



CASL: Giving Nuclear Energy More Power

Nuclear reactors generate nearly a fifth of America's electricity. However, due to upcoming license expirations and unfavorable economic conditions, almost all of today's operating reactors could be shut down by 2050.

To address this challenge, in 2010, the US Department of Energy established the Consortium for Advanced Simulation of Light Water Reactors. Based at Oak Ridge National Laboratory, CASL is DOE's first Energy Innovation Hub—an integrated research center focused on a single topic, with the objective of rapidly bridging basic research, engineering development, and commercialization.

Mission and Impact

CASL is a collaboration of the nation's leading scientists, institutions, and supercomputers, with an aim to confidently predict the performance of existing and next-generation commercial nuclear reactors through comprehensive science-based modeling and simulation. Real-world impacts include the following.



- Improving efficiency in nuclear power production by reducing unanticipated plant outages, enhancing flexible operations of nuclear reactors to adjust as power demand fluctuates, and enabling future increases in operating power, resulting in additional power generation
- Lowering costs by better understanding how long fuel can reside in a reactor, which could save energy providers millions of dollars annually
- Enhancing safety through evaluation of new fuels that can better endure the severe conditions within a reactor
- Extending the life of existing reactors through improved prediction of the lifetimes of key structural components

19%

Total US electricity generated by nuclear reactors in 2018, up from 11% in 1980

96

Commercial nuclear reactors in the United States


\$60 billion

Value added to America's gross domestic product from nuclear industry*

72 million

Homes that can be powered on an annual basis through US nuclear reactors*

*Source: The Nuclear Energy Institute



"Our mission is to develop, apply, and deploy advanced science-based modeling and simulation technologies to enhance the operational performance, efficiency, and safety of light water reactors."

Dave Kropaczek,
CASL Director

“Looking” Inside a Nuclear Reactor

The CASL project has developed and tested what amounts to a virtual nuclear reactor. VERA, or the Virtual Environment for Reactor Applications, can simulate the operation of an entire reactor down to the characteristics of a single fuel rod, significantly exceeding the resolution of industry tools. Because some reactors have more than 50,000 rods, predicting individual rod behavior can greatly enhance safety and performance.

Researchers have used VERA to accurately simulate the entire 20 year history of the Tennessee Valley Authority's Watts Bar Unit 1 nuclear reactor, proving the software's groundbreaking capabilities.

When the Watts Bar Unit 2 reactor started up in 2016, VERA was used to perform hour-by-hour simulations of the new plant's first 6 months, with predictions providing important data to support the achievement of full-power operations. Westinghouse used VERA to accurately predict the operation of the first four AP1000 reactors—reactors with complex fuels designed to increase efficiency.

As new reactors come online and old reactors age, such simulations will give energy companies a chance to accurately predict the future performance of their plants and an opportunity to make improvements to avoid costly shutdowns.



CASL provides high-fidelity simulation results for operating reactors.



Critical Collaboration

CASL's 10 founding partners—three universities, four national laboratories, and three nuclear industry organizations—and additional contributing institutions provide the technical foundation for the hub. This includes unmatched high-performance computing technology, world-leading nuclear science expertise, state-of-the-art facilities, extensive nuclear reactor knowledge, and consultation on the innovative research taking place.

Taking the Next Steps

In 2020, CASL will come to an end and transition into a combined program with the Nuclear Energy Advanced Modeling and Simulation program. This integration will continue to advance research in light water reactor technology, keeping a focus on new types of fuels and extended nuclear power plant lifetimes.

CASL has established the VERA Users Group to support continuing improvement of VERA and deployment of the modeling suite to users. Through this new program, VERA technology will be offered to the nuclear industry through collaboration with utilities, vendors, and nuclear service providers.

In addition, the users group will help in accessing high-performance computing resources available at DOE national laboratories to perform large-scale simulations and will offer training in the use of VERA, thereby ensuring CASL's impact on the nuclear industry through the 2020s.

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