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Reducing the Carbon Footprint of Computing

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Over the past year, the soaring cost of electricity in many parts of the world has brought the power-requirements of computing infrastructure sharply into focus, building on the existing environmental concerns around the issue of global warming. We report here on the investigations, and subsequent actions, in the UK to respond to this pressure. The issues we address are both the overall reduction in power-used, but also the quality of the power used, where quality refers to whether the power has larger or small fractions of renewable energy. To reduce power consumption, we have investigated the performance of ARM-based systems compared to AMD processors, using the new HEPScore test workloads as they have become available. We will show results of our measurements at the University of Glasgow on identically priced ARM and AMD systems, and also compare these with a standard AMD worker-node from the Glasgow Tier-2 sites. We will demonstrate that major power-savings may be possible, and that the work is done in comparable, or faster, times on ARM. The LHC experiments are at different stages of readiness to use ARM architectures and we summarize which workloads currently compile, and which have been physics-validated. Whilst a reduction in the carbon footprint of computing can be achieved with more efficient hardware, it can also be addressed by load-shaping: Reducing the amount of power-used when the fraction of renewable energy in the national power network is low and the fossil-fuel generated power is high. We present an analysis of the UK power-generation data and suggest methods of presenting the reduction in carbon footprint that can be achieved by reducing computing-load at times of peak fossil-fuel use. The ability to load-shape would also allow facilities to respond to calls for reductions in power-use at peak times; a possibility that may be essential in Europe over the winter of 2022-2023. Achieving load-shaping in practice is not easy because LHC workloads run for much longer times than the typical load-shaping timeframe, and hardware does not like being repeatedly power-cycled. We discuss various methods of reducing computing at peak times, and report on various tests and measurements made in the UK designed to investigate the feasibility, such as frequency throttling. Finally, we will summarise the current and future strategy in the UK, how this ties in with the NetZero policies of funding agencies, and the compromises that this will entail.

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