

REDUCING HPC-CI

GREENHPC

HPC-CI as part of a net zero strategy

- The HPC-CI is a metric specifically designed to drive the elimination of emissions. The only way to reduce your rate is to invest time and resources into actions that eliminate emissions.
- The only activities the HPC-CI recognises as elimination actions are making your use of HPC systems more energy efficient, more hardware efficient, or consuming lower carbon energy sources.
- Offsets are an essential component of any climate strategy; however offsets are not eliminations and therefore are not included in the HPC-CI metric.

HPC-CI as part of a net zero strategy

- Any net zero strategy needs to have plans for how to both eliminate as well as neutralise emissions.
- The HPC-CI helps organisations and users drive the elimination of emissions due to HPC system use.
- This makes the HPC-CI metric a useful component of any net zero strategy for operation and use of HPC systems.

How can the HPC-CI rate be reduced?

- We have mentioned how the HPC-CI metric is designed to drive abatement of emissions but how can users of HPC systems and organisations that procure HPC systems actually improve the HPC-CI metric?
- We will look at this but it is worth noting that action is required by all of these parties to reduce emissions from HPC systems.

Reduction in consumption of HPC

- While we cover strategies for reducing emissions from a (roughly) constant amount of HPC use or HPC provision, it is clear that a key part of reduction of emissions from HPC use is a reduction in the consumption and provision of HPC.
- At a fundamental level we need to reduce the amount of compute we are using, and the amount of compute hardware we are buying.
- “We seem to need reminding that computing is not exempt from having to drastically reduce emissions. Instead of assuming computing can innovate the path to a greater future, the bravest and most heroic action the computing sector could take is to show restraint and leadership, ...” Bran Knowles et al. Our House Is On Fire: The climate emergency and computing’s responsibility.

Users of HPC systems

- Before we delve into different approaches for the separate components of the HPC-CI equation, there is a high level consideration that can reduce both the E and M terms simultaneously: **Ensure any use of HPC is useful.**
- This sounds obvious but most HPC users will have had the experience of running jobs on HPC systems which consume resources but do not produce useful output due to errors in the software, in the input parameters, or even in the script that runs the job.

Users of HPC systems

- To improve the HPC-CI rate:
 - Ensure that the jobs you are running will produce useful or significant output even if they run correctly – do not run calculations or jobs without a clear understanding of what they add to the research project.
 - Carefully test input files and job scripts with small or short jobs before running at large scale to reduce the likelihood of wasted emissions.
 - Consider if you can achieve the same project goals with fewer jobs or calculations. For example, optimise the sampling choices when exploring parameter spaces.
- Similarly, for people involved in operating and procuring HPC systems, they need to work to ensure that users on the system have the best opportunity to do useful work and reduce wastage.
- This could be achieved through high quality documentation and training, and a service design that supports users in making the most of their resources.

Users of HPC systems

Other strategies for improving the HPC-CI metric depend on the dominant component.

Operational emissions dominate

- Improve the energy efficiency of your use – this may involve power or frequency capping of the hardware you are using (improves the ratio of E to R).
- Temporal shifting – run when carbon intensity is lower (reduces CI).
- Spatial shifting – run on a system where carbon intensity is lower (reduces CI), run on hardware which has better energy efficiency for your use case (improves the ratio of E to R).
- Run fewer calculations or jobs (reduces E and M).

Embodied emissions dominate

- Improve the performance of your use – more output per unit of time, even at the expense of energy efficiency by removing any power (improves the ratio of M to R).
- Spatial shifting – run on a system which has lower embodied emissions rate for your use (reduces M).
- Run fewer calculations or jobs (reduces E and M).

Operators and procuring HPC systems

Evaluation of the emissions of the system must be taken into account as part of HPC system procurement.

Operational emissions dominate

- Improve the energy efficiency of your HPC systems – this may involve power or frequency capping of the hardware you are providing or purchasing hardware that is more energy efficient for the system use cases (improves the ratio of E to R).
- Ensure that the power and cooling plant are as efficient as possible to minimise overheads (reduces E).
- Enable temporal shifting (either automatically or user controlled) – for example, run workloads with higher power intensities at times when carbon intensity is lower (reduces CI).
- Spatial shifting – site HPC systems in locations that have the lowest carbon intensities (reduces CI).

Embodied emissions dominate

- Work with users to improve the performance of jobs on the service – more output per unit of time (even at the expense of energy efficiency by removing any power).
- Extend the lifetime of the service as long as possible to extract maximum value from the emissions already in the atmosphere from purchase of the HPC system.
- Purchase HPC systems that have the best ratio of embodied emissions to performance for the workloads that will be run.

Key Points

- There are a number of methodologies commonly applied to help in the overall fight against climate change. These fall into the general categories of carbon elimination (abatement), carbon avoidance (compensating), or carbon removal (neutralising).
- Abatement is the most effective way to fight climate change although complete carbon elimination is not possible.
- Compensating includes the adoption of renewable energy sources, sustainable living practices, recycling, planting trees, etc.
- Neutralisations refer to the removal and permanent storage of atmospheric carbon to counterbalance the effect of releasing CO₂ into the atmosphere. Neutralisations tend to remove the carbon from the atmosphere in the short and medium term.
- Net zero aims to eliminate emissions and only offset the residual emissions that you cannot eliminate to reach the 1.5°C target set by the Paris Climate Agreement.
- Which strategies users or HPC system operators prioritise to reduce emissions depend on if the operational or embodied emissions dominate.
- A key part of reducing emissions from HPC use is reducing our consumption of HPC resources.