

# Exa2Green

energy-aware numerics



# Motivation & Background

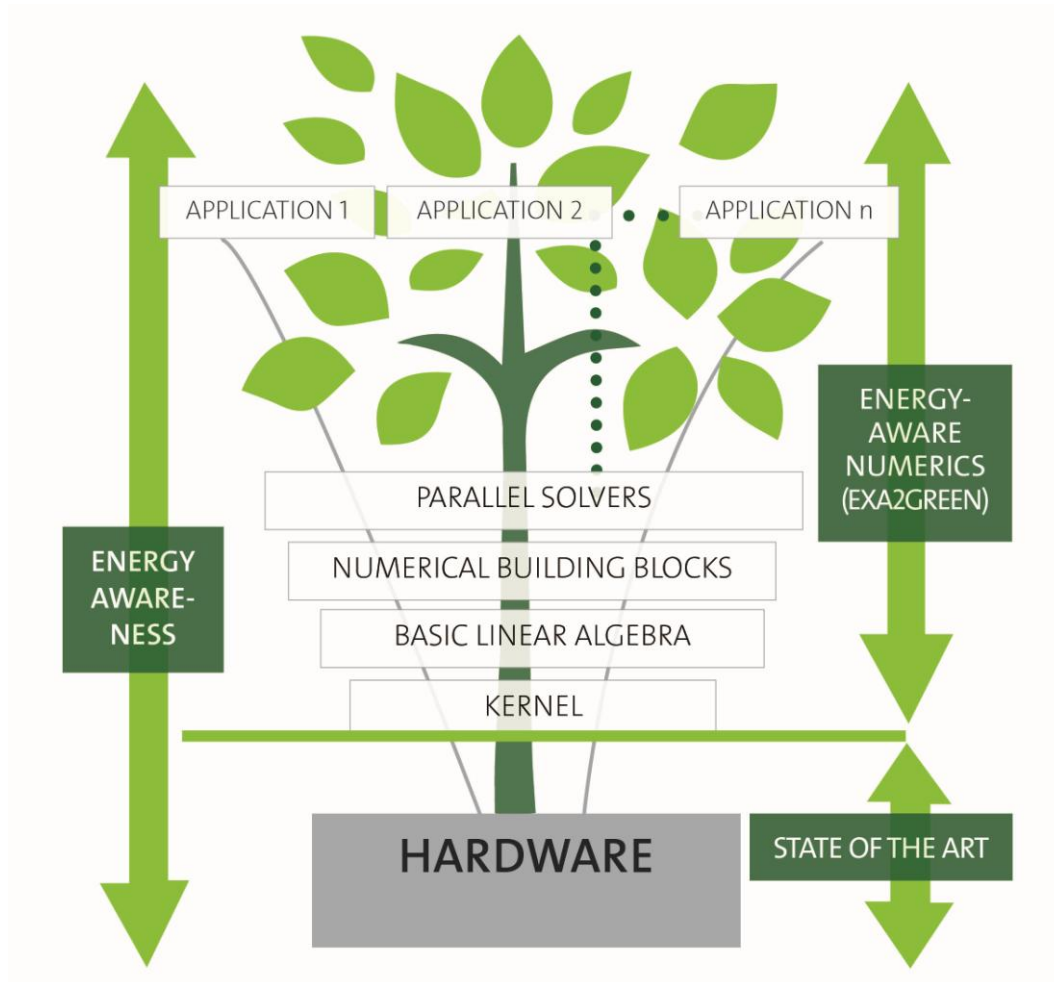
- ✓ Power wall
  - ✓ Huge power demand for future HPC
  - ✓ Extensive cooling is required
  - ✓ Power supply becomes a critical issue
- ✓ Ecological impact
  - ✓ CO2 footprint of IT industry is not acceptable
  - ✓ Simulation vs. experiment: cost-benefit analysis
- ✓ Energy-aware HPC
  - ✓ Optimize algorithms for energy consumption – not only runtime performance
  - ✓ Leverage power saving techniques provided by hardware



# Objectives

- ✓ New metrics for quantitative assessment and analysis of the energy profile of algorithms
- ✓ Develop an advanced and detailed power consumption monitoring and profiling
- ✓ New smart algorithms using energy-efficient software implementations
- ✓ Smart and power-aware scheduling technology for HPC
- ✓ Proof of concept using the weather forecast model COSMO-ART

# Energy-awareness



# Consortium

1	Engineering Mathematics and Computing Lab at University of Heidelberg, Germany	UHEI
2	Steinbeis Europa Zentrum of Steinbeis Innovation gGmbH, Germany	SEZ
3	Scientific Computing Group at University of Hamburg, Germany	UHAM
4	High Performance Computing and Architectures Group at University Jaume I de Castellon, Spain	UJI
5	Swiss National Supercomputing Centre at Swiss Federal Institute of Technology Zurich, Switzerland	ETH Zurich
6	IBM Research Division – Zurich Research Laboratory, Switzerland	IBM
7	Institute for Meteorology and Climate Research at Karlsruhe Institute of Technology, Germany	KIT

# Technical work packages

No	Title	Lead
1	Design of tools for power and energy analysis on HPC systems	UHAM

- ✓ Develop tools for high resolution tracing and visualization of energy consumption
- ✓ Model the power consumption from the cores to the system
- ✓ Account the energy usage of applications

# Technical work packages

No	Title	Lead
2	Setup for innovative energy-efficient algorithmic kernels	IBM

- ✓ Investigate the power consumption of elementary kernels on different HPC systems
- ✓ Develop new metrics for analyzing the tradeoff between energy and runtime performance
- ✓ Implement energy-aware elementary kernels

# Technical work packages

No	Title	Lead
3	Development of energy-aware numerical linear algebra libraries	UJI

- ✓ Design and implement energy-efficient linear algebra libraries
- ✓ Setup for dynamic execution environments



# Technical work packages

No	Title	Lead
4	Advancing hardware-aware algorithms	UHEI

- ✓ Develop asynchronous iteration methods towards massively parallel computing
- ✓ Building platform for energy-efficient multilevel methods on HPC clusters

# Technical work packages

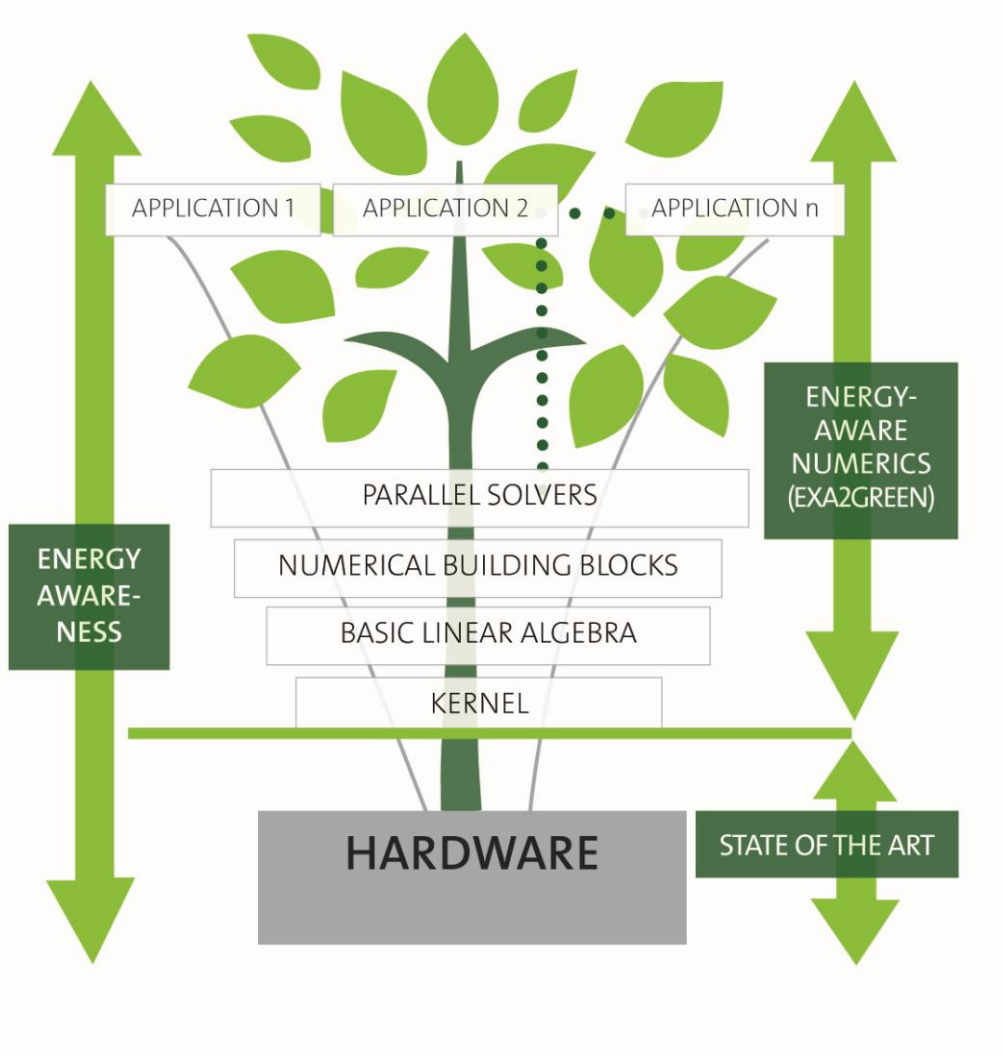
No	Title	Lead
5	Showcase for energy-optimized aerosol chemistry packages	ETH Zurich

- ✓ Reduce COSMO-ART energy requirements on existing CPUs
- ✓ Extend COSMO-ART for multi-core architectures
- ✓ Investigate COSMO-ART for future energy-efficient architectures

# Administrative work packages

No	Title	Lead
6	Project management	SEZ
7	Dissemination, collaboration, exploitation and IPR management	SEZ

- ✓ Finances, accounting, administrative management
- ✓ Website, press releases, newsletter, IPR



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