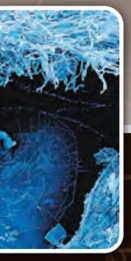
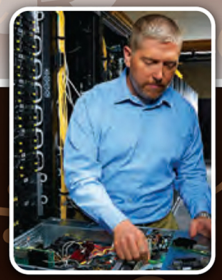
Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by* **Battelle** *Since 1965*

# DISCOVERY *in action*







U.S. DEPARTMENT OF
ENERGY

# DISCOVERY *in Action*

Pacific Northwest NATIONAL LABORATORY

## OUR MISSION

*At PNNL, we transform the world through courageous discovery and innovation.*

## OUR VISION

*PNNL's science and technology inspires and enables the world to live prosperously, safely and securely.*

"Powered by the creativity and imagination of more than 4,000 exceptional scientists, engineers and support professionals, at PNNL we advance the frontiers of science and address some of the most challenging problems in energy, the environment and national security. As DOE's premier chemistry, environmental sciences and data analytics laboratory, we provide national leadership in four areas:

- **deepening our understanding of climate science**
- **inventing the future power grid**
- **preventing nuclear proliferation**
- **speeding environmental remediation.**

Other areas where we make important contributions include **energy storage**, **microbial biology** and **cyber security**. PNNL also is home to EMSL (the Environmental Molecular Sciences Laboratory), one of DOE's scientific user facilities.

We apply these science strengths to address both national and international problems in complex adaptive systems that are too difficult for one institution to tackle alone. Take earth systems, for instance. The earth is a complex adaptive system because it involves everything from climate and microbial communities in the soil to emissions from cars and coal-powered industrial plants. All of these factors and others ultimately influence not only our environment and overall quality of life, but cause the earth to adapt in ways that must be further addressed. PNNL researchers are playing a vital role in finding solutions across every area of this complex adaptive system.

In the following pages you'll learn more about how some of our researchers are helping address other systems in energy and security. I encourage you to go online at **www.pnnl.gov/discoveryinaction** to listen as these spirited discoverers share the personal commitment and passion they bring to transforming the world. Better yet, we welcome your help and engagement, and invite you to join us as a collaborator or new hire.

I'm also personally committed to pushing the boundaries of science so that we all benefit from a reliable power grid, travel safer through airports, drive more efficient automobiles, and much more. I share my vision on how we'll accomplish this at **www.pnnl.gov/discoveryinaction**.

Now, come see how our researchers are advancing science to improve the lives of millions."

— *Dr. Steven Ashby*
**DIRECTOR**

# A Bold Science Vision

What really distinguishes PNNL is our ability to focus on discovery science—our desire to understand the world around us and the universe in which we live. We then leverage this understanding to seek solutions to many of the most challenging problems facing our country and the world in energy, the environment and national security. Our bold science vision to address these challenges is rooted in our strengths in **chemistry**, **environmental sciences** and **data analytics**. Researchers use these competencies to understand, predict and control the behavior of **complex adaptive systems**, including those that impact our **climate**, the future **power grid**, **nuclear nonproliferation** and **environmental remediation**. The figure below illustrates this connectivity.

Climate Science

Environmental Remediation

Power Grid

Nuclear Nonproliferation

Chemistry

Environmental Science

Data Analytics

## EARTH

*Examples include:*

- Clouds and Aerosols
- Water Cycle
- Microbial Communities

## ENERGY

*Examples include:*

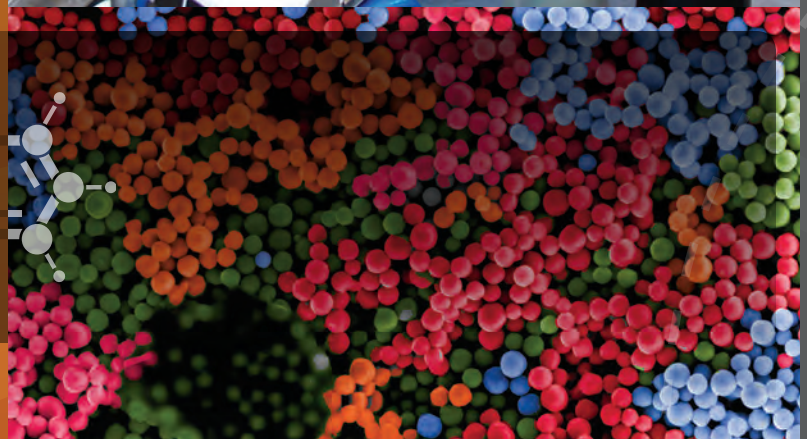
- Energy Storage
- Energy Conversions
- Control and Security

## SECURITY

*Examples include:*

- Ultratrace Detection
- Novel Signatures
- Data-Driven Discovery

# CORE CAPABILITIES



PNNL is recognized by DOE for 10 core capabilities, which form the enduring science and technology base of the Laboratory. Each capability is a powerful combination of people, facilities and equipment—nurtured and enabled through programmatic and institutional investments.

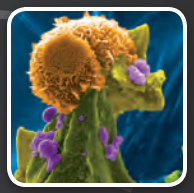
APPLIED MATERIALS SCIENCE AND ENGINEERING

CHEMICAL AND MOLECULAR SCIENCES

ADVANCED COMPUTER SCIENCE, VISUALIZATION AND DATA

ENVIRONMENTAL SUBSURFACE SCIENCE

APPLIED NUCLEAR SCIENCE AND TECHNOLOGY



CLIMATE CHANGE SCIENCE

BIOLOGICAL SYSTEMS SCIENCE

SYSTEMS ENGINEERING AND INTEGRATION

CHEMICAL ENGINEERING

LARGE-SCALE USER FACILITIES/ ADVANCED INSTRUMENTATION

# SCIENCE.
# It's in Our Blood.

## Strengthen the U.S. scientific foundation for innovation

Science is at the heart of all we do at PNNL. It fuels our discovery to serve humanity, leading to innovations that change the way we think about the world. Our researchers are redefining the boundaries of science, advancing our understanding of nature and the cosmos, and providing scientific foundations for technological innovations.

We have substantial science and technology experience in biology, chemistry, physics, computational sciences and materials science, as well as climate and earth systems science. And we apply this leading knowledge to research that encompasses everything from fundamental and applied science to technology development and commercialization efforts.

# A CATALYST for Change

PNNL's catalysis research is serving as a catalyst for changing how our nation will secure a strong, clean energy future. Senior Physical Chemist **Johannes Lercher** leads an award-winning team that is developing catalysts that efficiently make fuels from alternate feedstocks, such as biomass, and can store electrical energy in chemical bonds. The researchers also are creating catalysts that can increase vehicle fuel efficiency, while simultaneously cutting emissions. About 80 percent of all man-made materials—from plastics to pharmaceuticals—are made using catalysts. Through PNNL's Institute for Integrated Catalysis, Johannes and colleagues study how to speed the catalysis reaction process for manufacturers, which ultimately cuts costs and production time.

> "With the push to develop biofuels and other alternative energy sources, at PNNL we have grown a substantial and internationally recognized effort in what we call molecular catalysis, where both the catalysts and the reactions they enable occur within a liquid environment. This effort includes one of DOE's Energy Frontier Research Centers, where Institute chemists are trying to significantly improve on catalysts similar to those found in nature, such as those in plants that convert sunlight and carbon dioxide into chemical energy."

— *Johannes Lercher*
SENIOR PHYSICAL CHEMIST
and Director of PNNL's
Institute for Integrated Catalysis

**CATCH THE FULL INTERVIEW...**
http://goo.gl/oqhVaA

# FINDING "MODELS" in Clouds

Internationally recognized Climate Scientist **Ruby Leung** is a cloud gazer. But rather than looking for shapes, Ruby's life's calling is to develop regional atmospheric models to better predict and understand the effects of global climate change at scales relevant to humans and the environment. Ruby's accomplishments include developing novel methods for modeling mountain clouds and precipitation in climate models, and improving understanding of hydroclimate variability and change. She also has led efforts to develop regional climate modeling capabilities in the Weather Research and Forecasting model that is widely adopted by scientists worldwide. Ruby is part of a team of PNNL researchers studying the impacts of global warming.


> "The kind of information we produce using computer models is really useful for policymakers when they consider where they should build a new power plant and how greenhouse gases produced by the power plant would contribute to water supply and demand changes."
>
> — *Ruby Leung*
> CLIMATE SCIENTIST

CATCH THE FULL INTERVIEW...
http://goo.gl/BGWgIL

# On the Matter of **DARK MATTER**

The mission of the USS Enterprise was to "*boldly go where no one has gone before.*" And so it is with Particle Physicist **John Orrell** as he seeks to solve the conundrum of elusive dark matter. It's a mystery that PNNL scientists have chased for more than 25 years. And, if dark matter is discovered, it will change our entire understanding of how the universe was formed. The first experiments to locate dark matter were conducted underground using specialized, radiation detector technology developed at PNNL.

> "Our theories of how the universe evolved posit that there must have been some seeds of gravitational material matter present early in the universe around which all of our galaxies and stars today formed. That has to have been the dark matter. If dark matter did not exist, then we would not exist today, in any form that we recognize. The universe would just be filled with diffuse hydrogen and helium gas."
>
> — *John Orrell*
> PARTICLE PHYSICIST

**CATCH THE FULL INTERVIEW...**
http://goo.gl/Wpf8De

# MICROBIOMES
## Have the Power to Help or Hinder Your Health

They are everywhere: countless microorganisms that inhabit our world—even in your skin, mouth, gut and other parts of your body. Called microbiomes, these communities play a fundamental role in our ecosystem and our bodies, influencing everything from climate to human health.

And scientists at PNNL are studying microbiomes to better understand how they influence our daily lives. Scientist **Janet Jansson** studies complex microbiomes in soil and the human intestine to understand changes in the composition or function of microbes. In the soil, these microbes are associated with carbon cycling and degrading pollutants, as well as plant health. In the intestine, they are responsible for digestion of our food and protection from pathogens. When they go awry, they can be associated with numerous inflammatory bowel diseases, such as Crohn's. Understanding the factors underlying these microbiome changes will ultimately help researchers develop solutions to problems encountered within our world and our bodies.

> "We have had amazing 'aha!' moments. Just recently, we developed a better way to assemble DNA sequences from soil. This has been a challenge, because soil is the most diverse habitat on earth —much more diverse than the human gut."
>
> — *Janet Jansson*
> SENIOR MICROBIAL SCIENTIST

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http://goo.gl/6McaUs

# FULLY CHARGED and Ready for Research

## Increase the U.S. energy capacity and reduce dependence on imported oil

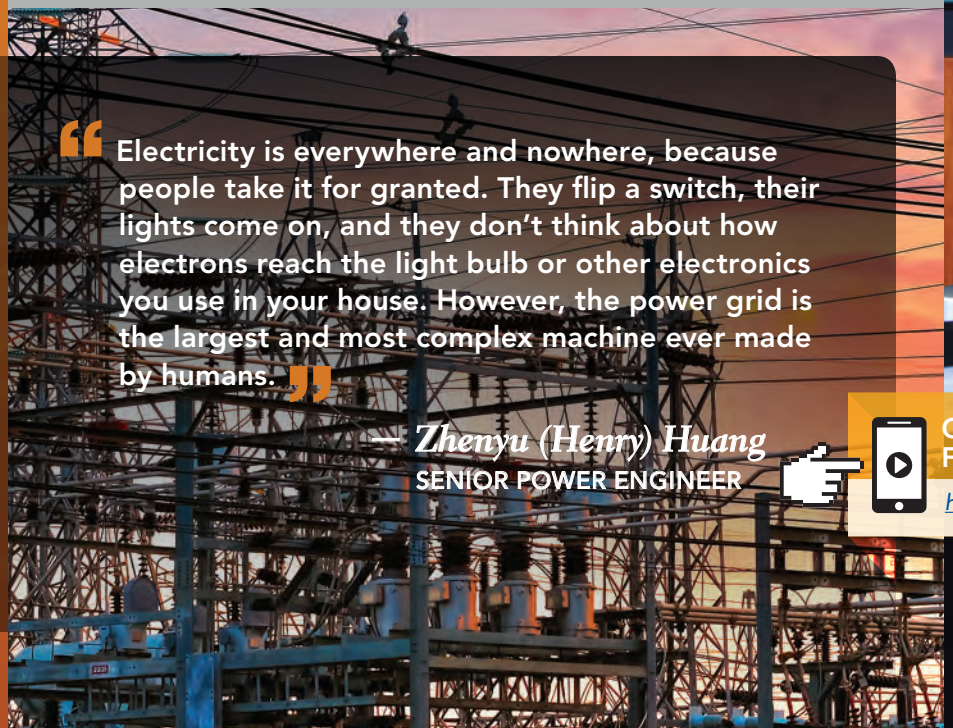
Finding clean and cost-effective ways to satisfy our nation's need for energy requires rapid innovation. Energy is critical to the health of our economy and our quality of life. It's essential to our productivity and mobility. Cleaner alternatives and advanced technologies are needed to reduce the nation's dependence upon fossil fuels, expand the use of renewable resources and increase energy efficiency. We'll need to make progress in these areas without straining our economy, threatening our energy security or reducing the reliability of the electric grid and energy infrastructure.

That's why at PNNL, energy is another complex adaptive system on which we focus. The mosaic of issues that comprise the energy system spans everything from renewable energy generated from biomass, solar, water and wind to power distribution and consumption. As the energy system adapts to this production, other things in the ecosystem are impacted. For instance, fish still need the ability to travel safely over or through dams that produce hydropower. PNNL researchers are exploring solutions in every aspect of this complex adaptive system—from creation to power distribution to ensuring a reliable grid.

At PNNL, our strengths in chemistry, nanoscale synthesis and materials processing, as well as advanced characterization tools, are a catalyst for change. We're focused on improving end-use efficiency in transportation, buildings and manufacturing, and increasing the use of renewable fuels.

# PREVENTING BLACKOUTS by Building a Better Power Grid

America's power grid is undergoing significant change. New mixes of electricity generation, as well as evolving consumer demand, make it even more challenging to manage. Moment-to-moment changes in electricity supply and demand can vary drastically, challenging power grid operators who must maintain a balance—in real time—to avoid disruptions and blackouts. Enter Senior Power Engineer **Zhenyu (Henry) Huang**. Henry leads PNNL's initiative to develop technologies that will shape the future of the power grid, and he's part of a team that is determined to make our nation's grid more reliable and secure.



> "Electricity is everywhere and nowhere, because people take it for granted. They flip a switch, their lights come on, and they don't think about how electrons reach the light bulb or other electronics you use in your house. However, the power grid is the largest and most complex machine ever made by humans."
>
> — *Zhenyu (Henry) Huang*
> SENIOR POWER ENGINEER

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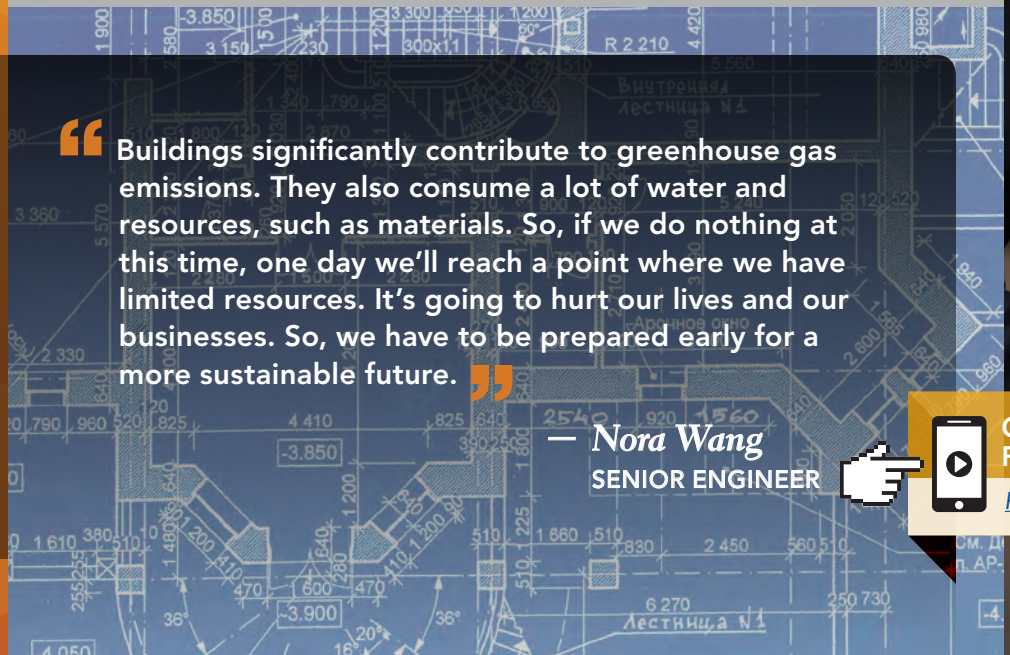
http://goo.gl/8nJhfX

# WHEN WALLS TALK, Buildings Can Be Made Better

What if your building could "tell" you how to save money? PNNL is inventing systems to turn buildings from passive users of energy into active participants in the power system—making the buildings we work or live in "work" for us instead. We're researching how buildings can respond intelligently to the natural environment, evolving grid conditions and dynamic occupant demands—not simply bracing for those external factors.

Why do buildings matter to our energy future? Senior Engineer **Nora Wang** says it's because buildings account for 75 percent of U.S. electricity consumption and 40 percent of our nation's energy use overall. That equates to $430 billion in energy bills every year. Powering U.S. buildings contributes more than 2,200 million metric tons of carbon dioxide to the atmosphere annually—more than the total emissions of Russia and Canada combined.



> **"Buildings significantly contribute to greenhouse gas emissions. They also consume a lot of water and resources, such as materials. So, if we do nothing at this time, one day we'll reach a point where we have limited resources. It's going to hurt our lives and our businesses. So, we have to be prepared early for a more sustainable future."**
>
> — *Nora Wang*
> SENIOR ENGINEER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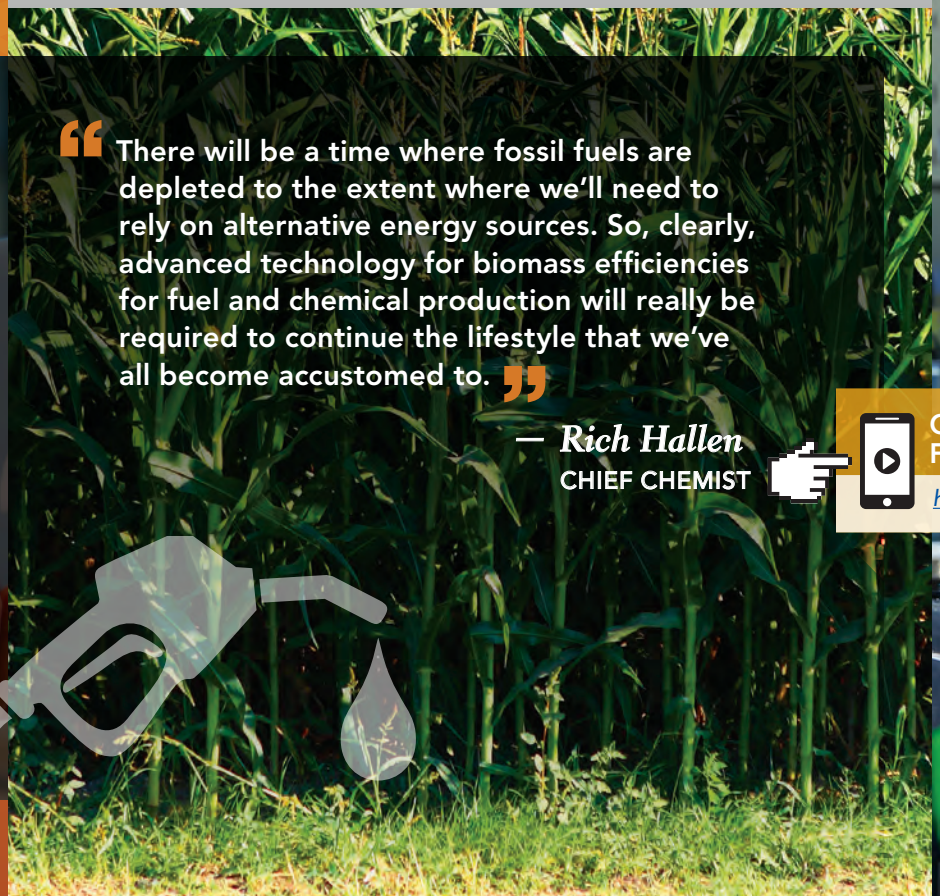
http://goo.gl/OHvjol

# THE FUELING POWER of Plants

Chief Chemist **Rich Hallen** is fueling our nation's ability to be less dependent on imported oil. He imagines ways to use plants and other biological organisms as cost-effective and clean alternatives for crude oil for aviation fuel, gasoline or diesel. It's a concept that has been around as long as cars have been on the road. Henry Ford's first car could run on peanut oil. Today, Rich's team is doing research that is sprouting new interest in the growing need for biofuels.



> "There will be a time where fossil fuels are depleted to the extent where we'll need to rely on alternative energy sources. So, clearly, advanced technology for biomass efficiencies for fuel and chemical production will really be required to continue the lifestyle that we've all become accustomed to."
>
> — *Rich Hallen*
> CHIEF CHEMIST

**CATCH THE FULL INTERVIEW...**
http://goo.gl/IKF0Kv

# IMPROVE OR PROTECT the World's Life Support System

Reduce the environmental effects of human activities and create sustainable solutions

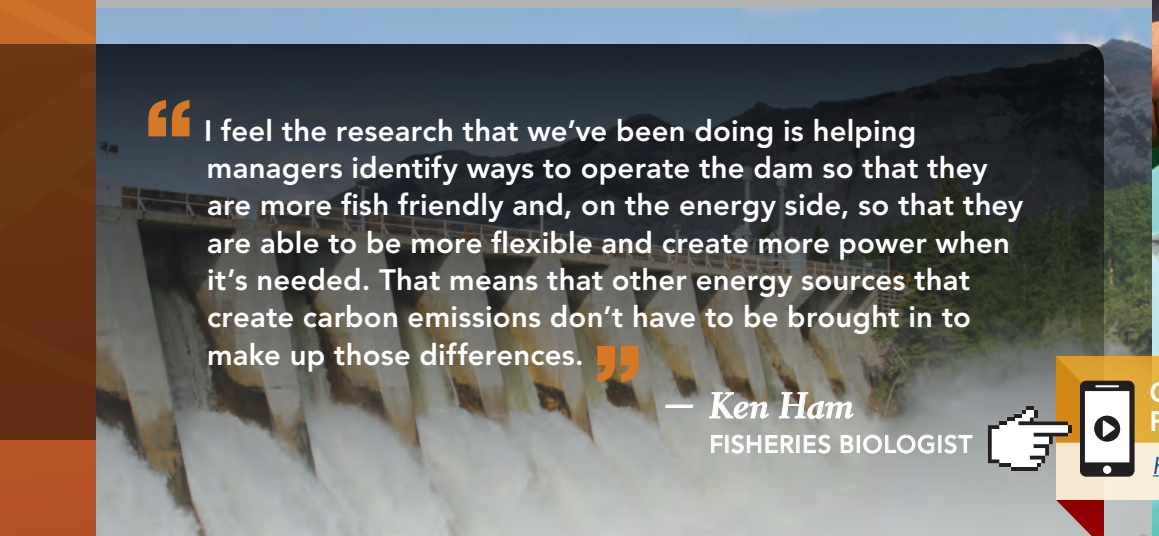
We are at an environmental crossroads nationally and internationally. In the U.S., we must address day-to-day impacts of human activity, provide scientifically defensible solutions for the challenge of legacy waste at former U.S. weapons production sites, and lend expertise to emerging global issues such as carbon emissions. How we respond to these challenges will impact our complex adaptive earth system. At PNNL, we apply our capabilities to develop solutions that protect our air, water and land, as well as to address numerous interrelated energy issues.

Our strengths that help drive change are: advanced computer science, visualization and data; applied materials sciences and engineering; applied nuclear science and technology; chemical engineering; and subsurface science.

# WATERING DOWN BARRIERS
## to Using Hydropower through Fisheries Research

Much of our work on clean energy is targeted at improving performance of hydropower, the largest source of renewable energy in the Pacific Northwest and the nation. PNNL experts in hydropower—from computer scientists to biologists and engineers—are helping to optimize the efficiency and environmental performance of hydroelectric plants. The Columbia River is the nation's most important hydropower resource, producing 40 percent of the nation's hydroelectric generation and up to 70 percent of the region's power.

At PNNL, Fisheries Biologist **Ken Ham** and others are working with stakeholders in the Pacific Northwest, the Army Corps of Engineers and DOE to ensure that this resource continues to provide its many benefits while setting a new standard for environmental sustainability. As aging turbines are replaced in existing hydropower dams, computational modeling and state-of-the-art fisheries research combine to aid the design of a next-generation hydro turbine that meets or exceeds current biological performance standards and produces more power.



> "I feel the research that we've been doing is helping managers identify ways to operate the dam so that they are more fish friendly and, on the energy side, so that they are able to be more flexible and create more power when it's needed. That means that other energy sources that create carbon emissions don't have to be brought in to make up those differences."
>
> — *Ken Ham*
> FISHERIES BIOLOGIST

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http://goo.gl/8adiA7

# RECOVERING
## from Disaster

From swords to plowshares—a PNNL-developed technology used to monitor compliance with the Comprehensive Nuclear Test-Ban Treaty was applied by Senior Nuclear Scientist **Harry Miley** for humanitarian purposes. In 2011, a powerful earthquake violently shook northeast Japan, triggering a massive tsunami with 133-foot-high waves that ravaged the land. These catastrophes set in motion a series of equipment failures, explosions, nuclear meltdowns and releases of radiation materials at the Fukushima Nuclear Power Plant in Japan. More than 80,000 residents vacated the surrounding area.

It was the largest nuclear disaster since the 1986 explosion at the Chernobyl Nuclear Power Plant in Ukraine. Soon after the accident at Fukushima, Harry and his colleagues were there to help public officials by determining the impact on North America, the radiation dose to people, and the safety of milk and harvested foods. He used ultra-trace nuclear detection technology to provide crucial information about the nature of the radiological release, its magnitude and its impact on human health in North America.

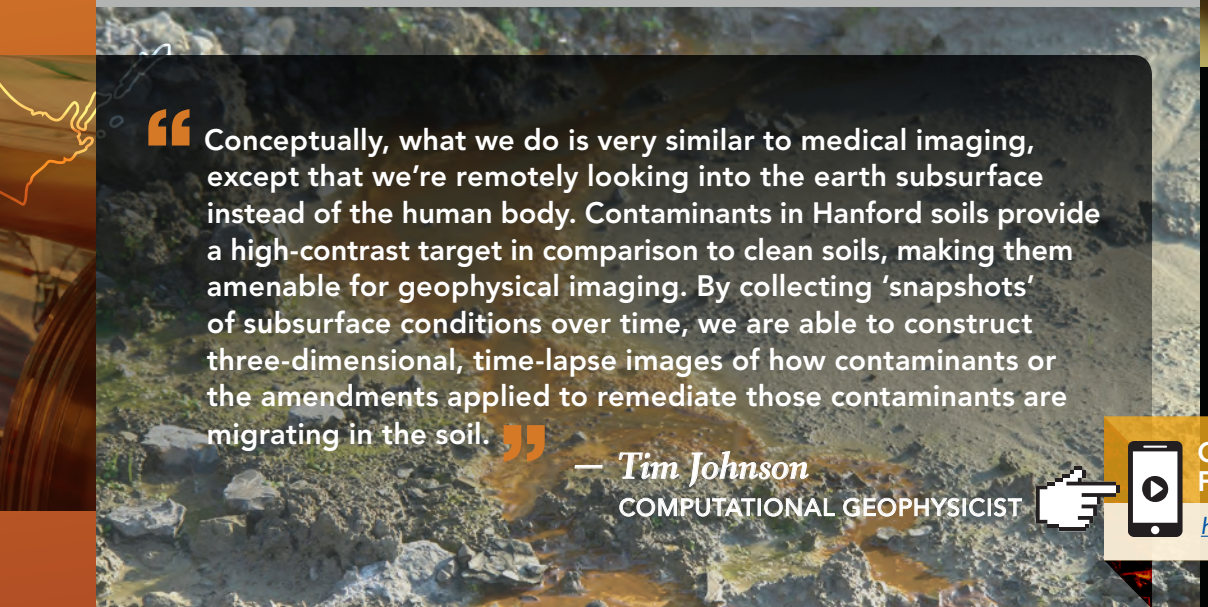
> **"In the case of Fukushima, we were able to rely on a network of PNNL-developed monitoring systems located around the world to measure air samples and determine the magnitude of radiation released from the plant. And, as a result, we were able to provide critical information to the highest levels of the U.S. government about the condition of the plant and the impact on Americans. My colleagues and I felt like we had really done our job that day."**
>
> — *Harry Miley*
> SENIOR NUCLEAR SCIENTIST

**CATCH THE FULL INTERVIEW...**
http://goo.gl/2W4cO5

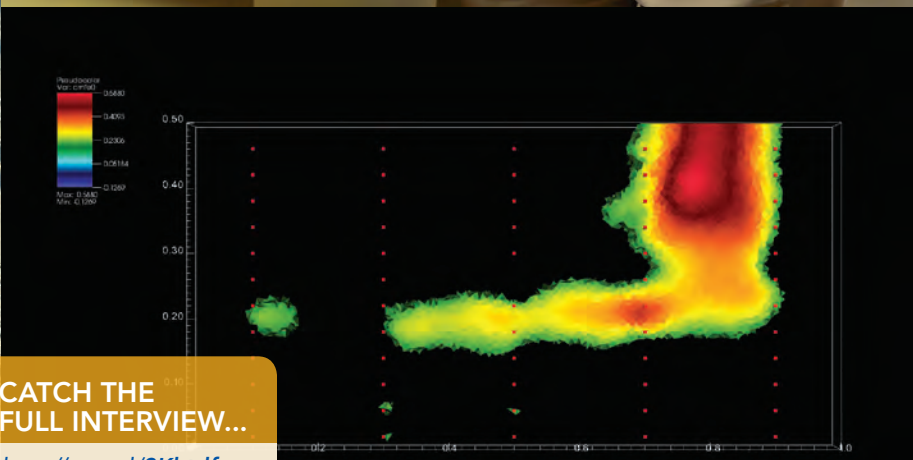
# What Lies Beneath
# CAN BE IMAGED

The Hanford Site was quickly established to help end World War II, making history for producing the plutonium used in the world's first nuclear weapons. Throughout the Cold War years, Hanford employees produced plutonium for most of the more than 60,000 weapons in the U.S. nuclear arsenal stockpile. Today, the once highly active nuclear reactors are shut down. And the mission at Hanford turned full-circle as scientists, engineers and specialists work to clean up our nation's most contaminated nuclear site.

PNNL Computational Geophysicist **Tim Johnson** is helping decision-makers understand the complexity and breadth of the contamination in soils at Hanford. Tim and others are applying remote, high-resolution geophysical imaging to determine the extent of contamination in the soil below the surface and understand the processes controlling its movement. They also provide real-time imaging of remediation processes that are working to limit the movement of contaminants below the surface and toward water resources. Geophysical imaging simply means that PNNL scientists are combining the techniques of geology, physics, mathematics and chemistry with supercomputer modeling to create three-dimensional images of the waste and its movement. These real-time, remote images are essential in reducing the uncertainty associated with cleanup costs and remediation technologies.



> "Conceptually, what we do is very similar to medical imaging, except that we're remotely looking into the earth subsurface instead of the human body. Contaminants in Hanford soils provide a high-contrast target in comparison to clean soils, making them amenable for geophysical imaging. By collecting 'snapshots' of subsurface conditions over time, we are able to construct three-dimensional, time-lapse images of how contaminants or the amendments applied to remediate those contaminants are migrating in the soil."
>
> — *Tim Johnson*
> COMPUTATIONAL GEOPHYSICIST

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# PARTNERS in Peace

Prevent and counter acts of terrorism and the proliferation of weapons of mass destruction

From satellites to smartphones, data is generated all around us. Separating noise from serious threats is just one component of our research into security and its associated complex adaptive system. Making sense of burgeoning data adds to the complexity of the security system. At the same time, it's a constantly changing environment as adversaries adapt to intelligence technologies and science.

Our researchers also are advancing strategies and methods to protect public places from terrorism, reduce nuclear threats, strengthen nonproliferation efforts and secure our nation's energy infrastructure.

PNNL's roots in national security research and development reach back to the 1940s and the establishment of the Hanford Site to produce the plutonium for the Manhattan Project. Since then, PNNL's scientific foundation in nuclear materials and fuel cycle research, radioanalytic chemistry, and environmental monitoring has expanded to include ultra-trace detection and forensics, cyber intelligence and resiliency, threat signature discovery and analysis, and information analytics and visualization.

# MAKE THE WORLD SAFER
## from Nuclear Weapons

Senior Nuclear Scientist **Ted Bowyer** knows firsthand the challenges associated with protecting our nation. Ted and his colleagues help detect the proliferation of nuclear weapons. They developed award-winning technologies that give international treaty verification authorities "eyes and ears" around the globe. The instruments, located in 80 countries, help ensure compliance with the Comprehensive Nuclear Test-Ban Treaty, or CTBT. They are completely automated radionuclide monitoring systems that would detect airborne radioactive particles if a nuclear detonation occurred in the air, underground or at sea.

Some samples collected through these technologies are sent to PNNL's Shallow Underground Laboratory—the only certified U.S. radionuclide laboratory for the CTBT's International Monitoring System Organization.


"We are able to produce technology that actually has an immediate impact to U.S. policy. So the measurements that we can do, and the kinds of analysis we can do, nobody else in the world can do—and this has a direct impact on what U.S. policy is on the CTBT and other treaties."

— *Ted Bowyer*
SENIOR NUCLEAR SCIENTIST

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http://goo.gl/Ct7DJk

# PROTECTING
## the Protectors

Program Manager **Kurt Silvers** helped protect the safety of U.S. troops who fought in Iraq and Afghanistan. PNNL researchers developed technology that monitored the battle-readiness of Hellfire II missiles onboard Army Apache helicopters. The technology continually monitors factors like vibration and temperature, providing key data when making decisions to deploy or retire weapons.

> **"Missiles featuring this monitoring device are able to maintain a detailed account of important conditions that can negatively affect a weapon's reliability. Conditions like temperature, vibration, humidity and shock are considered 'health factors' that can degrade a missile's readiness. This system instills confidence in soldiers who rely and depend on the weapons to perform without failure at all times."**
>
> — *Kurt Silvers*
> PROGRAM MANAGER


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http://goo.gl/A8bXsw

# Big Data, BIG SOLUTIONS

Data—lots of data—generated in seconds and piling up on the internet, streaming and stored in countless databases. Big data is important for commerce, society and our nation's security. Yet the volume, velocity, variety and veracity of data is simply too great for any single analyst to make sense of alone. It requires advanced, data-intensive computing. Simply put, data-intensive computing is the use of sophisticated computers to sort through mounds of information and present analysts with solutions in the form of graphics, scenarios, formulas, new hypotheses and more. This scientific capability is foundational to PNNL's energy, environment and security missions. Senior Scientist and Division Director **Bill Pike** and his team are developing analytic tools that are used to solve important national challenges, including cyber systems defense, power grid control systems, intelligence analysis, climate change and scientific exploration.

**"Computing has transformed science, engineering and society in remarkable ways. But as huge amounts of new data are generated daily by scientific instruments and household electronics, new technologies and approaches are needed to give that information more meaning. One of the things that I think we'll be focusing on for the next five, 10, 15 years really is the interplay between humans and computers and making sense of the world through data."**

— *Bill Pike*
SENIOR SCIENTIST
and Division Director

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http://goo.gl/a4Cuws

# EXTRAORDINARY LABORATORIES and INSTRUMENTS
## Located at PNNL

Instruments, state-of-the-art facilities and internationally recognized scientists are a powerful combination. In fact, some instruments and laboratories at PNNL are unlike any in the rest of the world.

### ENVIRONMENTAL MOLECULAR SCIENCES LABORATORY

EMSL, the Environmental Molecular Sciences Laboratory, is a DOE national scientific user facility located on the PNNL campus. EMSL offers an open, collaborative environment for scientific discovery to researchers around the world. As a user facility, its advanced scientific capabilities—experts, instruments and facilities—provide innovative solutions to the nation's environmental and energy production challenges in areas such as atmospheric aerosols, feedstocks, global carbon cycling, biogeochemistry, subsurface science and energy materials.

### RADIOCHEMICAL PROCESSING LABORATORY

Environmental, national security and science missions at PNNL are supported by capabilities located in the Radiochemical Processing Laboratory. The RPL is one of only two DOE Office of Science Hazard Category 2 Non-Reactor Nuclear Facilities capable of multi-disciplinary research and development. Research in the RPL primarily focuses on solving problems in environmental remediation, such as tank waste, and nuclear fuel-cycle applications.


### SYSTEMS ENGINEERING BUILDING

Industry, academia and government scientists are jointly conducting research at the Systems Engineering Building to tackle the nation's top challenges in grid modernization, buildings efficiency and renewable energy integration. The SEB houses a unique suite of capabilities, including power grid and buildings control rooms, specialized laboratories, real-time grid data and advanced computation.

### RADIATION DETECTION LABORATORY

At the Radiation Detection Laboratory and the Ultratrace Laboratory, researchers develop and apply radiation detection methods needed for identifying weapons of mass destruction and terrorist activities, and in support of international treaties and agreements.

### SHALLOW UNDERGROUND LABORATORY

The Shallow Underground Laboratory houses some of the world's most sensitive radiation detection systems. This facility is the only certified U.S. radionuclide lab for the International Monitoring System of the Comprehensive Nuclear Test-Ban Treaty Organization.

## INTERDICTION TECHNOLOGY & INTEGRATION LABORATORY

Researchers develop and test radiation detection technologies designed to be deployed at U.S. borders and ports of entry at the Interdiction Technology and Integration Laboratory.

## MATERIAL SCIENCE & TECHNOLOGY LABORATORY

In the Material Science & Technology Laboratory, PNNL scientists develop and test high-performance materials used in next-generation energy and transportation technologies.

## BIOPRODUCTS, SCIENCES AND ENGINEERING LABORATORY

At the jointly sponsored Bioproducts, Sciences and Engineering Laboratory, Washington State University and PNNL work together to create a portfolio of biobased products and fuels that will help reduce the nation's dependence on foreign petroleum and carbon footprint of energy use.

## MARINE SCIENCES LABORATORY

Located in Sequim, Wash., PNNL's Marine Sciences Laboratory is DOE's only marine research laboratory. At MSL, researchers study ocean energy and how to protect coastal environments from security threats. The laboratory contains biology labs for chemistry and aquatics, as well as biosafety level 2 labs for national security research.

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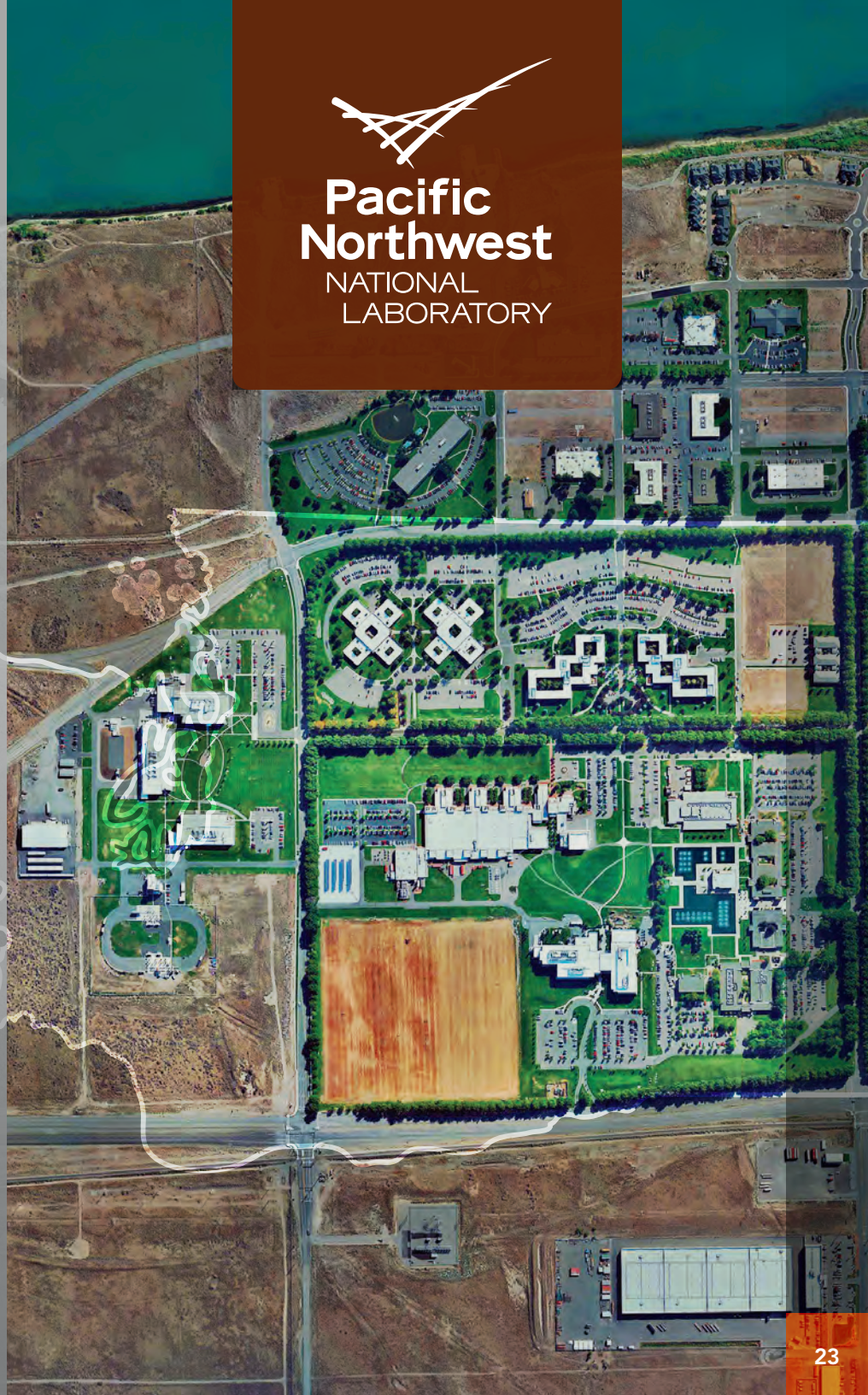


Pacific Northwest
NATIONAL LABORATORY

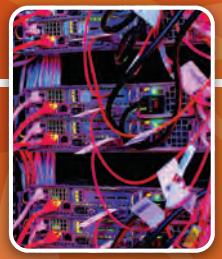
*Proudly Operated by* Battelle *Since 1965*

# DISCOVERY *in Action*

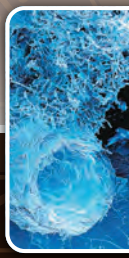
We've shared a few stories about how PNNL scientists and engineers are helping people around the world live more prosperous, safe and secure lives. You can listen to more from our featured experts by visiting **www.pnnl.gov/discoveryinaction**, or explore **www.pnnl.gov** to learn other ways that we can help you solve your challenges in the environment, energy or national security through science and technology.

For 50 years, PNNL has collaborated with DOE, the National Nuclear Security Administration, the Department of Homeland Security, other federal agencies and private industry... perhaps, one day, we'll also collaborate with you.

Our main campus is located in Richland, Wash., but we also operate the Marine Sciences Laboratory in Sequim, Wash., as well as offices in Seattle, Wash.; Portland, Ore.; College Park, Md.; and Washington, D.C.




*For more information, contact:*

**Public Affairs**
Pacific Northwest National Laboratory
902 Battelle Boulevard
P.O. Box 999
Richland, WA 99352
1 (888) 375-7665
publicaffairs@pnnl.gov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