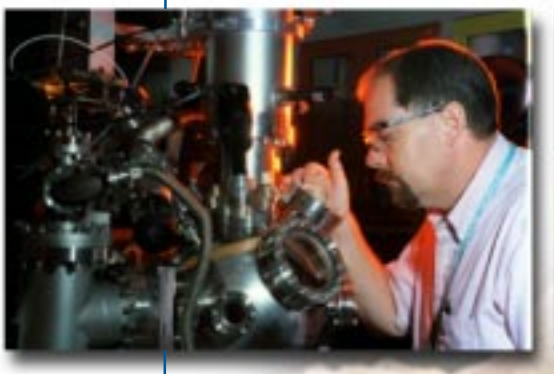







The Science and Technology Directorate's more than 400 scientists and engineers apply the energy of innovation to some of the most daunting science challenges of our day.

Science & Technology

Science and Technology

The science, engineering and technologies that underpin INL's most visible missions in energy and homeland security are the responsibility of the Science & Technology (S&T) Directorate. The directorate addresses some of the nation's most pressing energy issues – including the rebirth of nuclear energy and closing the nuclear fuel cycle.

The directorate also focuses its science and technology on developing America's hydrogen economy and alternative fuels and energy systems. It supports the development of advanced energy storage and transportation systems, critical energy infrastructure and water resources, and manages the environmental consequences of energy development and use.

Divisions within INL's S&T Directorate carry out a range of multiprogram research and development activities with these and other diverse initiatives. For example, research is being conducted in the areas of liquefied and compressed natural gas; high-powered batteries and ultra capacitors; integrated fuel processors and fuel cell systems; renewable energy systems; and carbon capture and sequestration. Still other research programs and projects involve hazardous waste

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S&T's capabilities are strategically aligned with major research programs such as (clockwise from upper left):

- ***Advanced polymer research (Physical Sciences)***
- ***Wind energy development (Energy & Technology Systems)***
- ***Structural alloy formulation (Engineering Technologies)***
- ***Pathogen detection (Life & Earth Sciences)***

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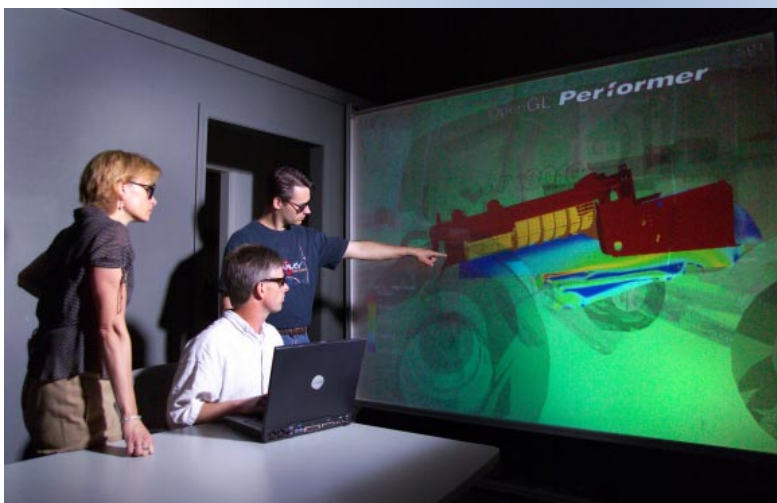
management and treatment; advanced offgas treatment systems; advanced welding systems; surface and subsurface monitoring systems; sustainable building design; and autonomous unmanned aerial and ground vehicles.

Organization and Structure

The S&T Directorate strives to add scientific and engineering skills to its portfolio of energy security capabilities. These capabilities are strategically aligned with major research programs, and are organized into the following functional research and development divisions.

- **Energy & Technology Systems** – oversees work related to the design, function and efficient use of fossil and renewable energy systems, industrial and transportation technologies, and robotic/human systems.
- **Engineering Technologies** – oversees work regarding the presence of hazardous and radioactive contaminants and how to manage, minimize, treat, package, store and protect humans and the environment from legacy wastes.
- **Life & Earth Sciences** – answers questions about living organisms, performs research to improve the understanding of chemical, biological, and geophysical processes in subsurface environments, and develops methods for identifying and decontaminating priority pathogens.
- **Physical Sciences** – addresses questions about the composition, properties, structures, energy and reactions of known and unknown substances; develops synthetic polymers; fabricates and tests structural materials and welding technologies; and devises measurement systems and noncontact sensors.

Engineers use virtual engineering software to accelerate modeling and design of structural elements and processes (below); Scientists access world-class computational capabilities in INL's Center for Advanced Modeling and Simulation to view results of complex 3D modeling (right).



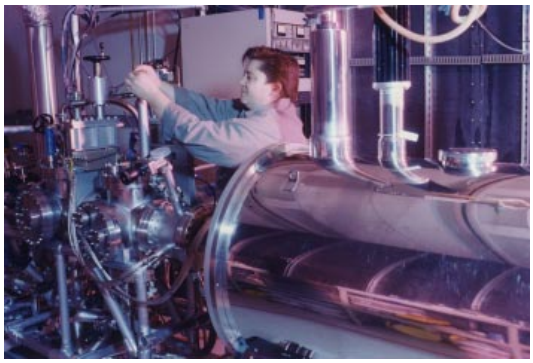
Science Base

By conducting basic and applied research, the directorate develops new knowledge, discovers characteristics and mechanisms, understands complex systems, and measures and predicts behavior – the quality of which forms the basis of INL's research reputation. To expand this science base and enable technological advances to continue, the directorate is building vital science programs and is leading the effort to establish nationally and internationally recognized "distinctive science signatures."

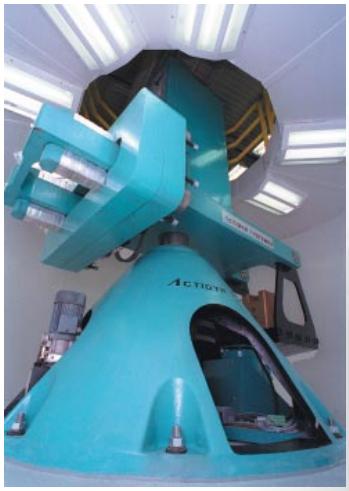
Distinctive Scientific Signatures

The following distinctive signatures are an integral part of S&T's energy security portfolio and are used to guide investments in science and technology research.

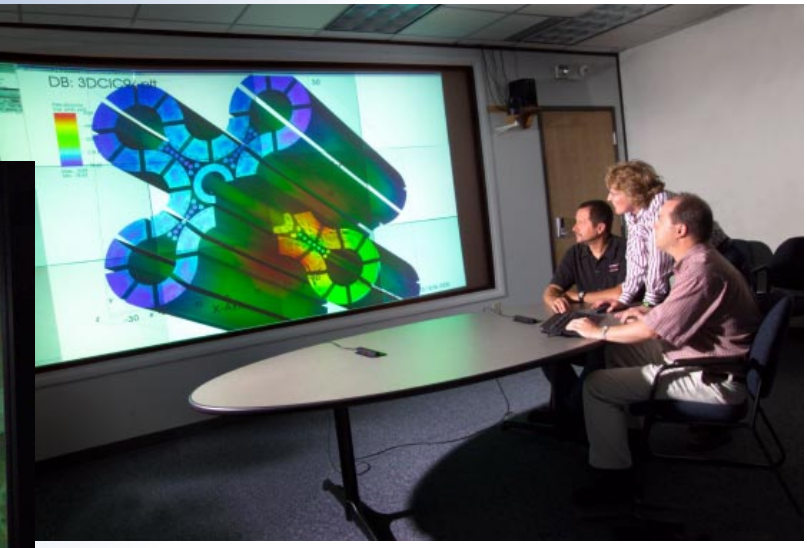
- **Instrumentation, Control and Intelligent Systems** – researches and develops advanced systems and processes to support the next wave of power and energy security innovation.
- **Materials and Nuclear Fuels Science and Technology** – enhances the function and reliability of energy systems by integrating physics-based material degradation models with validation of performance models.
- **Microbiological and Geological Systems Science** – provides predictable, large-scale microbiological systems to manage and resolve energy and water security issues.
- **Separations and Actinide Science** – sustains the nuclear fuel cycle by addressing economic, environmental, safety and security issues and applying separation and actinide science.











Center for Advanced Modeling and Simulation

As a significant contributor to the science base, the Center for Advanced Modeling and Simulation (CAMS),

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INL's Distinctive Science Signatures include (clockwise from upper left):

- ***Instrumentation, Control and Intelligent Systems***
- ***Materials and Nuclear Fuels Science and Technology***
- ***Separations and Actinide Science***
- ***Microbiological and Geological Systems Science.***

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brings together INL's resources and those of the National and Idaho University Consortia. Together, they build world-class computational capabilities in modeling and simulation of advanced energy systems – with emphasis on nuclear energy system concepts.

Engineering Base

The Directorate is enhancing its already successful engineering legacy to develop, demonstrate and deploy innovative solutions that improve complex systems. A key example of this expertise is INL's Bioenergy Program. This major S&T program promotes "Whole Crop Utilization" by using the grain and the discarded plant material to produce food, feed, fiber and fuel. It researches a variety of crops to identify the genetic makeup that impacts the cost and quality of the biomass throughout the phases of harvest, storage, transportation and pre-processing.

Summary

The Science and Technology Directorate's more than 400 scientists and engineers apply the energy of innovation to some of the most daunting science challenges of our day. The results of their research have been published in the scientific literature, been recognized with numerous awards and resulted in scores of patents. Most important of all, though, the research has led to real-world solutions that have improved quality of life and substantially advanced U.S. interests for enhanced energy, economic and environmental security.









Examples of INL's engineering experience include developing processes to sustain a supply of biomass feedstock, producing a hydrogen-rich gas for use in fuel cells, liquefying natural gas, and monitoring and testing alternative fuels on advanced internal combustion engine vehicles.

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