Top: Researchers draw upon historic expertise and use modern instrumentation to develop new methods for turning biomass, such as agricultural byproducts and municipal waste, into clean fuels, chemicals, and other useful products.

Bottom: The PNNL-developed Grid Friendly™ Appliance Controller was successfully tested in clothes dryers and water heaters in Washington and Oregon during a 2007 demonstration project. The controller senses stress on the electric grid and automatically and instantaneously responds to reduce the demand for electricity from appliances, such as turning off the heating element in a dryer for a few minutes. When applied in concert across multiple appliances in multiple households, this temporary drop in energy demand could give grid operators the cushion they need to balance the system. The Grid-Friendly Appliance Controller won a prestigious R&D 100 Award in 2008.

information technologies to modernize the grid, making it smarter, stronger, and more secure. We're focused on how to effectively integrate cleaner, renewable energy sources, such as wind and solar power; on understanding the impacts of evolving technologies, such as plug-in hybrid electric vehicles, on the grid; and on using information technology to manage the demand for electricity as a resource in grid operations.

Our capabilities in power engineering and high-performance computing are shaping an interactive approach to grid management. Complete with near real-time data and visualization tools, this "smart" grid will allow grid operators to better understand the health of the system, take action to address potential problems before they spin out of control, and manage the use of generation, transmission, and distribution resources more effectively. A smart grid, powered by high-speed, real-time information, can play a role in tracking reductions in carbon emissions, help deploy renewable resources, and send reliable electricity where and when it is needed most.

The Electricity Infrastructure Operations Center (EIOC) brings together industry-leading software, real-time grid data, and advanced computation in a fully capable control room. It serves as a safe test bed where our researchers can assess new technologies and "virtually" deploy them to understand how they would perform in the real world. The new technologies we develop in the EIOC with our collaborators are transferable across the energy industry to address the national need for a more reliable and effective grid.

Leading the way in energy research

Our staff, facilities, capabilities, and approach to research have established us as a premier science and technology enterprise for more than 40 years. As we advance energy solutions, we're especially proud of our unique ability to marshal interdisciplinary research teams, collaborate with academia and industry, and leverage research funding to move technologies from development to deployment.

To learn more about the Pacific Northwest National Laboratory and the resources we offer, contact:

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U.S. DEPARTMENT OF ENERGY

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ADDRESSING OUR NATION'S ENERGY CHALLENGES

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NATIONAL LABORATORY

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PNNL provides the science, technology, and leadership to increase U.S. energy capacity and reduce dependence on imported oil.

Above: Capturing carbon dioxide from coal-fueled plants rather than releasing it into the atmosphere is one of the nation's biggest technical challenges. Currently available technologies can trap relatively low amounts of carbon. Our researchers are developing novel crystalline materials for carbon capture, as well as exploring how CO_2 can be safely injected into basalt formations for long-term storage.

Cover: Coal gasification offers a clean, versatile process for turning coal into electricity and capturing carbon dioxide. Researchers are using PNNL's research-scale gasifier to advance and test gasification technology.

Leading the world to a cleaner energy future

Finding clean and cost-effective ways to satisfy our nation's growing need for energy and electricity requires rapid innovation. Energy is critical to the health of our economy and our quality of life. It is essential to our productivity and mobility. Currently, 85 percent of our nation's primary energy comes from fossil fuels, 40 percent of which is used to generate electricity. Globally, production of fossil fuels, such as oil, may be nearing its peak and competition for these resources is affecting prices and increasing political tensions.

As society rapidly moves into a carbon-constrained era, cleaner alternatives and advanced technologies are needed to reduce the nation's dependence upon fossil fuels, expand the use of renewable resources, and increase energy efficiency. And we must make progress in these areas without straining our economy, threatening our energy security, or reducing the reliability of the electric grid and energy infrastructure.

At the U.S. Department of Energy's Pacific Northwest National Laboratory, we are aligning our capabilities and expertise to solve the most pressing energy problems. For decades we have been committed to finding ways to help the nation meet its growing needs with clean, reliable, affordable, and sustainable energy. We conduct the research necessary to develop and deploy technologies that advance renewable energy, energy efficiency, clean fossil energy, nuclear energy, and the reliability and management of the electric grid.

Improving efficiency and advancing renewable energy

Scientists and engineers at PNNL are paving the way to a cleaner, more efficient energy future. Our strengths in chemistry, nanoscale synthesis and materials

processing, advanced characterization tools, computational chemistry, and electrochemistry are driving this change. We are focused on improving end-use efficiency in transportation, buildings, and industry, and increasing the use of renewable fuels.

The Energy Independence and Security Act of 2007 mandates that vehicle fuel efficiency will increase to 35 miles per gallon by 2020. The technologies needed to get us there, including hybrid vehicle systems and fuel cells, will require effective electrical or hydrogen storage. We are helping develop better battery materials and fuel cells for the nation's transportation fleet.

Buildings in the United States are responsible for nearly 40 percent of the nation's total primary energy consumption, and therefore are a large contributor to national carbon emission levels. Over the next decade, rising energy prices, caps on carbon emissions, and constraints on utility construction will further drive the need for energy-efficient buildings. Our researchers are leading this charge by standardizing building energy codes and energy-efficient appliances, and integrating energy efficiency technologies, such as renewable solar energy and fuel cells, into modern construction practices.

Understanding current building operating conditions is the first step in reducing energy consumption. We apply metering technologies to measure temperature, pressure flow, illumination, and power parameters to identity how operational issues can be improved and quantify a building's potential for energy savings. We have joined DOE and five other national laboratories in support of the Zero-Net Energy Commercial Buildings Initiative. The goal of this program is to develop new commercial buildings that produce as much energy as they use by 2025.

Bio-based fuels and products are not only cleaner—they offer a domestic option for reducing dependence on oil. Our expertise in catalysis, thermal processing, catalytic processing, and fungal biotechnology is directly helping to develop the next generation of infrastructure-ready, bio-based fuels and chemicals. We are recognized leaders in chemical conversion, and are using our scientific expertise to develop additional conversion pathways to replace petroleum-derived chemicals. The Bioproducts, Sciences, and Engineering Laboratory, built in partnership with Washington State University Tri-Cities, is a state-of-the-art facility that provides opportunities for researchers, faculty, students, and industry to collaborate in the development of next-generation biofuels and bioproducts.

Fueling the world with cleaner energy

Fossil fuels, or hydrocarbons, such as coal, oil, and natural gas, are by far the most widely used energy resources around the globe. Carbon emissions continue to increase as energy consumption rises, contributing to climate change. We are addressing the challenge of using America's energy resources cleanly by applying our core strengths in chemical and materials sciences, catalysis, process engineering, and subsurface science and engineering.

Despite the advancement and deployment of renewable energy sources, the nation will remain dependent upon fossil fuels for decades, if not centuries. Coal is our nation's most abundant fossil fuel, with about 25 percent of the world's reserves located in the United States. We are advancing the cleaner use of fossil fuels through engineered carbon capture and storage. This involves stripping carbon dioxide produced at power plants and injecting it deep underground for safe, long-term storage rather than emitting it into the atmosphere.

As recognized leaders in site characterization, modeling, and simulation of carbon dioxide injection into geological formations, we are committed to helping fuel the world with clean hydrocarbon energy.

Additionally, our researchers are producing technologies to extract syngas and refinery-grade feedstocks from hydrocarbon resources, such as oil shale, methane hydrates, and depleted oil reserves, as well as biomass. These advances will help meet America's energy demand, improve the nation's ability to tap its own abundant hydrocarbon resources for energy, and allow continued use of fossil fuels in a carbon-constrained world.

Expanding safe nuclear energy

Nuclear energy is a carbon-free and relatively inexpensive energy option. As such, nuclear energy is re-emerging on a global scale, with more than 30 new reactors proposed for the United States alone. We are applying our strong nuclear energy heritage, including capabilities in irradiated materials research, radiochemical separations, safeguards, and proliferation resistance, to enable the safe and secure expansion of nuclear energy. We provide solutions in four areas that enable nuclear energy growth—safety, spent fuel disposition, nonproliferation, and the life extension of existing nuclear power plants.

As DOE and industry begin to invest more in accelerating safe nuclear power, we will contribute to the international nuclear community with advancements in structural materials and domestic fuel recycling. We continue to operate the Radiochemical Processing Laboratory, which is a Hazard Category 2 nuclear facility, and a Category 1 fuel cycle research facility. To further advance used fuel and radioisotope processing technologies, we are establishing a research, development, and demonstration center at PNNL.

Building a smarter grid

The demand for electricity in the United States is projected to double by 2050. The system built to deliver this electricity was designed without the benefit of today's communication and information technology. At PNNL, we are looking at how energy technologies can be combined with

PNNL leads CALiPER, a U.S. Department of Energy Solid State Lighting testing program that provides reliable, unbiased product performance information to foster the developing market for high-performance solid state lighting products. Lighting consumes about 20 percent of the total electricity produced in the United States. As an alternative to today's inefficient incandescent light bulbs, solid state lighting could save Americans $280 billion in energy costs over the next 20 years.