
A Call for Research on Storage Emissions

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A perspective view of a long, narrow corridor in a datacenter. Both sides are lined with tall, dark server racks. The floor is a light-colored tile. The ceiling is white with some visible structural beams. The perspective leads the eye down the center of the corridor.

Storage in datacenters account for:

A perspective view of a long, narrow corridor in a datacenter. Both sides are lined with tall, dark server racks. The floor is a light-colored polished concrete. The ceiling is white with some visible structural beams and lighting fixtures. The overall atmosphere is clean and industrial.

Storage in datacenters account for:

33% of operational emissions

[Wang ISCA '24]

The background of the slide shows a perspective view of a long, brightly lit corridor in a datacenter. Both sides of the corridor are lined with tall, dark server racks. The floor is a polished white, and the ceiling has a grid of recessed lighting. The overall atmosphere is clean and modern.

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Solution: Renewable energy

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61% of embodied emissions

The background of the slide shows a perspective view of a long, brightly lit corridor in a datacenter. Both sides of the corridor are lined with tall, dark server racks. The floor is a polished white, and the ceiling has a grid of recessed lighting. The perspective creates a sense of depth, leading the eye down the center of the hallway.

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So let's talk about storage

But... what about AI?



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Even given aggressive forecasts, **storage dominates emissions**

- AI = lots of operational emissions, offset by renewables
- **Embodied emissions: 2 CPUs \approx 1 GPU \approx 1.6-17 TB SSD**

What is datacenter storage?



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8 HDD blades
1-2 CPUs, 88 HDDs \approx 2.6 PB



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Across cluster: 100,000s of disks
Multiple clusters per datacenter

Where are embodied emissions from?

HDD racks:



Capacity tier:

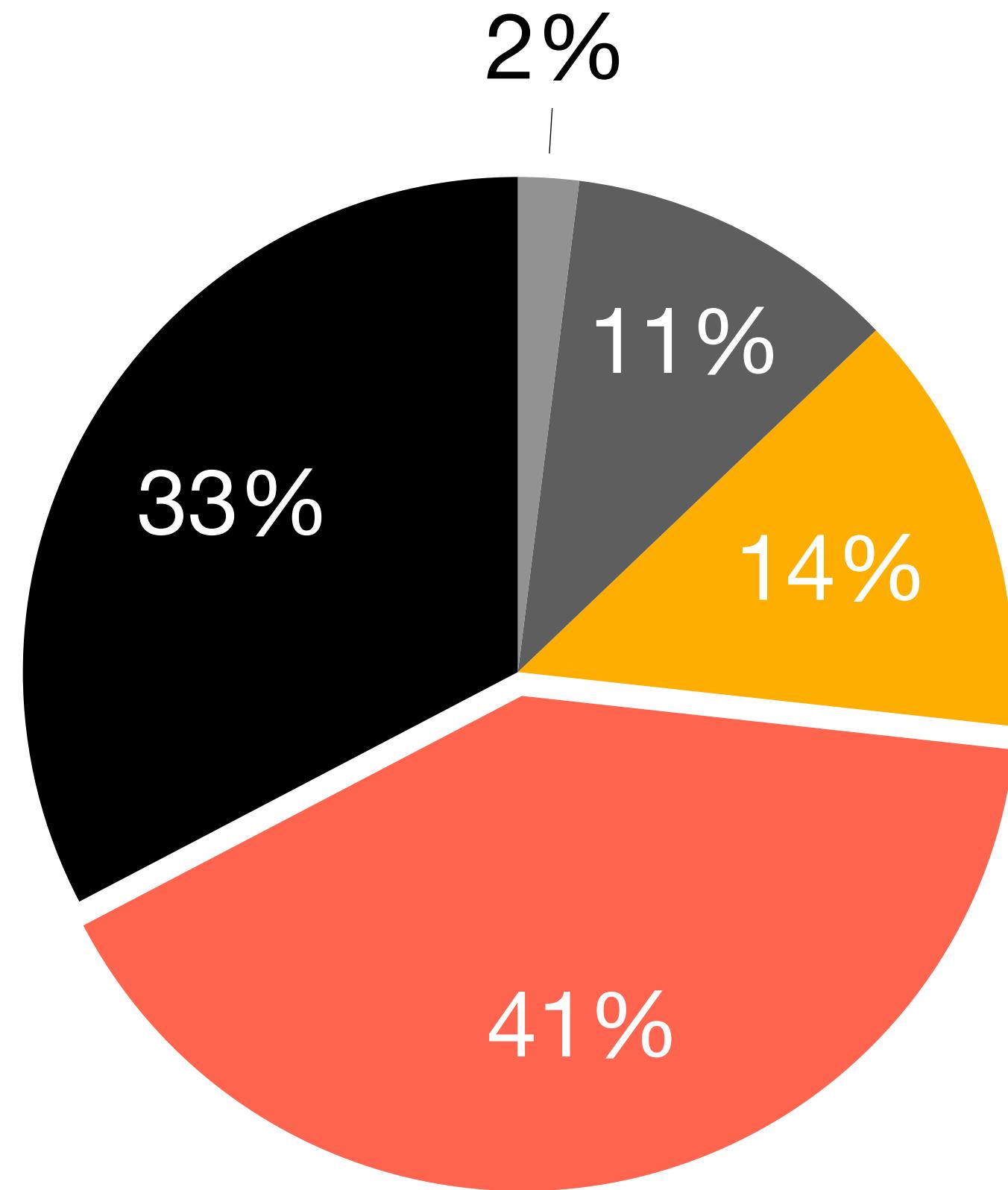
Less expensive per bit, large capacity

Where are embodied emissions from?

HDD racks:



- CPU
- DRAM
- SSD
- HDD
- Other



Capacity tier:

Less expensive per bit, large capacity

Where are embodied emissions from?

SSD racks:



Performance tier:

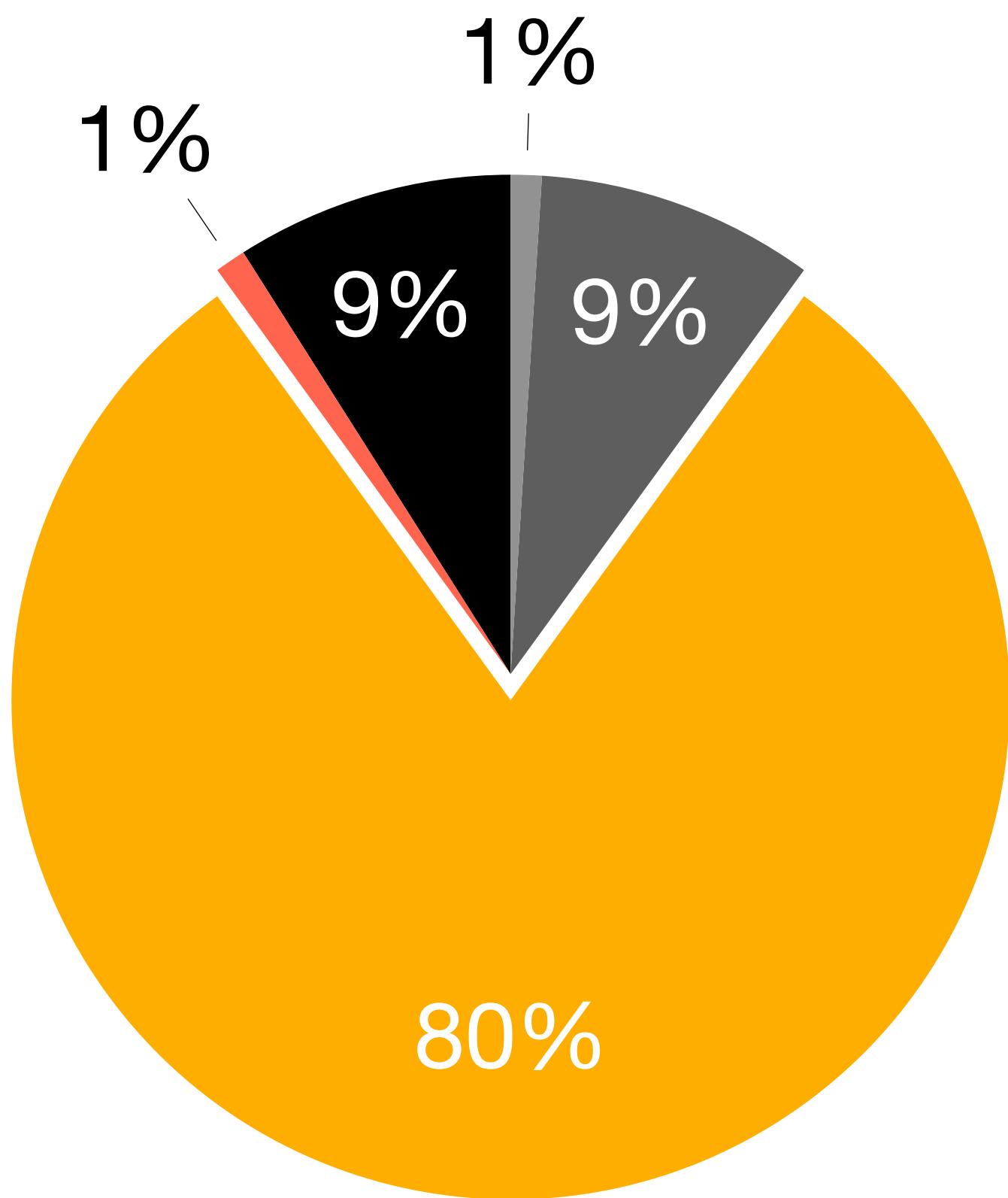
More expensive per bit, lower capacity

Where are embodied emissions from?

SSD racks:



- CPU
- DRAM
- SSD
- HDD
- Other



Performance tier:

More expensive per bit, lower capacity

Storage is different: Storage is stateful

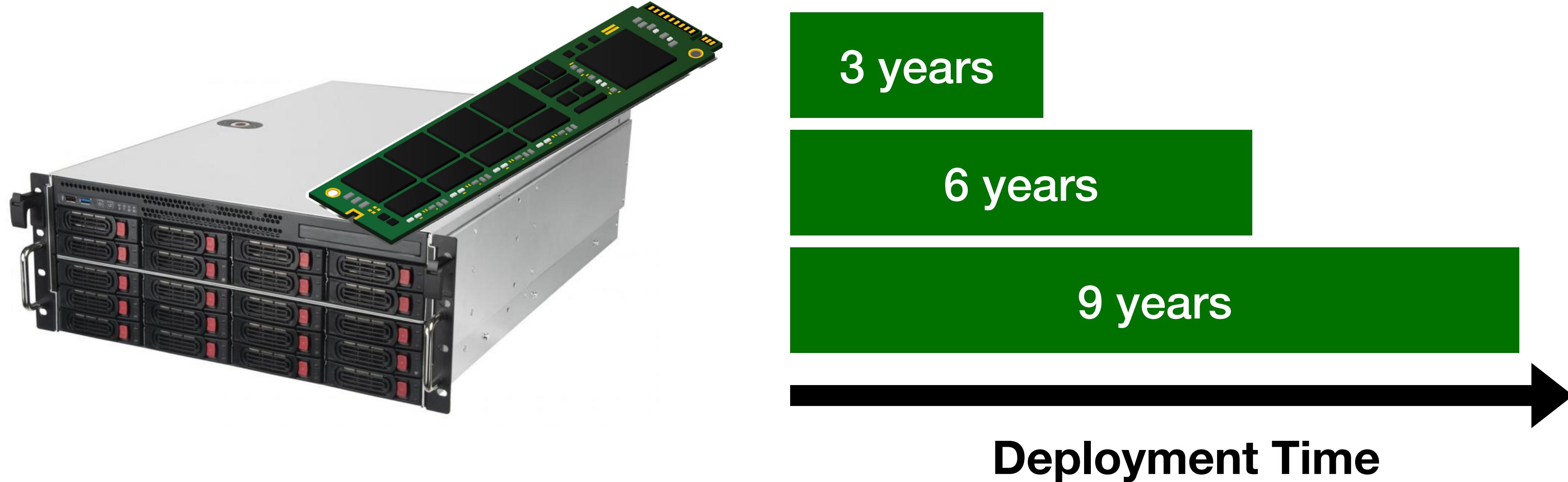
Longer lifetimes amortize embodied emissions

Extending lifetime causes extra, correlated failures

Storage is different: Storage wears out

Longer lifetimes amortize embodied emissions

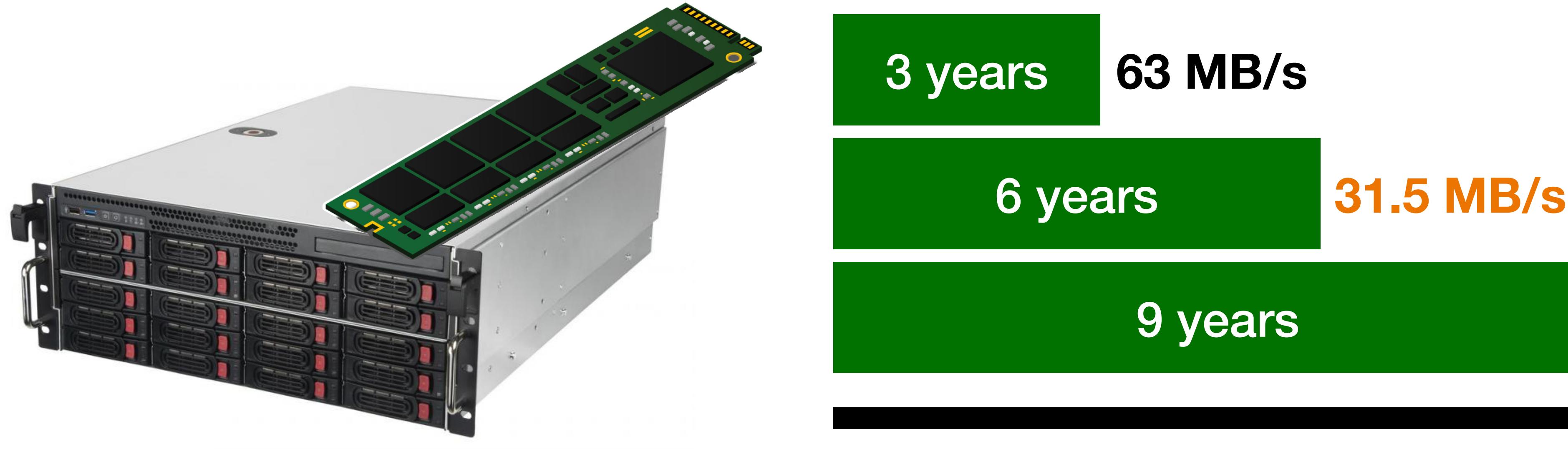
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Storage is different: Storage wears out

Longer lifetimes amortize embodied emissions

Extending lifetime causes **extra, correlated failures**

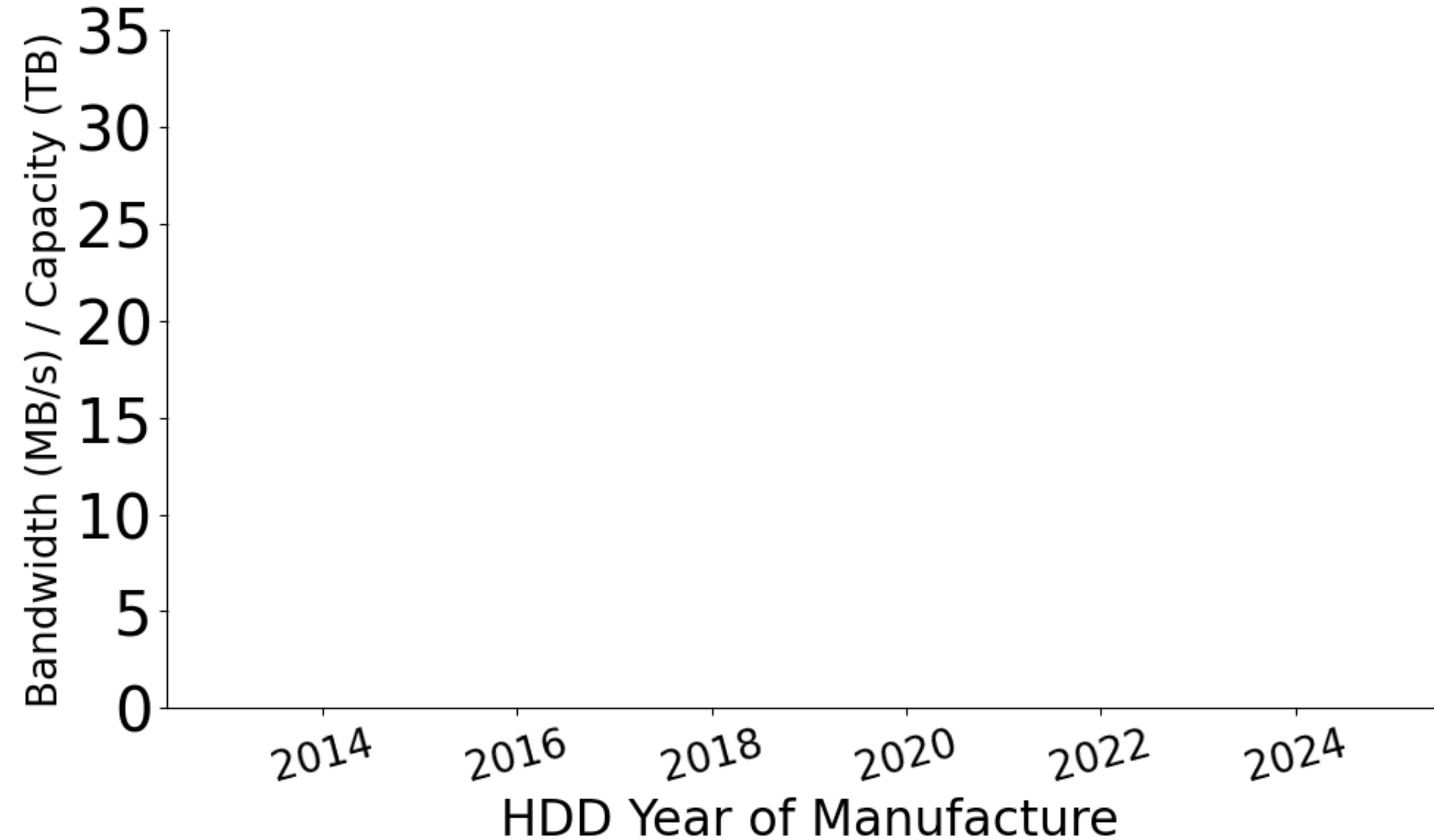


Storage is different: Denser drives → IO problems

Denser drives lead to fewer embodied emissions-per-bit

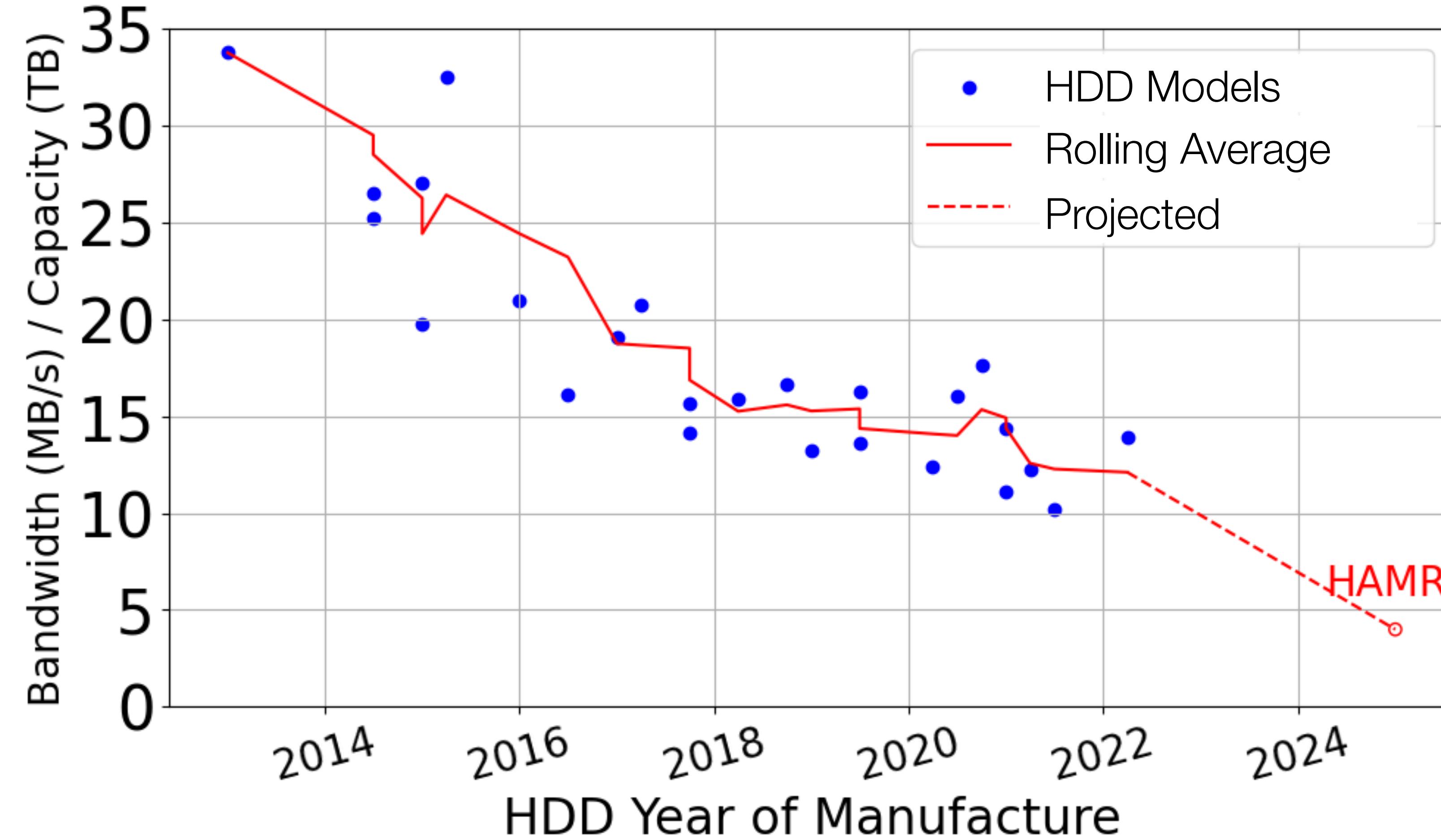
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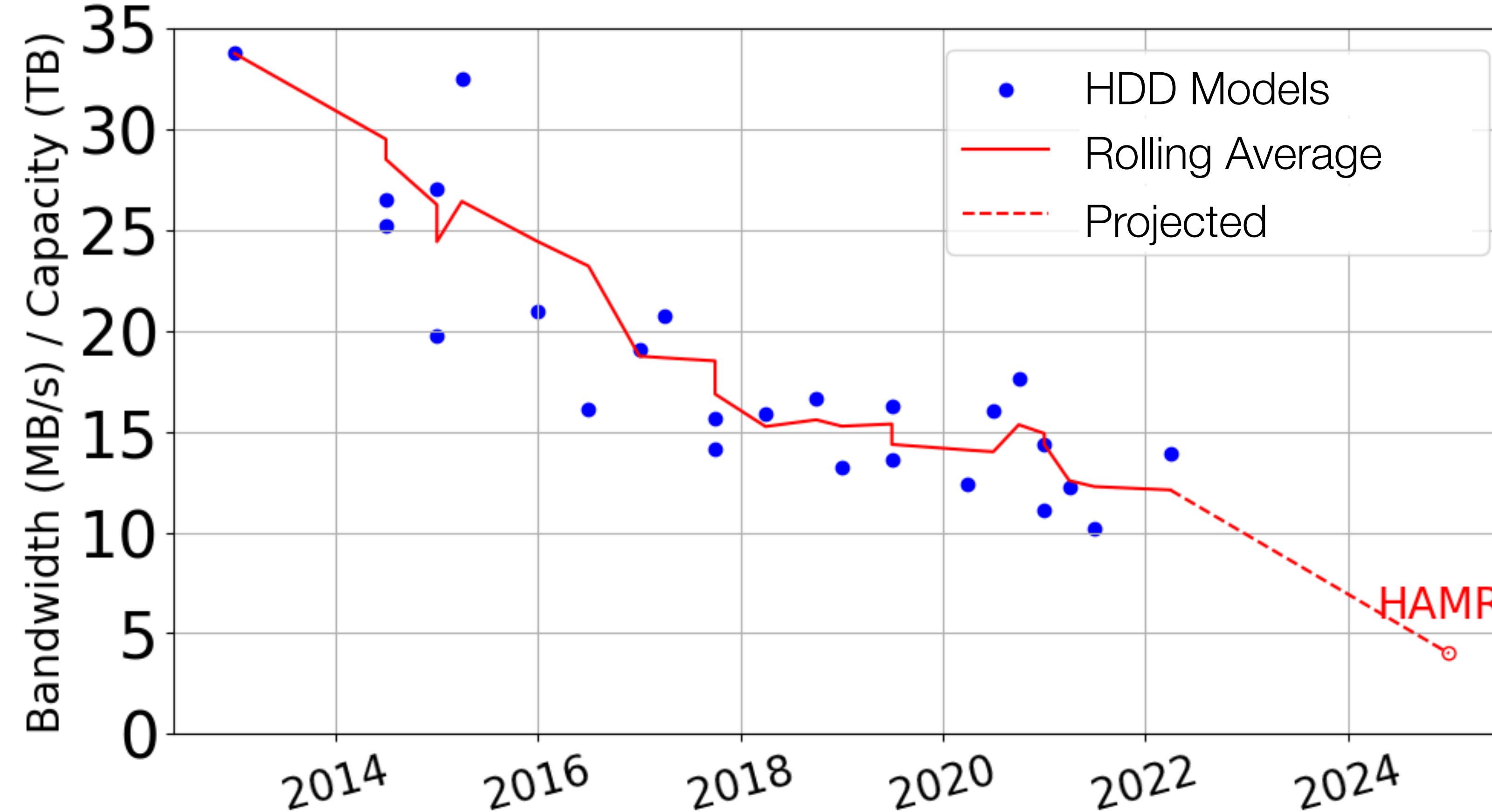
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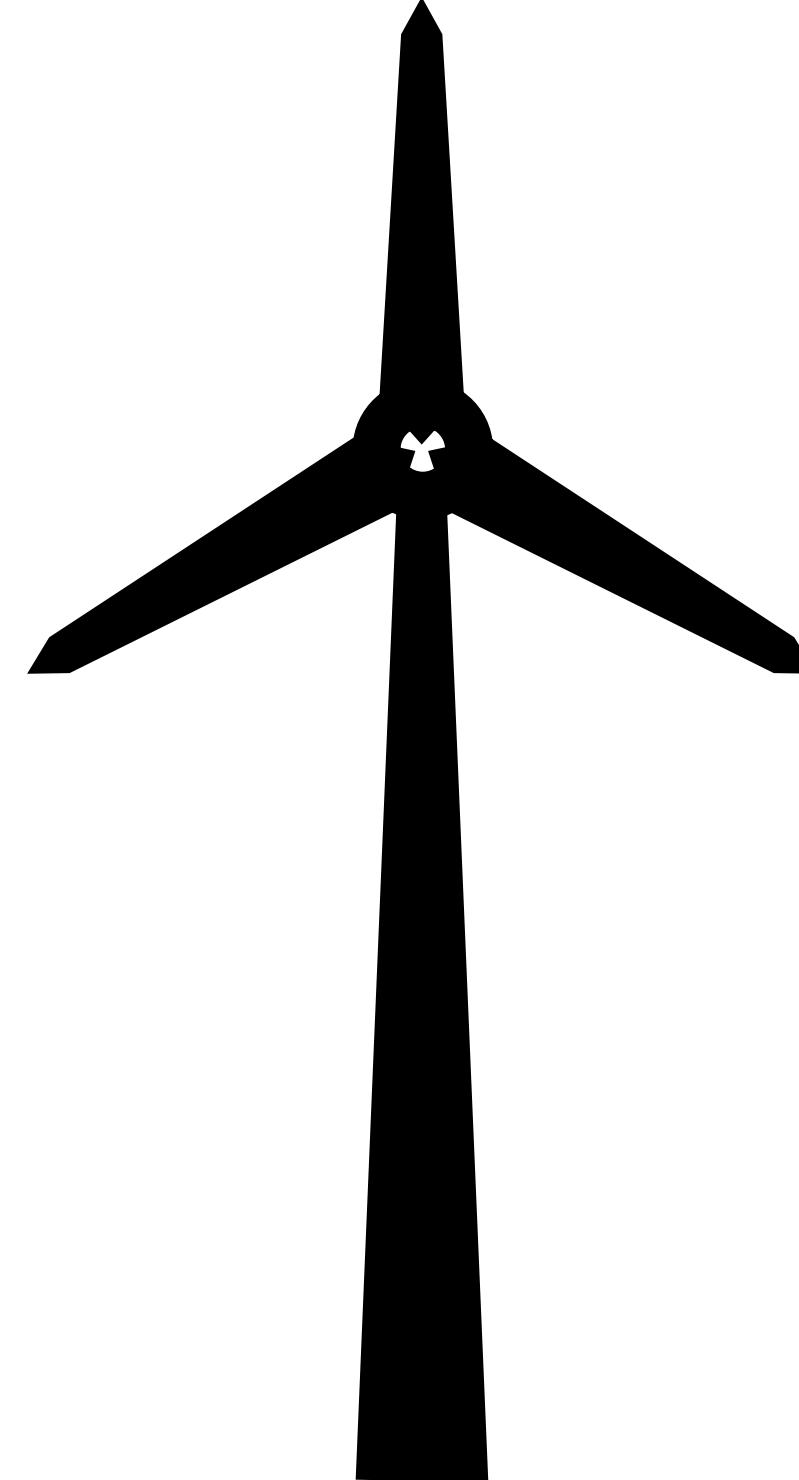


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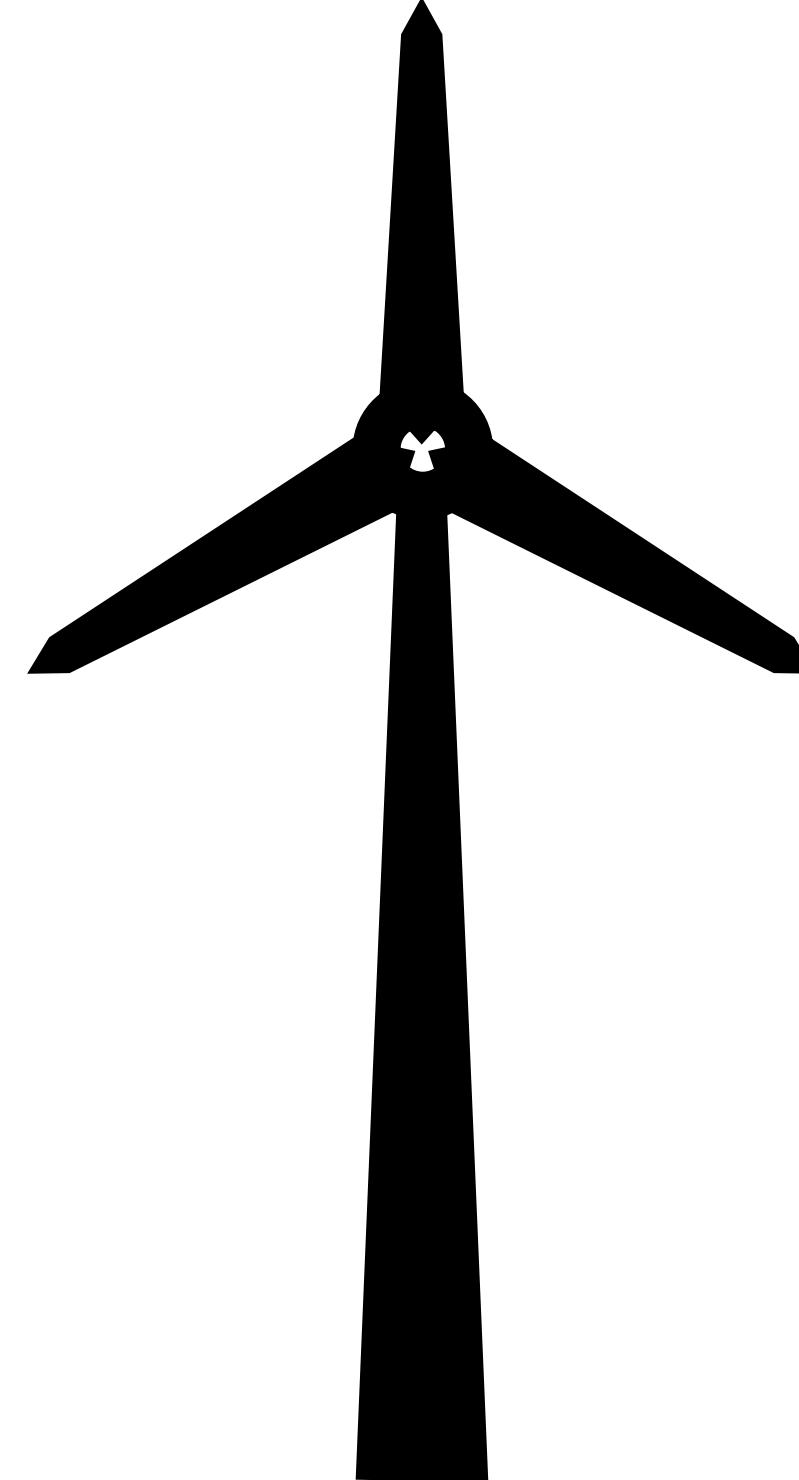


Storage is different: Embodied >>> Operational



Little dynamic power variation per day
Storage rack power changes <3% over a week

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Need to focus on embodied emissions



Storage is different
We need solutions to reduce emissions in storage