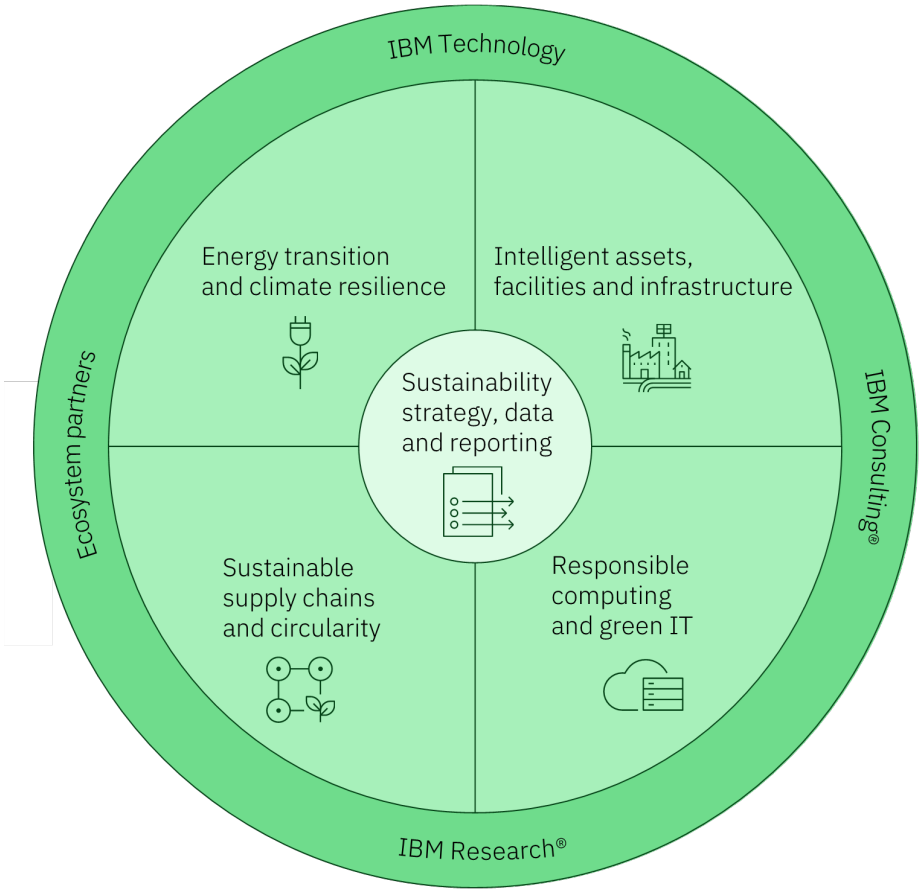
Driving Sustainability in the Age of AI-Driven Storage

Dave Verburg & Samuel Sitorus

IBM Sustainability Vision – Turning ambition into action



To innovate and execute on environmental sustainability initiatives leveraging hybrid cloud and emerging AI technologies across IBM's operations, supply chain, products, and services. To partner across business units and external stakeholders to solve broader sustainability and climate challenges.

Source: https://w3.ibm.com/w3publisher/chief-sustainability-office/cso-home
Source : https://w3.ibm.com/w3publisher/ibm-sustainability/strategy

Driving Sustainability in the Age of AI-Driven Storage

Sustainability is becoming increasingly critical in the storage industry:

- Responsibility to customers & Global Community
- Rapid growth of AI has led to a surge in power-intensive computing systems

Three main areas for improvement:

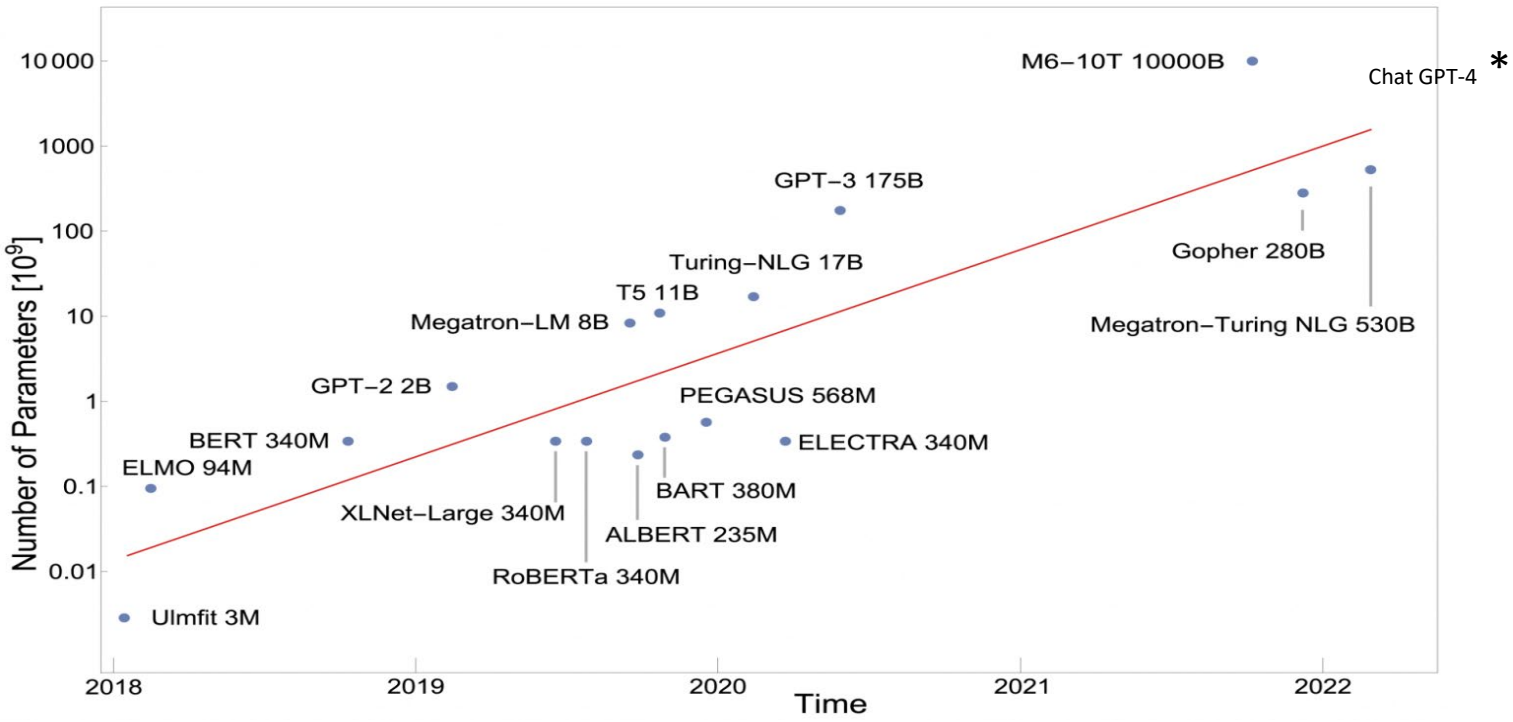
- Energy consumption during manufacturing,
- Operational energy efficiency and technology choices, and
- End-of-life strategies through circular economy principles.

We will also consider the trade-offs associated with each storage technology and highlight the challenges the industry must overcome to achieve meaningful progress.

Driving Sustainability in the Age of AI-Driven Storage

- **Key Focus Areas**
  - Carbon emissions from storage device production and usage
  - Power consumption trends and challenges
- **Context and Challenges**
  - Rapid data growth driving increased energy demands
  - Historical trends in Life Cycle Assessment (LCA) data
- **Exploring Solutions**
  - Total Cost of Ownership (TCO): Evaluating SSDs as a more efficient alternative
  - Carbon comparison: Review of LCA data for the new QLC SSD
  - SSD recertification: Opportunities for reuse and extended lifecycle
  - HDD circularity: Promoting reuse and recycling
  - Renewed customer Engagement : Addressing the issue of drive destruction: Educating customers on alternatives
  - Extending HDD lifespan: Techniques for continued use despite partial failures (e.g., one head failure)
- **Industry Collaboration**
  - Partnering with industry leaders to drive sustainable practices

Challenge of Data Explosion



Source: Contact Software Blog

AI Model Parameters growing exponentially

- Real time AI workloads require ingestion of large amount of data at high throughput
- Data movement is a key concern
  - How do I feed my (expensive) beast?

Leading to …

- Move compute closer to the source
- Processing on the edge
- SSDs assigned to specific purposes
  - Direct attach to the GPUs
  - Inferencing
  - Data lakes

AI Effects on Sustainability for HDD/SSD

Power increasing with AI

- Nvidia GEForce RTX 4090 spec'd at 450W under load
- The amount of electricity required by AI data center racks is estimated to require seven times more power than traditional data center racks^
- Goldman Sachs estimates there will be a 160% increase in demand for power propelled by AI applications by the end of this decade^
- At 2.9 watt-hours per ChatGPT request, AI queries are estimated to require ten times the electricity of traditional Google queries, which use about 0.3 watt-hours apiece^
- Power draw can be a double hit … it has to be supplied and cooled

More capacity needs

- Real time AI workloads require ingestion of large amount of data at high throughput

Compute closer to the source

- Saves energy that otherwise would be used for data transmission
- But …
  - More computing resources increases overall power consumption/introduce utilization challenges *
    - Need more modular and efficient solutions to power the servers that will live at the edge *

^ Source: Hitachi: Taking on Generative AI's Green Energy Dilemma

* Source: https://www.datacenterfrontier.com/sponsored/article/21438777/advanced-energy-getting-closer-to-the-edge-data-centers-move-closer-to-consumption

Sustainability Calculations

- Key factors
  - CO_2 used for creation
    - SSD has higher “embodied CO2” on creation
    - CO2e creation per TB is improving!
    - Energy taken from SNIA calculator
  - CO_2 used for operation
    - SSD is much lower; expect to improve
    - Could improve with more green energy
  - Cooling
    - SSDs run reliably at higher temperatures

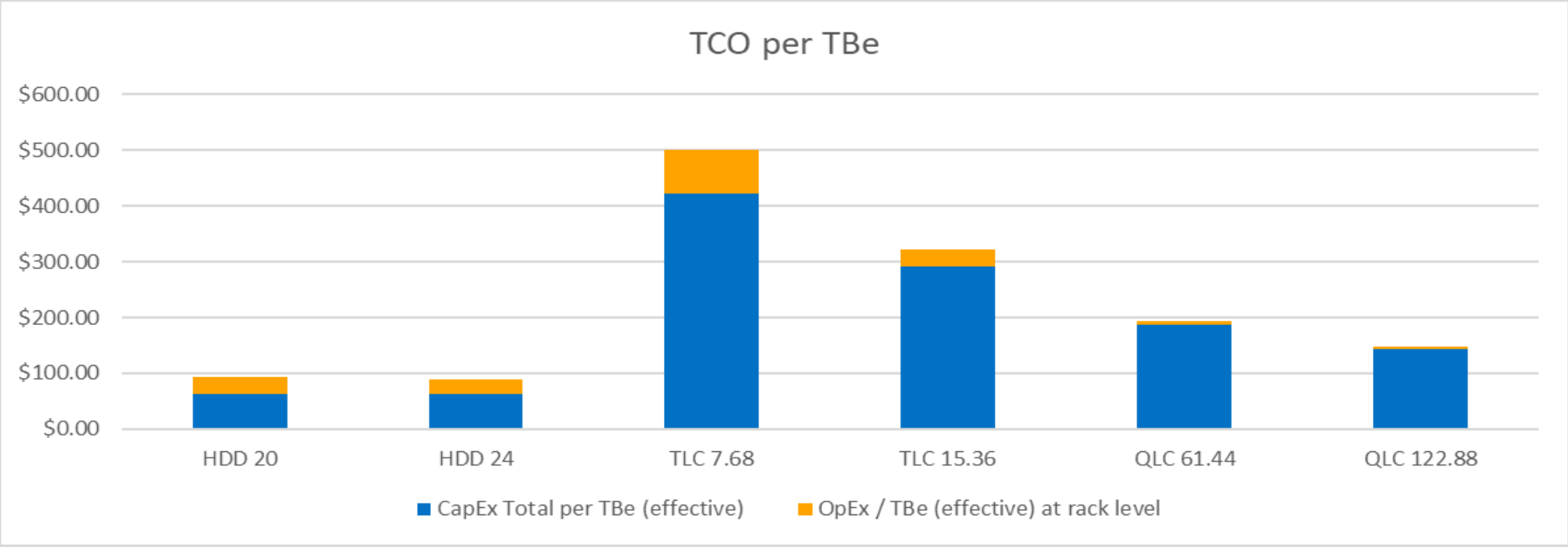
CO2e creation for HDD vs SSD, 5-year life

Storage	Energy (KWh)	OPEX CO_2e (Kg)	CAPEX CO_2e (Kg)	Total CO_2e (Kg)
HDD/TB ~2021	183.9	79.6	20	99.6
SSD/TB ~2021	56.9	24.6	160	184
HDD/TB current	46.1	17.1	1.1+2 (+ drawers)	20.2
SSD/TB current	19.8	7.3	24.0	31.3

Source: https://futurumgroup.com/insights/are-ssds-really-more-sustainable-than-hdds/, Seagate website

Will QLC have a cheaper TCO than HDD?

- Assumes more replication needed for HDD, less utilization
- QLC prices need to fall in order to get to cost cross-over for raw TB
- QLC wins with OP Ex cost/sustainability, HDD wins with acquisition cost and Cap Ex sustainability



AI Effects on Sustainability HDD/SSD

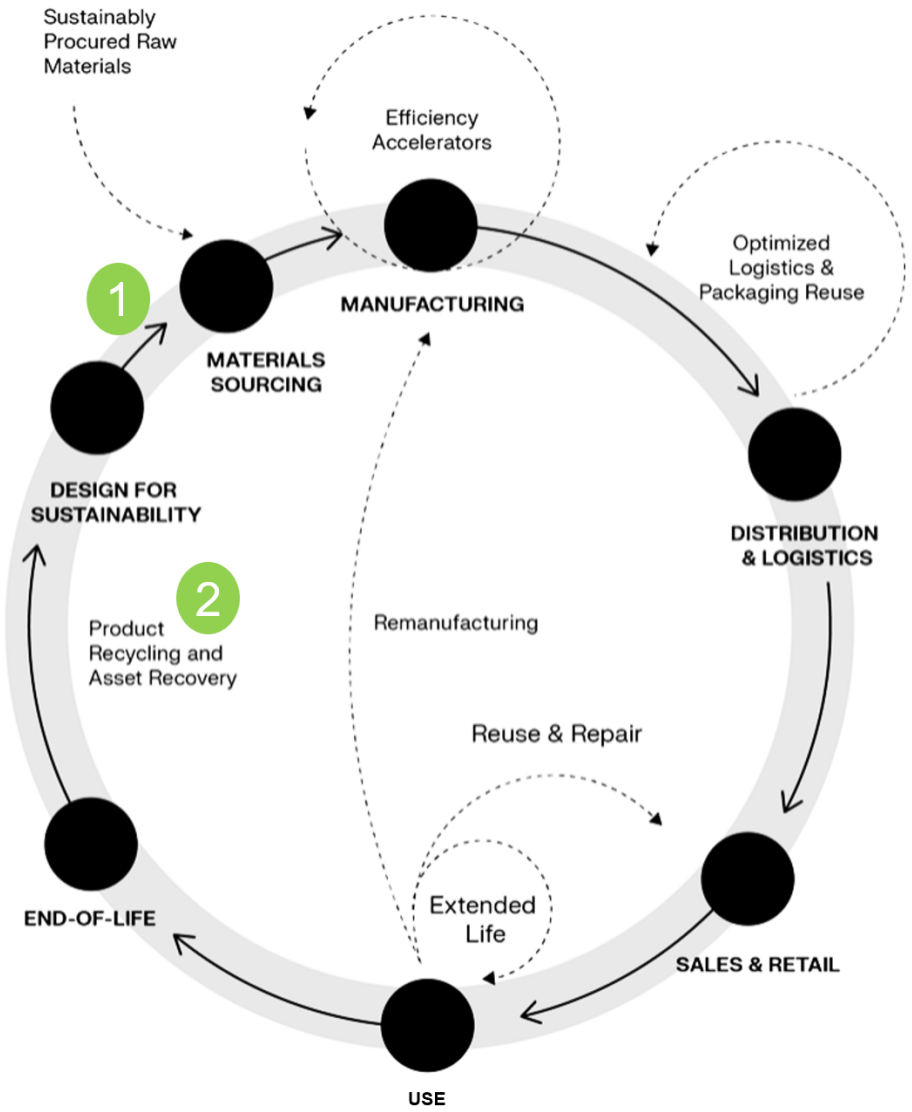
What can we do?

- Leverage larger capacity drives with same power profile & compression
- Investigate SSD vs HDD … SSD lower power per TB but are they more sustainable?
- Minimize data movement/duplication
- Tune models
- Leverage tape for cold storage
- Understand cooling needs
- Need more modular and efficient solutions to power the servers that will live at the edge *

^ Source: Hitachi: Taking on Generative AI's Green Energy Dilemma

* Source: https://www.datacenterfrontier.com/sponsored/article/21438777/advanced-energy-getting-closer-to-the-edge-data-centers-move-closer-to-consumption

Circularity: The Potential



Linear Economy not Sustainable

- **1.75x** natural resources that earth is capable of regenerating
- EU accelerating circularity through new standards
- Circularity offers resilience, sustainability & growth

HDD, a natural fit for circularity

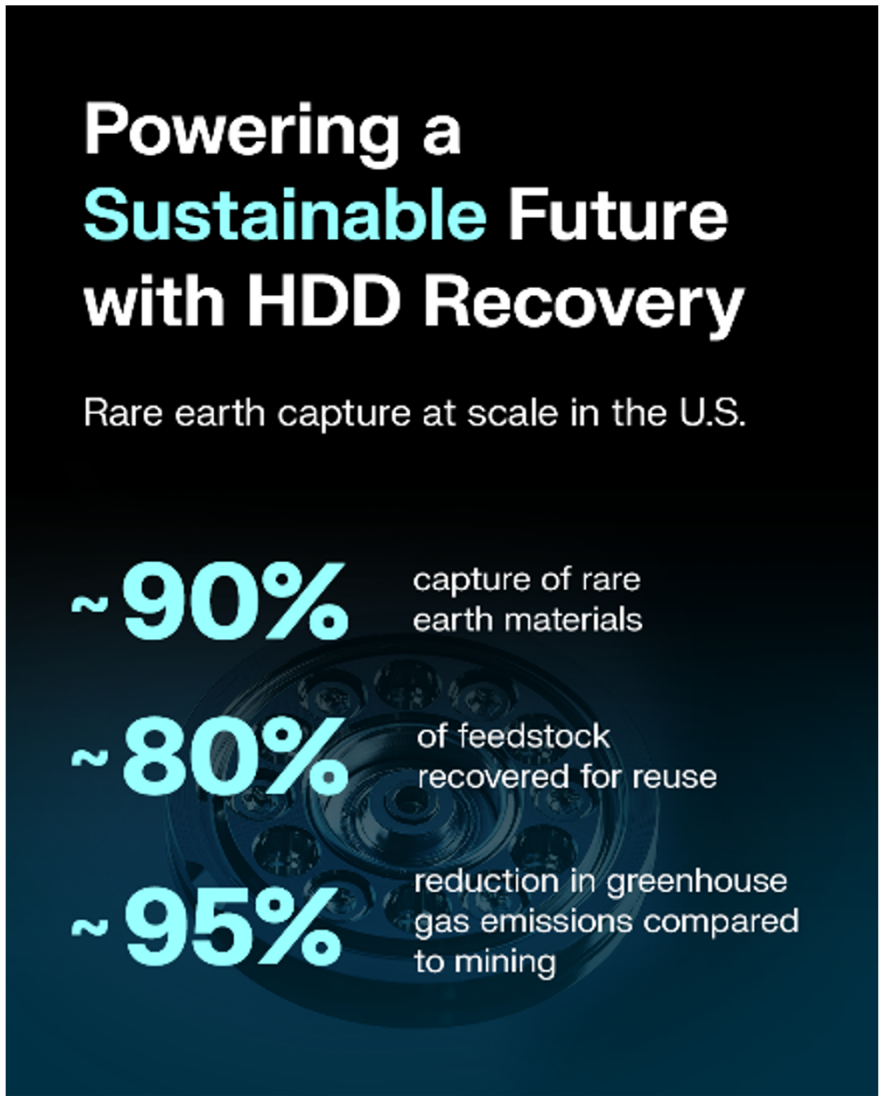
- High elemental content and mechanicals
- Al, Fe, Cu, Au high recovery levels, new technology for rare earths

Our Opportunities

1. **Recycled content: Product and Packaging**
2. **Advanced Recovery** benefiting our entire ecosystem

Chart source: Western Digital

Powering a Sustainable Future with HDD Recovery



Press Release:

Western Digital Advanced Recovery and Rare Earth Capture

Blog:

Giving HDD Rare Earth Elements New Life

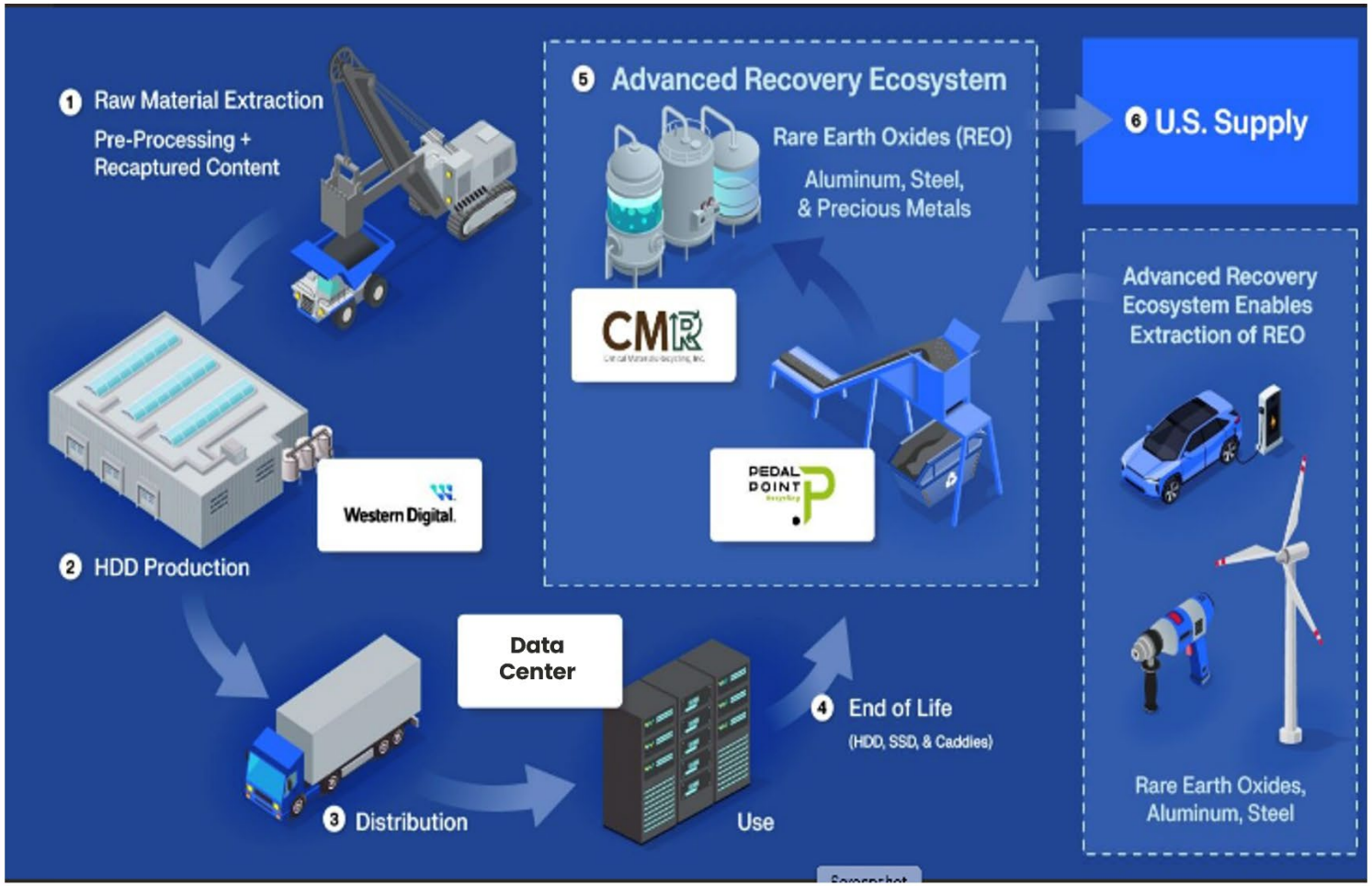
Whitepaper:

Advanced Recycling and Rare Earth Recovery at Scale

Chart source: Western Digital

Advanced Recovery EcoSystem

Chart source: Western Digital



Big leap in eco-system influence for responsible End of Life Management

Circularity

Meaningful progress requires industry-scale collaboration

- Extending the life of the HDD is the most environmentally sustainable option
- Harvesting and reusing components reduced e-waste generation but has technical challenges
- Material recovery has reduced environmental benefit with a lower bar for implementation

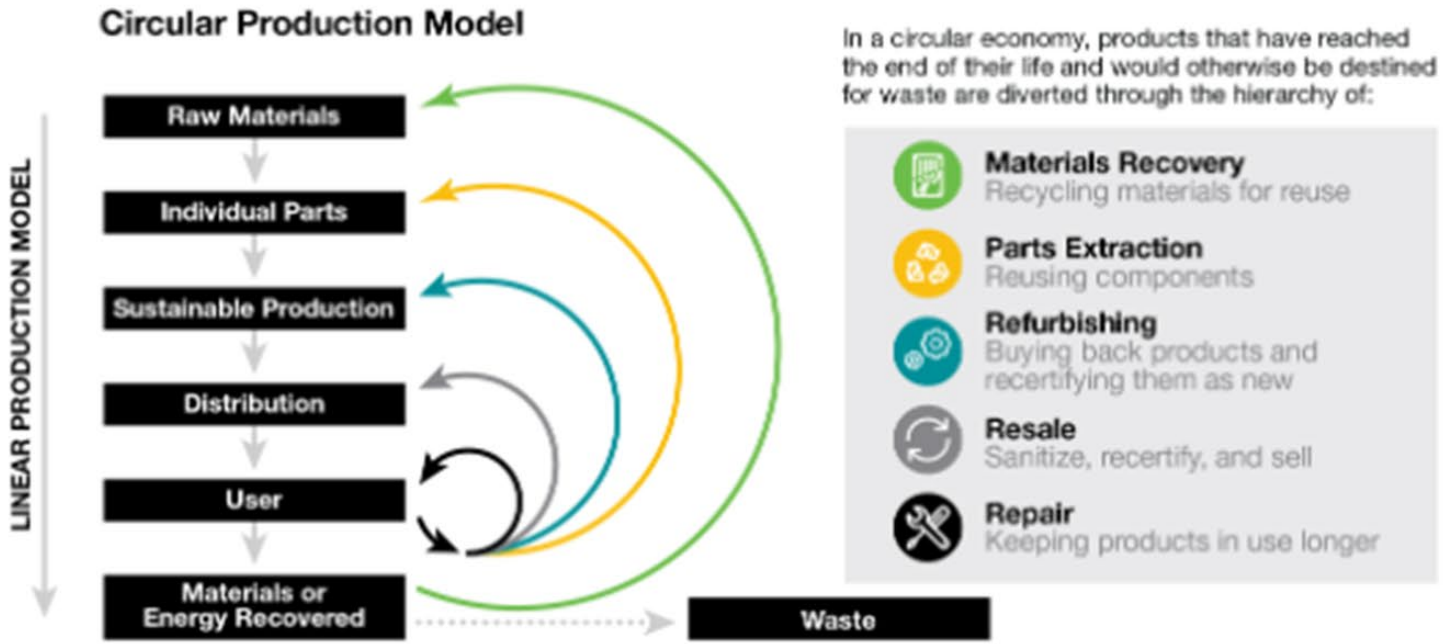


Chart source: Seagate Technology

Circularity Progress

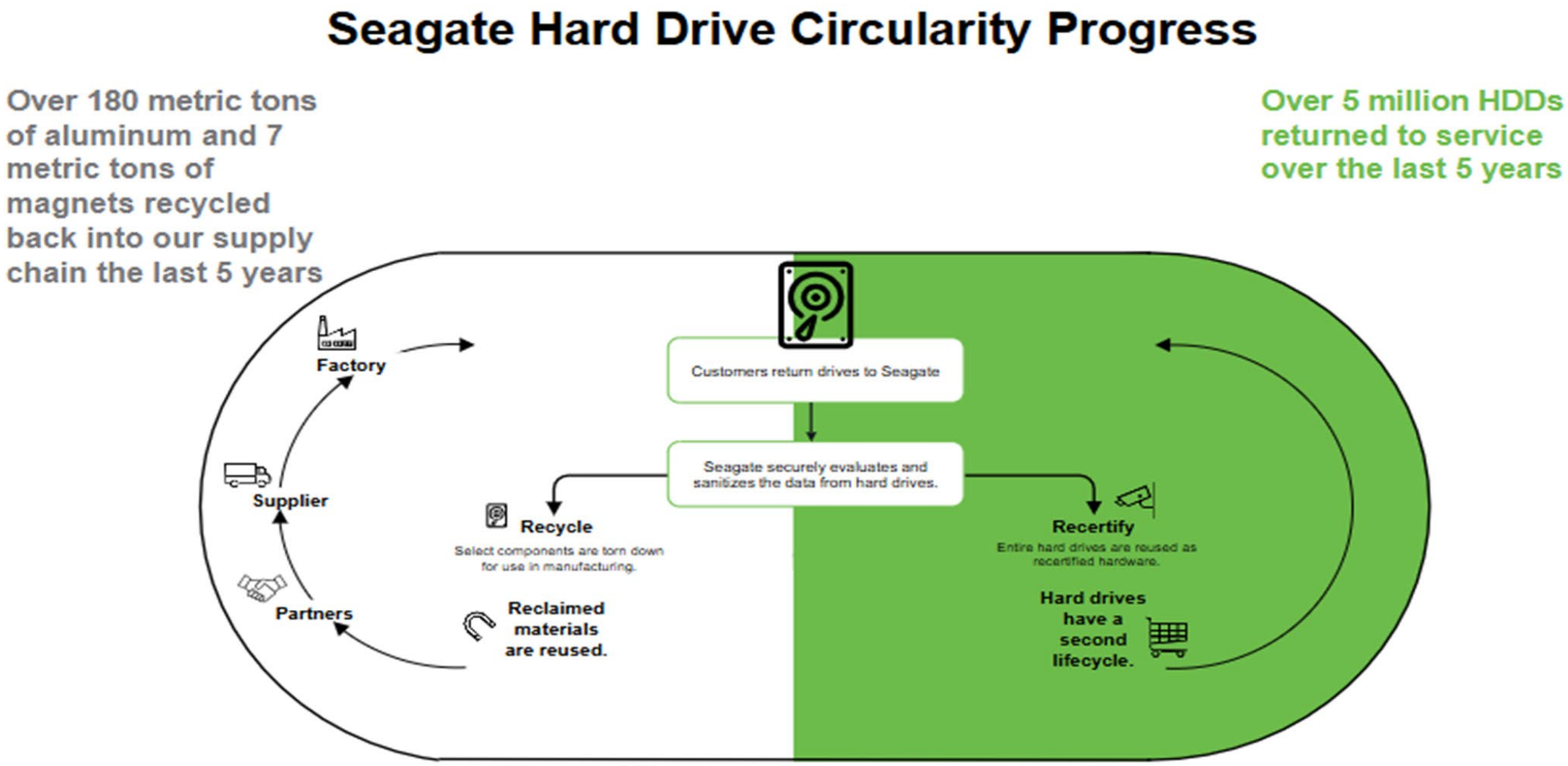
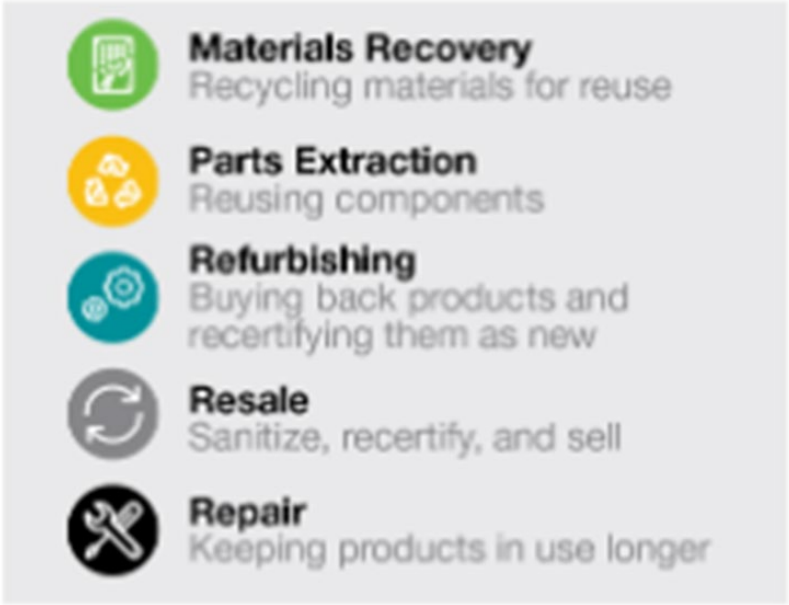


Chart source: Seagate Technology

Circularity Call to action



User circularity

- Enable HDD Regen after Depop

Repair/recertify

- Leverage as certified parts

Parts extraction/Materials recovery

- Leverage erasure techniques; prove to customers data is erased
  - Many older HDD don’t have secure erase
- If drives crushed, ensure materials recovered appropriately*

Summary

- **Rising Demand for Storage Efficiency:** AI workloads require massive data throughput and low latency, increasing the energy footprint of traditional storage systems.
- **Sustainability as a Strategic Imperative:** Organizations are under growing pressure to reduce carbon emissions and adopt greener IT practices, including in data storage infrastructure.
- **AI-Optimized Storage Architectures:** Intelligent storage systems can dynamically manage data placement, reduce redundancy, and optimize energy use across tiers.
- **Lifecycle and Circular Economy Integration:** Emphasis on sustainable materials, modular design, and end-of-life recycling to minimize environmental impact.
- **Cross-Functional Industry Collaboration:** Success depends on alignment between engineering, procurement, and sustainability teams to drive innovation and accountability.
- **Future-Proofing Digital Infrastructure:** Investing in sustainable storage solutions not only meets ESG goals but also enhances long-term operational resilience and cost efficiency.