

VISION & MISSION

- HiDALGO2 envisions a future where Advanced Simulation, High-Performance Computing and Artificial Intelligence drive data-led innovation to address complex societal challenges
- HiDALGO2 is developing cutting-edge simulation tools and models as well as fostering collaboration to enable data-informed decision-making in real-time across diverse sectors like energy, urban planning and disaster preparedness.

USE CASES & PROGRESS



URBAN AIR PROJECT

HPC-computation of the air in the urban areas for air quality, wind comfort, and urban planning by 1 meter resolution. Open source (e.g. OpenStreetMap) and sensor data for inputs, web-based user interface for EuroHPC-execution and visualization.



URBAN BUILDINGS

Ktirio Urban Building (KUB) is a EuroHPC-ready platform to simulate building-stock energy demand, thermal comfort and indoor air quality at building and district/city scales. It combines data enrichment, automated preprocessing/meshing and scalable MPI/Feel++ execution.



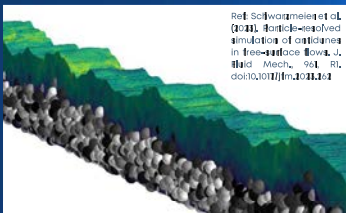
RENEWABLE ENERGY SOURCES

RES is a HPC- and AI-based simulation code that forecasts energy production from renewable sources such as wind farms and solar panels. The solutions are accustomed to urban and rural areas.



WILDFIRES

HPC high-resolution simulation of wildfire atmosphere interactions and smoke dispersion in forest and urban areas. Immersive 3D visualization with Unreal Engine visualizer.



MATERIAL TRANSPORT IN WATER

The scalar transport simulations provide insights into temperature distribution in particle-laden flows in the study of aquatic ecosystems and large river bodies.

- Scalable CFD solutions with OpenFOAM and RedSim on EuroHPC machines.
- Real-time digital twin for urban wind comfort and air quality.
- RedSim: HPC-code for CFD for compressible fluids on unstructured mesh, optimized for CPU (vectorized with AVX512 for x86_x64, blend masks, atomics) and native OpenMPI + CUDA.

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- Companion desktop and wasm KtirioGUI: supports GIS/3D generation and visualization, interactive scenario setup, reporting, with export to data platforms.
- MPI-parallel Feel++ core (C++), scalable to EuroHPC systems
- Containerised deployment: Docker + Aptainer containers
- Multi-source climate forcing: Open-Meteo, WRF, UAP coupling for urban refinement
- KPIs: energy (heat/cool demand), comfort (PMV/PPD), IAQ (CO₂/PM2.5/NO₂/O₃, ventilation), emissions (CO₂/NO_x)
- Ensemble runs for UQ (MC/LHS/QMC sampling) and scenario comparison - Outputs: parallel HDF5 + Parquet; dashboard; Girder/CKAN integration

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- Based on MPI Fortran HPC WRF and EULAG models
- AI-driven energy production forecasts
- Uncertainty quantification and sensitivity analysis with mUQSA toolkit
- Using orchestration portal with the HPC environment to facilitate simulation setup and job execution.
- Using openly available data: OpenStreetMaps, OpenMeteo, GFS, Copernicus.
- Coupled with Urban Buildings pilot for better accuracy in PV modeling.

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- Two different scenarios for fire spread and smoke dispersion: Wildfires and Wildland-Urban Interface.
- Wildfires simulation with WRF-Sfire deployed in multiple JU-HPC machines.
- Special attention is paid to the interactions between the atmosphere and the wildfire: wind, energy, water vapor and smoke.
- Wildland-Urban simulation with OpenFOAM and fireFOAM on JU-HPC machines.
- Vegetation representation at different scales to suit simulation requirements.

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- Our in-house CFD solver employs the lattice Boltzmann method for highly scalable fluid-solid-particle interaction processes on off-HPC clusters, with support for GPU architectures.
- Additionally, we utilize existing datasets from various sources to model and improve predictions of flow dynamics and material transport in water.

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FURTHER TOOLS

- MathSO and QCG, workflow orchestrator engines which manage the execution of jobs within the EuroHPC systems
- Visualization tools like VISTLE-COVISE which allows for interactive and immersive visualization environments for collective analysis of simulation results and UEAV for the compilation of photorealistic VR experiences
- mUQSA, a Web-based platform developed to support Uncertainty Quantification and Sensitivity Analysis of computational models

