Karlsruhe Institute of Technology

Division V – Physics and Mathematics

Institute for Beam Physics and Technology (IBPT)
Institute for Technical Physics (ITEP)

KITTEN: Shaping the energy future of large-scale research

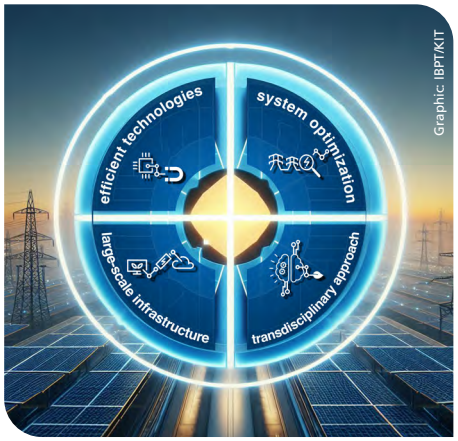
Test center for sustainable technologies on all scales

Whether energy supply, climate protection, mobility transition, materials science or medicine - in order to meet the challenges of the future, researchers are dependent on efficient infrastructures. The KITTEN test center (**KIT** Test Field for Energy Efficiency and Grid Stability) combines the Energy Lab, Europe's largest research laboratory for renewable energies, with the Karlsruhe research accelerator KARA. KITTEN develops new concepts for energy efficiency and sustainability in large research infrastructures - from individual components to fully optimized systems.

The concepts developed are directly validated experimentally under real conditions and under physical and technical aspects - a unique combination worldwide. In this way, the KITTEN project is paving the way for energy-efficient, energy- and resource-saving and sustainable research. The findings can be transferred to other energy-intensive infrastructures such as data centers, heavy industry and hospitals.

From research to scalable solutions

Research at KITTEN plays a key role in shaping the next generation of large-scale, complex research infrastructures and their seamless integration into future energy systems. It combines basic research with a holistic systems approach. It is also characterized by its interdisciplinarity. This is crucial in order to be able to integrate efficiency deeply into the systems. However, this also presents a challenge: many things have to be developed from scratch and some existing technologies have to be rethought. Of course, a system can save energy if its technical components become more efficient. But the KITTEN approach goes much further and addresses the following questions: How can experiments and operating cycles be designed to conserve resources? Where can synergies be created?



Transdisciplinary approaches enable new concepts for energy efficiency and sustainability in large research infrastructures - from individual components to fully optimized systems.

Energy-efficient technologies

The expertise contributed to KITTEN ranges from system analysis to the development of advanced components. Participating scientists design highly efficient microstructured power supplies for high-current applications and are leaders in the development of high-temperature superconducting materials and magnet systems. They are also driving forward compact, light-driven accelerator technologies.

KITTEN combines two of KIT's major research infrastructures - the Energy Lab (left) and the KARA accelerator test facility (right).

Intelligent energy management

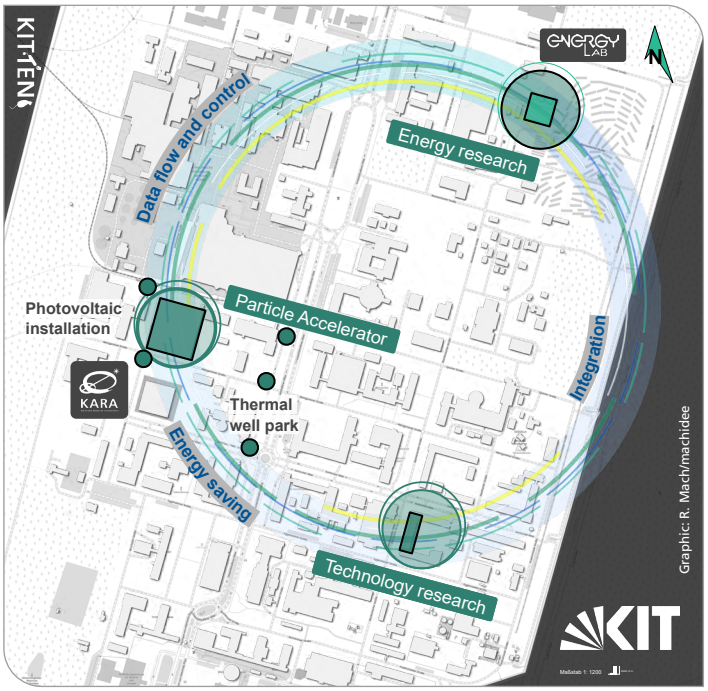
As Europe's largest research infrastructure for renewable energies, KIT's Energy Lab researches the intelligent integration of various energy generation, conversion, storage and supply solutions. AI-controlled load management and physics- and energy system-informed digital twins make it possible to monitor, control and optimize energy flows in systems with KITTEN.

Particle accelerator as a test platform

Particle accelerators are among the most sensitive research devices in the world. The Karlsruhe research accelerator KARA is equipped with multimodal diagnostic systems that detect even the smallest fluctuations in the energy flow. Its operationally large load fluctuations combined with enormous precision in all parameters make it an ideal test facility for practical experiments on energy efficiency and the perfect test object for the infrastructures of the future.

Integration of renewable energies

KITTEN integrates photovoltaics, storage technologies, a thermal well system and an innovative cooling system on the way to CO_2 neutrality. The first phase already covers 20 percent of the total electrical energy requirement - the equivalent of around 1,000 households. Optimized operating processes and energy-efficient components have reduced energy consumption by a further 20 percent. But the potential of KITTEN goes even beyond that.



KITTEN on the North Campus of KIT combines energy research with the development of efficient technologies in the specific application of a large-scale research environment.

Research also wins

Researching the tiniest particles in the universe requires gigantic particle accelerators - with gigantic energy requirements. The annual power consumption of the particle accelerators at CERN in Geneva is comparable to that of the city of Karlsruhe. In view of climate change and the energy transition, large-scale research facilities must also become more energy-efficient and be able to cope with fluctuating energy supplies. With KITTEN, KIT researchers are working on making these facilities fit for the future.

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KITTEN
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