# EAR is an Energy Management Framework

for the efficient energy control of a cluster of interconnected nodes. EAR provides **control, accounting, monitoring and optimization of energy** on both the applications running in the cluster and on the overall global cluster.

At EAR's core is a monitoring tool which gathers data on the nodes and on the applications running on the cluster. So, in addition to optimizing the energy consumed by the applications running on the cluster, EAR reports the system and application performance metric information.

The system information collected by EAR (the **system signature**) reports the performance of the major components of each node (cpu, memory). It is used to
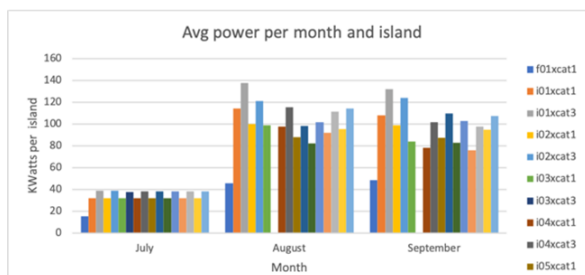
optimize the cluster energy usage but it is also able to report which components are not working to the expected level expected, for example, the memory DIMMs in a node are not providing the bandwidth they should, or a CPU in a node is not running at the expected frequency. Therefore, EAR makes sure the performance efficiency of the cluster is kept to its maximum.

The application information collected by EAR (the **application signature**) reports basic performance metrics of the application. It is used to optimize the application energy but it can also be used to determine that one application could perform better due to, for example, a high memory bandwidth or a low percentage of AVX512 instructions. Therefore, EAR helps to a better utilization of the system.

EAR is also **robust and reliable** as it is operational on **SuperMUC-NG at the Leibniz Supercomputing Centre (LRZ)** in Garching near Munich since August 8 2019. After a very productive co-design work, EAR is running on the 6480 nodes cluster helping LRZ to meet its energy goals. At LRZ, EAR is transparently used through a SLURM plugin https://doku.lrz.de/display/PUBLIC/Energy+Aware+Runtime. **EAR now is extensible offering plugins for policies, power models, application tracing, and node energy readings.**
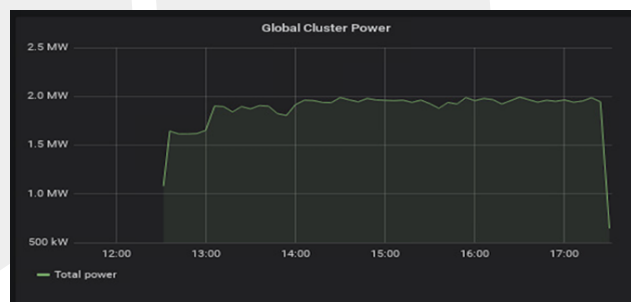
With the latest version, EAR has reported **energy savings of more than 10% on average** across a set of applications evaluated in collaboration with **SURF Open Innovation Lab (SOIL).**