CIUK Cluster Challenge 2025 – EPCC Challenge

Welcome to the EPCC Challenge. By now, you should have completed the Driving Test, received your ARCHER2 access, and become familiar with the system. We expect you'll be referring frequently to the ARCHER2 documentation, and we'd like to highlight the following section as particularly useful for this challenge. You may also find the following course useful.

EPCC Green HPC Student Challenge

For this challenge, you will run, analyse, and optimise two important benchmarks: HPL (High Performance Linpack) and HPCG (High Performance Conjugate Gradient). These benchmarks are widely used in the TOP500 and Green500 rankings to evaluate the performance and energy efficiency of supercomputers. Your goal is to balance high performance with energy efficiency. You can scale your experiments up to 8 nodes on ARCHER2. You will submit your results, binaries, scripts, and a short presentation describing your findings.

High Performance Linpack (HPL)

HPL is a compute-intensive benchmark that measures how many floating-point operations per second (FLOPS) a system can perform. It stresses the CPU and floating-point performance, making it a classic benchmark for peak computational efficiency.

- Compile and run HPL on ARCHER2.
- Scale your runs from 1 node up to a maximum of 8 nodes.
- Measure:
  - Runtime (time-to-solution).
  - Performance (GFLOPS).
  - Energy consumption (via ARCHER2 energy tools).
  - Energy efficiency (GFLOPS/W).
- Analyse the trade-offs between adding more nodes and energy-to-solution.
- Optimise your runs by exploring:
  - Problem size selection.
  - Compiler optimisation flags.
  - MPI/OpenMP configuration.

Deliverables

- Compiled binaries of HPL used in your experiments.
- Run scripts and input files so results can be reproduced.
- Results summary (tables/plots of runtime, GFLOPS, Joules, GFLOPS/W).
- Presentation slides (5–7 min) explaining:
  - Your optimisation strategies.
  - Best results achieved.

    - Lessons learned about performance vs energy efficiency.

High Performance Conjugate Gradient (HPCG)

HPCG is a benchmark designed to better reflect real-world scientific workloads, which are often memory-bound and communication-heavy. HPCG stresses memory bandwidth, network latency, and data movement. It is increasingly seen as a complement to HPL in benchmarking supercomputers.

- Compile and run HPCG on ARCHER2.
- Scale your runs from 1 node up to 8 nodes.
- Measure:
    - Runtime.
    - Performance (GFLOPS).
    - Energy consumption.
    - Energy efficiency (GFLOPS/W).
- Explore optimisations such as:
    - Problem size configuration.
    - MPI/OpenMP hybridisation.
    - Compiler flags.

Deliverables

- Compiled binaries of HPCG used in your experiments.
- Run scripts and input files so results can be reproduced.
- Results summary (tables/plots of runtime, GFLOPS, Joules, GFLOPS/W).
- Presentation slides (5–7 min) explaining:
    - Your optimisation strategies.
    - Best results achieved.
    - Insights on differences between compute-bound (HPL) and memory-bound (HPCG) workloads.

Scoring Item	Weight	Quality metric
Performance and energy efficiency (GFLOPS/W for HPL)	35	Measured at best node count
Performance and energy efficiency (GFLOPS/W for HPCG)	35	Measured at best node count
Scaling analysis	20	Must demonstrate energy vs performance trade-off across 1–8 nodes
Presentation & insight	10	Clarity of analysis and lessons learned
Total	100	