

# Carbon impact of HPC

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Ranking list of HPC machines every 6 months

Two main metrics:

- Rpeak: specification on CPU/GPU
- Rmax: based on the run of a benchmark

Based on LINPACK benchmark:

- Linear algebra
- Choice of an instance size
- Nmax: size of the best instance that obtain Rmax FLOPS

# Data of Top500

Rank	1
Previous rank	0.906
First appearance	1
First rank	1
Name	0.806
Computer	1
Site	1
Manufacturer	1
Country	1
Year	1
Segment	1
Total Cores	1
Accelerator/Co-Processor Cores	0.376
Rmax	1
Rpeak	1
Nmax	0.988
Nhalf	0.034
HPCG	0.226
Power	0.376

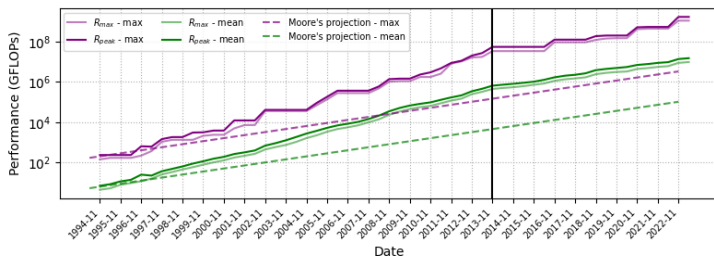
Power Source	0.376
Energy efficiency	0.376
Memory	0.002
Architecture	1
Processor	1
Processor Technology	1
Processor Speed	1
Operating System	1
OS Family	1
Accelerator/Co-Processor	1
Cores per Socket	1
Processor Generation	1
System Model	1
System Family	1
Interconnect Family	1
Interconnect	1
Continent	1
Site ID	1
System ID	1

# Data of Top500

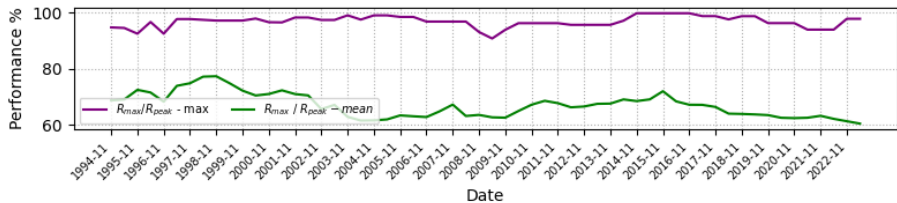
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# performance increase



# Rpeak vs Rmax

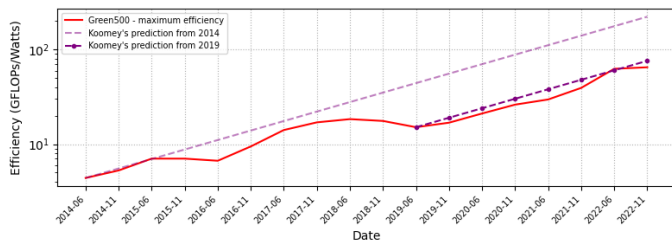


# Different benchmarks

			2010-2014	2014-2018	2018-2022
Top500	$R_{max}$ (FLOPS)	top 1	13.20	4.24	7.68
		top 5	11.19	4.72	5.26
		top 15	8.50	4.53	4.75
		top 500	7.07	4.58	3.44
	HPCG (FLOPS)	top 1	-	-	5.47
		top 5	-	-	6.11
		top 15	-	-	5.03
		top 500	-	-	4.99
Graph500	BFS (TEPS)	top 1	-	1.32	3.29
		top 5	-	1.50	1.79
		top 15	-	1.57	1.76
	SSSP (TEPS)	top 1	-	-	11.81
		top 5	-	-	54.18
		top 15	-	-	186.98

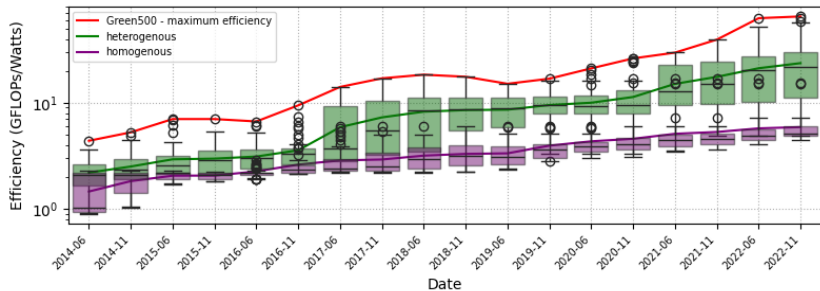
**Table:** Ratio of increase over 4 years periods per list between 2010 and 2022 in Top500 and Graph500.

# Energy efficiency

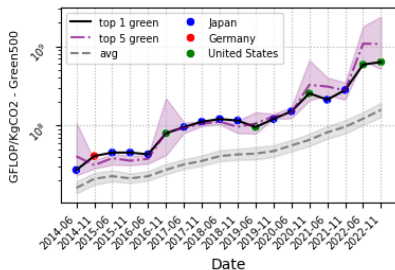
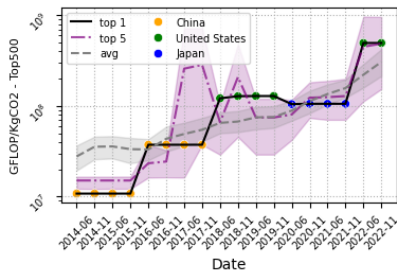




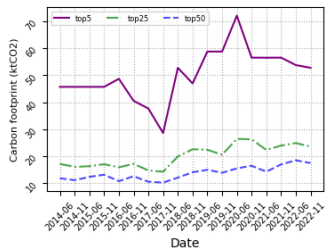
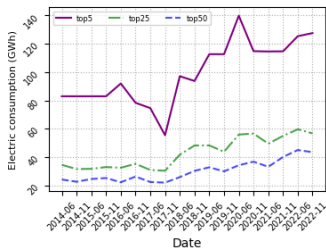
# Energy efficiency



# Carbon efficiency



# Emission per machine

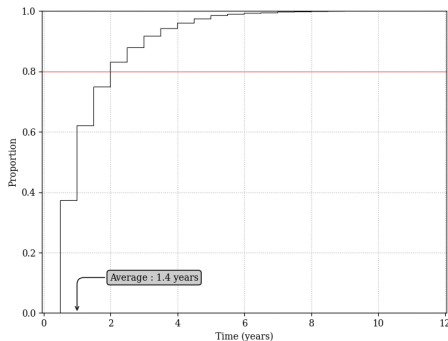


# Age of HPC

Mean time in TOP500 of 1.4 years

80% below 2 years

But how many times do they last?  
How many times per CPU/GPU?



# Age of HPC

