EAR ISC2024 tutorial: Monitoring

Julita Corbalan (julita.corbalan@eas4dc.com)
Benjamin Czaja (benjamin.czaja@surf.nl)

Monitoring

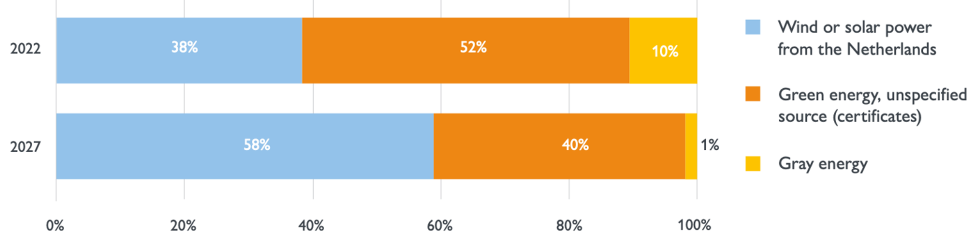
- Execution environment: Snellius
- Use cases and scripts in Snellius shared folder and Github
    - CPU use cases
    - GPU use cases
- Changing CPU frequency
    - CPU cases
- Energy efficiency vs Resource consumption
- Energy efficiency vs architecture

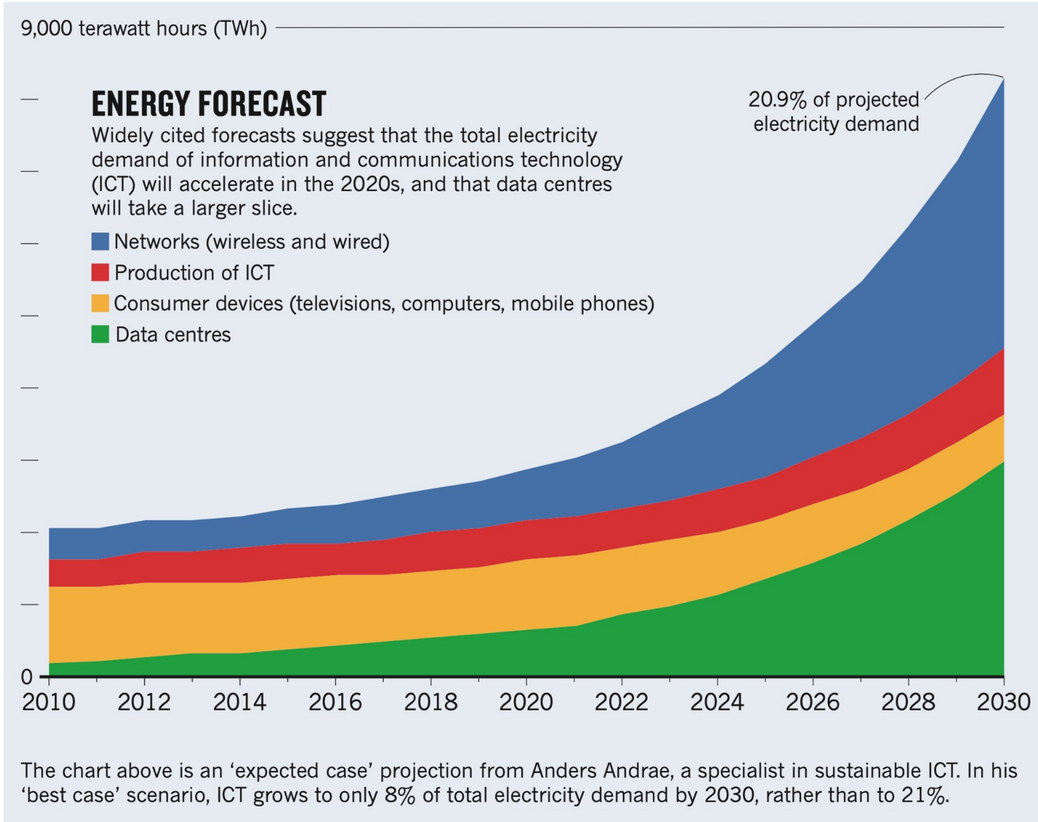
Snellius

Dutch National Supercomputer

ICT/Data center energy forecast

- Data centre energy usage:
  - ~ 200 TWh for data centres in 2018
  - ~ 3000 TWh in 2030
- Dutch Data Center Usage (2019)
  - 1300 MW installed capacity
  - 0.3 % electricity usage of the Netherlands (CBS)
  - 3x as much power than the NS
- Dutch Data center energy consumption (2022)
  - 90% of all energy consumed by colocation data centers is green.





- Jones, Nicola. "How to stop data centres from gobbling up the world's electricity." *Nature* 561.7722 (2018): 163-166.
- Andrae, Anders SG, and Tomas Edler. "On global electricity usage of communication technology: trends to 2030." *Challenges* 6.1 (2015): 117-157.
- Bakkeren, Hanno. "Datacenters verbruiken drie keer zoveel stroom als de NS". NRC, 14 May 2019
- State of the Dutch Data Centers, The Dutch Data Center Report, 2022, https://www.dutchdatacenters.nl/

Snellius - Dutch National supercomputer

- AMD Rome (EPYC 7H12)
  - 500 nodes (128 cores-per-node)
  - 2.1 PFlop/s 0.5MW
- AMD Genoa (EPYC 9654)
  - 786 nodes (192 cores-per-node)
  - 5.4 PFlop/s 0.8 MW
- NVIDIA A100
  - 72 nodes (4 NVIDIA A100 SXM4 40 GB)
  - 3.6 PFlop/s. 0.2 MW

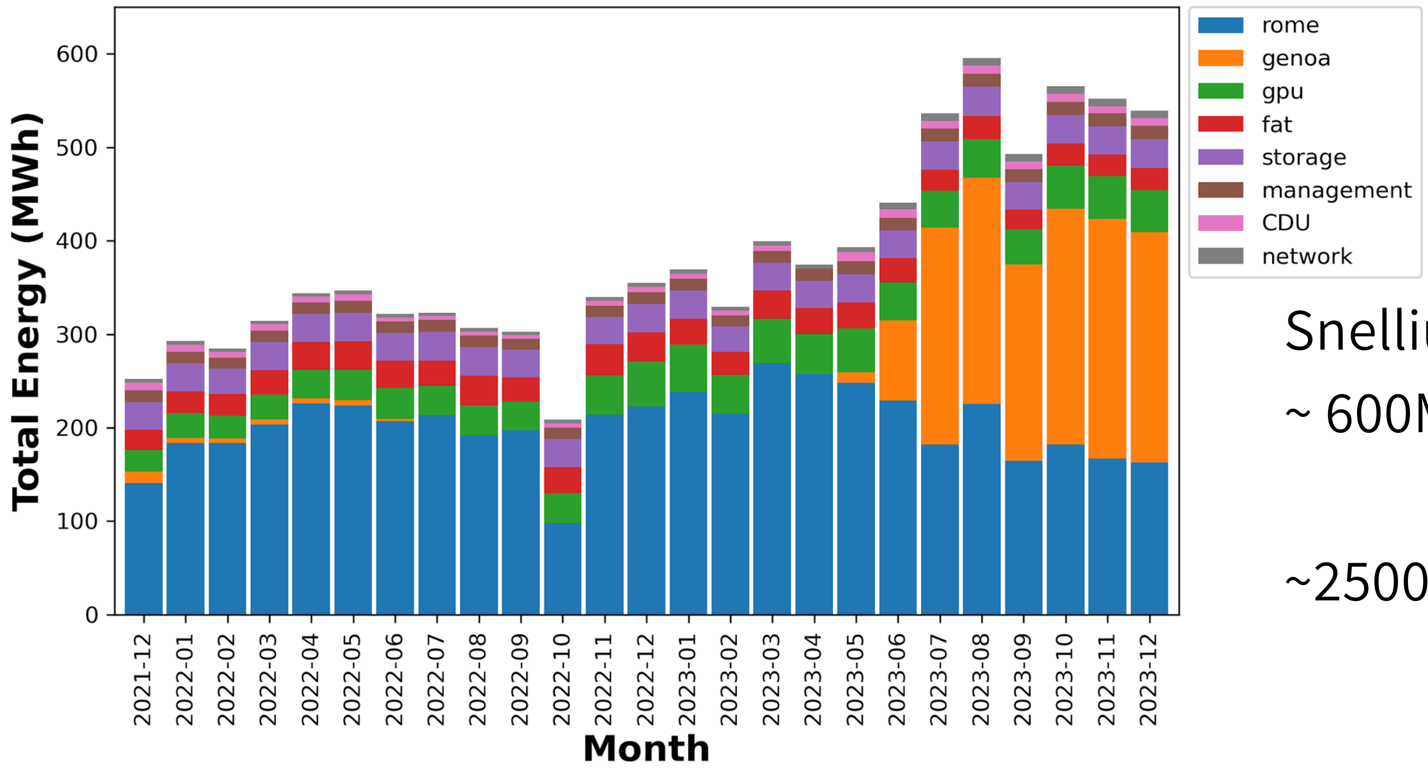
Top 500 (Nov-2023)

1. Frontier (22.7 MW) 1,194.0 PFlop/s
2. Aurora (24 MW) 585.34 PFlop/s
3. Eagle (??) 561.20 PFlop/s
4. Fugaku (29.9 MW) 442.01 PFlop/s
5. LUMI (7.1 MW) 379 PFlop/s

Snellius

~ 11.1 Pflops (1.5 MW)

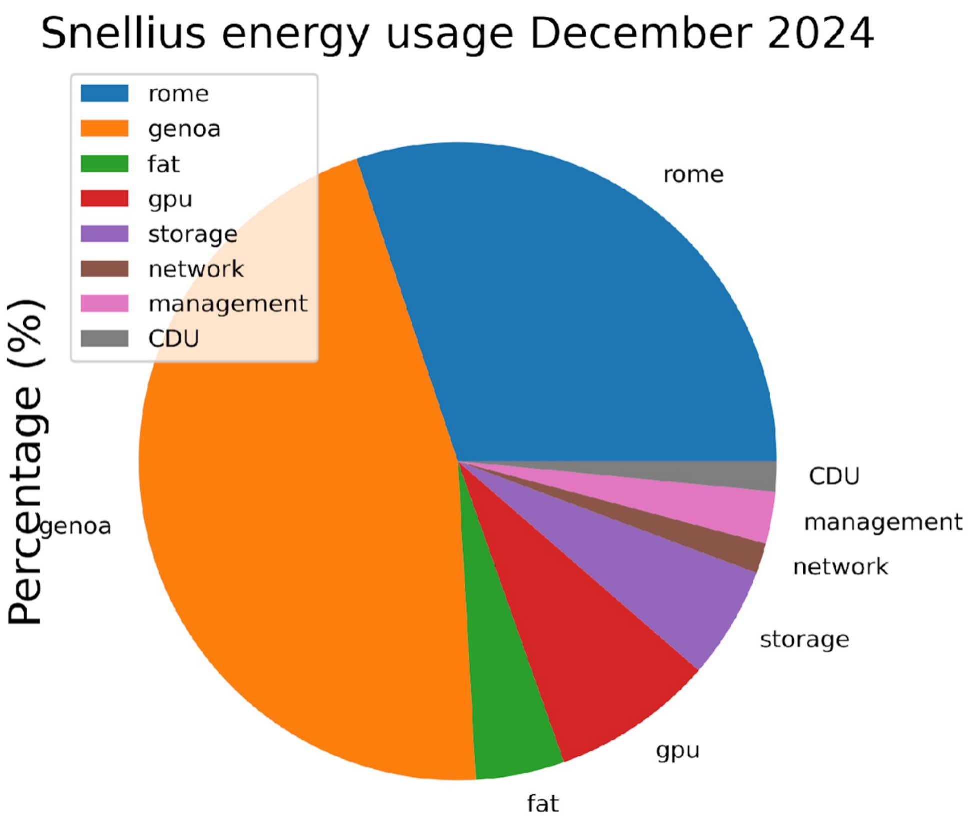
Snellius - Total Energy Usage



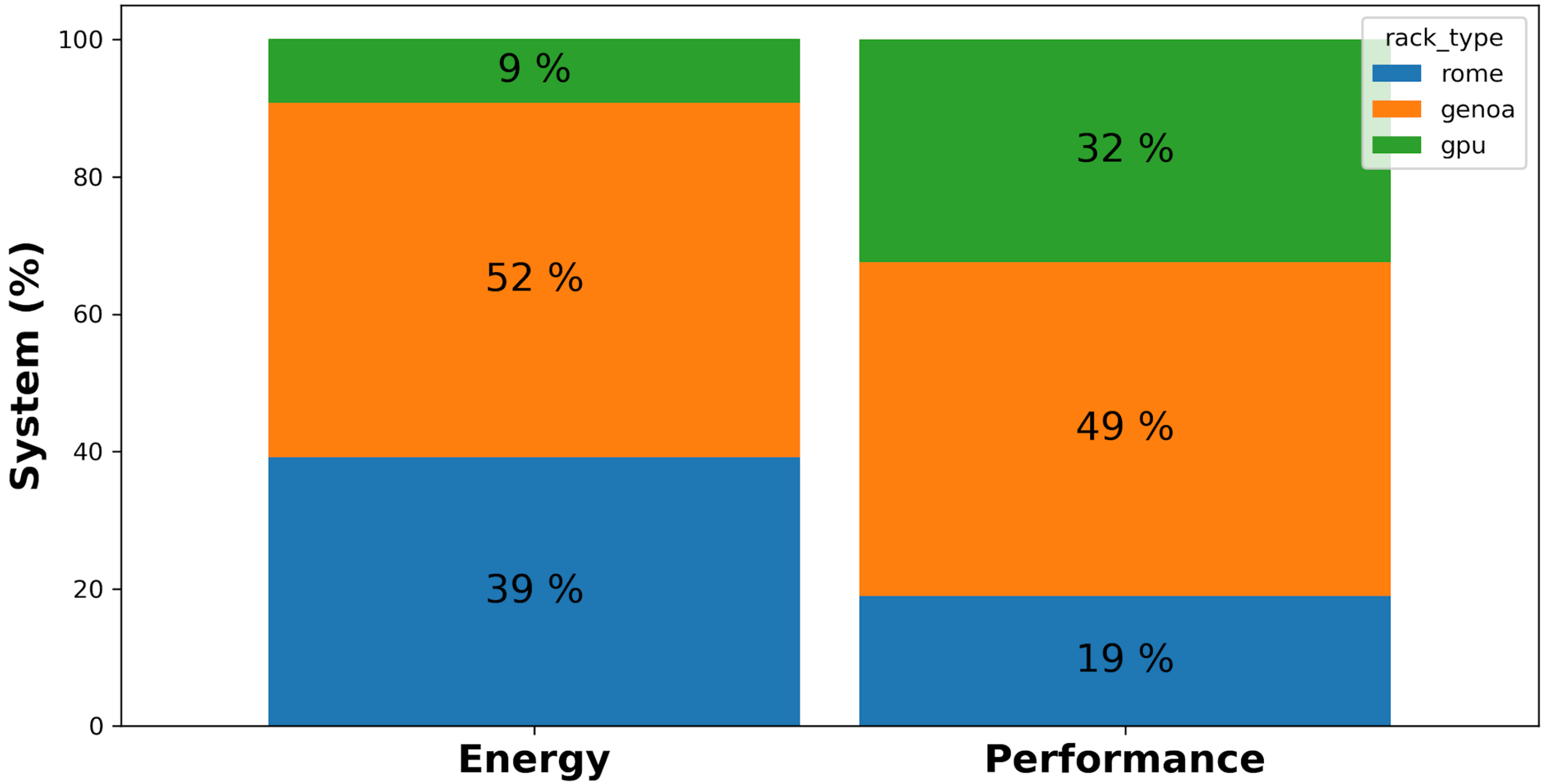
Snellius in December used ~ 600MWh of energy.

~2500 house holds worth

Snellius - Energy usage per partition

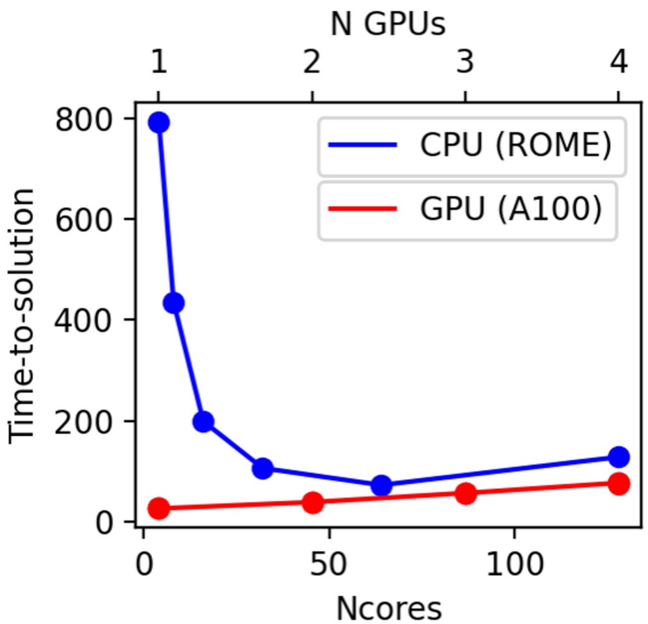


- 88% Compute
  - 80% CPU
    - 34% Rome (3% fat)
    - 45% Genoa
  - 8% Gpu
- 12% Other
  - 5.0% Storage
  - 2.6% Management
  - 1.5% Cooling
  - 1.5% Network



System (%)
100
80
60
40
20
0
9 %
52 %
39 %
32 %
49 %
19 %
rack_type
rome
genoa
gpu
Energy
Performance

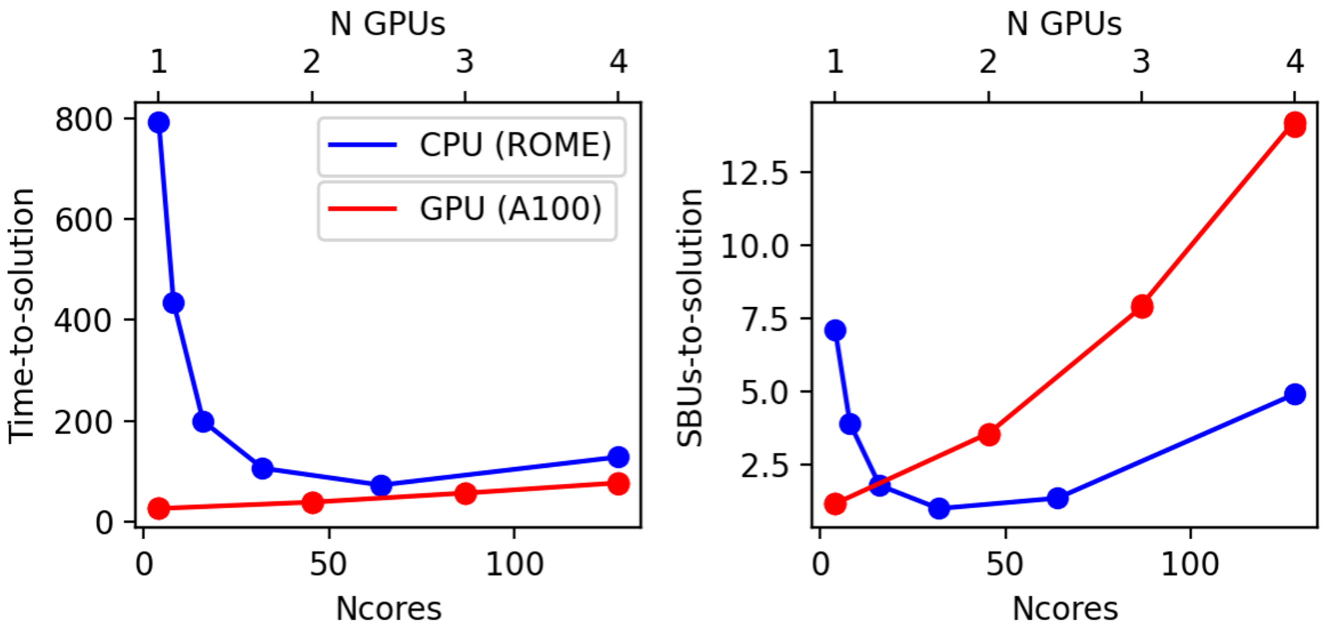
HemeLB:
A Computational Science Use-case



Performance:
1 NVIDIA A100 GPU

HemeLB:

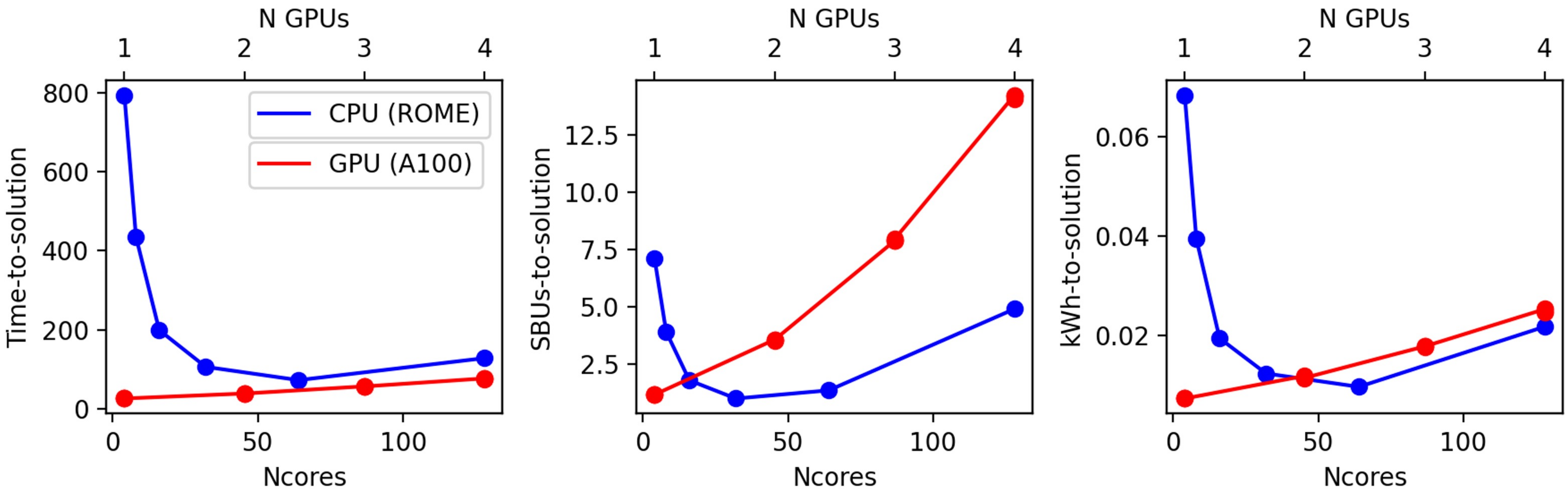
A Computational Science Use-case



Performance:
1 NVIDIA A100 GPU

Budget:
32 AMD Rome cores

HemeLB:
A Computational Science Use-case



Performance:
1 NVIDIA A100 GPU

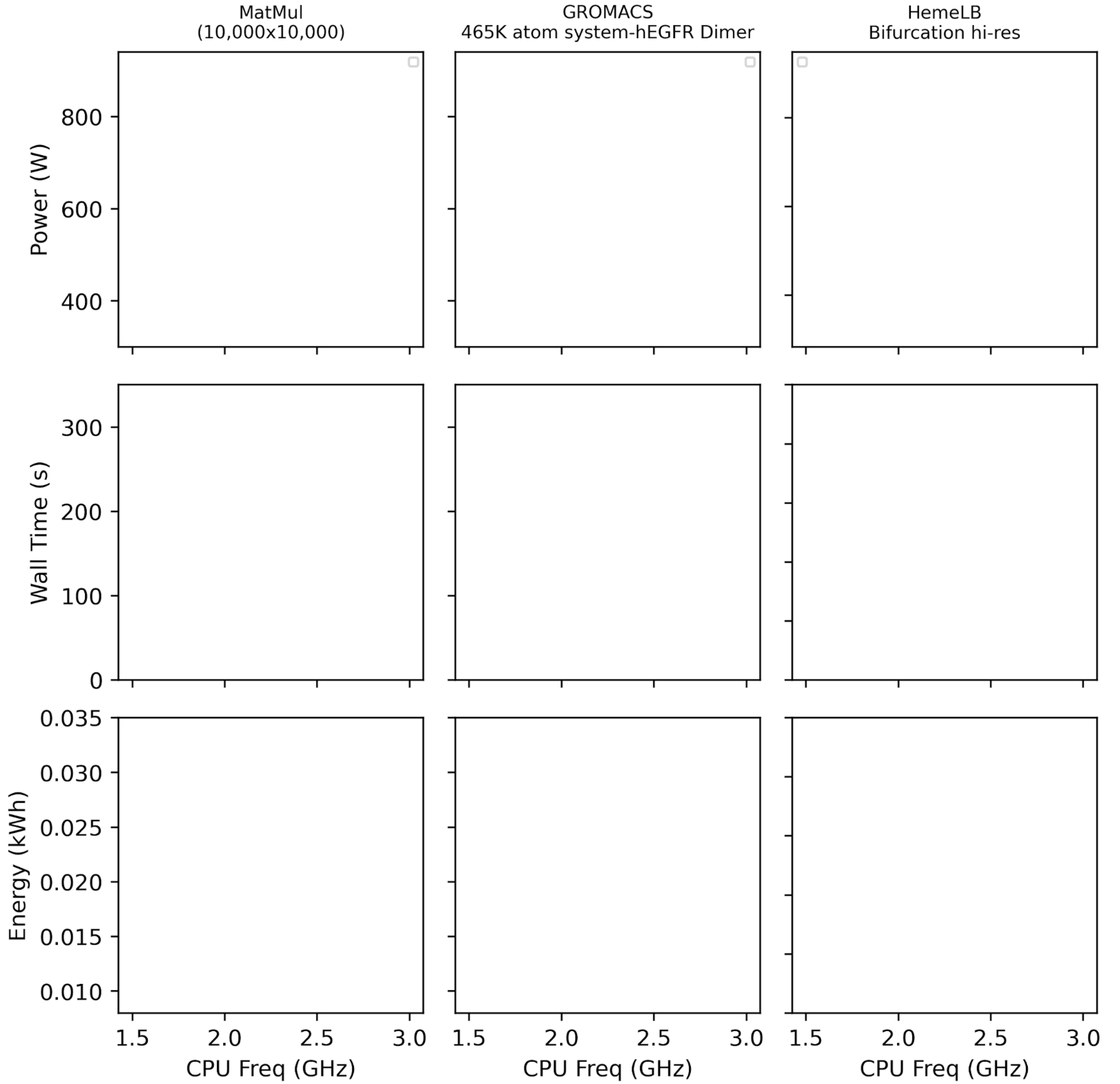
Budget:
¼ AMD Rome

Energy:
1 NVIDIA A100 GPU

Dynamic Voltage Frequency Scaling on Snellius:

To boost, or not too boost, that is the question

- Rome “Zen2” Released 07 August 7 2019
  - Nominal Freq (2.6 Ghz)
- Genoa “Zen4” Released 10 November 2022
  - Nominal Freq (2.4 Ghz)



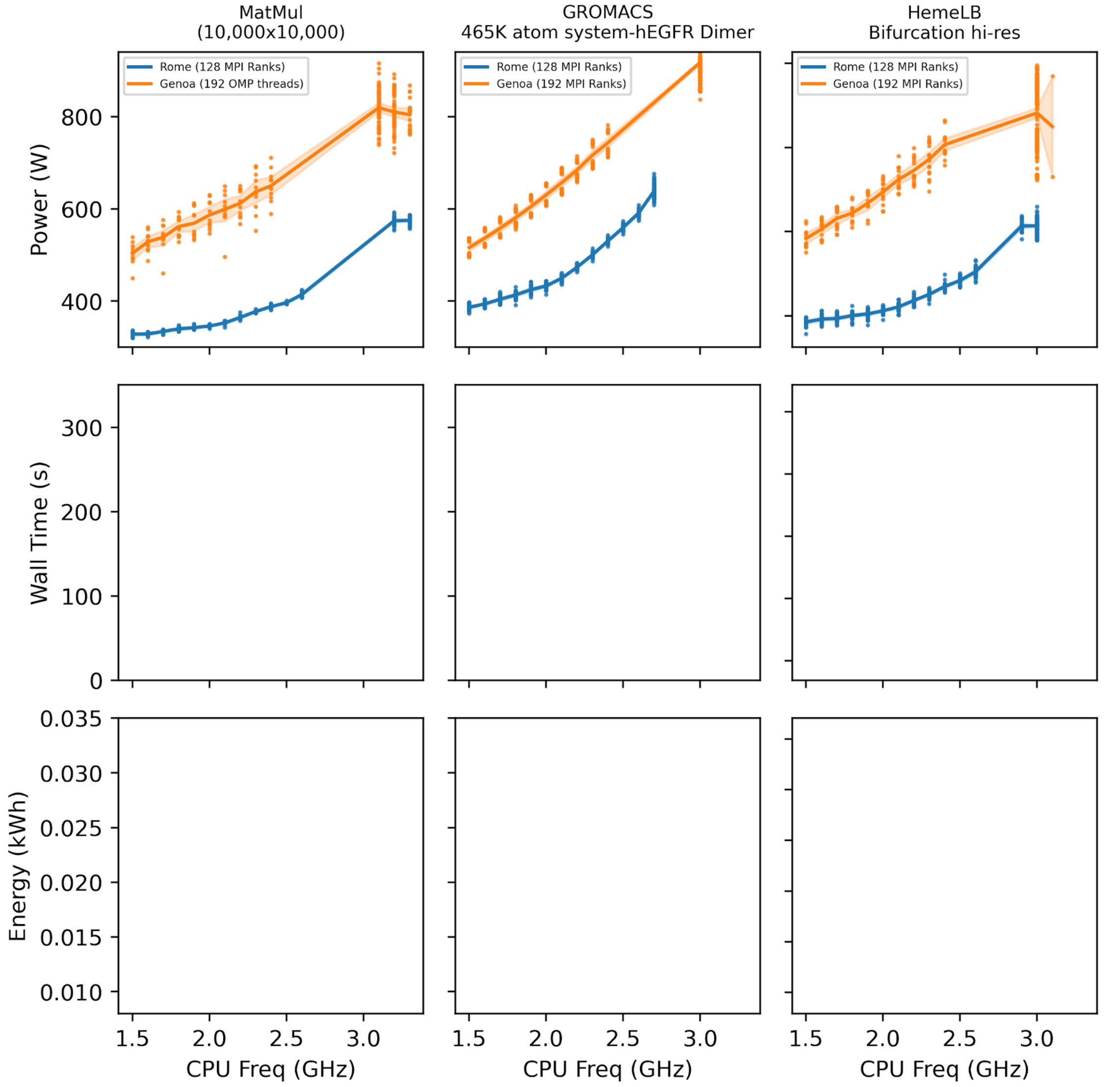
Dynamic Voltage Frequency Scaling on Snellius:

To boost, or not too boost, that is the question

- Rome “Zen2” Released 07 August 7 2019
  - Nominal Freq (2.6 Ghz)
- Genoa “Zen4” Released 10 November 2022
  - Nominal Freq (2.4 Ghz)

Observations:

1. Genoa draws more power
2. Each application has a different “power draw signature”



Dynamic Voltage Frequency Scaling on Snellius:

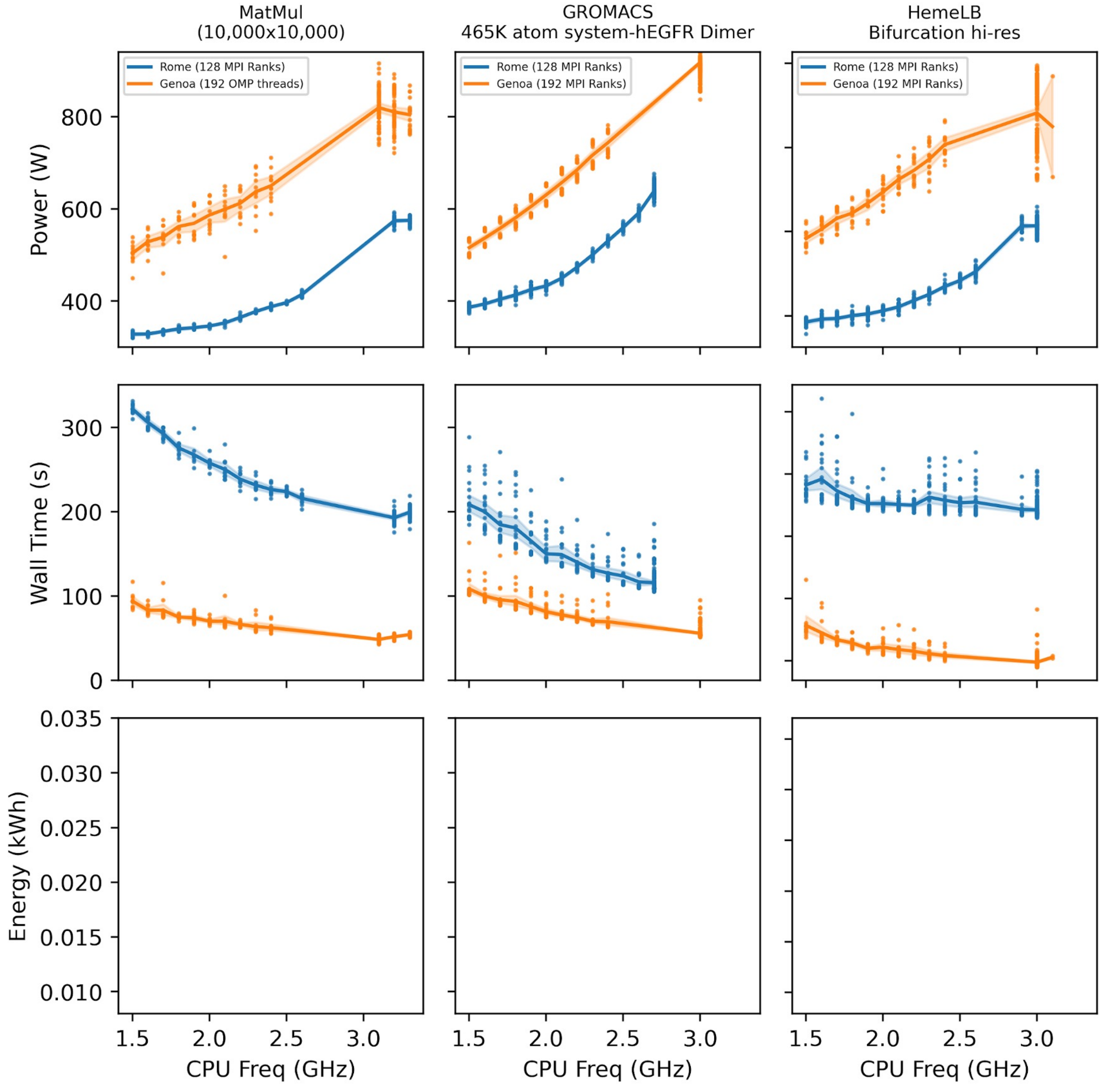
To boost, or not too boost, that is the question

- Rome “Zen2” Released 07 August 7 2019
    - Nominal Freq (2.6 Ghz)
- Genoa “Zen4” Released 10 November 2022
    - Nominal Freq (2.4 Ghz)

Observations:

1. Genoa is more performant
    - More Logical cores to devote to problem

2. In the 3 cases, Boost does not have the similar effect in performance vs power draw. i.e. its performance increase is flat as compared to its power draw



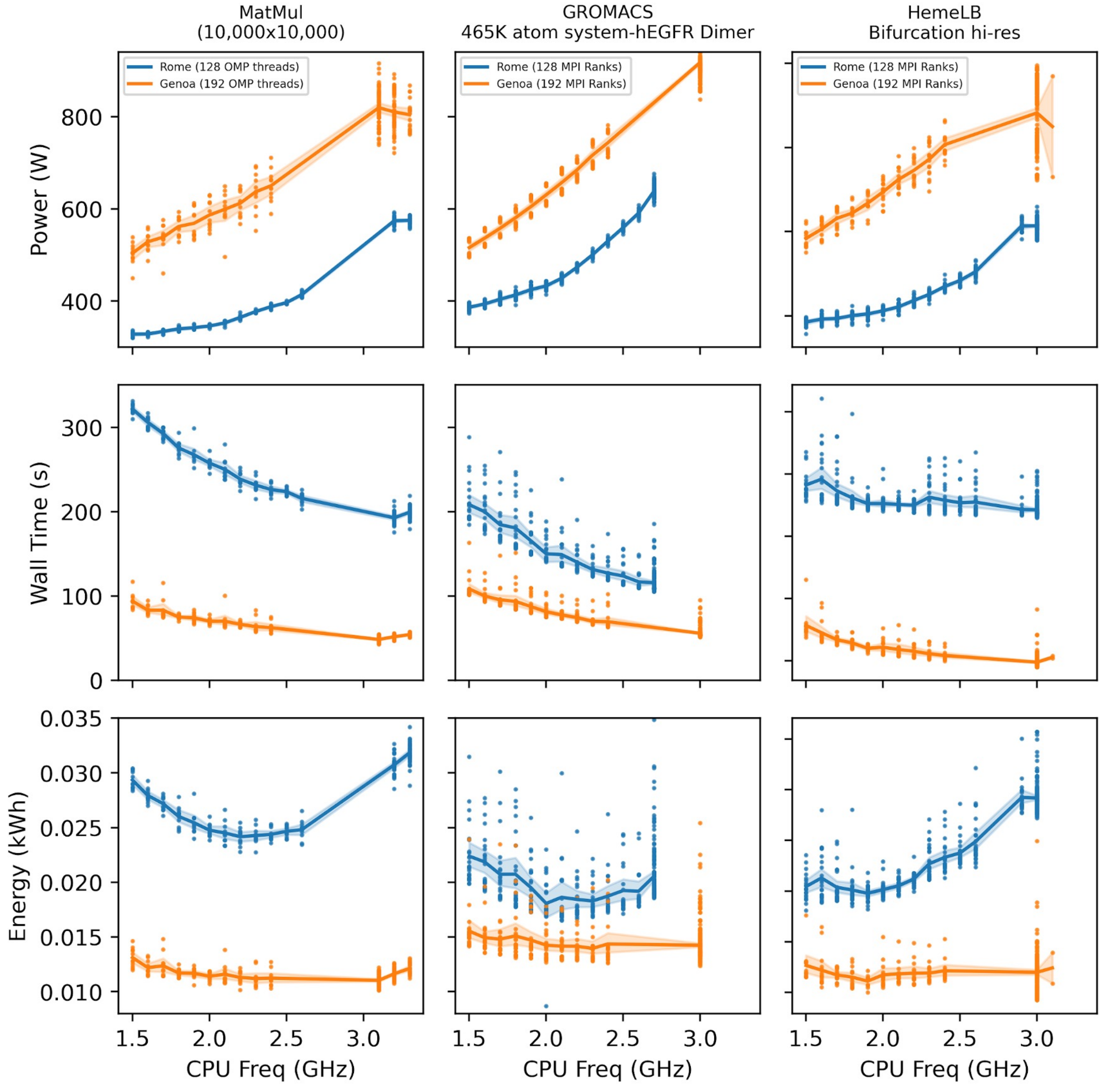
Dynamic Voltage Frequency Scaling on Snellius:

To boost, or not too boost, that is the question

- Rome "Zen2" Released 07 August 7 2019
  - Nominal Freq (2.6 Ghz)
- Genoa "Zen4" Released 10 November 2022
  - Nominal Freq (2.4 Ghz)

Observations:

1. Genoa is more energy efficient.
2. Each application has its own energy minimum.
3. **DVFS "by hand" is HARD!!!!!!!**




Exercices

1- Basic EAR monitoring

- Codes in /projects/0/energy-course
- GIT: https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main
- Get the examples and test them
  - https://github.com/sara-nl/ISC-2024-EAR-tutorial/tree/main/tutorials/monitoring_ear
  - NPB CPU use cases
  - GROMACS-GPU
  - HemePure CPU
  - HemePure GPU
  - PyTorch
  - *Or select another use case from the list*
- Wait for jobs to finalize
- Get the ear metrics
  - module load ear
  - eacct -j jobid1
- Understand the metrics

For each case

- Execute with ear=on and get the metrics
  - Per job
  - Per node (if it applies)
  - Runtime metrics
- Understand application characteristics
  - Is my application CPU bound?
  - Is my application Memory bound?
  - Is it a power hungry application? Are we close to the TDP?
  - Does my application shows IO activity?
  - Does my application shows high MPI percentage?
  - Does my application present phases of execution?
- For GPU application
  - Is my application pure GPU? Or CPU/GPU ?
  - What is the GPU activity and power consumption? Are we close to the TDP?

eacct options

- eacct -j jobid –l → show average metrics (per-node)
- eacct -j jobid -r → shows runtime metrics (per-node)
- eacct -j jobid -r c filename → saves ear metrics in csv file

2- Static energy optimization

- What is the effect of changing my resource requirements? (Use GROMACS)
  - Number of Nodes
  - Number of tasks
  - Ratio tasks/cpus-per-task
  - Ratio tasks per GPU
- What is the effect of changing the CPU frequency? (use NPB)
  - EAR provides its own list of CPU frequencies, use enode_info to get the list
  - Is it worth to do it in CPU bound cases?
  - Is it worth to do it in Memory bound cases?

3- Energy efficient architectures

- GENOA nodes consumes more power than ROME nodes but….Are they more energy efficient (use NPB)
  - What is the total energy consumption for the same problem?
  - What's the ratio performance variation vs Energy/Power variation?