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Project Profile

OpenSCALING

Extending open standards to scale-up virtual engineering of sustainable solutions

To achieve long-term sustainability goals, the ITEA project OpenSCALING (Open standards for SCALable virtual engineerING and operation) will enhance open standards and modelling/simulation tools to better support and optimise large-scale systems (LSS) and distributed controllers.

Addressing the challenge

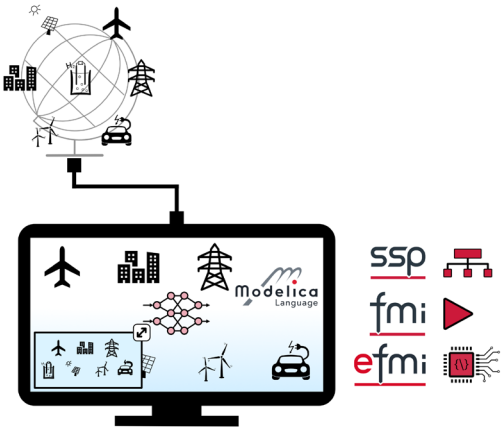
Europe's targets of reducing net greenhouse gas emissions by >55% by 2030 and becoming climate-neutral by 2050 require investments in energy, building and production infrastructure. Simulations are key to evaluating possible concepts, designs and operational strategies, but such large-scale, long-term scenarios can only be analysed using highly simplified models with low accuracy. The entire virtual engineering process must be scaled up, yet existing model-based processes scale poorly with increasing complexity. Modelling standards must therefore be enhanced to better support credible engineering processes, embrace machine learning techniques in combination with classical modeling, and enable fast compilation and robust execution of equation-based models.

Proposed solutions

To enable this, OpenSCALING will extend the open standards Modelica, FMI, eFMI, SSP and their toolchains to scale with size, cope with increasing dimensionality, and enable more generic, configurable and adaptable solutions after compilation. LSS models of eco-friendly solutions and runtime adaptable distributed controllers thus become feasible and can be optimised to minimise energy consumption and greenhouse gas emissions. The extension will take place through various innovations. For instance, standardised uncertainty quantification of model parameters and its influence on simulation results across the standards will broaden the explanatory power and trustworthiness of LSS simulations. Physics-enhanced neural ordinary differential equations (PeN-ODEs) will allow these models to seamlessly integrate in machine learning environments, enabling massive modelling efficiency improvements. Other OpenSCALING outcomes include changing the connection causality, array sizes and neural network parameterisation of FMI models without regeneration (enabling lifetime improvements to LSS digital twins) and the enhancement of certified virtual testing to reduce time-to-market.

Projected results and impact

With OpenSCALING, users can expect major modelling improvements: 10 times faster simulation compared to the purely physical model, 10 times larger models compared to the current largest Modelica model that a tool can translate, simulate and export, and 100 times faster start-up compared to the current time to generate and translate code and start executable for LSS Modelica models. Through this, wholistic optimisation will become possible for systems with over 100 million unknowns. The project's demonstrators will show how this can directly reduce energy consumption and greenhouse gas emissions in the energy, building, aviation and automotive domains via green hydrogen production, efficient heat pumps, fuel cell propulsion and electrified vehicles. Additionally, OpenSCALING's partners will be the first to bring software with these advanced features to the market, enabling greater competitiveness in a simulation software market expected to grow by 12% annually to reach USD 40 billion by 2030. Finally, the project will reduce the high degree of expertise needed when uncertainty quantification and modelling methods from machine learning are involved, making it easier for its innovations to spread and have a real impact on Europe's long-term sustainability goals.



OpenSCALING will enhance open standards and modelling/simulation tools to better support and optimise large-scale systems.

Project partners

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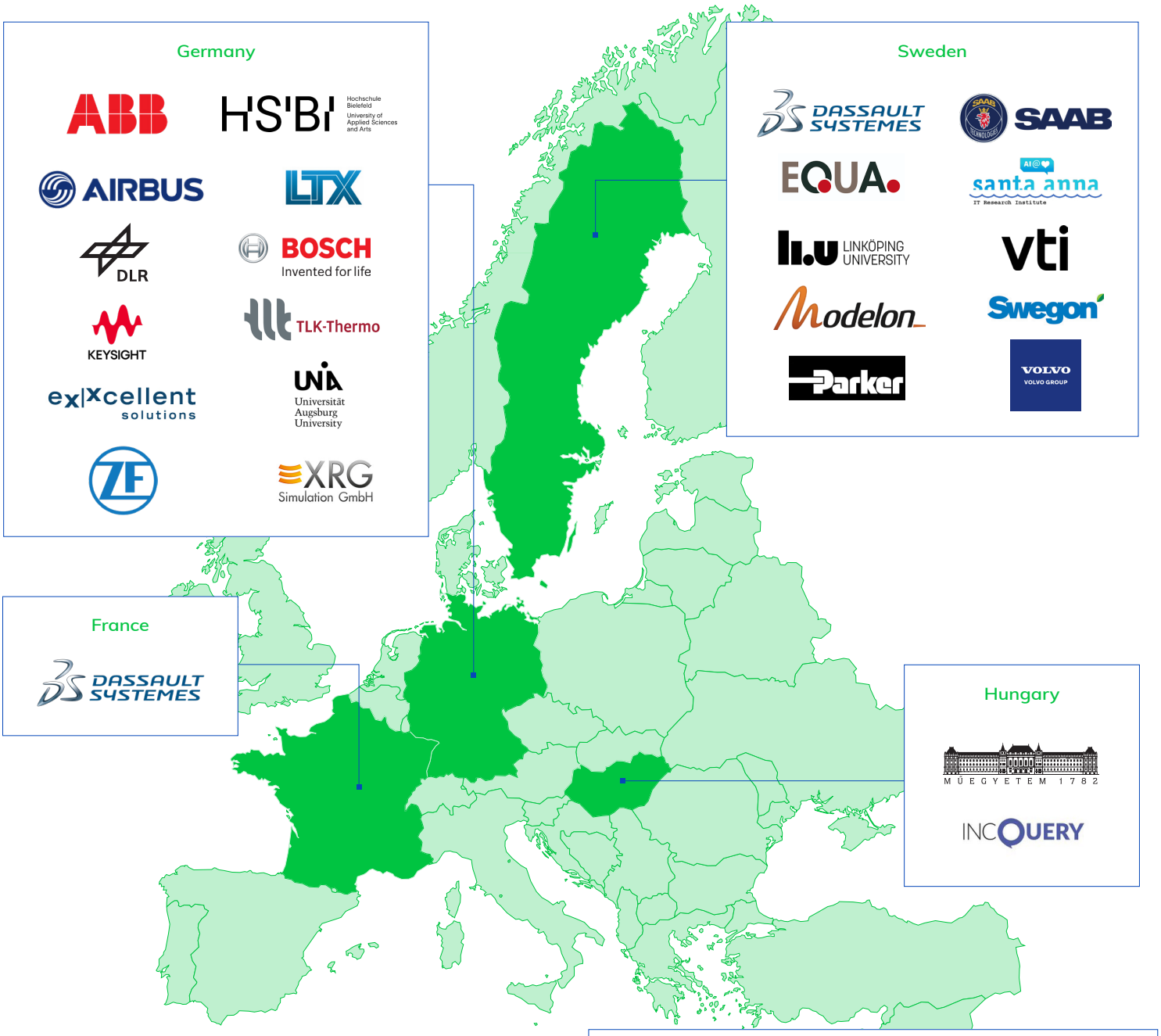

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Project website
https://itea4.org/project/openscaling.html

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