



Modelling the Power Consumption of Scientific Computing

Dr Jack Coker

Step-up: Developing a Sustainable Research Computing Environment at UK Universities, July 2026



Background

Computing is a fundamental pillar of modern science, but...

Computing is one of the main ways science contributes to climate change

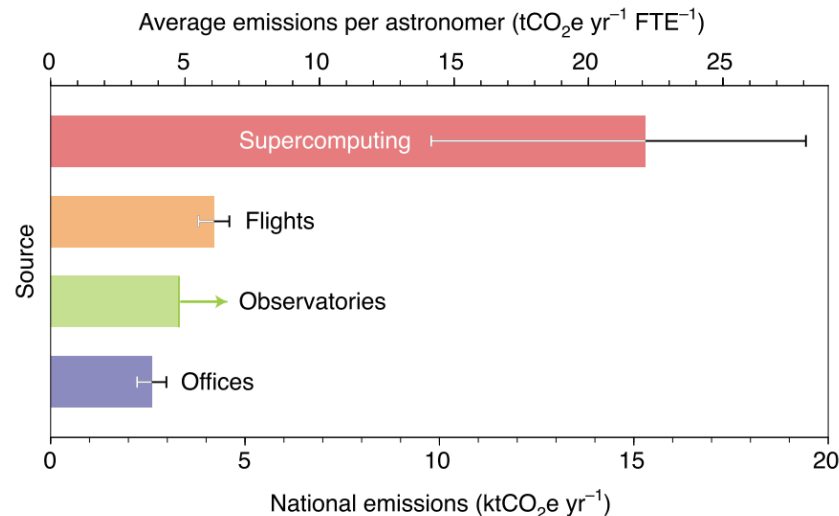
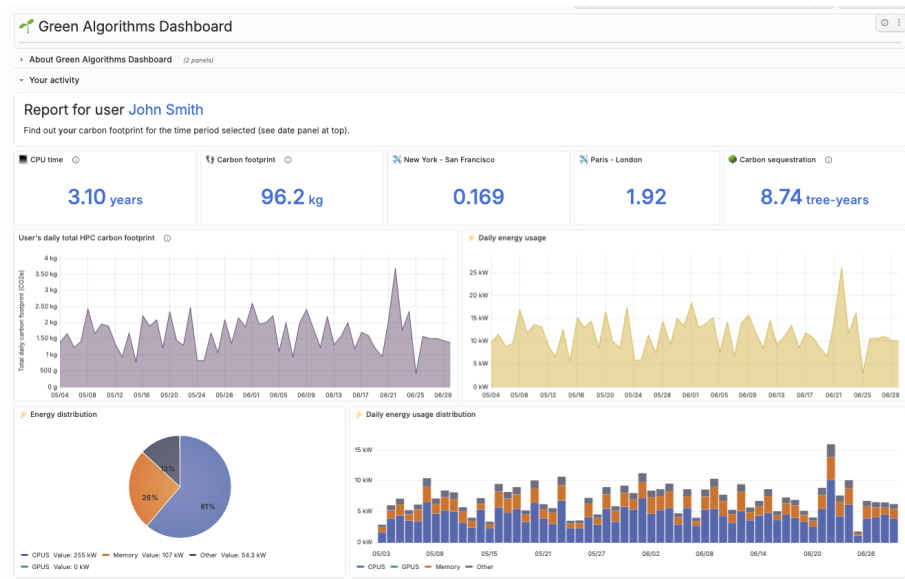
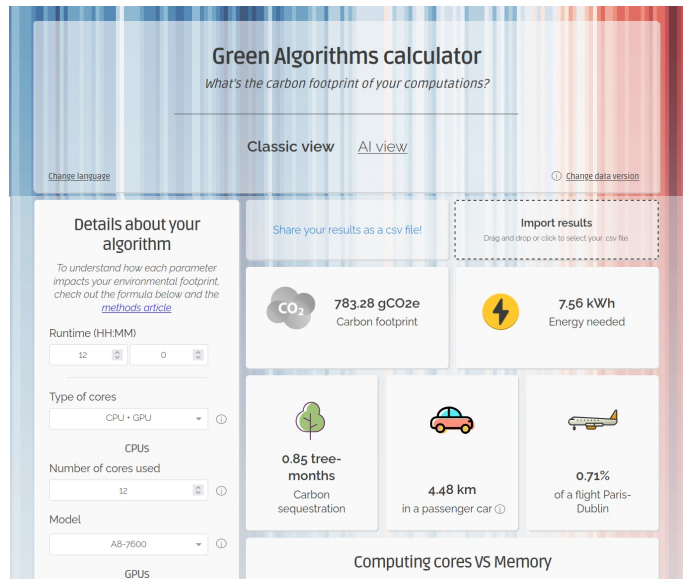


Fig. 2 | Breakdown of the four sources of Australian astronomers' emissions considered in this work.

What we do at cambridge sustainable computing lab

We study the environmental impact of computational work and develop tools to help researchers measure their impact



Power measurement tools

Measurement is (relatively) easy, but...



Hardware
devices



```
→ ~ sudo perf stat -a -e power/energy-pkg/,power/energy-cores/ stress-ng -c 0 -l 1
stress-ng: info: [26471] setting to a 60 second run per stressor
stress-ng: info: [26471] dispatching hogs: 8 cpu
stress-ng: info: [26471] successful run completed in 60.01s (1 min, 0.01 secs)

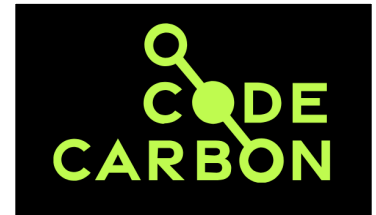
Performance counter stats for 'system wide':

    983.72 Joules power/energy-pkg/
    836.14 Joules power/energy-cores/

    60.018345776 seconds time elapsed
```

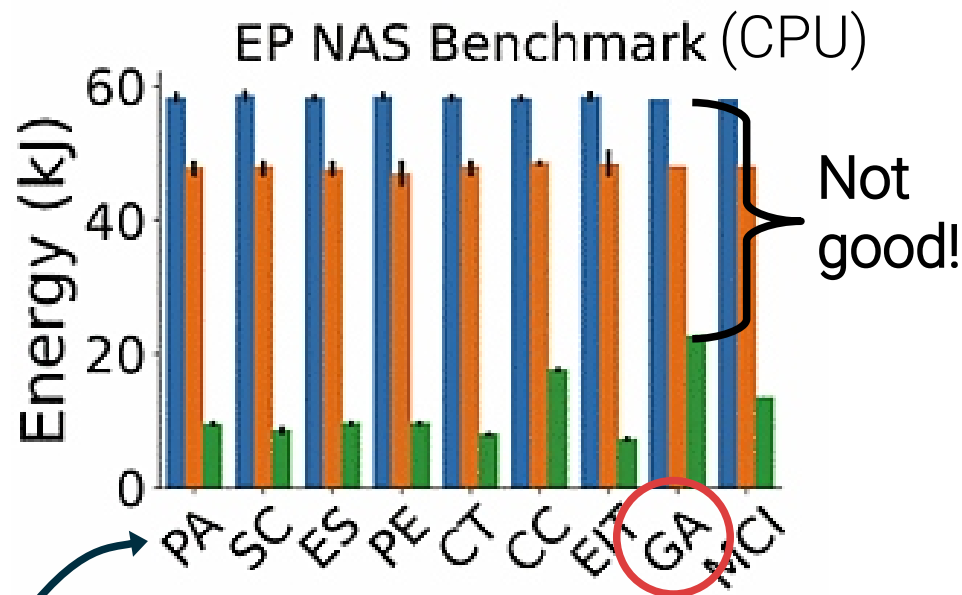
Perf (RAPL)

Performance
counters



Model-based power estimation

...prediction is hard



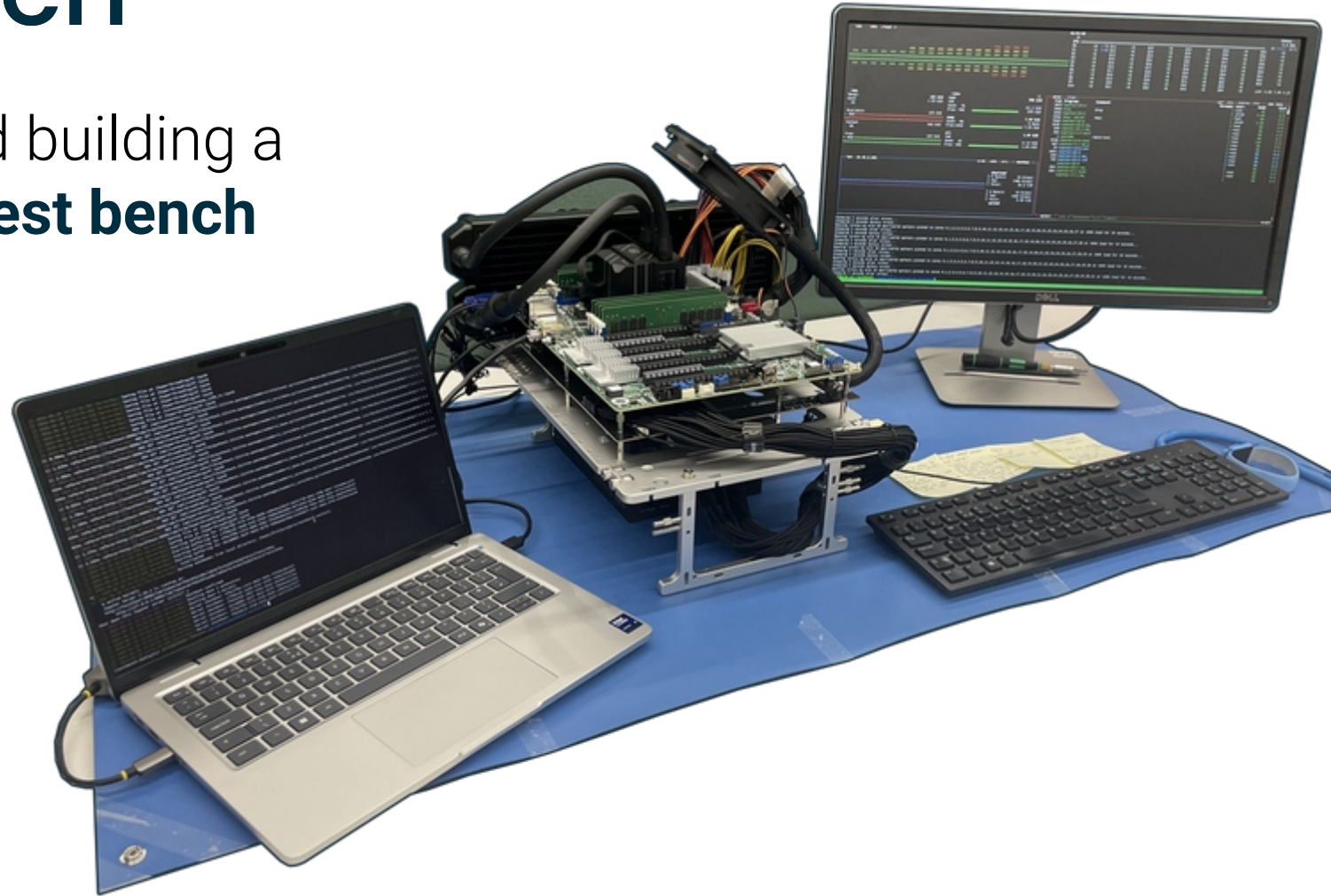
All **models** perform poorly against **hardware measurements**

Data is required to improve power consumption models

Test bench

Recently finished building a
computational test bench

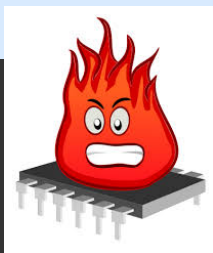
Hardware
sensors for
component-level
power readings



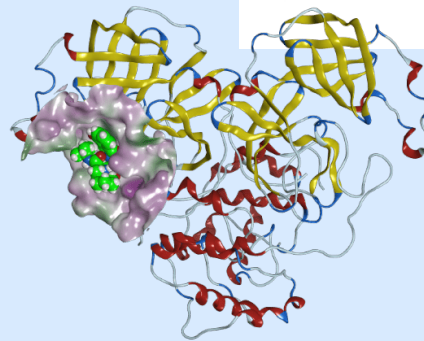
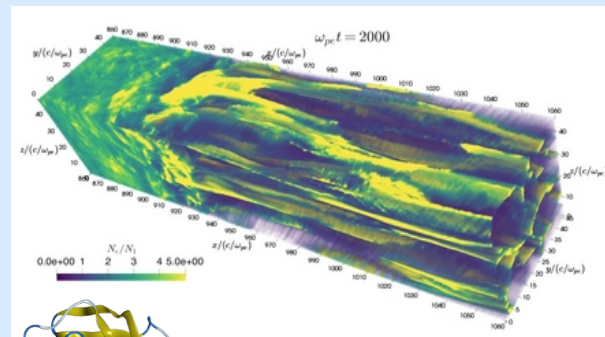
Experiments

Synthetic benchmarks (stress tests)

```
12:22:30 up 1:26, 1 user, load average: 1.08, 1.43, 1.22
[tecmint@tecmint:~]$
[tecmint@tecmint:~]$ sudo stress --cpu 8 -v --timeout 30s
stress: info: [14072] dispatching hogs: 8 cpu, 0 io, 0 vm, 0 hdd
stress: debug: [14072] using backoff sleep of 24000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 8 [14073] forked
stress: debug: [14072] using backoff sleep of 21000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 7 [14074] forked
stress: debug: [14072] using backoff sleep of 18000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 6 [14075] forked
stress: debug: [14072] using backoff sleep of 15000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 5 [14076] forked
stress: debug: [14072] using backoff sleep of 12000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 4 [14077] forked
stress: debug: [14072] using backoff sleep of 9000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 3 [14078] forked
stress: debug: [14072] using backoff sleep of 6000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 2 [14079] forked
stress: debug: [14072] using backoff sleep of 3000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 1 [14080] forked
^C
[tecmint@tecmint:~]$
```



Scientific workloads



Experiments

Synthetic benchmarks (stress tests)

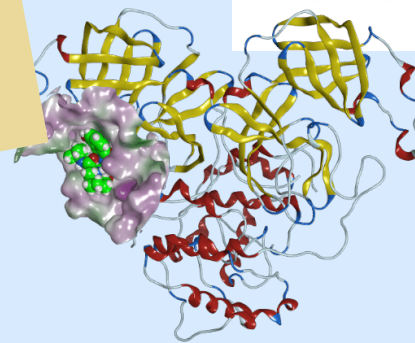
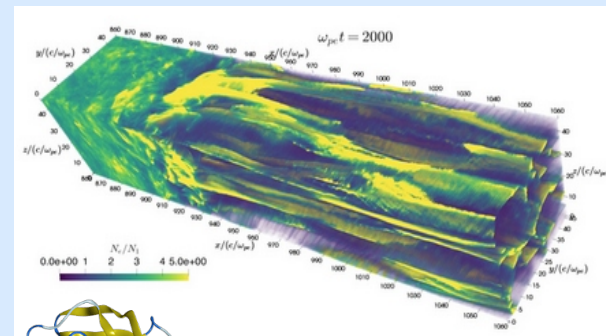
```
12:24:30 up 1:26, 1 user, load average: 1.08, 1.08, 1.08
[140700@tecmini:~]$
[140700@tecmini:~]$ sudo stress --cpu 8 --time 1m
stress: info: [14072] dispatching hogs: 8 cpu, 0 io, 0 memory
stress: debug: [14072] using backoff sleep of 24000
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 8 [14073] forked
stress: debug: [14072] using backoff sleep of 21000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 7 [14074] forked
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stress: debug: [14072] --> hogcpu worker 2 [14079] forked
stress: debug: [14072] using backoff sleep of 3000us
stress: debug: [14072] setting timeout to 30s
stress: debug: [14072] --> hogcpu worker 1 [14080] forked
^C
[140700@tecmini:~]$
```

Interested in measuring your
work on the test bench?
Contact me: jfc53@cam.ac.uk

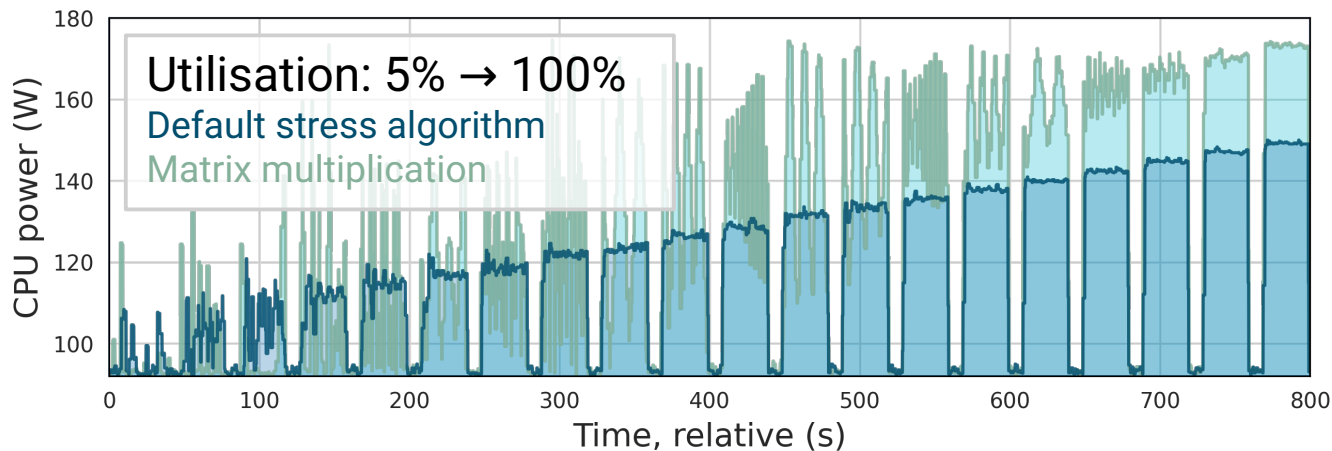
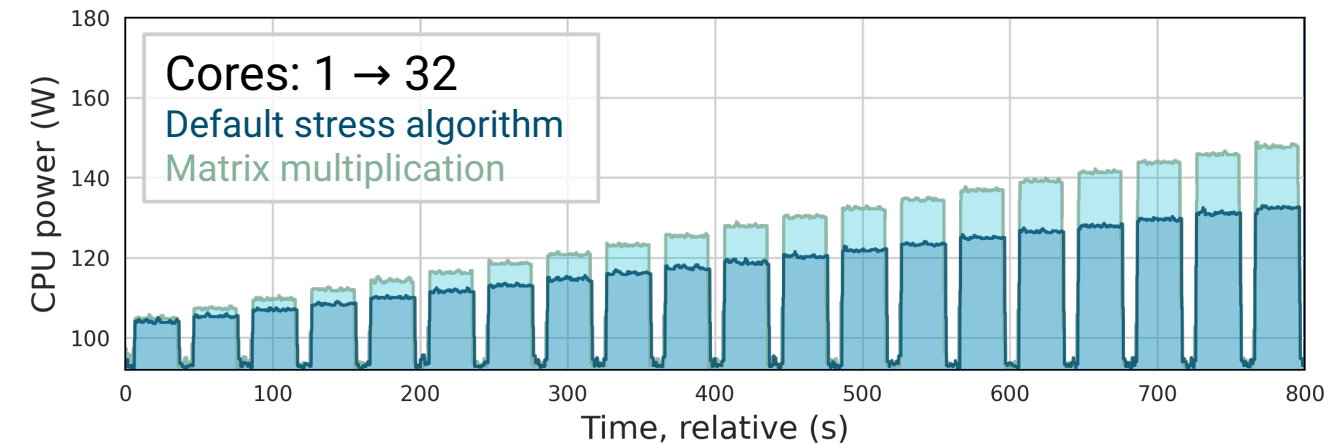


My profile website ^

Scientific workloads



Preliminary results



Test bench results

- Linear relationship between cores/util and CPU power
- But workload dependent!

Next steps

- Other components (GPU, memory, storage)
- Model development
- Benchmark against realistic scientific workloads

Thank you for listening!



Jack Coker – jfc53@cam.ac.uk

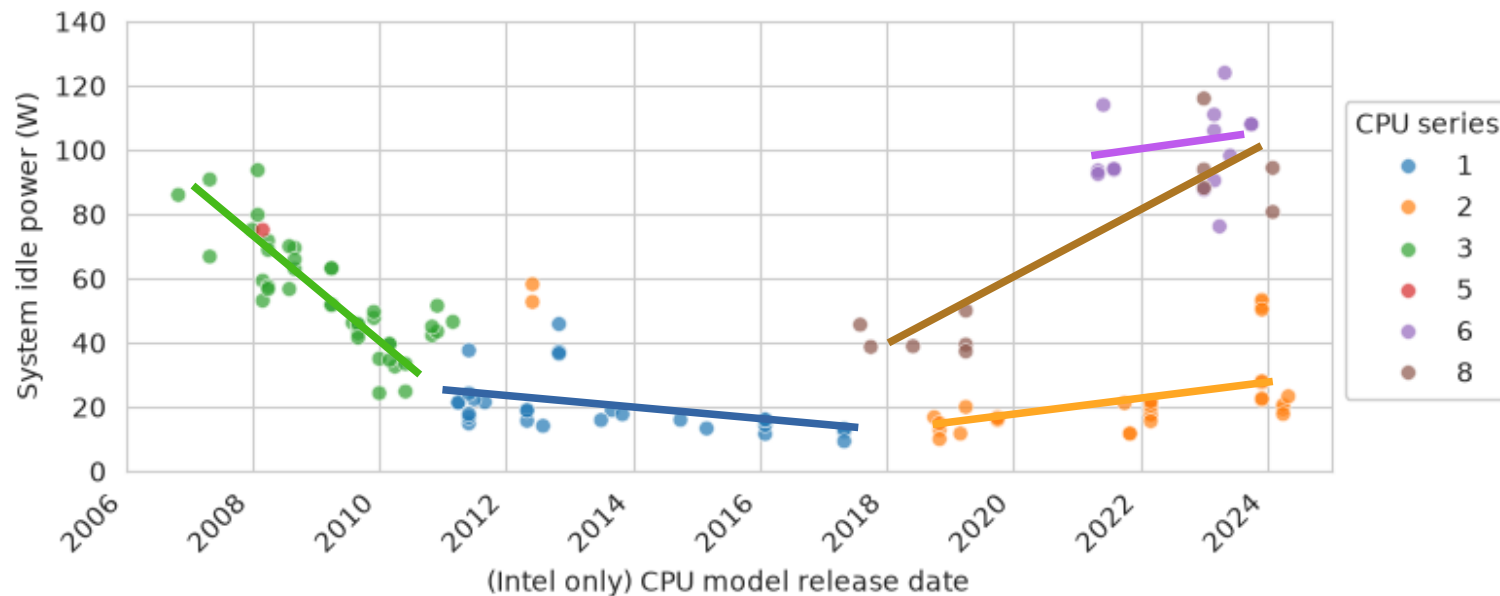


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Preliminary results: Idle power



Non-linear changes due to combination of increased computational capability (e.g. higher core-density) and improved power saving technologies. (Empirical model likely necessary)