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Optimizing Data Center TCO: An In-depth Analysis and Sensitivity Study

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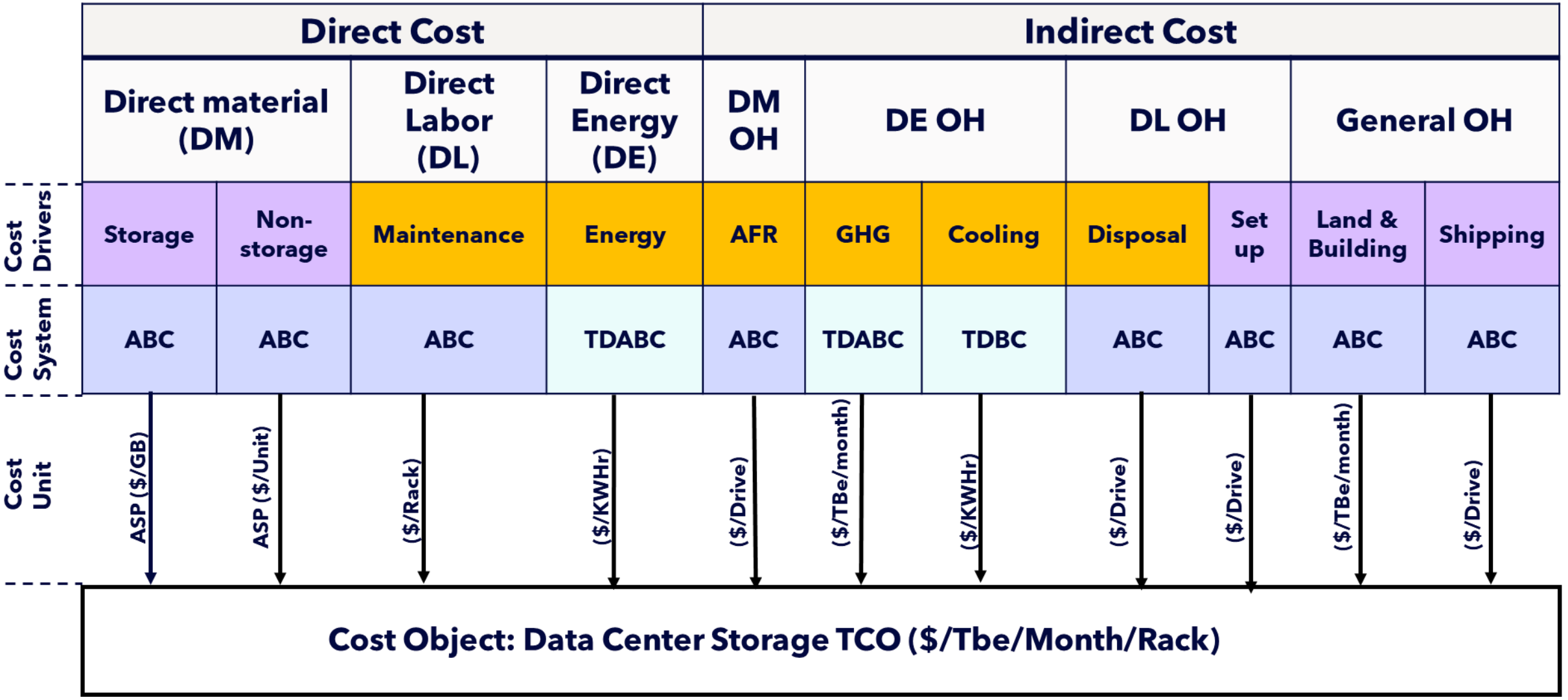
Solidigm

Cost system in TCO model

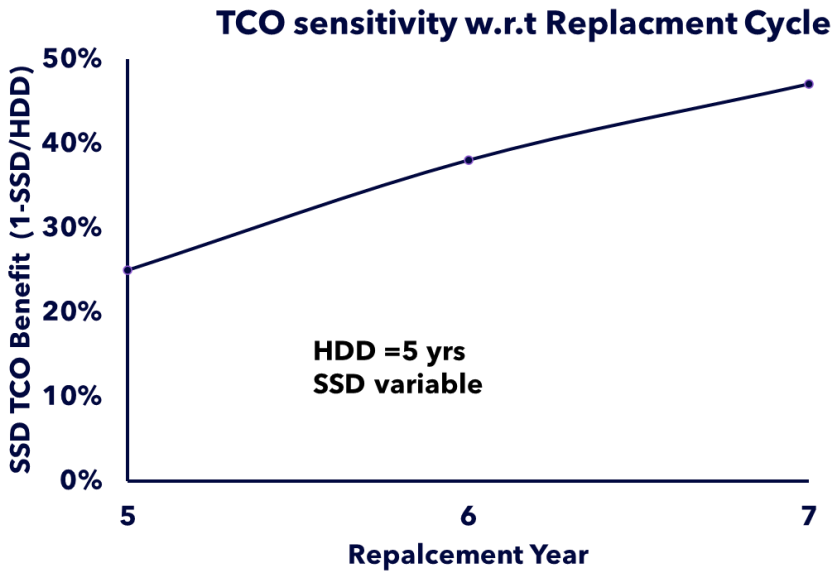


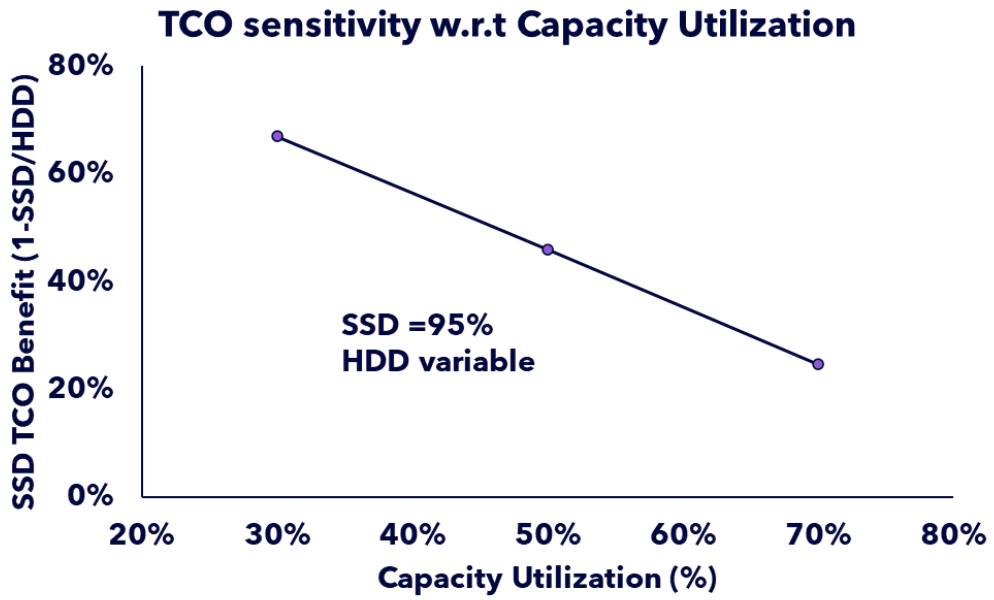
	CapEx
	OpEx
	ABC (Activity based cost)
	TDABC (Time Driven ABC)

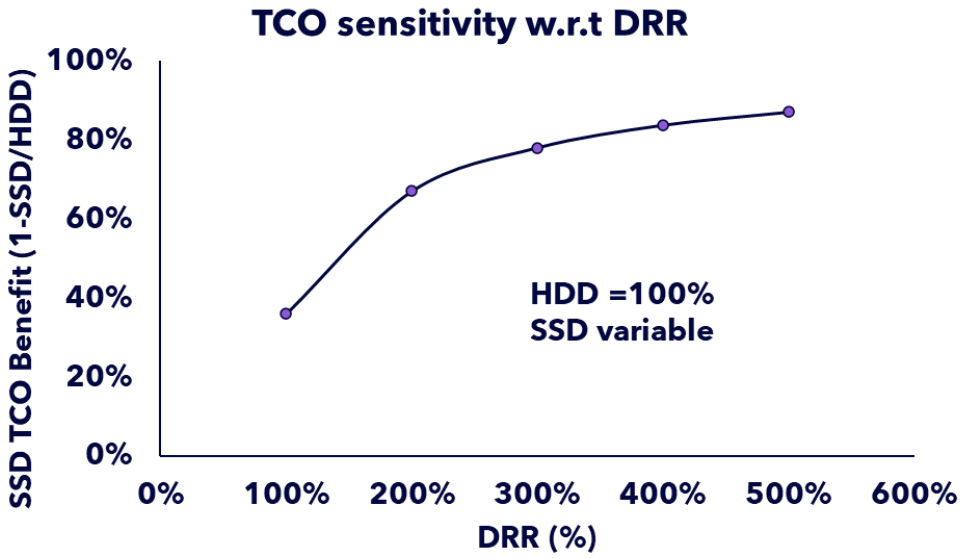
Changes in TCO model

Cost Pools	Change summary	SNIA Model	This Model	Notes
CAPEX	HW configuration	Static	Dynamic	More reliable model
	Shipping Cost		✓	Favors High density and lower weight SSDs
	Land & Building Cost		✓	
	Drive's Replacement cycle		✓	3/5/7 yr. Drive replacement
	Others	✓	✓	ASP, Drive Density
OPEX	$/KWh Idle Power Active Power Activity Factors	✓	✓	
Advanced OPEX	Workload Mix		✓	Higher Perf Tepid favors QLC
	AFR	Static	Dynamic	1.3% per 1% AFR
	TVM (Time Value of money)		✓	12% compounded monthly
	Maintenance cost		✓	
	Disposal Cost		✓	
	GHG TAX		✓	Average ~50$/lb
Choice of Architecture	In Line Data Reduction	✓	✓	
	Redundancy (RAID)	✓	✓	

TCO sensitivity Analysis







Key Takeaway:

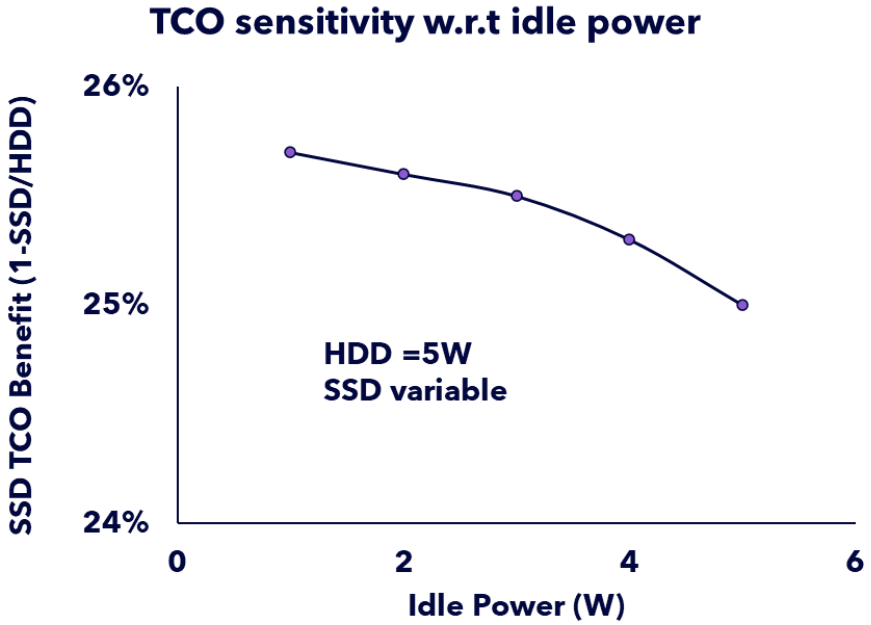
With 1x-5x DRR, TCO improves from 25-84%

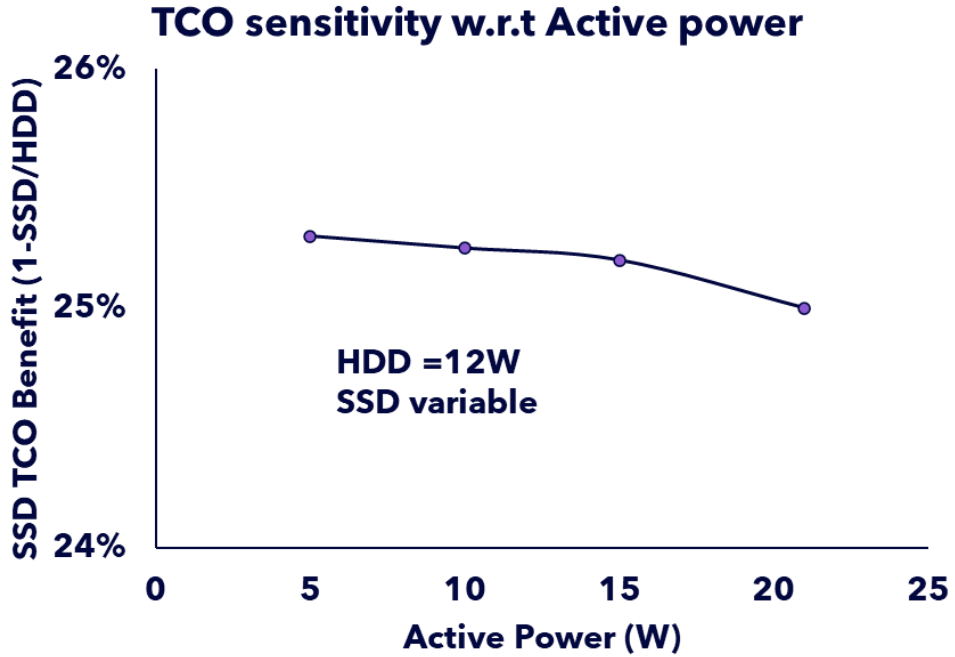
With 30-70% HDD utilization, TCO improvement from 25-67%

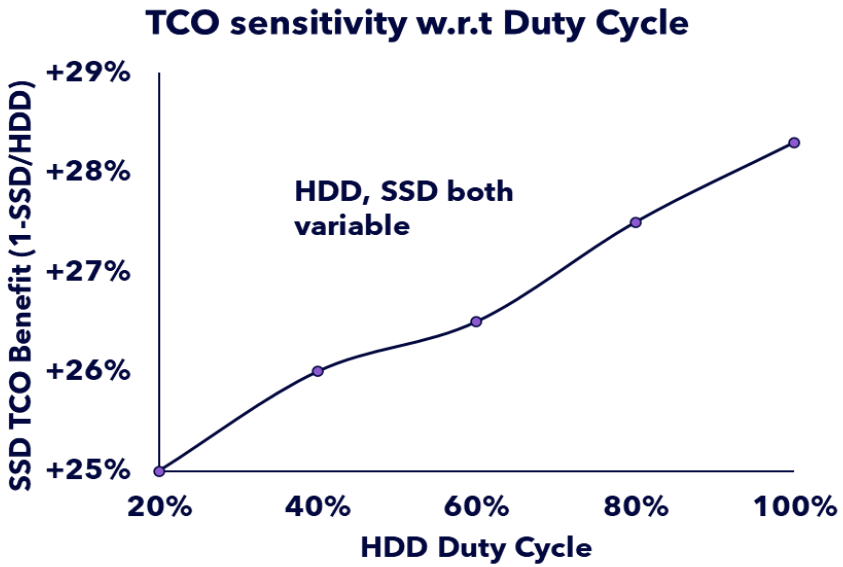
With 5-7 yr SSD replacement cycle, TCO improves from 25-47%

Sensitivity analysis was done keeping HDD and SSD at low case and Sweeping one variable at a time.
SSD ASP @4X and Density @5X compared to HDD.

TCO sensitivity Analysis



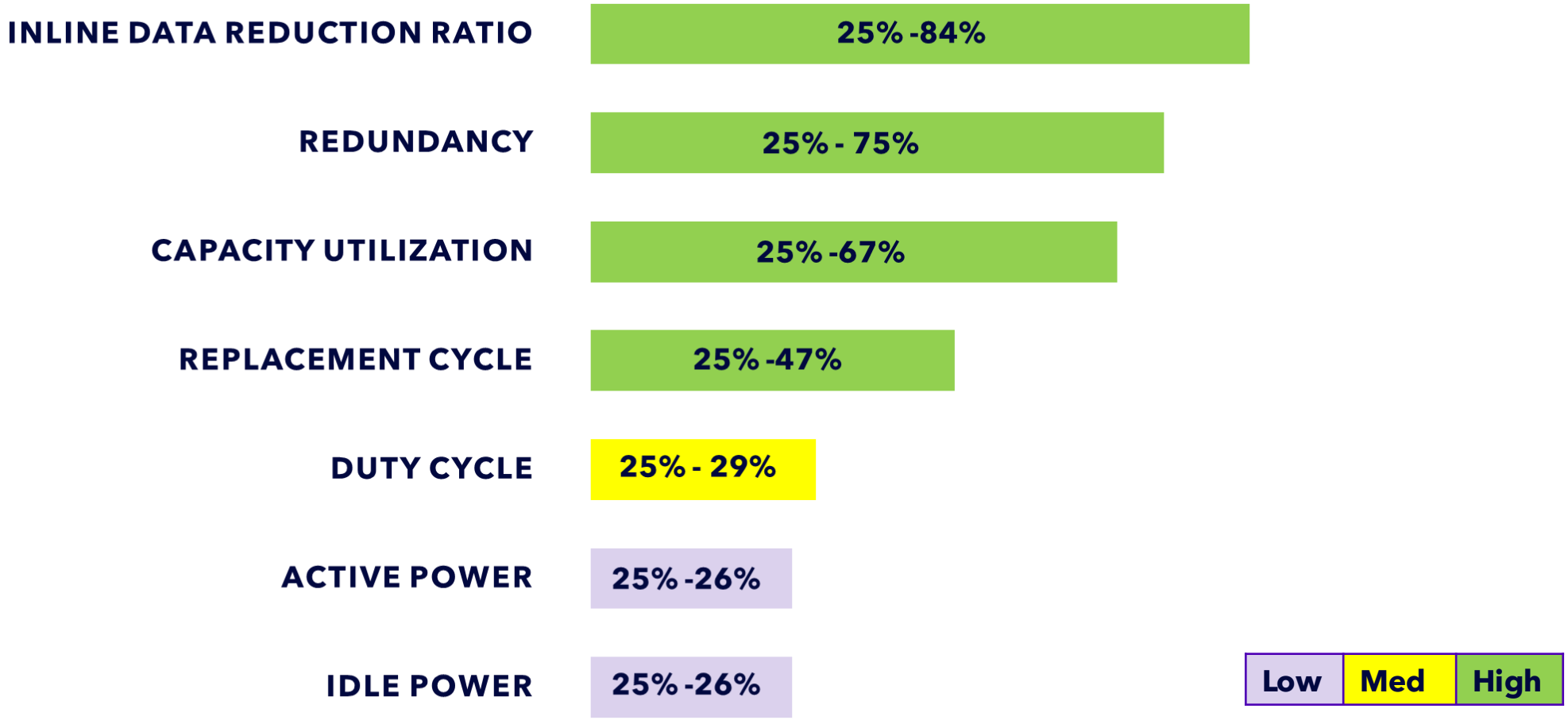




Key Takeaway:
No significant TCO improvement found w.r.t Idle and active power consumption.

Sensitivity analysis was done keeping HDD and SSD at low case and Sweeping one variable at a time.
SSD ASP @4X and Density @5X compared to HDD.

TCO sensitivity Summary



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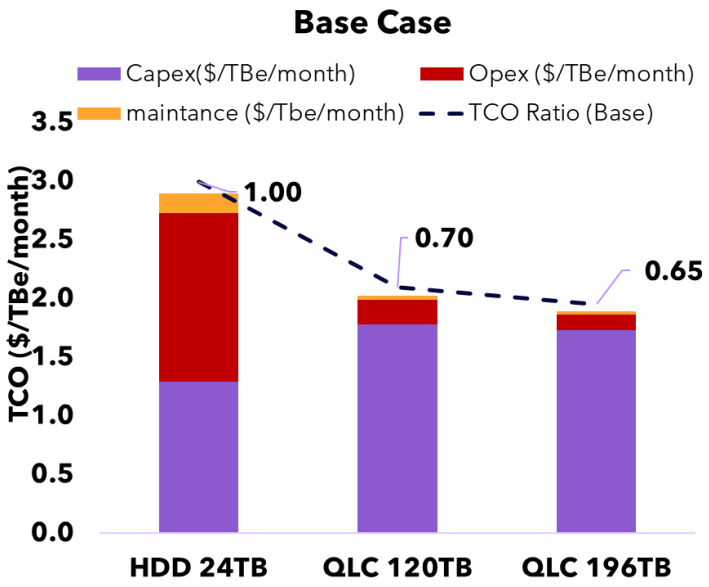
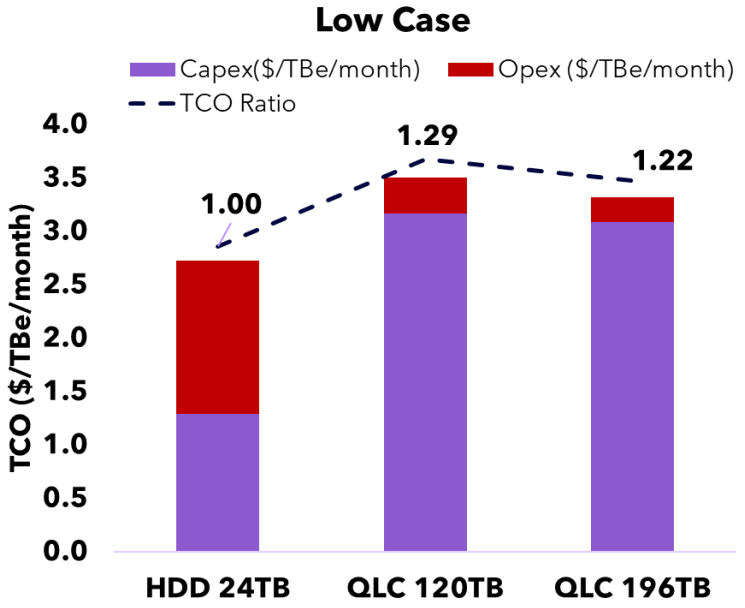
SSD ASP @4X and Density @5X compared to HDD.

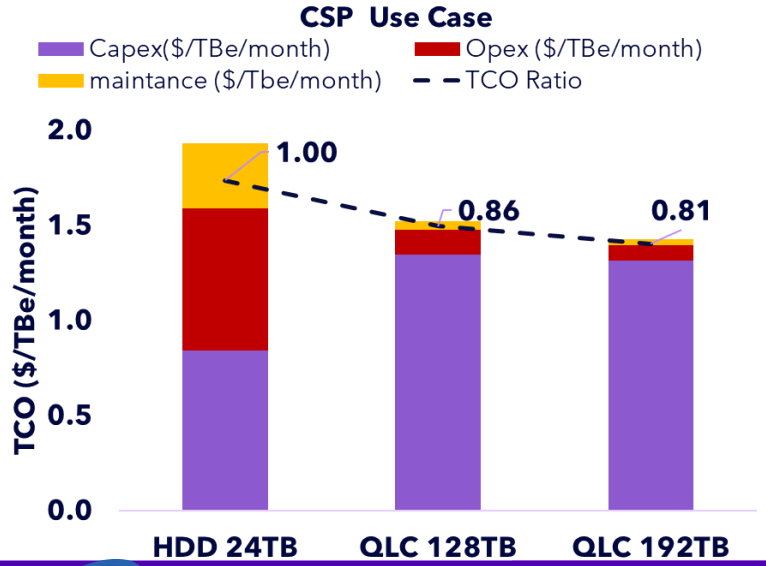
TCO Scenarios

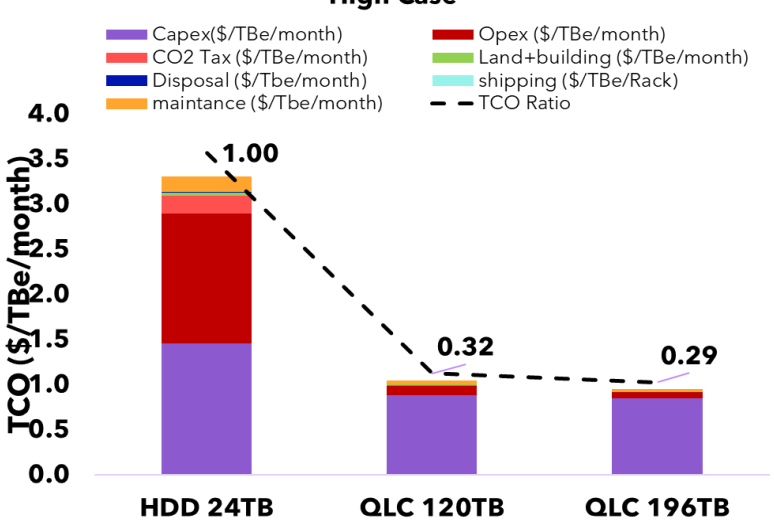
Optimization Factors	Low (Worst TCO for SSD)	Base	High (Best TCO for SSD)	CSP Use Case
Refresh cycle (yrs.)	HDD: 5 SSD: 5	HDD: 5 SSD: 6	HDD: 4 SSD: 7	HDD: 4.5 SSD: 6
Inline Data Compression	HDD: 1X SSD: 1X	HDD: 1X SSD: 1X	HDD: 1X SSD: 3X	HDD: 1X SSD: 1X
Capacity Utilization	HDD: 80% SSD: 80%	HDD: 80% SSD: 80%	HDD: 80% SSD: 95%	HDD: 80% SSD: 80%
HW Redundancy	HDD: 3 SSD: 3	HDD: 3 SSD: 2	HDD: 3 SSD: 1.14	HDD: 1.8 SSD: 1.28
Perf./TB	HDD :1 SSD :4	HDD :1 SSD :2	HDD :1 SSD :1	HDD :1 SSD :4
CapEx factors	✓	✓	✓	✓
OpEx factors	✓	✓	✓	✓
maintenance		✓	✓	✓
CO2 Tax			✓	
Land/building			✓	
Disposal			✓	
shipping			✓	

HD QLC TCO Results





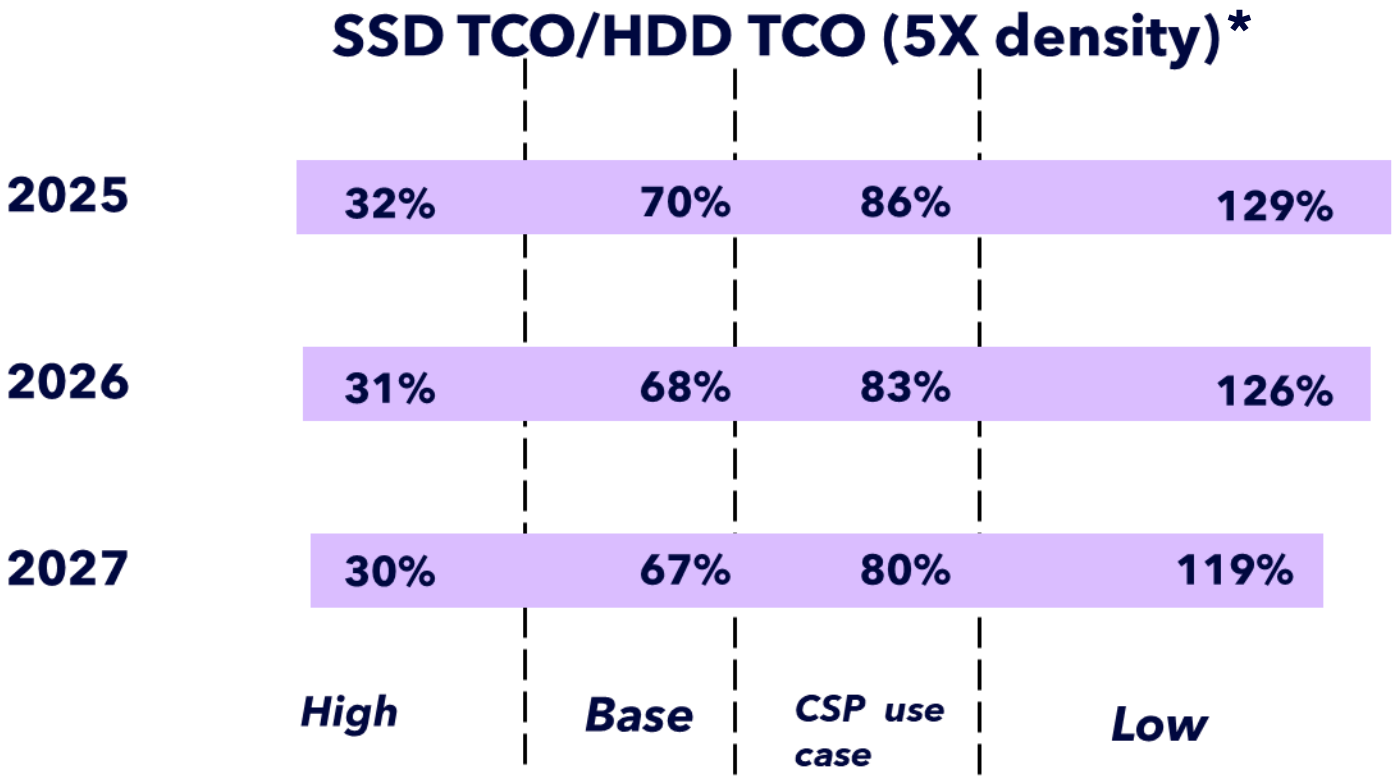




From this TCO Model analysis, we believe upcoming high-density QLC can deliver "Standard Storage SSD" value

SSD ASP @4X compared to HDD.

HD QLC TCO trends



TCO Ratio Lower is better

Key Take away:

- **Base Case shows ~30% TCO improvement @ 4X ASP with @2X perf.**
- Base case can achieve same TCO as HDD with 7X ASP with @2X Perf.

- **CSP use case shows ~14% TCO improvement @4X ASP with @4X perf.**
- CSP use case can achieve same TCO as HDD @5X ASP with @4X perf.
- 8X density shows the similar trend.

Takeaways

Key Factors Impacting TCO:

- Average Selling Price (ASP)
- Replacement Cycle
- Redundancy
- Capacity Utilization

TCO Cross-Over Trend:

- Consistent improvement starting from 2025
- Significant TCO improvement with high-density QLC

Next-Gen QLC SSDs Market Outlook:

Promising market adoption due to:

- Enhanced performance
- Longer replacement cycles
- Lower TCO

Thank you.