



ENERGY AND ENVIRONMENTAL SCIENCES

Mission Statement

The Energy and Environmental Sciences (E&ES) Division develops the crosscutting science that underpins Department of Energy (DOE) missions to provide reliable energy, ensure national security, clean up and close sites used in DOE's weapons programs, and conduct fundamental science. The division maintains core capabilities in the fundamental disciplines of physics, materials science, chemistry, geosciences, and microbiology that are needed to support all INEEL missions.

Description

The E&ES Division has a significant part of the basic and applied research capabilities of the INEEL. The FY-04 program is structured to position the INEEL to

- Support the science missions of the DOE and other federal agencies (frequently in collaboration with universities for non-DOE customers)
- Provide science underpinnings for the more applied mission areas of DOE (such as environmental, energy security, and national security)
- Develop capabilities in emerging areas of research that form the base for future activities for INEEL.

The base business for the division is from three primary customer sets:

- DOE's Office of Science (SC)
- Other DOE offices (Office of Fossil Energy [FE], Office of Energy Efficiency and Renewable Energy [EE], National Nuclear Security Administration [NN], Office of Nuclear Energy, Science and Technology [NE], etc.)
- Other INEEL divisions, including the Idaho Completion Project (ICP).

The Office of Science programs consist of a number of independent programs that are grouped together for this discussion. These programs are from various suboffices (chemistry, materials, engineering research, biology) within Basic Energy Sciences and Biological and Environmental Research. These programs typically are small (two to three staff members) and somewhat open-ended. The primary measure of their success is peer-reviewed publications. An important goal for the E&ES Division over the next five years is to increase the level of funding from the Office of Science. To meet that objective, E&ES will focus on crosscutting science that underpins the DOE missions to (1) provide reliable energy, ensure energy security, and conduct fundamental energy-related science, (2) support the Office of Biological and Environmental Research, and (3) support programs under development in legacy management of DOE sites. An Office of Science, Basic Energy Sciences Advisory Committee subpanel issued a report in October 2002 outlining the basic research needs to assure a secure energy future: materials science to transcend energy barriers, energy biosciences, basic research toward the hydrogen economy, novel membrane assemblies, and heterogeneous catalysis. We will focus on these areas. The division will focus much of its efforts in two thrust areas, metabolomics of C-1 metabolism and materials performance and characterization research. These two thrust areas are complementary and will position

the INEEL to develop a research base and expertise in assembly of man-made materials based on lessons learned from nature. This will set the INEEL apart as a leader in energy-related science.

The primary non-SC DOE offices supported by E&ES are the Office of Nuclear Energy, Science and Technology (NE), Office of Fossil Energy (FE), and Office of Energy Efficiency and Renewable Energy (EE). The E&ES Division will work closely with the E&ET Division and the Nuclear Energy Division relationship managers to identify opportunities and customer needs. Opportunities for growth in FY-04 include:

- National Energy Technology Laboratory—The Carbon Sequestration program has requested \$62 million for research in FY-04 (FY-04 Congressional Budget)
- A request for proposals entitled “Development of Technologies and Capabilities for Developing Coal, Oil, and Gas Energy Resources” specifies “activities that promote the efficient and sound production and use of fossil fuels (coal, natural gas, and oil)”
- Vision 21 program for clean and efficient combustion based on gasification and separation
- Biomass and Industrial Technologies Programs—The Biomass program to convert biomass to fuels and other value-added products, while a component of the Industrial Technologies Program, deals with advanced biocatalysis
- Freedom Car and other related hydrogen economy materials needs
- Anticipated proposal calls in response to the needs identified in the DOE Nuclear Hydrogen R&D program.

A large fraction of the E&ES Division’s work supports ICP and other INEEL divisions. Work for other government agencies represents a potential for broadening INEEL’s base business. The E&ES Division will work closely with the other INEEL divisions and relationship managers to identify customer needs and funding opportunities. Examples of non-DOE government agencies that have potential for broadening our base business in FY-04 include:

- Department of Defense, in particular, work sponsored by the Defense Advanced Research Projects Agency (DARPA) and the Defense Threat Reductions Agency (DTRA)
- Navy Research Laboratory, our partner in active environmentally-oriented proposals, sponsors work on methane hydrate formation and deep ocean carbon cycling
- Environmental Protection Agency sponsors work on environmental remediation using biological processes employing organisms with C-1 metabolic pathways
- National Science Foundation’s Microbial Observatories Program is interested in a variety of areas that include C-1 metabolism research.

The division’s research is performed by two directorates: Physical Sciences, and Bio and Geological Sciences. The two directorates are composed of 8 departments: Physics, Materials Science, Chemistry, Analytical Laboratories, Prototype Shops, Applied Geosciences, Geoscience Research, and Biotechnology. Individual departments, following a division-wide business plan, capture our business, which is organized into five formal business lines: Physics, Materials Science, Chemistry, Geosciences, and Biotechnology. Prototype Shops is a service organization that supports the INEEL and ICP and does not capture new business. The Analytical Laboratories’ work is captured within the Chemistry business line. Research and development conducted by the Applied Geosciences and Geoscience Research Departments are both captured within the Geosciences business line. A brief description of the work performed, the client base, and the goals of each business line follows.

Physics

The Physics Department performs basic and applied materials physics research that supports INEEL's goal to provide safe and efficient state-of-the-art research capabilities for nuclear fuels, materials, and systems testing and evaluation. The Physics Department is highly expert in two areas: thermal processing of materials in plasmas and material microstructure analysis using acoustical methods. The department will continue to build this capability in support of DOE's energy security mission. Primary customers include DOE-FE, EE, and NE. In FY-04, the Physics Department will also focus on development and integration of a range of sensing and control technologies and characterization technologies for DOE's national security, environmental, and energy missions. Primary customers include DOE-SC, NN, EE, NE and the Department of Defense.

Materials Science

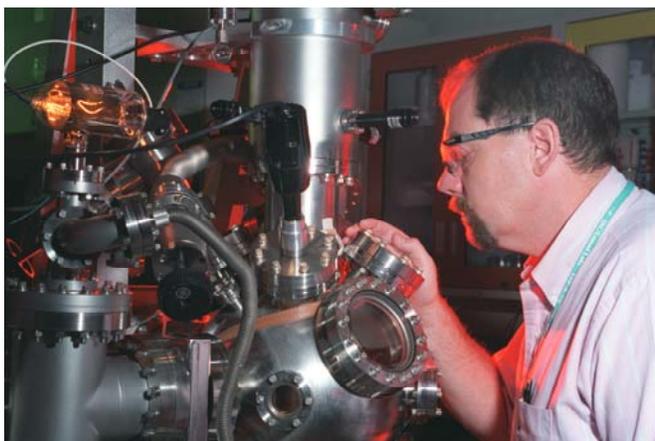
The Materials Science Department's research will focus on experimental characterization and theoretical understanding of both bulk and surface properties of advanced materials, including coatings. Topical areas of research currently include high temperature materials, particulate materials, advanced ceramics, and biocorrosion. A significant percentage of the department's R&D focuses on microstructural characterization and control to enhance properties and meet performance specifications. In FY-04 the Materials Science Department will focus on further developing a program on materials performance characterization and validation. Development of advanced materials is a critical enabling technology for most of the proposed Laboratory initiatives as well as the DOE missions.



Rapid solidification processing through gas atomization

Chemistry

The Chemistry business line, which includes both the Chemistry Department and the Analytical Labs, conducts chemical research and provides technical support to ICP and other INEEL programs. DOE customers for chemistry research include SC, EE, FE, and NE. Primary non-DOE customers are Department of Defense (i.e. DARPA) and industry. Primary customers for analytical support include ICP, BNFL, and DOE-EM. Chemistry currently has four product areas: solid/liquid interfacial science, analytical ion chemistry, polymers and separation science, and chemical and analytical support. The strength of these business activities is growing due to their narrow research focus and a good history of high-quality products. Chemistry's weaknesses include insufficient senior technical staff in areas such as ion mobility and supercritical fluids, laboratories in aging nuclear facilities, and aging equipment.



Attachment of chemical compounds to surfaces is being studied using advanced mass spectrometric methods to understand how chemicals interact with surfaces.

Chemistry will expand all business activities over the next five years and has an objective to increase the amount of basic and fundamental research by almost 300% over this period.. To support this objective, four specific strategies will be pursued. The principal focus of these strategies is to enhance the technical reputation of the chemistry organizations, expand the number of peer-reviewed publications, maintain high quality and timely products to base business customers, and increase the technical competency of the staff.

Geosciences

The geosciences business line (which includes both the Applied Geosciences Department and the Geosciences Research Department) comprises six mutually supportive activities: coupled reactive transport of chemical species, subsurface fate and transport modeling, energy research and development, sensing and imaging of the subsurface environment, environmental site characterization, and studies of the dispersion of chemical species in the atmosphere. These activities or focus areas capitalize on core technical strengths in hydrology, geochemistry, reservoir engineering, geophysics, and seismology. Although much of the work is related to understanding physical-chemical processes and the ultimate fate of contaminants and fluids in the subsurface, each area addresses unique problems and supports a varied customer base. The capabilities of the two geosciences departments have been significantly increased in the last three years by acquisition of new Ph.D.-level staff under funding for the Subsurface Science Initiative. The Geosciences business line will continue to support the Subsurface Science Initiative in FY-04. With the Geocentrifuge Research Laboratory, the INEEL gained a new, relatively unique, research tool to be applied to scientific and engineering problems. The geosciences business line provides basic and applied research, technology development and deployment, and technical consultation and support to a varied customer set. Primary customers include DOE's Office of Science, FE, and EE, other DOE sites, Work for Others (Environmental Protection Agency), and support to Site operations (ICP). Potential for growth is evident in all of these customers, but perhaps the areas of greatest potential are in sensing and geophysics, energy research and development, and in geocentrifuge applications. FY-04 activities will

focus on applications of sensing and imaging to national security and fundamental geoscience research in support of DOE–FE.

Biotechnology

The Biotechnology Department is presently focusing on three technical areas: environmental biotechnology, energy, and biotechnology for national security. In environmental biotechnology, the department will focus on maintaining expertise and funding for research that enables the cleanup of subsurface organic and inorganic contamination by investigating subsurface microbial ecology, microbial activity, and the microbial impacts on fate and transport of organic and inorganic contaminants such as trichloroethylene, strontium-90, and chromium. The department’s focus within this area is in deep fractured rock environments. Much of the environmental biotechnology work has been in support of the Subsurface Science Initiative and of completing DOE’s legacy cleanup and stewardship responsibilities. In the energy area, biotechnology has several foci, including enhancing recovery of oil and gas and investigating methane hydrates production, biocatalysis, whittings production, biocorrosion in geothermal systems, and whole-crop utilization. Primary customers for energy biotechnology currently are DOE FE and EE. In the area of national security, the department is establishing business in the field of priority pathogens. The department has identified its specific focus on genomics and detection of priority bacterial pathogens. The primary customers for this work include DOE-NN, Department of Defense, and Department of Homeland Security. The Biotechnology Department will continue to work closely with the INEEL National Security Division to identify customers and determine customer needs in order to broaden the biotechnology base business in the area.

In FY-04, the Biotechnology Department will focus new efforts on development and application of metabolomics (specifically C-1 metabolism) for energy, environmental, and national security missions. Metabolomics is the next step in the emerging biological revolution. While genomics has provided the words in the “genetic dictionary” and proteomics strives to understand the structure and function of proteins, metabolomics builds on this knowledge base by using a systems approach to understand cellular metabolism, and studies the total population of metabolic compounds in a particular system, usually a cell or tissue. The culmination of these efforts will be an understanding of assembly processes in cells and new micro- and nano-scale biomimetic approaches to materials synthesis. Focusing on C-1 metabolism (i.e., compounds like CO₂ or CH₄ with a single carbon atom) will allow INEEL to become a leader in development of approaches and application of metabolomics. From there, we can diversify into applications such as electron transfer, inorganic transformations, lignin transformation, and hydrogen generation, as market opportunities dictate. This opens the door to potential future funding in these areas from both government and industry and will place us at the forefront of biotechnology. The parallel focus on materials performance and characterization (within the Materials Science business line) allows the division to focus on demanding energy applications like hydrogen separation membranes for fuel cells and molecular wires for electronic and power switching applications. The two thrusts converge at the point of developing biomimetics—the design and processing of man-made materials based on lessons learned from nature. The two thrusts also share a common need for extensive modeling and simulation. Focusing on these two emerging areas of fundamental science will position the division for a long-term research future.



Real-time PCR for detecting pathogens

Projected Business Volume

Major Business Area	FY-04 (\$M)
E&ES Base Business	9.0
ESRA carryover	4.5
Total	13.5