Open source for a global 'energiewende'

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The Helmholtz Energy Computing Initiative (HECI) provides free modeling tools for energy system optimization. Credit: KIT Bildstelle; Bernhard Mühr www.wolkenatlas.de; Julian Quinting

Computer models are essential for achieving energy turnaround also known as "Energiewende". Simulations can help in the planning of capacities for generating, transporting, and storing energy, taking into account dynamic parameters such as the weather and energy consumption. Scientists from Karlsruhe Institute of Technology (KIT) had a crucial part in developing the corresponding modeling tools that

the Helmholtz Association (HGF) has recently made available on an Internet platform—free of charge and open source. This Helmholtz Energy Computing Initiative (HECI) aims at facilitating the cooperation when implementing climate-protection measures in energy systems.

Whether in the context of planning new power lines, distributed power plants or an upcoming amendment to the energy market regulation—computer models help to make well-founded decisions in the context of the energy turnaround. Until now, no common modeling standards existed. With the Helmholtz Energy Computing Initiative (HECI), in which scientists from various Helmholtz centers, including KIT, are participating, the HGF is now presenting a platform on which, for the first time, open-access benchmarks, scalable methods, realistic data, and open source software are available for project planning and the optimization of future energy systems: "With this initiative, we provide free access to valuable resources on the way to a secure, sustainable, and affordable energy system," says Professor Holger Hanselka, Vice-President of the Energy research field of the Helmholtz Association and President of KIT. "We are thus clearly committed to open source and a transparent exchange in science. In this way, we not only set global standards for energy system modeling, but also for cooperation and open science in the spirit of the principles of the Helmholtz Association."

Toolbox for the transformation of the energy system

Among HECI's numerous offerings is, for example, a free software toolbox called "Python for Power System Analysis" (PyPSA), which can be used to simulate and optimize modern power supply systems. The "Framework for Integrated Energy Assessment" (FINE) - software specially developed to improve cross-sectoral energy systems—helps to determine transformation paths for the overall system. Newly developed algorithms such as the "McCormick-based Algorithm for mixed-integer Nonlinear Global Optimization" (MAiNGO) or the "Time Series

Aggregation Module" (tsam), are available to solve typical optimization problems in the expansion of renewable energy. Besides the software offers, the HECI platform contains data records as well as benchmarks, i.e. completed energy system models including data for the evaluation and enhancement of simulation methods. The interaction of different tools enables optimal operational and investment decisions within the full range of energy systems, from those for individual properties to trans-European power transmission grids. At the same time, they help to work towards meeting the Paris climate targets.

The HECI platform was implemented by scientists within the scope of the joint Helmholtz "Energy System 2050" initiative. For this initiative, KIT cooperated with the German Aerospace Center (DLR) and Forschungszentrum Jülich (FZJ), Helmholtz Centre Potsdam (GFZ), Helmholtz-Zentrum Berlin (HZB), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Max-Planck Institute for Plasma Physics (IPP—associated partner), Helmholtz Center for Environmental Research (UFZ).

Fostering cooperation and exchange in energy research

An open and shared ecosystem for the modeling of energy systems has many advantages: Since energy politics can be highly controversial, open research increases the confidence of political decision makers and the public in the results of science. The open-access availability also reduces redundancies in research work, so that resources can be used more efficiently. Moreover, this will have a beneficial effect on the quality of the research itself: Feedback and error corrections from numerous actors can contribute to the further development of the open source code.

And finally, the availability of open source software also promotes

cooperation in the energy sector at an national and international level. This facilitates the exchange of models as they have been created with the same tools; and software can also be adapted more easily to individual needs. Instead of having to resort to expensive training, users can support each other when working with the tools. The Helmholtz Association's modeling tools are already in use today, for example, at major power transmission grid operators in Germany. They are also used worldwide by research institutions, NGOs, and enterprises.

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