Furthur
Market Research

ALL DATA IS INDISPENSABLE:

The Staggering Immensity of an Active Archive

We will see a paradigm shift from a “cold” to an “active” archive.

Even with widespread implementation of transformative new storage technologies, we cannot possibly sustain historic ~25%/year growth rates from 2030-2050

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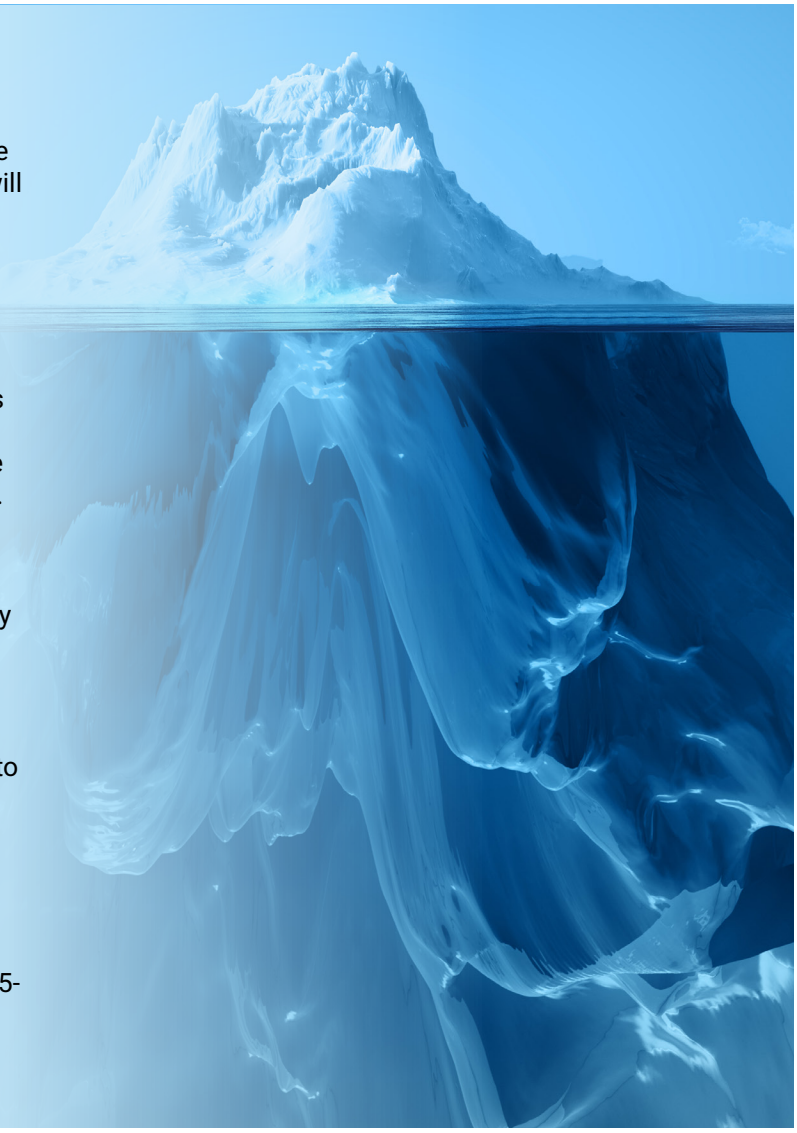
In this report we will estimate the changing 2025-2050 revenue opportunities in enterprise storage markets by predicting the approximate number of exabytes (EB) delivered and determining the evolving estimated user initial integrated average acquisition cost/terabyte (TB) on solid-state-drive (SSD), hard-disk-drive (HDD), tape, and emerging technology media.

Preliminary Expectoration: A Dataverse of Stunning Dimensions

The escalating enormity of our digital dataverse is literally unimaginable but we can with a degree of rigorous certainty determine its current size.

The "facts" that we can uncover about our expanding dataverse on which to base our current forecasts remain largely unchanged as we enter the era of GenAI (Generative Artificial Intelligence). And although we constantly refine our forecast assumptions, they, too, remain largely unchanged. Much of what we can say here by way of preamble is already a cliché—but we should always remember that cliches earn their status as cliches by being so obviously and enduringly true, and the changing contexts of these cliches can generate incisive insights.

- Data has become the new oil, unlike oil never to be burned but like oil always to be mined for its potential value. "Data is the new oil" is of course a cliché, but as we enter the AI era, this cliché will become more deeply and disturbingly true, and may determine the fates of nations.
- Data "pools" have morphed into data "lakes" which in turn have morphed into data "oceans" that now engulf our entire planet.
- The billions of people and systems and sensors connected in the global dataverse will continue to generate immense quantities of data, and we are deleting less and less of the data we create.
- In the GenAI era, all stored data will become "indispensable."
- Acute "dysposaphobia" will become increasingly pandemic.
- GenAI engenders an age of perpetual data migration.
- There will be a paradigm shift from "cold" data to an "active" archive.
- Even with the advent and implementation of transformative new enterprise storage technologies, we cannot feasibly maintain the historic ~25% growth rates we saw 2000-2021.
- Gen AI will help to drive ~25% growth rates 2025-2030 but after 2030 GenAI will increasingly be utilized to enhance storage efficiencies.

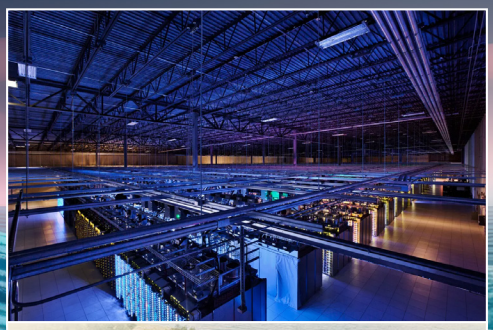


Unimaginable Immensity...

How much of these surging data oceans can our infrastructures manage?

>100ZB? >250ZB? >500ZB?

Enormous data centers fueled by local nuclear power sources may still be insufficient to meet evolving demand...



A Bit of History

We saw disastrous and unprecedented declines in enterprise data expansion in 2022 and 2023, wherein overall shipments grew by only 2.2% and 4% respectively. Enterprise SSD deliveries declined 30.5% in 2023, causing a 43.3% decline in vendor average selling prices (ASPs) and a 60.6% decline in vendor revenue. HDD deliveries declined for the first time in history by 1.8% in 2022 and displayed a tepid recovery of 10.3% growth in 2023 and 4.4% growth in 2024. Enterprise tape deliveries expanded by only 8.9% in 2022 and 10.1% in 2023 after a 39.7% uptick in 2021. Meanwhile, the active installed base grew 23% to 4,916EB in 2022 and 16.9% to 5,746EB in 2023.

To put this in historical perspective: From 2000-2021—despite, among much else, the impacts of the 2008-2009 economic meltdown crisis, the Q4/2011 effects of the Thai floods (which temporarily reduced HDD production capabilities by >60%), and a cyclic downturn in 2019 SSD demand which caused vendor ASPs to drop 51% and vendor revenue to decline 37%—there were no years of <5% expansion and only one year of <10% expansion (9.8% in 2009), and we saw a >25% compound annual growth rate (CAGR) in total enterprise EB delivered.

After the 2022-2023 dramatic downturns, 2024 was a year of renewed growth, with SSD shipments up 108.7% and overall shipments up 17%. The active installed base of enterprise data grew 16.5% to 6,693EB, up 73.5x over 91EB in 2010.

Future Prospects

Partially because of the data demands of GenAI, we currently believe we will see a steady ~25% CAGR from 2025 through 2030. But from 2031 onward, due to manufacturing and cost constraints, energy compliance regulations, and sustainability requirements, GenAI will of necessity be increasingly utilized to enhance storage efficiencies.

With more-disciplined, -responsible and -sophisticated market management on the part of all storage vendors—having recently suffered once again the searing recognitions that "inventory is not an asset," that "the effects of overproduction are always ruinous" (it's like a combination of Alzheimers disease and deja-vu: we've forgotten how terrible it was all over again)—we do not anticipate any further precipitous declines of the sort we saw in 2022 and 2023, and we believe it is increasingly obvious that growth rates must decline.

After a 24.9% 2025-2030 CAGR, our current likely scenarios envision a 12.6% 2030-2035 CAGR, a 13.2% 2035-2040 CAGR, an 11.6% 2040-2045 CAGR, and a 9.8% 2045-2050 CAGR, which leads to shipments of 57,311EB and associated user spend of $147.4 billion in 2050, with an active installed base of 243,469EB.

However, if we assume a ~25% 2030-2050 CAGR, which merely mimics the actual 2000-2021 CAGR and our forecast 2025-2030 CAGR, this leads to shipments of 533,852EB and associated user spend of $1.37 trillion in 2050, with an active installed base of 1,794,599EB.

Irrespective of demand—and perhaps even with the widespread implementation of transformative new technologies—we simply cannot afford to build and maintain the technology and manufacturing infrastructures capable of sustaining that ~25% rate of historic annual growth.

Enterprise Data Shipment History and Revenue Expansion Estimates, 2020-2050

An Enduring Question: Will the Past be Prologue, or Will History Be Bunk?

Our forecasts are always devised with these precautionary adages in mind:

- The only thing we know with certainty about any forecast is that it will be wrong.—Anonymous
- He who foretells the future lies, even if he tells the truth.—Arab Proverb

Enterprise Exabytes

We define enterprise EB as the capacities delivered on all enterprise-class SSDs, HDDs, tape, and—in the near future—enterprise emerging storage media. This definition specifically excludes EB shipments of consumer-grade SSDs, HDDs, and flash modules delivered to PCs, entertainment devices, cell phones, home video surveillance, and other consumer and industrial applications (such as aircraft and telecom installations), the vast majority of which are already backed up in, and therefore reflected by, the enterprise-grade EB serviced by corporate and cloud data centers.

Note: *A byte is a unit of digital information that usually consists of eight bits and is the smallest addressable unit of memory in most computer architectures. A kilobyte (KB) is a thousand bytes of data. A megabyte (MB) is a thousand kilobytes. A gigabyte (GB) is a thousand megabytes. A terabyte (TB) is a thousand gigabytes. A petabyte (PB) is a thousand terabytes. An exabyte (EB) is a thousand petabytes. A zettabyte (ZB) is a thousand exabytes.*

Enterprise Emerging Storage Technologies

Proposed but still nascent emerging technologies include, in alphabetical order: Cerabyte's ceramic nanolayers, DNA data storage, Folio Photonics' dynamic multi-layer optical discs, Group47's DOTS (Digital Optical Technology System), HoloMem's high-capacity holographic media cartridges, Huawei's MED (Magneto-Electric Disk—combining SSD speed with the capacity of tape), Microsoft's silica, and SPhotonix's 5D memory crystals (data is written inside of quartz glass). One or more of these technologies may initially be available in strategic volume during 2026, but Microsoft's silica will likely be used internally and will not be available externally for commercial consumption, and the distribution of Huawei's MED may be limited to China. DNA storage has been generously funded by many companies but will have minimal impact prior to 2030. New breeds of tape, as yet uncreated and unspecified, outside of and distinct from the LTO and IBM TS1100 specifications and roadmaps, may be included in the "Enterprise Emerging" storage category.

Notes Relevant to All Figures and Tables

- SSD capacities reflect an approximate 5x compression ratio, but only for approximately 5% of all enterprise SSD EBs shipped, the vast majority of which (~95%) are configured in server/direct-attached storage (DAS) systems, with little or no data compression, not in fabric-attached solid-state arrays (SSAs), wherein sophisticated data compression software is the norm.
- HDD capacities are raw/uncompressed, since so few enterprise HDDs utilize any form of data compression.
- Tape capacities include both LTO and IBM TS1100 shipments and reflect global averages of at least 2.5x data compression.
- Enterprise optical shipments remain minimal at <1,000 PB per year—less than half of 1% of the 2024 total—and have not been included in our estimates of historical shipments or the current active installed base.
- However, there will be huge opportunities for what we are now referring to collectively as "Enterprise Emerging" storage technologies to play dominant roles in future markets, as indicated in our 2026-2050 growth estimates.
- The "Total Active Archive" market is the sum of all LTO+IBM TS1100+enterprise emerging technology shipments.
- For the active installed base, we assume a 5-year average infrastructure refresh/replacement cycle, retiring, for example, all 2015 shipments in 2020 while adding 2020 shipments to the installed base of the prior year, and we repeat this cycle through 2050.
  - Some users replace their SSD infrastructures every three years while others claim their SSD infrastructures last for >5 years. Some users claim their HDDs last for >7 years and their tapes last for >10 years. Emerging technologies theoretically should have >25-year cycles (perhaps even >50-year or >100-year cycles; obviously, we do not yet have any hard data for this class of product). Most users we have spoken with agree that a 5-year infrastructure refresh/replacement cycle is a good and meaningful average to use, at least for today's extant technologies.
  - We have not yet incorporated any variable refresh/replacement cycles in our active-installed-base calculations, but it is obvious that longer emerging technology refresh cycles will substantially increase the size of the installed base 2035-2050 because fewer EBs will be retired while annual shipments continue to escalate, and emerging technologies will display the greatest growth, accounting for the majority of annual shipments beginning in 2037.

Revenue Estimates

We have depicted the reported and unreported 2020-2024 SSD and HDD vendor revenue with a great degree of accuracy, but because there are so many variables involved with so many different kinds of storage systems, it is impossible to know just what kind of average markups over bare-bones SSD and HDD vendor revenue to determine cost/TB user spend are truly realistic. Major IT analyst firms forego any scrupulous analysis and simply use a 30% markup over vendor revenue as a universal average for all manner of hardware and software technologies to determine "user spend," but that indolent estimate cannot possibly reflect actual user spend.

We know the 2020 vendor ASP for SSAs was $1,536/TB (uncompressed) and for Hybrid SSD/HDD arrays was $265/TB (uncompressed). These estimates were extracted from the vendor revenue derived from the sale of external controller-based (ECB)/network fabric-attached storage systems to their direct customers. At a 30% markup for "user spend," this would equate to $1,843.20/TB for SSAs and $318/TB for Hybrid SSD/HDD arrays.

We know the DAS ASPs were much lower but much harder to determine with any degree of accuracy, since the server vendors do not separately report their substantial storage revenue.

Our 2020 estimates of a compressed $190.56/TB user-integrated SSD cost at 50% average markup over uncompressed SSD vendor revenue and of an uncompressed $24.99/TB user-integrated HDD cost at 35% average markup over uncompressed HDD revenue, are probably far too conservative a reflection of actual user spend, even considering that >60% of all the enterprise SSD and HDD EB go to the hyperscale customers at rock-bottom prices.

In any case, one can certainly argue that our SSD (50% markup) and HDD (35% markup) user spend estimates are responsibly cautious and perhaps greatly understated, and yet they still portend enormous growth in user spend.

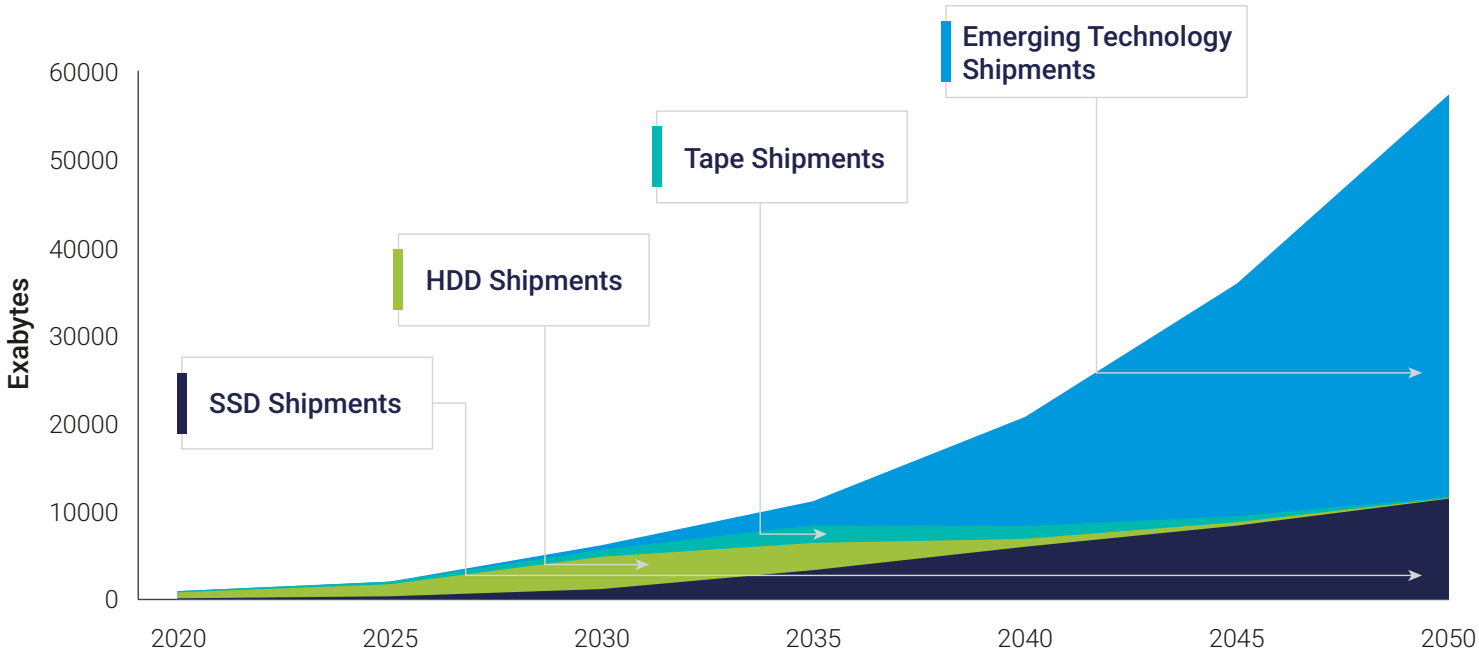
Compressed tape user spend is based on our estimates of the media, drives and libraries required to support our estimates of compressed tape EB shipments. Emerging storage revenue is entirely speculative but is based on a competitive need to be 5x-10x less than HDD acquisition costs/TB to achieve >50% market penetration.

Figures and Tables

Extracted from Table 1, Figure 1 depicts enterprise SSD, HDD, tape and emerging storage shipments in EB, 2020-2050; Figure 2 depicts enterprise SSD, HDD, tape and emerging storage revenue in $M, 2020-2050; Figure 3 depicts an alternate scenario of 25% growth estimates in EB shipped and $M revenue, compared with our current forecast, 2030-2050; and Figure 4 compares the active installed base in our current forecast with an alternate scenario of 25% growth estimates in EB shipped, 2030-2050.

Table 1 is a quick-reference summary of our 2020-2050 shipment and revenue estimates, including an alternate 25% growth scenario. Tables 2-7 in the Appendix provide additional comparison data and granular annual details of the forecasts summarized in Table 1.

Figure 1: Enterprise SSD, HDD, Tape and Emerging Technology Shipments, 2020-2050



Source: Furthur Market Research and Brad Johns Consulting (August 2025)

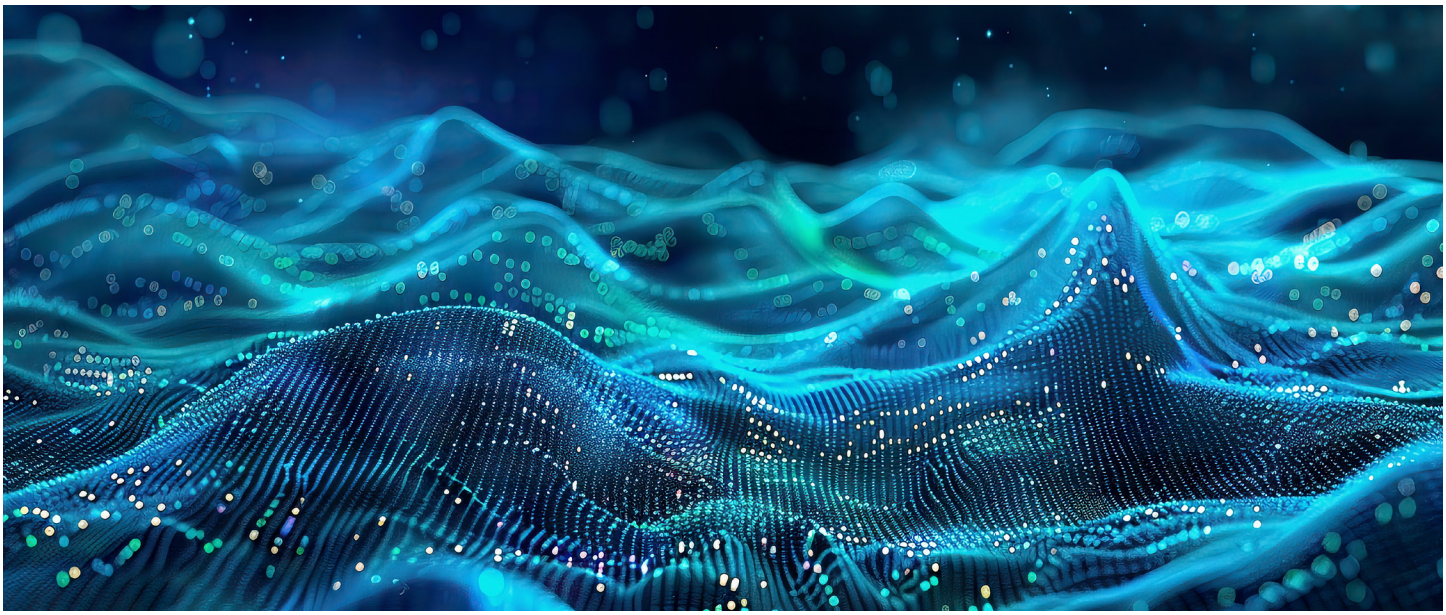
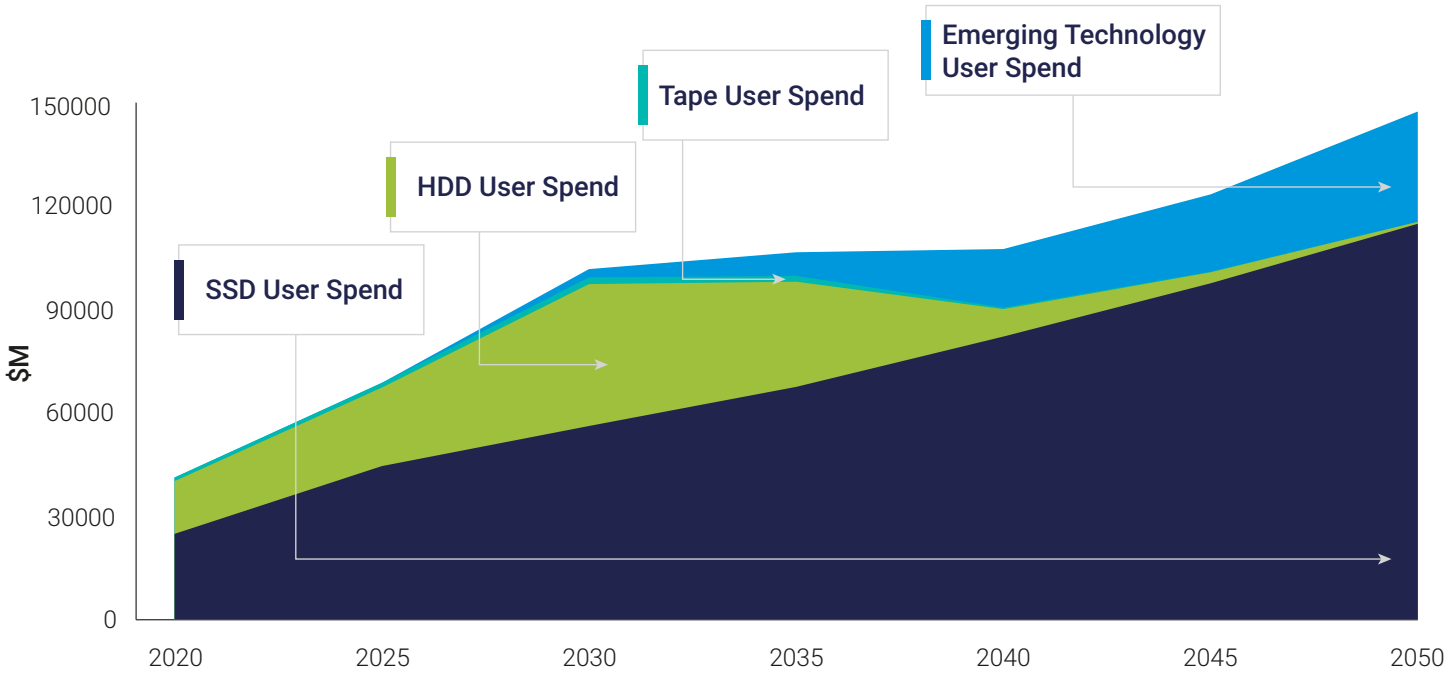
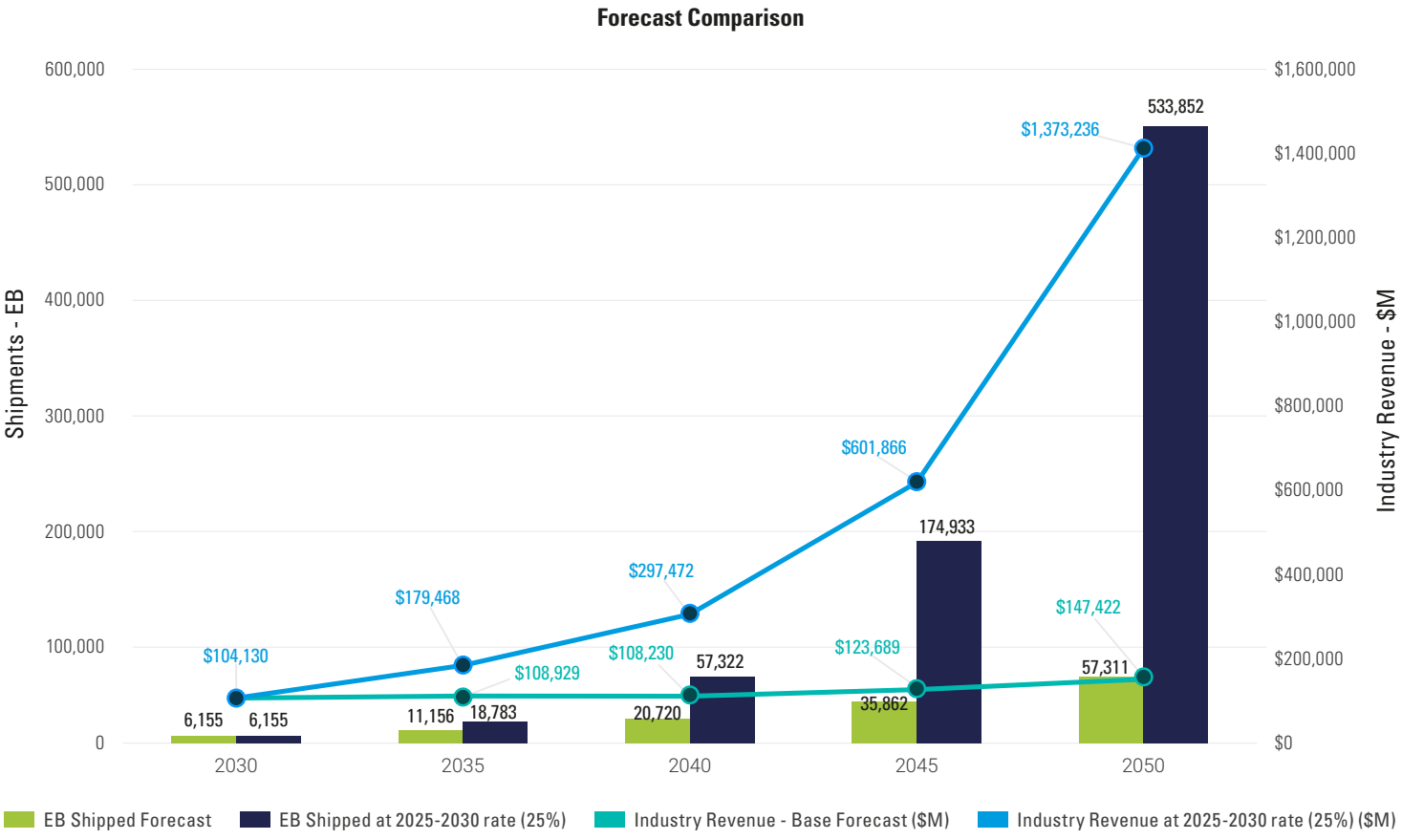


Figure 2: Enterprise SSD, HDD, Tape and Emerging Technology Revenue, 2020-2050



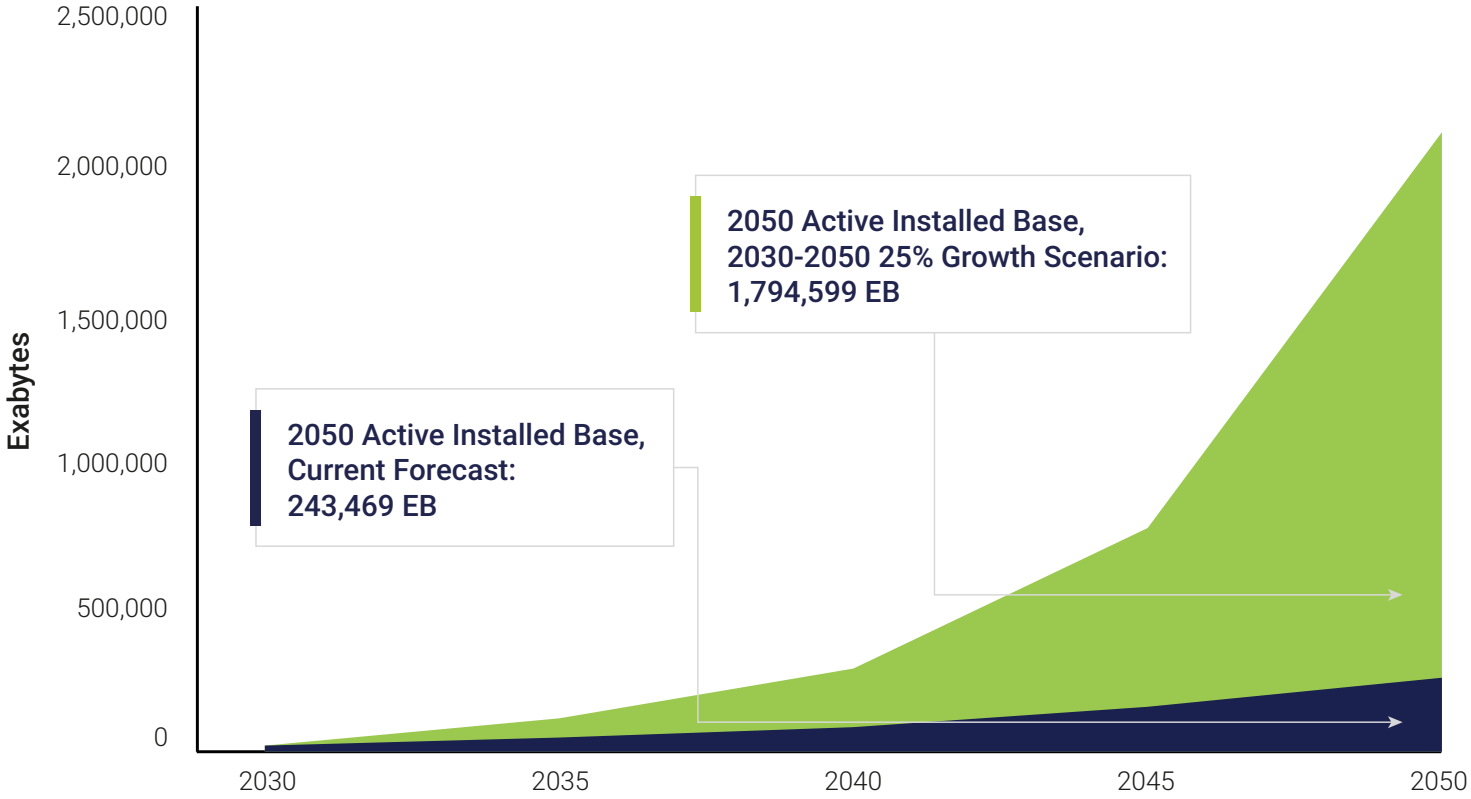
Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Figure 3: Comparative Shipment and Revenue Scenario of 25% Growth Estimates vs Current Forecast, 2030-2050



Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Figure 4: Comparative Estimates of the Active Installed Base, Current Forecast vs an Alternative 25% Growth Rate, 2030-2050



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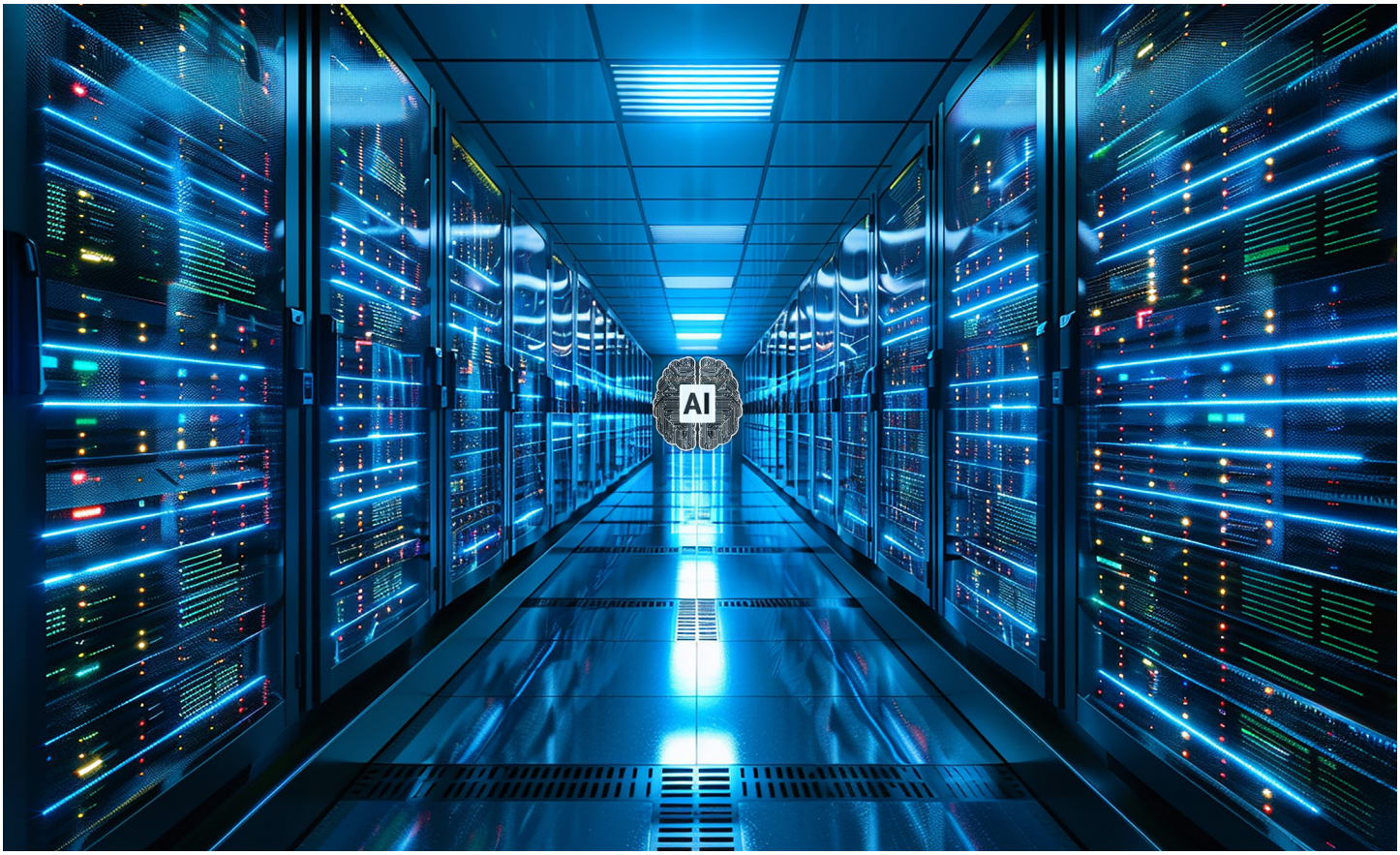


Table 1: Quick-Reference Summary, Enterprise Storage History and Forecasts, 2020-2050

	2020	2025	2030	2035	2040	2045	2050
Vendor Enterprise SSD Compressed Shipment Estimates (EB)	**131**	**359**	**1,180**	**3,331**	**5,984**	**8,386**	**11,442**
Estimated SSD User Revenue, 50% Markup Over Vendor Revenue ($M)	$24,902	$44,551	$56,193	$67,540	$82,136	$97,587	$114,849
Estimated SSD User Initial Integrated Compressed Average Acquisition Cost/TB ($)	$190.56	$124.17	$47.64	$20.28	$13.73	$11.64	$10.04
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	**680**	**1,366**	**3,665**	**3,088**	**896**	**390**	**72**
Estimated HDD User Revenue, 35% Markup Over Vendor Revenue ($M)	$15,289	$22,775	$41,165	$30,516	$7,971	$3,201	$566
Estimated HDD User Initial Integrated Uncompressed Average Acquisition Cost/ TB ($)	$24.99	$16.67	$11.23	$9.88	$8.90	$8.21	$7.86
Enterprise Tape Compressed Shipment Estimates (EB)	**136**	**299**	**821**	**1,995**	**1,453**	**690**	**108**
Estimated Tape User Revenue ($M)	$1,048	$1,360	$1,946	$1,683	$451	$159	$25
Estimated Tape User Initial Integrated Compressed Average Acquisition Cost/TB ($)	$7.71	$4.55	$2.37	$0.84	$0.31	$0.23	$0.23
Vendor Enterprise Emerging Shipment Estimates (EB)			**489**	**2,742**	**12,387**	**26,396**	**45,689**
Estimated Emerging User Revenue ($M)			$2,401	$6,855	$16,970	$22,437	$31,982
Estimated Emerging User Initial Integrated Average Acquisition Cost/TB ($)			$4.91	$2.50	$1.37	$0.85	$0.70
Total Compressed Enterprise Shipment Estimates (EB)	**947**	**2,024**	**6,155**	**11,156**	**20,720**	**35,862**	**57,311**
SSD % of Total Shipments	13.8	17.7	19.2	29.9	28.9	23.4	20.0
HDD % of Total Shipments	71.8	67.5	59.5	27.7	4.3	1.1	0.1
Tape + Emerging (Active Archive) % of Total Shipments	14.4	14.8	21.3	42.5	66.8	75.5	79.9
Total Compressed Enterprise Active Installed Base Estimates (EB)	**3,032**	**7,770**	**20,219**	**46,705**	**80,907**	**147,886**	**243,469**
Total Enterprise User Revenue Estimates ($M)	**$41,240**	**$68,686**	**$101,706**	**$106,594**	**$107,528**	**$123,384**	**$147,422**
Total Estimated User Initial Integrated Compressed Average Acquisition Cost/TB ($)	$43.57	$33.94	$16.52	$9.55	$5.19	$3.44	$2.57
SSD % of Total Spend	60.4	64.9	55.3	63.4	76.4	79.1	77.9
HDD % of Total Spend	37.1	33.2	40.5	28.6	7.4	2.6	0.4
Tape + Emerging (Active Archive) % of Total Spend	2.5	2.0	4.3	8.0	16.2	18.3	21.7
Alternate 2030-2050 Shipment Scenario at 25% Annual Expansion, Mimicing the 2025-2030 Forecast CAGR (EB)				**18,783**	**57,322**	**174,933**	**533,852**
EB Delta to Current Forecast				7,627	36,602	139,071	476,541
Alternate 2030-2050 User Revenue Scenario ($M)				**$179,468**	**$297,472**	**$601,866**	**$1,373,236**
$ Delta to Current Forecast				$72,874	$189,943	$478,482	$1,225,815
Alternate 2030-2050 Active Installed Base Scenario at 25% Annual Expansion, Mimicing the 2025-2030 Forecast CAGR (EB)				**63,142**	**192,694**	**588,054**	**1,794,599**
EB Delta to Current Forecast				16,437	111,787	440,168	1,551,130

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

II Assumptions, Analysis

Global Perspective

Revenue, Shipments

Largely because "data is the new oil" and may in fact play a crucial role in determing the fates of nations, we have forecast enterprise storage user spend to expand from $41 billion in 2020 to >$140 billion in 2050. Since 2010, customers have shown a (perhaps begrudging) willingness to allocate greater portions of their limited IT budgets to storage, and with the enhanced value of data in the GenAI era, it is reasonable to assume that more and more of the total IT budgets will be dedicated to storage, which may expand to exceed $250 billion. But a scenario that envisions a >$1.3 trillion annual storage spend is, at best, absurd.

Demand may certainly swell to levels beyond our current conservative forecast, and many analysts seem convinced that an enduring ~25% per annum growth curve in demand is inevitable, but it is hard for us to imagine an actual annual demand that greatly exceeds 6ZB in 2030, 21ZB in 2040 and 57ZB in 2050. It is also difficult for us to imagine that all the storage vendors—recently seared by the fiscal challenges of those unanticipated 2022-2023 declines in demand—will make frivolous future infrastructure investments in the face of multiple uncertainties.

Business Considerations

There are colossal differences of opinion regarding the ability and the willingness of the storage makers to invest adequately to build to a feasible—but unlikely, and possibly profitless—storage demand of staggering dimensions.

We have deepening doubts about maximum production capabilities, partially because the costs and availability of the basic building blocks of enterprise storage will undergo diverse transformations during the next 25 years.

Though storage prices to customers will continue to decline on a per-bit basis, the expense to produce the bare bits of advanced technologies on enterprise-grade media—and resale prices to customers—will decline at slower rates during the 2025-2050 than in the 2000-2024 time period, and maximum available capacities may be limited.

One thing is certain: Limited SSD and HDD production capabilities measured against actual storage and sustainability needs may drastically alter the potential market size and demand for new generations of tape and emerging storage technologies.

SSDs

Technology

There is more confusion than clarity about the timing of future NAND technology transitions and there will be many evolving tradeoffs between the number of bits per cell (3, 4, 5, 6, 7+?) and the number of media layers (200-1,000+?) and the number of Tb per die relative to costs/TB, performance, reliability and total capacity needs.

Currently, four bits per cell (QLC) and 276-layer technologies represent the highest available NAND densities, but <10% of total production is based on those technologies. Five bits per cell (PLC) will not be produced until after 2026 and may never be produced at all; the reality is that six- or seven-bits per cell will be needed, and low-cost QLC with 4Tb die may be more likely technologies to be produced in massive volume during the near term.

At the moment, the largest shippable SSD per-drive capacity is 245.76TB, based on QLC and 2Tb die technologies. Despite the apparent great demand for high-capacity SSDs in AI data centers, projected near-term shipments of >50TB, much less >100TB, SSDs remain minimal.

Most applications do not require the highest available capacity. The NAND industry can now deliver cost-effective 500GB or 1TB modules or SSDs to its largest customers in the mobile phone or PC markets, but average capacity demands remain below 250GB for phones and 500GB for PCs. In the enterprise, many customers have chosen, for example, to use four 4TB or four 8TB SSDs rather than one 16TB or one 32TB SSD because of cost, performance and reliability issues.

Revenue, Shipments

Senior NAND executives are prone to "magical thinking" and still envisage eviscerating the enterprise HDD markets before 2030 and quickly ramping revenue to >$100 billion, but we foresee a viable progression of enterprise SSD user spend from $24.9 billion in 2020 to >$110 billion in 2050, in concert with near-term growth in HDD shipments and revenue through 2032 and a gradual demise thereafter, with effective HDD end of life (EOL) by 2050.

There will be a greater emphasis on profitable resale prices by all vendors and fewer price wars as NAND industry consolidation progresses. Enterprise SSD ASPs/TB may never decline to match enterprise HDD ASPs/TB, and there will be enduring >10:1 initial integration cost differentials between enterprise SSDs and enterprise emerging technologies.

GenAI's insatiable demand for exceptionally high performance, both in model training and deployment, will be a key driver of the increase in annual uncompressed enterprise SSD shipments, which could grow from ~299EB in 2025 to ~1ZB in 2030 to ~5ZBs in 2040 and to ~10ZB in 2050; this will require greater allocations of overall NAND production to enterprise SSDs (currently at <30%) and enormous investments—which could cumulatively total >$1 trillion—in new fabs.

As with all enterprise-grade storage media, NAND technology transitions will prove to be slower and more costly 2025-2050, and it might be impossible for the NAND makers to profitably deliver more than 5ZB of enterprise-grade SSDs in 2040 and 10ZB of enterprise-grade SSDs in 2050.

Business Considerations

NAND CAPEX is forecast to remain at lower levels 2025-2029 than during the 2020-2024 time period ($107 billion vs $119 billion).

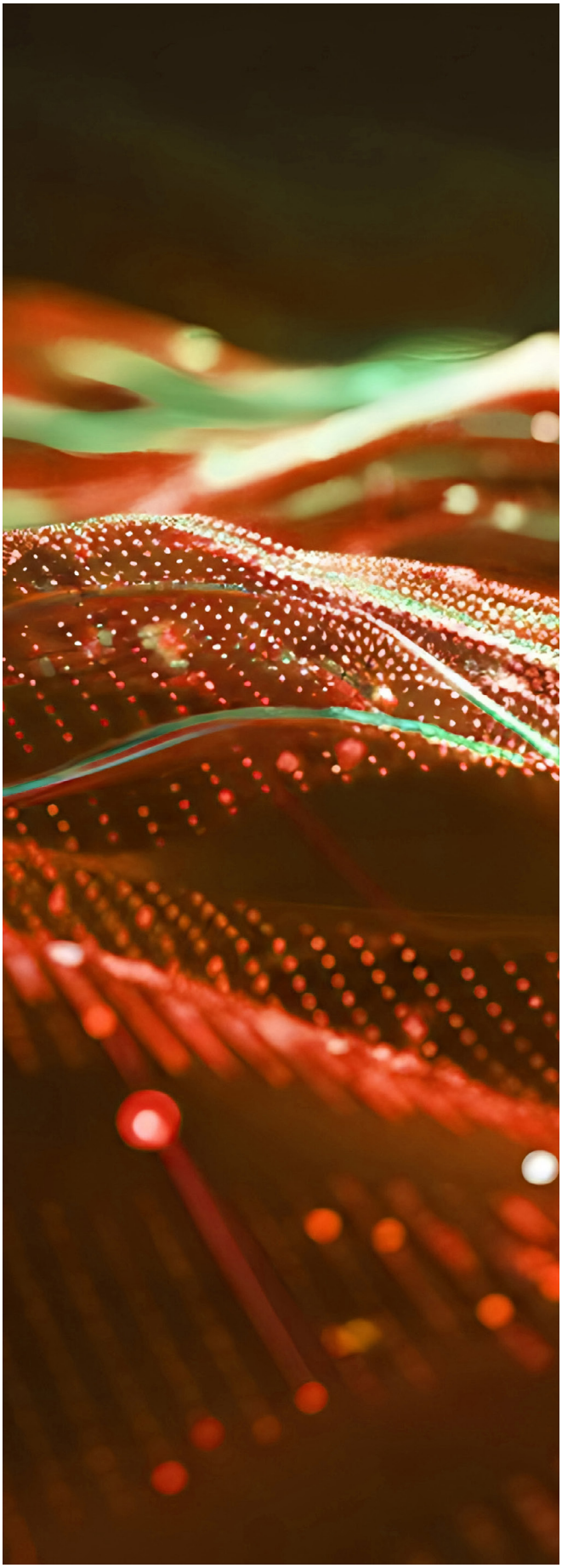
Given the recent precipitous price erosions—the price for raw NAND dropped by more than 70% during 2H22—and the inevitability of future supply/demand imbalances and the attendant price fluctuations, we have growing doubts that the NAND industry will make the necessary cumulative trillion-dollar investment required to deliver >10ZB of enterprise-grade SSD capacity per year; even attaining >5ZB per year production levels may become a fiscal obstacle impossible to surmount.

New kinds of low-cost, high-speed, non-volatile semiconductor storage will surely be needed in the coming decades, but at the moment, NAND seems to be the only viable solution. Various "emerging memory" technologies have been "in development" for many years, but none have yet emerged as scalable, cost-effective alternatives to NAND.

Though it was not intended to be a replacement of NAND but to address a potential need for high-performance, non-volatile storage between expensive DRAM and relatively inexpensive NAND, the recent fate of Intel's Optane provides a cautionary tale. Despite a multi-billion-dollar R&D investment, huge hype and aggressive marketing, Optane was a phenomenal failure, eventually resulting in an announced $559-million inventory write-down in addition to the unannounced total R&D and manufacturing expense.

The chances for profitably delivering a new semiconductor technology are dauntingly slim, and NAND now has immense inertia.

We have yet to see the "next big thing" in non-volatile semiconductor memory, and it is important to remember that once a new semiconductor technology has proved to be viable, it takes 10-20 years to reach cost-effective production and widespread integration. NAND flash technology was launched in 1987 but did not begin to achieve strategic market penetration in SSDs until 2007.



HDDs

Technology

The much-anticipated (and much-delayed) shipment of heat-assisted magnetic recording (HAMR) technology, which began in strategic volume during 1H25, will enable the expansion of current capacities from 30TB/drive (3TB per media disk) to at least 50TB/drive (5TB per media disk) by 2030 (if not before). Beyond 50TB/drive is, to our mind, questionable, but many technologists firmly believe the industry will achieve 100TB/drive (10TB per media disk).

Cost-effective, first-time-through manufacturing yields will become a Herculean challenge as areal density and capacities increase and will impact ASPs and available volumes. Because performance will decline as areal densities increase, there has been much talk of dual-actuator HDDs to improve access times in higher capacity drives, but to date there has been no production, and we seriously doubt there will be any significant future shipments of these designs, primarily because major customers historically have refused to pay any premiums for HDD "enhancements."

Revenue, Shipments

HDD user spend will expand from $19 billion in 2024 to $51.9 billion in 2032 and decline thereafter.

Because of GenAI's need for relatively quick access to large amounts of data for scrutiny and analysis, demand for the relative speed and cost-effective capacity of HDDs will remain unabated during the near term. But due to enlarging SSD and enterprise emerging technology incursions, HDD shipments will peak at ~4.8ZB in 2032 and gradually decline to effective EOL by 2050.

Despite shipment declines, HDD ZB deliveries in 2038 will still exceed the HDD ZB delivered in 2024 (~1.5ZB vs. 1.1ZB).

Enterprise SSD ZB deliveries will not exceed enterprise HDD ZB deliveries until 2036.

Business Considerations

Due to slowing areal density growth, modulating ASP declines, and more-disciplined market management, it is unlikely that the HDD makers will ever deliver much more than ~4.5ZB/year.

Tempered by a colorful history of profitless price wars caused by needless surplus production—which, until recently, have sadly recurred with a regularity that rivaled the seasons—the HDD makers have grave fiscal concerns about investing unprofitably in future CAPEX in the face of uncertain demand and growing SSD and emerging technology incursions.

Primarily due to increasing CEO/CFO insistence on consistent and predictable profitability, we believe the HDD industry will not adequately invest to be able to deliver >5ZB of enterprise-grade capacity per year.

Tape

Technology

The LTO consortium (lto.org) has published a roadmap through Generation 14. Recently, they have demonstrated a three-year announcement cycle with LTO 5 having been announced in 2010 and LTO 10 in 2025. We are basing our estimates on this historical experience. Further, we predict that the LTO consortium will deliver on its roadmap with new generations every three years, resulting in LTO 11 with a compressed capacity of 180TB being offered in 2028, LTO 12 with a 360TB compressed capacity in 2031, LTO13 with a 720TB compressed capacity in 2034, and LTO 14 with a 1,440TB compressed capacity in 2037. These massive capacities will enable tape storage to continue to be a competitive alternative for organizations with enormous amounts of inactive data through at least 2040. We are not projecting additional generations of LTO beyond 14.

The proprietary IBM TS1100 formats currently can deliver a 3x compressed capacity of 150TB per cartridge based on a 50TB native capacity per cartridge, compared with the 2.5x 75TB compressed capacity per cartridge of LTO 10 based on a 30TB native capacity per cartridge. IBM does not formally publish a TS1100 roadmap, but in December 2020, IBM and Fujifilm demonstrated in their labs a potential 3x compressed per-cartridge capacity of 1,740TB based on a 580TB native capacity per cartridge.

Revenue, Shipments

The dramatic growth in the active installed base from 7.8ZB in 2025 to over 20ZB in 2030 will require organizations to optimize costs, lower power consumption, and minimize carbon emissions. Today's tape technology is the obvious answer to address these concerns.

We forecast that tape EB shipments will increase from 299EB in 2025 to 821EB in 2030, a 22.4% CAGR, and industry revenues will grow from $1.36 billion to $1.946 billion, a 7.4% 2025-2030 CAGR, despite the introduction of competing emerging technologies and lower tape cost/TB end-user prices. Tape EB shipments are projected to peak in 2035 at 1,995EB, while industry revenue declines to $1.683 billion. From there, we estimate that shipments slowly decline to 1,453EB in 2040 and $451 million in revenue before fading to 105EB shipped and $25 million in revenue in 2050, as emerging storage technologies grow to dominate the evolving active-archive markets.

Tape revenue includes estimates for tape drives, libraries and media. Our total tape EB shipments and revenue include an estimate of the IBM TS1100 series of tape drives, libraries and media. Also, it should be noted that organizations continue to purchase older generations of drives and media even after the announcement and shipment of a new, higher-capacity generation, and our capacity and revenue estimates incorporate these time lags. The reduction in tape capacity shipments in the late 2030s is predicated on emerging technologies fulfilling their promise of faster retrieval times, lower power consumption, elimination of the need for data migration, and extended media life.

Business Considerations

The tape industry has seen significant consolidation over the past decades, going from four enterprise tape drive suppliers (HPE, IBM, Quantum and StorageTek) to only one tape drive supplier, IBM (and only one tape read/write head supplier, Western Digital). Additionally, only two media suppliers remain: Fujifilm and Sony. Four major tape library suppliers remain: HPE, IBM, Quantum and Spectra Logic.

The LTO consortium (HPE, IBM and Quantum) continues to deliver on the roadmap, which spans out to LTO Generation 14. The recent announcement and delivery of LTO 10 illustrates an ongoing commitment to bringing the roadmap to the market, and IBM continues to offer its own TS1100 series of tape drives.

While there are several promising emerging storage technologies, none of them are available in the marketplace today, and the future costs, roadmaps, and integration requirements are unknown. Until these factors are clearer, in the near term, tape storage remains the optimal solution for storing and managing the immense active archive of infrequently accessed data. We are forecasting that one or more of the emerging technologies will come to market in the next two years and will impact tape and HDD storage shipment volumes later in the decade.

Emerging

Technology

As previously mentioned, proposed but still nascent emerging technologies include, in alphabetical order: Cerabyte's ceramic nanolayers, DNA data storage, Folio Photonics' dynamic multi-layer optical discs, Group47's DOTS (Digital Optical Technology System), HoloMem's high-capacity holographic media cartridges, Huawei's MED (Magneto-Electric Disk—combining SSD speed with the capacity of tape), Microsoft's silica, and SPhotonix's 5D memory crystals (data is written inside of quartz glass).

Specifications for these technologies are fluid, and there is not yet any hard data regarding costs or delivery dates, but we believe at least one emerging technology will begin strategic shipments in 2026, and we believe at least one, more probably two or three, emerging technologies will gain enormous market share 2030-2050.

An important consideration for acceptance by the largest customers will be time-to-data. Tape's best access time is ~25 seconds (if the cartridge happens to be in the drive at the time of the data request), but more frequently will be minutes to hours or even days (if the tapes are off-site). One emerging technology supplier claims ultra-low-cost and -power combined with high-capacity and consistent access times of <30 seconds (with the aim of taking access times to <10 seconds in the next 2-3 years). Another emerging technology supplier claims a current 72TB capacity per drive with 8 GB/s data speeds.

Revenue, Shipments

User spend on emerging technologies will grow quickly, from $11 million in 2026 to >$2 billion in 2030 to $17 billion in 2040 to $32 billion in 2050. Shipments will expand from 489EB in 2030 to 12,387EB in 2040 to 45,689EB in 2050.

Business Considerations

In addition to time-to-data, power consumption will be a crucial element in purchasing decisions.

In a prior paper, we estimated that, in 2023, the 5-year active installed base kWh/TB power consumption for an SSD system was 580x and for an HDD system was 90x that of a tape-based, active-archive system. In 2035, we projected the 5-year installed base kWh/TB power consumption for an SSD system will be 1,000x and for an HDD system will be 200x that of a tape-based, active-archive system.

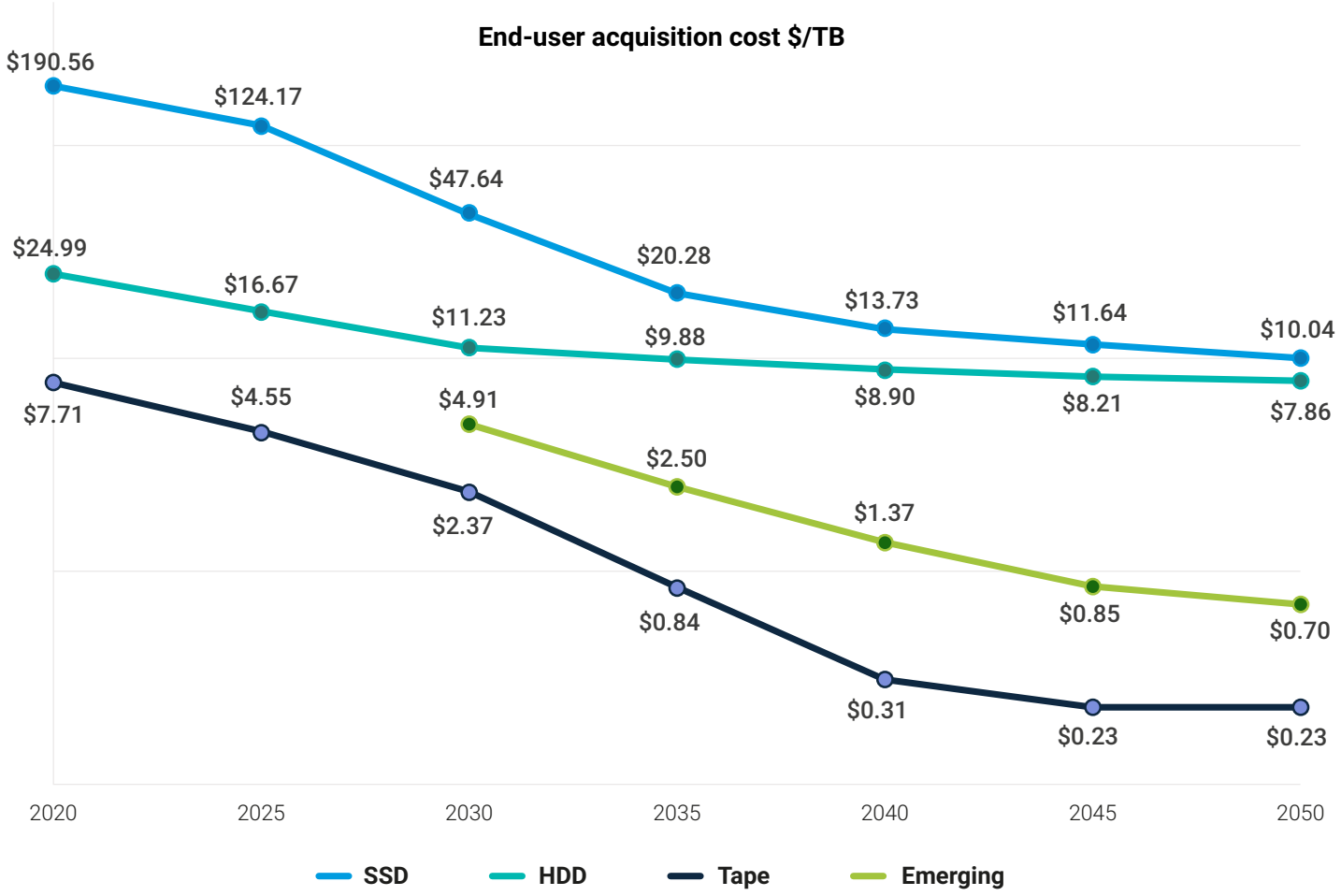
These differences in long-term power consumption are stunning, and these x-factors will likely increase substantially in favor of emerging technologies.

Emerging storage technologies will be comparatively cost-effective and more available but will not greatly accelerate the rate of decline in initial resale prices to customers. The value of these new technologies will be more clearly seen in their time-to-data metrics and long-term power and TCO benefits.

Sustainable Long-Term Data Management and Preservation Costs/TB Trends Over Time, 2020-2050

Extracted from Table 1, Figure 5 depicts five-year cost/TB trends from 2020-2050.

Figure 5: Projected Initial Acquisition Cost/TB of SSD, HDD, Tape and Emerging Technologies, 2020-2050



Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Note: Figure 5 uses a log scale.

The end-user acquisition cost/TB of storing information in an active archive is substantially less than in SSD or HDD infrastructures today and will continue to have even more-compelling cost advantages in the coming years.

In 2020, the acquisition cost/TB for an SSD system was 24.7X and for an HDD system was 3.2X the acquisition cost/TB for an active archive solution based on tape storage. In 2030, we project the acquisition cost/TB for an SSD system will be 20.1X and for an HDD system will be 4.7X the acquisition cost/TB for an active-archive system based on tape storage. However, in 2030, we are anticipating that emerging technologies will make a material impact in the market even with a higher cost/TB acquisition expense than tape because of the promise of very long media life, minimal migration requirements, and faster retrieval speeds than tape. Given the high initial expense, we estimate that SSD will be 9.7 times the cost/TB and HDD will be 2.3 times the cost/TB of emerging storage. See Table 6 in Appendix for all cost/TB ratios.

In the 2030-2040 time period, we are estimating SSD cost/TB will drop from $47.64 to $13.73, an annual cost reduction of 11.7%. It will be increasingly difficult for HDDs to achieve greater areal densities, and we are moderating our annual cost reduction to 2.3%, resulting in a cost/TB for HDD in 2040 of $8.90. The 2030-2040 gap between SSD:HDD cost/TB ratios narrow dramatically from 4.6 to 1.7. With the introduction of LTO 14 in 2037, tape cost/TB drops at an 18% 2030-2040 CAGR. Emerging technologies drop at a 12% yearly rate, falling from $4.91/TB in 2030 to $1.37/TB in 2040. Over this decade, emerging storage technologies become increasingly competitive with HDDs as the HDD:emerging cost/TB ratio increases from 2.3 to 6.5.

In the 2040-2050 time period, all the cost/TB reductions moderate, masking essential changes in the underlying technologies. For SSD, HDD, tape and emerging storage, the annual cost/TB reductions are 3.1%, 1.2%, 3% and 6.5%, respectively.

Eventually, SSDs will comprise 20% of all EB shipments and emerging storage technologies will comprise 79.7%, leaving only 0.3% of the shipments divided between HDD and tape, both of which in our current scenario reach effective EOL status by 2050 (if not before).

SSD cost/TB will decline from $190.56 in 2020 to $10.04 in 2050. Despite this huge decline, SSD user spend will expand from $24.9 billion in 2020 to $114.8 billion in 2050, representing 60.4% and 77.9%, respectively, of the total user spend. This assumes that at least 20% of shipments and the installed base will be “hot data” that will actually require the speed of semiconductor storage technologies.

Active-archive cost/TB will decline from $7.71 in 2020 to $0.70 in 2050, and user spend will grow from $1.04 billion in 2020 to $32 billion in 2050, representing 2.5% and 21.7%, respectively, of the total user spend. This assumes that at least 70% of shipments and the installed base will become an archive of infrequently accessed data, which might be classified as 100% “cold.” However, in the GenAI era, any file in the “cold” data archive might become “hot” at any time depending on unpredictable data access requests. As we move through a paradigm shift from a “cold” to a seamlessly accessible “active” archive with acceptable (consistently <30-second, preferably <10-second) data-access metrics, our assumption is that all data will be accessed eventually but may never require the 25-to-100 microsecond or 5-10 millisecond access speeds of SSDs or HDDs.

If most of the active-archive technologies can achieve consistent access times of <30 seconds, there should be a much greater shift of total EB to low-cost, active-archive infrastructures, thereby decreasing our user spend estimates. However, if the access times of most high-capacity, low-power active-archive technologies remain slow, ranging from minutes to hours to days, then the demand for SSDs could be greater and the demand for HDDs may linger much longer, increasing our user spend estimates.

IV Inconclusive Conclusions

Despite the impacts of GenAI and its expansive high-speed need to summon and scrutinize increasingly gigantic chunks of data, not all data will need to be accessed and analyzed simultaneously. As one of our interview clients remarked last year: "Even with GenAI, you don't need to plow a field with a Ferrari"—in most cases, oxen will suffice.

The costs of managing our multi-zettabyte-fold dataverse over increasingly lengthy time periods will continue to swell, and the power demands of enterprise storage—accelerated and exacerbated by GenAI server farms—will continue to increase as a percentage of the overall data center energy budget. It will become an increasing imperative for data center managers to integrate more cost-effective and power-efficient storage technologies.

In 2024, SSDs comprised 18.2%, HDDs 65.7%, and tape only 16.1% of the total enterprise EBs delivered, which means that SSDs and HDDs managed 83.9% of all the enterprise data delivered, 70% of which (1.2ZB) should have been managed as an active archive by more cost-effective and power-efficient tape technologies, but only 265EB of tape capacity were shipped in 2024.

We fear there will continue to be immense waste of energy and money expended in the ways we choose to manage the new shipments and active installed base of enterprise data. This will be tragic—"tragic" because the consequences of this waste can be so easily avoided, but only if we deploy more tape and actively engage in and help to fund the creation of new technologies that can be deployed at massive scale with minimal power consumption and deliver consistent data recovery time objectives of less than 30 seconds (preferably <10 seconds, but <30 seconds will be a good start) at costs/TB of <$1.00.

Our general conclusions may continue to be increasingly obvious—not to say blindingly blatant—but we believe they are far-reaching in their implications.

The surging tide of stuff to be stored cannot be wholly stemmed, but the rate and impacts of this tide's incursion can be moderated by judicious use of GenAI to create greater storage efficiencies.

More than 70% of enterprise data will not have any enduring need for the performance of SSDs and HDDs, but will have greatly expanding needs for low-cost Sustainability, Immutability and Security (SIS), attributes the active-archive technologies have been and will be custom-tailored to deliver.

Huge numbers of HDDs and a significant number of SSDs are managing and, during the near term, likely will continue to manage far too many of the active-archive workloads at far too great a cost/TB while consuming an inordinate share of the world's available energy.

Evolving enterprise data infrastructures must not only cost less but must also consume less power to be in crucial and resilient alignment with the total availability of energy; this will require dramatic change in the purchasing and integration practices of myriad small and large data centers scattered throughout the world.

This change can only come with a profound shift toward the installation of active-archive technologies and away from the continued integration of traditional SSD and HDD infrastructures, which currently manage more than 80% of the evolving demand.

Healthy ecosystems have become more crucial considerations in all IT purchasing decisions, and many data center managers will soon be forced—by upper-level management edict or by compliance regulations—to use active-archive storage technologies as ultra-low-cost, sustainable storage alternatives.

In the end, the CFOs will have the final say. And in the active-archive enterprise data layers, the most cost-effective and power-efficient technologies will inevitably prevail, because they make the greatest fiscal and ecological sense.

V Appendix

Appendix Table 2: Enterprise Storage SSD and HDD Vendor Revenue Estimates, 2020-2050

	2020	2021	2022	2023	2024	2025	CAGR 2020-2025	2026	2027	2028	2029	2030	CAGR 2025-2030
SSD													
Vendor Enterprise SSD Uncompressed Shipment Estimates (EB)	109	149	173	120	251	299	22.4	395	501	575	752	983	26.9
YoY Change %	*64.0*	*36.9*	*16.0*	*(30.5)*	*108.7*	*19.2*		*32.1*	*26.8*	*14.8*	*30.8*	*30.7*	
Vendor Enterprise Uncompressed SSD Direct Revenue Estimates ($M)	$16,601	$20,353	$20,741	$8,173	$26,891	$29,701	12.3	$34,108	$34,557	$26,909	$31,671	$37,462	4.8
YoY Change %	*76.2*	*22.6*	*1.9*	*(60.6)*	*229.0*	*10.4*		*14.8*	*1.3*	*(22.1)*	*17.7*	*18.3*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	680	959	942	1,039	1,085	1,366	15.0	1,629	1,912	2,407	3,088	3,665	21.8
YoY Change %	*38.9*	*41.0*	*(1.8)*	*10.3*	*4.4*	*26.0*		*19.2*	*17.4*	*25.9*	*28.3*	*18.7*	
Vendor Enterprise Uncompressed HDD Direct Revenue Estimates ($M)	$11,326	$13,035	$12,887	$13,755	$14,077	$16,870		$18,925	$20,803	$24,022	$27,638	$30,493	
YoY Change %	*(15.6)*	*(26.6)*	*0.6*	*(3.2)*	*(2.0)*	*(4.9)*		*(5.9)*	*(6.4)*	*(8.3)*	*(10.3)*	*(7.0)*	

	2030	2031	2032	2033	2034	2035	CAGR 2030-2035	2036	2037	2038	2039	2040	CAGR 2035-2040
SSD													
Vendor Enterprise SSD Uncompressed Shipment Estimates (EB)	983	1,233	1,509	1,784	2,372	2,776	23.1	3,310	3,691	3,894	4,399	4,987	12.4
YoY Change %	*30.7*	*25.4*	*22.4*	*18.2*	*33.0*	*17.0*		*19.2*	*11.5*	*5.5*	*13.0*	*13.4*	
Vendor Enterprise Uncompressed SSD Direct Revenue Estimates ($M)	$37,462	$40,923	$44,712	$36,661	$42,672	$45,027	3.7	$49,451	$52,486	$44,197	$48,785	$54,757	4.0
YoY Change %	*18.3*	*9.2*	*9.3*	*(18.0)*	*16.4*	*5.5*		*9.8*	*6.1*	*(15.8)*	*10.4*	*12.2*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	3,665	4,318	4,833	4,277	3,560	3,088	(3.4)	2,555	1,980	1,545	1,119	896	(21.9)
YoY Change %	*18.7*	*17.8*	*11.9*	*(11.5)*	*(16.8)*	*(13.3)*		*(17.3)*	*(22.5)*	*(22.0)*	*(27.6)*	*(19.9)*	
Vendor Enterprise Uncompressed HDD Direct Revenue Estimates ($M)	$30,493	$35,105	$38,422	$33,104	$26,736	$22,604		$18,268	$13,880	$10,630	$7,576	$5,905	
YoY Change %	*10.3*	*15.1*	*9.4*	*(13.8)*	*(19.2)*	*(15.5)*		*(19.2)*	*(24.0)*	*(23.4)*	*(28.7)*	*(22.1)*	

	2040	2041	2042	2043	2044	2045	CAGR 2040-2045	2046	2047	2048	2049	2050	CAGR 2045-2050
SSD													
Vendor Enterprise SSD Uncompressed Shipment Estimates (EB)	4,987	5,659	6,092	5,689	6,381	6,988	7.0	7,644	7,989	7,865	8,873	9,535	6.4
YoY Change %	*13.4*	*13.5*	*7.7*	*(6.6)*	*12.2*	*9.5*		*9.4*	*4.5*	*(1.6)*	*12.8*	*7.5*	
Vendor Enterprise Uncompressed SSD Direct Revenue Estimates ($M)	$54,757	$60,099	$64,271	$55,126	$63,044	$65,058	3.5	$67,267	$69,424	$66,853	$72,315	$76,566	3.3
YoY Change %	*12.2*	*9.8*	*6.9*	*(14.2)*	*14.4*	*3.2*		*3.4*	*3.2*	*(3.7)*	*8.2*	*5.9*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	896	788	721	535	454	390	(15.3)	350	276	215	150	72	(28.7)
YoY Change %	*(19.9)*	*(12.1)*	*(8.5)*	*(25.8)*	*(15.1)*	*(14.1)*		*(10.3)*	*(21.1)*	*(22.1)*	*(30.2)*	*(52.0)*	
Vendor Enterprise Uncompressed HDD Direct Revenue Estimates ($M)	$5,905	$5,059	$4,578	$3,365	$2,801	$2,371		$2,111	$1,653	$1,275	$881	$419	
YoY Change %	*(22.1)*	*(14.3)*	*(9.5)*	*(26.5)*	*(16.8)*	*(15.3)*		*(11.0)*	*(21.7)*	*(22.9)*	*(30.9)*	*(52.4)*	

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Appendix Table 3: Enterprise Storage User Spend and Acquisiton Cost/TB Estimates, 2020-2030

	2020	2021	2022	2023	2024	2025	CAGR 2020-2025	2026	2027	2028	2029	2030	CAGR 2025-2030
SSD													
Vendor Enterprise SSD Compressed Shipment Estimates (EB)	131	179	207	144	301	359	22.4	474	601	690	902	1,180	26.9
YoY Change %	*64.0*	*36.9*	*16.0*	*(30.5)*	*108.7*	*19.2*		*32.1*	*26.8*	*14.8*	*30.8*	*30.7*	
Estimated SSD User Revenue, 50% Markup Over Vendor Revenue ($M)	$24,902	$30,529	$31,112	$12,260	$40,337	$44,551	12.3	$51,161	$51,835	$40,364	$47,507	$56,193	4.8
YoY Change %	*76.2*	*22.6*	*1.9*	*(60.6)*	*229.0*	*10.4*		*14.8*	*1.3*	*(22.1)*	*17.7*	*18.3*	
Estimated SSD User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$190.56	$170.63	$149.95	$85.00	$134.03	$124.17	(8.2)	$107.94	$86.22	$58.50	$52.65	$47.64	(17.4)
YoY Change %	*7.4*	*(10.5)*	*(12.1)*	*(43.3)*	*57.7*	*(7.4)*		*(13.1)*	*(20.1)*	*(32.2)*	*(10.0)*	*(9.5)*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	680	959	942	1,039	1,085	1,366	15.0	1,629	1,912	2,407	3,088	3,665	21.8
YoY Change %	*38.9*	*41.0*	*(1.8)*	*10.3*	*4.4*	*26.0*		*19.2*	*17.4*	*25.9*	*28.3*	*18.7*	
Estimated HDD User Revenue, 35% Markup Over Vendor Revenue ($M)	$15,289	$17,597	$17,397	$18,569	$19,004	$22,775	8.3	$25,549	$28,083	$32,430	$37,311	$41,165	12.6
YoY Change %	*5.5*	*15.1*	*(1.1)*	*6.7*	*2.3*	*19.8*		*12.2*	*9.9*	*15.5*	*15.1*	*10.3*	
Estimated HDD User Initial Integrated Uncompressed Average Acquisition Cost/ EB ($)	$24.99	$18.35	$18.47	$17.87	$17.52	$16.67	(7.8)	$15.69	$14.69	$13.47	$12.08	$11.23	(7.6)
YoY Change %	*(15.6)*	*(26.6)*	*0.6*	*(3.2)*	*(2.0)*	*(4.9)*		*(5.9)*	*(6.4)*	*(8.3)*	*(10.3)*	*(7.0)*	
TAPE													
Enterprise Tape Compressed Shipment Estimates (EB)	136	190	207	228	265	299	17.1	350	435	501	639	821	22.4
YoY Change %	*1.5*	*39.7*	*8.9*	*10.1*	*16.2*	*12.8*		*17.1*	*24.3*	*15.2*	*27.5*	*28.5*	
Enterprise Tape User Revenue Estimates ($M)	$1,048	$1,172	$1,068	$1,132	$1,296	$1,360	5.3	$1,442	$1,650	$1,665	$1,672	$1,946	7.4
YoY Change %	*(1.7)*	*11.8*	*(8.8)*	*6.0*	*14.4*	*4.9*		*6.0*	*14.5*	*0.9*	*0.5*	*16.4*	
Estimated Tape User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$7.71	$6.17	$5.16	$4.97	$4.89	$4.55	(10.0)	$4.12	$3.79	$3.32	$2.62	$2.37	(12.2)
YoY Change %	*(3.1)*	*(20.0)*	*(16.3)*	*(3.8)*	*(1.5)*	*(7.0)*		*(9.4)*	*(7.9)*	*(12.4)*	*(21.2)*	*(9.5)*	
EMERGING													
Vendor Enterprise Emerging Shipment Estimates (EB)								1	17	121	296	489	>1000
YoY Change %								-	*1,600.0*	*611.8*	*144.6*	*65.2*	
Vendor Enterprise Emerging Revenue Estimates ($M)								$11	$134	$788	$1,669	$2,401	>1000
YoY Change %								-	*1,092.3*	*487.3*	*111.9*	*43.8*	
Estimated Enterprise Emerging User Initial Integrated Average Acquisition Cost/TB ($)								$11.25	$7.89	$6.51	$5.64	$4.91	(18.7)
YoY Change %								-	*(29.9)*	*(17.5)*	*(13.4)*	*(12.9)*	
TOTAL ACTIVE ARCHIVE													
Active-Archive Storage, Vendor Tape+Emerging Shipment Estimates (EB)	136	190	207	228	265	299	17.1	351	452	622	935	1,310	34.4
YoY Change %	*1.5*	*39.7*	*8.9*	*10.1*	*16.2*	*12.8*		*17.4*	*28.8*	*37.6*	*50.3*	*40.1*	
Active-Archive Storage, Tape+Emerging Revenue Opportunity ($M)	$1,048	$1,172	$1,068	$1,132	$1,296	$1,360	5.3	$1,453	$1,784	$2,452	$3,342	$4,347	26.2
YoY Change %	*(1.7)*	*11.8*	*(8.8)*	*6.0*	*14.4*	*4.9*		*6.8*	*22.8*	*37.4*	*36.3*	*30.1*	
Total Compressed Enterprise EB Shipped	**947**	**1,328**	**1,356**	**1,411**	**1,650**	**2,024**	**16.4**	**2,454**	**2,965**	**3,719**	**4,925**	**6,155**	**24.9**
YoY Change %	*34.6*	*40.3*	*2.2*	*4.0*	*17.0*	*22.6*		*21.2*	*20.8*	*25.4*	*32.4*	*25.0*	
Compressed SSD % of Total EB Shipped	13.8	13.5	15.3	10.2	18.2	17.7		19.3	20.3	18.6	18.3	19.2	
Uncompressed HDD % of Total EB Shipped	71.8	72.2	69.4	73.6	65.7	67.5		66.4	64.5	64.7	62.7	59.5	
Compressed Active Archive % of Total EB Shipped	14.4	14.3	15.3	16.2	16.1	14.8		14.3	15.2	16.7	19.0	21.3	
Total Compressed Active Installed Base of Enterprise EB	**3,032**	**3,997**	**4,916**	**5,746**	**6,693**	**7,770**	**20.7**	**8,896**	**10,505**	**12,813**	**16,088**	**20,219**	**21.1**
YoY Change %	*-*	*31.8*	*23.0*	*16.9*	*16.5*	*16.1*		*14.5*	*18.1*	*22.0*	*25.6*	*25.7*	
Total End-User Enterprise Storage Spend	**$41,240**	**$49,299**	**$49,577**	**$31,962**	**$60,636**	**$68,686**	**10.7**	**$78,164**	**$81,703**	**$75,245**	**$88,160**	**$101,706**	**8.2**
YoY Change %	*38.9*	*19.5*	*0.6*	*(35.5)*	*89.7*	*13.3*		*13.8*	*4.5*	*(7.9)*	*17.2*	*15.4*	
SSD % of Total Spend	60.4	61.9	62.8	38.4	66.5	64.9		65.5	63.4	53.6	53.9	55.3	
HDD % of Total Spend	37.1	35.7	35.1	58.1	31.3	33.2		32.7	34.4	43.1	42.3	40.5	
Active Archive % of Total Spend	2.5	2.4	2.2	3.5	2.1	2.0		1.9	2.2	3.3	3.8	4.3	

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Appendix Table 4: Enterprise Storage User Spend and Acquisiton Cost/TB Estimates, 2030-2040

	2030	2031	2032	2033	2034	2035	CAGR 2030-2035	2036	2037	2038	2039	2040	CAGR 2035-2040
SSD													
Vendor Enterprise SSD Compressed Shipment Estimates (EB)	1,180	1,480	1,811	2,141	2,846	3,331	23.1	3,972	4,429	4,673	5,279	5,984	12.4
YoY Change %	*30.7*	*25.4*	*22.4*	*18.2*	*33.0*	*17.0*		*19.2*	*11.5*	*5.5*	*13.0*	*13.4*	
Estimated SSD User Revenue, 50% Markup Over Vendor Revenue ($M)	$56,193	$61,385	$67,068	$54,992	$64,008	$67,540	3.7	$74,177	$78,729	$66,295	$73,177	$82,136	4.0
YoY Change %	*18.3*	*9.2*	*9.3*	*(18.0)*	*16.4*	*5.5*		*9.8*	*6.1*	*(15.8)*	*10.4*	*12.2*	
Estimated SSD User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$47.64	$41.49	$37.04	$25.69	$22.49	$20.28	(15.7)	$18.68	$17.78	$14.19	$13.86	$13.73	(7.5)
YoY Change %	*(9.5)*	*(12.9)*	*(10.7)*	*(30.6)*	*(12.5)*	*(9.8)*		*(7.9)*	*(4.8)*	*(20.2)*	*(2.3)*	*(1.0)*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	3,665	4,318	4,833	4,277	3,560	3,088	(3.4)	2,555	1,980	1,545	1,119	896	(21.9)
YoY Change %	*18.7*	*17.8*	*11.9*	*(11.5)*	*(16.8)*	*(13.3)*		*(17.3)*	*(22.5)*	*(22.0)*	*(27.6)*	*(19.9)*	
Estimated HDD User Revenue, 35% Markup Over Vendor Revenue ($M)	$41,165	$47,392	$51,870	$44,690	$36,093	$30,516	(5.8)	$24,662	$18,738	$14,350	$10,227	$7,971	(23.5)
YoY Change %	*10.3*	*15.1*	*9.4*	*(13.8)*	*(19.2)*	*(15.5)*		*(19.2)*	*(24.0)*	*(23.4)*	*(28.7)*	*(22.1)*	
Estimated HDD User Initial Integrated Uncompressed Average Acquisition Cost/ EB ($)	$11.23	$10.98	$10.73	$10.45	$10.14	$9.88	(2.5)	$9.65	$9.46	$9.29	$9.14	$8.90	(2.1)
YoY Change %	*(7.0)*	*(2.3)*	*(2.2)*	*(2.6)*	*(3.0)*	*(2.5)*		*(2.3)*	*(2.0)*	*(1.9)*	*(1.6)*	*(2.7)*	
TAPE													
Enterprise Tape Compressed Shipment Estimates (EB)	821	1,030	1,267	1,525	1,807	1,995	19.4	1,939	1,890	1,599	1,510	1,453	(6.1)
YoY Change %	*28.5*	*25.4*	*23.0*	*20.4*	*18.5*	*10.4*		*(2.8)*	*(2.5)*	*(15.4)*	*(5.6)*	*(3.8)*	
Enterprise Tape User Revenue Estimates ($M)	$1,946	$2,001	$2,018	$2,037	$1,918	$1,683	(2.9)	$1,315	$1,053	$708	$561	$451	(23.2)
YoY Change %	*16.4*	*2.8*	*0.8*	*0.9*	*(5.8)*	*(12.3)*		*(21.9)*	*(20.0)*	*(32.7)*	*(20.8)*	*(19.6)*	
Estimated Tape User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$2.37	$1.94	$1.59	$1.34	$1.06	$0.84	(18.7)	$0.68	$0.56	$0.44	$0.37	$0.31	(18.1)
YoY Change %	*(9.5)*	*(18.0)*	*(18.0)*	*(16.1)*	*(20.5)*	*(20.5)*		*(19.6)*	*(17.9)*	*(20.5)*	*(16.2)*	*(16.4)*	
EMERGING													
Vendor Enterprise Emerging Shipment Estimates (EB)	489	654	851	1,293	1,856	2,742	41.2	3,942	5,806	8,081	9,867	12,387	35.2
YoY Change %	*65.2*	*33.7*	*30.1*	*51.9*	*43.5*	*47.7*		*43.8*	*47.3*	*39.2*	*22.1*	*25.5*	
Vendor Enterprise Emerging Revenue Estimates ($M)	$2,401	$2,780	$3,191	$4,267	$5,197	$6,855	23.3	$8,672	$11,322	$13,980	$15,294	$16,970	19.9
YoY Change %	*43.8*	*15.8*	*14.8*	*33.7*	*21.8*	*31.9*		*26.5*	*30.5*	*23.5*	*9.4*	*11.0*	
Estimated Enterprise Emerging User Initial Integrated Average Acquisition Cost/TB ($)	$4.91	$4.25	$3.75	$3.30	$2.80	$2.50	(12.6)	$2.20	$1.95	$1.73	$1.55	$1.37	(11.3)
YoY Change %	*(12.9)*	*(13.4)*	*(11.8)*	*(12.0)*	*(15.2)*	*(10.7)*		*(12.0)*	*(11.4)*	*(11.3)*	*(10.4)*	*(11.6)*	
TOTAL ACTIVE ARCHIVE													
Active-Archive Storage, Vendor Tape+Emerging Shipment Estimates (EB)	1,310	1,684	2,118	2,818	3,663	4,737	29.3	5,881	7,696	9,680	11,377	13,840	23.9
YoY Change %	*40.1*	*28.5*	*25.8*	*33.1*	*30.0*	*29.3*		*24.2*	*30.9*	*25.8*	*17.5*	*21.6*	
Active-Archive Storage, Tape+Emerging Revenue Opportunity ($M)	$4,347	$4,781	$5,209	$6,304	$7,115	$8,538	14.5	$9,987	$12,374	$14,688	$15,854	$17,421	15.3
YoY Change %	*30.1*	*10.0*	*9.0*	*21.0*	*12.9*	*20.0*		*17.0*	*23.9*	*18.7*	*7.9*	*9.9*	
Total Compressed Enterprise EB Shipped	**6,155**	**7,482**	**8,762**	**9,236**	**10,069**	**11,156**	**12.6**	**12,408**	**14,105**	**15,898**	**17,775**	**20,720**	**13.2**
YoY Change %	*25.0*	*21.6*	*17.1*	*5.4*	*9.0*	*10.8*		*11.2*	*13.7*	*12.7*	*11.8*	*16.6*	
Compressed SSD % of Total EB Shipped	19.2	19.8	20.7	23.2	28.3	29.9		32.0	31.4	29.4	29.7	28.9	
Uncompressed HDD % of Total EB Shipped	59.5	57.7	55.2	46.3	35.4	27.7		20.6	14.0	9.7	6.3	4.3	
Compressed Active Archive % of Total EB Shipped	21.3	22.5	24.2	30.5	36.4	42.5		47.4	54.6	60.9	64.0	66.8	
Total Compressed Active Installed Base of Enterprise EB	**20,219**	**25,247**	**31,043**	**36,560**	**41,704**	**46,705**	**18.2**	**51,632**	**56,975**	**63,637**	**71,342**	**80,907**	**11.6**
YoY Change %	*25.7*	*24.9*	*23.0*	*17.8*	*14.1*	*12.0*		*10.5*	*10.3*	*11.7*	*12.1*	*13.4*	
Total End-User Enterprise Storage Spend	**$101,706**	**$113,558**	**$124,147**	**$105,986**	**$107,217**	**$106,594**	**0.9**	**$108,827**	**$109,841**	**$95,334**	**$99,259**	**$107,528**	**0.2**
YoY Change %	*15.4*	*11.7*	*9.3*	*(14.6)*	*1.2*	*(0.6)*		*2.1*	*0.9*	*(13.2)*	*4.1*	*8.3*	
SSD % of Total Spend	55.3	54.1	54.0	51.9	59.7	63.4		68.2	71.7	69.5	73.7	76.4	
HDD % of Total Spend	40.5	41.7	41.8	42.2	33.7	28.6		22.7	17.1	15.1	10.3	7.4	
Active Archive % of Total Spend	4.3	4.2	4.2	5.9	6.6	8.0		9.2	11.3	15.4	16.0	16.2	

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Appendix Table 5: Enterprise Storage User Spend and Acquisiton Cost/TB Estimates, 2040-2050

	2040	2041	2042	2043	2044	2045	CAGR 2040-2045	2046	2047	2048	2049	2050	CAGR 2045-2050
SSD													
Vendor Enterprise SSD Compressed Shipment Estimates (EB)	5,984	6,791	7,310	6,827	7,657	8,386	7.0	9,173	9,587	9,438	10,648	11,442	6.4
YoY Change %	*13.4*	*13.5*	*7.7*	*(6.6)*	*12.2*	*9.5*		*9.4*	*4.5*	*(1.6)*	*12.8*	*7.5*	
Estimated SSD User Revenue, 50% Markup Over Vendor Revenue ($M)	$82,136	$90,148	$96,406	$82,690	$94,566	$97,587	3.5	$100,901	$104,137	$100,279	$108,472	$114,849	3.3
YoY Change %	*12.2*	*9.8*	*6.9*	*(14.2)*	*14.4*	*3.2*		*3.4*	*3.2*	*(3.7)*	*8.2*	*5.9*	
Estimated SSD User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$13.73	$13.28	$13.19	$12.11	$12.35	$11.64	(3.2)	$11.00	$10.86	$10.63	$10.19	$10.04	(2.9)
YoY Change %	*(1.0)*	*(3.3)*	*(0.7)*	*(8.2)*	*2.0*	*(5.8)*		*(5.5)*	*(1.3)*	*(2.2)*	*(4.1)*	*(1.5)*	
HDD													
Vendor Enterprise HDD Uncompressed Shipment Estimates (EB)	896	788	721	535	454	390	(15.3)	350	276	215	150	72	(28.7)
YoY Change %	*(19.9)*	*(12.1)*	*(8.5)*	*(25.8)*	*(15.1)*	*(14.1)*		*(10.3)*	*(21.1)*	*(22.1)*	*(30.2)*	*(52.0)*	
Estimated HDD User Revenue, 35% Markup Over Vendor Revenue ($M)	$7,971	$6,830	$6,181	$4,543	$3,782	$3,201	(16.7)	$2,849	$2,232	$1,721	$1,189	$566	(29.3)
YoY Change %	*(22.1)*	*(14.3)*	*(9.5)*	*(26.5)*	*(16.8)*	*(15.3)*		*(11.0)*	*(21.7)*	*(22.9)*	*(30.9)*	*(52.4)*	
Estimated HDD User Initial Integrated Uncompressed Average Acquisition Cost/ EB ($)	$8.90	$8.67	$8.57	$8.49	$8.33	$8.21	(1.6)	$8.14	$8.09	$8.01	$7.92	$7.86	(0.9)
YoY Change %	*(2.7)*	*(2.6)*	*(1.1)*	*(0.9)*	*(1.9)*	*(1.5)*		*(0.8)*	*(0.7)*	*(1.0)*	*(1.0)*	*(0.9)*	
TAPE													
Enterprise Tape Compressed Shipment Estimates (EB)	1,453	1,299	1,085	904	782	690	(13.8)	491	345	293	199	108	(31.0)
YoY Change %	*(3.8)*	*(10.6)*	*(16.5)*	*(16.7)*	*(13.5)*	*(11.8)*		*(28.8)*	*(29.7)*	*(15.1)*	*(32.1)*	*(45.7)*	
Enterprise Tape User Revenue Estimates ($M)	$451	$396	$297	$197	$176	$159	(18.8)	$113	$79	$67	$46	$25	(31.0)
YoY Change %	*(19.6)*	*(12.2)*	*(25.0)*	*(33.7)*	*(10.7)*	*(9.7)*		*(28.9)*	*(29.7)*	*(15.1)*	*(32.1)*	*(45.7)*	
Estimated Tape User Initial Integrated Compressed Average Acquisition Cost/ TB ($)	$0.31	$0.30	$0.27	$0.22	$0.22	$0.23	(5.8)	$0.23	$0.23	$0.23	$0.23	$0.23	(0.0)
YoY Change %	*(16.4)*	*(1.8)*	*(10.2)*	*(20.4)*	*3.3*	*2.3*		*(0.0)*	*0.0*	*0.0*	*0.0*	*0.0*	
EMERGING													
Vendor Enterprise Emerging Shipment Estimates (EB)	12,387	15,155	17,863	19,988	23,865	26,396	16.3	31,544	34,782	37,286	41,381	45,689	11.6
YoY Change %	*25.5*	*22.3*	*17.9*	*11.9*	*19.4*	*10.6*		*19.5*	*10.3*	*7.2*	*11.0*	*10.4*	
Vendor Enterprise Emerging Revenue Estimates ($M)	$16,970	$18,489	$19,649	$19,788	$21,001	$22,437	5.7	$24,604	$25,739	$26,846	$29,381	$31,982	7.3
YoY Change %	*11.0*	*9.0*	*6.3*	*0.7*	*6.1*	*6.8*		*9.7*	*4.6*	*4.3*	*9.4*	*8.9*	
Estimated Enterprise Emerging User Initial Integrated Average Acquisition Cost/TB ($)	$1.37	$1.22	$1.10	$0.99	$0.88	$0.85	(9.1)	$0.78	$0.74	$0.72	$0.71	$0.70	(3.8)
YoY Change %	*(11.6)*	*(10.9)*	*(9.8)*	*(10.0)*	*(11.1)*	*(3.4)*		*(8.2)*	*(5.1)*	*(2.7)*	*(1.4)*	*(1.4)*	
TOTAL ACTIVE ARCHIVE													
Active-Archive Storage, Vendor Tape+Emerging Shipment Estimates (EB)	13,840	16,454	18,948	20,892	24,647	27,086	14.4	32,035	35,127	37,579	41,580	45,797	11.1
YoY Change %	*21.6*	*18.9*	*15.2*	*10.3*	*18.0*	*9.9*		*18.3*	*9.7*	*7.0*	*10.6*	*10.1*	
Active-Archive Storage, Tape+Emerging Revenue Opportunity ($M)	$17,421	$18,885	$19,946	$19,985	$21,177	$22,595	5.3	$24,717	$25,818	$26,913	$29,426	$32,007	7.2
YoY Change %	*9.9*	*8.4*	*5.6*	*0.2*	*6.0*	*6.7*		*9.4*	*4.5*	*4.2*	*9.3*	*8.8*	
Total Compressed Enterprise EB Shipped	**20,720**	**24,033**	**26,979**	**28,254**	**32,758**	**35,862**	**11.6**	**41,558**	**44,990**	**47,232**	**52,378**	**57,311**	**9.8**
YoY Change %	*16.6*	*16.0*	*12.3*	*4.7*	*15.9*	*9.5*		*15.9*	*8.3*	*5.0*	*10.9*	*9.4*	
Compressed SSD % of Total EB Shipped	28.9	28.3	27.1	24.2	23.4	23.4		22.1	21.3	20.0	20.3	20.0	
Uncompressed HDD % of Total EB Shipped	4.3	3.3	2.7	1.9	1.4	1.1		0.8	0.6	0.5	0.3	0.1	
Compressed Active Archive % of Total EB Shipped	66.8	68.5	70.2	73.9	75.2	75.5		77.1	78.1	79.6	79.4	79.9	
Total Compressed Active Installed Base of Enterprise EB	**80,907**	**92,531**	**105,406**	**117,762**	**132,745**	**147,886**	**12.8**	**165,411**	**183,422**	**202,400**	**222,019**	**243,469**	**10.5**
YoY Change %	*13.4*	*14.4*	*13.9*	*11.7*	*12.7*	*11.4*		*11.9*	*10.9*	*10.3*	*9.7*	*9.7*	
Total End-User Enterprise Storage Spend	**$107,528**	**$115,862**	**$122,533**	**$107,218**	**$119,525**	**$123,384**	**2.8**	**$128,467**	**$132,187**	**$128,913**	**$139,087**	**$147,422**	**3.6**
YoY Change %	*8.3*	*7.8*	*5.8*	*(12.5)*	*11.5*	*3.2*		*4.1*	*2.9*	*(2.5)*	*7.9*	*6.0*	
SSD % of Total Spend	76.4	77.8	78.7	77.1	79.1	79.1		78.5	78.8	77.8	78.0	77.9	
HDD % of Total Spend	7.4	5.9	5.0	4.2	3.2	2.6		2.2	1.7	1.3	0.9	0.4	
Active Archive % of Total Spend	16.2	16.3	16.3	18.6	17.7	18.3		19.2	19.5	20.9	21.2	21.7	

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Appendix Table 6: Enterprise Storage SSD and HDD Vendor ASP Ratios and User Acqusition Cost Ratios, 2020-2050

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Vendor ASP Ratios											
SSD:HDD Vendor ASP/TB	9.2	10.0	8.8	5.1	8.3	8.0	7.4	6.3	4.7	4.7	4.6
User Acquisition Cost Ratios											
SSD:Tape User Cost/TB	24.7	27.7	29.1	17.1	27.4	27.3	26.2	22.7	17.6	20.1	20.1
HDD:Tape User Cost/TB	3.2	3.0	3.6	3.6	3.6	3.7	3.8	3.9	4.1	4.6	4.7
SSD:Emerging User Cost/TB							9.6	10.9	9.0	9.3	9.7
HDD:Emerging User Cost/TB							1.4	1.9	2.1	2.1	2.3
Tape:Emerging User Cost/TB							0.4	0.5	0.5	0.5	0.5

	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Vendor ASP Ratios											
SSD:HDD Vendor ASP/TB	4.6	4.1	3.7	2.7	2.4	2.2	2.1	2.0	1.6	1.6	1.7
User Acquisition Cost Ratios											
SSD:Tape User Cost/TB	20.1	21.4	23.3	19.2	21.2	24.0	27.5	31.9	32.0	37.3	44.2
HDD:Tape User Cost/TB	4.7	5.6	6.7	7.8	9.6	11.7	14.2	17.0	21.0	24.6	28.7
SSD:Emerging User Cost/TB	9.7	9.8	9.9	7.8	8.0	8.1	8.5	9.1	8.2	8.9	10.0
HDD:Emerging User Cost/TB	2.3	2.6	2.9	3.2	3.6	4.0	4.4	4.9	5.4	5.9	6.5
Tape:Emerging User Cost/TB	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2

	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Vendor ASP Ratios											
SSD:HDD Vendor ASP/TB	1.7	1.7	1.7	1.5	1.6	1.5	1.5	1.5	1.4	1.4	1.4
User Acquisition Cost Ratios											
SSD:Tape User Cost/TB	44.2	43.6	48.2	55.6	54.9	50.6	47.8	47.2	46.2	44.3	43.6
HDD:Tape User Cost/TB	28.7	28.4	31.3	39.0	37.0	35.7	35.4	35.2	34.8	34.5	34.2
SSD:Emerging User Cost/TB	10.0	10.9	12.0	12.2	14.0	13.7	14.1	14.7	14.8	14.3	14.3
HDD:Emerging User Cost/TB	6.5	7.1	7.8	8.6	9.5	9.7	10.4	10.9	11.1	11.2	11.2
Tape:Emerging User Cost/TB	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

Appendix Table 7: Alternate 2031-2050 Expansion Scenarios at 25% Annual Growth

	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Alternate 2030-2040 Shipment Scenario at 25% Annual Expansion (EB)		**7,694**	**9,617**	**12,021**	**15,027**	**18,783**	**23,479**	**29,349**	**36,686**	**45,858**	**57,322**
EB Delta to Current Forecast		212	855	2,785	4,957	7,627	11,071	15,244	20,788	28,083	36,602
Alternate 2030-2040 Active Installed Base Scenario at 25% Annual Expansion (EB)		**25,459**	**32,110**	**40,413**	**50,514**	**63,142**	**78,928**	**98,660**	**123,324**	**154,155**	**192,694**
EB Delta to Current Forecast		212	1,067	3,853	8,810	16,437	27,296	41,684	59,687	82,813	111,787

	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Alternate 2040-2050 Shipment Scenario at 25% Annual Expansion (EB)	**57,322**	**71,652**	**89,566**	**111,957**	**139,946**	**174,933**	**218,666**	**273,332**	**341,666**	**427,082**	**533,852**
EB Delta to Current Forecast	36,602	47,620	62,586	83,703	107,188	139,071	177,108	228,343	294,434	374,704	476,541
Alternate 2040-2050 Active Installed Base Scenario at 25% Annual Expansion (EB)	**192,694**	**240,867**	**301,084**	**376,355**	**470,444**	**588,054**	**735,068**	**918,835**	**1,148,543**	**1,435,679**	**1,794,599**
EB Delta to Current Forecast	111,787	148,336	195,678	258,593	337,699	440,168	569,657	735,413	946,144	1,213,660	1,551,130

Source: Furthur Market Research and Brad Johns Consulting (August 2025)

This report was jointly sponsored by Cerabyte, Fujifilm and IBM and was written by **John Monroe** and **Brad Johns.**

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cerabyte

Cerabyte is a deep-tech start-up developing a new ecosystem for sustainable low-cost long-term data storage at the verified prototype system level (TRL6). Ceramic-on-Glass media using laser-matrix writing and high-speed microscope reading technology is the foundation enabling the storage of vast amounts of cold data, that is kept for decades to centuries and rarely retrieved. Leveraging semiconductor tool R&D investment, Cerabyte is uniquely positioned to deliver the sustainable, accessible, and affordable EB-scale data center rack storage solutions required for the yottabyte era.

FUJIFILM
Value from Innovation

FUJIFILM North America Corp., Data Storage Solutions delivers breakthrough data storage products based on a history of thin-film engineering and magnetic particle science such as Fujifilm's NANOCUBIC and Barium Ferrite technology. Our mission is to enable organizations to effectively manage the world's exponential data growth with innovative products and solutions, recognizing the social responsibility to protect the environment and preserve digital content for future generations.

IBM

International Business Machines Corporation is an American multinational information technology company headquartered in Armonk, New York, with operations in over 170 countries. IBM offers a full range of tape storage products including drives, autoloaders, libraries, virtual tape systems, IBM Spectrum Archive software and Hybrid solutions.

Monroe Biography

John Monroe has been involved with the storage industry for more than 40 years, beginning in 1980.

- From 1997 to 2022, Monroe was a VP Analyst at Gartner, covering the history and forecasting the future of consumer and enterprise storage markets.
- From 1990 to 1997, he was the VP of all storage lines at SYNNEX Information Technologies (now TD SYNNEX), a global distribution and manufacturing services firm, responsible for the profitable resale and OEM integration of HDDs, controllers, subsystems, and tape.
- From 1988 to 1990 he was Director of North American Sales for Kalok Corporation (a startup HDD manufacturer).
- From 1983 to 1988 he was part owner and general manager of Media Winchester, Ltd., a storage products distributor and integrator which was one of Seagate's inaugural "SuperVARs."
- He began his career in 1980 at Electrolabs, selling ICs, power supplies, cables, monitors, printers, 8-inch floppy disk drives, and 8-inch HDDs ("oddments of all things" related to computing electronics).

Unlike most industry analysts, Monroe has had balance-sheet accountability for the stuff that he studies. Monroe earned a BA degree summa cum laude, Phi Beta Kappa from Amherst College in 1976 and a master's degree in fine arts (MFA) with a merit scholarship from Columbia University in 1980.

Johns Biography

Brad Johns is President of Brad Johns Consulting LLC, an Information Technology consulting firm specializing in storage technology economics, marketing, and strategy. He has over 40 years of experience in the IT industry.

- In 2010, he established and led Brad Johns Consulting LLC, which provides consulting and marketing strategy assistance for storage technology companies.
- From 1997 until his retirement in 2010, he held various IBM storage product marketing and management leadership positions for IBM's worldwide disk, storage virtualization, tape storage, and archive product portfolio.
- From 1978 to 1997, after starting with the Data Processing Division, he held a variety of enterprise sales, sales management, industry marketing, and consulting positions. He was a founding member of IBM's Innovation Workflow consulting team and engaged with leading-edge clients in the aerospace, automotive, and information technology industries.
- Johns earned a BA in Economics from the University of Arizona in 1976 and a master's in business administration (MBA) in 1977.

As in his analyses and forecasts of "infinitely-self-similar-but-never-the-same" storage market trends over many years, Monroe's aim at Furthur Market Research is to bring actionable business perspectives tempered by Chaos Science, knowing that, within the unpredictably turbulent flow of dynamically changing systems—which "mirror a universe that is rough, not rounded, scabrous, not smooth," which reflect a fractal "geometry of the pitted, pocked and broken up, the twisted, tangled, and intertwined"*—there lies a deeply mysterious order that, in some way, at some scale, will always repeat itself.

**Chaos, Making a New Science*
—James Gleick

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