide treatment for liquid tumors like multiple myeloma.[1] Solid tumors, which constitute 90% of annual diagnoses, require deep, expensive sequencing, making solid tumor MRD testing prohibitively expensive, until recently.[2]

Thanks to less expensive sequencing techniques, oncologists now test solid tumor patients not only with imaging but also with molecular MRD. ctDNA can predict relapse-free survival, helping patients avoid unnecessary chemotherapy.[3,4]

ctDNA Status is an Excellent Predictor of Relapse-Free Survival for Multiple Cancers[3]



ctDNA-Guided Cancer Care Achieved Comparable Survival Rates While Halving The Percent of Patients On Chemo[4]

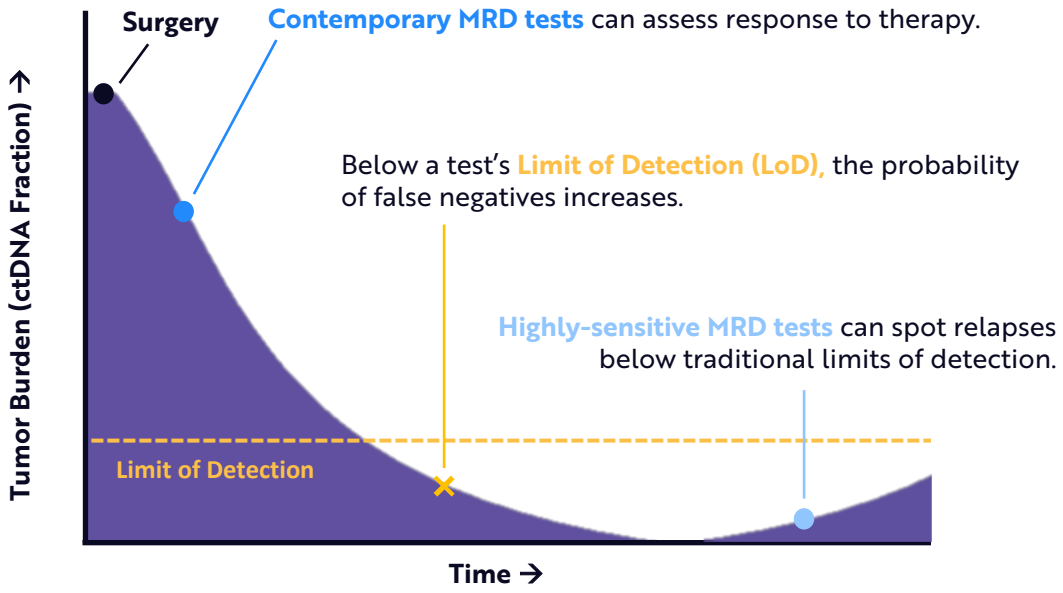


Sources: ARK Investment Management LLC, 2023. [1] Rawstron, A. et al. 2015; [2] Haque, I. et al. 2018; [3] Natera, Inc, data as of 01/19/23; [4] Tie, J. et al. 2022. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Highly Sensitive Technologies Can Detect The Recurrence Of Cancer

Following successful treatment, ctDNA levels can drop far below the limit at which MRD tests can detect cancer (LoD: Limit of Detection)—roughly 10 ctDNA parts per million molecules.[1]

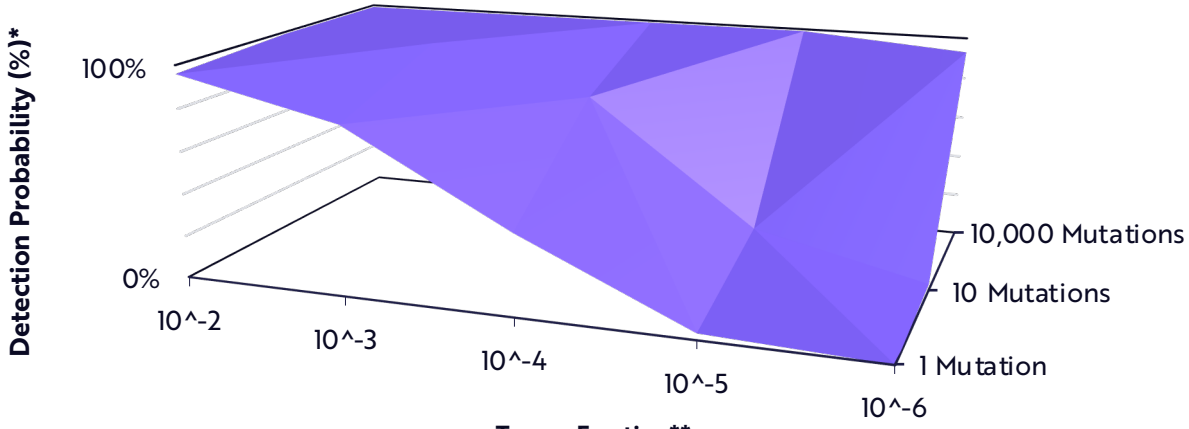
LoD is an obstacle more common in early-stage tumors or in cancers like breast that shed little ctDNA.[2]



New MRD tests can measure thousands of ctDNA mutations, increasing the sensitivity of detection by an order of magnitude[3] and helping to assess tumor reactions to treatment.[4]

While broad based MRD panels have been prohibitively expensive, competition is driving down the cost of DNA sequencing dramatically, increasing access to highly sensitive MRD tests.[5]

MRD Panels Will Broaden and Improve as NGS Costs Decline[3]



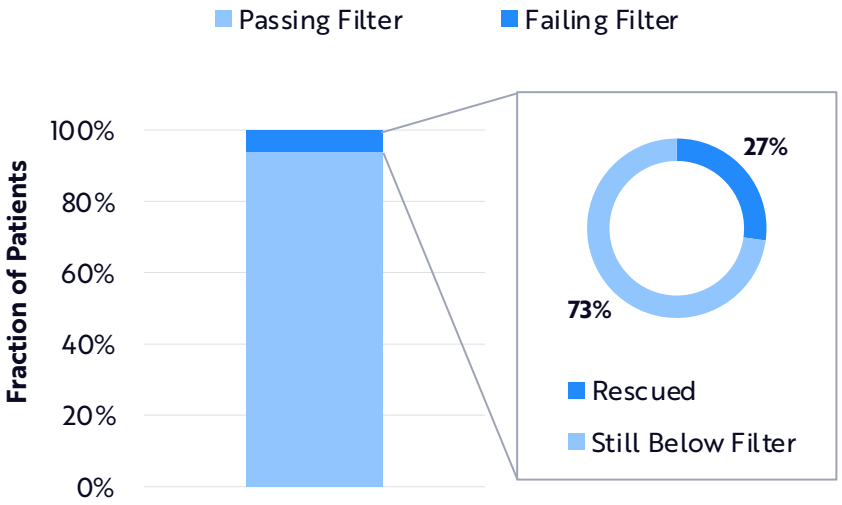
At 2,000 genome equivalents of DNA in the blood sample;
***For example, 10^-4 means 100 ctDNA parts-per-million (PPM)*

Sources: ARK Investment Management LLC, 2023. [1] Personalis Inc, data as of 01/19/23; [2] Avanzini, S. et al. 2020; [3] Zviran, A. et al. 2020; [4] Abbosh, C. et al. 2017; [5] Rusinek, I. et al. 2022. 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.

Therapy Selection Tests Add More Content And Sample Types

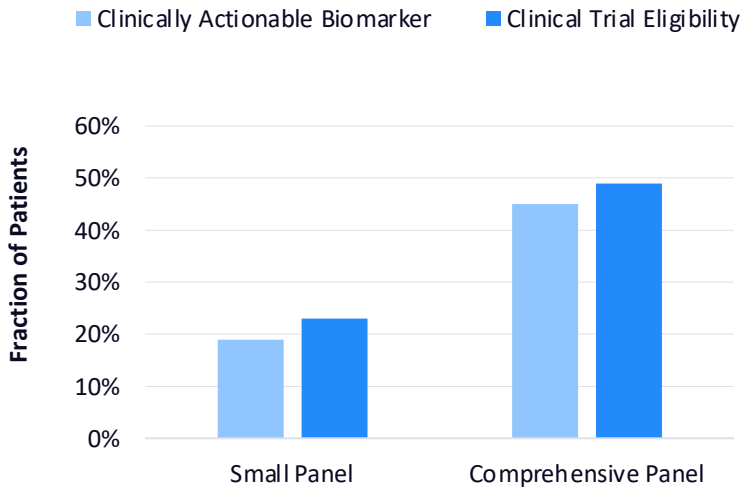
Designed for patients with more advanced cancers, therapy selection tests surface cancers' molecular drivers. While more mature than other molecular diagnostics, therapy selection tests are adding more sample types like blood,[1] more genes, and more analytes like RNA, increasing patient access and the probability of matches to targeted therapies or clinical trials.[2,3] For most solid tumor indications, therapy selection is likely to become standard of care, with adoption potentially doubling from 25% in 2022 to more than 50% in 2030.

Blood-Based Therapy Selection Is An Alternative for Patients with Insufficient Tissue[1]

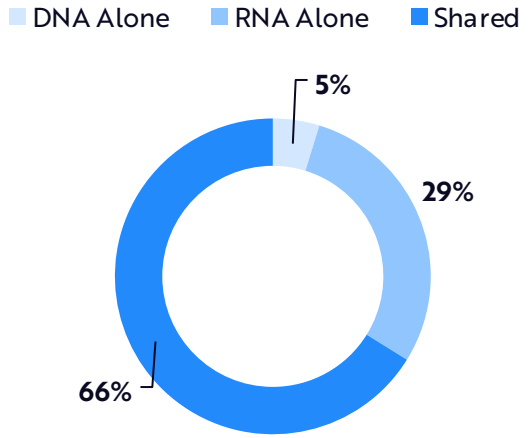


Passing filter means a patient has sufficient, high-quality tumor tissue for molecular testing.

Comprehensive Therapy Selection Tests Surface More Actionable Information for Patients



RNA Sequencing Discovers 29% More Fusion Targets Than DNA Sequencing Alone[3]



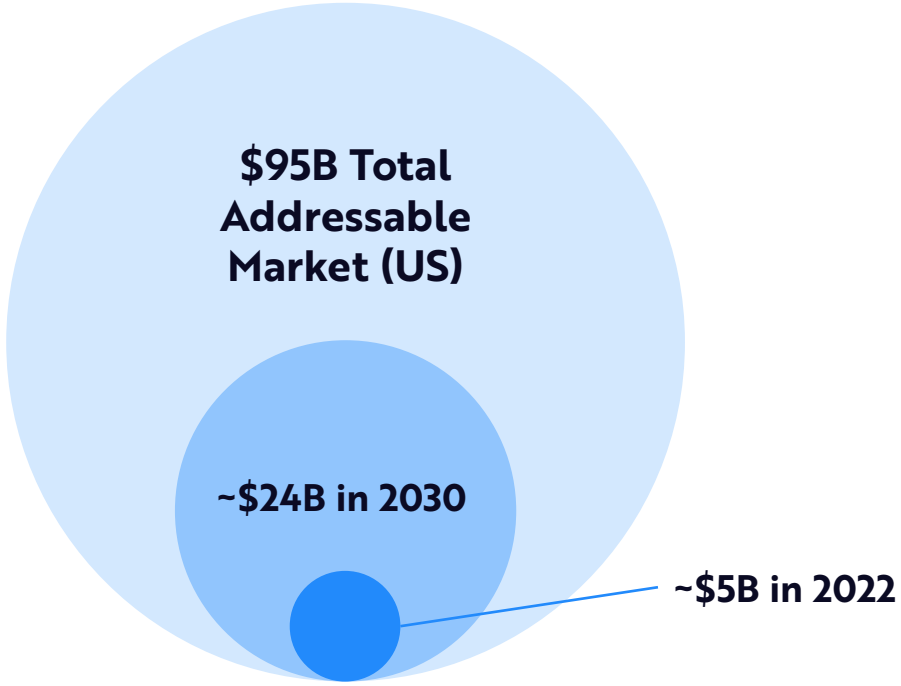
RNA fusions are a class of druggable targets for cancer therapies.

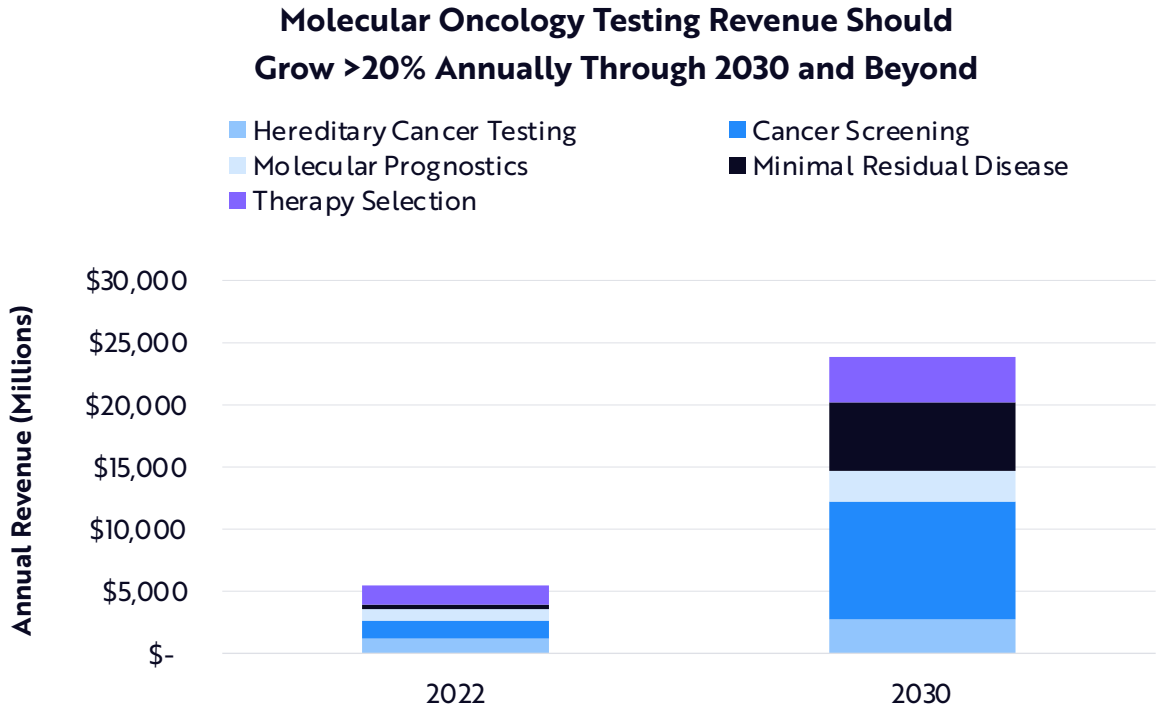
Sources: ARK Investment Management LLC, 2023. [1] Mackay, M. et al. 2022; [2] Raval, A. 2022; [3] Michuda, J. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Sizing The Opportunity

Cancer has galvanized demand for powerful diagnostics and therapeutics. Thanks to rapid cost declines, particularly in sequencing, molecular methods for screening, diagnosing, risk-stratifying, and monitoring cancer are translating into clinical practice.

According to our research, the total addressable market (TAM) for molecular diagnostics is roughly $95 billion in the United States alone. Molecular cancer diagnostics revenues are likely to grow faster than 20% per year, from ~$5 billion today to more than $24 billion in 2030. Collectively, the enterprise value for molecular cancer testing companies should compound at a similar rate, growing from ~$30 billion in 2022 to $145 billion in 2030.





Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

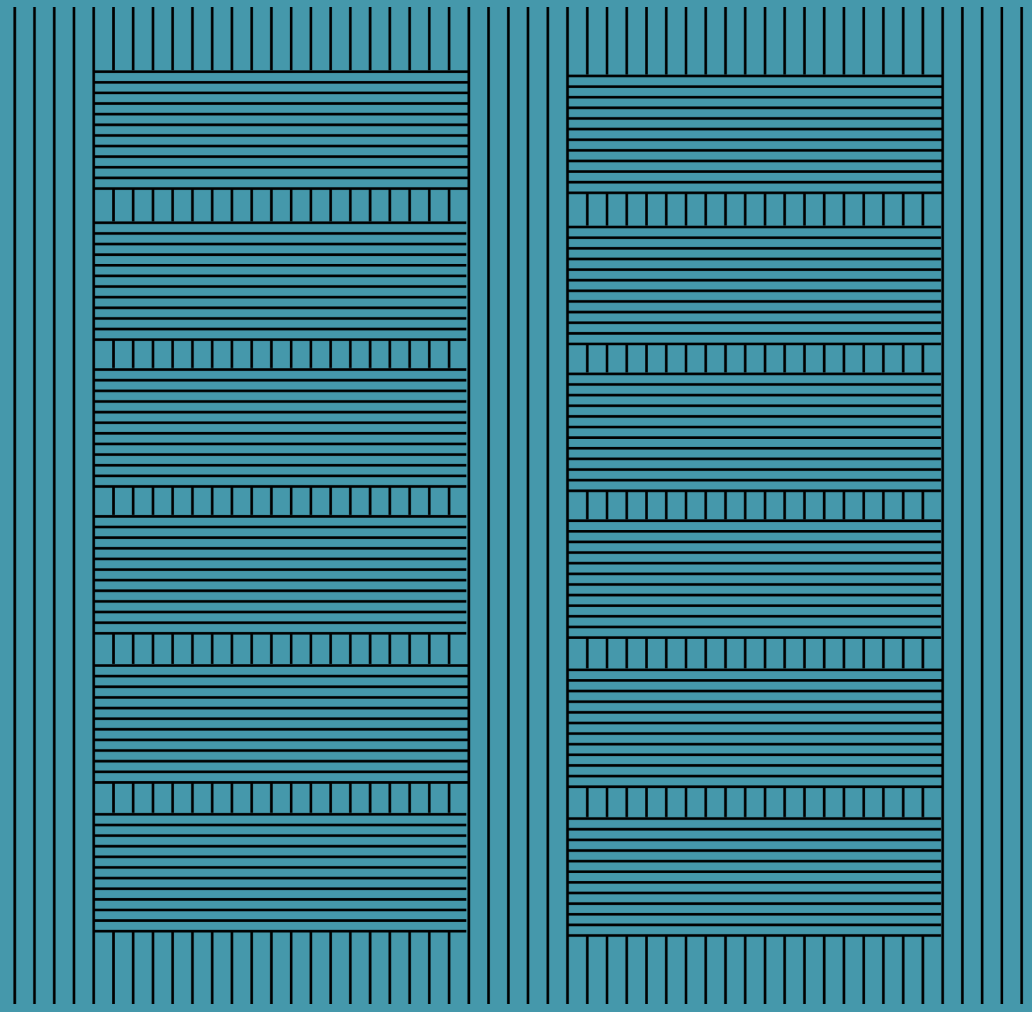
Electric Vehicles

Defying The Skeptics With Exponential Growth

Investors once questioned whether the future was electric. Demand for EVs has scaled despite a pause in cost declines caused by commodity price shocks. Now investors doubt whether or not the growth will be exponential.

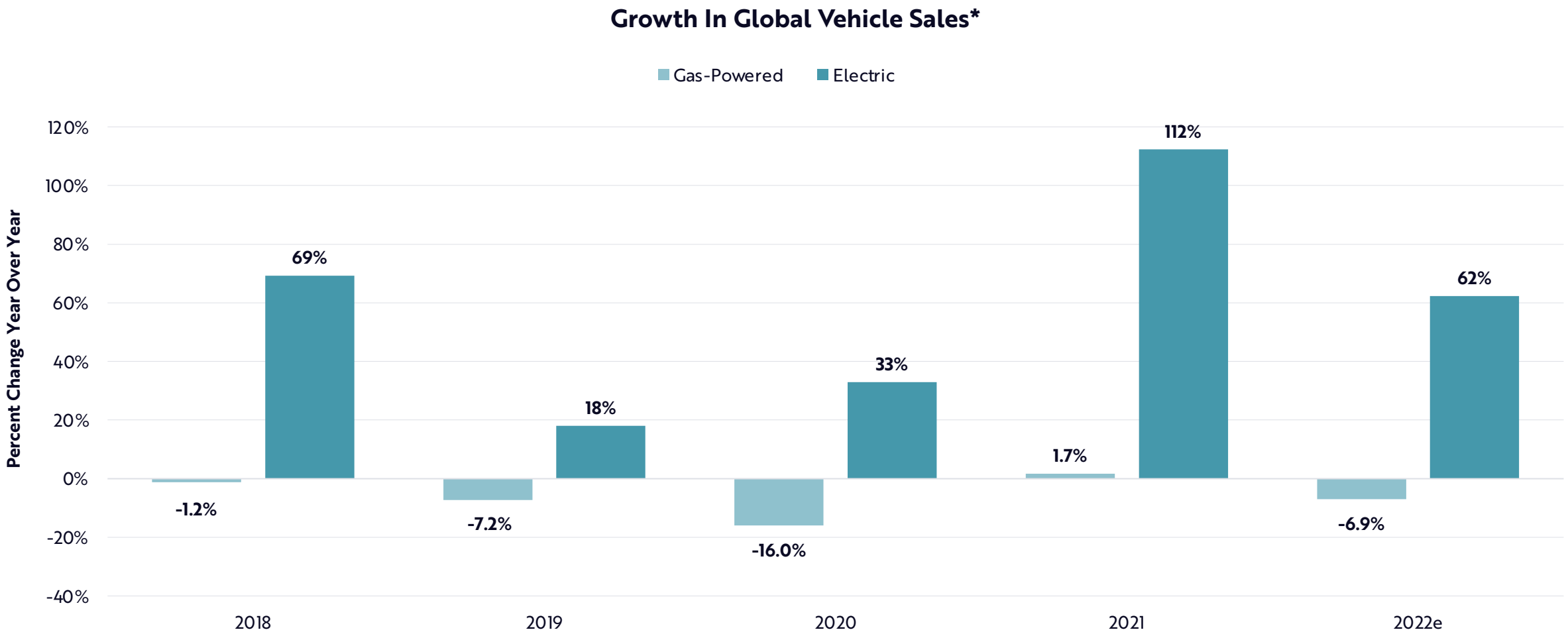
The debate around electric vehicles has shifted from demand to supply. Based on Wright's Law, ARK forecasts that EV prices will decline and sales will increase more than 7-fold, or 50% at an annual rate, from roughly 7.8 million in 2022 to 60 million units in 2027.

The biggest downside risks to our forecast are supply constraints that could continue to impact pricing and the speed at which traditional automakers transition to electric vehicles.



Research by Sam Korus, Director of Research, Autonomous Technology & Robotics

Electric Vehicle Sales Continue To Take Share

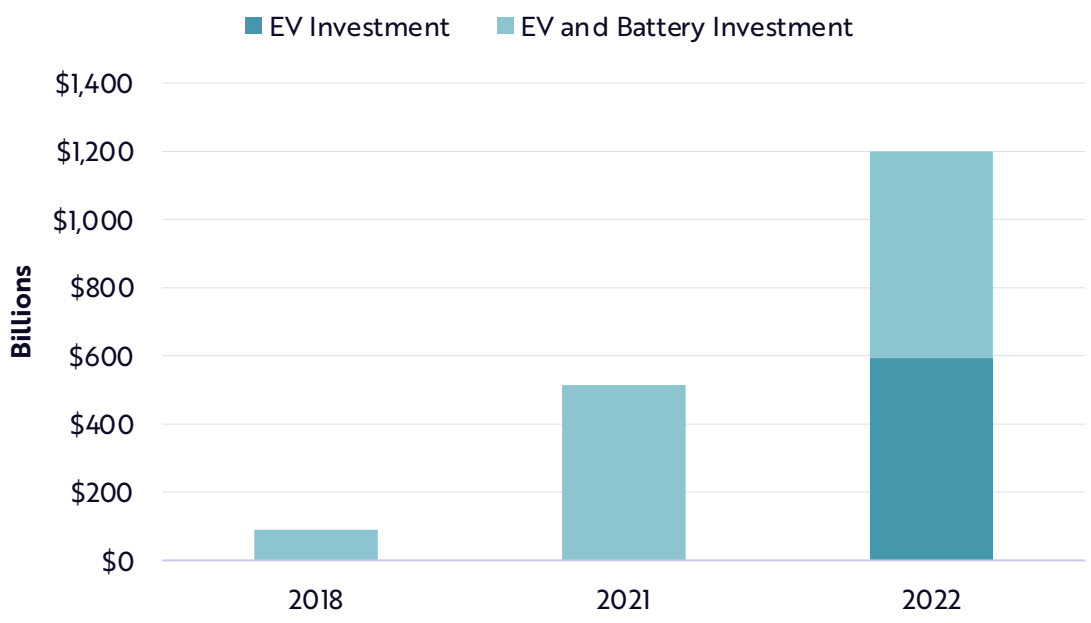


*The chart's "Gas-Powered" category includes hybrid vehicles. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

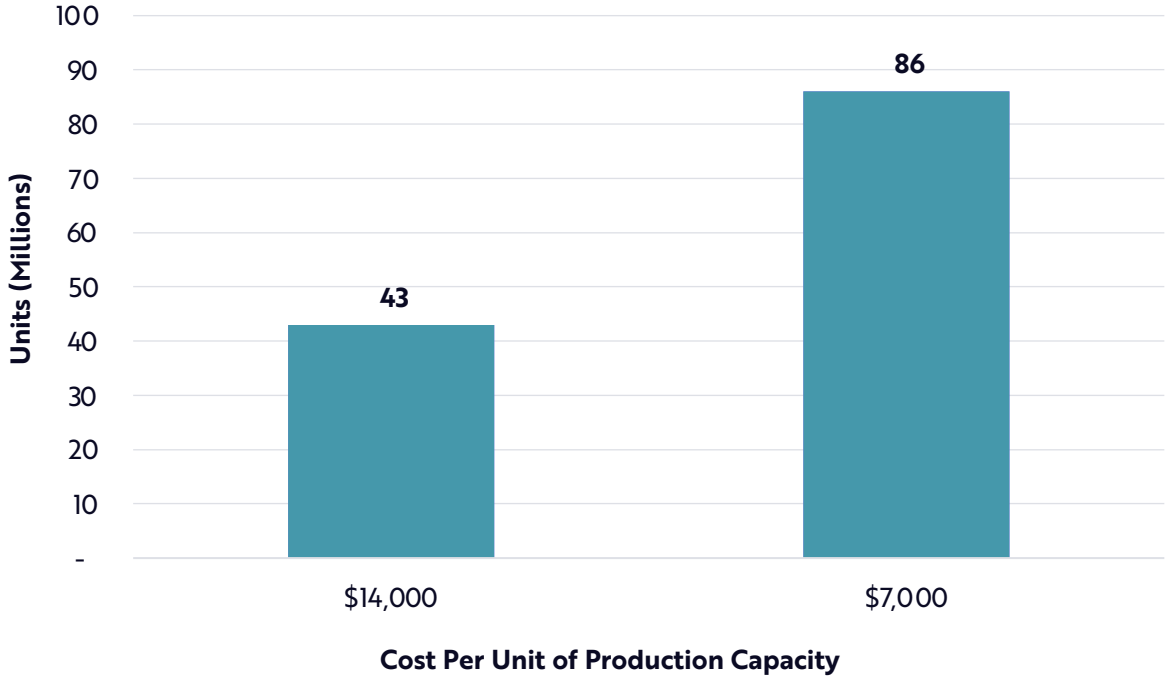
Global Automakers Have Increased Investment Plans For EVs And Batteries More Than 10-Fold Over The Past Four Years

At a historical auto industry capital efficiency of $14,000 per unit capacity, the annualized ~$600 billion earmarked for EV investment would equate to 43 million units in annual production per year. If all automakers were to realize the capital efficiency associated with EVs, $600 billion would accommodate 86 million units, approaching total auto production today.

Global Automaker Investment Plans for Electric Vehicles and Batteries Over The Next Ten Years



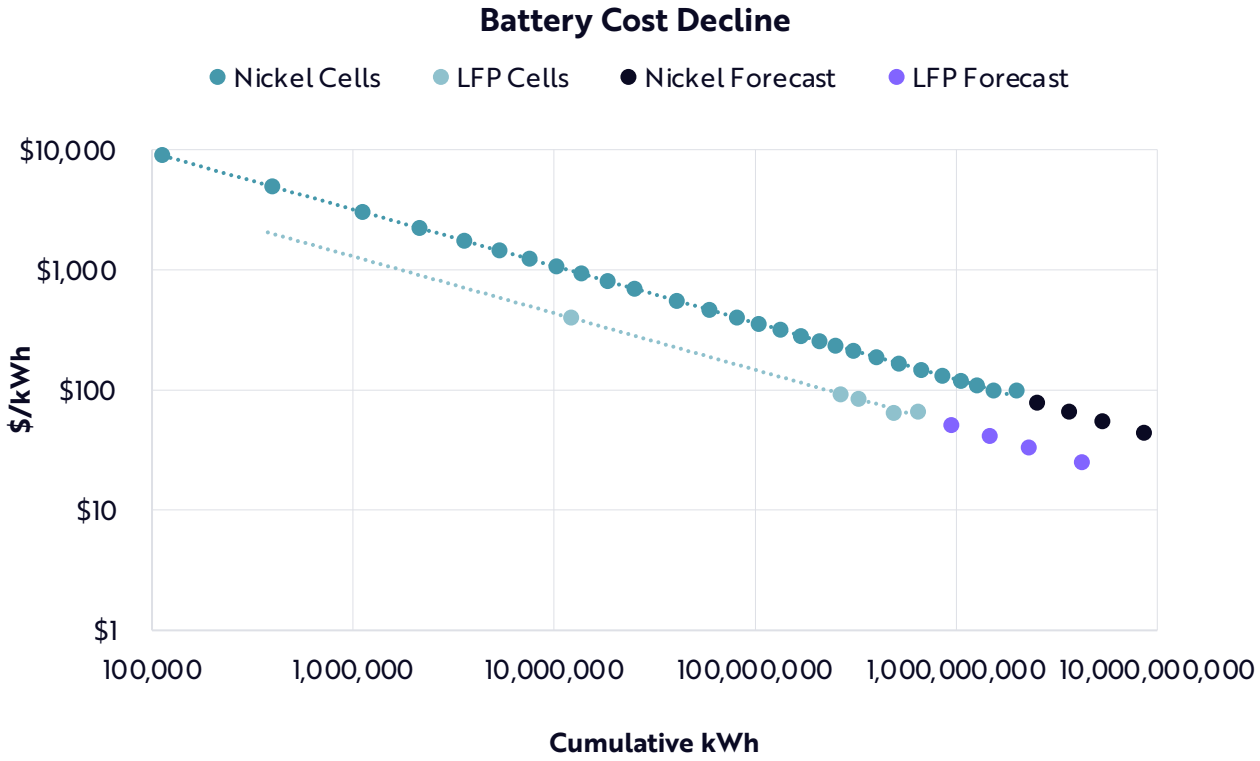
Annual EV Production Capacity

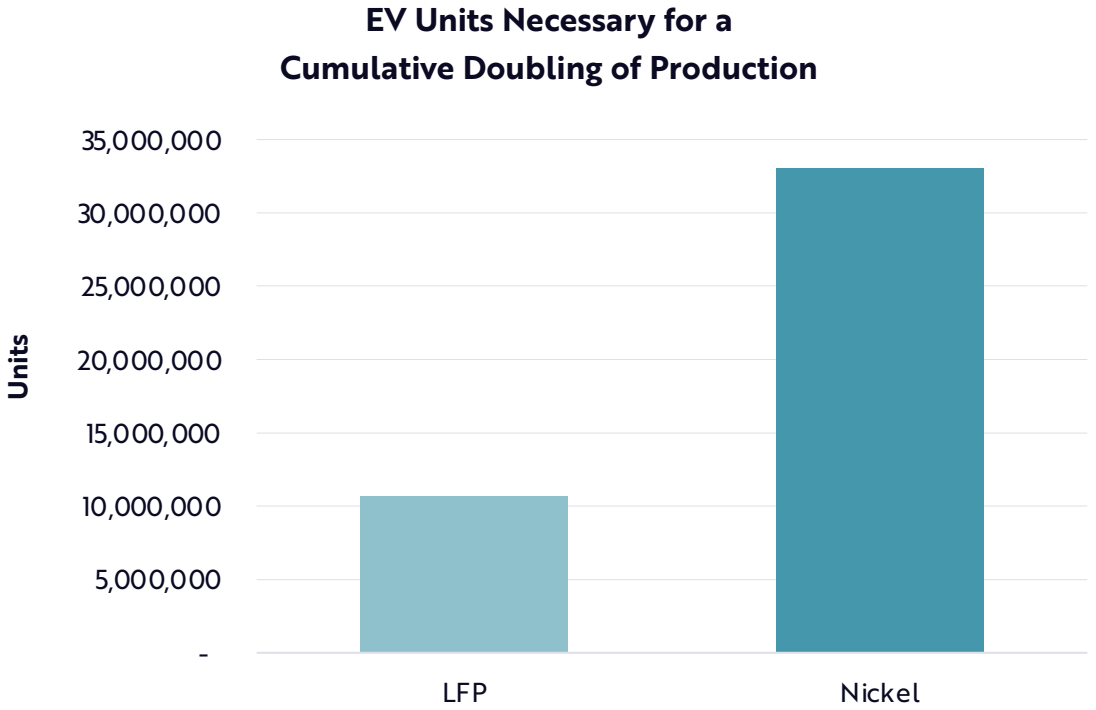


Sources: ARK Investment Management LLC, 2023. Lienert, P. 2022; Lienert, P. et al. 2021; Lienert, P. 2018; White, J. et al. 2017. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Wright's Law Has Modeled The Decline In Battery Costs Accurately And Points To LFP* Cells As The Dominant Chemistry

The largest cost component of an EV is its battery, the declining cost of which will be critical to reaching sticker-price parity with gas-powered vehicles. According to Wright's Law, for every cumulative doubling in the number of units produced, battery cell costs will fall by 28%. Despite the recent commodity spikes and associated battery price increases, this relationship should persist over the long term. At a lower production base, lithium iron phosphate cells could accelerate the cost and price declines.

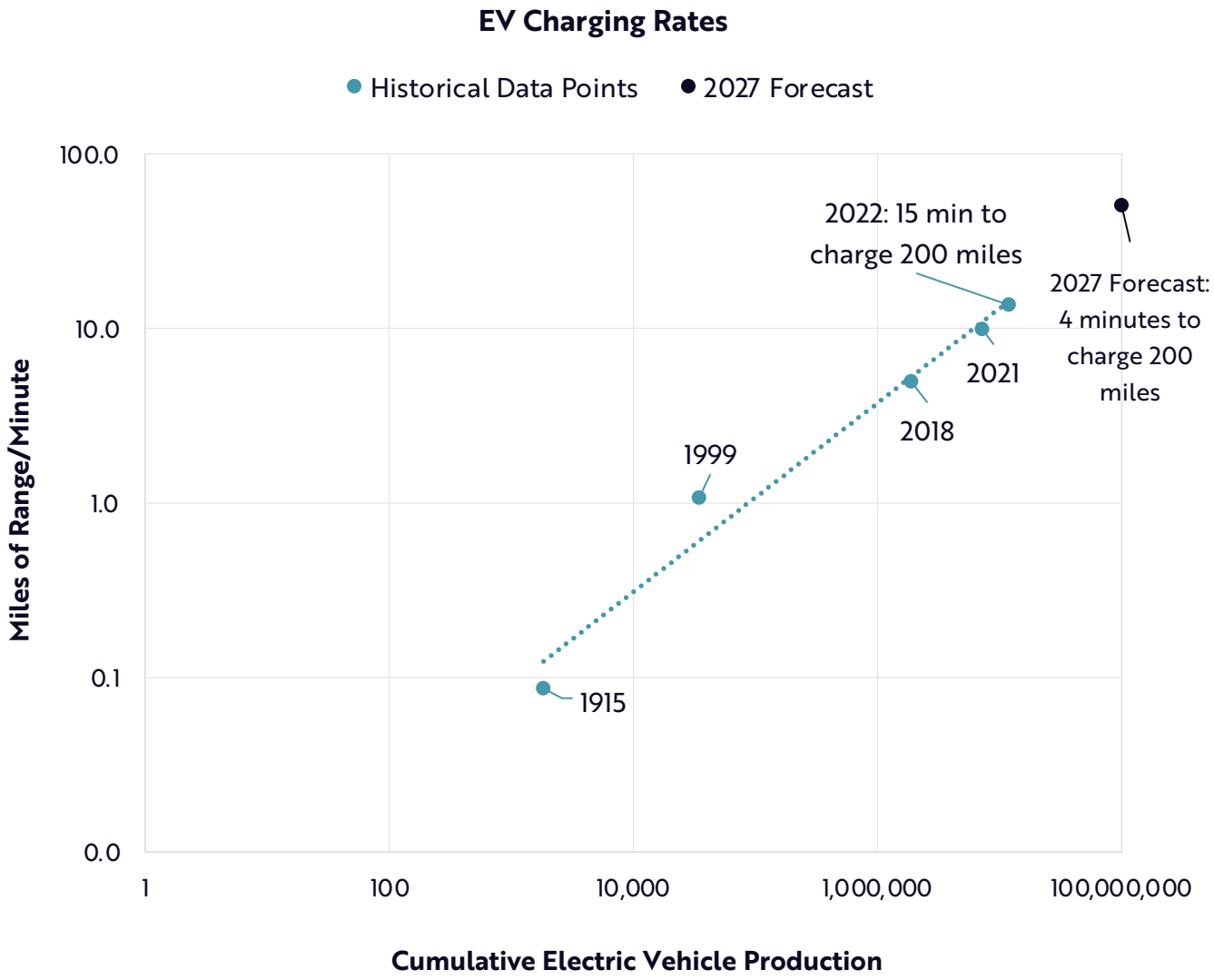




*Lithium iron phosphate (LFP). Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Wright's Law Points To Faster EV Charging Rates

ARK believes that an EV charging rate is a good proxy for overall performance, capturing the efficiency, range, and power capabilities of the system. In the past four years, charging rates have improved nearly three-fold, from 40 to 15 minutes for 200 miles of range. During the next five years, it could drop nearly four-fold to 4 minutes. As EV charging reaches an acceptable rate, ARK expects the industry to optimize for other features like autonomous driving, safety, and entertainment.



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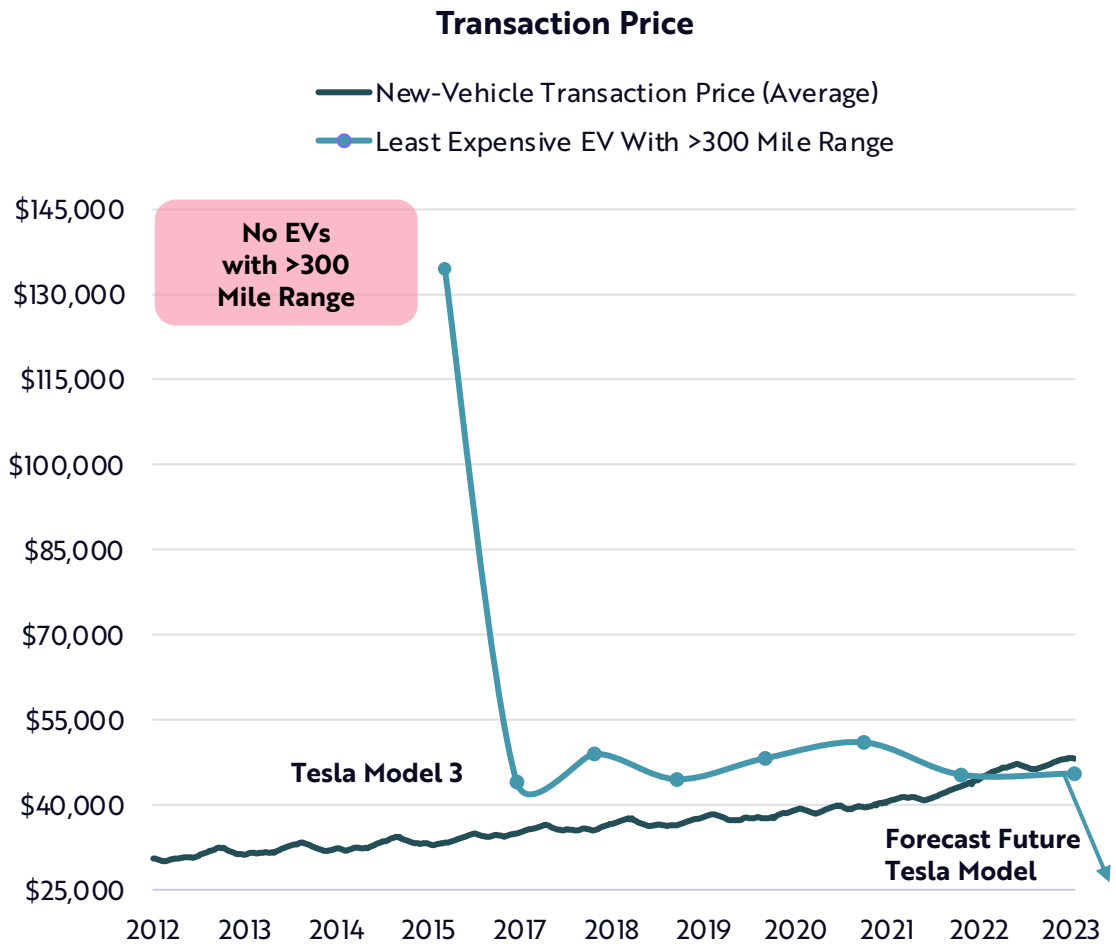
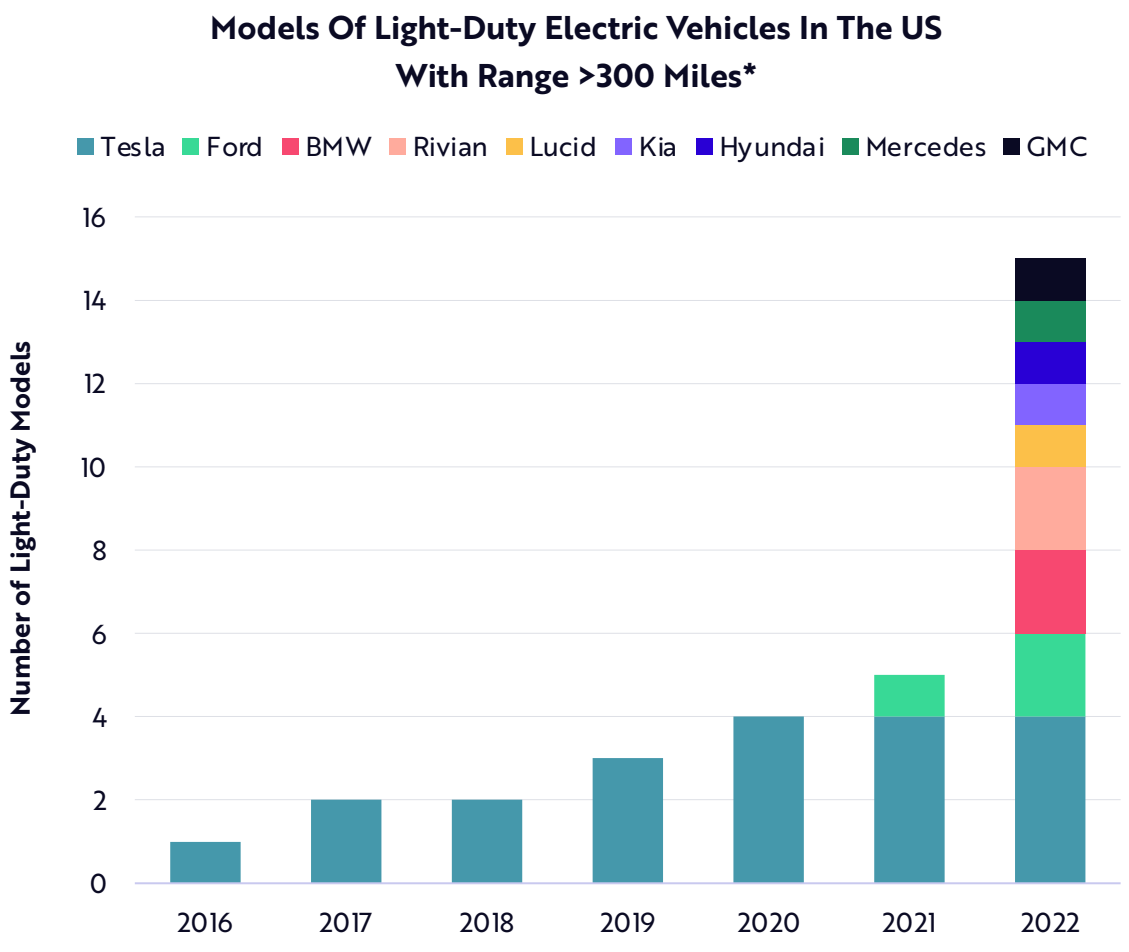
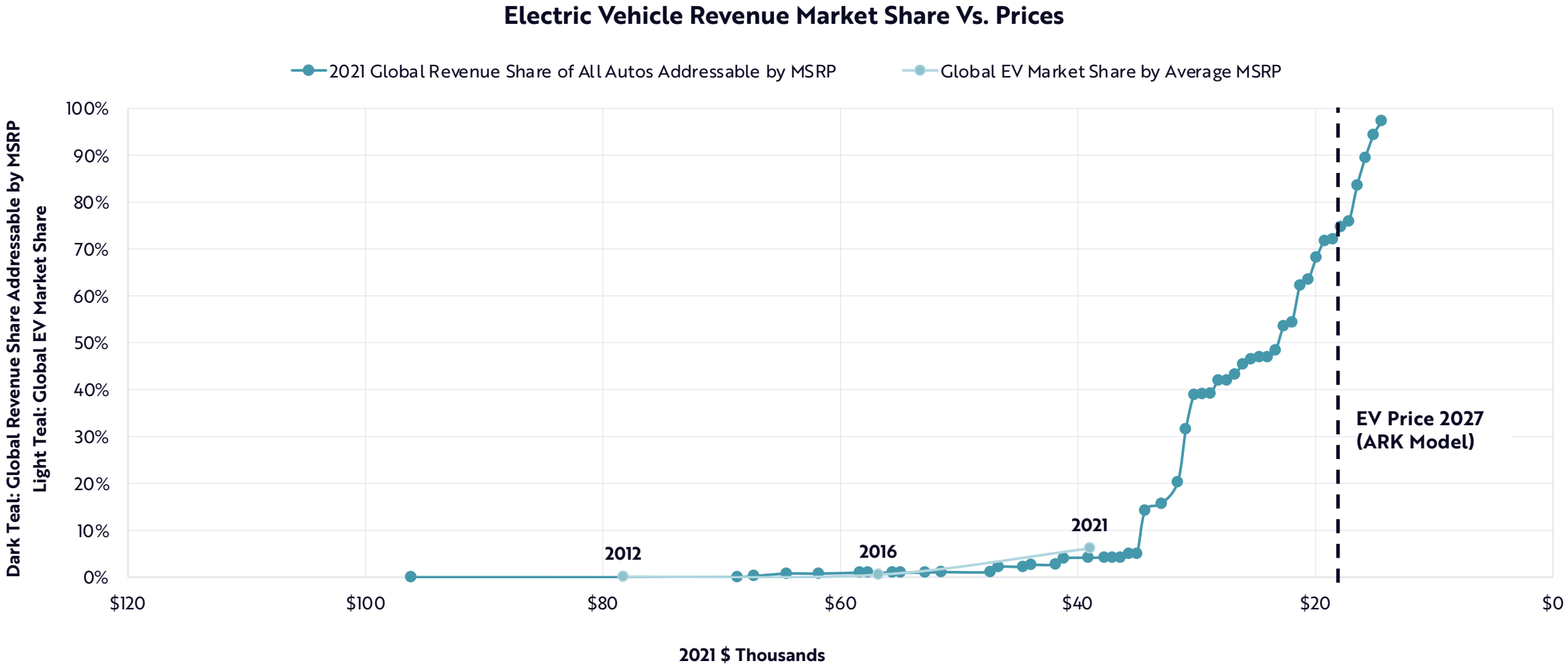
EVs Have Hit Price-Parity With Gas-Powered Vehicles





*Model Year 2016-2022. Sources: ARK Investment Management LLC, 2023. Kane, M. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

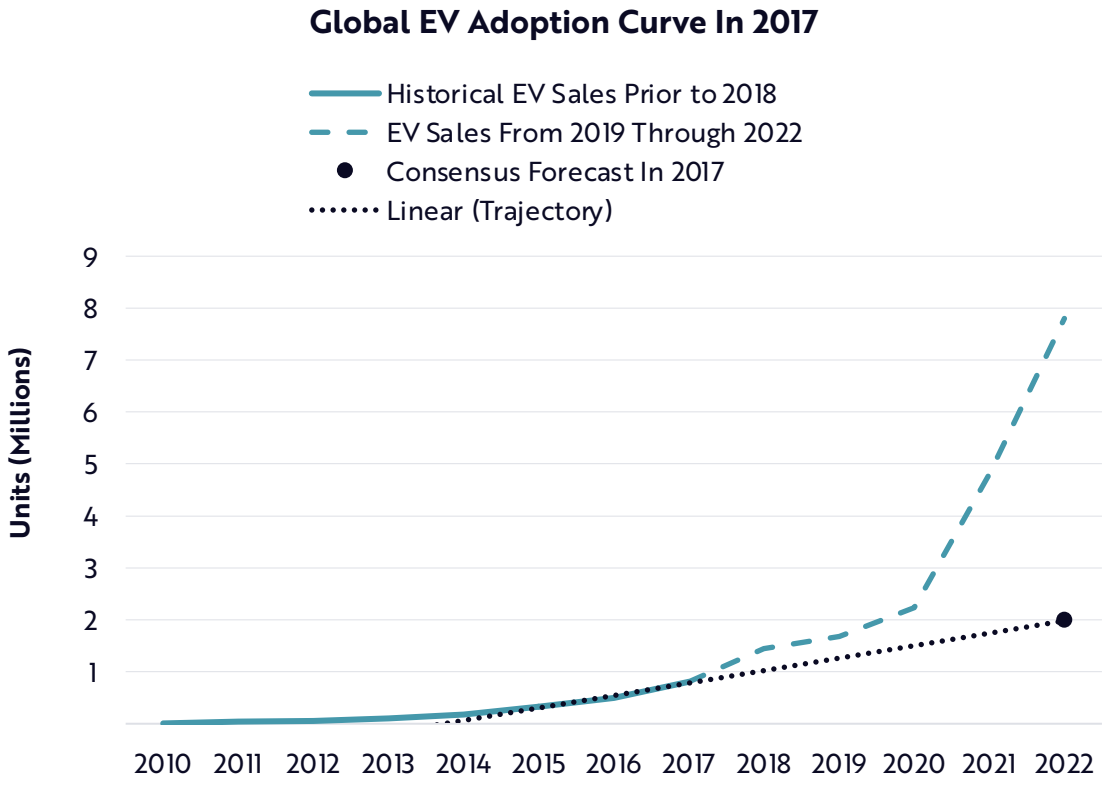
Battery Cost Declines Should Continue To Drive Exponential Growth in EV Sales

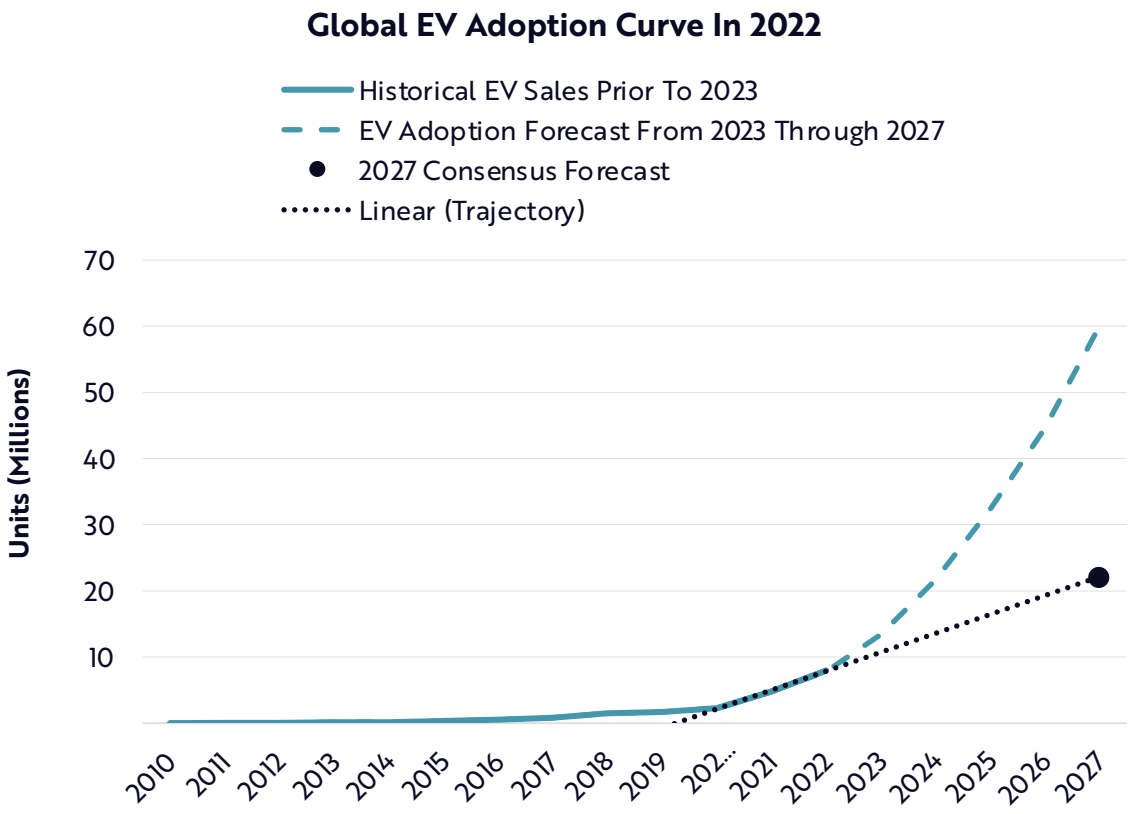


Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Although EV Sales Have Scaled Exponentially, The Consensus Forecast Is Linear

In 2017, ARK forecasted that global sales of EV with 200+ mile range would approach ~17 million in 2022. A global pandemic, supply challenges, commodity price spikes, and the consumer preference for longer ranges limited unit sales to ~8 million, still 4-times the consensus estimate in 2017. In other words, ARK's forecast was off by ~45%, but the consensus estimate was off by ~400%. Now, look at the difference in forecasts for 2027. Will EVs be 25% or 65% of total auto sales?

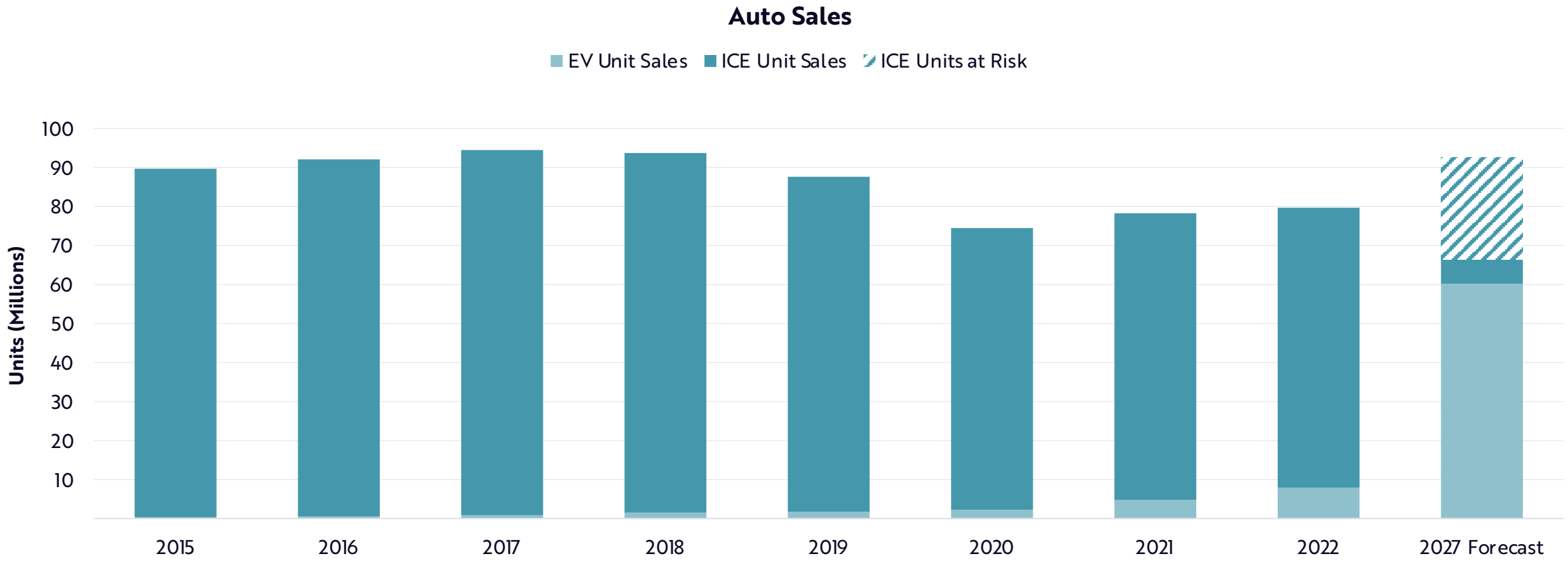




Sources: ARK Investment Management LLC, 2023. Irle, R. 2022; Bloomberg Finance L.P., data as of 01/19/23. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Internal Combustion Engine (ICE) Vehicles Are Likely To Lose Significant Share

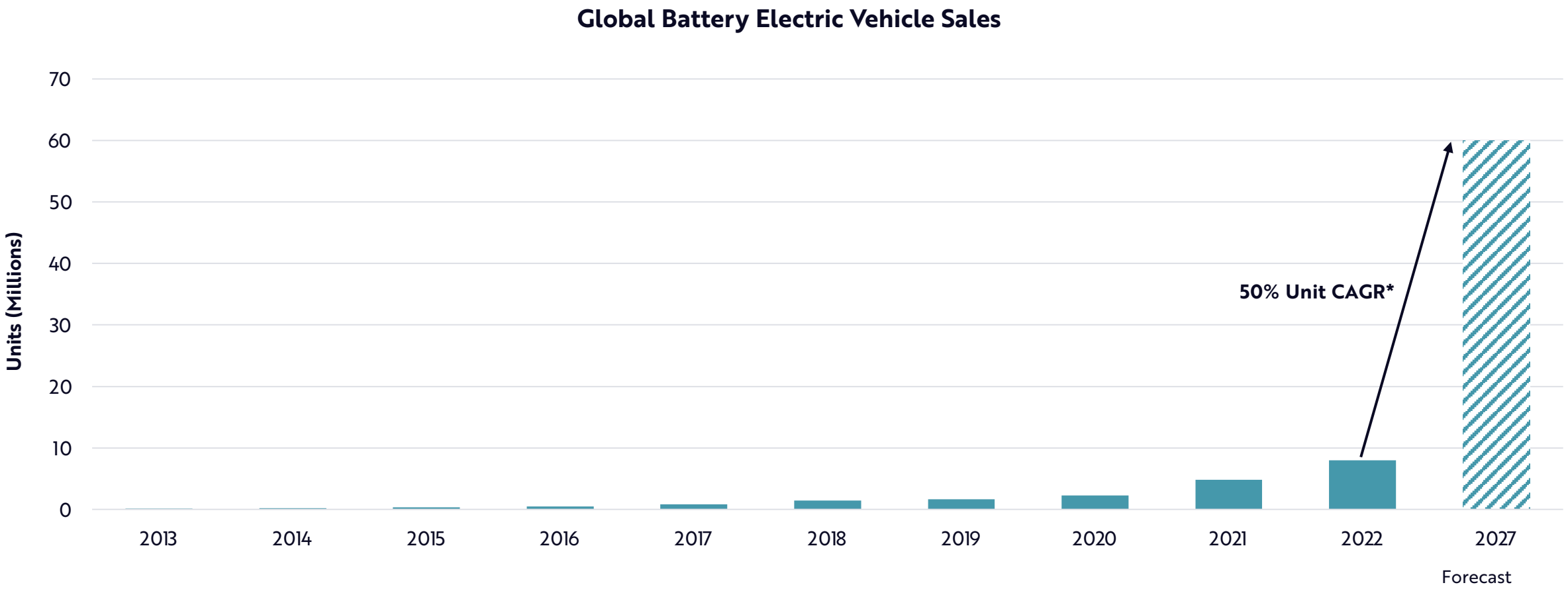
By 2027, auto buyers probably will conclude that used cars or new EVs will make more economic sense than new ICE vehicles. If so, the drop in ICE vehicle sales could set in motion a death spiral for many incumbent automakers. In response to falling prices, consumers could delay EV purchases or purchase used cars at the expense of new internal combustion cars.



Sources: ARK Investment Management LLC, 2023. Irle, R. 2022; S&P Global, data as of 12/29/22. Forecasts are inherently limited and cannot be relied upon. 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.

Planned Investment Levels Should Support A ~7-Fold Increase In EV Production From 7.8 Million To 60 Million During The Next Five Years

If ARK's forecasts for 2027 are correct, EV unit sales will scale at 50% during the next five years, from roughly 7.8 units million in 2022 to 60 million units in 2027.



*Compound Annual Growth Rate (CAGR). Sources: ARK Investment Management LLC, 2023. Irle, R. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

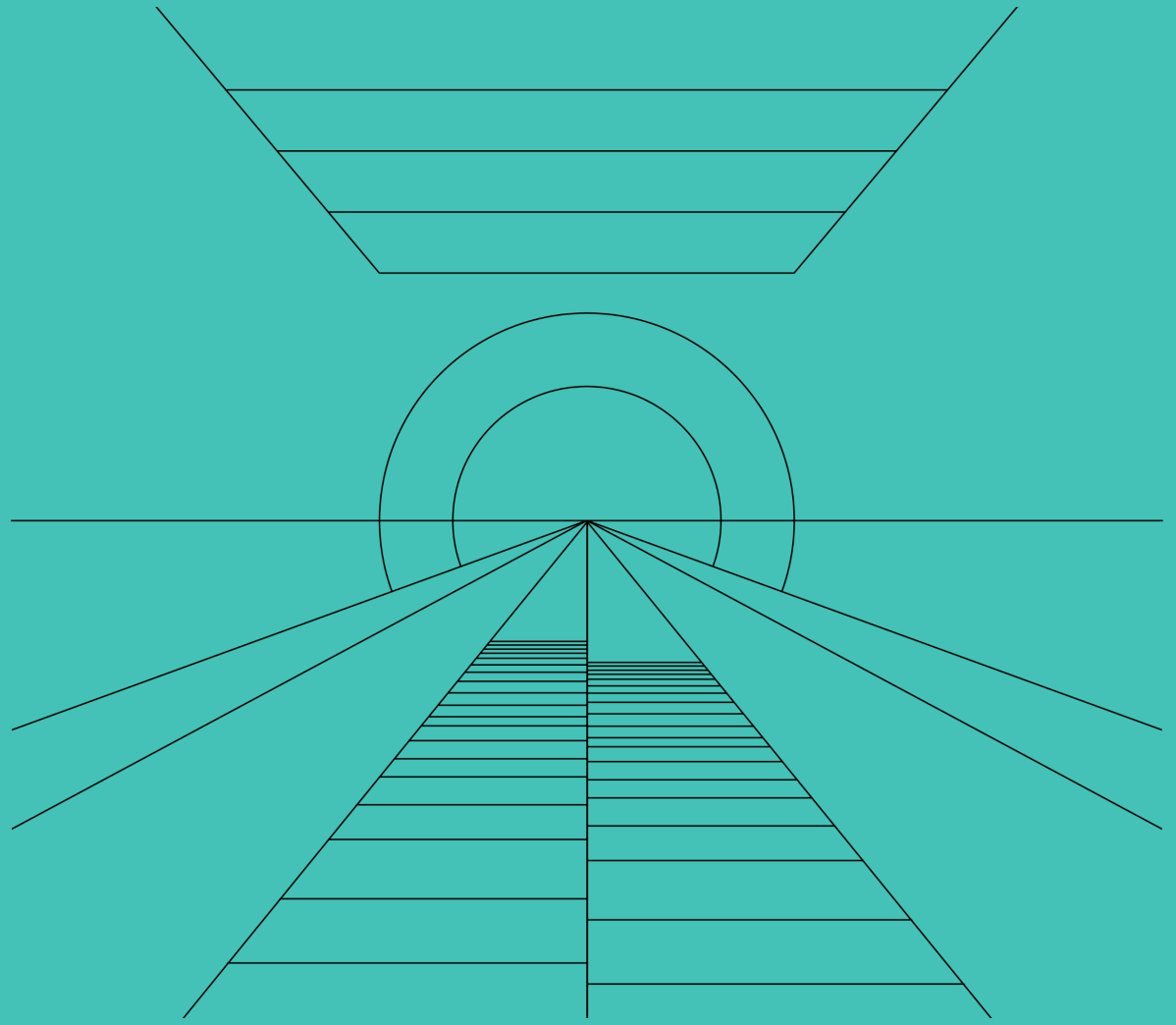
Autonomous Ride-Hail

Scaling Toward Widespread Commercial Adoption

Today, autonomous ride-hail services delight riders across ~15 cities internationally* and should scale into widespread commercial adoption within the next ten years.

Autonomous technology should reduce the cost of mobility to ~12% the average cost of human-driven ride-hail service today.

ARK's research suggests that global autonomous ride-hail platforms will create $14 trillion in enterprise value, based on $4 trillion in revenue during the next five years.

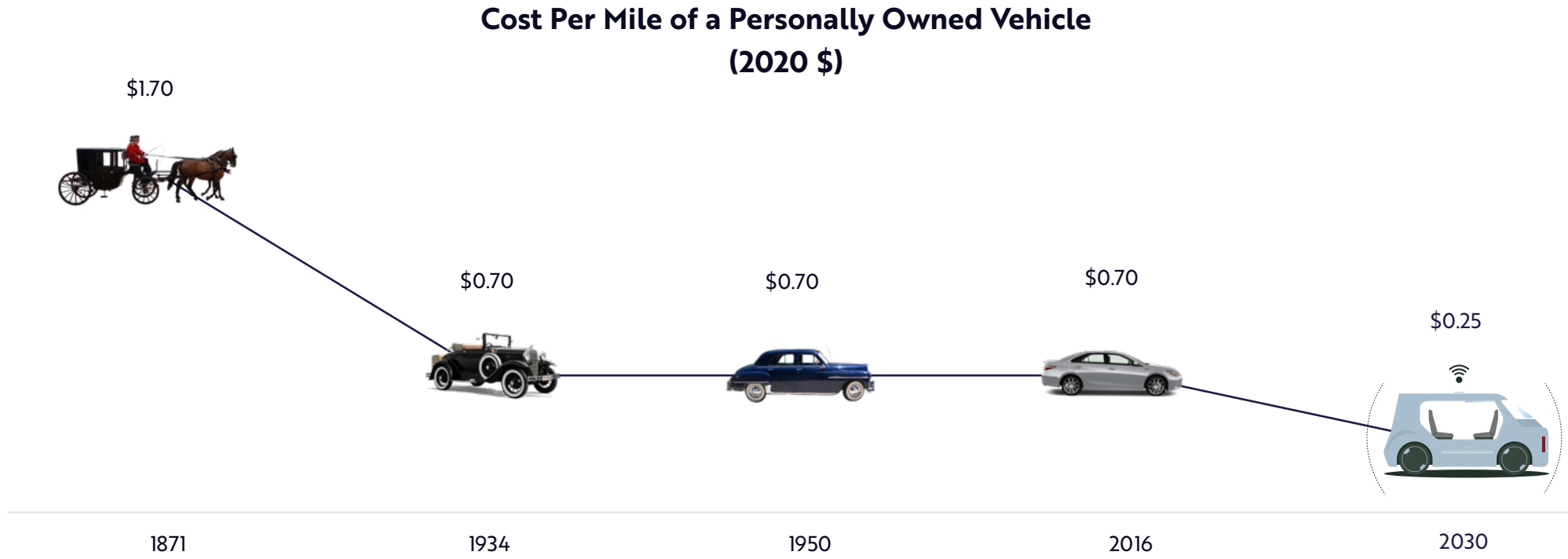


Research by Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

*This number includes both commercial and non-commercial services operating at the end of 2022. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Ride-Hail Is Likely To 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 nearly 100 years ago. ARK estimates that autonomous taxis at scale could cost consumers as little as $0.25 per mile, spurring widespread adoption.



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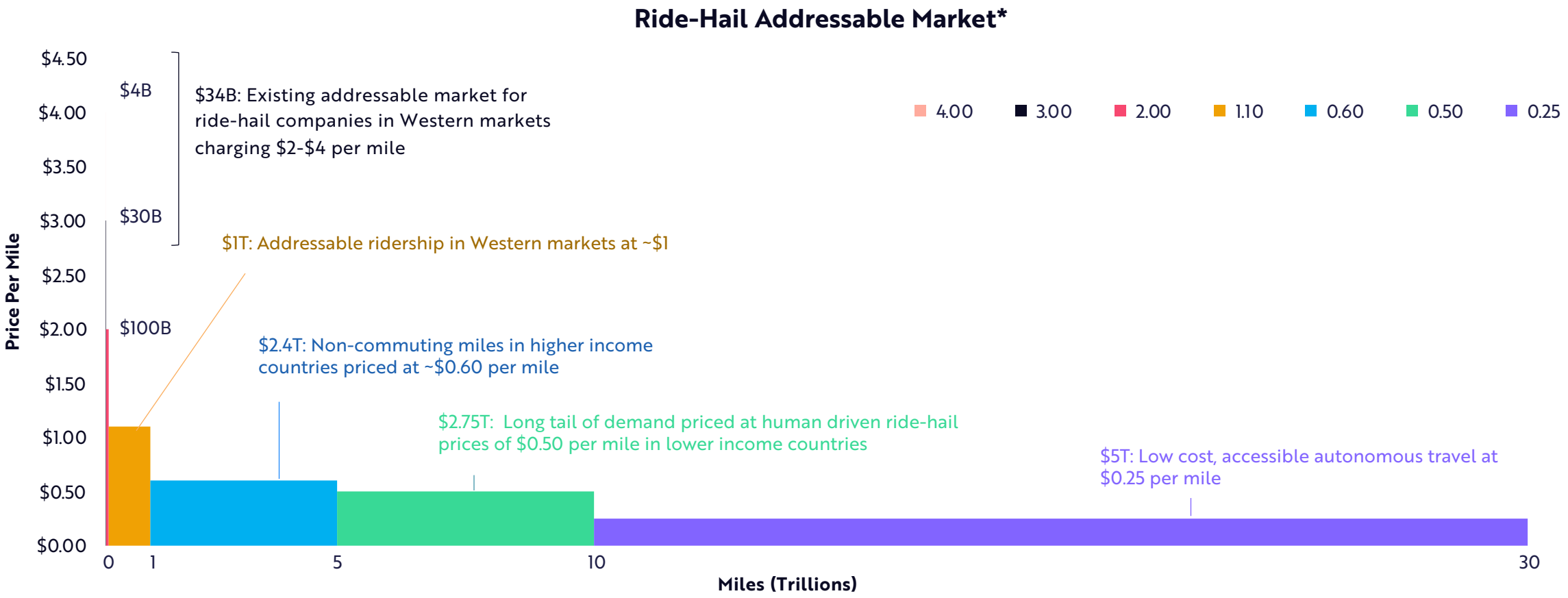
Ride-Hail Is Likely To Create An $11 Trillion Addressable Market

At $0.25 cents per mile, autonomous could serve a wider population than does human-driven ride-hail today. In the meantime, ARK expects significant demand generation at higher price points based on the value that consumers place on their time.



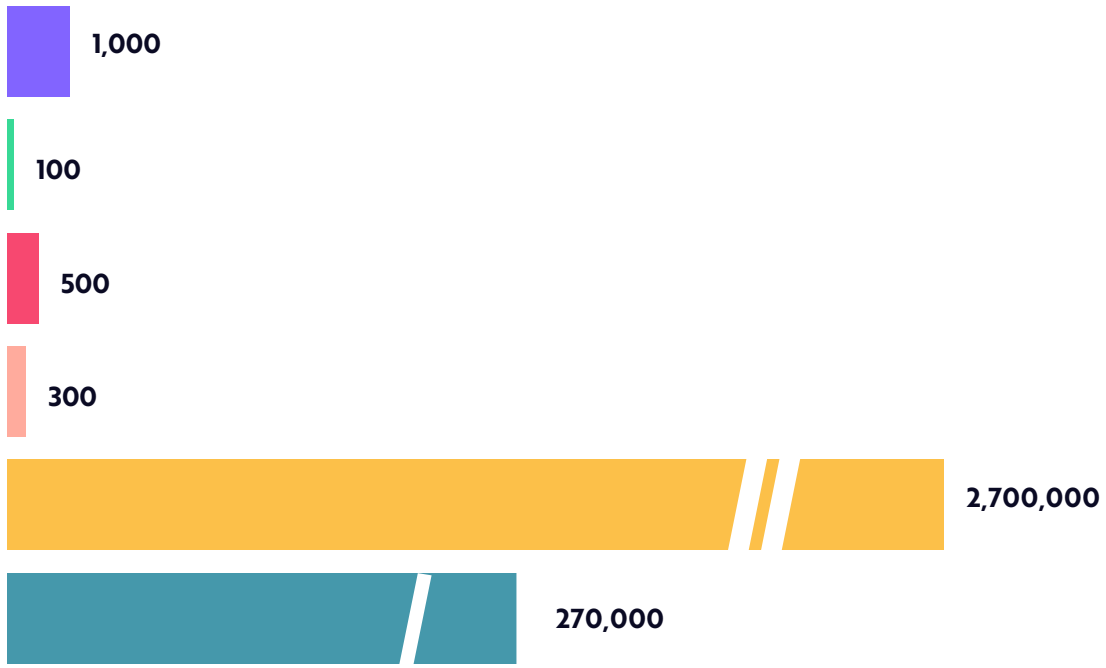
*$11 trillion is the addressable market, not the revenue we expect in 2030, as we do not expect autonomy will penetrate all addressable miles. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Autonomous Taxis Are A Reality Today

The first players to scale should become the market leaders.

Robotaxi Commercial Launch Year

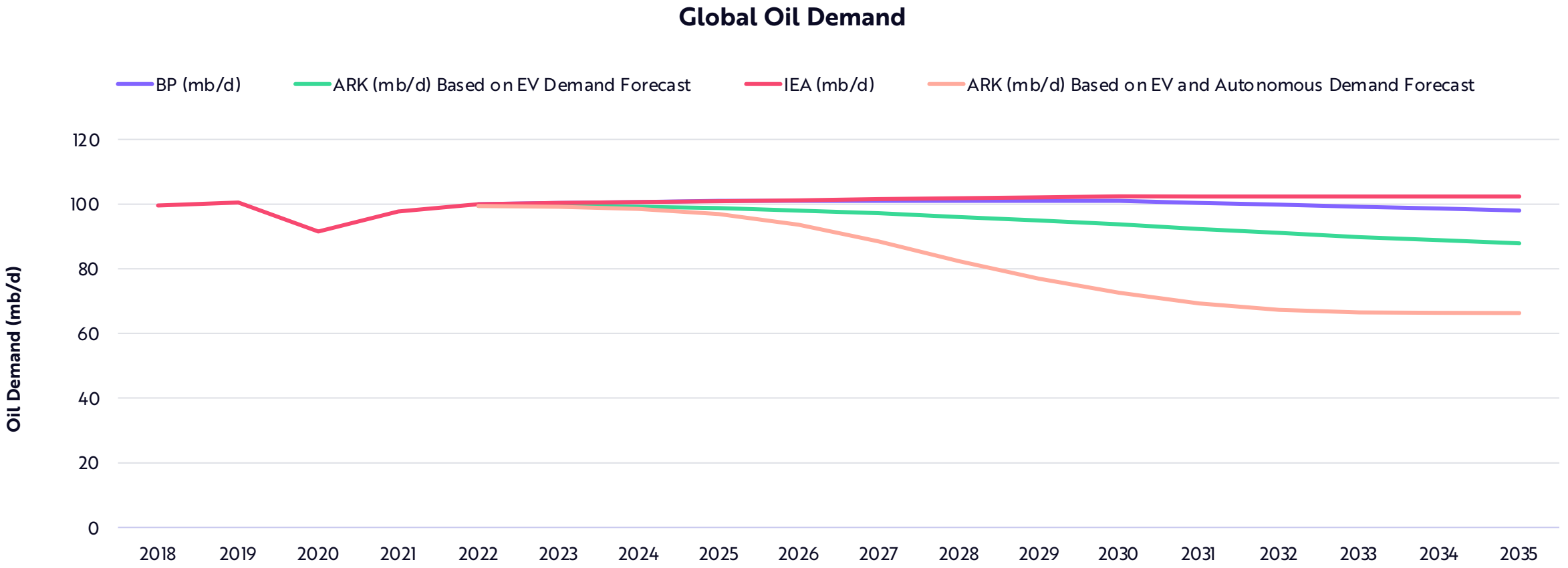
Number of Cars Collecting Data Today*



*These cars can collect data for autonomous driving, though all the vehicles are not yet "robotaxi ready" in the the case of Xpeng. Estimates are based on publicly available data and ARK research. Numbers are rounded and may not be exact. Sources: ARK Investment Management LLC, 2023. Welch, D. 2022; Bellan, R. 2022; Zhang, P. 2022; Irle, R. 2022; Lee, T. 2022; Wessling, B. 2022; TechNode 2022; TechNode 2022; Pandaily 2022; Bellan , R. et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

Based On The Shift To Autonomous Electric Vehicles, Oil Demand Could Decline 30% By 2030

Based on ARK's electric vehicle forecast, oil demand is peaking and could decline by 5%, or 5 million barrels per day, by 2030 and 10% by 2035. Adding the adoption of autonomous vehicles, the capacity utilization of which could be 10x higher than that for personally-owned cars, oil demand could decline 30 million barrels per day by 2035.



Sources: ARK Investment Management LLC, 2023. Cozzi, L. et al. 2022; BP p.l.c. 2022; IEA 2021. Forecasts are inherently limited and cannot be relied upon. 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.

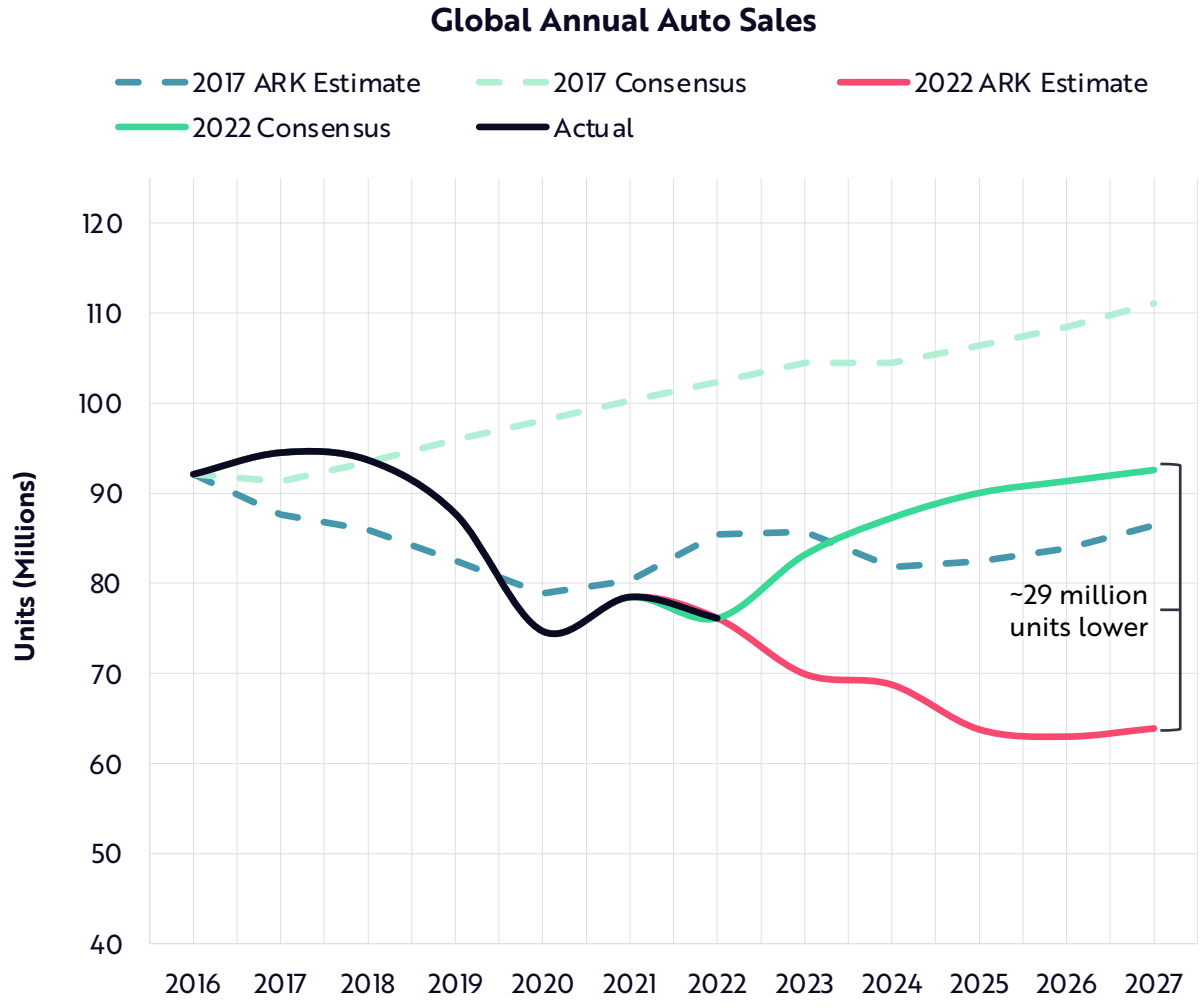
Global Auto Sales May Have Peaked In 2017

In 2017, ARK predicted that human-driven ride-hail and autonomous taxis would reduce overall auto sales by ~24 million relative to consensus expectations for 2025.

Since 2017, auto sales have declined more than we predicted, largely because of the supply chain crisis associated with COVID-19.

Autonomous vehicles should have higher utilization rates than human-driven cars, lowering the number of vehicles on the road despite higher numbers of passengers and per capita miles.

As autonomous taxis begin to dominate urban transit, ARK now expects unit volumes to be ~26 million and ~29 million units lower than today's consensus expectations for 2025 and 2027, respectively.



Sources: ARK Investment Management LLC, 2023. S&P Global, data as of 12/28/22. Forecasts are inherently limited and cannot be relied upon. 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 Taxis Could Eliminate ~60% Of Short-Haul Airline Flights

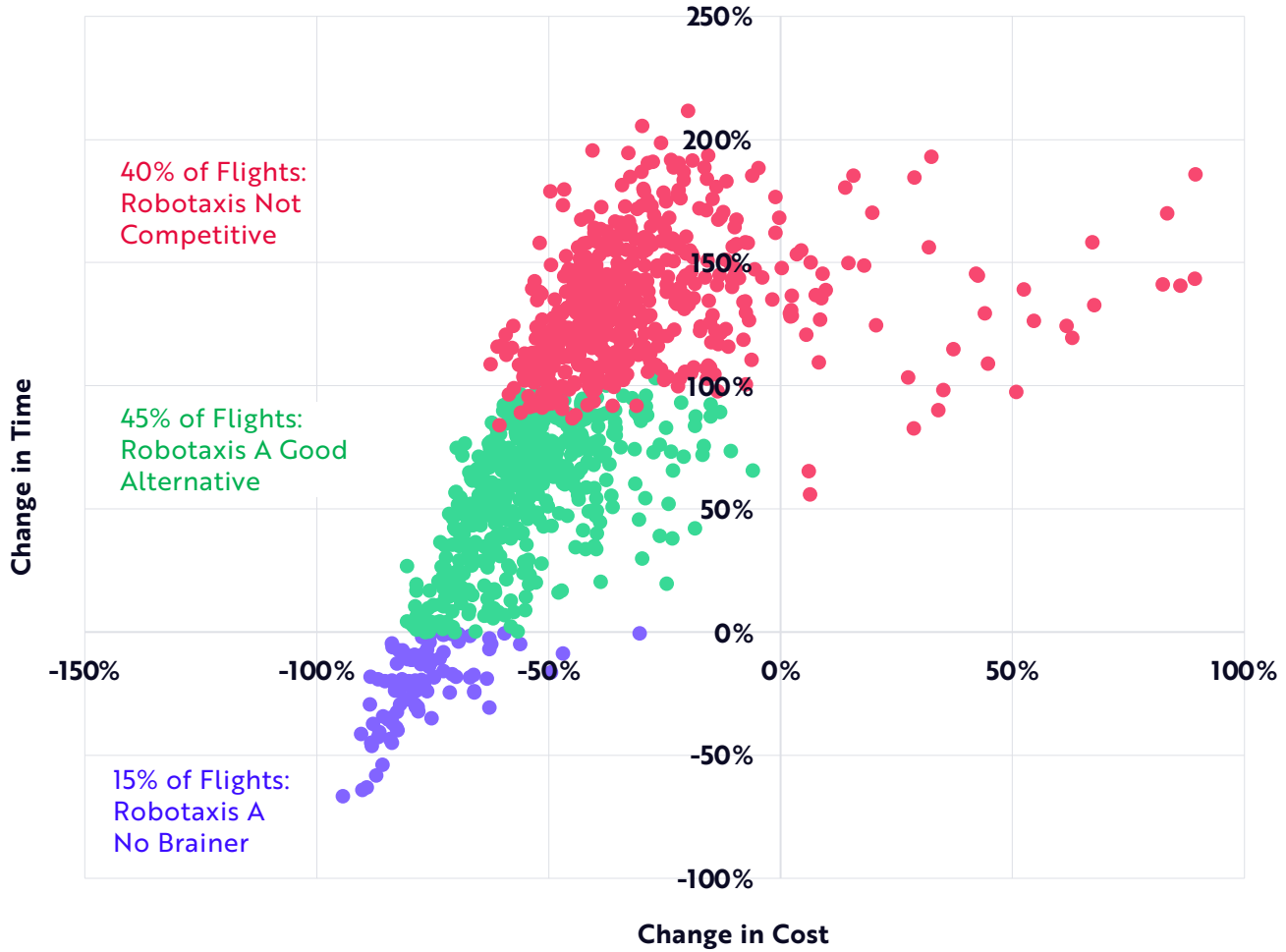
With prices ranging from $4 to $0.25 per mile, robotaxis could be a more attractive option than ~60% of short-haul airline flights, based on time and cost savings including transport to and from airports.

Short-haul flights at risk currently generate ~$100 billion, or 20%, of all airline revenues globally.

Priced at $0.50 per mile, a robotaxi service would be less expensive than more than half of short-haul airline flights. At $0.25 per mile, robotaxi services could be more cost effective than 95% of short-haul journeys.

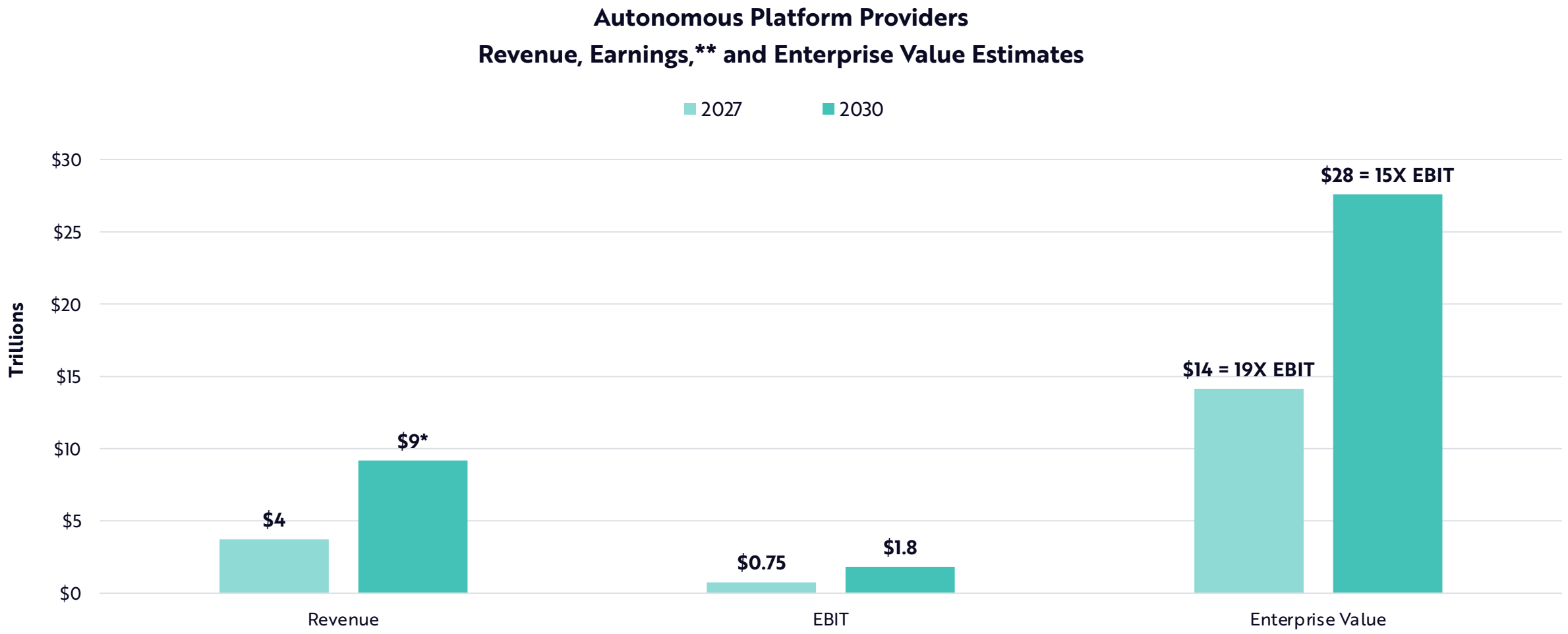
The cost and time advantages should be more dramatic for group travel. An autonomous taxi for 2-3 people could be a better option than 75%-84% of short-haul airline flights.

Robotaxi Versus Short-Haul Airline Flight Cost and Time Savings*



*Single Person Short-Haul Flights / $0.25 Per Mile Robotaxi. This graphical analysis includes the increase in traffic ARK expects with robotaxis as well as the drive time associated with flying. Sources: ARK Investment Management LLC, 2023. Google Fligths, data as of 01/20/23; Miller, A. 2021; Federal Highway Administration 2020; Federal Highway Administration, data as of 12/28/22. Forecasts are inherently limited and cannot be relied upon. 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.

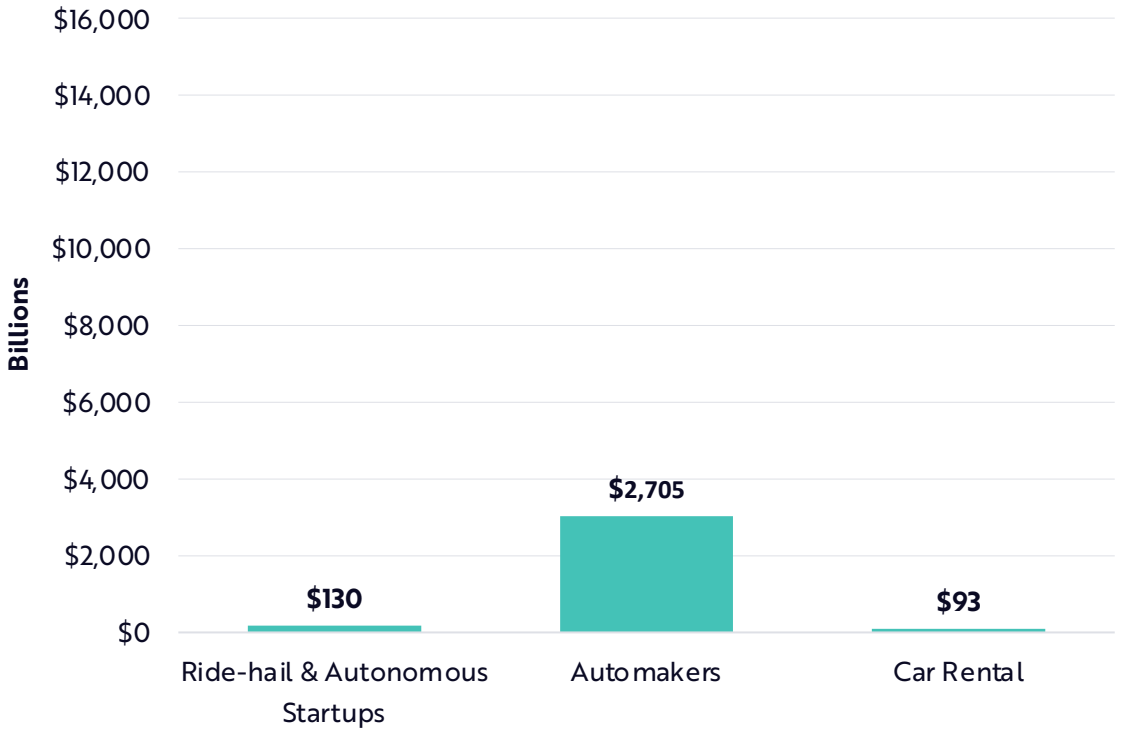
Autonomous Taxis Could Generate $4 Trillion In Revenue In 2027



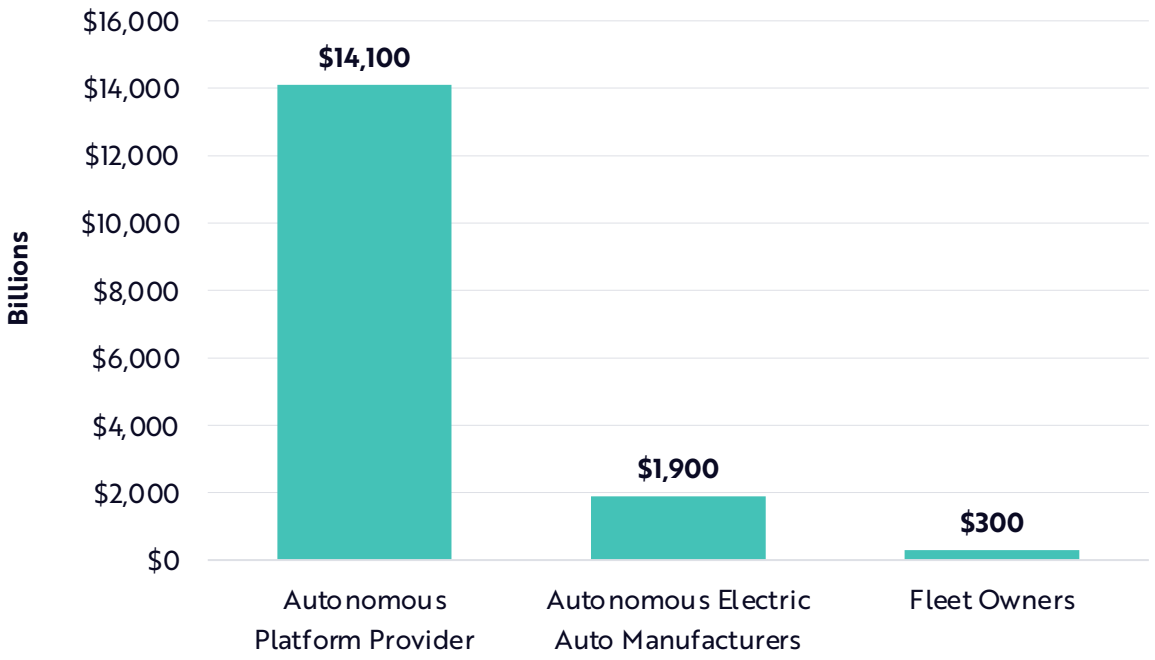
*Note that $9 trillion is the expected revenue in 2030 based on our adoption curve, as opposed to the entire addressable market that we are estimating will be worth $11 trillion. **Earnings before interest and taxes (EBIT).
Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Platform Providers Could Dominate The Enterprise Value Generated By Autonomous Mobility In 2027

Current Enterprise Value*



2027 Enterprise Value Estimate



Last Year Values:	**$300B**	**$4,100B**	**$100B**
5 Year CAGR:	**137%**	**-7%**	**99%**

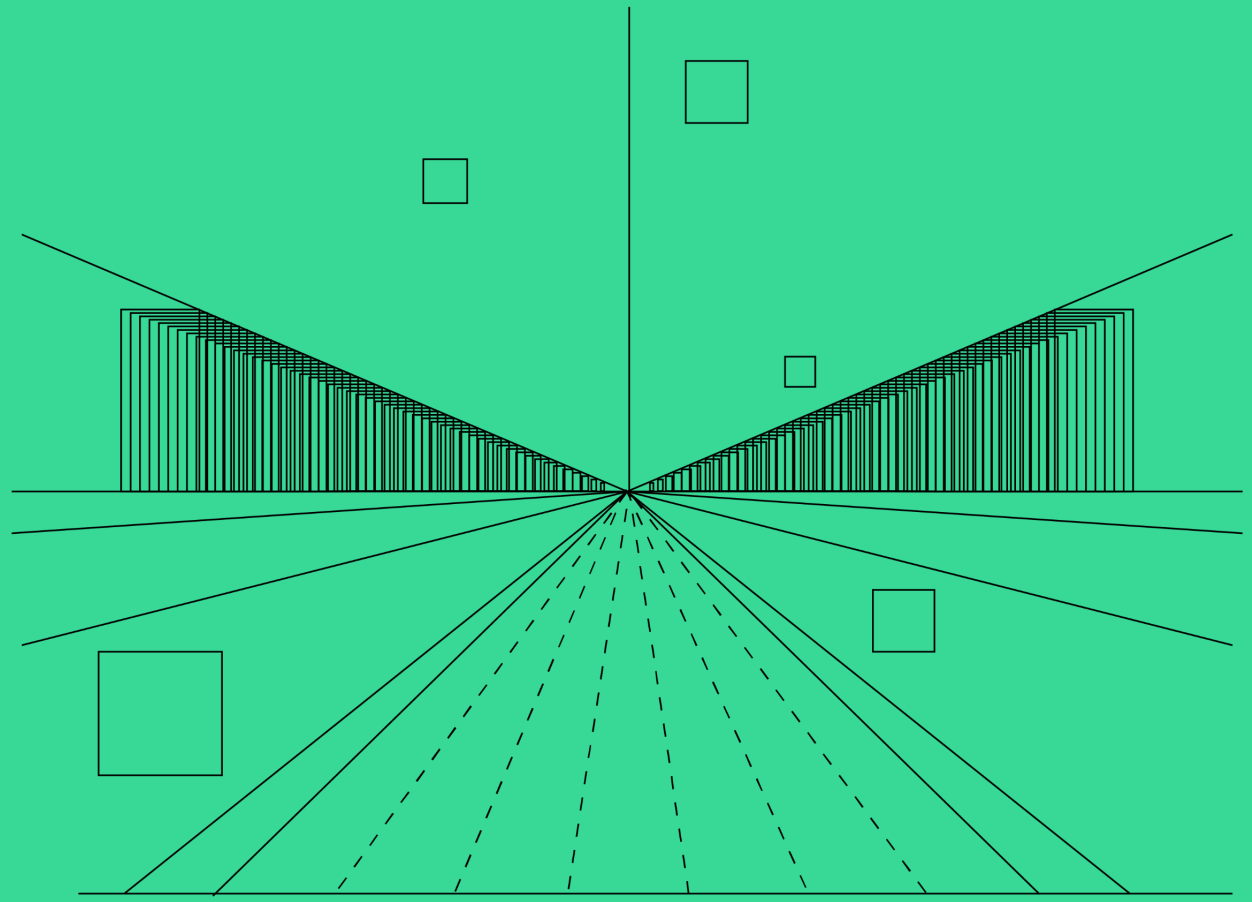
*January 2023 Enterprise Value. Discounted private valuations by 60% in current enterprise value for autonomous startups. Sources: ARK Investment Management LLC, 2023. CapitalIQ, data as of 01/23/23; Kuzmichenok, V. 2021; PitchBook, data as of 01/23/23. Forecasts are inherently limited and cannot be relied upon. 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 Logistics

Reshaping The Global Supply Chain

Autonomous logistics—including trucks, drones, and robots—should lower delivery costs and increase convenience.

Based on our updated assumptions on pricing, ARK estimates that autonomous logistics revenue could scale from nearly zero today to $1-2 trillion by 2030. Autonomous delivery charges could range from $0.20 to $10 per trip.

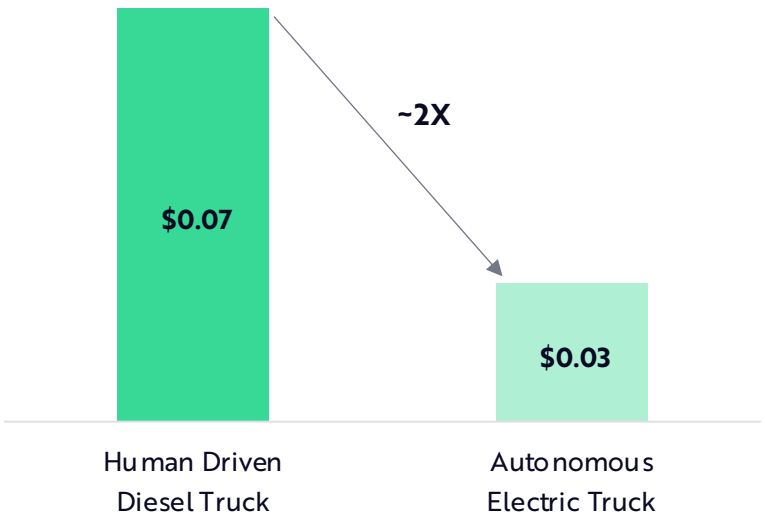


Research by Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

Autonomous Vehicles That Roll And Fly Could Lower Costs Across The Supply Chain

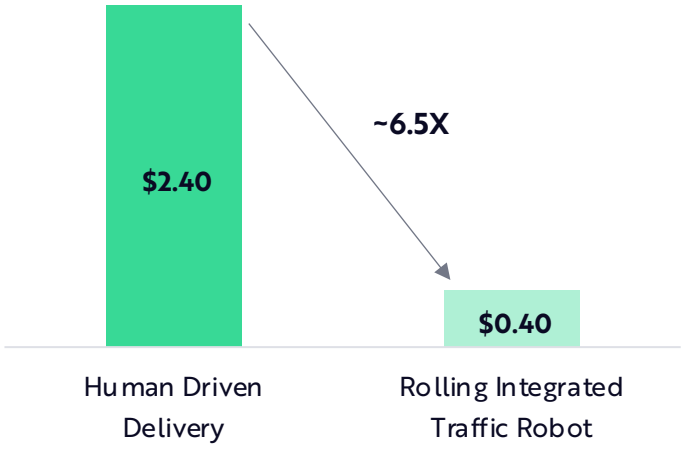
According to our research, autonomous vehicles should operate at higher utilization rates than human-in-the-loop systems, creating more cost-effective delivery systems for small volumes in the last mile.

Truckload Delivery Cost (Per Ton-Mile)



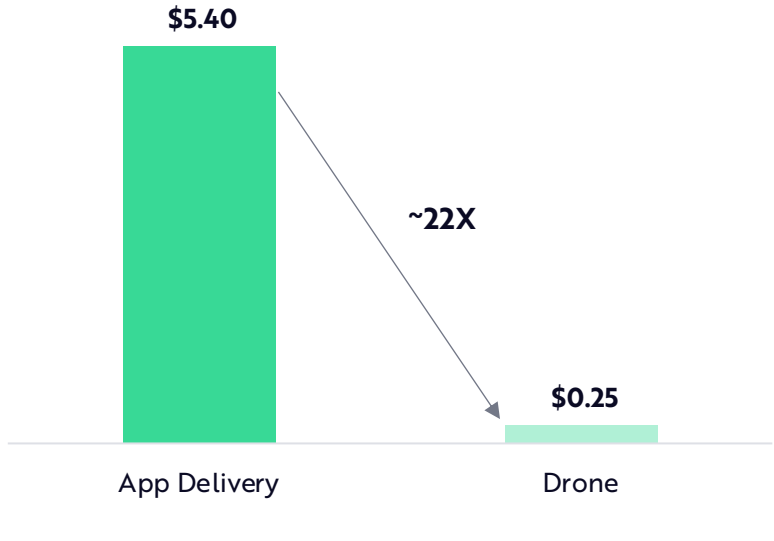
Autonomous electric trucks should benefit from higher utilization as well as lower maintenance and labor costs than human-driven diesel trucks.

Local Batch Delivery Cost (Per Trip)



Rolling robots should enable inexpensive and convenient delivery, reshaping consumer shopping habits.

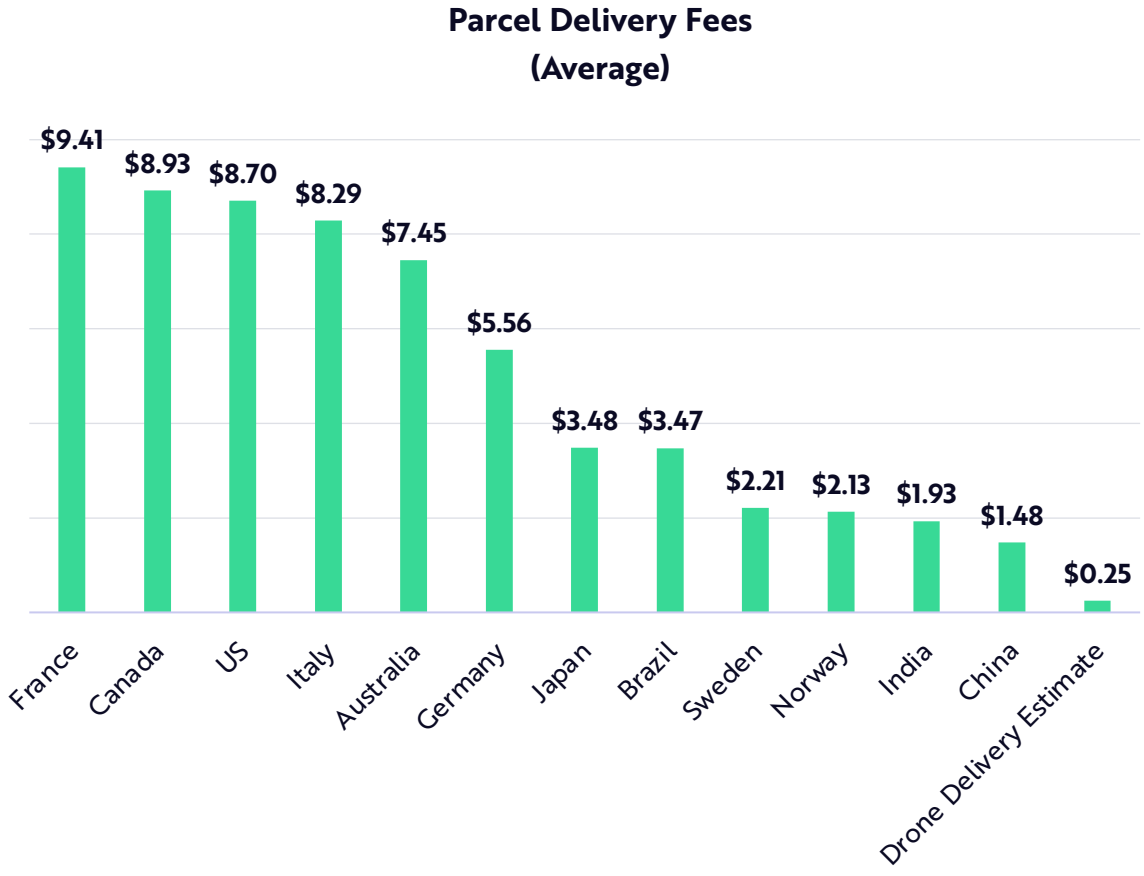
Local Small Item Delivery Cost (Per Trip)

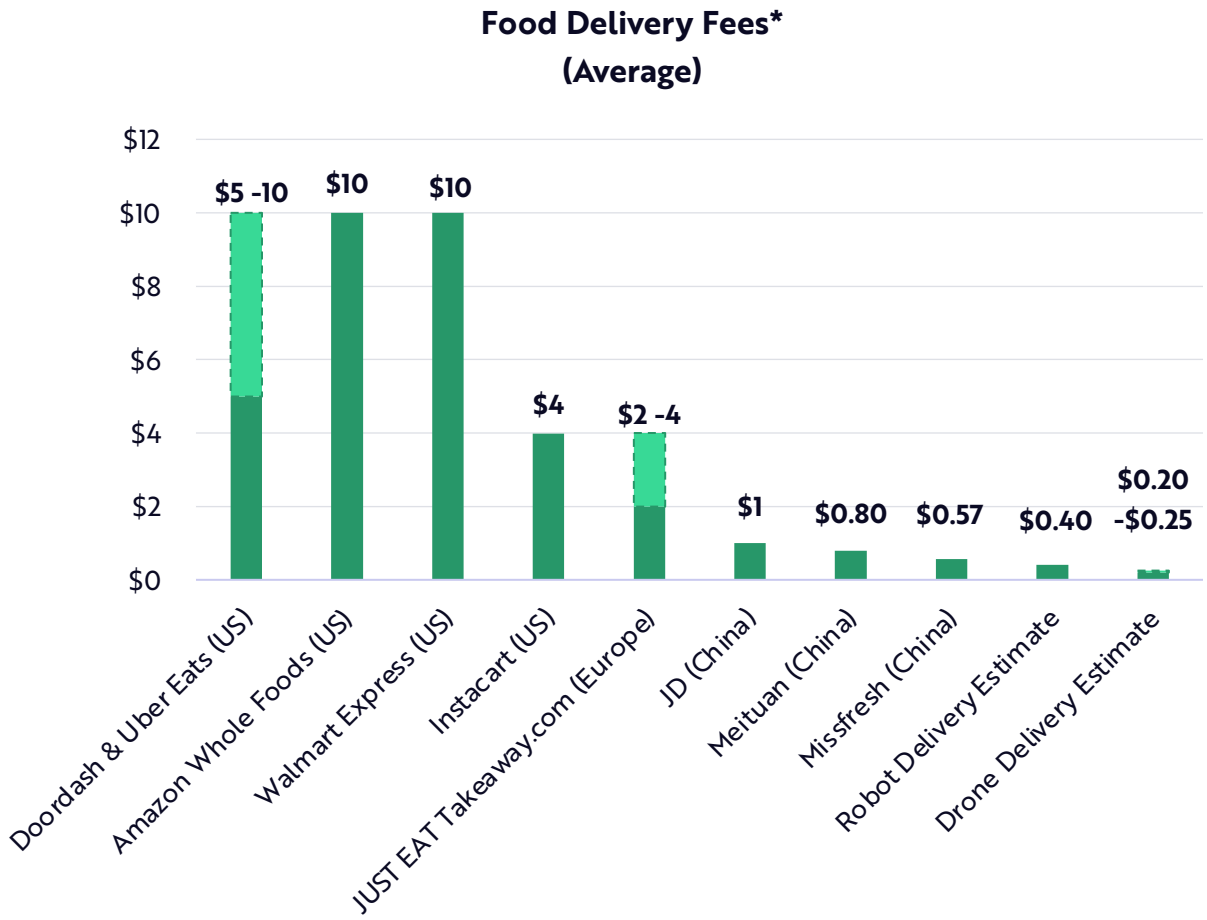


Autonomous drones are likely to deliver a substantial share of e-commerce parcels and online food sales.

Sources: ARK Investment Management LLC, 2023. Bureau of Transportation Statistics, data as of 01/27/23; Kilcarr, S. 2014; AAA 2021; Morrison, R. et al. 2015; Ferguson, D. 2020; DJI, data as of 01/27/23; Chen, B. 2020. Forecasts are inherently limited and cannot be relied upon. 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.

Like Autonomous Ride-Hail, Robots And Drones Should Have A Greater Impact In Countries With High Delivery Fees





*Dotted boarder regions in the right-hand chart show the range of prices for platforms. Sources: ARK Investment Management LLC, 2023. Pitney Bowes Inc., data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. 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.

Real-Time Autonomous Delivery Could Generate A ~$1-2 Trillion Addressable Market In 2030

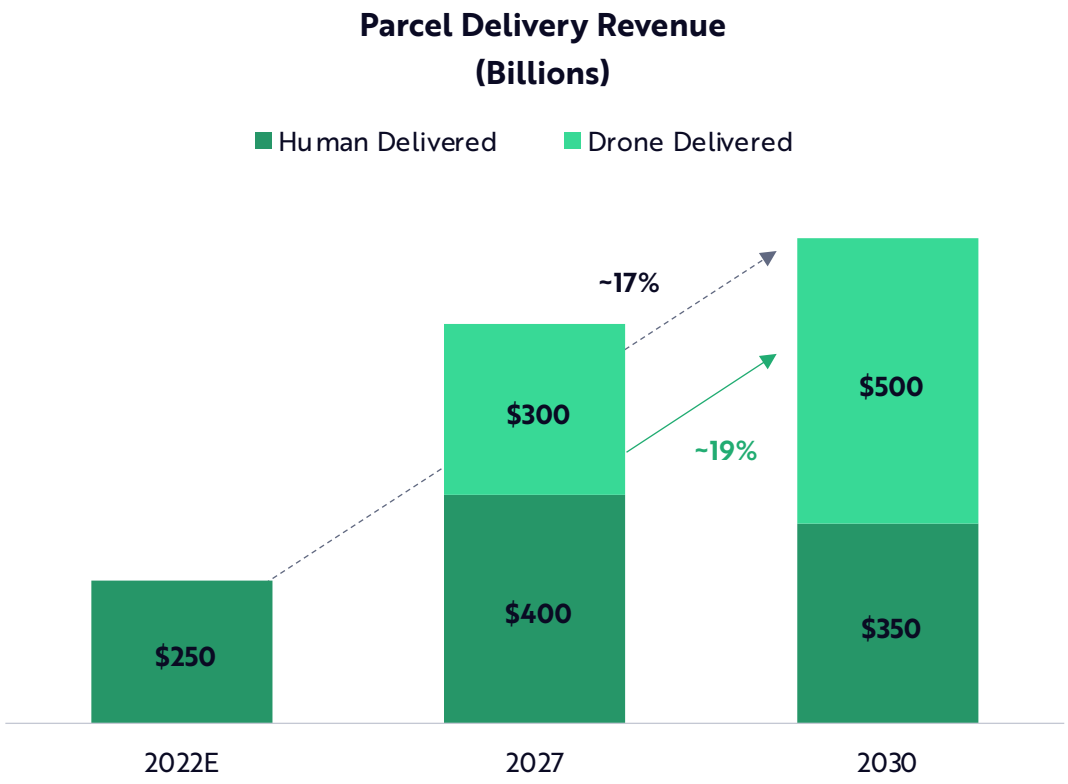
While drone and robot delivery could price profitably at $0.20-$0.40 cents per trip, current fee structures for mail and real-time delivery could support price points as high as $10 per delivery in the short term.

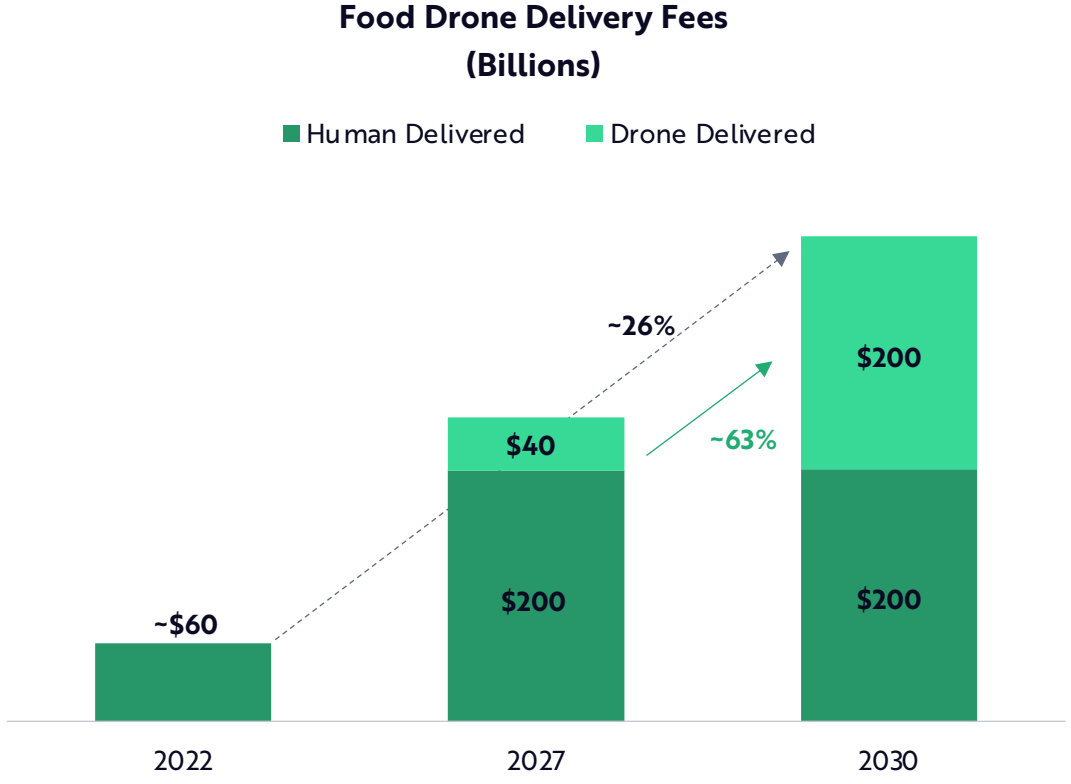
Addressable Market For Autonomous Delivery of Food and Parcels In 2030*
—Markets Segmented by Price Point—

*Numbers in graph are rounded. ~$1.2 Trillion is the addressable opportunity, but total revenues / market size by 2030 will depend on penetration rates. Those figures are detailed in later slides. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Meal And Parcel Drone Delivery Could Be A Larger Opportunity Than Initial Estimates

Based on higher initial price points, drone delivery fees could total $500 billion for parcels and $200 billion for restaurant meals, ~5X more than ARK previously estimated, by 2030. Drones could carry more than half the ~$20 trillion in e-commerce and the ~$2 trillion in meals in 2030. The acceleration in growth toward the end of this decade is pointing to super exponential growth.

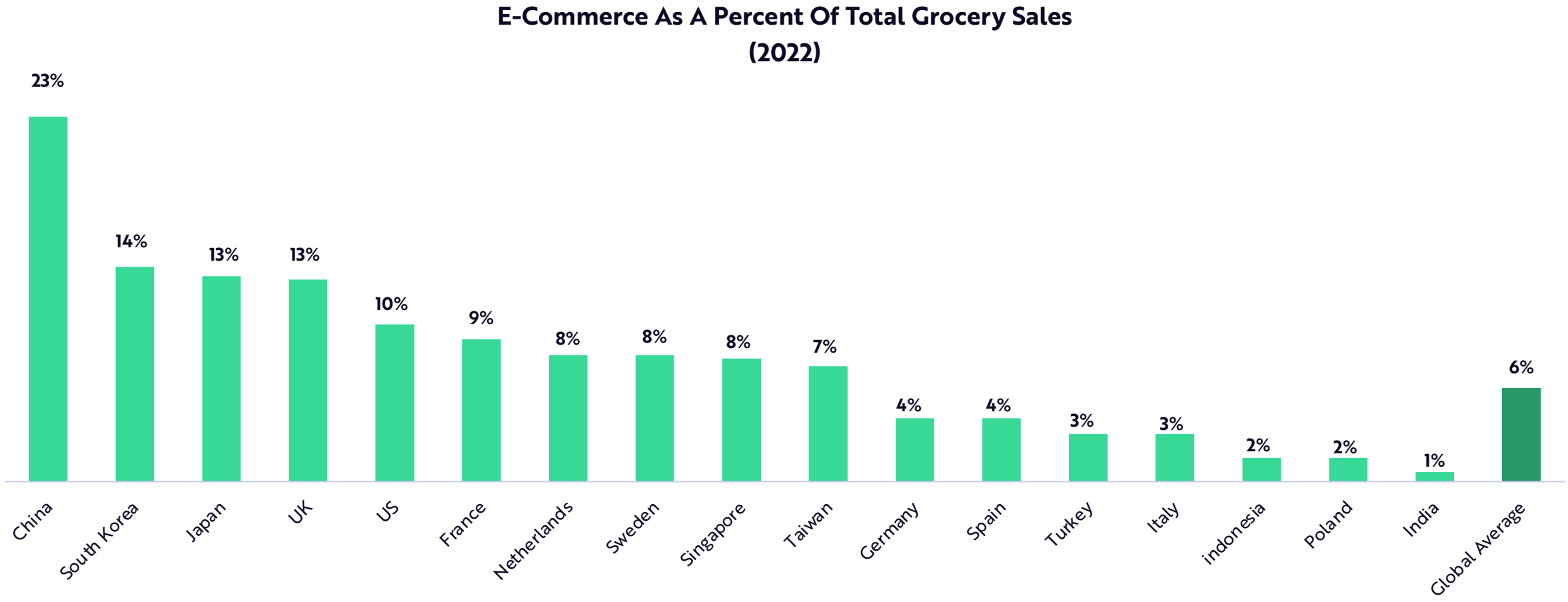




*Parcel revenue shown is for last-mile delivery only. 2022 Numbers are rounded. Parcel Revenue is estimated using 2021 data from Pitney Bowes and applying a compound annual growth rate that falls within their forecast range for the next five years. Note that numbers in the graph are rounded and growth rates are calculated off of rounded numbers.. Sources: ARK Investment Management LLC, 2023. Pitney Bowes, data as of 01/27/23; Insider Intelligence, data as of 01/27/23. Forecasts are inherently limited and cannot be relied upon. 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.

Online Accounts For Only 6% of Grocery Sales Globally

Interestingly, shoppers in the US pick up online grocery orders 30-40% of the time, a figure that should shrink with convenient, inexpensive robotic delivery.

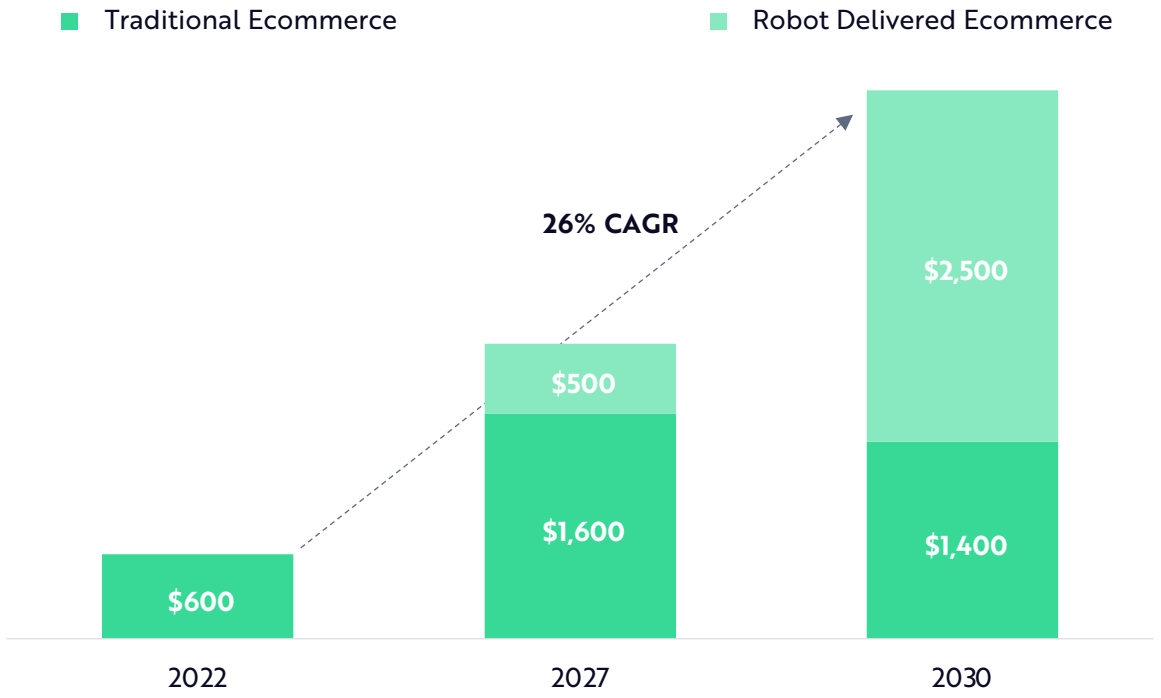


*Figures for Japan, Spain, Italy, Poland, Sweden were extrapolated from 2018,2019, and 2021 data, respectively. Global average is extrapolated by weighting countries by their share of global food at home. Sources: ARK Investment Management LLC, 2023. Crisp, A. 2018; Simmons, V. et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

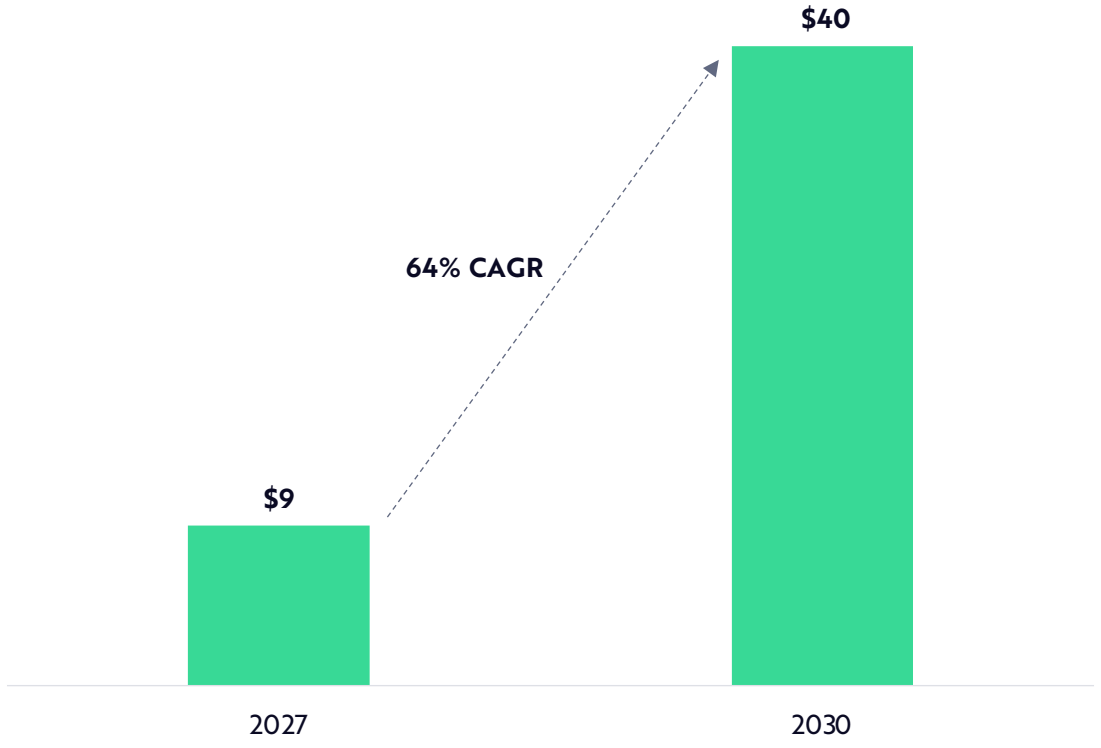
Robot Grocery Delivery Could Generate $40 Billion In Fees By 2030

In 2030, e-commerce could capture 35% of the $11 trillion grocery market globally, with robots accounting for more than half of the deliveries.

Online Grocery Revenues
(Food Purchases Excluding Delivery Fees, Billions)



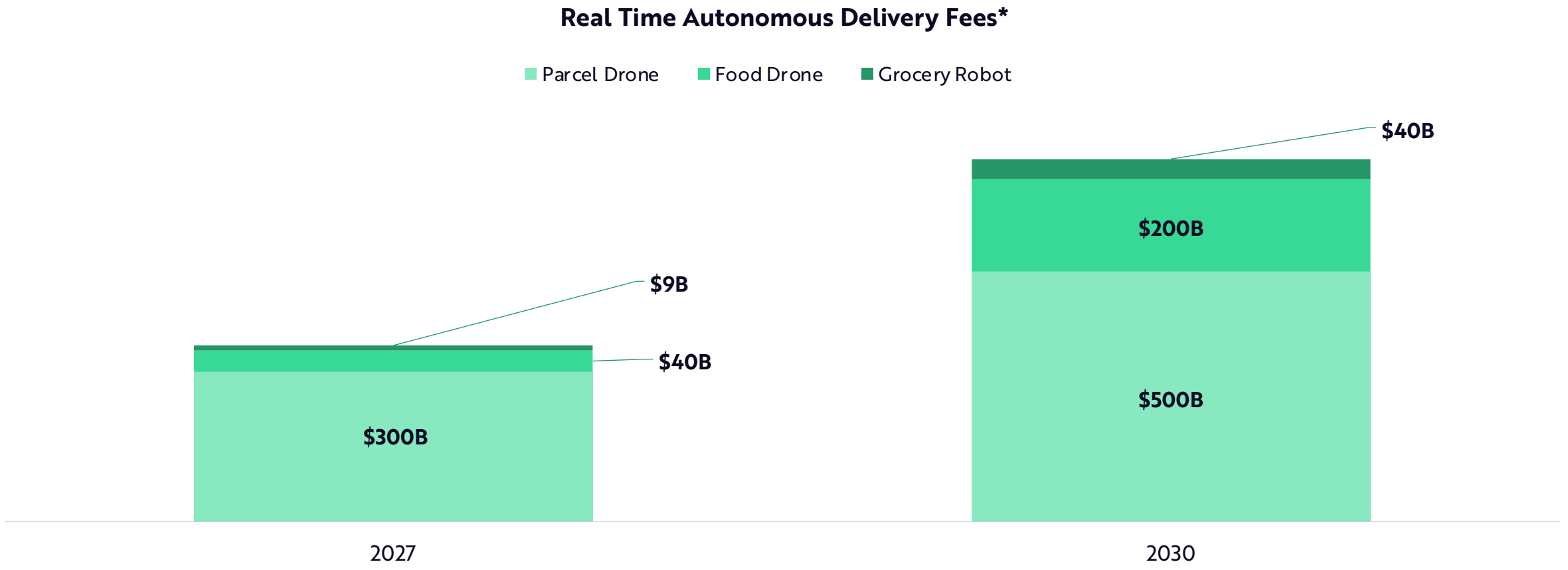
Robot Grocery Delivery Fees*
(Billions)



*The biggest risk to our robot delivery forecast is the production rate of integrated traffic robots. If auto sales decline as ARK expects over the next ten years, traditional automakers could pivot production to robots and other machine types faster than otherwise would be the case. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

Parcel And Food Drones Are Likely To Generate More Than $700 Billion In Fees By 2030

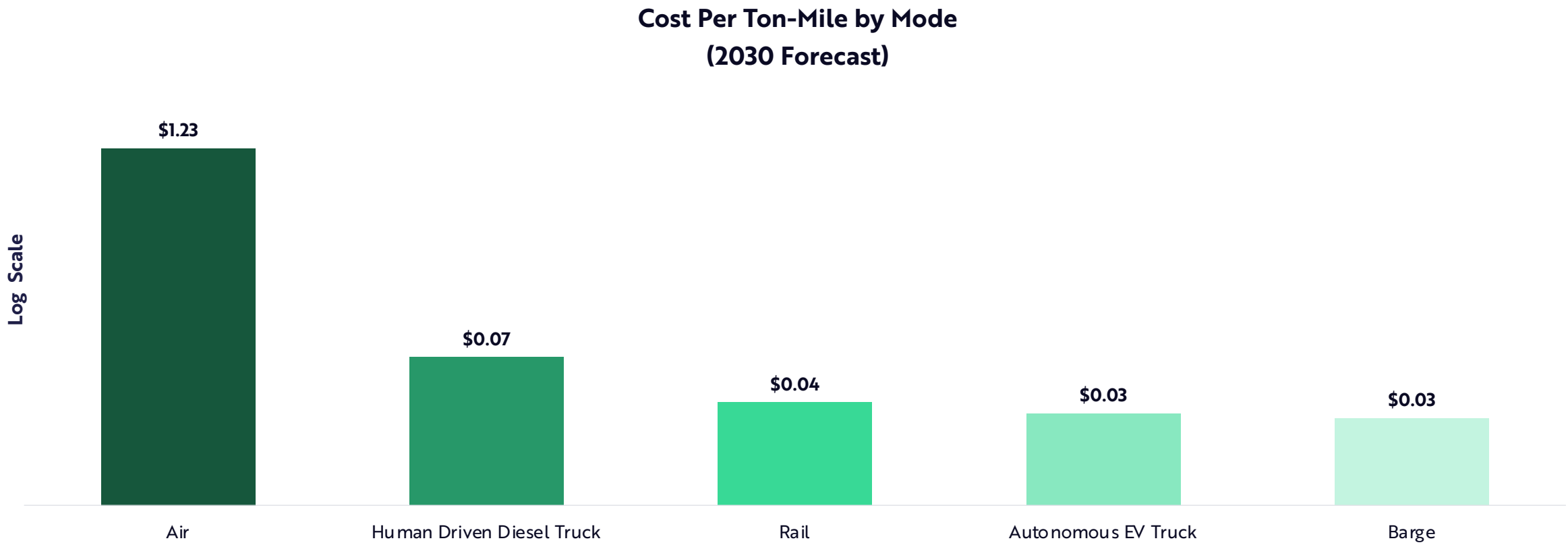
Google Wing, Amazon Prime Air, Nuro, Meituan, Alibaba, JD, Walmart, and Domino's Pizza are developing drone and robotic delivery solutions, either in-house or through partners. In ARK's view, companies that own and operate the autonomous technology stack will win the lion's share of the economics.



*Numbers in the graph are rounded. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 Trucks Should Become More Cost Effective Than Rail By 2030

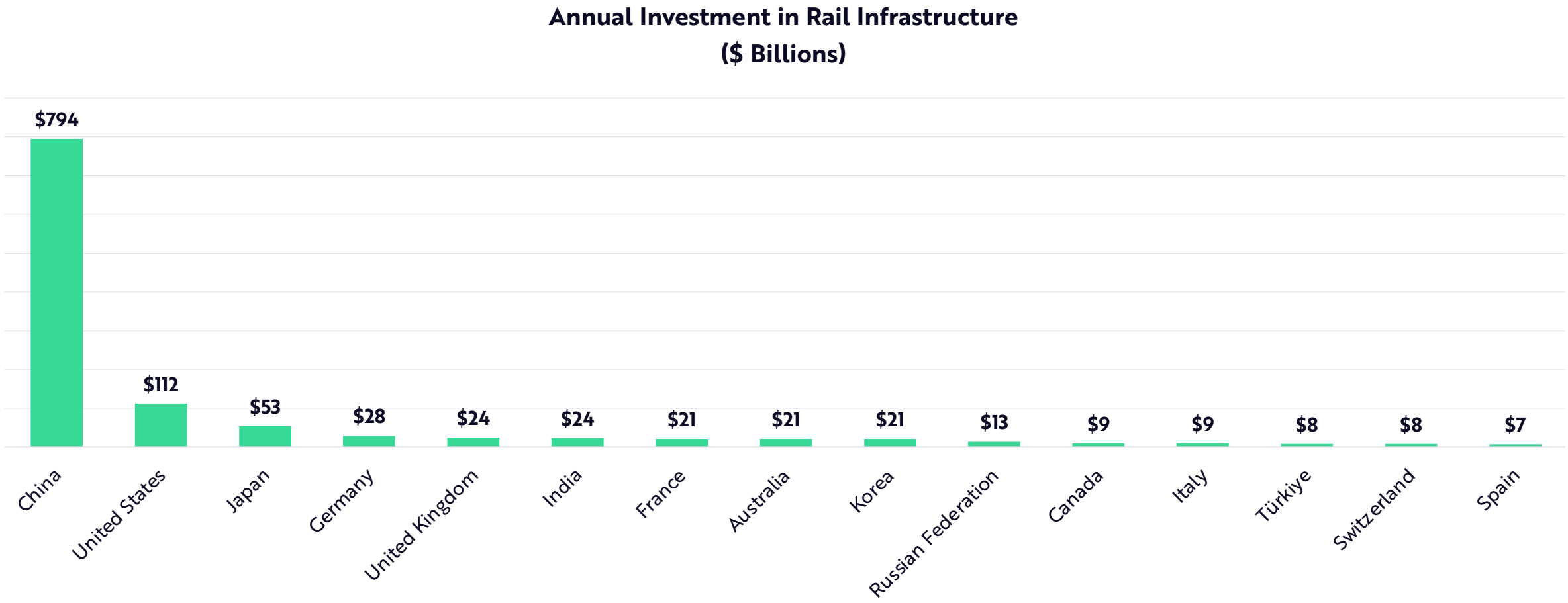
Door-to-door trucks should offer significant speed advantages over rail, taking share from intermodal transport. Aurora, Waymo, and Pony.ai are examples of companies developing autonomous truck platforms.



Note: Numbers in chart are rounded. Sources: ARK Investment Management LLC, 2023. Bureau of Transportation Statistics 2017. Forecasts are inherently limited and cannot be relied upon. 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 Trucks Could Strand Rail Assets

Globally, more than $1.2 trillion per year is spent on infrastructure, with China accounting for more than half of the total.*

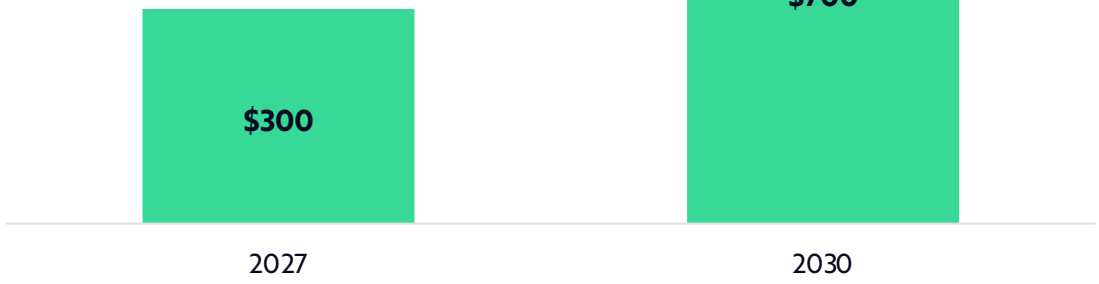


*Latest Annual Data Available for Years 2016-2020. $1.2 trillion is the sum of investment for countries with available data. The global total likely is slightly higher. Sources: ARK Investment Management LLC, 2023. Barreto, M. et al. 2022. Forecasts are inherently limited and cannot be relied upon. For 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.

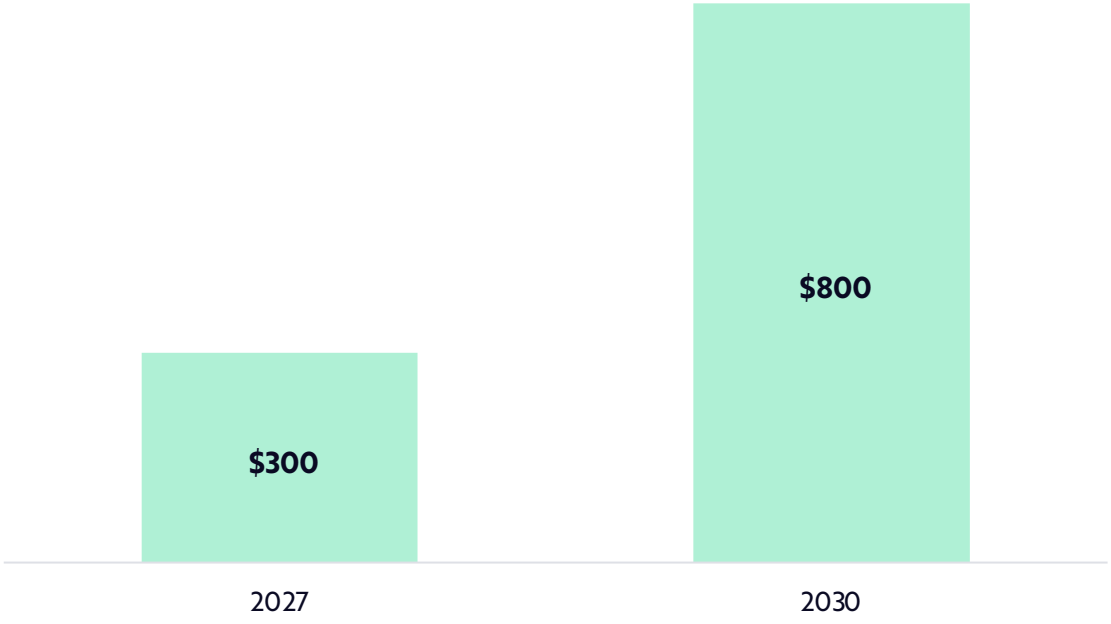
Global Autonomous Delivery Revenue Could Total $1-2 Trillion By 2030*

Autonomous logistics should help companies transport goods to consumers and businesses much more quickly and conveniently, likely changing buying patterns and reshaping global supply chains.

Real Time Autonomous Delivery Revenue (Billions, Robots And Drones Only)



Autonomous Truck Delivery Revenue (Billions)



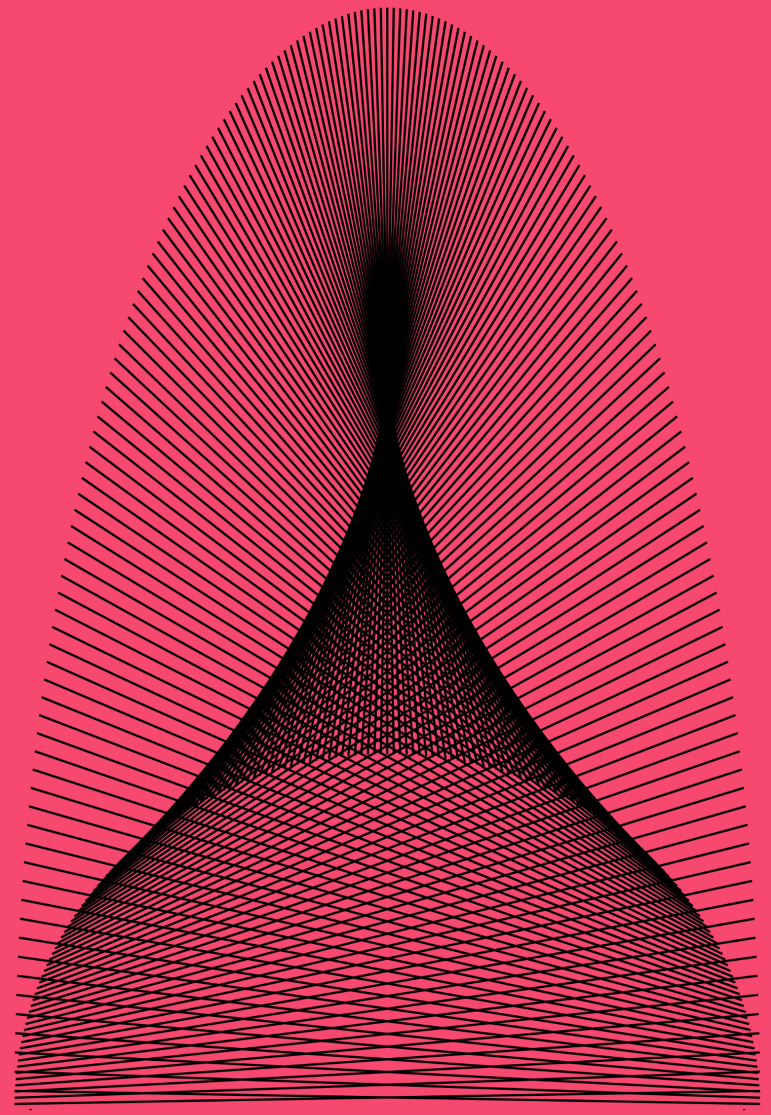
*Note that instant delivery revenues are net while autonomous truck revenues are gross. We expect autonomous truck operators to take a cut of gross revenues, much like ride-hail companies do today. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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 And 3D Printing

Promoting A Manufacturing Revolution

Robotics and 3D printing can collapse time from development to production, shorten supply chain footprints, reduce waste, and lower costs.

ARK estimates that manufacturing robots and 3D printing could scale at a ~80% annual rate during the next eight years, from $70 billion in 2022 to ~$9 trillion by 2030.

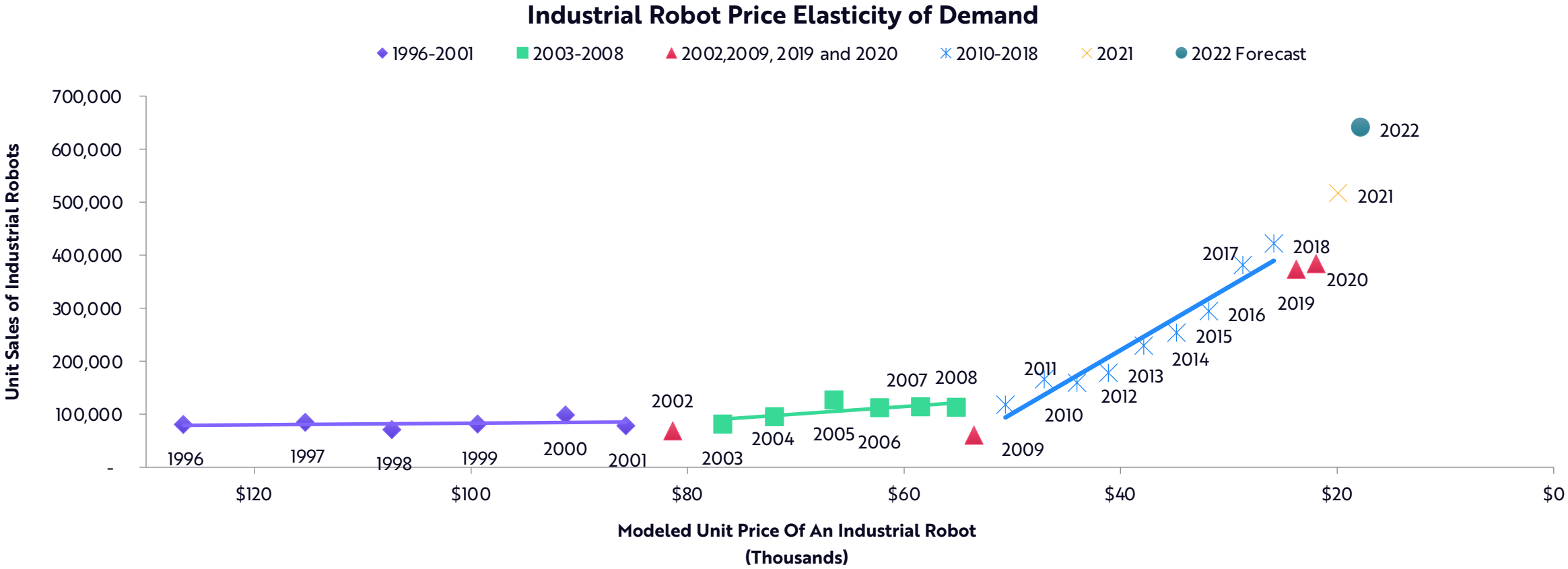


Research by Sam Korus, Director of Research, Autonomous Technology & Robotics

Tasha Keeney, CFA, Director of Investment Analysis & Institutional Strategies

The Adoption Of Automation Typically Accelerates During Recessions And Crises

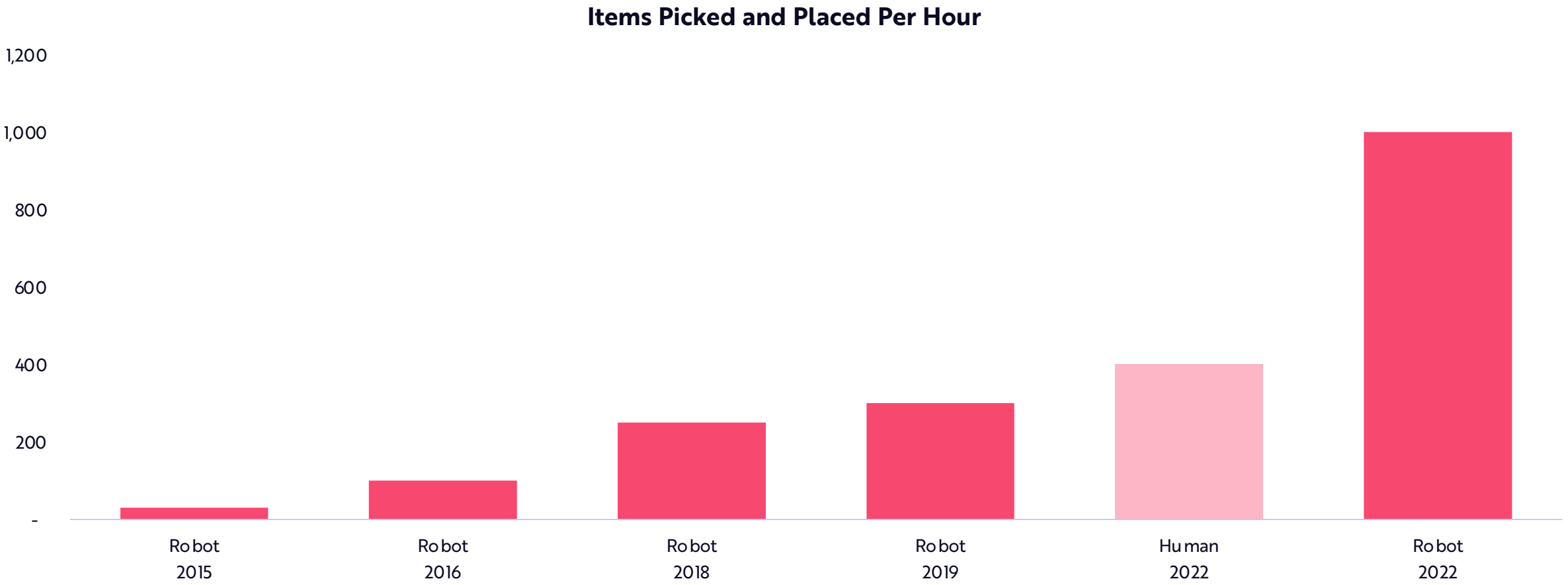
The adoption of industrial robots accelerated after the 2002 dot-com bust and again after the 2008-2009 crisis. The responses to the China/US trade conflict in 2019 and supply chain bottlenecks from 2020 through 2022 have been the same.



Sources: ARK Investment Management LLC, 2023. Müller, C. 2022. International Federation of Robotics. Forecasts are inherently limited and cannot be relied upon. 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 Performance Has Improved 33-Fold In The Past Seven Years

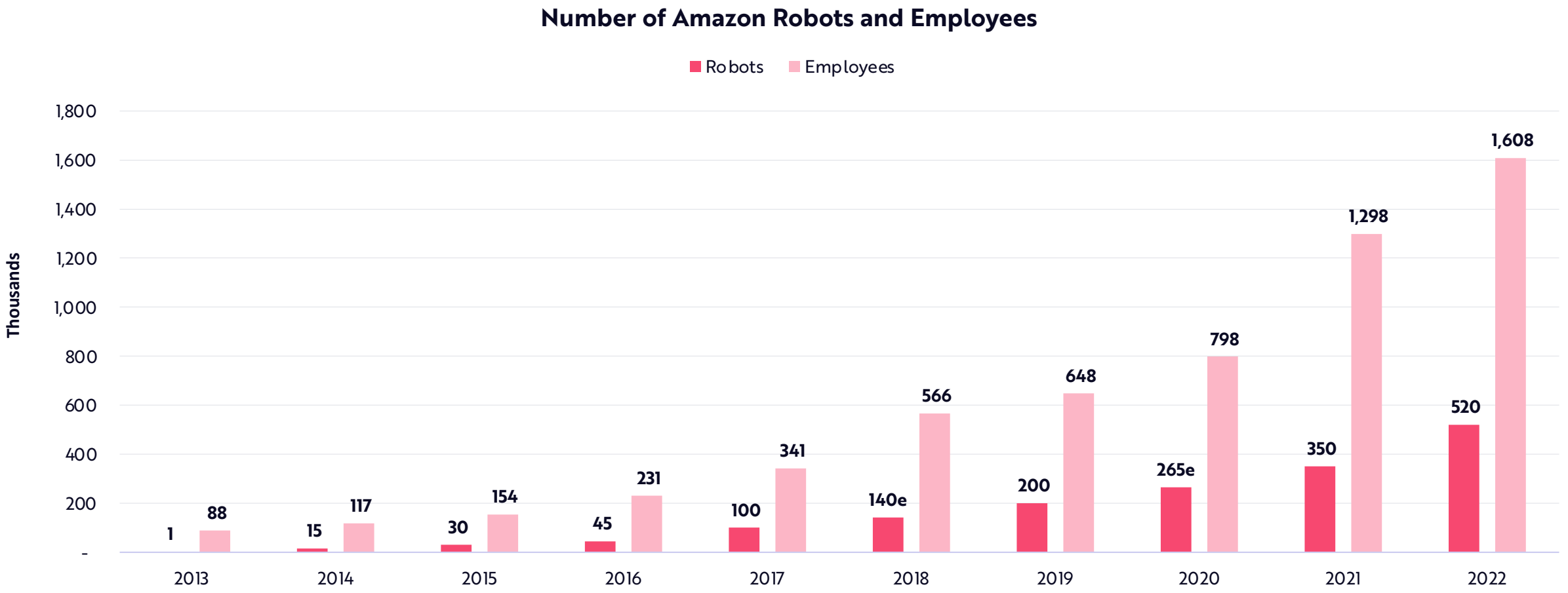
Advances in computer vision and deep learning have increased the performance of robots.



Sources: ARK Investment Management LLC, 2023. Roach, J. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

Amazon Could Be Approaching An Inflection Point In Robotics

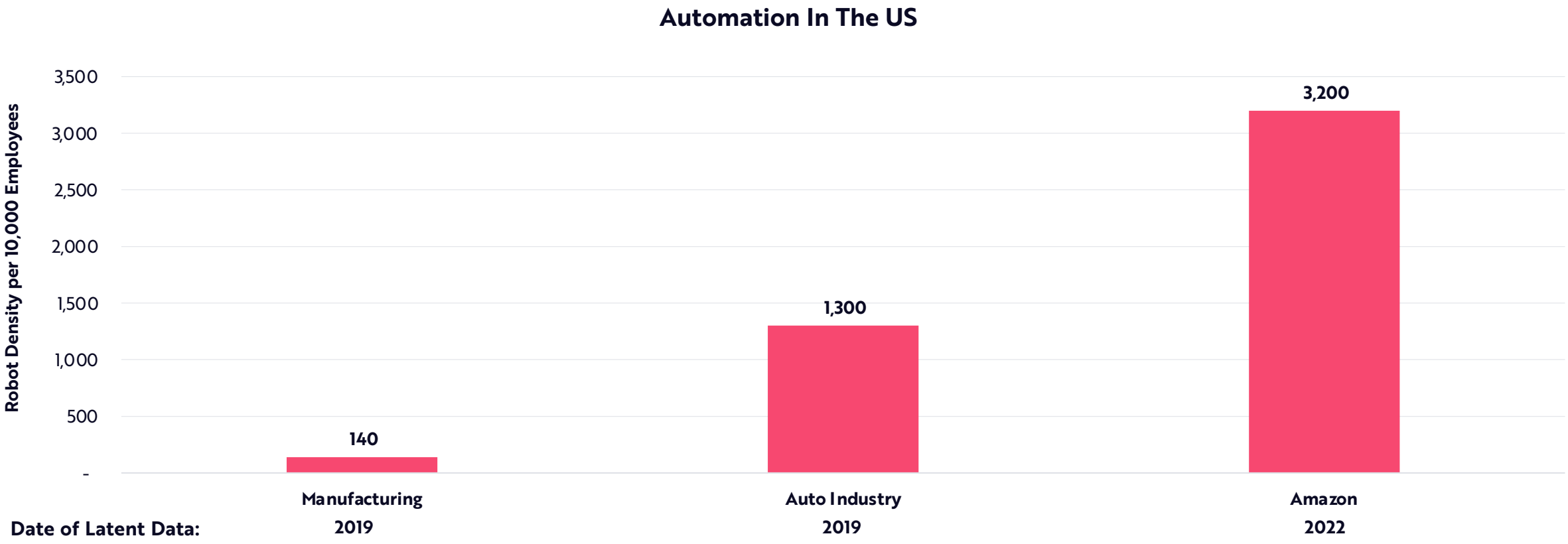
Amazon is producing ~1,000 robots per day. Within the next few years, it could add more robots than employees per year.



Sources: ARK Investment Management LLC, 2023. Jabil Inc. 2021. Amazon, data as of 12/31/22. Forecasts are inherently limited and cannot be relied upon. 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.

The Opportunity For Robot Penetration In Manufacturing Is Immense

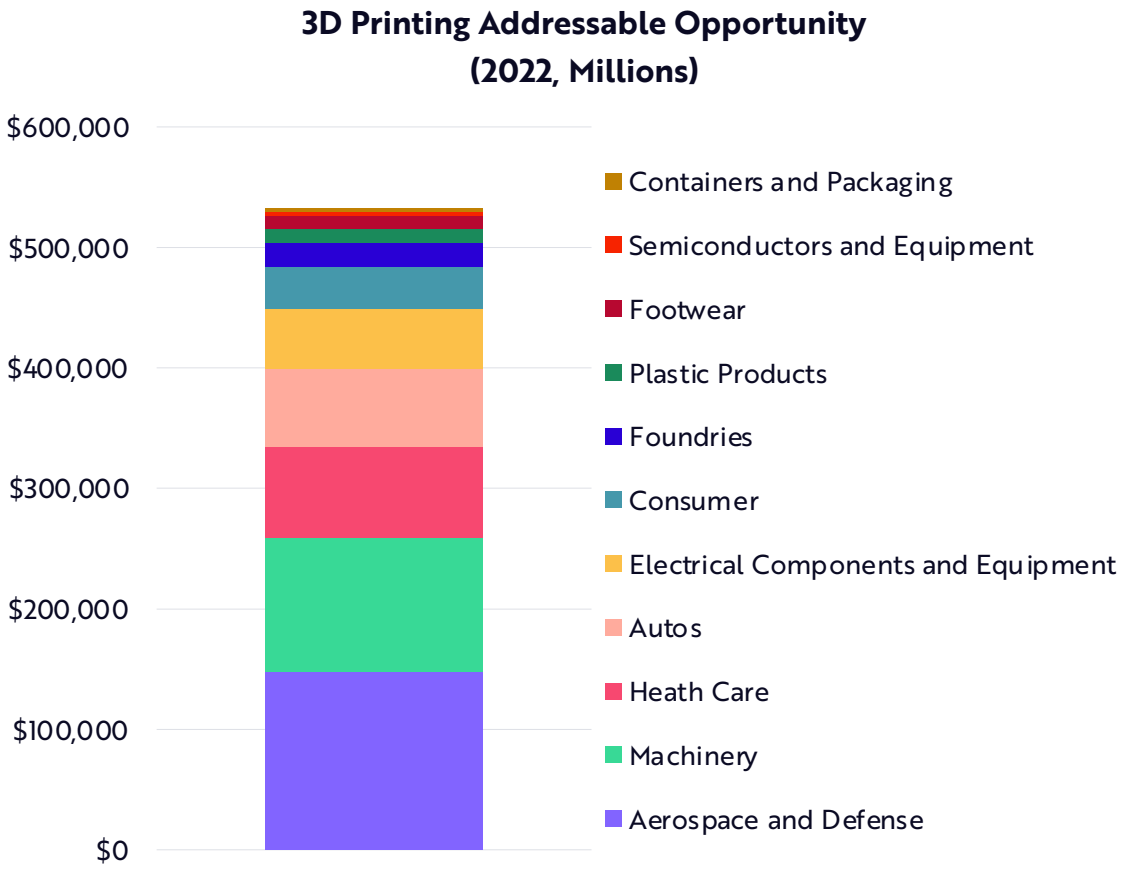
Amazon is in the early days of mass robot adoption, pointing the way for other industries. To reach Amazon's robot density, the US manufacturing industry would have to add four million robots, roughly 6X the unit sales of industrial robots globally today. What is the upper bound for robot density long term?



Sources: ARK Investment Management LLC, 2023. Automation.com 2021; Amazon 2022. Forecasts are inherently limited and cannot be relied upon. 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.

3D Printing Should Impact Many Industries

ARK estimates that 3D printing will be a $500 billion market opportunity as applied to existing products.



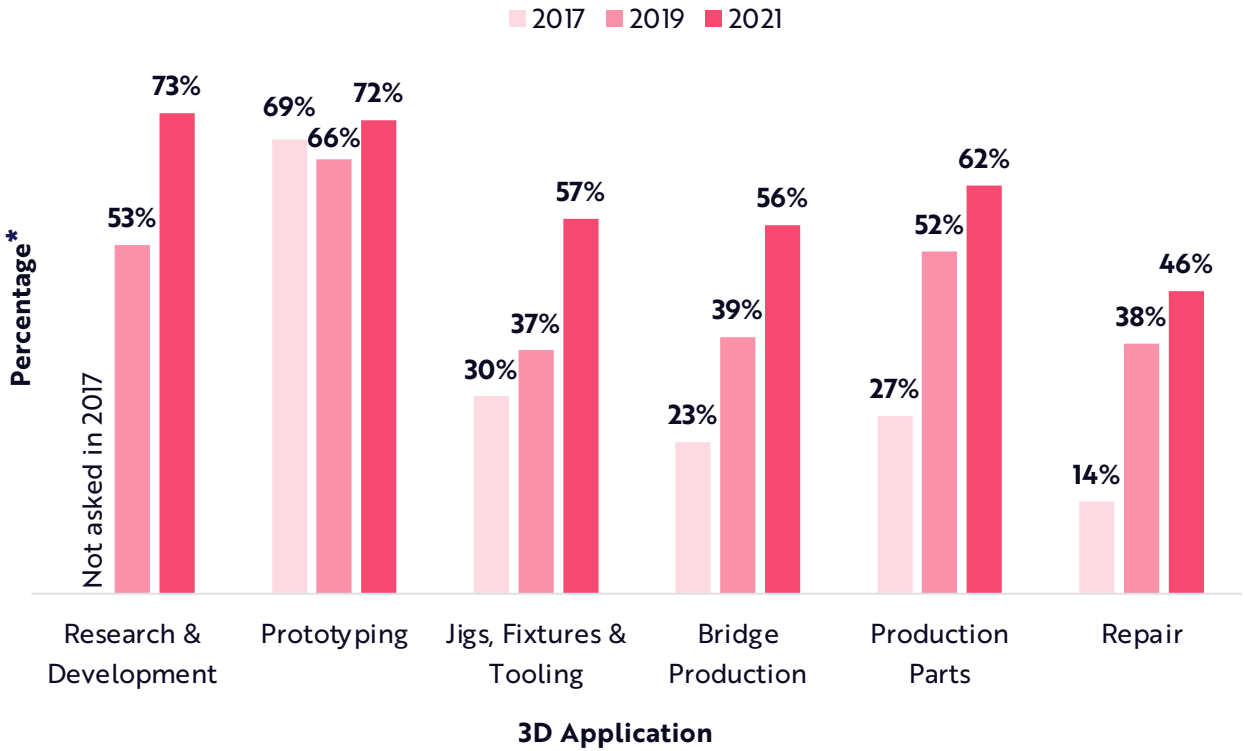
3D printing is likely to enable new products and markets. Boston Dynamics' Atlas humanoid robot, for example, achieved a strength-to-weight ratio that enabled leaps and somersaults, thanks to 3D printing.

Sources: ARK Investment Management LLC, 2023. S&P Global Market Intelligence, data as of 01/26/23. Forecasts are inherently limited and cannot be relied upon. 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.

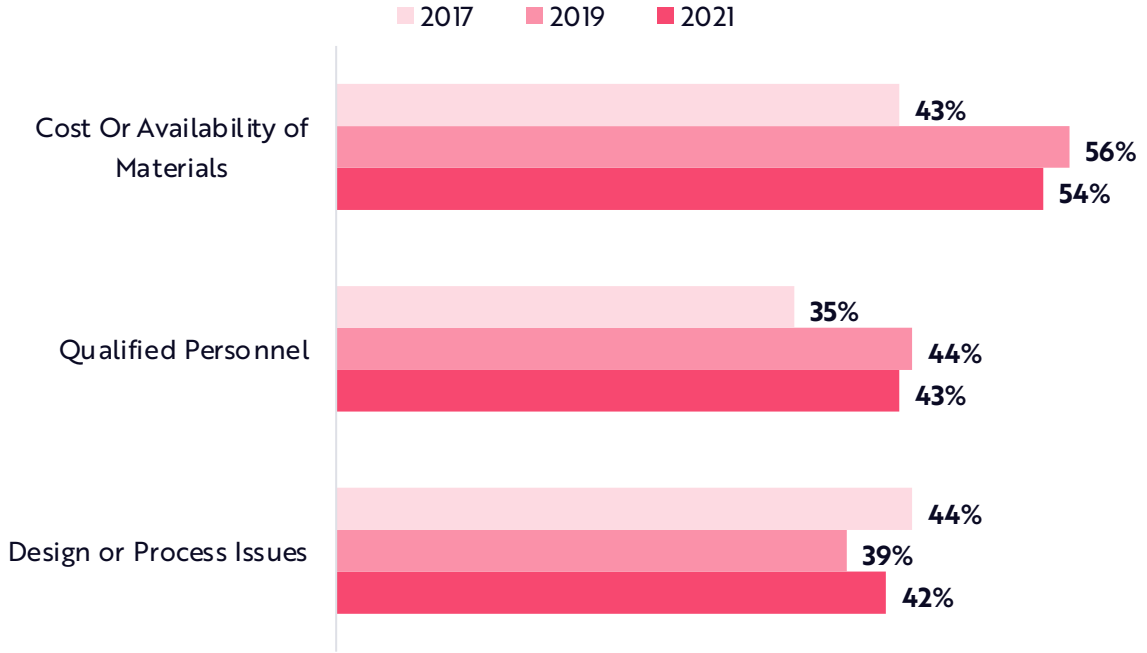
The Barriers To 3D Printing Adoption Include Materials, Costs, Know-How, And Processing

3D printing costs should be compared to those over the lifetime of a part—from design to retirement—in traditional manufacturing. While upfront costs can be higher, 3D printed parts can be produced much faster with more durability than parts manufactured traditionally.

Use Of 3D Printing Across Applications And Time
"In What Way Does Your Company Currently Use 3D Printing?"



Top 3 Barriers To 3D Printing Adoption*
"What Prevents Your Company From Doing More 3D Printing In Production Today?"



*Percentage of respondents selecting an answer. Survey respondents totaled 302 individuals responsible for 3D printing decisions at manufacturing companies across the Electronics, Plastics and Packaging, Industrial Machinery, Heavy Equipment, Automotive, Healthcare, Footwear, Orthopedics, Aerospace and Defense, and Transportation industries globally. Sources: ARK Investment Management LLC, 2023. Jabil Inc. 2021. Forecasts are inherently limited and cannot be relied upon. 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.

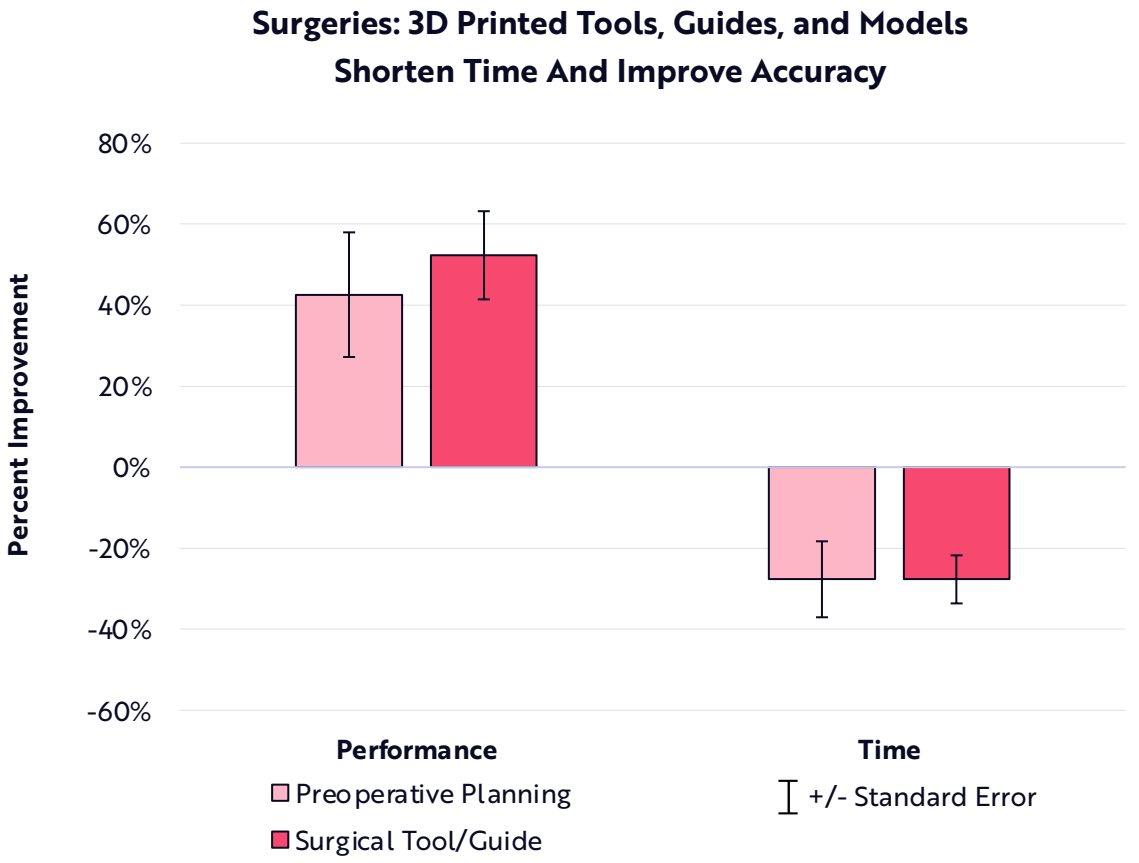
In Healthcare, 3D Printing Can Make A Big Difference In The Operating Room And Beyond

Doctors use patient-specific 3D printed models to pre-plan surgeries and customize 3D printed tools/surgical guides for procedures, shortening operating room time and improving patient outcomes.

Across a range of surgeries, 3D printed tools, guides, and models reduced operating time on average by ~30% and increased performance, measured by surgical accuracy and results, on average by ~40-50%.

According to ARK's research, 3D printing could reduce total time spent in US operating rooms for all surgery types by 5%, saving ~$12.5 billion. Worldwide, cost savings could approach $80 billion based on surgery time alone, before accounting for improved accuracy, reduced complications, and faster patient recovery.

3D printing could increase access to surgery around the globe by reducing costs and increasing throughput. Health systems and services fall short of patient surgery demand by roughly 140 million cases a year.*



Note: Time Savings and Accuracy Improvements Provided by 3D Printed Surgical Guides and Preoperative Planning Aides: bars represent the average percent improvement in time or performance as described in Bergmann et al. 2017 and Woodard et al. 2019, N=6-9 for each sample group. Error bars represent +/- standard error. The above analysis was conducted across medical fields; however, oral maxillofacial surgery and musculoskeletal studies were the most prevalent.

*Latest estimate available as of 2015. Sources: ARK Investment Management LLC, 2023. Diment, L. et al. 2017; Meara et al. 2015; Dobson, G. 2020. Forecasts are inherently limited and cannot be relied upon. 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.

AI Improves 3D Printing Accuracy, Strength, And Repeatability

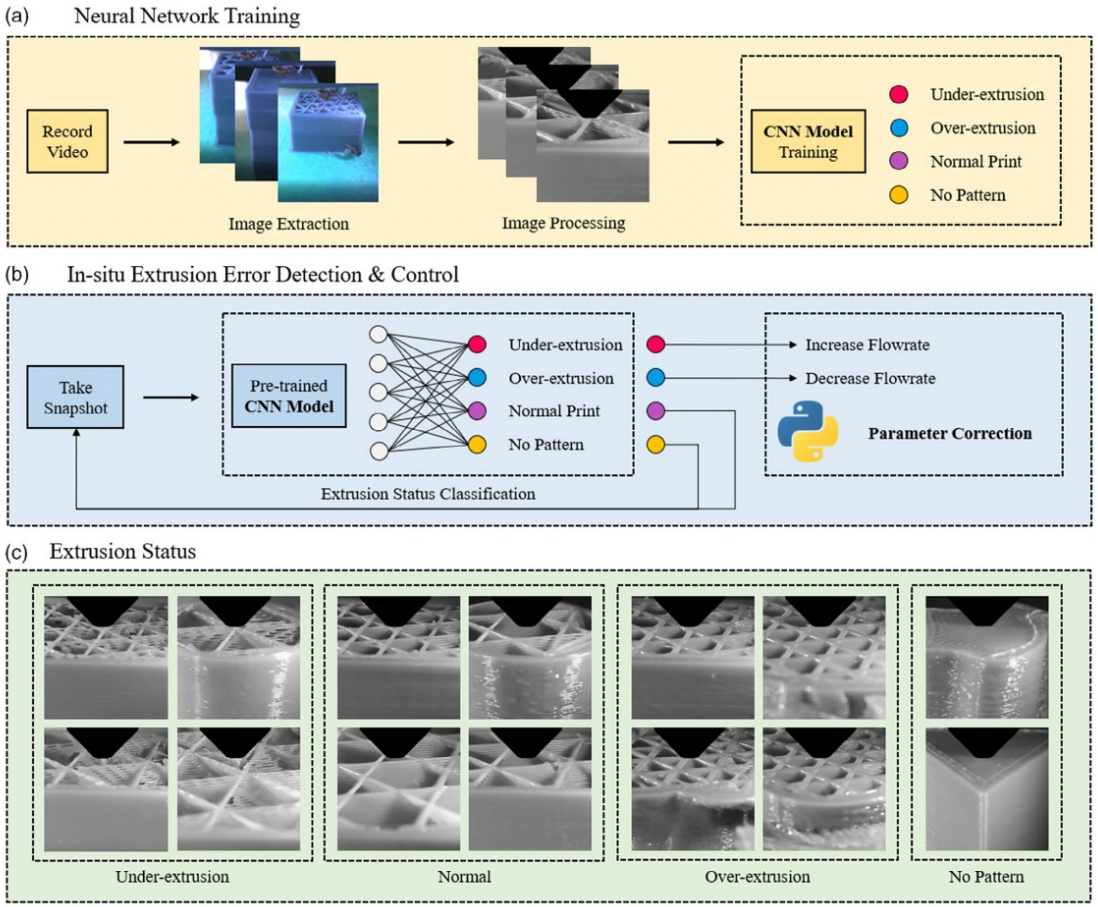
Using sensors and machine learning algorithms to control the print process, researchers reduced print error by ~30%, strengthened products by up to 2X, and reduced waste in materials by up to 40%.

Higher accuracy could result in parts with better finish, less need for post-processing, and fewer defects than in human-driven 3D printing processes.

AI enables repeatability, which is critical to companies with strict manufacturing standards and companies that need to scale 3D printers across locations.

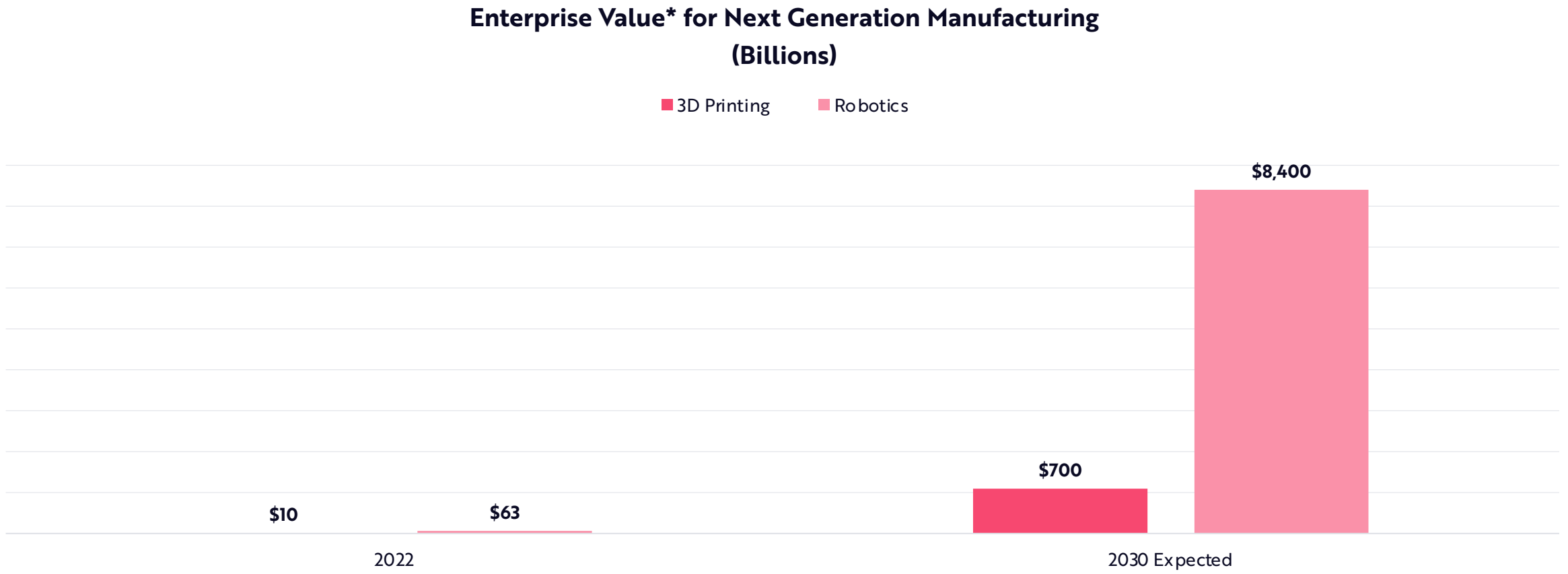
Companies that own the full software stack, build printers with sensors that gather data, and enable over-the-air software updates should enjoy competitive advantages.

Example: Machine Learning Control Algorithm For 3D Printing



Sources: ARK Investment Management LLC, 2023. Lee, W. et al. 2022; Piovarči et al. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

ARK Expects The Enterprise Value For Robotics And 3D Printing To Scale 80% At An Annual Rate During The Next Eight Years, From $70 Billion Today To More Than $9 Trillion In 2030



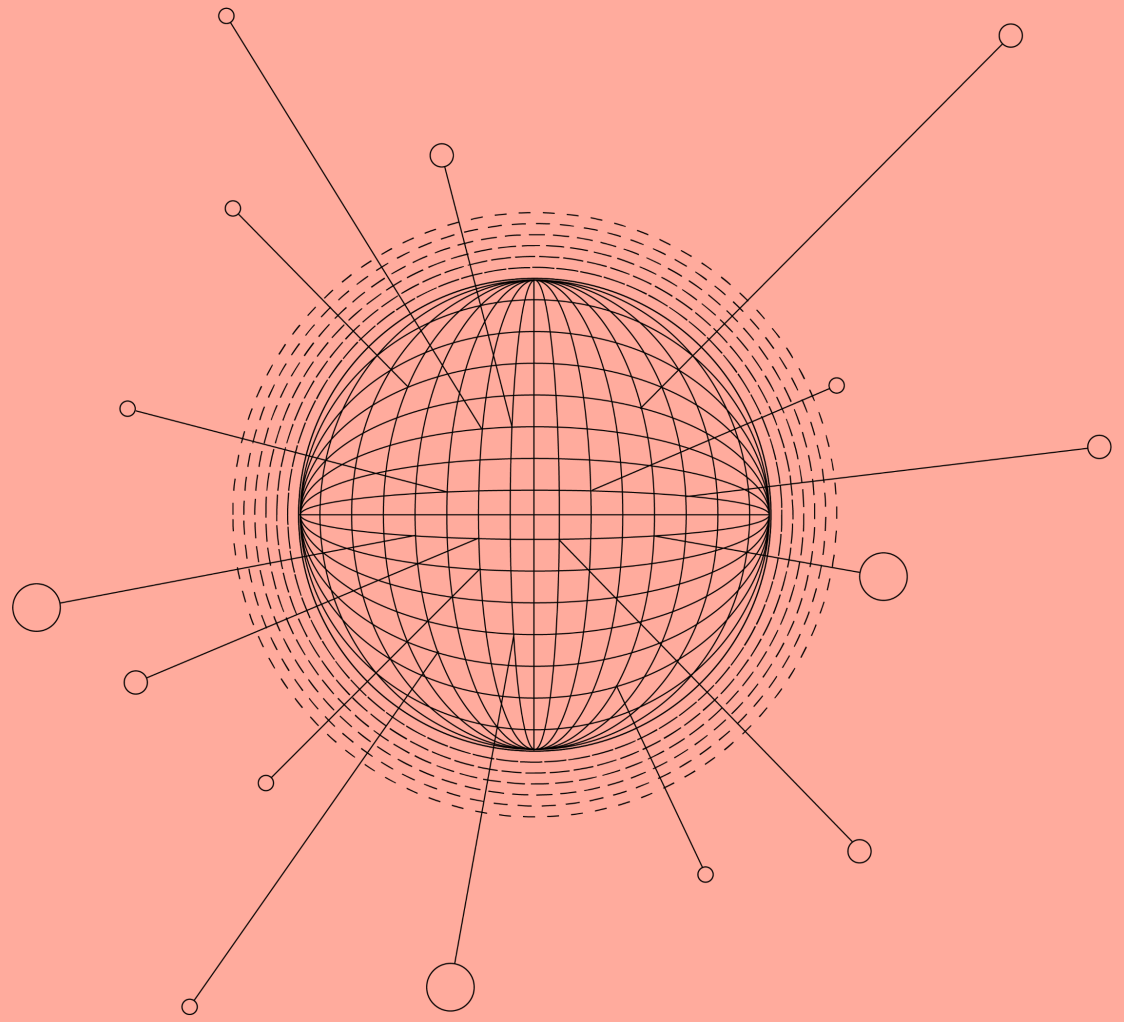
*2022 Enterprise Value for 3D printing includes a ~60% discount on private valuations. ARK updated its 3D printing adoption curve to better match recent growth rates. Sources: ARK Investment Management LLC, 2023. PitchBook, data as of 01/26/23; S&P Global Market Intelligence, data as of 01/26/23. Forecasts are inherently limited and cannot be relied upon. 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.

Orbital Aerospace

Enabling Global Connectivity

Aerospace costs are declining, thanks to advancements in deep learning, mobile connectivity, sensors, 3D printing, and robotics. As a result, satellite launches and rocket landings are proliferating.

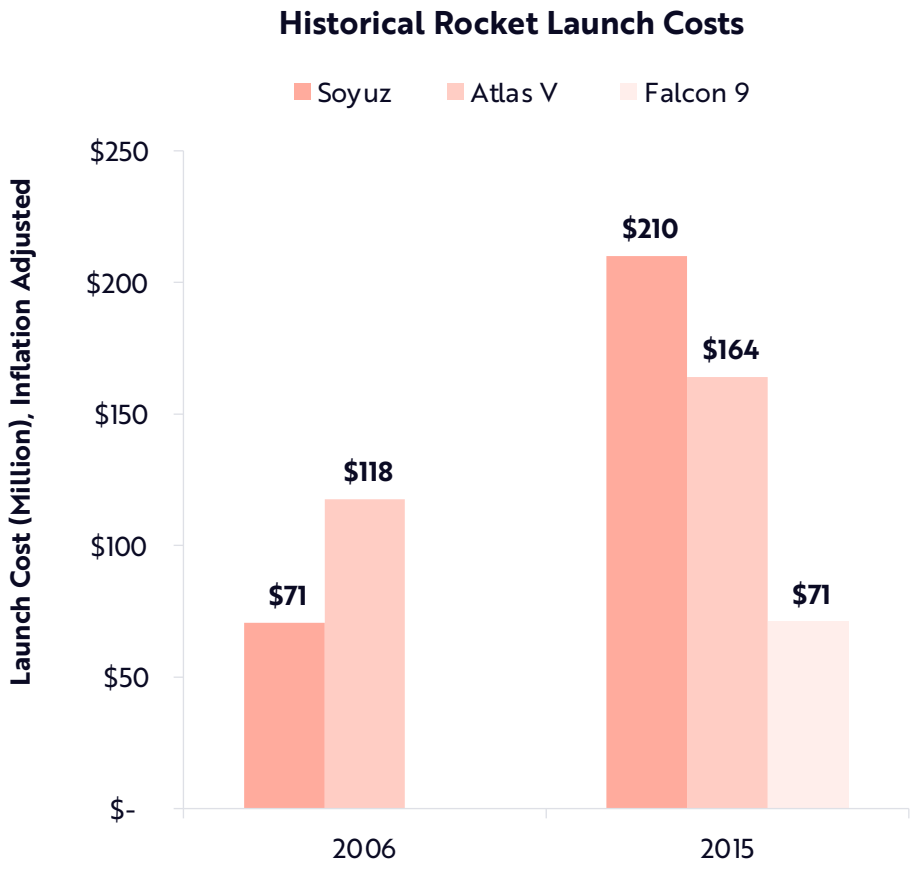
In the coming decade, satellite broadband and hypersonic flight could generate annual revenues of ~$84 billion and ~$270 billion, respectively.

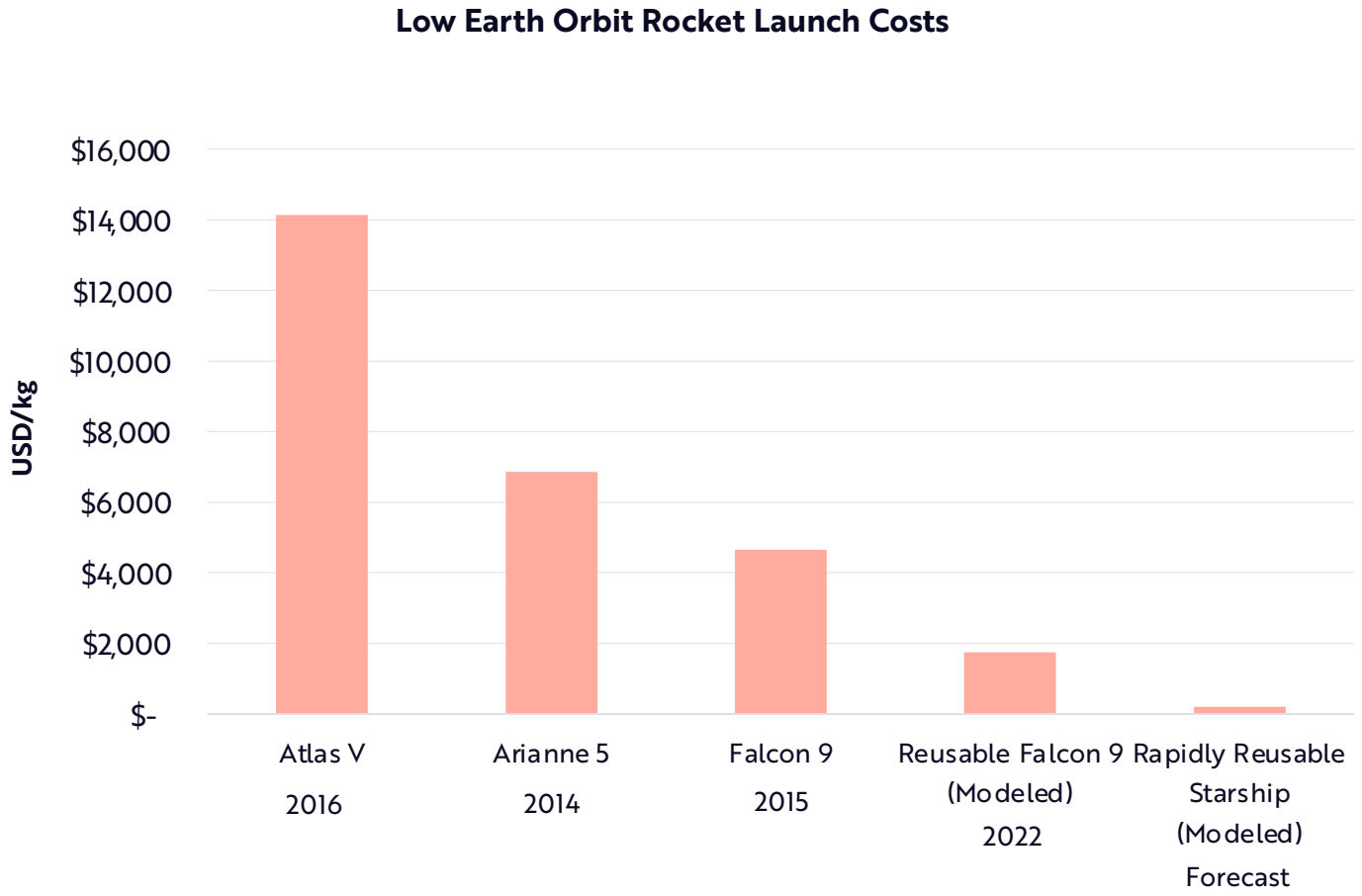


Research by Sam Korus, Director of Research, Autonomous Technology & Robotics

Reusable Rockets Should Lower Launch Costs By An Order of Magnitude...Or Two!

SpaceX put an end to soaring launch costs with its Falcon 9 reusable rocket. Falcon 9 has flown the same booster 14 times. Thanks to reusable rockets, SpaceX nearly doubled its launches to 61 rockets in 2022.

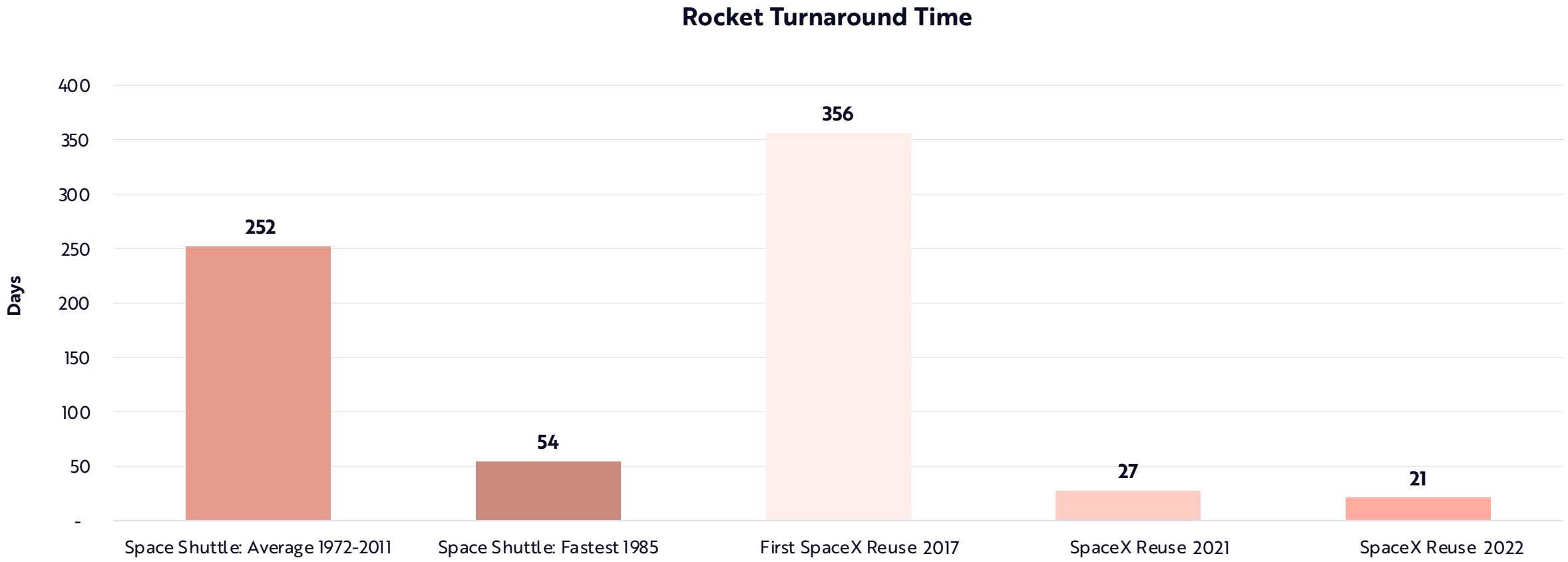




Sources: ARK Investment Management LLC, 2023. SpaceX, data as of 01/12/23; Svitak, A. 2011; Martin, P. 2013; United Launch Alliance, data as of 01/19/23; de Selding, P. 2014. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

SpaceX Is Refurbishing Rockets In Record Time

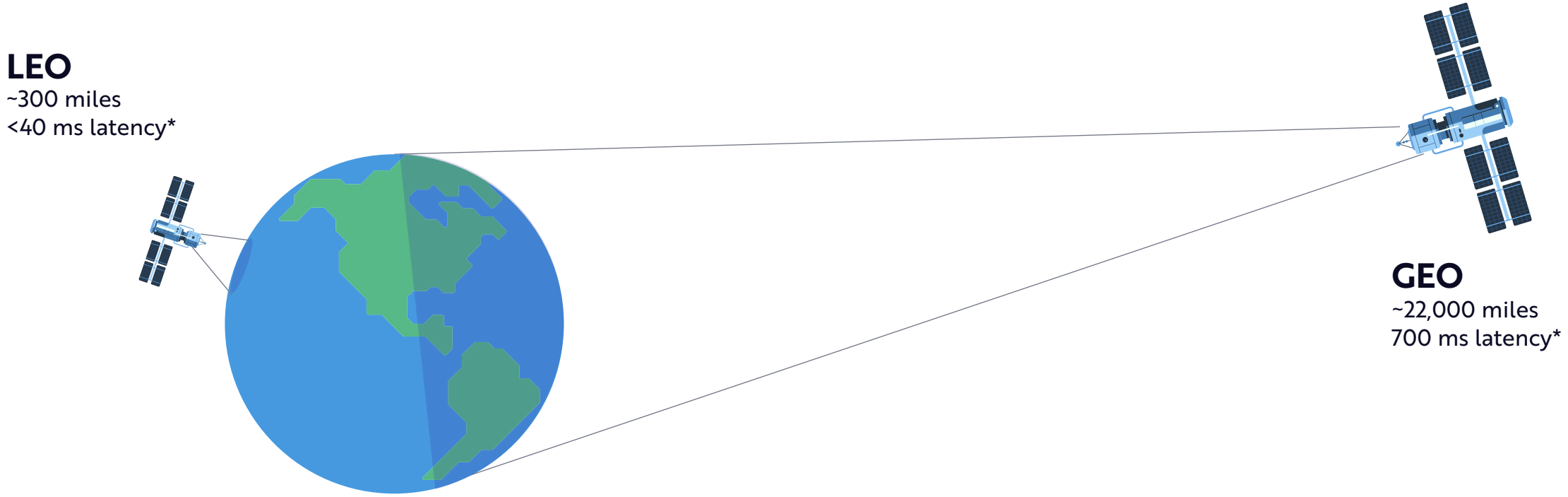
Thanks primarily to its rapid turnaround time, the first stage of the Falcon 9 costs less than $1 million to refurbish, according to our model. In contrast, each Space Shuttle launch cost ~$1.5 billion.



Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

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

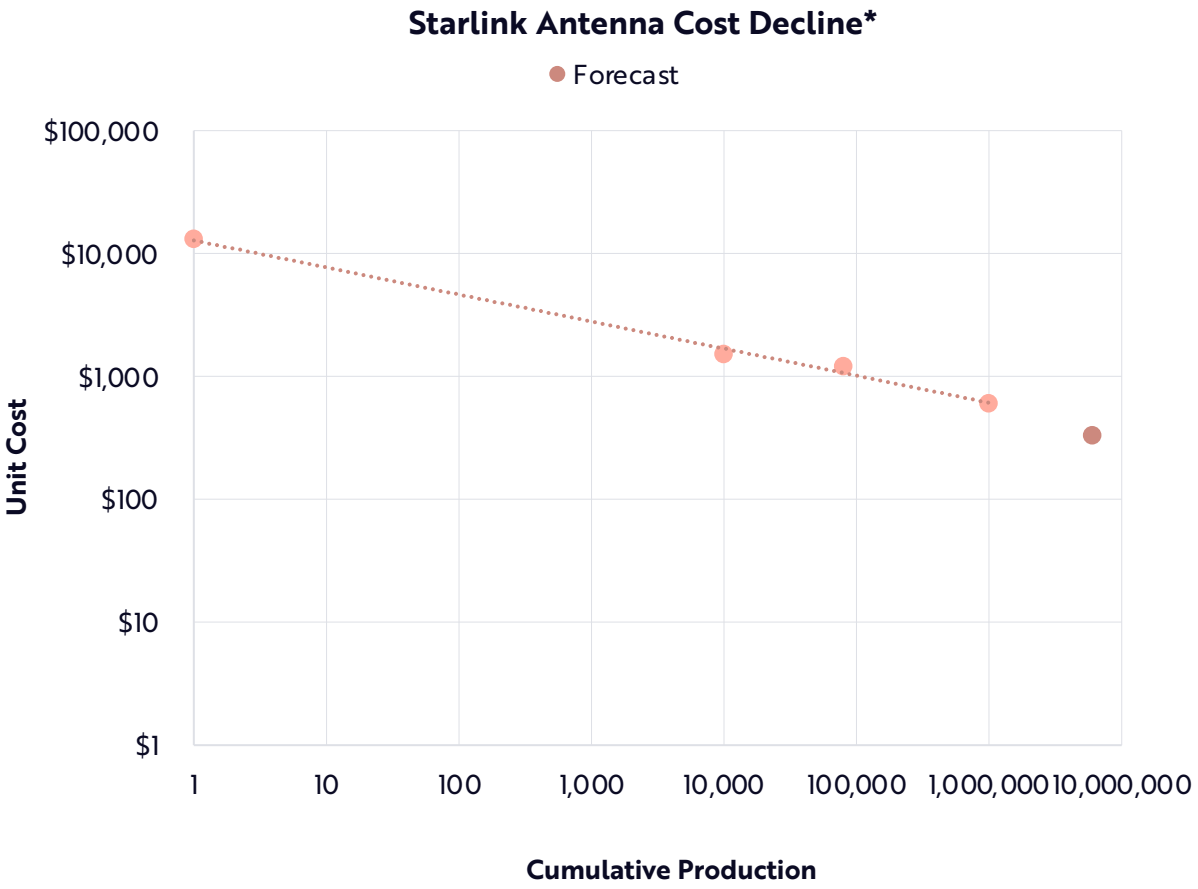
While satellites launched into geostationary orbit (GEO) technically offered global coverage, latency limited a compelling broadband internet experience. Today, companies are launching thousands of low-cost satellites into low earth orbit (LEO) and enabling continuous global coverage with low latency and direct-to-mobile device connectivity.

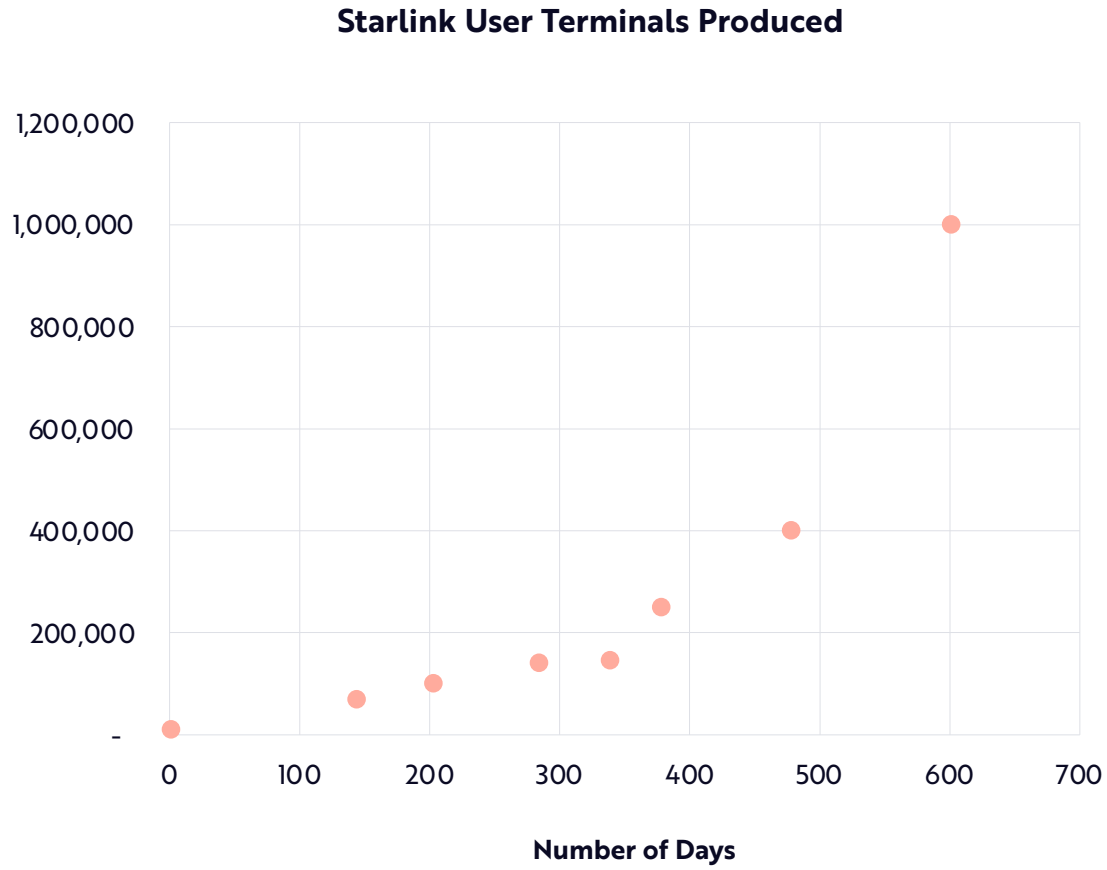


*Latency is measured in milliseconds (ms). Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

Antenna Costs Could Drop To A Few Hundred Dollars By 2027

ARK's research suggests that, as cumulative production reaches six million units, antenna costs could drop from roughly $500 today to $300 by the end of 2027. In fewer than two years, SpaceX has produced ~1 million Starlink terminals.





*This estimated cost decline is based on limited data, including our modeled adoption curve for Starlink users. Sources: ARK Investment Management LLC, 2023. Quilty, C. et al. 2020. Forecasts are inherently limited and cannot be relied upon. 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.

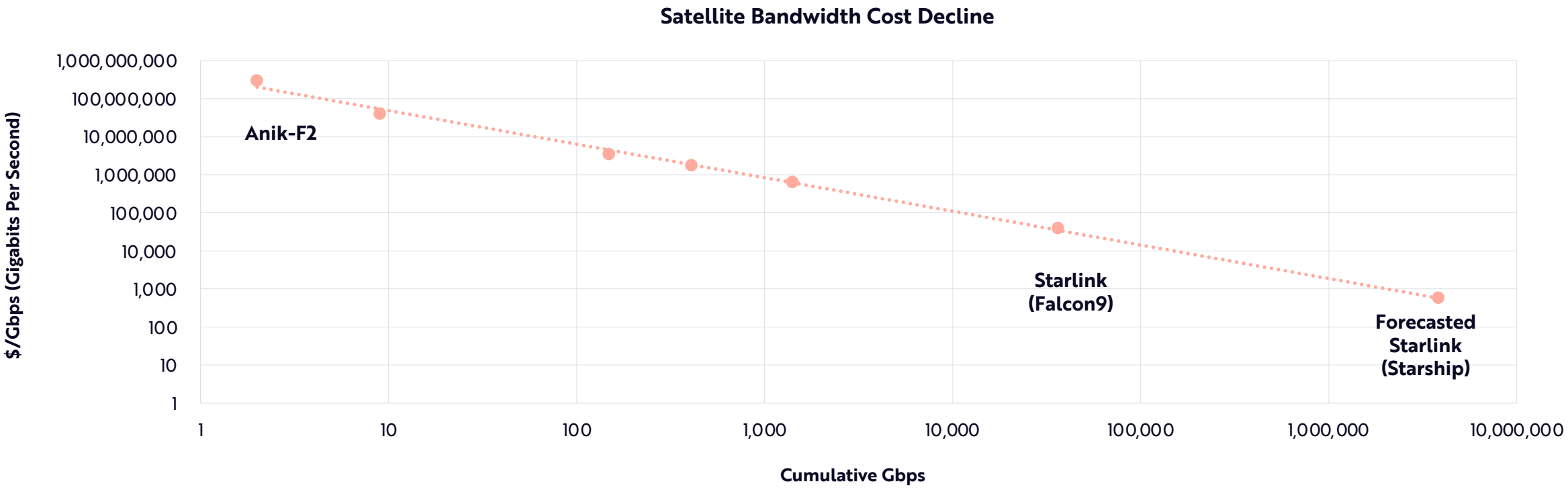
The Number Of Satellites Scheduled For Orbit Should Increase As Costs Decline

Vertically integrating rocket and satellite launches should sustain the cost decline of rocket launches.

*ARK estimates that this will occur within a ten-year timeframe, by ~2032. Sources: ARK Investment Management LLC, 2023. Lifson, M. et al. 2022; UCS 2022; Roberts, T. 2022. Forecasts are inherently limited and cannot be relied upon. 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.

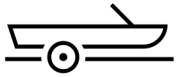
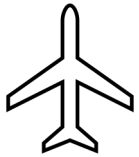
According To Wright's Law, Satellite Bandwidth Costs Should Decline Roughly 45% For Every Cumulative Doubling In Gigabits Per Second In Orbit

Since 2004, the cost of satellite bandwidth has dropped 7,500-fold, from $300,000,000 to $40,000/ Gigabits per second (Gbps). Thanks to Starship,* costs could fall another 40-fold to ~$1,000/Gbps during the next five years. According to ARK's research, 1 Gbps can serve 200 customers. At a capital cost of ~$1,000/Gbps, SpaceX could recoup its Starship investment with a one-time charge of $5 per customer.**



*Starship is SpaceX's next generation rocket and satellites. **This assumes an oversubscription ratio of 20: 20x more people are paying for the service than are actively using it at a given time. Note also that this calculation does not incorporate satellite lifespans, satellite utilization, and ground-based infrastructure costs, all of which will impact costs and pricing decisions. Sources: ARK Investment Management LLC, 2023. VanderMeulen, R. et al. 2015. Forecasts are inherently limited and cannot be relied upon. 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.

Satellite Broadband Could Generate $84 Billion In Annual Revenue Over The Next 10 Years

		Addressable Subscribers*		Annual Broadband Bill*		Annual Addressable Market*
Households Globally 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
						~$84 Billion

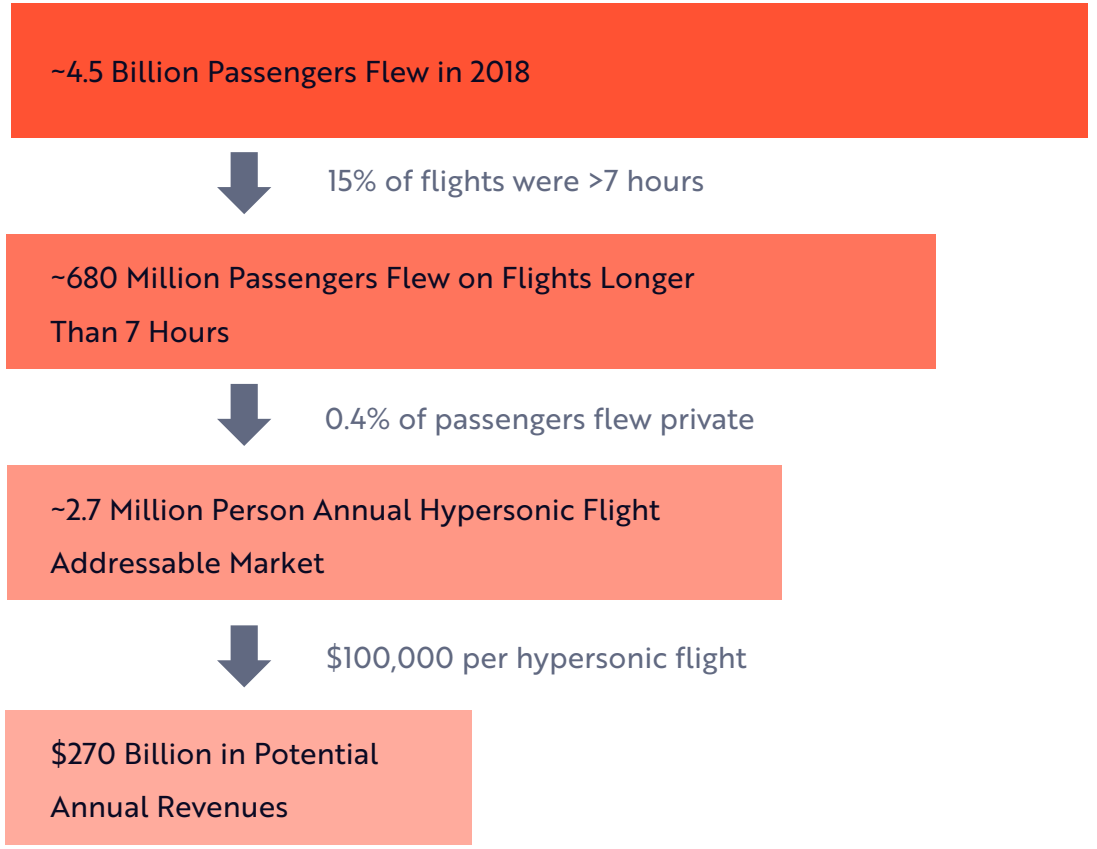
*Data presented in all columns are forecasts. Sources: ARK Investment Management LLC, 2023. VanderMeulen, R. et al. 2015. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

The Demand For Hypersonic Flight Could Skyrocket In Response To Declining Launch Costs

According to our research, passengers* on short-haul private flights should be willing to pay ~$15,000 for every two hours saved on private planes.

Based on the economics of the short-haul flight market, ARK estimates that passengers and businesses would be willing to pay $100,000 to save 13 hours on a 2–3-hour private hypersonic flight from New York City to Japan.

Potential Hypersonic Cost Declines Over Time



*This research assumes passengers and businesses with the financial resources to afford these prices today, not necessarily the average traveler. Sources: ARK Investment Management LLC, 2023. Forecasts are inherently limited and cannot be relied upon. 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.

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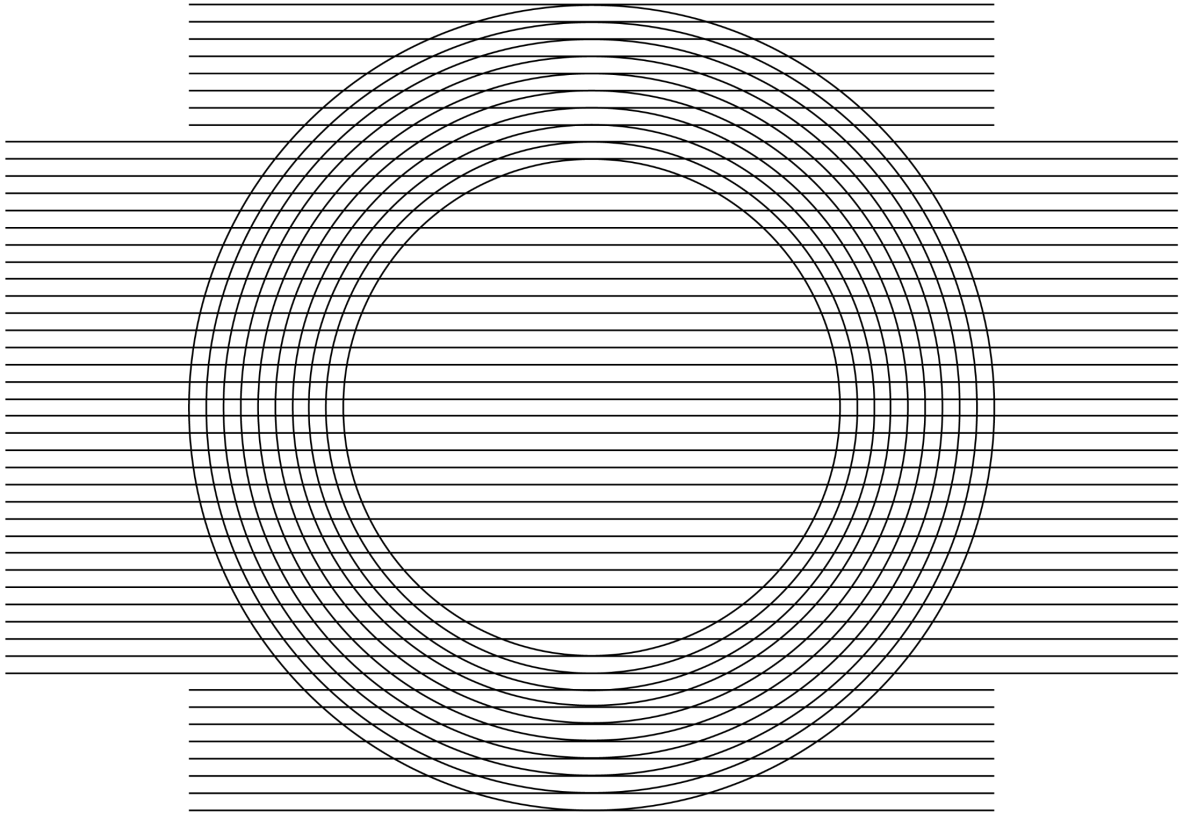

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