



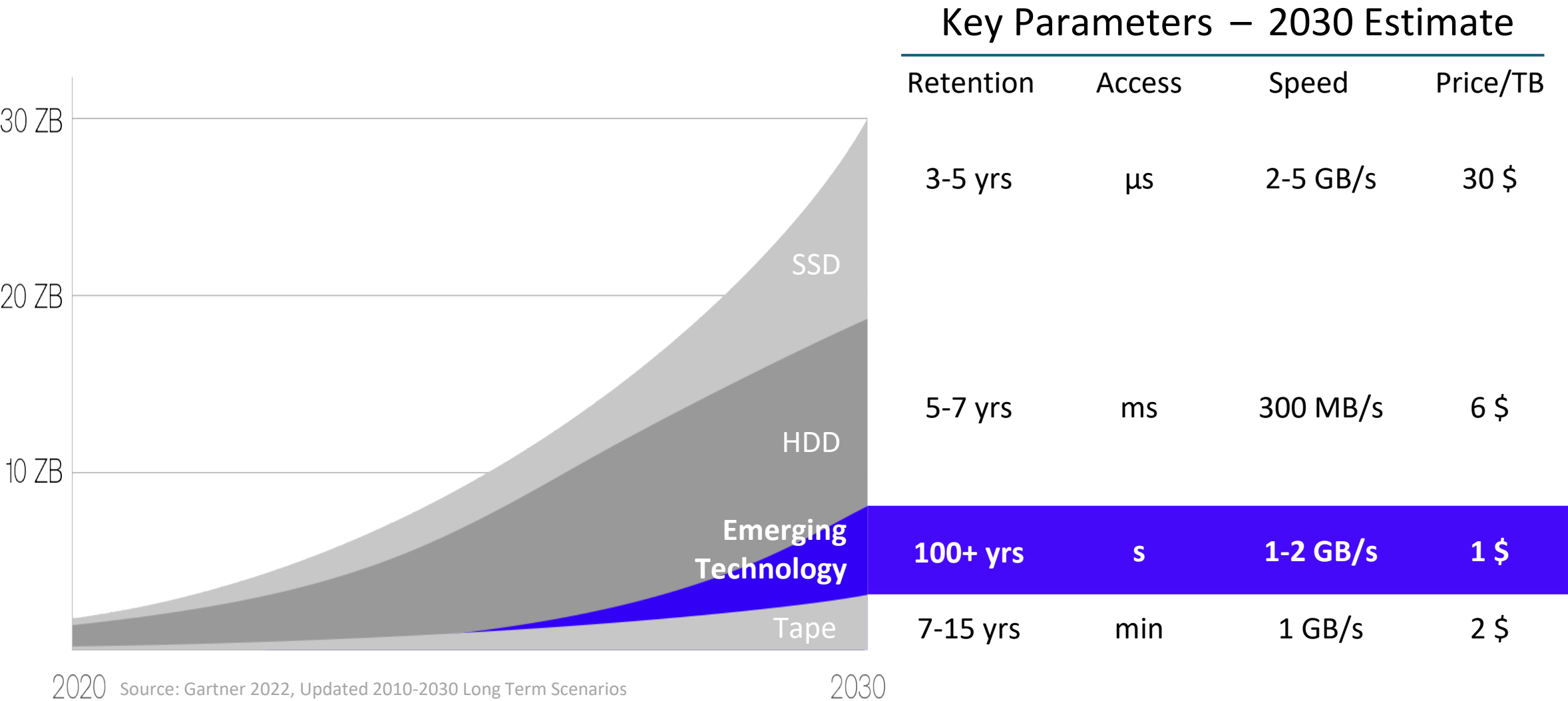
Store all data forever

Ceramic Data Storage Productization & Scaling

Library of Congress - 24th March 2025
Christian Pflaum, CEO



Emerging Technology 2030: Accessible Permanent Data Storage Tier





Virtually unlimited storage media life



x 24

since Demo 2024

Smaller Pixels 4 x
Double-Sided 2 x
Larger Sheets 1,5 x
New Codec 2 x

Ceramic-on-glass sheets

95 x 95 mm

Ceramic-on-glass sheet

100 x 100 μm

Data Matrices

500 nm

Physical Bits

Laser nanoscale matrices



Leveraging scale of **display glass**, semiconductor & tape industry



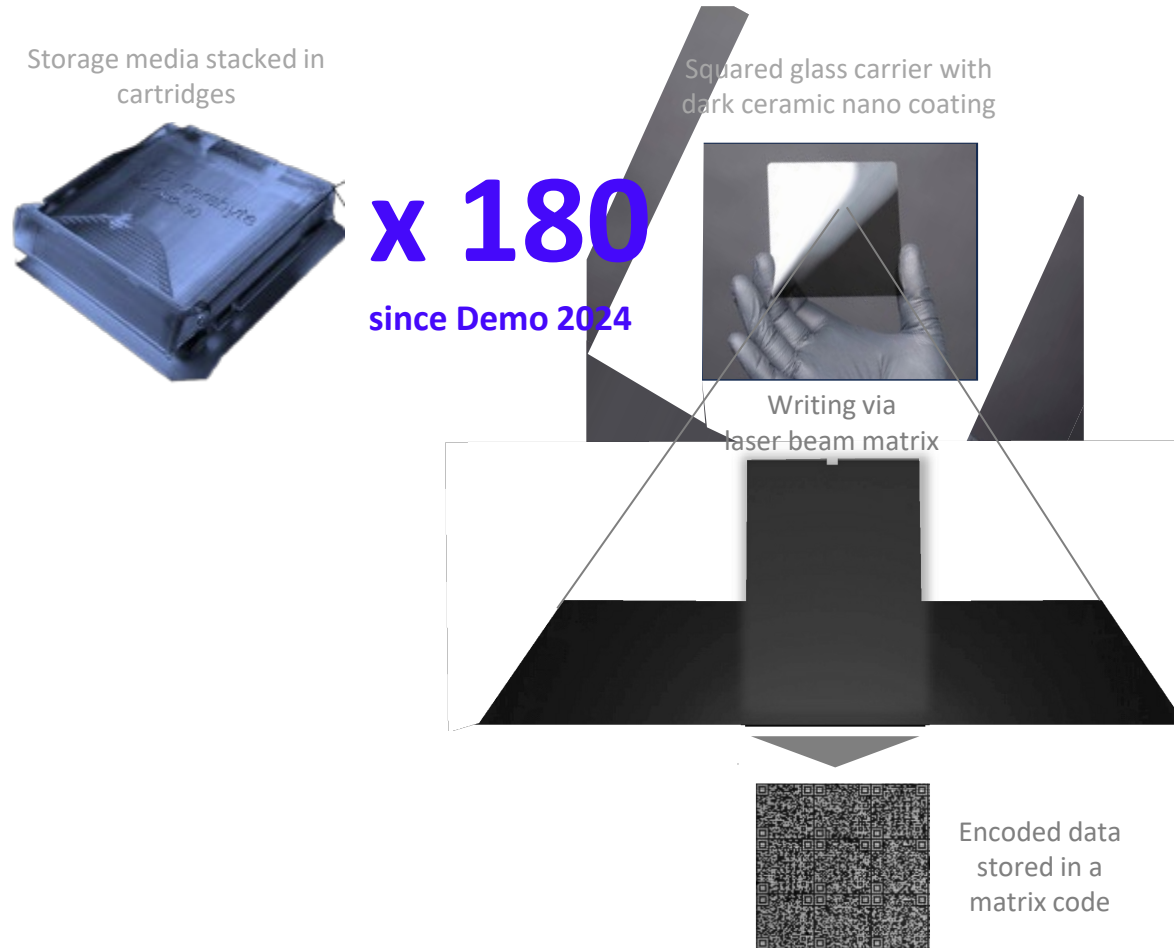
- **Display glass** with ceramic nano-layers enabling extreme durability & retention

Leveraging scale of display glass, **semiconductor** & tape industry



- ▶ **Display glass** with ceramic nano-layers enabling extreme durability & retention
- ▶ **Parallel laser writing** with digital megapixel mirror device targeting 1-2 GB/s in 2030
- ▶ **Parallel reading** with ultra-fast megapixel image sensor targeting 1-2 GB/s in 2030

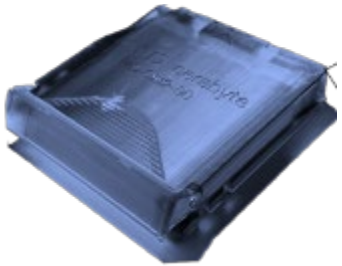
Leveraging scale of display glass, semiconductor & **tape industry**



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- ▶ **180 sheets per cartridge** using existing robotic libraries & handling system

Leveraging scale of display glass, semiconductor & **tape industry**

Storage media stacked in
cartridges



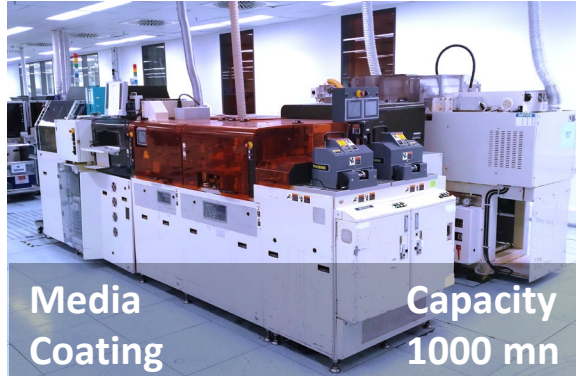
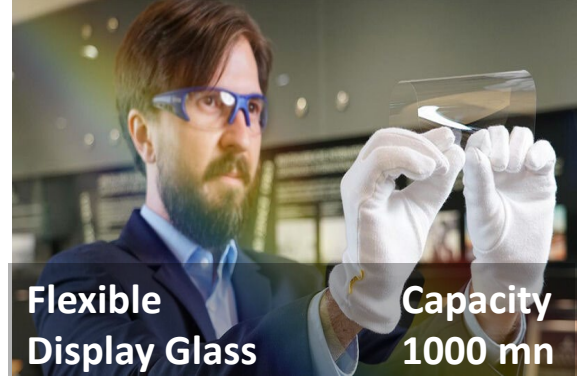
< 10 s

Integrated
Reader



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- ▶ **s-range access** to first bit by integration of reader in ultra high-density library module

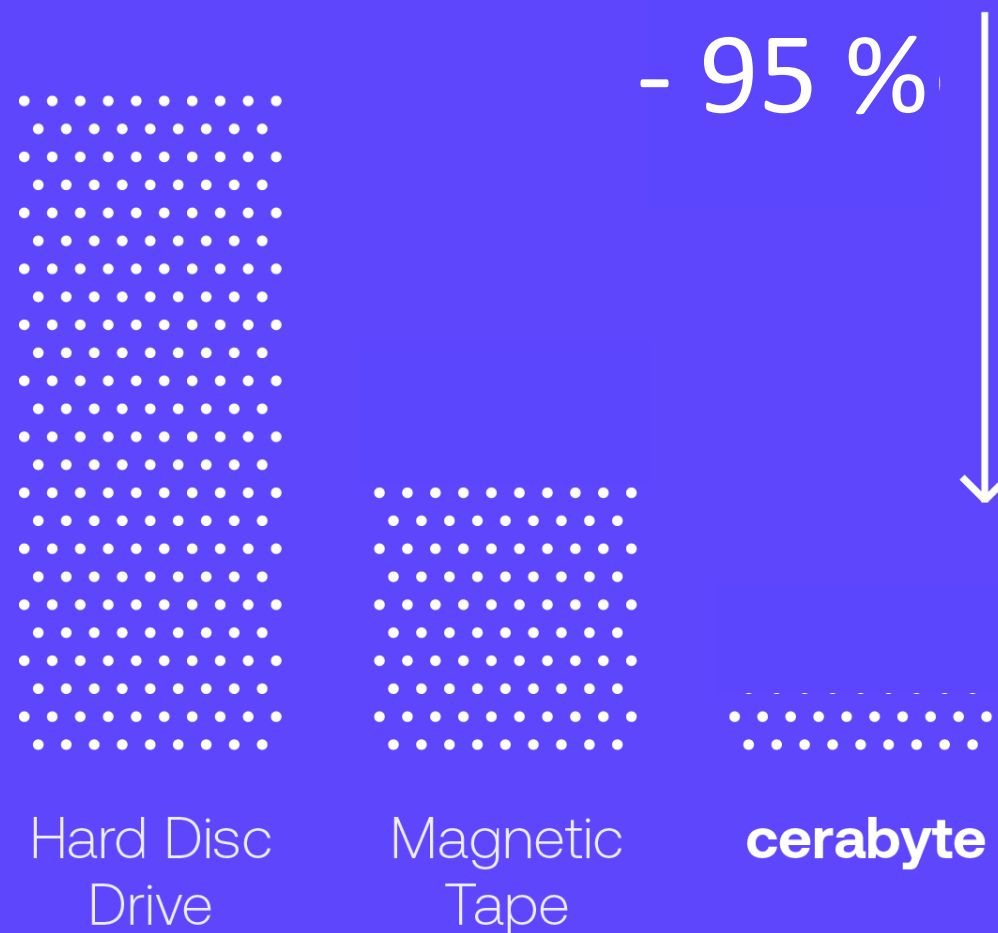
Cerabyte selected **global leading manufacturers** for initial development

Write/Read Module	Robotic Library	Media Production	Media Substrate
 Femtosecond Laser Sources	 Modular Tape Libraries	 Optical Disc Production	 Display Glass Production
 W/R Device Capacity 1,000	 High-density Modules Capacity 10,000	 Media Coating Capacity 1000 mn	 Flexible Display Glass Capacity 1000 mn

Cerabyte **adapts** existing products or processes to **scale production**



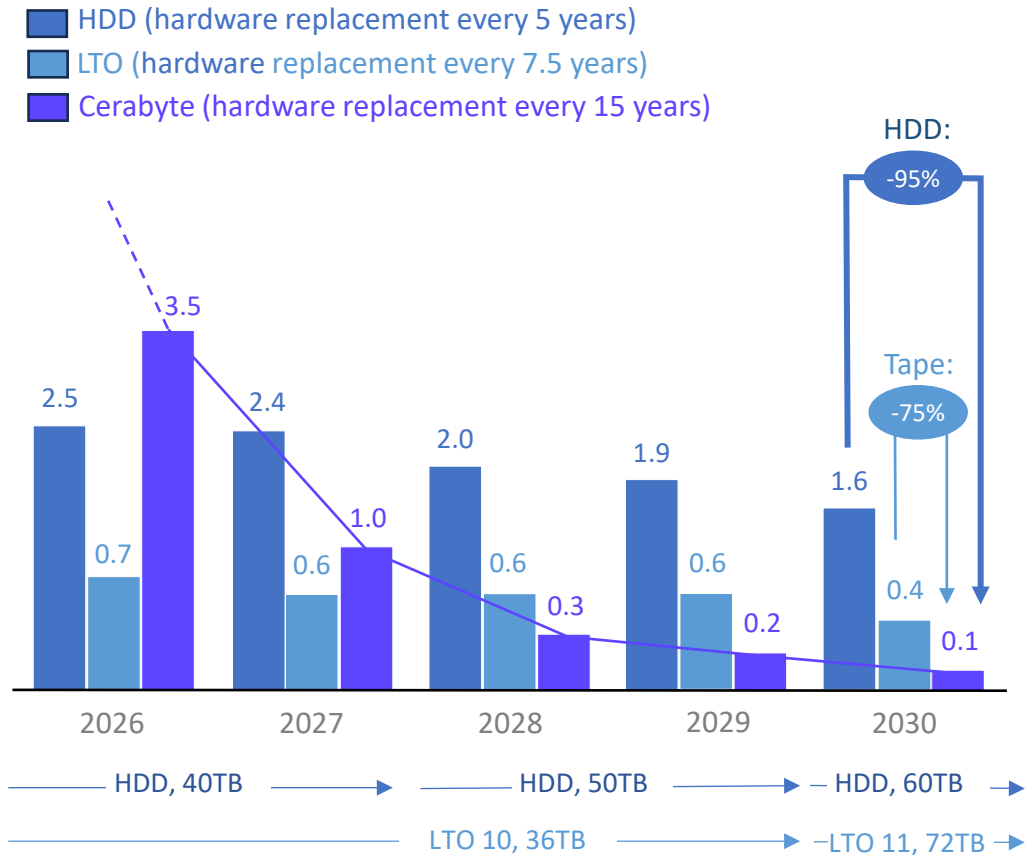
Reduction of
Total Cost of
Ownership by
95% vs HDD





Significant TCO savings compared to HDD and tape **at scale** ...

TCO in \$/TB/year



- ▶ **TCO of Cerabyte strongly decreases with scale**
- ▶ **Savings of 95% vs. HDD and 75% vs. tape in 2030**
- ▶ **Key drivers are:**
 - lower media cost
 - less hardware replacement
 - less energy consumption



Zero energy for storing data

99%
less energy

100%
recyclable

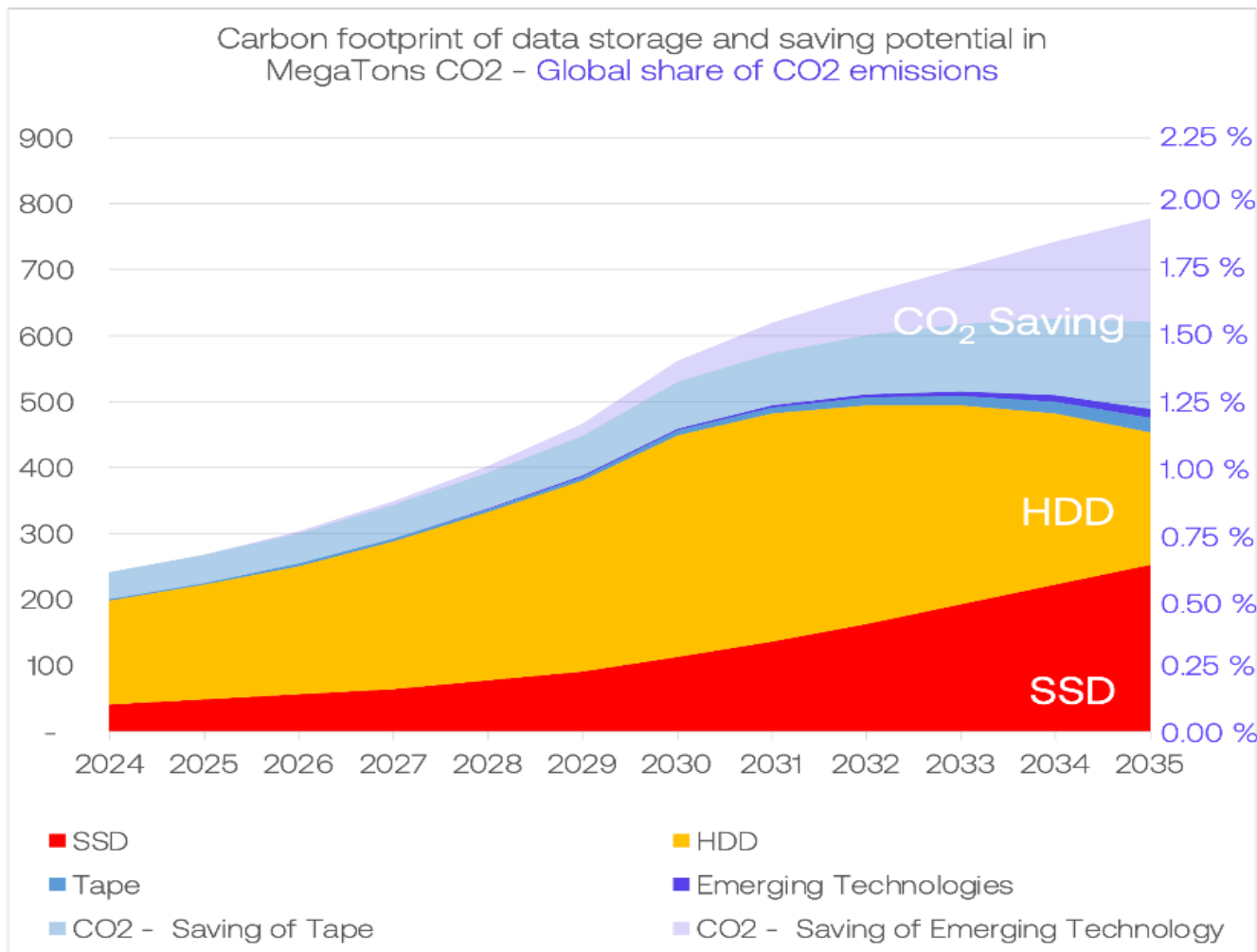
99%
CO₂ reduction

100%
less waste

CO₂ – Emission Estimate for Data Storage



Tape & Emerging technologies could reduce global CO₂ emissions by 30%



Source: Gartner 2022, Updated 2010-2030 Long Term Scenarios

CO₂ OPEX & CO₂ CAPEX for SSD & HDD

Storage	Energy (KWh)		OPEX CO2e (Kg)		CAPEX CO2e (Kg)		Total CO2e (Kg)		
	Exp. Life	5yr	10yr	5yr	10yr	5yr	10yr	5yr	10yr
HDD (1TB)		183.9	367.9	79.6	159	20	40	99.6	199
SSD (1TB)		56.9	113.8	24.6	49.2	160	320	184	369.2

Source: The Dirty Secret of SSDs: Embodied Carbon – Swamit S Tannu, Prashant J. Nair - ACM SIGEnergy Energy Informatics Review Volume 3 Issue 3 pp 4–9

<https://arxiv.org/pdf/2207.10793.pdf>

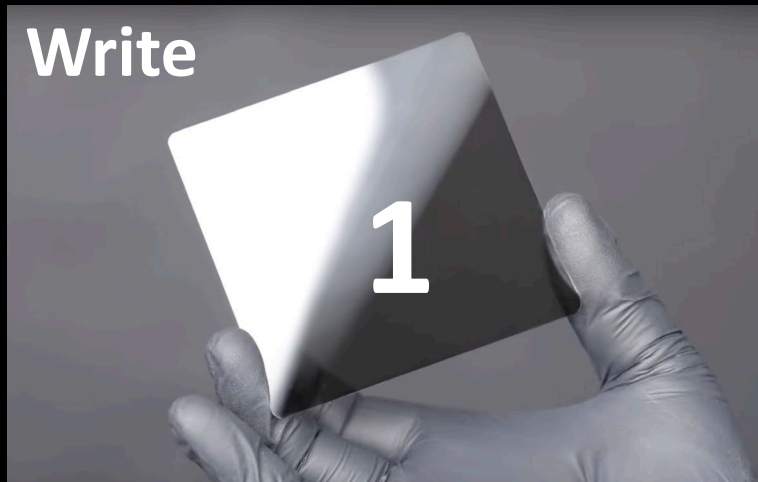
CO₂ Emissions in Data Centers

	DC 1	DC 2	DC 3	DC 4	Average
Server	17%	6%	1%	8%	6%
Storage	55%	51%	65%	63%	62%
Network	2%	8%	4%	1%	3%
Infrastructure	27%	36%	29%	28%	29%
	100%	100%	100%	100%	100%

Source: Green Cloud Computing – German Federal Environment Agency - ens Gröger, Ran Liu, Öko-Institut e.V., Berlin, Dr. Lutz Stobbe, Jan Druschke, Nikolai Richter, Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration (IZM), Berlin

https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-06-17_texte_94-2021_green-cloud-computing.pdf

Resilience Test





How to read data in 100 years ?

- How to avoid bit rot over wide temperature & humidity range - store & retrieve of media ?
- How to read the data in an archive – source & operate a reader ?
- How to decode the data in an archive – source & operate a codec ?

Global Open Archive Standard for Media

Work with industry bodies to define physical media level standards for Digital Archival Storage

Cerabyte Approach

- ▶ **Ceramic Data Storage**
- ▶ **Digital Microscope 50x**
- ▶ **Open-Source Decoder**





Founders & **data storage pioneers** team up to deliver **Cerabyte roadmap**



Christian Pflaum
CEO & Founder

Mobile & cloud services roll out with Apple, Amazon, Google, Facebook, Microsoft & Samsung generating \$ 500+ M in revenues



Martin Kunze
Inventor & Founder

Entrepreneur, silicate technologist, long-term information storage expert, and visionary inventor of Cerabyte technologies.



Alexander Pflaum
Finance & Founder

Founder & Co-CEO at Strategy Consultancy (NASDAQ/NYSE clients), Tech-MD at mechanical engineering Company, dev. of autom. production



Steffen Hellmold
President Cerabyte Inc.

Strategy, BusDev & Sales with Western Digital, Everspin, Seagate, Sandforce, Samsung & Twist Bioscience (DNA data storage)



Steve Campbell
CTO

Former CTO of Western Digital (WDC) & Hitachi Global Storage (HGST), who pioneered data storage on HDD, SSD and optical media



John Colgrove
Board Member

Founder Pure Storage (PSTG) and first engineer at VERITAS



Cerabyte roadmap addresses one **cold data segment** after the other

2023-24 P1 Demo System	2025 P2 Pilot System	2026 P3 On-Prem System	2027-28 P4 Data Center System	2029-30 P5 Cloud System
Capacity per rack	1 PB	5 PB	20-40 PB	80 - 160 PB
Speed per drive	100 MB/s	100-250 MB/s	250-1000 MB/s	1000-2000 MB/s
Access time	60 sec	30 sec	10 sec	5 sec
Use cases & customers per cold data segment	WriteaaS & ReadaaS - Archives - Science - Insurance - Media	Remote pilots with - Archives & Libraries - Big Science - Government - News & Local Media	Data Center Systems - Medical - Insurance - Banking - Media & Entertainment	Cloud Systems - Consumer Cloud - Business Cloud - Automotive - Transport & Logistics



Cerabyte collaborates with **CERN on early access pilot** engagement

 2023-24 P1 Demo System	 2025 P2 Pilot System	 2026 P3 On-Prem System	 2027-28 P4 Data Center System	 2029-30 P5 Cloud System
	1 PB 100 MB/s 60 sec	5 PB 100-250 MB/s 30 sec	20-40 PB 250-1000 MB/s 10 sec	80 - 160 PB 1000-2000 MB/s 5 sec
	WriteaaS & ReadaaS • Archives • Science • Insurance • Media	Remote pilots with • Archives & Libraries • Big Science • Government • News & Local Media	Data Center Systems • Medical • Insurance • Banking • Media & Entertainment	Cloud Systems • Consumer Cloud • Business Cloud • Automotive • Transport & Logistics
	► Pilot with CERN openlabs			



Cerabyte also offers early access **pilots with Archives & Libraries**



1 PB
100 MB/s
60 sec

WriteaaS & ReadaaS

- Archives
- Science
- Insurance
- Media

5 PB
100-250 MB/s
30 sec

Remote pilots with

- Archives & Libraries
- Big Science
- Government
- News & Local Media

► Archive & Library Pilots

2025 Early Access - Media

- 1H GB-scale media reliability tests
- 2H First TB-scale customer datasets

2026 Early Access - System

- 1H Library with reader
- 2H Library with write & read

2027+ Upgrade option to commercial Data Center and Cloud System



Early Access Opportunity



Experience Cerabyte in a pilot engagement

For more information contact

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Global Market

Disruptive Technology

Focused Team

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