

## **Post-doc “Energy System Design”: “Multi-modal modelling for digital real time simulation”**

**Supervisor: Dr.-Ing. Giovanni De Carne, Prof. Dr.-Ing. Mathias Noe**

Future energy systems will be characterized by large power volatility, created by intermittent energy sources, and low system inertia, due to the power electronics interfaced resources. As consequence, the frequency and voltage control will be more challenging, without re-thinking the system control. The multi-modal networks can represent a promising solution at this regard. Having strong interconnection among energy layers, these networks allow to shift energy between two different layers (e.g., from electrical to heating network), in order to, e.g., store it during renewables peak production times, and inject it back in the grid during high load conditions.

However, the study of multi-modal networks put practical challenges: the simulation of different energy layers requires complex models that work with very different time constants. As an example, while the electromechanical transients acts on milliseconds range, the thermal network interact with its components in the minute time-scale. In off-line software, this challenge has been solved with co-simulation solutions. Two parts of the software run at different time steps, allowing to optimize the computational time. However, this is not possible if real-time simulations are involved. Each developed model is pre-compiled before a simulation, thus, it must contain the time constants of all multi-modal components. While this approach allows the highest accuracy in the testing, it represents a large burden on the computational aspect.

The Post-doc position shall cover the optimal modelling, under reduced execution time and high accuracy, of multi-modal components. The positions will take place at the Energy Lab 2.0 facility, where the Real Time System Integration (<https://www.itep.kit.edu/english/68.php>) research group is located. The following tasks are foreseen for this position:

- Development of a library of multi-modal models, to be implemented in digital real time simulation. Different models with different complexity levels (e.g., switching vs. average models) are planned, which, depending on the investigated system phenomena, can accurately represent the hardware in realistic power system conditions.
- Optimization of the developed multi-modal models by artificial intelligence or data-driven techniques, focusing on optimizing the execution time, while keeping high the model accuracy. To reduce model complexity, both analytical and data-based methods will be used in a hybrid fashion.
- Creation of Digital Twins of the multi-modal resources available in Energy Lab 2.0. The accuracy of these digital twins must be evaluated and optimized. In particular, the digital twins will be verified by means of power- and multi-modal hardware in the loop testing.
- Support in the supervision of PhD students in the control and power electronics area. In particular, the Post-doc will supervise directly a small team (3-4 PhD students) and direct their research activities in coordination with the Team Leader (Dr.-Ing. Giovanni De Carne).
- Support in writing and carrying out research and industrial projects. It is expected that the Post-doc will be able to contribute actively in the writing of proposal, and manage the correct development of projects.

Required competences:

- PhD in electrical engineering related fields

- Extensive experience in power system simulation software, such as Matlab/SimPowerSystem, DigSilent.
- Extensive experience in real time software, such as RT-LAB and Hypersim.
- Strong record of publications in the energy systems modelling and real time simulation area.
- Strong command of the English language and excellent communication skills

For further information regarding this position, please, write to [giovanni.carne@kit.edu](mailto:giovanni.carne@kit.edu).