Grid components

Germany’s largest solar power storage park:
Started up in July 2014, this research facility consists of solar modules, rectifiers, and lithium-ion batteries of the latest generation. It can produce a maximum of 1 MW_{el} and contains over 100 different system configurations.

bioliq® pilot plant:
In operation since 2013, this plant converts waste biomass like straw in multiple reaction steps. The most important intermediate is synthesis gas which can be processed into synthetic fuels or chemicals. More than 1000 m³ per hour of synthesis gas are available. The Energy Lab 2.0 uses a part of this for the dynamic generation of electrical energy.

State of the art

The project started in October 2014. The engineering of the components and the preparation for construction are ongoing. The components are intended to be completed in 2017. In the long term, cooperations with industrial partners as well as external energy producers such as wind parks, geothermy facilities, or conventional energy providers are projected.

Energy Lab 2.0 is a research facility of the Helmholtz Association. Coordinator is the Karlsruhe Institute of Technology (KIT). Partners are the Forschungszentrum Jülich (FZJ) and the German Research Centre for Air and Space Travel (DLR).

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Energy Lab 2.0 will become part of C/sells, a cross-national platform for energy supply, industry, politics and science, coordinated by Smart Grids Baden-Württemberg e.V.

Further informations www.elab2.kit.edu

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The challenge

Until 2050, renewable energies are aimed to reach a share of at least 80 percent of Germany’s gross electricity production. This target demands a continued build-up of wind and photovoltaic plants. Though, wind and sun do not deliver a constant level of electricity over daytime and season, and the electricity consumption also shows considerable fluctuations. Further, the most effective sites for wind energy generation are located at the shore of Northern Germany, while most of the electricity is needed in the industrial congested areas in the South and West of Germany.

Large-scale lab and simulation center

In Energy Lab 2.0, the following research questions are in the focus:

- How should we integrate different energy storage technologies with electricity generation and energy consumption in the grid to establish a “smart energy system” with greatly reduced carbon dioxide footprint?
- How can we achieve more flexible electricity generation from chemical energy carriers with regard to load and fuel?
- How can we compensate the role of decreasing availability of rotating masses (“spinning reserve”) by energy system services based on decentralized components?
- How can we achieve this by establishing a parallel energy information network? What kind of information grid is necessary for this task?
- What kind of grid topologies are most appropriate for a scenario of a mainly decentralized power generation from renewable sources?

To evaluate these issues, an exemplary intelligent energy grid serving as a validation platform is being installed. The heart or rather the brain of the Energy Lab 2.0 is the Smart Energy System Simulation and Control Center (SEnSSiCC). SEnSSiCC controls most of the plants and collects all the data which can then be stored, displayed in various ways, and thoroughly analysed.

Measures Required

To successfully achieve the „Energiewende“, the transport, distribution, storage, and usage of electricity have to be improved. This requires a new grid architecture, the integration of different storage technologies, new grid hardware, and control strategies as well as a smart interconnection of electricity, heat and chemical energy carriers by efficient transformation technologies.

In order to extensively investigate all these issues, a large-scale research infrastructure is being built up at KIT – the Energy Lab 2.0.

Accelerator of the „Energiewende“

As a development environment for controlling local intelligent energy systems, SEnSSiCC offers a platform to experiment with all relevant components in small to study even critical operating states as well as for training. Further, SEnSSiCC provides a power hardware in-the-loop test facility with real-time monitoring and control. SEnSSiCC also enables the detailed investigation and simulation of multi-scale energy systems involving different energy carriers.

Daily power production in Germany exemplarily shown for one week in winter (Graphics: B. Burger, Fraunhofer ISE).

Energy Lab 2.0 connects the following plants and facilities:

- KIT’s solar power storage park with 1 MWpeak output
- KIT’s biolig® pilot plant for the production of synthetic fuels from waste biomass
- Three novel micro gas turbines with a rated power output of 100 kWel used for the dynamic generation of electrical energy from synthesis gas or natural gas
- A new lithium-ion battery system with a capacity of 1 MWh
- Two plants to convert electrical energy and carbon dioxide into synthetic methane (power-to-gas) and into synthetic fuels (power-to-fuel), respectively, with an output of about 100 kWth
- The German Research Centre for Air and Space Travel’s (DLR) high-temperature thermal energy storage facility in Stuttgart
- A new facility to be established at the Forschungszentrum Jülich (FZJ) for dynamic testing of large electrolyzers