# EoCoE Performance Benchmarking Methodology for Renewable Energy Applications

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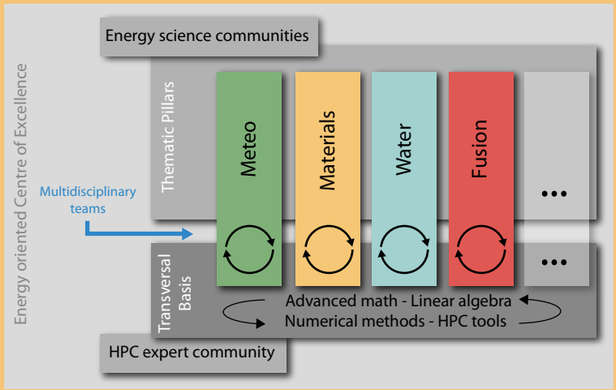
## EoCoE Project



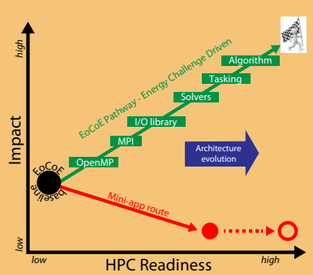

### Goals

EoCoE - the EU funded Energy-oriented Centre of Excellence – combines four strategically important carbon-free energy domains in meteorology, materials, hydrology and fusion with a transversal, multi-layered platform of computational expertise within a consortium of 21 partners in 8 countries. EoCoE strives to enhance the modelling capability of renewable-energy applications and make this know-how available to institutional and commercial stakeholders.

### Energy application challenges

Applications in this area show a vast range of HPC maturity, from serial code to highly scalable algorithms. To impact these real-world applications therefore, the EoCoE support portfolio includes a comprehensive skill-set including parallel I/O, performance benchmarking, applied mathematics and programming methods for Exascale.

### Strategy




EoCoE provides support for renewable energy applications with varying degrees of HPC maturity. Developer teams are guided along a structured pathway of self-contained optimisation measures, starting from simple parallelisation and I/O to deep refactoring including replacement of algorithmic kernels.

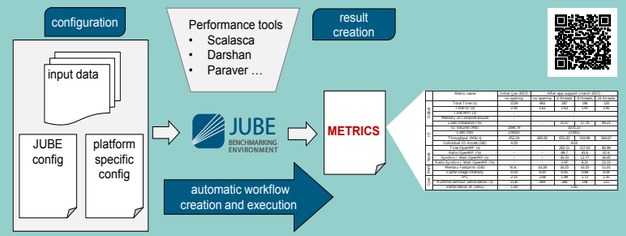
## Methodology

### 1. Hands-on performance workshops

A central feature of EoCoE has been the regular staging of application performance analysis workshops with a 1:1 tutor-client ratio. Jointly hosted with the POP CoE, these serve to:

- provide first contact point for project partners, external academic and commercial groups
- establish the baseline status of an application via a set metrics
- create long-term bilateral 'code-teams'

### 2. Performance metric extraction (1 month)




During and immediately following the workshop, JUBE is deployed to compile, run and *automatically extract* a comprehensive set of 28 performance metrics for any application. These are obtained by coupling the application to performance tools such as Scalasa, Paraver and Darshan. This procedure guarantees reproducible results at different points in time and location with the same or improved code versions.

### 3. Code optimization and refactoring (2-12M)

Code-teams comprising members of developer group and the EoCoE HPC staff continue to monitor the code progress over subsequent months as optimisation and refactoring efforts are undertaken.

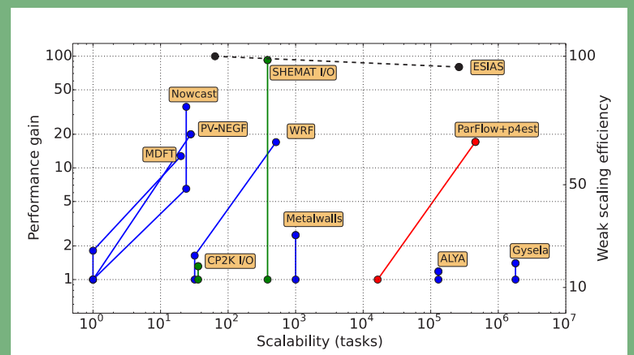
Enhancements mainly undertaken within the developer teams, but support can also be requested via EoCoE service page.

Specialized workshops on next-generation architectures organised by EoCoE together with supercomputing centres.

## Results

### Accelerating renewable energy applications

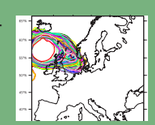
Significant time-to-solution improvements have been made to EoCoE applications in the first 18 months of operation, resulting in 50 Mcore-hours aggregate savings of compute-time. The chart shows actions such as optimisation and parallelisation (blue); exchange of I/O libraries (green), kernel refactoring (red) and rescheduling (weak scaling - dashed).

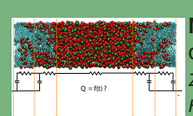



### Impact

**ESIAS**: 1000-member super-ensemble for probabalistic solar & wind power forecasts

*J. Berndt and H. Elbern, 11th European Conf. on Applied Climatology (ECAC), Trieste,12–16 September (2016)*



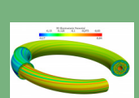


**Metalwalls**: all-atom modelling of supercapacitors up to device scales

*Z. Li, G. Jeanmaire, T. Méndez-Morales, M. Burbano, M. Haefele, M. Salanne, J. Phys. Chem. Lett. 8, 1925 (2017)*

**ParFlow**: high-resolution predictions of streamflow for hydropower management

*J. Keune, F. Gasper, K. Goergen, A. Hense, P. Shrestha, M. Sulis, and S. Kollet, J. Geophys. Res. Atmos. 121, 13301 (2016)*



**Gysela**: Multithreading optimisations reduce run times of ion turbulence computations by 25%

*V. Girard et al., Comp. Phys. Commun. 207, 35 (2016)*

**www.eocoe.eu**

European Commission | EU H2020 Centre of Excellence Grant Agreement No. 676629