



Energy Science

for a *Secure World*



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Think for a moment.

How was the electricity generated?

What's going on under your car's hood?

What powers your home heating and cooling system?

Most of us are unaware of the vital, invisible role combustion plays in our lives. Combustion powers our cars, trucks, airplanes, furnaces, power plants, and manufacturing processes. Since humans first harnessed fire some 400,000 years ago, we have become increasingly reliant on combustion processes. Today, combustion is involved in 85 percent of the world's energy use and is a key element in many critical technologies.



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***Without giving it much thought,
we flip on a light switch.***

Turn the key in a car's ignition.

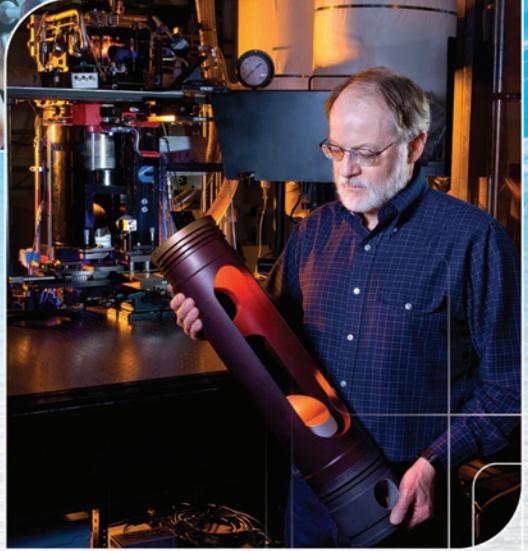
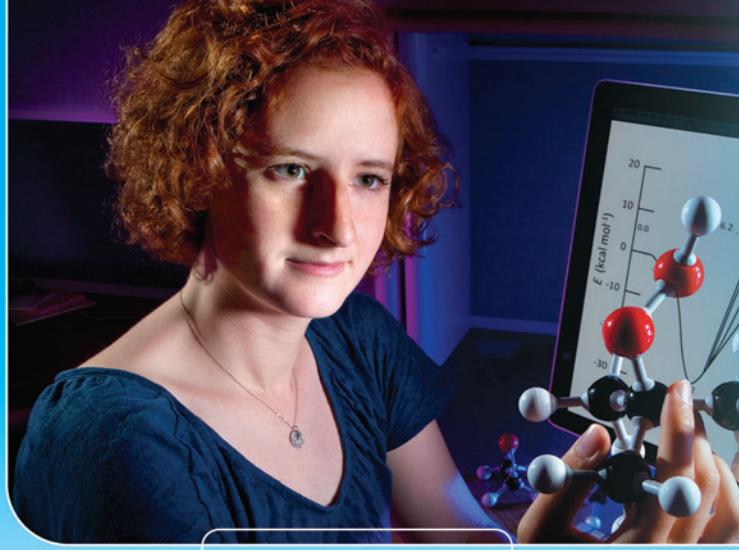
Adjust a thermostat.

***We have developed combustion technologies for centuries,
and yet mysteries and challenges remain. For instance,***

- Developing more efficient car and truck engines. Future high-efficiency, ultra-clean engines will employ new fuels and new combustion processes.*
- Further reducing emissions from motor vehicles, power plants, and industrial processes. Research has led to significant reductions in emissions, but improvements are necessary to meet future environmental standards.*
- Improving manufacturing efficiencies and product quality of combustion-intensive industries (e.g., steel, glass, and chemicals). Often, the science behind high-temperature industrial processes is not well understood, and improvements are achieved through trial and error.*

Combustion is

*The Office of Science
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Filling a Vital Role

For over 30 years, scientists and engineers at the **Combustion Research Facility (CRF)** at Sandia National Laboratories have strived to solve these important energy-related problems. As a U.S. Department of Energy collaborative research facility, the CRF has significantly advanced the science and technology of combustion.

The CRF is known for its pioneering work in using lasers to penetrate the hostile environments of combustion events. Researchers “dissect” complex combustion processes—such as soot formation in a diesel engine—and study the constituent chemical reactions and fluid mixing processes. By understanding the steps in soot formation, for example, researchers and engine designers are working to reduce the amount of soot formed in the first place.

With better lasers and faster computers, researchers have gone from measuring single step reactions 15 years ago to unraveling complex reactions of twenty or more steps.

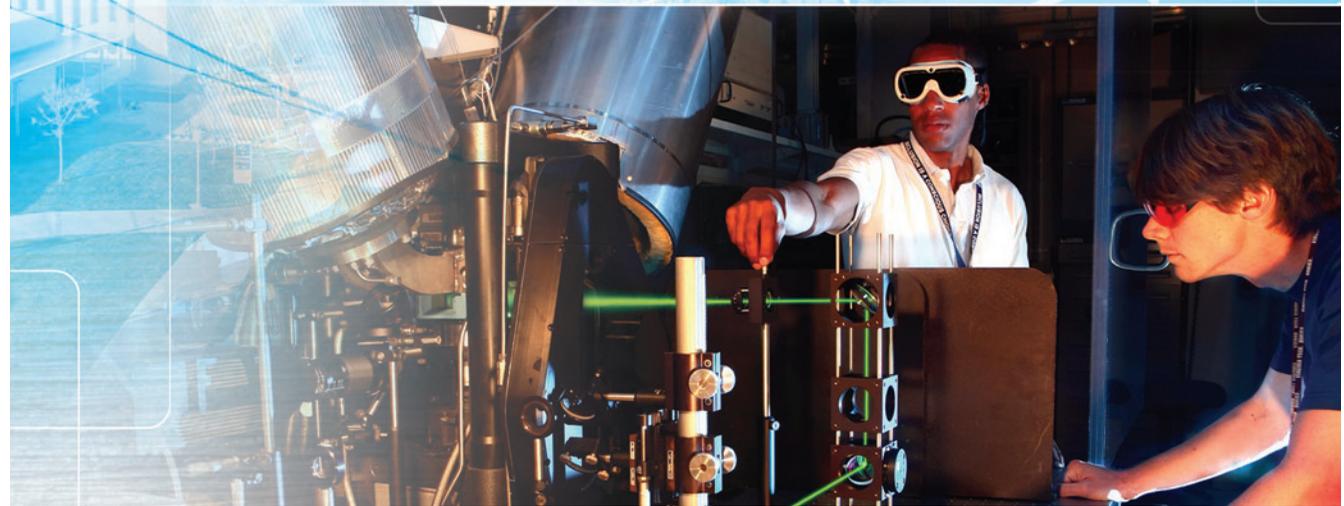
We all benefit from cleaner air and greater energy efficiency. Even small improvements can have dramatic impacts. For example, a 5 percent increase in automotive fuel efficiency could save the U.S. 140 million barrels of oil annually—about \$4 billion.



essential to life as we know it.

With its ten National Laboratories and broadly funded university research program, has been the source of many discoveries that have defined our current understanding of the most fundamental aspects of nature, have helped define the sciences and have led to a deep understanding of many important materials.

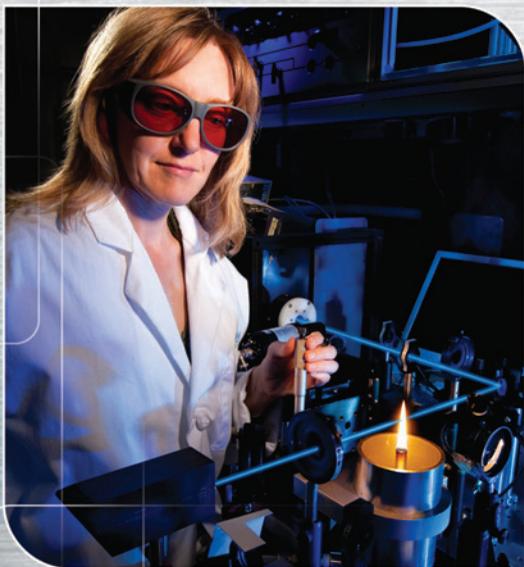
— William F. Brinkman, Director, DOE Office of Science



A New Era of Opportunities

Years of investment in fundamental research have led to unprecedented opportunities.

We've made great strides in understanding reacting flows, turbulence, and chemical kinetics and dynamics through experiments and models. Our work contributes to advances ranging from more environmentally friendly diesel engines to improved rocket engine processes.



New scientific understanding, advanced detection methods, sophisticated models, and novel information-sharing tools are accelerating advancements in clean energy. Our ability to understand and exploit chemical reactions at the molecular level is key to developing advanced fossil-derived fuels, biofuels, and hydrogen.

One outgrowth of our work in laser-based measurements is sensors for remotely detecting gas leaks and other chemicals—technology which could benefit refineries and companies operating gas pipelines. The CRF's laser diagnostics and chemical sciences expertise is also being tapped to develop devices to detect chemical and biological warfare agents.

Broad, flexible capabilities coupled with user collaborations enable the CRF to address national challenges.

From transportation to terrorism, the CRF will continue to advance and apply energy science and technology, to benefit our economy, environment, security, and quality of life.



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CRF at a glance:

- *Over 100 resident researchers*
- *Over 100 visiting collaborators per year*
- *82,000 sq.ft. office and lab complex*
- *36 highly specialized labs*
- *Multiple cluster computers including a 5,000 core, 50 teraflop system*



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