Karlsruhe Institute of Technology

ENERGY LAB 2.0

EGSAL designs and digitalizes future energy grids.

Energy Grids Simulation and Analysis Laboratory

Energy networks (electricity, gas, heat, fuels) connect producers, storage facilities and consumers. The future electricity grid will play a central role in the integration of all energy forms and networks in the energy transition. Planning, simulation, analysis and optimization of the interconnected grid is therefore essential. EGSAL provides a hardware and software infrastructure for modelling, simulation and analysis of energy grids.

The investigated networks range include micro-grids (house networks, island networks), the KIT Campus north power grid, as well as distribution and transmission networks (Karlsruhe city, Baden-Württemberg, Germany, and the interconnected European grid). State-of-the-Art software and self-developed, novel solutions form the basis for the simulation and analysis.

- Key hardware component: real-time digital simulator (RTDS) for real-time simulation of electrical networks
- 2 RTDS with GTNETx2
- Installed protocols: TCP/UDP Sockets (SKT), MODBUS, IEC 61850 Sampled Values (SV), and IEC 61850 GOOSE Messaging (GSE)
- Directly connected through a Global Bus Fiber Cable to combine their computing power for distributed simulation of large networks
- Direct connection of 3 or more racks requires the RTDS Global Bus HUB (GBH) for coordinating the operation of the simulators
- Can be extended through the VILLAS framework for geographically distributed real-time simulations.
- GPU-enhanced power workstation used for offline simulation and modelling work running the eASiMOV framework and commercial simulation software

View of EGSAL with the two RTDS systems for the real-time simulation of power networks, the visualization monitor, and the different work stations in laboratory.

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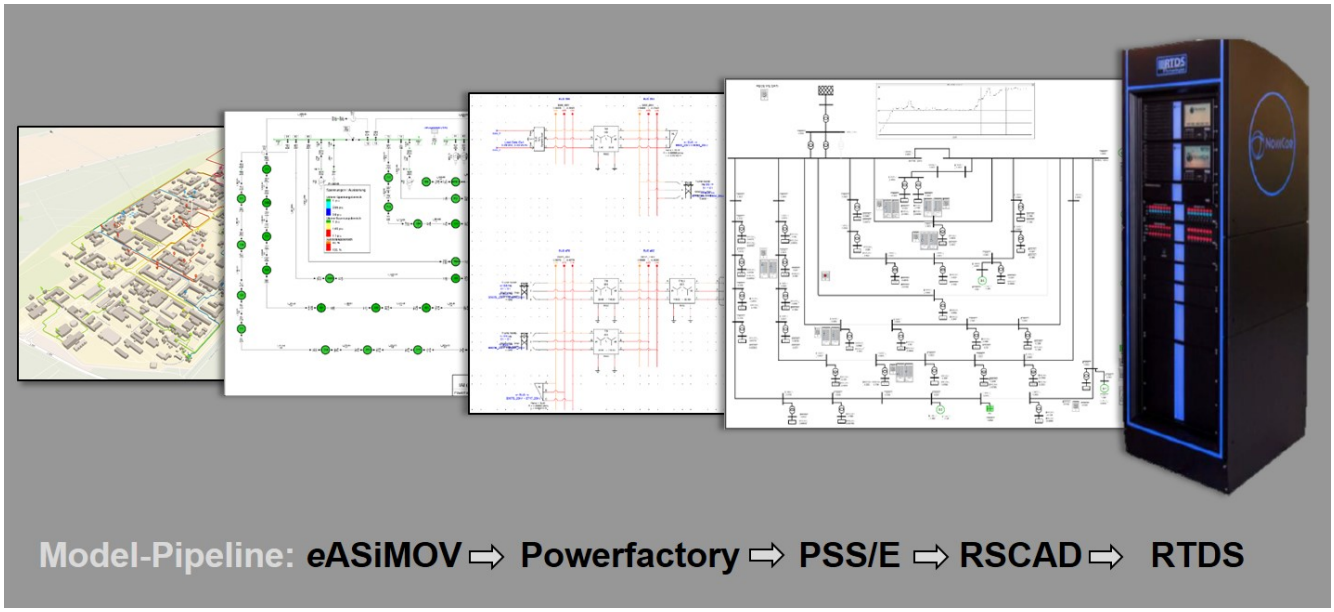

An example of the EGSAL modeling pipeline showing the KIT 20kV campus north network from the model in the eASiMOV framework to the converted model in the RSCAD software for real-time simulation.

EGSAL Specific Scenarios

One scenario is the so-called Campus network simulation, consisting of the KIT campus north 20kV network. Combined with the measurement devices installed on the campus, the state of the real network will be fed to the real-time simulated network to form a digital twin of the campus network. This information will be used for online security assessment of the network based on the real operating point. The simulated state of the network can be visualized in the control and visualization center. This scenario is based on the compatibility of measurement devices and the EGSAL simulation hardware. The intercommunication between the hardware should be supported by the existing communication standards based on the IEC 61850.

A further scenario is the distributed simulation for interconnection of multiple simulators in a geographically distributed real-time simulation. This will integrate the Energy Lab and other real laboratories into an evaluation environment for HIL and PHIL simulations with increased computing power through a combination of several simulators. The VILLAS framework is used to couple the geographically distributed real-time simulators. The EGSAL setup with the real-time simulation is extended to offline-simulations provided by available commercial simulation software and the in-house developed eASiMOV-framework, which among others enables multi-modal energy system analysis in a co-simulation environment.

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