

# Pacific Northwest National Laboratory

## Work Plan

## Fiscal Years 2007–2011

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Pacific Northwest National Laboratory  
Richland, Washington 99352

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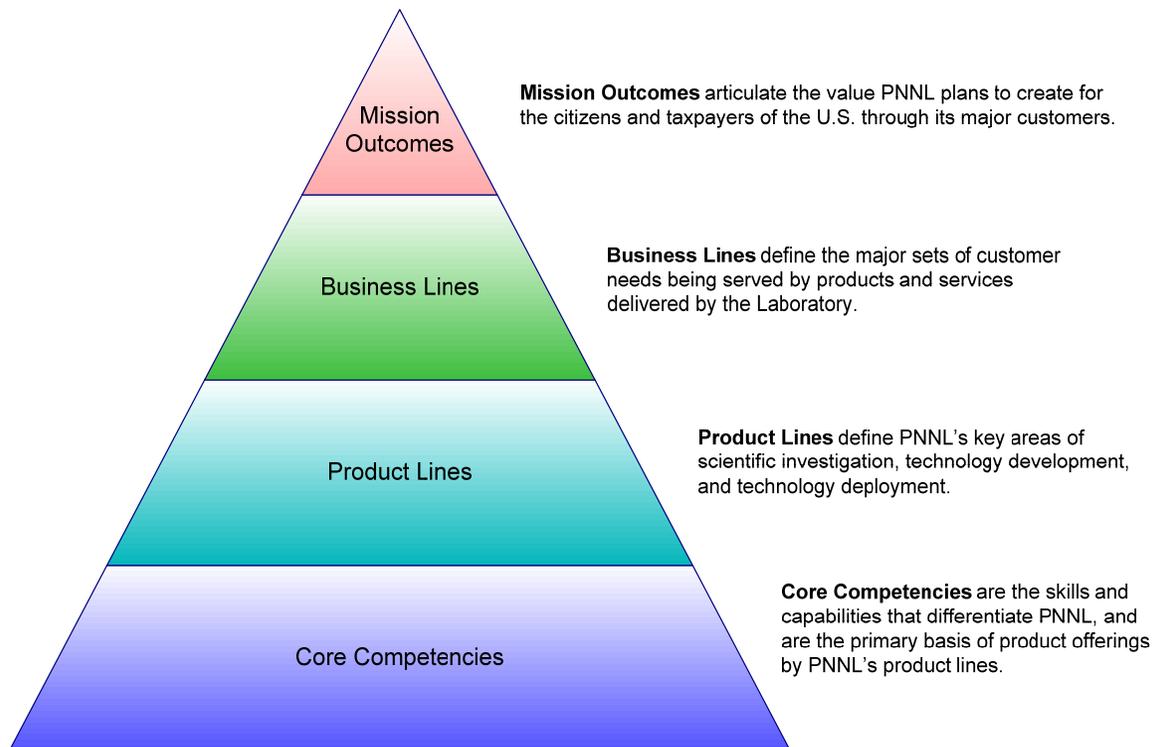
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PACIFIC NORTHWEST NATIONAL LABORATORY  
*operated by*  
BATTELLE  
*for the*  
UNITED STATES DEPARTMENT OF ENERGY  
*under Contract DE-AC05-76RL01830*

# Executive Summary

This Work Plan describes the most important elements of Pacific Northwest National Laboratory's (PNNL's) five-year strategy to meet evolving United States (U.S.) Department of Energy (DOE) and other federal agency mission needs for research and development. Although this Work Plan specifically focuses on the next five years (fiscal years 2007–2011), it reflects the understanding that PNNL must provide science and technology (S&T) to address the most important research and development needs of PNNL's mission customers over the next several decades.

PNNL's mission is to perform basic and applied research to deliver energy, environmental, and national security for the nation. PNNL's mission is being realized by executing the Laboratory's strategy, which is principally focused on sustaining PNNL as a world-class research organization by building world-class S&T capabilities and stewarding PNNL's assets. In order to execute this strategy, PNNL maintains four overarching business lines – foundational science, energy S&T, national and homeland security S&T, and environmental S&T – that span fundamental science to technology development and, in some cases, to full-scale deployment. The business lines are aligned with PNNL's major customers and are served by multiple product lines that deliver products. This plan presents the business lines and the market needs they serve, as well as the product lines and core competencies that are the foundation of these business lines (see figure below). This plan integrates mission and vision, business and product lines, and core competencies for an overall view of PNNL's business for FY07–FY11. The understanding of PNNL's customers and S&T strengths and the needs of the nation yield Mission Outcomes, which are the primary strategic focus at PNNL.



Mission Outcomes define the areas where PNNL intends to provide science, technology, and leadership that contribute to solutions of major national challenges over the next five years and beyond. Delivering these Mission Outcomes is the principal focus of the PNNL strategy. Overall, PNNL intends to provide the scientific and technical basis to predict behavior of complex systems (for example, the global climate system), prevent the proliferation of weapons of mass destruction and acts of terrorism, sustain a healthy environment, and reduce U.S. dependence on imported oil. Over the next decade, PNNL will remain strategically focused on delivering real, sustained economic value to the nation by providing the scientific tools, methods, and technologies to:

- Strengthen U.S. Scientific Foundations for Innovation
- Prevent and Counter Acts of Terrorism and the Proliferation of weapons of mass destruction (WMD)
- Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil
- Reduce Environmental Effects of Legacy Waste and Energy Use

In order to deliver this scientific and technical value to the nation, PNNL requires funding commitments from its customers. PNNL's financial outlook includes increasing the overall funding at PNNL from \$742 million in FY06 (estimate) to between \$892 million (conservative scenario) and \$1,190 million (optimistic scenario) of funding by FY11. These funding scenarios anticipate funding growth from many of PNNL's principal customers. PNNL anticipates moderate funding increases across the DOE and NNSA business, and a steady increase in Department of Defense (DoD) and DHHS (NIH) Work for Other (WFO) programs. DOE-SC will provide ~17% of the PNNL funding in FY07, and will grow to 20 to 22% of PNNL's funding by FY11. NNSA will grow modestly or maintain 15 to 19% of PNNL's funding base. The optimistic funding scenario explicitly includes DOE-SC-BER launching major new efforts in a Genomics:GtL Bioenergy Center and computational capability required for DOE-SC research, a collaborative research facility in catalysis supported by BES, and continued PNNL leadership in the DHS Radiation Portal Monitoring Project (RPMP). Furthermore, the external commitments include sustained financial and DOE management commitment during FY07–FY11 to build facilities to offset the imminent closure of 300 Area facilities due to DOE's accelerated cleanup of the Hanford Site. These external commitments are necessary for success, but must be coupled to a detailed plan for sustaining and enhancing PNNL's capabilities (including staff, facilities, and research equipment) over the next five years in order to serve the mission needs of PNNL's customers.

PNNL currently has six science and technology core competencies (skills and capabilities) that differentiate the Lab from other national laboratories and competitors: Microbial and Cellular Biology, Environmental Sciences, Analytical and Interfacial Chemical Sciences, Radiological Sciences, Information Analytics, and Sensor and Measurement Technology. The staff outlook at PNNL includes increasing the number of direct FTEs (full-time equivalent) charging to projects at the Laboratory from 1,872 (estimate) to 2,148 from FY06–FY11. PNNL plans to simultaneously constrain the growth of indirect FTE (support and other personnel), and effectively increase the ratio of direct FTEs to total FTEs from 51.0% in FY06 to 53.7% in FY11. This direct FTE growth and constrained indirect FTE growth translate into an increase of total staff at PNNL of approximately 700 from FY06–FY11, which increases total staff to 4,899 by FY11. The primary staff growth is anticipated in the Microbial and Cellular Biology, Information Analytics, and Sensor and Measurement Technology core competencies over the next five years.

The staff outlook, combined with the major issues associated with 300 Area closure plans, results in PNNL experiencing an unprecedented facilities-related challenge over the next five years.<sup>1</sup> PNNL's Ten Year Site Plan (TYSP) provides the comprehensive multi-year plan for facilities and infrastructure at the Laboratory, and is the basis for the information in this Work Plan. Most critically, the 300 Area closure will require significant new replacement facilities in order to meet current and future mission needs. The TYSP details the acquisition of ~538,000 gross square feet of facilities space for the Capability Replacement Laboratories (CRL) project that was approved in 2005, as well as a complementary set of actions to provide up to 380,000 gross square feet of facilities for decompression of existing space and to accommodate mission/customer future requirements for expanded research programs. One of the principal facilities of the CRL is the Physical Sciences Facility (PSF), which is a \$224 million line item capital project funded by DOE-SC, NNSA, and DHS. The additional major facilities will be funded by a combination of Battelle Memorial Institute (BMI) capital funding (PNNL M&O contractor funding), other capital funding (e.g., GPP and IGPP funding), and a series of new third-party-financed facilities and/or lease agreements. The five-year facilities plan will realize many new facilities at PNNL, offset by the loss of 300 Area facilities, and increase PNNL's total space from ~2.1 to ~2.4 million gross square feet between FY06 and FY11.

Beyond staff and facilities, the Laboratory capabilities are also defined by PNNL's research equipment. PNNL generally attains funding for research equipment from customers or from internal overhead accounts, with the funding being either capital or non-capital funding. The forecast for research equipment focuses on capital funding, which includes most equipment with acquisition costs that exceed \$50 thousand. The capital equipment forecast is conservatively estimated to include ~\$13 million of programmatic capital and \$3 million of overhead capital per year during FY07–FY11. The programmatic funding is largely directed by PNNL's customers in order to serve their mission needs from PNNL. The majority of PNNL's programmatic capital is directed to the acquisition of new equipment for EMSL, which is forecast to receive \$8.8 to \$10 million per year over the next five years as part of the EMSL refreshment and revitalization plan. The overhead capital funding is allocated through internal competition that is brokered by an internal review committee and PNNL's Chief Research Officer. This capital funding (combined with non-capital funding allocated by project and line managers) represents the primary capacity at PNNL to expand or revitalize the research equipment at PNNL over the next five years.

PNNL's principal strategic intent is to Be World Class by delivering the Mission Outcomes defined in the PNNL strategy and to steward the Laboratory's assets by optimizing investment in the Lab and building the Research Campus of the Future (RCF). PNNL intends to deliver on these strategic objectives by building world-class capabilities and operating the Laboratory with excellence. The overall plan is to deliver real, sustained value to the nation, and PNNL appears poised for five years of outstanding performance.

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<sup>1</sup> This Work Plan is based on the PNNL FY06 Ten Year Site Plan and does not include discussion of recent direction from DOE for PNNL to assess alternative options for the Physical Sciences Facility while retaining some portion of the 300 Area facilities.

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## Acronyms

AEC	Atomic Energy Commission (historical)
AMMA	Advanced Materials and Manufacturing Application
ARM	Atmospheric Radiation Measurement Program
ASCP	Atmospheric Science and Climate Policy
B&ES	Biological and Environmental Sciences
BER	U.S. Department of Energy Biological and Environmental Research program
BES	U.S. Department of Energy Basic Energy Sciences program
BMI	Battelle Memorial Institute
BSEL	Bioproducts, Sciences, and Engineering Laboratory
BSF	Biological Sciences Facility
CBP	Customs and Border Protection
CD	Critical Decision
CRL	Capability Replacement Laboratories
CSF	Computational Sciences Facility
DHHS	U.S. Department of Health and Human Services
DHS	U.S. Department of Homeland Security
DNN	Office of Defense Nuclear Nonproliferation (NNSA)
DOE	U.S. Department of Energy
DOE-EERE	U.S. Department of Energy Office of Energy Efficiency and Renewable Energy
DOE-FE	U.S. Department of Energy Office of Fossil Energy
DOE-NE	U.S. Department of Energy Nuclear Energy Program
DOE-SC	U.S. Department of Energy Office of Science
DoD	U.S. Department of Defense
EM	U.S. Department of Energy Office of Environmental Management
EMSL	(William R. Wiley) Environmental Molecular Sciences Laboratory
EP&O	Energy Products and Operations
EPAct	Energy Policy Act
EPA	U.S. Environmental Protection Agency
ES&H	Energy Products and Operations
F&I	Facilities and Infrastructure plan
FTE	full-time employees
FY	fiscal year
GNEP	Global Nuclear Energy Partnership
GPE	General Purpose Equipment
GPP	General Plant Process
gsf	gross-square-feet
HHS	U.S. Department of Health and Human Services

IGPP	Institutional General Plant Projects
LSF	Life Sciences Facility
M&O	Management and Operations
MFSF	Maintenance & Fabrication Support Facility
MSCF	Molecular Science Computing Facility
NASA	National Aeronautic and Space Agency
NIGMS	National Institute for General Medical Sciences
NIH	National Institutes of Health
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
ONAMI	Oregon Nanoscience and Microtechnologies Institute
PNNL	Pacific Northwest National Laboratory
PSF	Physical Sciences Facility
R&D	Research and Development
RCF	Research Campus of the Future
RPMP	Radiation Portal Monitor Project
S&E	Scientists and Engineers
S&T	science and technology
SciDAC	Scientific Discovery through Advanced Computing (DOE-SC-ASCR)
TYSP	Ten Year Site Plan
U.S.	United States
WFO	Work for Other (programs)
WMD	weapons of mass destruction
WSU	Washington State University
WTP	Waste Treatment Plan

# Introduction

Pacific Northwest National Laboratory (PNNL) was established in 1965 as part of a reconfiguration of the U.S. Department of Energy's (DOE's) Hanford Site in Richland, Washington. Its forerunner, the Hanford Laboratories, was part of the World War II Manhattan Project. PNNL has evolved from a nuclear engineering laboratory dedicated to Hanford operations to a full-fledged multi-program laboratory focused on scientific discovery and the translation of discoveries into technical solutions to meet national needs. PNNL was designated an Office of Science Laboratory in 1984. Today, PNNL performs nearly \$750 million of research annually, mainly for DOE (60%), but also for other federal agencies (30%), including the Department of Homeland Security (DHS), the Department of Defense (DoD), and the National Institutes of Health (NIH), and private research for government and industry (10%). PNNL is also home to the (William R. Wiley) Environmental Molecular Sciences Laboratory (EMSL), a 200,000-square-foot national scientific user facility. EMSL is central to and leverages PNNL's research and development programs and provides research resources to more than 1,000 non-PNNL users each year from academia, other research and development laboratories, and industry.

This document begins with an overview of the PNNL mission, vision, and strategy. The strategy articulates the basic, long-term goals and objectives that constitute the overarching direction for the institution. The basic strategy discussion is followed by a detailed discussion of PNNL's business lines. PNNL routinely executes strategy through the business lines, and they are the primary conduits used to deliver high-impact science and science-based solutions to major customers. The business line managers and the PNNL executive management team also serve to inform the strategy and identify the critical national needs based on the prevailing social, economic, and political conditions within the United States and across the world. From this knowledge, PNNL identifies and executes mission outcomes that support, strengthen and refresh the business lines and core competencies; as well as articulate the value the Lab will deliver to the nation.

PNNL manages mission outcomes to deliver high-value solutions to the most critical challenges facing the nation. This Work Plan articulates the major federal agency missions being served through these mission outcomes and their intended benefit for the citizens and taxpayers of the United States. In addition, the plan presents the overall five-year funding necessary for PNNL to deliver on the major customer missions, and sustain and enhance all the mission critical capabilities that are stewarded at PNNL.

The remainder of this plan focuses on PNNL's capabilities and how these capabilities will evolve over the next five years in order to execute the Laboratory strategy and deliver the mission outcomes. The collective set of capabilities of PNNL can be resolved into three primary categories: staff, facilities, and research equipment, which are introduced and discussed separately. Finally, the overall PNNL Work Plan is summarized for the next five years. This Work Plan is primarily focused on excellence in science, and on PNNL's detailed technical and management plans to deliver high-value outcomes for the nation. Consequently, this plan does not explicitly discuss the significant operations-related commitment and activities at PNNL, nor does it attempt to discuss PNNL's commitment to community service.

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# PNNL – An Overview

## Mission

PNNL performs basic and applied research to deliver energy, environmental and national security for our nation.

## Vision

PNNL will be recognized worldwide and valued regionally for its leadership in rapidly translating discoveries into solutions for challenges in energy, national security, and the environment by integrating the chemical, physical, and biological sciences.

## Strategy

PNNL plans to accomplish this mission and realize this vision by focusing on some of the most challenging and urgent issues facing the nation and PNNL customers.

Figure 1 shows PNNL’s Laboratory Strategy. PNNL’s strategy is focused on enabling the achievement of four mission outcomes defined under the Be World Class theme of the strategy; and sustaining PNNL’s ability to serve the missions of customers over the long term by stewarding the capabilities,



Figure 1. PNNL’s Laboratory Strategy

assets, operations, and the organizational culture that drive the productivity and value of the institution. The PNNL strategy has five major themes: Be World Class, Build World Class Capabilities, Steward Laboratory Assets, Operate with Excellence, and Evolve Organizational Culture and Strengths.

**Be World Class.** Being world class means solving world-class problems. PNNL’s strategy begins with a commitment to deliver science, technologies, and leadership to four mission outcomes aligned with critical national priorities and societal needs. PNNL will significantly advance and deliver four mission outcomes aligned with the nation’s critical priorities and the Laboratory’s business lines:

**PNNL will provide the science, technology and leadership to:**

- **Strengthen U.S. Scientific Foundations for Innovation**
  - Deliver unique user facilities to the scientific community.
  - Predict and engineer the behavior of complex systems to solve energy, environment and security challenges
- **Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil**
  - Enable economically and environmentally sustainable conversion of domestic hydrocarbons to gases, liquid fuels, electricity and chemicals.
  - Improve grid reliability and productivity
  - Accelerate safe and economic expansion of nuclear power
  - Increase the efficiency of powering vehicles and buildings
- **Prevent and Counter Acts of Terrorism and the Proliferation of Weapons of Mass Destruction**
  - Predict, prevent and mitigate acts of terrorism through predictive analytics.
  - Counter threats posed by the global expansion of nuclear energy & legacy WMD materials.
  - Detect the production, characteristics and movement of weapons of mass destruction and effect.
  - Respond more rapidly and effectively to events of mass effect.
- **Reduce Environmental Effects of Legacy Waste and Energy Use**
  - Accelerate cost-effective cleanup of contaminated nuclear weapons sites
  - Protect human health and the environment from the effects of contaminants
  - Improve knowledge of climate change and its impacts to enable cost-effective solutions
  - Deploy air and water neutral processes and technologies for energy generation and use, including comprehensive solutions for carbon management

**Build World Class Capability.** A tenet of our strategy is to ensure that PNNL is and remains central to our customers’ priorities. These objectives are designed to ensure we have distinctive and relevant capabilities, delivered through forefront user facilities, strategic partnerships, and focused investments in capability and program development activities across the research-to-deployment life cycle.

PNNL's intent for this strategic theme in FY07–FY11 is to build distinction in rapidly moving science to solutions. More specifically, PNNL will:

- implement investment portfolio management practices that lead more rapidly to fully integrated and demonstrated capabilities aligned with the defined mission outcomes;
- identify and build a small number of institutional partnerships for sustained, broad, accelerated mission impact; and,
- successfully recapitalize EMSL and increase outreach to PNNL staff and partners regarding the value of EMSL capabilities for delivering novel solutions that are critical to deliver solutions to PNNL's mission customers most important problems.

**Steward Laboratory Assets.** Battelle (as the contractor operating the Lab) is responsible to DOE for managing the Laboratory's research program base, the overhead budget generated from that base, and the facilities and infrastructure essential to the Laboratory's mission, in order to ensure the long-term viability and value of those resources to DOE and other federal agencies.

PNNL's primary challenge in this area over the next five years is to build an affordable research campus. PNNL needs to replace mission critical capabilities slated for cleanup along the Columbia River corridor (300 Area); maintain the facilities that will be retained in that area; and ensure sufficient space for mission growth. In order to steward the Laboratory assets over the next five years, PNNL will:

- add at least five new facilities over the next five years (BSEL, PSF, CSF, BSF, and LSF);
- maintain continuity of research programs and strengthen the research base to ensure essentiality of the research in PNNL's new facilities;
- ensure adequate space and equipment for mission-critical research during and after the transition; and
- manage costs in order to cover transition and new facility costs while maintaining effective laboratory management and operations without significantly raising rates.

**Operate with Excellence.** Operational excellence is essential to our ability to deliver capabilities to our customers on time, on budget, as promised, every time. This includes excellence in the core business processes and in the management systems that support those work processes. PNNL's overall core business processes for ensuring research quality are continually improved to meet both DOE's and Battelle's performance standards. In order to operate with excellence over the next five years, PNNL will:

- clarify and strengthen accountabilities and systems supporting research delivery/core business processes;
- strengthen business processes to ensure they are compliant and effectively and efficiently deliver services to conduct of research;
- improve processes for ensuring the quality of the work PNNL conducts; and
- sustain and improve safety and security performance to meet DOE and Battelle expectations.

**Evolve Our Organizational Culture and Strengths.** The foundation for making and sustaining change is organization and culture. This objective is concerned with evolving PNNL's culture in ways that drive operational improvements and support world-class capabilities, now and in the future.

In the last two years, the Lab has focused on improving recruitment and development of S&E staff. The improvement agenda for PNNL operations and PNNL's goals with respect to building world class capability suggest that this focus needs to be complemented by additional actions for ensuring that staff are fully equipped to define and deliver research consistent with DOE and Battelle expectations. In order to evolve organization culture and strengths over the next five years, PNNL will:

- continue to improve recruiting and develop staff to support diversity goals and specific mission outcome contributions;
- clarify staff expectations for each role within the Laboratory, strengthen the staff feedback, and align awards to reinforce the core work processes and priorities of the Laboratory; and
- improve how management trains staff, from the time they enter the Laboratory and throughout their careers to ensure staff remain cognizant of evolving expectations and have the information they need to do their jobs well.
- evolve staff communications so there is a robust flow of information both up and down the organization; and staff have the knowledge they need to align their work with the laboratory strategy.

## **Five-Year Strategy Drivers**

PNNL's strategy is developed in response to specific opportunities and priorities within the Laboratory and those being articulated in the external environment. The priorities being articulated in the external environment include the President's American Competitiveness Initiative and Advanced Energy Initiative, DOE's Strategic Research Portfolio report to Congress (response to the Energy Policy Act of 2005 [EPAct] Section 994), and the Strategic and Five-Year Plans of customers. Along with information gleaned through direct engagements with customers, these priorities and opportunities are placed in the context of the business lines to refresh the Lab's strategy, update business projections, and realign investments.

### **The American Competitiveness Initiative**

The American Competitiveness Initiative commits \$5.9 billion in federal funding in FY07 to increase investments in research and development, strengthen education, and encourage entrepreneurship with the goal of increasing the nation's capacity to innovate. Over 10 years, the Initiative commits \$50 billion to increase federally funded research in the physical sciences through DOE-SC, the National Science Foundation and the National Institute of Standards and Technology. The Initiative recognizes that investments in physical science and engineering lead to broad and sometimes unexpected economic and commercial benefits. It therefore places priority on cutting edge research, tools and technologies with the potential for accelerated and broad economic impact, with particular emphasis on imaging, manipulation, analysis and simulation of matter at the atomic scale. Within the DOE Office of Science, this focus includes high-end computing and advanced networking, nanotechnology, biotechnology, energy sources, and other materials science research.

## **The Advanced Energy Initiative**

In the State of the Union address, the President announced a goal of replacing more than 75% of U.S. oil imports from the Middle East by 2025 through new technology. In support of this goal, the President's budget includes a new Global Nuclear Energy Partnership (GNEP) to support an expansion of nuclear power generation while addressing waste and proliferation issues; a new biomass technology initiative that promotes energy security; a new solar initiative that promotes clean electricity production; as well as funding increases for domestic oil, oil shale and gas development and operations.

## **The DOE and DHS 2006 Strategic Plans**

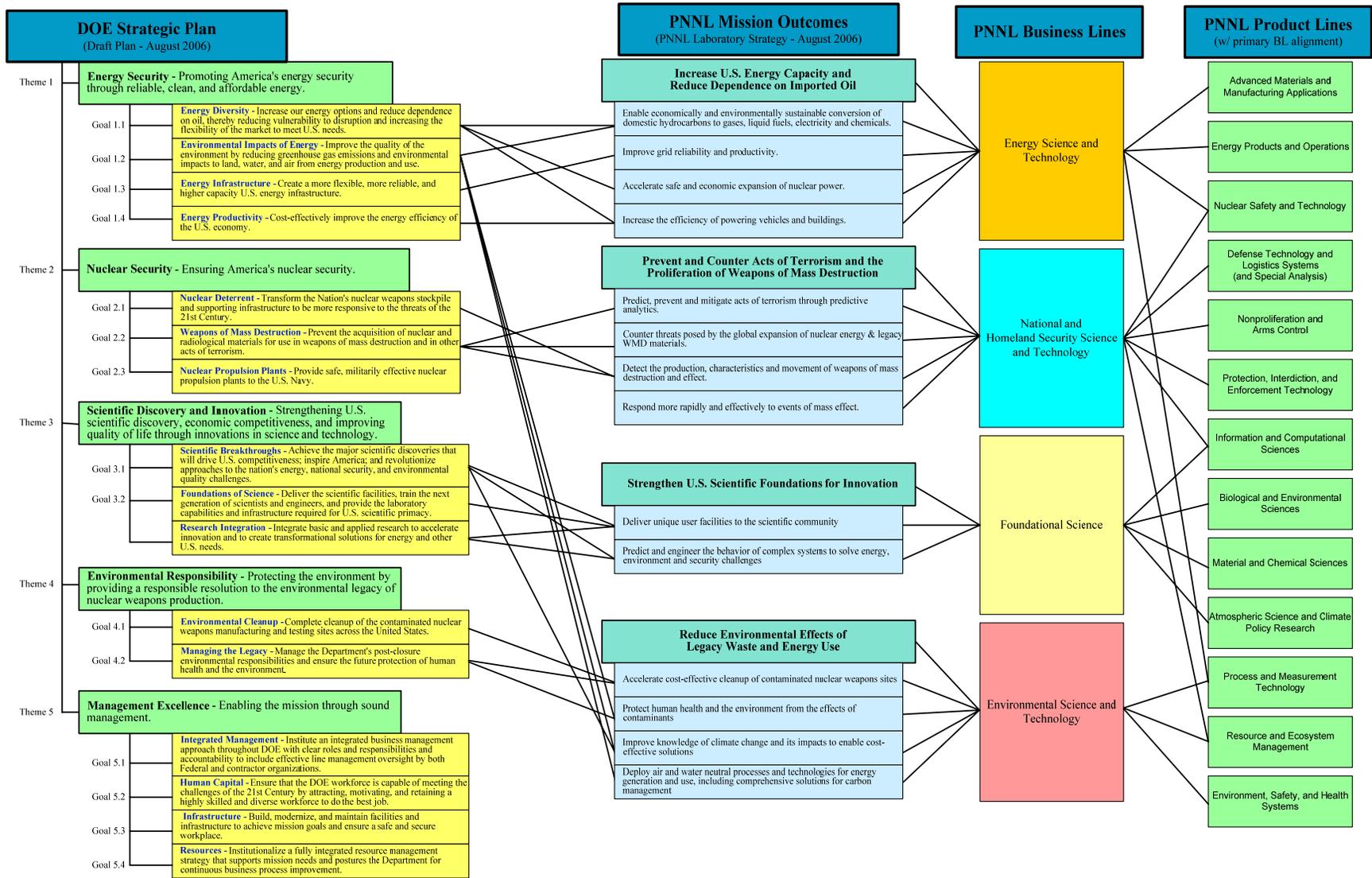
DOE's most recent strategic plan outlines twelve goals related to its energy, nuclear security, science and environmental missions. The DHS 2006 strategic plan outlines seven goals and twenty-six objectives to achieve its mission. The alignment of PNNL's mission outcomes, business lines, and product lines with these elements of these strategic plans is illustrated in Figures 2 and 3.

## **DOE's Strategic Research Portfolio Analysis and Coordination Plan**

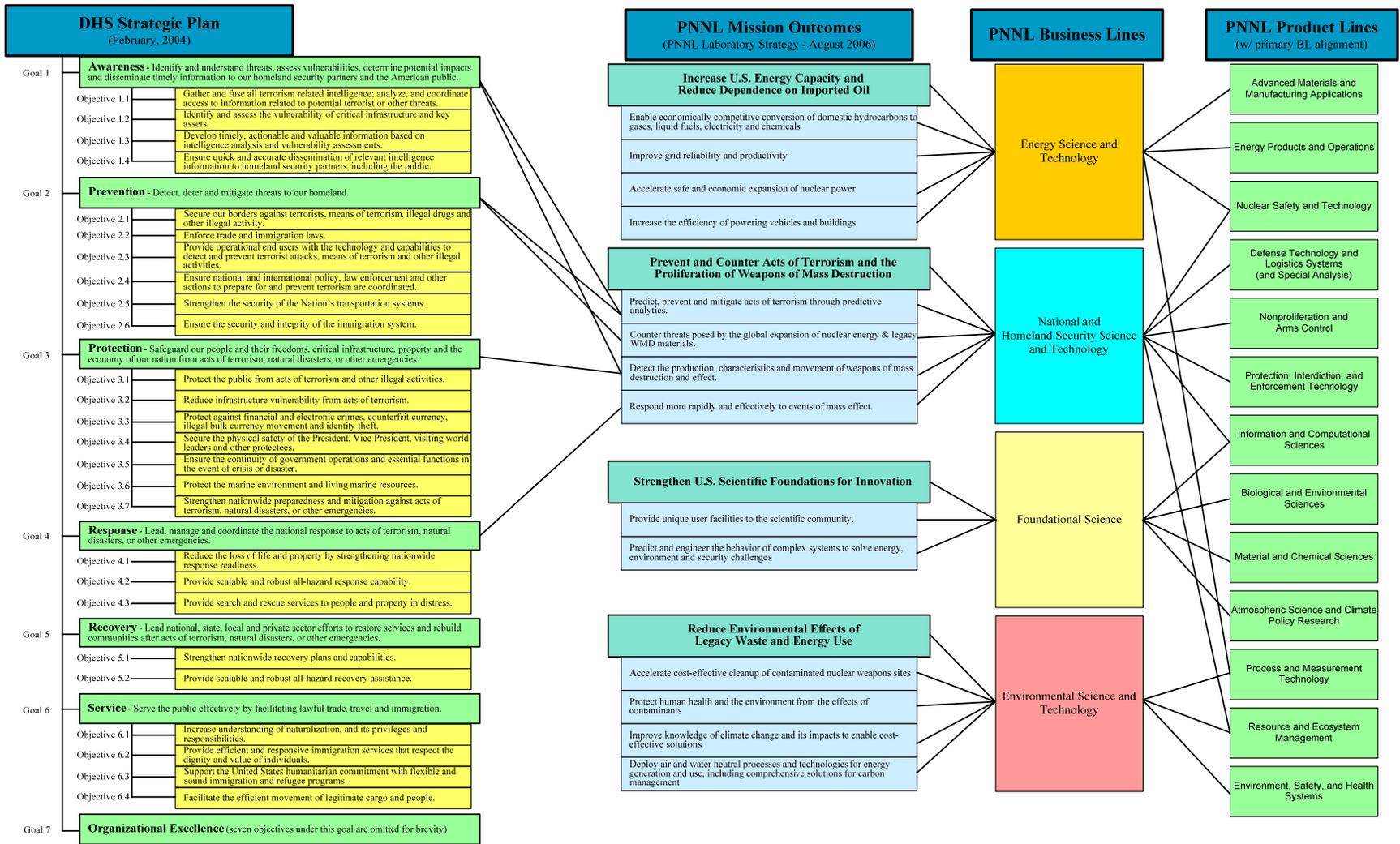
The EPAct, Section 994, requires DOE to periodically review all of the science and technology activities of the Department in a strategic framework that takes into account the frontiers of science to which DOE contributes and the national needs relevant to DOE's standing missions. In addition, DOE is required to develop a plan to improve coordination and collaboration in research, development, demonstration, and commercial application activities across the DOE organization. DOE's first report to Congress in response to this requirement identifies 21 areas of opportunity for significant impact on national priorities in energy, national nuclear security, and environmental management through better coordinated research and development programs. PNNL's capabilities and program base align well with 13 of these:

- Advanced mathematics for optimization of complex systems
- Grid control
- Catalysis for energy efficiency and renewable energy
- Nuclear fuel materials and design
- Catalysis for hydrogen production from nuclear energy
- Risk assessment for geological carbon sequestration
- Gasification and combustion modeling
- High performance materials for advanced fossil energy processes
- Nuclear test detection
- Remote sensing and analysis of radioactive materials and nuclear weapons
- Chemistry and separation of radioactive waste
- Modeling, simulation and scaling issues for environmental management
- Predicting high level waste system performance over extreme time horizons

These areas provide opportunity for synergies in the research investments PNNL makes and suggest opportunities exist for coordinated programs across PNNL's business lines. PNNL customers' five-year plans provide additional information on specific research programs that take many of these priorities into account and provide further direction for PNNL's research strategy.



**Figure 2.** Illustration of the relationship between elements of the DOE Strategic Plan and the PNNL Mission Outcomes, Business Lines, and Product Lines. The lines connecting the elements of the DOE Strategic Plan and PNNL Mission Outcomes show areas where PNNL is in direct alignment with the DOE strategy.

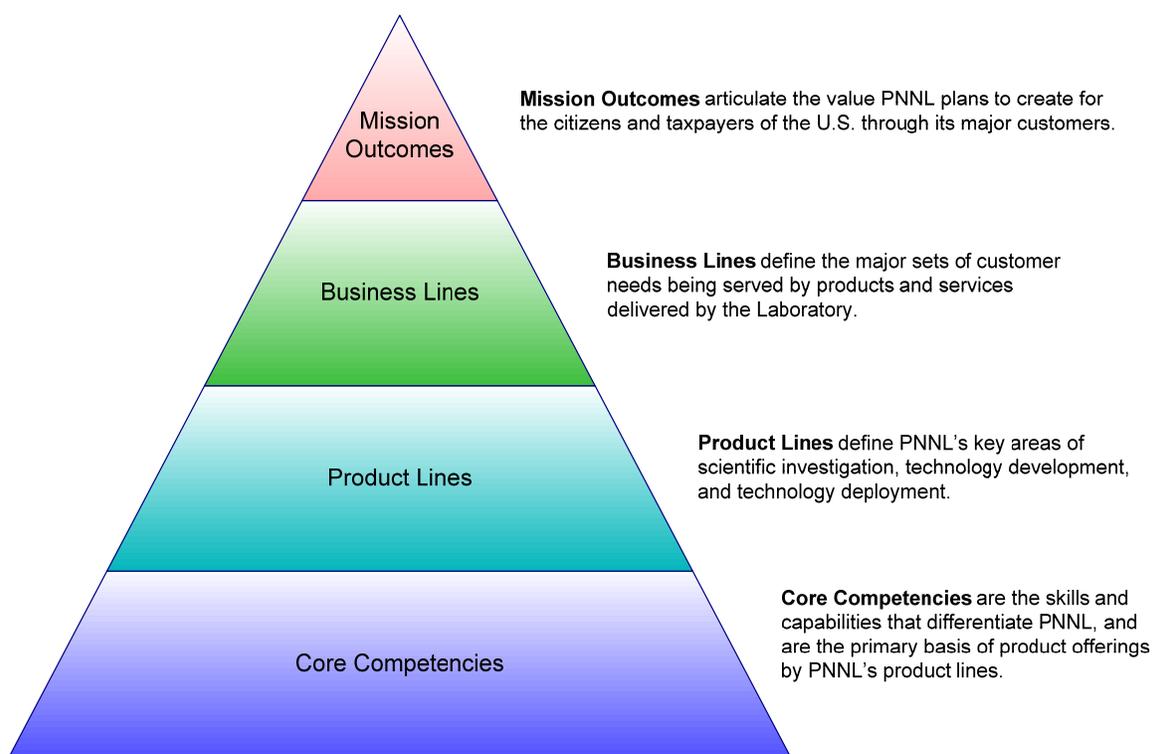


**Figure 3.** Illustration of the relationship between the elements of the DHS Strategic Plan and the PNNL Mission Outcomes, Business Lines, and Product Lines. The lines connecting the elements of the DHS Strategic Plan and PNNL Mission Outcomes show areas where PNNL is in direct alignment with the DHS strategy.

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## Major Business Lines

PNNL's research and development business is structured around business lines, product lines, and core competencies; and these three elements of the business are managed to execute the PNNL strategy and deliver PNNL's mission outcomes. Figure 4 illustrates and defines how PNNL builds upon core competencies, product lines, and business lines to deliver value for mission customers. PNNL has four **business lines**, each supported by multiple **product lines** that have product offerings that span fundamental science to technology development and, in some cases, to full-scale deployment. The product lines are built upon **core competencies** that are the basis of PNNL's product offerings delivered to customers. These three elements of the PNNL business are the basic responsibilities of the Associate Laboratory Directors and the EMSL Director. Through regular interactions with customers, PNNL continually examines emerging and unmet national needs. In addition, PNNL makes investments to refresh and extend core competencies or to develop new product offerings for specific business lines; ensuring that PNNL continues to meet the most urgent challenges facing its customers. This section introduces and describes PNNL's business lines, and is followed by discussions of the product lines, core competencies, and mission outcomes at PNNL.



**Figure 4.** Relationship between Mission Outcomes, Business Lines, Product Lines, and Core Competencies that are the major elements of PNNL's business plan.

PNNL's four overarching business lines – foundational science, energy science and technology, national and homeland security, and environmental science and technology – span fundamental science to technology development and, in some cases, to full-scale deployment. The business lines are aligned with PNNL's major customers and are served by multiple product lines that deliver products and services to diverse customers. The four business lines are described below.

## **Foundational Science**

The Foundational Science business line delivers new methods, tools, and discoveries to advance the fundamental understanding of physical, biological, and chemical systems underpinning DOE's missions. PNNL is improving the ability to predict the behavior of complex systems from molecular to global scales by building multidisciplinary, multi-institutional teams across the physical, chemical, and biological sciences. PNNL is a national leader in this business, with capabilities that position the Lab for world leadership in core product lines over the next 5 to 10 years. The primary customers for PNNL's Foundational Science business line are DOE-SC (BER, BES, and ASCR) and the National Institute for General Medical Sciences (NIGMS) and the National Heart, Lung and Blood Institute. This business line includes operating National User Facilities for DOE and other federal agencies.

A major component of the Foundational Science business lines are the scientific user facilities that create and deliver unique research resources to the scientific community. Currently, PNNL operates two user facilities for the Office of Science: EMSL and the Atmospheric Radiation Measurement (ARM) Program Climate Research Facility; as well as the Proteomics Research Resource for Integrative Biology user facility supported by the National Center for Research Resources component of the National Institutes of Health. PNNL also operates the Research Aircraft Facility for the DOE Atmospheric Science Program (ASP), which is used by scientists conducting research for the ASP and others. EMSL is the largest User Facility managed by PNNL on behalf of DOE for the scientific community. EMSL's mission is to provide integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation. EMSL's strength and uniqueness as a national user facility is in providing a problem-solving environment (tools, methods, and expertise) that enables scientists to address complex scientific problems in unexpected and non-traditional ways, resulting in a more productive and valuable research effort. The Research Aircraft Facility serves atmospheric scientists at DOE and other federal, state, and industrial laboratories in carrying out airborne research to better understand atmospheric processes as they relate to the DOE's environmental missions and the global environment. The ARM Climate Research Facility provides essential data for the study of alterations in climate, land productivity, oceans or other water resources, atmospheric chemistry, and ecological systems that may alter the capacity of the earth to sustain life.

## **Market and Customer Needs**

PNNL's business in this area has been growing steadily over the last five years, and growth of 7-20% per year is expected to continue – with substantial growth in the biological sciences. PNNL meets market needs for scientific knowledge in the broad areas of biological and environmental sciences, chemical and materials sciences, and computational sciences.

DOE, NIH, EPA, DHS, and DoD have a need to predict the behavior of biological systems – ranging from nanobiotechnologies to communities of microbes to animals to humans – under a wide range of

conditions. This predictive capability is essential for designing microbial and fungal systems and nanobiotechnologies to produce fuels, remediate environmental contaminants, capture and sequester carbon, and detect and remediate biological threats. They also have substantial value in predicting and managing disease. BER, NIGMS, and NHLBI are the primary direct sponsors of this research, and PNNL directs these capabilities to other customers through different business and product lines as this fundamental understanding is translated to solutions.

DOE, DoD, and DHS have a need to understand how geometric and electronic structures and defects control the chemical and physical processes in nanostructured materials under realistic operating conditions. This understanding will allow design of new interfacial catalysts and photocatalysts, hydrogen storage materials, membranes for high-temperature gas separation, spectroscopic detectors of ionizing radiation, selective adsorbent materials for preconcentration, and structural materials for high-intensity radiation environments and materials for long-term storage of radioactive waste. BES is the primary sponsor of this science, which PNNL translates to solutions for additional customers through other business and product lines. PNNL is a national leader in this business, growing into a world leader.

DOE, NIH, DHS, DoD, and the intelligence community need computational capabilities well beyond the current state of the art to solve problems involving large, complex data sets. This capability is fundamental for advancing data-intensive sciences, including systems biology, as well as for making sense of the huge volumes of complicated data related to national and homeland security. These clients need these capabilities to address the essential complexities in biological, environmental, and chemical sciences; monitor and control large and complex systems (e.g., power grids); and rapidly discover, characterize, and respond to threats to national and homeland security. Funding for this business comes from multiple customers, including ASCR, DoD, and the intelligence community. PNNL is a national leader in high-performance computing, established through EMSL's Molecular Science Computing Facility (MSCF); and PNNL is making substantial investments in this area to evolve this position to world leadership in this new class of data-intensive high-performance computing.

Fundamental discovery in the environmental molecular sciences will continue to be focused on intermolecular interactions within complex systems: from understanding and mitigating the effects of pollution to the design of electronic materials; from the role of aerosols in climate change to energy efficiency; from genomics to an understanding of cellular behavior and microbial communities. EMSL is well positioned to meet these scientific demands and PNNL will continue to manage EMSL's strategic capabilities to new frontiers and create a transparent and supportive user environment to meet the challenges of multidisciplinary research via EMSL.

The primary focus of the Foundational Science business line over the next five years and beyond is to *Strengthen U.S. Scientific Foundations for Innovation*, which is a mission outcome defined in the PNNL strategy. The specific focus of this mission outcome, the associated milestones, and associated PNNL investments are defined under the Mission Outcome section of this Work Plan.

## **Energy Science and Technology**

The Energy Science and Technology business line supports DOE's mission to use energy resources in the most efficient and environmentally acceptable manner possible. PNNL is bridging the gap to advanced energy systems, enabling a more secure and environmentally acceptable carbon-based economy. In addition, PNNL is moving towards a more secure, decentralized infrastructure based on a "smart" grid, fuel cells, biofuels, and, ultimately, a fully integrated hydrogen economy. This business line supports DOE's efforts to reduce America's dependence on foreign oil and develop energy-efficient technologies for buildings, homes, transportation, power systems, and industry. PNNL is a national leader in energy science and technology, with market niches in solid oxide fuel cells, carbon capture technology, future grid concepts, and biofuels. The primary customers for PNNL's Energy Science and Technology business line are DOE-EERE, DOE-FE, DOE-NE, and DOE-OE; secondary customers include NASA, the Nuclear Regulatory Commission (NRC) and private industry. The experimental and computational capabilities in EMSL are essential resources for the elements of this business line at the molecular and nano-scales.

### **Market Needs**

PNNL's energy business has been relatively small but growing over the last decade, with modest funding increases expected in energy funding over the next several years. However, the nation's energy outlook is not consistent with this picture. Both domestic and global dependency on hydrocarbon fuels will continue to increase beyond a current 85% dependence through at least 2025 or longer. The country needs to expand substantially the environmentally acceptable and economically competitive use of domestic hydrocarbon resources, including all coals, oil shales, and a spectrum of biomass and municipal wastes. At the same time, the United States must continue to move towards a more secure, decentralized energy production and delivery infrastructure based on renewable, nuclear, and hydrogen resources, a smarter and more effective grid delivery system, and more efficient energy demand-side technologies.

PNNL plans to serve the energy market needs of reducing the country's reliance on imported oil and increasing domestic energy capacity by developing hydrocarbon conversion process capabilities, improving grid management and operations, advancing domestic nuclear resources, and increasing the use of energy efficient technologies. PNNL is working closely with DOE and industry to define the future efforts in this area, including the required R&D programs and specific benefits to the country. PNNL expects these ideas to substantially influence PNNL's energy R&D programs and market outlook over the next decade, and project a 30% increase in this business over the next 5 to 10 years.

The primary focus of the Energy Science and Technology business line over the next five-years and beyond is to *Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil*, which is a mission outcome defined in the PNNL strategy. The specific focus of this mission outcome, the associated milestones, and associated PNNL investments are defined under the Mission Outcome section of this Work Plan.

## **National and Homeland Security Science and Technology**

The National and Homeland Security Science and Technology business line at PNNL supports the U.S. government's efforts to prevent proliferation of weapons of mass destruction (WMDs), protect the

U.S. homeland, and ensure a strong and responsive military. PNNL's broad range of scientific and engineering expertise enables the delivery of high-impact, science-based, practical solutions to customers. PNNL is meeting the needs of NNSA by preventing and detecting proliferation of WMDs, countering WMD terrorism, maintaining the nuclear deterrent, and monitoring compliance with nuclear treaties. PNNL brings to bear on these challenges decades of expertise in the technical aspects of nuclear materials production and detection (e.g., the nuclear fuel cycle, weapons material production, environmental monitoring, transuranic waste management, and safeguards, detection, and measurement technologies), as well as in such complex social and technical matters as economic diversification and international relations. PNNL is meeting the needs of the DHS to counter the terrorist threat by developing and deploying technologies that enhance the security, safety, and reliability of U.S. borders and surface transportation systems by stopping illicit materials from entering the United States. PNNL also provides DoD and the intelligence community with information systems, special equipment, and technology that support military operations, armaments, intelligence, and logistics. PNNL is a national leader in this business overall, and a world leader in radiological sciences, which underpins the largest portion of this business. The primary customers for PNNL's National and Homeland Security Science and Technology business line are NNSA, DHS, DoD, and the intelligence community. Secondary customers include National Institute for Allergies and Infectious Diseases and private industry. The advanced analytical capabilities in EMSL are an essential resource for this business line.

## **Market Needs**

NNSA, DHS, and the intelligence community need detection and characterization materials, methods and systems that are substantially more sensitive, reliable under field conditions, and integrate diverse forms of data into information that decision-makers can use. These new systems will lead to more rapid, sensitive, and accurate detection and response to biological, chemical, nuclear, radiological, and high-explosive threats. Scientific advances in materials, physical and chemical controls, systems biology and computation, and remote-sensing engineering, provide the basis for this new generation of detection systems. In combination with the Foundational Science business line, PNNL is uniquely positioned to respond to this need.

The market for these systems is expanding quickly, and PNNL projects a 15 to 35% increase in this business over the next five years. To ensure that the solutions being provided take full advantage of scientific and engineering advances, PNNL has established major investments to develop "next generation" threat detection and prevention systems. PNNL is moving to meet the market needs in this business line by developing and integrating new materials, detection systems, information analysis, and visualization tools to detect threats remotely and accurately while minimizing economic disruption.

The primary focus of the National and Homeland Security Science and Technology business line over the next five-years and beyond is to *Prevent and Counter Acts of Terrorism and the Proliferation of Weapons of Mass Destruction*, which is a mission outcome defined in the PNNL strategy. The specific focus of this mission outcome, the associated milestones, and associated PNNL investments are defined under the Mission Outcome section of this Work Plan.

## **Environmental Science and Technology**

The Environmental Science and Technology business line delivers practical strategies and technologies that allow federal and state agencies responsible for managing sensitive ecologies to monitor indicators and respond to a broad set of environmental stressors. This business line provides solutions to the DOE's challenges effectively to close and provide long-term stewardship for its legacy waste sites. In this area, PNNL also provides the scientific and technical basis for developing processes, policies, and regulations that provide necessary protections with greater reliability and efficiency. Beyond cleanup, this business line produces science and technology solutions to monitor environmental change and predict environmental damage from intentional and unintentional insults, providing the basis for rapid response to environmental events and long-term regulation of sensitive ecologies. PNNL also provides science and technology supporting sustainable process engineering for a variety of industries, including chemical, radiochemical, petrochemical, pharmaceutical, electronics, agricultural, and food production.

PNNL is a national leader in Environmental Science and Technology, with areas of world leadership in subsurface fate and transport modeling and integrated assessments for environment and energy. PNNL is the largest supplier of science and technology supporting DOE's ongoing cleanup mission (at Hanford). The primary customers for PNNL's Environmental Science and Technology business line are DOE-EM, DoD (Corps of Engineers), and EPA. Secondary customers for environmental security and sustainability markets include DHS and private industry. This business line also provides environmental research in the earth sciences to NASA. EMSL is an essential resource for the elements of this business line at the molecular and nanoscale and especially for the most complex models of contaminant fate and transport.

### **Market Needs**

As DOE-EM moves towards final cleanup closure of its large legacy waste sites under continuously tighter budgets, it has a continuing need for targeted science and technology (S&T) to ensure the reliability of its processes, increase efficiencies, and support site closures and long-term stewardship. DOE, EPA, DoD (the Army Corps of Engineers), and a number of local governments need the ability to predict more accurately environmental change and damage from both unintentional (e.g., economic) and intentional (e.g., terrorist) activity, effectively reducing both the uncertainty of current fate and transport models and the time it takes to assess exposure to toxin or disease. Moreover, there is a growing demand in private industry for advances in process engineering that will reduce its environmental and energy "footprint" and provide a more sustainable production cycle. Advances by PNNL are leading to practical strategies and technologies that will allow federal and state agencies responsible for managing sensitive ecologies to monitor indicators that provide early responses to a broad set of environmental insults, predict how whole ecologies will respond to changing conditions, and support policies that provide necessary protections with greater reliability and efficiency. The same underlying capability will allow homeland and national security customers more quickly and accurately to assess threats and damage from intentional releases and more effectively to protect troops and citizens. PNNL's strengths in process engineering combined with core competencies in environmental science and technology are providing new product offerings to private industry in sustainable production.

Under most scenarios, DOE-EM budgets will decline significantly over the next five years, reducing the environmental cleanup portion of this business line by almost 40%. However, there appears to be a growing demand for S&T to support DOE-EM in accomplishing its mission in a timely and cost-efficient

manner. PNNL is already redirecting a substantial portion of the underlying capability for this business line from supporting environmental cleanup to providing the S&T to enable such. For example, PNNL's process science and engineering capabilities are being called upon to resolve issues, and shorten the life-cycle at DOE's Waste Treatment Plant. The projected growth in the S&T elements of the business line will mitigate the overall impacts from the declining DOE-EM cleanup budgets. PNNL is investing in environmental sciences initiatives aimed at developing the underlying science, enhanced system models (e.g., for climate change and subsurface fate and transport), and improved technologies to support these urgent, strategic goals. In support of DOE's Strategic Plan, PNNL is also working with DOE-EM and DOE-OSC to integrate and leverage our capabilities, knowledge and our funded projects to reduce the technical risks over the life of the DOE Mission.

In addition to providing DOE-EM its S&T base, the environmental business line is also working with growing its business with the environmental missions of NASA, NOAA, DOD Environmental (primarily the ACOE), and in emerging areas with DOI. And finally, preventing negative environmental impacts during energy generation is a critical focus of the business line, specifically in the areas of carbon management and water resources.

The primary outcome of the Environmental Science and Technology business line over the next five years and beyond is to *Reduce Environmental Effects of Legacy Waste and Energy Use*, which is a mission outcome defined in the PNNL strategy. The specific focus of this mission outcome, the associated milestones, and associated PNNL investments are defined under the Mission Outcome section of this Work Plan.

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# Product Lines

PNNL has 13 product lines that deliver specific products and services (product offerings) to customers through business lines. Some of these product lines are almost fully subscribed by one business line; others deliver products and services that serve diverse customers and, therefore, cross multiple business lines. These product lines are described below. Table 1 illustrates the alignment of product lines with business lines and primary customers.

**Table 1.** PNNL’s Major Product Lines Serve Multiple Business Lines and Customers – Table shows primary (●), secondary (○), and expected (\*) customers.

*Indication of primary (●), secondary (○), and expected (\*) customer for product lines.*

PRODUCT LINES	BUSINESS LINES (w/ Primary Customers)																				
	Foundational Science						Energy S&T				National and Homeland Security S&T					Environmental S&T					
	BER	BES	ASCR	NIH	EMSL (BER)	ARM (BER)	NCRR (NIH)	EE	FE	NE	NRC	NNSA	DHS	NIH	DOD	IC	EM	DOD	NASA	DOI	EPA
Advanced Materials and Manufacturing Applicat.		○					●		○						○						
Energy Products and Operations							●	●							○						
Process and Measurement Technology		○					●		○		○					●					
Environmental, Safety and Health Systems				○						○		○				●			○		○
Resource and Ecosystem Management	○							○								●	●		*		○
Biological and Environmental Sciences	●			●	●		●						*	*							*
Material and Chemical Sciences	●	●	○																		
Information and Computational Sciences			●	○								●		○	●	○					
Atmospheric Science & Climate Policy Research	●					●		○													○
Defense Tech. and Logistics Systems(w/Special Analysis)														●	●						
Nonproliferation and Arms Control											●				○						
Nuclear Safety and Technology									●	●	●				○						
Protection, Interdiction, and Enforcement Technology												●		●	○						

## Biological and Environmental Sciences

The Biological and Environmental Sciences (B&ES) product line delivers systems biology and bioinformatics tools and results, understanding of biological interactions with environments (e.g., microbes, health effects), and subsurface-interaction models and assessments. Specific product offerings include:

- Biogeochemistry
- Environmental microbiology
- Geohydrology and geophysics
- Carbon sequestration research.

## **Material and Chemical Sciences**

The Material and Chemical Science product line delivers fundamental chemical physics, theoretical chemistry, and synthetic and mechanistic organic/inorganic/materials chemistry research. Specific product offerings include:

- Theoretical and computational chemistry and chemical physics
- Inorganic, organic, and materials chemistry
- Interfacial chemistry and catalysis
- Novel instrumentation and instrument design
- Material design and fabrication
- Actinide and trace metal chemistry.

## **Information and Computational Sciences**

The Information and Computational Sciences product line delivers tools that enable the research community to solve complex, large-scale multi-disciplinary, and data-intensive problems and to meet the long-term goals of government agencies and industry. The specific product offerings include:

- Visual analytics; large-scale information integration
- Information assurance and operations; situation planning and response
- Large-scale data analysis, discovery, and management
- Rich interaction environments; problem-solving environments
- Advanced and high-performance computing and network architectures
- Computational mathematics; sampling and experimental design; statistical sciences.

## **Atmospheric Science and Climate Policy Research**

The Atmospheric Science and Climate Policy (ASCP) product line delivers theoretical and experimental studies in atmospheric chemistry, meteorology, transport and dispersion phenomena, and climate physics to enhance understanding of the sources and mechanisms of change in local, regional, and global air quality, as well as the implications of these changes for long-term climate change. The specific product offerings include:

- Atmospheric and aerosol chemistry; monitoring, modeling and air quality
- Meteorology and boundary layer dynamics
- Climate physics; regional climate modeling and impacts
- Climate policy and integrated assessment
- Advanced scientific instrumentation and user facilities (ARM Facilities and the Research Aircraft).

## **Resource and Ecosystem Management**

The Resource and Ecosystem Management product line delivers solutions to complex environmental problems related to site management, restoration, and stewardship of natural resources. Specific product offerings include:

- Environmental monitoring and assessment; fate and transport of contaminants
- Management of natural resources
- Ecological and human risk assessment
- Environmental remediation systems
- Statistical analysis and design.

## **Process and Measurement Technology**

The Process and Measurement Technology product line delivers technology that focuses on the discovery, testing, evaluation, development and deployment of characterization, retrieval, conversion, separation, immobilization, as well as process inspection, monitoring, and control technologies. Specific product offerings include:

- Biobased Fuels, Products, and Processes
- Micro Chemical and Physical Systems
- Advanced Sensors for Inspection, Monitoring, and Control
- Retrieval, Treatment, Utilization, and Disposition of Legacy Radioactive Materials
- Chemical Processing Flowsheet Development and Optimization

## **Environment, Safety, and Health Systems**

The Environment, Safety, and Health (ES&H) product line delivers technology that enables clients to respond effectively to regulation and better protect the worker, the public, and the environment. Specific product offerings include:

- Occupational safety and emergency management
- Chemical and radiation dosimetry; radiation protection services
- Human health exposure and risk assessments
- Effluent monitoring and waste management
- Safety measurement systems and personnel monitoring
- Irradiation facilities and measurement technologies.

## **Advanced Materials and Manufacturing Applications**

The Advanced Materials and Manufacturing Application (AMMA) product line delivers practical and innovative materials solutions via design, synthesis, processing, and characterization of new materials, as well as technology that yields more efficient, effective manufacturing processes and products. Specific product offerings include:

- Materials for use in aggressive operational environments
- Materials for energy and industrial applications; photonic/electronic applications
- Engineering modeling and simulation
- Advanced and affordable manufacturing technologies for engineered material
- Intelligent sensors and process controls for manufacturing processes and inspection systems

## **Energy Products and Operations**

The Energy Products and Operations (EP&O) product line delivers analytic tools and technological products and services for a secure, clean, and affordable energy supply and management. Specific product offerings include:

- Advanced energy system condition monitoring, prognostics, and control
- Energy system operations and asset management; policy, planning, and analysis
- Advanced energy supply, storage, and conversion systems
- Energy efficiency technology codes, standards, market deployment
- Carbon management policy and technology development
- Clean fuels/hydrogen production and utilization systems.
- Nuclear energy science and technology, and plant licensing support

## **Defense Technology and Logistics Systems (and Special Analysis)**

The Defense Technology and Logistics Systems product line delivers military-specific products, systems, technology and analysis to users and operators in the defense and intelligence communities. Specific product offerings include:

- Logistics science and technology
- Defense technologies
- Chem/bio defense technologies
- Special programs technology
- Operations research and systems analysis.

## **Nonproliferation and Arms Control**

The Nonproliferation and Arms Control product line delivers products and services to the nonproliferation community in a wide spectrum of Weapons of Mass Destruction (WMD) nonproliferation, arms control, and WMD threat reduction and proliferation prevention and detection missions. Specific product offerings include:

- Treaty negotiation and implementation
- WMD threat reduction
- Proliferation prevention; arms control technologies
- Sample measurements and analyses; nonproliferation analysis and interpretation
- Global nuclear and radiological threat reduction
- Export control technologies and policy implementation.

## **Nuclear Safety and Technology**

The Nuclear Safety and Technology product line delivers solutions to nuclear safety, technology, and operations problems by analyzing and developing technology to maintain and improve the safety of nuclear reactors and associated facilities related to national defense and commercial nuclear power. Specific product offerings include:

- International nuclear safety, operations, and project management
- Nuclear safety analysis
- Excess nuclear material disposition
- Advanced nuclear energy systems; advanced power sources
- Medical isotopes
- Tritium production support.

## **Protection, Interdiction, and Enforcement Technology**

The Protection, Interdiction, and Enforcement Technology product line delivers comprehensive programs and countermeasures to identify and protect customer assets and operations from known and evolving threats in a cost-effective manner and manage risk in an optimized fashion. Specific product offerings include:

- Nuclear safeguards and security; security systems and technology
- Counterintelligence; critical infrastructure protection
- Interdiction: technology, operations, support, and analysis
- Forensics and law enforcement investigative support technologies
- Crisis management and response to terrorist incidents
- Information assurance/cyber security.

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## Core Competencies

Core competencies are the skills and capabilities that differentiate an organization from alternative providers of their products and services, and afford them a competitive advantage. At PNNL, core competencies underpin the products offerings that are developed by product lines and delivered to customers through the business lines. PNNL currently has six core competencies, which are described below.

### Microbial and Cellular Biology

PNNL's Microbial and Cellular Biology core competency includes world-class capabilities in environmental microbiology and applied proteomics. These competencies extend to predictive biology of prokaryotic and eukaryotic systems, analysis of molecular machines, and multispectral and multimodal microscopy.

PNNL is a National Leader in this core competency, and it is currently thriving.

- Distinguishing Characteristics:
  - Environmental microbiology
  - Applied proteomics
  - Predictive biology of prokaryotic and eukaryotic systems
  - Analysis of molecular machines
  - Multispectral and multimodal microscopy

### Environmental Sciences

PNNL's key capabilities include world-class competencies in biogeochemistry and subsurface science, in climate physics (including global and regional modeling), and in integrated assessment of energy and the environment. PNNL also has competencies in ecosystem science (freshwater, coastal, and arid lands), atmospheric science and chemistry, and carbon management and sequestration. This is a thriving core competency, and PNNL is a National Leader in this arena.

- Distinguishing Characteristics:
  - Biogeochemistry and subsurface science
  - Ecosystem science – freshwater, coastal, arid lands
  - Climate physics, global and regional scale modeling
  - Atmospheric science and chemistry
  - Integrated assessment for energy and environment
  - Carbon management and sequestration

## **Analytical and Interfacial Chemical Sciences**

This competency includes world-class capabilities in chemical physics, computational chemistry, chemical analysis, and process engineering. PNNL's capabilities in interfacial catalysis and functional nanoscale and multiscale materials are on the way to being world-class. PNNL is a National Leader in this core competency, and it is currently thriving.

- Distinguishing Characteristics:
  - Chemical physics
  - Computational chemistry
  - Functional nanoscale and multiscale materials
  - Process engineering
  - Chemical analysis
  - Interfacial catalysis

## **Radiological Sciences**

PNNL's areas of world leadership in radiological sciences, which it inherits from the Hanford Site's early support of the AEC, includes radiation detection, radioanalytical chemistry and radiochemical processing, irradiated materials research, and surface and interfacial radiological science. New programs in the discovery of new radiation-detection materials and in double beta decay and neutrino physics (the DOE-SC Majorana project) are built on these world-class capabilities. PNNL is a World Leader in this core competency, and it is currently thriving.

- Distinguishing Characteristics:
  - Radiation detection science and technology
  - Radioanalytical chemistry and radiochemical processing
  - Irradiated material science and technology
  - Surface and interfacial science
  - Science-based material discovery
  - Double beta decay and neutrino physics

## **Information Analytics**

The strength of PNNL's Information Analytics competency lies in visual analytics and cyber security, including the growing area of cyber forensics. PNNL's capabilities in knowledge discovery, e.g., bioinformatics, scientific data management, data-intensive computing, and the statistics of anomalous events are also strong. PNNL is a National Leader in this core competency, and it is currently thriving.

- Distinguishing Characteristics:
  - Visual analytics
  - Cyber security/forensics
  - Knowledge discovery, e.g., bioinformatics

- Scientific data management and data-intensive computing
- Statistics of anomalous events

## **Sensing and Measurement Technologies**

PNNL's capabilities in sensing and measurement are currently directed to security applications, energy systems, environmental monitoring, and industrial applications. PNNL's competencies span a range of the Laboratory's S&T disciplines: nuclear radiation sensors and systems, in which PNNL is a world leader; biological, chemical, and physical sensors and systems; macro-property measurements; and electronic sensors, including controls. PNNL is a National Leader in this core competency, and it is currently stable.

- Distinguishing Characteristics:
  - Nuclear radiation sensors and systems
  - Biological, chemical, physical property sensors and systems
  - Macro-property measurements
  - Electronic (including controls)

The business lines employ these core competencies to offer high-impact science and science-based solutions to customers. The needs of PNNL's customers are constantly evolving, and these core competencies must be continually honed and refined in order to sustain relevance of these national assets. PNNL invests to strengthen and evolve these core competencies, and refocuses these core competencies on the most critical challenges facing the Nation. These core competencies are central to the PNNL strategy (shown in Figure 1), and further building and otherwise stewarding core competencies is a critical element of PNNL strategy execution. Core competencies, product lines, and business lines are the business systems that routinely deliver value to PNNL customers, and they are the primary tools that will allow PNNL to provide the science, technologies, and leadership to deliver Mission Outcomes.

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## PNNL's Mission Outcomes

PNNL's Mission Outcomes define the areas where PNNL intends to provide science, technology and leadership that contribute to solutions of major national challenges over the next five-years and beyond. Delivering these Mission Outcomes are the principle focus of the PNNL strategy. The four Mission Outcomes, PNNL's strategic intent for each mission outcome, and planned outcome and milestones for each Mission Outcome are described in this section.

### **Strengthen U.S. Scientific Foundations for Innovation**

**The Challenge.** Increasing global competition demands new capabilities for advanced scientific discoveries that are essential to fueling the U.S. economy and securing the future. The President has established the American Competitiveness Initiative, and Congress has introduced legislation to increase investments in physical sciences and engineering with the intention to accelerate discovery and the translation of those discoveries into positive economic impact.

**DOE Five Year Priorities.** In response, DOE has issued in its Five Year Plan new research priorities aimed at accelerating science in areas consistent with the American Competitiveness Initiative, the goals of the Advanced Energy Initiative, and DOE's 2006 Strategic Plan. In areas consistent with PNNL's Foundational Science business line and capabilities, these include:

- BER's accelerated program of microbe-based biotechnology for production of ethanol from cellulose and for the generation of hydrogen, bioremediation, and sequestration of carbon dioxide. BER will also continue to support programs in climate change and environmental remediation research.
- BES new initiatives in solar energy, advanced nuclear energy systems, chemical imaging, complex systems and mid-scale instrumentation.
- ASCR activities focused on tools and systems needed for scientists to make effective use of Leadership Class and petascale computers.
- Research for HHS, leveraging DOE capabilities, in areas related to clinical applications of proteomics and system biology.

**PNNL's Strategic Focus.** PNNL will provide the science, technology and leadership to:

- **Predict and engineer the behavior of complex systems to solve energy, environment and security challenges**, emphasizing five research goals:
  - Synthesize arrangement of atoms at interfaces and in solids to control chemical and physical processes, with a focus on catalytic materials and processes relevant to carbon capture and reduction, hydrogen and energy storage, improved gasification, and remediation of chemical and biological agents.

- Predict, manipulate and design biological systems for bioenergy, bioremediation, carbon sequestration and responses to stress, with a focus on high-throughput characterization technologies (proteomics, imaging, etc.), computational capabilities (bioinformatics, data intensive computing), cellular and community function, and system design relevant to energy conversions and predictive capabilities for environmental and human health.
  - Develop validated, scalable models to reduce the uncertainty in global and regional climate change predictions and impacts, with a focus on integrating complex earth system processes and their interaction with significant energy systems (atmospheric and hydrologic processes, aerosols, surface flux, and carbon capture).
  - Develop validated contaminant fate and transport models by advancing the understanding of chemical, biological, and physical processes and the coupling of those processes in the subsurface.
  - Develop concepts, models, tools and approaches to predict behavior of multiscale phenomena and complex systems, including underlying mathematical understanding of physical, chemical and biological systems; environments for integrating data intensive and model-driven systems and analysis; and, computational methods that allow coupling of temporal, spatial, and complexity scales critical to chemical, biological and environmental phenomena underlying subsurface, climate, and energy systems.
- **Deliver unique user facilities to the scientific community**, focusing on capabilities critical to molecular sciences:
    - Recapitalize capabilities around EMSL’s science themes in
      - Biological Interactions and Interfaces
      - Geochemistry/Biogeochemistry/Subsurface science
      - Atmospheric Aerosol Chemistry
      - Science of Interfacial Phenomena
    - Explore the value of additional user facilities that compliment EMSL and will greatly accelerate discovery and technology solutions related to national priorities in bioenergy, carbon sequestration and threat reduction, including integrated high throughput characterization and analysis technologies and multi-scale imaging.

**Science and Technology Investments.** PNNL’s primary S&T investments (primarily LDRD) in this area include:

- *Biomolecular Systems Initiative.* Over the past several years, this initiative has developed world-class scientific leadership and technical capabilities in “systems biology” in order to understand, control and predict the behavior of the cellular networks in prokaryotic and eukaryotic systems that are responsible for information processing, energy generation and carbon utilization. The initiative has made fundamental contributions to proteomics, cell imaging, cell signaling mechanisms, microbial communities such as biofilms, bioinformatics and others. By taking a systems approach to systems

biology, these capabilities provide the scientific foundations for advancements in bioenergy, bioremediation, biodetection, low-dose radiation effects and carbon sequestration.

- *Catalysis Initiative.* The Catalysis Initiative is developing advanced scientific understanding, models and methods that result in greatly improved abilities to design and control the activity and selectivity of catalysts associated with chemical transformations that are important to achieving a more secure energy future. The initiative will accelerate progress by combining the power of computational modeling, nanophase synthesis and operando measurements (measurements at actual operating conditions). The centerpiece of the initiative is the creation of the Institute for Interfacial Catalysis which intends to become an internationally recognized center of excellence in catalysis research and applications.
- *Data Intensive Computing Initiative.* As the successor to previous investments in computing, this initiative focuses on developing solutions to complex, data-intensive (petascale) computing challenges associated with scientific discovery and insight, situational awareness and response, and decision support and control. The initiative is structured around a novel architecture encompassing computing platforms, data management and analysis algorithms customized to the unique challenges of data-intensive computing. The initiative will have strong impacts on a wide range of national priorities in science, global and homeland security, energy, and environmental quality.
- *EMSL Grand Challenges.* These are collaborative efforts that challenge EMSL and the User Community to solve large, difficult technical problems in the areas of biogeochemistry and membrane biology under the auspices of an external panel of experts and DOE-SC-BER.

This Mission Outcome also benefits from these S&T investments:

- *Environmental Biomarkers Initiative.* This pioneering initiative is focused on developing the scientific understanding, tools and methods to discover and utilize environmental biomarkers as predictive, early indicators of change or stress in ecological systems and humans. While the focus on this initiative is on the discovery and validation of specific biomarkers (and the tools for doing so), the overall systems approach for end-use applications consists of three stages: biomarker discovery, sensors and data analysis, and model-based decision support and action. Through integrative research across multiple disciplines, advancements will be made in understanding the inhalation toxicology of nanomaterials, response of humans to biological agents, and predicting ecosystem change and damage.
- *Energy Conversions Initiative.* In response to urgent national priorities, this new initiative will develop and apply coal gasification technologies, gas separation technologies, improved conversion processes and implementation strategies that accelerate the development and operation of viable, commercial-scale, coal-to-liquid-transportation-fuels production plants. These advanced capabilities will also help accelerate progress in zero-emissions coal-based electricity generation and hydrogen production and utilization. All of these efforts and outcomes will work together to enable significant reductions in the nation's dependence on foreign oil.

Details for these initiatives can be found at <http://pnnlsp1.pnl.gov/sites/IPAMS/IM/default.aspx>.

**Strategic Partnerships.** PNNL management and research staff aggressively reach out to the broader research community in the various scientific disciplines to pursue programmatic and collaborative research partnerships. The Laboratory will make additional institutional investments in partnerships in the following areas:

- Institute for Interfacial Catalysis, aimed at developing a DOE sponsored Collaborative Research Facility, will forge formal ties between some of the most productive catalysis institutes world-wide, including; University of Texas, University of Delaware, University of Washington, the Dalian Institute of Chemical Physics (China), and the Fritz Haber Institute (Germany), among others.
- Joint Global Climate Change Research Institute, a joint institute with the University of Maryland, and a cornerstone for the Laboratory's programmatic research in integrated climate change research.

## **Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil**

**The Challenge.** As global economies and populations grow, so does the need for additional energy. Currently, 85% of the global and domestic demand for energy is fulfilled with carbon-based energy sources, and forecasts show that this will increase substantially over the next 25 years. Increases in energy supply from alternative sources such as renewables, nuclear or hydrogen, while promising, will not substantially meet the demand for energy for more than 25 years. The nation and the world needs a secure "energy bridge" that will help transition the global economy to a renewable, nuclear and hydrogen energy base while reducing U.S. dependence on imported oil.

**DOE Five Year Priorities.** DOE's Five Year Plan outlines priorities for new technology development that support the goals of the Advanced Energy Initiative, Global Nuclear Energy Partnership (GNEP), Advanced Fuel Cycle Initiative, Generation IV Energy Systems Initiative, and DOE's 2006 Strategic Plan. Areas consistent with PNNL's Energy Science and Technology business line and capabilities include:

- DOE-FE: R&D activities that support FutureGen's goals of constructing and operating a cost-effective, "zero emissions" coal fueled power plant, hydrocarbon gasification and separation technologies, and fuel cells. These R&D activities are aimed at improving efficiency, achieving dramatically reduced atmospheric emissions for criteria pollution, cost-effective capture and storage of carbon dioxide, improving hydrocarbon gasifier systems, and lowering fuel cell costs and expanding their use in power generation and military applications.
- DOE-OE: R&D programs that are based upon improving the resiliency of the grid and reducing congestion, including visualization and control technologies, and power system efficiencies, reliability, and security.

## Strengthen U.S. Scientific Foundations for Innovation Foundational Science

PNNL Contribution	Customer	Planned Outcomes and Milestone		
		FY07	FY08	FY09-FY11
Provide Unique user facilities to the scientific community	DOE-SC-BER	<ul style="list-style-type: none"> <li>• Complete Biogeochemistry Grand Challenge</li> <li>• Complete Membrane Biology Grand Challenge</li> <li>• Complete repopulation of EMSL advisory committees under new charters</li> </ul>	<ul style="list-style-type: none"> <li>• Complete construction of EMSL southwest office addition</li> <li>• Host National Users Facility Organization annual meeting</li> <li>• Refresh high-performance computing capabilities</li> <li>• Increase scientific leadership in EMSL by two strategic hires</li> </ul>	<ul style="list-style-type: none"> <li>• Increase the number of distinguished EMSL participants by 15%</li> <li>• Develop eight new or improved capabilities supporting research on EMSL Science Themes via EMSL Recapitalization Plan Complete construction of the EMSL radiological annex.</li> </ul>
Predict and engineer the behavior of complex systems to solve energy, environment and security challenges	DOE-SC-BER NIH	<ul style="list-style-type: none"> <li>• Initiate new program related to the GtL Bioenergy Center</li> </ul>		<ul style="list-style-type: none"> <li>• Establish a major new program on Aerosol Chemistry at PNNL</li> </ul>
	DOE-SC-BES	<ul style="list-style-type: none"> <li>• Complete ASCR stretch goal of making significant improvements in the HP 11-TeraFLOPS computer in EMSL</li> <li>• Build a facility (GPP funded) to support catalysis-related R&amp;D</li> </ul>	<ul style="list-style-type: none"> <li>• Establish the Institute for Interfacial Catalysis (IIC) as a Basic Energy Sciences program</li> </ul>	

- DOE-NE: Activities focused on advanced fuel cycle R&D in support of GNEP, R&D related to reactor fuels and high-temperature materials related to the Next Generation Nuclear Plant, and collaboration with the U.S. NRC to develop a strategy for combined construction and operating licenses for new reactors.
- DOE-EERE: Critical path technologies in fuel cells, hydrogen storage and safety, biomass systems R&D, photovoltaics, advanced internal combustion engines, advanced batteries for electric energy storage, lightweight materials, advanced fuels, solid state lighting, and appliance efficiency standards.

**PNNL's Strategic Focus.** PNNL will provide the science, technology and leadership to:

- **Enable economically and environmentally sustainable conversion of domestic hydrocarbons to gases, liquid fuels, electricity and chemicals.** PNNL's specific contributions in this area focus on:
  - Coal to electricity: Drive zero-emission coal-to-electricity to commercial competitiveness, including deliver the world's first near zero-emissions coal to electricity plant by 2012, on time and on budget.
  - Coal to liquids: Enable "air and water neutral" conversion of coal-to-liquid fuels to support 2.4 million barrels/day of new domestic production capacity by 2015.
  - Biomass to fuels, feedstocks and products: Enable conversion of biomass to chemicals and fuels to support 0.5 million barrels/day of new domestic production capacity by 2015.
- **Improve grid reliability and productivity** through the development of interconnection-scale tools for wide area monitoring and real-time analysis of grid operations, moving control and operation timescales from minutes to seconds
- **Accelerate safe and economic expansion of nuclear power** by supporting new nuclear facility siting, operation, waste management and regulatory analysis, advanced fuels and small reactors for developing countries and advancing structural materials and chemical processes for actinide-bearing waste forms
- **Increase the efficiency of powering vehicles and buildings** by developing low-cost solid oxide fuel cells, advanced combustion technologies and materials, advanced chemical hydrogen storage systems, and technologies and innovative approaches to increase building energy efficiencies

**Science and Technology Investments.** PNNL's S&T investments (primarily LDRD) in this area include:

- *Energy Conversion Initiative.* In response to urgent national priorities, this new initiative will develop and apply hydrocarbon gasification technologies, gas separation technologies, improved conversion processes and implementation strategies that accelerate the development and operation of viable, commercial-scale, coal-to-liquid-transportation-fuels production plants. These advanced capabilities will also help accelerate progress in zero-emissions coal-based electricity generation and hydrogen production and utilization. All of these efforts and outcomes will work together to enable significant reductions in the nation's dependence on foreign oil.

- *Electricity Infrastructure Operations Initiative.* The purpose of this initiative is to develop and validate next-generation power grid modeling and control technologies coupled with watershed models to integrate grid operational processes, expand situational awareness to an entire grid interconnect and reduce the system control timescale from minutes to seconds. This requires advancements in high performance computing, data acquisition and management, remote sensing, all coupled with power grid and watershed modeling. The outcomes of this work will enable grid operators to improve grid stability, productivity and reliability while reducing its environmental footprint.

This Mission Outcome also benefits from these S&T investments:

- *Catalysis Initiative.* The Catalysis Initiative is developing advanced scientific understanding, models and methods that result in greatly improved abilities to design and control the activity and selectivity of catalysts associated with chemical transformations that are important to achieving a more secure energy future. The initiative will accelerate progress by combining the power of computational modeling, nanophase synthesis and operando measurements (measurements at actual operating conditions). The centerpiece of the initiative is the creation of the Institute for Interfacial Catalysis which intends to become an internationally recognized center of excellence in catalysis research and applications.

Details for these initiatives can be found at <http://pnnlsp1.pnl.gov/sites/IPAMS/IM/default.aspx>.

**Strategic Partnerships.** PNNL management and research staff aggressively reach out to the broader research community to pursue programmatic and collaborative research partnerships. The Laboratory will make investments in the following partnerships for this mission outcome.

- Washington State University (WSU)<sup>2</sup> to deliver advanced biotechnologies that support the Northwest's regional biofuels initiative and the national energy agenda.
- WSU and the states of Washington and Oregon to create a national center for bioenergy and bioproducts research in the Northwest.
- FutureGen Alliance to enable the deployment of multiple, first-generation near-zero emission plants and revolutionize commercial coal-fueled power production.
- Refineries, coal companies, technical providers such as General Electric, and government entities, such as South Dakota and the Navajo Tribal Utility Authority to catalyze the first coal to liquid fuel plant and enable an industry.
- Northwest Center for Electric Power Technologies (NCEPT) to partner with utilities, academia, and industry in the Northwest to identify regional priorities and opportunities for collaboration related to grid operation and reliability.
- DOE/Industry partnerships that support critical DOE missions

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<sup>2</sup> The PNNL WSU partnership supports multiple mission outcomes and includes a distinct focus on radiochemistry for national and homeland security and environmental science and technology.

## Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil Energy Science and Technology

PNNL Contribution	Customer	Planned Outcomes and Milestone		
		FY07	FY08	FY09-FY11
Enable economically and environmentally sustainable conversion of domestic hydrocarbons to gases, liquid fuels, electricity and chemicals	DOE-FE DOD	<ul style="list-style-type: none"> <li>Secure role in next phase of FutureGen*</li> <li>Down select to a final FutureGen site*</li> <li>Down select SECA fuel cell teams</li> <li>Establish coal gasification test bed facility</li> </ul>	<ul style="list-style-type: none"> <li>Complete final engineering design for FutureGen plant*</li> <li>Create a military application of SOFCs</li> </ul>	<ul style="list-style-type: none"> <li>Commercialize SOFCs</li> </ul>
Improve grid reliability and productivity	DOE-OE	<ul style="list-style-type: none"> <li>Secure DOE programmatic funding to support EIOC</li> <li>Engage stakeholder experts to develop the principles and conceptual framework that facilitate multi-party, multi-device interoperability consistent with the GridWise vision of a transformed energy system</li> </ul>	<ul style="list-style-type: none"> <li>Develop advanced operational capability of wide area phasor data</li> <li>Develop metrics to benchmark security posture for control systems used in critical energy infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Develop and demonstrate better real-time tools for grid operators to enhance power system reliability</li> </ul>
Accelerate safe and economic expansion of nuclear power	DOE-NE NRC	<ul style="list-style-type: none"> <li>Secure additional NRC programmatic funding for new reactor combined operating licenses (COL)</li> <li>Develop integrated PNNL DOE-NE strategy</li> </ul>	<ul style="list-style-type: none"> <li>Assist NRC in pre-COL activities for six new nuclear plants</li> </ul>	
Increase the efficiency of powering vehicles and buildings	DOE-EERE	<ul style="list-style-type: none"> <li>Collaborate with DOE-OE and OFCVT regarding plug-in hybrid electric vehicles</li> <li>Deliver experimental data to the Chemical Storage Center for supporting the go/no go decision on sodium borohydride</li> </ul>	<ul style="list-style-type: none"> <li>Start a new Li-Ion research project</li> </ul>	

\* FutureGen activities are primarily accomplished under the PNNL Use Permit (1831 contract)

## Prevent and Counter Acts of Terrorism and the Proliferation of Weapons of Mass Destruction

**The Challenge.** Global terrorism, increased opposition to U.S. interests, greater global pursuit of nuclear power, and increased access by adversaries to sophisticated technologies and materials are creating more dynamic and complex threats to national and homeland security.

- In the area of nuclear nonproliferation, NNSA priorities that align with PNNL capabilities include: provide technical assistance to strengthen physical protection and accounting for nuclear weapons and materials in Russia and elsewhere; address the threat from rogue-state WMD programs including DPRK and Iran, through plans to eliminate and confirm dismantlement of nuclear weapons and weapons programs and strengthening safeguards, controls and interdiction efforts; enable secure, orderly expansion of nuclear energy world wide; identify, secure, remove or disposition nuclear and radiological materials that pose a global threat; develop and implement a strategy to strengthen DNN's nonproliferation expertise, R&D, and technology base.
- At the core of the DHS mission<sup>3</sup> is preventing and deterring terrorist attacks in the U.S. homeland. PNNL's capabilities align strongly with the DHS functions and activities that support this mission, specifically:
  - *Awareness:* Identify and understand threats, understand vulnerabilities, determine impacts and disseminate information
  - *Prevention:* Detect, deter and mitigate threats to our homeland.
  - *Protection:* Safeguard our people and their freedom, critical infrastructure and economy,
  - *Response:* Lead, manage and coordinate the national response to acts of terror, natural disasters and other emergencies,
  - *Recovery:* Lead national, state, local and private sector efforts to restore service and rebuild communities after acts of terrorism, natural disasters or other emergencies.

As a national laboratory, PNNL has a significant role in supporting the Science and Technology Directorate of DHS in their mission to advance scientific information and understanding, develop technologies, and promote standards that increase the effectiveness of government and the private sector in protecting the homeland.

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<sup>3</sup> *Department of Homeland Security Strategic Plan, February, 2004.*

**PNNL's Strategic Focus.** PNNL will provide the science, technology and leadership to:

- **Predict, prevent and mitigate acts of terrorism through predictive analytics** of large, complex and disparate data sets, by delivering critical enabling breakthroughs in predictive information analytics, applied mathematics, visualization, data-intensive computing, integrated secure systems, and modeling and simulation methods.
- **Counter threats posed by the global expansion of nuclear energy & legacy WMD materials**, through accelerated fuel qualification and rapid development of transuranic recycle and proliferation resistant technologies.
- **Detect the production, characteristics and movement of weapons of mass destruction and effect** using advanced sensors and systems that function at remote and standoff distances, under field conditions and with few false positives, through the rapid translation of fundamental research in materials discovery and the control of chemical and physical properties to “next generation” detection technology.
- **Respond more rapidly and effectively to events of mass effect**, focusing initially on a partnership with first responders to establish a regional center of excellence in security and a demonstration of technology and operations platforms that dramatically improve information collection, integration, analysis and coordination across multiple parties, data sets, and locations.

**Science and Technology Investments.** PNNL's primary S&T investments (primarily LDRD) in this area include:

- *Radiation Detection Materials Discovery.* In the goal of dramatically reducing the time required to discover, develop and deploy new radiation detection materials, this initiative is focused on developing a first-principles approach for discovery of radiation detection materials that provide high spectral resolution and radioisotope identification. The integrated approach consists of understanding fundamental energy deposition mechanisms, being guided by materials informatics, accelerating development through rapid thin film characterization. Such materials would increase the effectiveness and reduce the operational cost of numerous radiation detection systems associated with global and homeland security.
- *Explosives Detection.* In response to unrelenting international threats and events involving explosive devices, this new initiative is focused on explosives detection. This initiative will build the science and technology base and provide the proof-of-principle experiments focused on standoff detection, enhanced trace detection, highly concealed explosives, and enhanced sampling and preconcentration. As progress is made, these capabilities will be integrated into a “system of systems” that will greatly improve capabilities for detecting a range of explosives for a dynamic variety of missions and operational scenarios.
- *Sustainable Nuclear Power.* In response to the global demand for expanded nuclear power and the associated proliferation risks, this new initiative will develop the scientific understanding, strategies and key technologies that will enable the safe, secure, and sustainable expansion of nuclear power in the United States and worldwide. The initiative will address critical gaps and needs related to

accelerated nuclear fuel qualification, transuranic recycling, and proliferation-resistant technologies. By expanding upon PNNL's historical strengths in these areas, this initiative will provide an even stronger basis for future contributions to the development and implementation of sustainable, proliferation-resistant nuclear power globally.

- *Information and Infrastructure Integrity.* This new highly exploratory initiative will define, develop and validate a new proactive-predictive-adaptive strategy for information security (along with enabling technologies) that enable information infrastructure operators to anticipate and adaptively respond to attacks in real time. The goal is to prevent loss of information integrity and system failure. The two main elements of the multi-element approach are predictive defense and adaptive response. These are supported by capabilities in cyber analytics (situational awareness) and trustworthy engineering (secure hardware platforms). These advancements will help ensure the integrity and secure operation of scientific institutions including the DOE national laboratories, national critical infrastructures, and other systems vital to economic and national security.

This Mission Outcome also benefits from these S&T investments:

- *Catalysis Initiative.* The Catalysis Initiative is developing advanced scientific understanding, models and methods that result in greatly improved abilities to design and control the activity and selectivity of catalysts associated with chemical transformations that are important to achieving a more secure energy future. The initiative will accelerate progress by combining the power of computational modeling, nanophase synthesis and operando measurements (measurements at actual operating conditions). The centerpiece of the initiative is the creation of the Institute for Interfacial Catalysis which intends to become an internationally recognized center of excellence in catalysis research and applications.
- *Data Intensive Computing.* As the successor to previous investments in computing, this initiative focuses on developing solutions to complex, data-intensive (petascale) computing challenges associated with scientific discovery and insight, situational awareness and response, and decision support and control. The initiative is structured around a novel architecture encompassing computing platforms, data management and analysis algorithms customized to the unique challenges of data-intensive computing. The initiative will have strong impacts on a wide range of national priorities in science, global and homeland security, energy, and environmental quality.

Details for these initiatives can be found at <http://pnnlsp1.pnl.gov/sites/IPAMS/IM/default.aspx>.

**Strategic Partnerships.** PNNL management and research staff aggressively reach out to the broader research community in the various scientific disciplines to pursue programmatic and collaborative research partnerships. The Laboratory will make investments in the following partnerships for this mission outcome.

- Regional Fusion Counter Terrorist Center (partnership with the Puget Sound Law Enforcement Community)
- National Center for Global Supply Chain Security, a partnership with the Ports of Seattle and Tacoma and the University of Washington.

- Institute for Global and Regional Security Studies, a partnership with the Jackson School of International Studies at the University of Washington.
- Regional Security Center of Excellence will bring together major stakeholders in Alaska, Oregon, Washington, Idaho, and possibly Hawaii and Montana to identify regional infrastructure vulnerabilities, foster collaborative approaches to regional challenges, respond to Northwest regional needs for DHS.
- The National Visualization and Analytics Center™ is a national and international resource providing strategic leadership and coordination for visual analytics technology and tools. NVAC supports the Department of Homeland Security's mission to secure our homeland and protect the American people by giving analysts and emergency responders valuable technology and capabilities. The unique partnerships created under NVAC between national laboratories, university research centers, scholars, and other government agencies represents an on-going commitment to collaboration in the discipline of visual analytics.

## Prevent and Counter Acts of Terrorism and the Proliferation of WMD National and Homeland Security Science and Technology

PNNL Contribution	Customer	Planned Outcomes and Milestone		
		FY07	FY08	FY09-FY11
Predict, prevent and mitigate acts of terrorism through predictive analytics	DHS OFA	<ul style="list-style-type: none"> <li>Develop advocacy and programs for Information Analytics work with DHS</li> <li>Integrate PNNL-developed tools into the NW regional information fusion center.</li> </ul>	<ul style="list-style-type: none"> <li>Re-establish visual analytics programs with DHS that leverage capabilities developed by PNNL Initiatives.</li> <li>Build programs with NGA and others.</li> <li>Expand programs with Defense Intelligence Agency (DIA) and other IC agencies.</li> </ul>	Deploy predictive-adaptive approach to cyber security to protect assets and information of DOE and other government agencies.
Counter threats posed by the global expansion of nuclear energy & legacy WMD materials	NNSA	<ul style="list-style-type: none"> <li>Develop and execute a strategy for PNNL leadership in proliferation resistant technologies.</li> <li>Establish/Demonstrate capabilities to build an energy production role in GNEP</li> </ul>	<ul style="list-style-type: none"> <li>Establish PNNL's leading role in nonproliferation and fuel-cycle aspects of NNSA-GNEP program</li> </ul>	
Detect the production, characteristics and movement of weapons of mass destruction and effect	NNSA DHS	<ul style="list-style-type: none"> <li>Strengthen programs with NNSA in Rad/Nuc detection; leverage capabilities developed by PNNL Initiatives</li> <li>Strengthen PNNL relationships/contributions to DHS operational agencies to sustain and initiate DHS-S&amp;T programs</li> </ul>	<ul style="list-style-type: none"> <li>Develop sensor-forensics programs with IC clients; Bioforensics and trace. Leverage HS-I capabilities</li> <li>Develop sensor-forensics programs with DOE clients; Bioforensics and trace. Leverage HS-I capabilities</li> <li>Secure new programs in explosives detection for NNSA, DHS, and DOD</li> </ul>	<ul style="list-style-type: none"> <li>Complete the DHS Radiation Portal Monitor Project</li> </ul>
Respond more rapidly and effectively to events of mass effect	DHS	<ul style="list-style-type: none"> <li>Complete DHS Stretch Goal by establishing a Northwest Regional Homeland Security Technology Center</li> <li>Establish regional advocacy and DHS programs for a testing and evaluation center for national and homeland security technologies</li> </ul>	<ul style="list-style-type: none"> <li>Establish a National Aquatic Protection Center</li> </ul>	

## Reduce Environmental Effects of Legacy Waste and Energy Use

**The Challenge.** The uncertain and increasing cost of cleaning up the nation's nuclear waste sites and a growing appreciation of the urgent and broad scope involved in managing global climate change underscore both the importance and difficulty of managing the environment. Dispersed chemicals and radionuclides are in the environment now. In many cases, they will continue to be released, both intentionally and unintentionally. The pathways by which contaminants flow through the air, water or ground are complex and difficult to anticipate, both in the short term and long term. Ecological and human health effects are equally or more complicated and hard to predict. This uncertainty creates economic and policy barriers that challenge the nation's ability to manage the environment.

**DOE Five Year Priorities.** The DOE Strategic Plan addresses this challenge under two themes: Promoting America's energy security through reliable, clean, and affordable energy (Goal 1.2) and Protecting the environment by providing responsible resolution to the environmental legacy of nuclear weapons production (Goals 4.1 and 4.2).

- DOE-EM's priorities for its long-term cleanup mission are to operate safely and in compliance; fully establish the disposition capability for tank waste, special nuclear materials, and spent nuclear fuel; dispose contact-handled and remote-handled transuranic and low-level waste; decontaminate and decommission facilities; remediate contaminated soil and groundwater; and address post-closure benefits and liabilities. Budgets for some of the major cleanup projects (including WTP at Hanford) are reduced or on hold pending resolution of issues (e.g., seismic) and uncertainties related to the baseline. Resolution of those baselines is critical to EM's overall goal of closing its cleanup sites.
- DOE-SC (BER and SciDAC) scope in this area includes priorities for climate change, carbon sequestration, and environmental remediation research aimed at a better fundamental understanding of complex environmental systems, improved prediction, and enhanced remediation.

**PNNL's Strategic Focus.** PNNL will provide the science, technology, and leadership to:

- **Accelerate cost-effective cleanup of contaminated nuclear weapons sites.** PNNL continues to develop staff capabilities and facilities to support DOE-EM in:
  - start up and full operations of Hanford's Waste Treatment Plant through specific knowledge of tank chemistry and waste separations leading to reduced design uncertainty, improved flow sheets, and reliable waste forms;
  - treatment and closure of DOE's most complex waste sites through improved modeling, long-term remediation technologies, and performance measurement tools
- **Protect human health and the environment from the effects of contaminants** by advancing environmental science to provide accurate measurement and prediction of ecological and human health effects over long time periods.

- **Improve knowledge of climate change and its impacts to enable cost-effective solutions,** emphasizing improved understanding of cloud physics, high resolution regional modeling, and improved impact assessment.
- **Deploy air and water neutral processes and technologies for energy generation and use, including comprehensive solutions for carbon management** from carbon capture and sequestration technology to risk assessment of deep geologic sequestration and long-term monitoring.

**Science and Technology Investments.** PNNL's primary S&T investments (primarily LDRD) in this area include:

- *Environmental Biomarkers Initiative.* This pioneering initiative is focused on developing the scientific understanding, tools and methods to discover and utilize environmental biomarkers as predictive, early indicators of change or stress in ecological systems and humans. While the focus on this initiative is on the discovery and validation of specific biomarkers (and the tools for doing so), the overall systems approach for end-use applications consists of three stages: biomarker discovery, sensors and data analysis, and model-based decision support and action. Through integrative research across multiple disciplines, advancements will be made in understanding the inhalation toxicology of nanomaterials, response of humans to biological agents, and predicting ecosystem change and damage.
- *Aerosol Climate Initiative.* This new initiative will explore key processes and feedback mechanisms within atmospheric-cloud-climate models, aerosol formation and aging on a regional scale, and aerosol indirect effects and life cycles. The three-pronged approach to these challenges includes developing a fully coupled aerosol-cloud microphysical model that can be used to explore physical and chemical reactions, developing a regional transport model with fully coupled atmospheric chemistry and aerosol physics, and the improvement and development of aerosol and cloud measurement systems. The outcomes of this initiative will provide the basis for aerosol-climate modeling systems suited for use in studies and policy decisions related to global climate change and the impacts of atmospheric aerosols on health and the environment.

This Mission Outcome also benefits from these S&T investments:

- *Biomolecular Systems Initiative.* Over the past several years, this initiative has developed world-class scientific leadership and technical capabilities in "systems biology" in order to understand, control and predict the behavior of the cellular networks in prokaryotic and eukaryotic systems that are responsible for information processing, energy generation and carbon utilization. The initiative has made fundamental contributions to proteomics, cell imaging, cell signaling mechanisms, microbial communities such as biofilms, bioinformatics and others. By taking a systems approach to systems biology, these capabilities provide the scientific foundations for advancements in bioenergy, bioremediation, biodetection, low-dose radiation effects and carbon sequestration.
- *Catalysis Initiative.* The Catalysis Initiative is developing advanced scientific understanding, models and methods that result in greatly improved abilities to design and control the activity and selectivity of catalysts associated with chemical transformations that are important to achieving a more secure energy future. The initiative will accelerate progress by combining the power of computational

modeling, nanophase synthesis and operando measurements (measurements at actual operating conditions). The centerpiece of the initiative is the creation of the Institute for Interfacial Catalysis which intends to become an internationally recognized center of excellence in catalysis research and applications.

- *Energy Conversions Initiative.* In response to urgent national priorities, this new initiative will develop and apply coal gasification technologies, gas separation technologies, improved conversion processes and implementation strategies that accelerate the development and operation of viable, commercial-scale, coal-to-liquid-transportation-fuels production plants that are air and water neutral. These advanced capabilities will also help accelerate progress in zero-emissions coal-based electricity generation and hydrogen production and utilization. All of these efforts and outcomes will work together to enable significant reductions in the nation's dependence on foreign oil.

Details for these initiatives can be found at <http://pnnlsp1.pnl.gov/sites/IPAMS/IM/default.aspx>.

**Strategic Partnerships.** PNNL management and research staff aggressively reach out to the broader research community in the various scientific disciplines to pursue programmatic and collaborative research partnerships. The Laboratory will make investments in the following partnerships for this mission outcome.

- Bechtel has teamed with PNNL to name a Chief Process Engineer responsible for finalizing and increasing the throughput of the WTP process system and PNNL will be providing S&T leadership in process chemistry, process engineering, waste form development, and tank chemistry.
- This EM S&T Lab Advisory Board is a collaboration of four national laboratories (Savannah River, Oak Ridge, Idaho and PNNL) who have teamed to support the development of the OET's Science and Technology Plan.
- The Joint Global Change Research Institute is a unique partnership formed in 2001 between PNNL and the University of Maryland to focus on understanding both the causes and effects of climate change, with particular emphasis on interactions between climate, energy production and use, economic activity and the environment.
- The Northwest Water Institute (NWI) is a partnership between PNNL, INL, and OSU to focus on improving science based management decisions for water resources in the Columbia River drainage to enable continued economic growth while allowing for other demands, such as energy production and fisheries protection.

## Reduce Environmental Effects of Legacy Waste and Energy Use Environmental Science and Technology

PNNL Contribution	Customer	Planned Outcomes and Milestone		
		FY07	FY08	FY09-FY11
Accelerate cost-effective cleanup of contaminated nuclear weapons sites	DOE-EM BER SC RW ACOE	<ul style="list-style-type: none"> <li>Develop and execute a strategy for PNNL leadership in subsurface system science.</li> <li>Develop and execute a strategy to re-establish DOE applied research investments in waste processing.</li> <li>Implement the MOA in support of BNI and ORP to address unresolved process chemistry issues for the WTP.</li> </ul>	<ul style="list-style-type: none"> <li>Lay the foundation for a predictive subsurface system science initiative to resolve intractable Ground Water/Vadose zone problems.</li> <li>Secure DOE programmatic funding to develop the scientific basis needed to define closure strategies.</li> </ul>	<ul style="list-style-type: none"> <li>Establish and lead a predictive subsurface system science institute.</li> <li>Apply next generation conceptual and scientific models to impact closure decisions.</li> <li>Deliver process performance solutions to increase throughput and performance of the WTP.</li> </ul>
Protect human health and the environment from the effects of contaminants	DOE-EM DHHS BER DOI NASA NOAA ACOE	<ul style="list-style-type: none"> <li>Deliver R&amp;D that protects Northwest water resources through accurate assessment and prediction of future impacts.</li> <li>Identify technical gaps (&amp; potential hires) in Radiation BioPhysics to enable Lab leadership in R&amp;D that protects workers &amp; first responders from radiation effects on health.</li> <li>Deliver state-of-the-art assessment of radiological &amp; chemical exposure in occupational and environmental settings.</li> </ul>	<ul style="list-style-type: none"> <li>Deliver an integrated biomarker discovery tool that can be used to assess adverse response in ecosystems and indicator species.</li> <li>Start a new initiative in Radiation BioPhysics to address ecological and human health effects of radiation.</li> <li>Deliver a program that combines the virtual respiratory tract and heart model to understand/predict nanomaterial (radiological/chemical) effects on humans.</li> </ul>	<ul style="list-style-type: none"> <li>Deliver integrated 'omic-based sensors for chemical &amp; radiological response in environmental indicator species.</li> <li>Deliver a new class of radioprotectants that minimizes radiation damage to workers and first responders.</li> <li>Combine functional-based biological models with the energy cascade model (Radiation Materials Initiative) to accurately predict radiation effects on sensitive biological systems.</li> <li>Deliver a predictive VRT and heart model that incorporates 'omic data into a dynamic, 3D, theoretical model.</li> </ul>

## Reduce Environmental Effects of Legacy Waste and Energy Use Environmental Science and Technology (cont'd)

PNNL Contribution	Customer	Milestone		
		FY07	FY08	FY09-FY11
Improve knowledge of climate change and its impacts to enable cost-effective solutions	DOE-SC	<ul style="list-style-type: none"> <li>• Deliver conceptual framework for integrating the hydrologic cycle and precipitation with atmospheric processes</li> <li>• Develop new 1-D benchmark computer model of aerosol-cloud microphysical interactions and completion of a set of reference simulations</li> </ul>	<ul style="list-style-type: none"> <li>• Develop a framework for representing the integration of complex earth system processes and their interaction with energy systems</li> <li>• Obtain field data for preliminary model validation tests</li> <li>• Develop conceptual model for building regional scale detail into the Integrated Assessment framework</li> </ul>	<ul style="list-style-type: none"> <li>• Develop a high-resolution, multiscale regional model that integrates key processes and provides outputs useful for impact assessments and mitigation options</li> <li>• Enhance field data bases to enable model validation</li> <li>• Develop regional detail on energy-economic systems in the Integrated Assessment framework to support local/regional analysis and decision making</li> </ul>
Deploy air and water neutral processes and technologies for energy generation and use, including comprehensive solutions for carbon management.	DOE-FE BPA Industry	<p>Execute on carbon sequestration programs:</p> <ul style="list-style-type: none"> <li>• Big Sky Regional Partnership demo on Hanford site,</li> <li>• Future Gen</li> </ul> <p>Demonstrate viable technology platform for metals removal from produced water and oil &amp; gas products.</p> <p>Develop and execute strategy for new program development :</p> <ul style="list-style-type: none"> <li>• Establish a working agreement w/private sector on oil shale</li> <li>• Secure role with BPA to implement improvements in hydrosystem operations</li> <li>• Secure role with DOE-FE in mercury control technology program</li> <li>• Establish new DOE-FE funded project on integrated CO<sub>2</sub> capture, compression, and delivery systems</li> </ul>	<ul style="list-style-type: none"> <li>• Secure role with DOI related to mitigation of environmental impacts from energy resource development</li> <li>• Secure sustainable JNWI funding for design of energy-water systems of the future in the mountain west.</li> <li>• Secure role with DOE-FE in mitigating environmental impacts from heavy hydrocarbon production</li> </ul>	<ul style="list-style-type: none"> <li>• Secure role in mercury control and water reuse for advanced coal conversion processes</li> <li>• Conduct pilot-scale testing of CO<sub>2</sub> capture system</li> </ul>

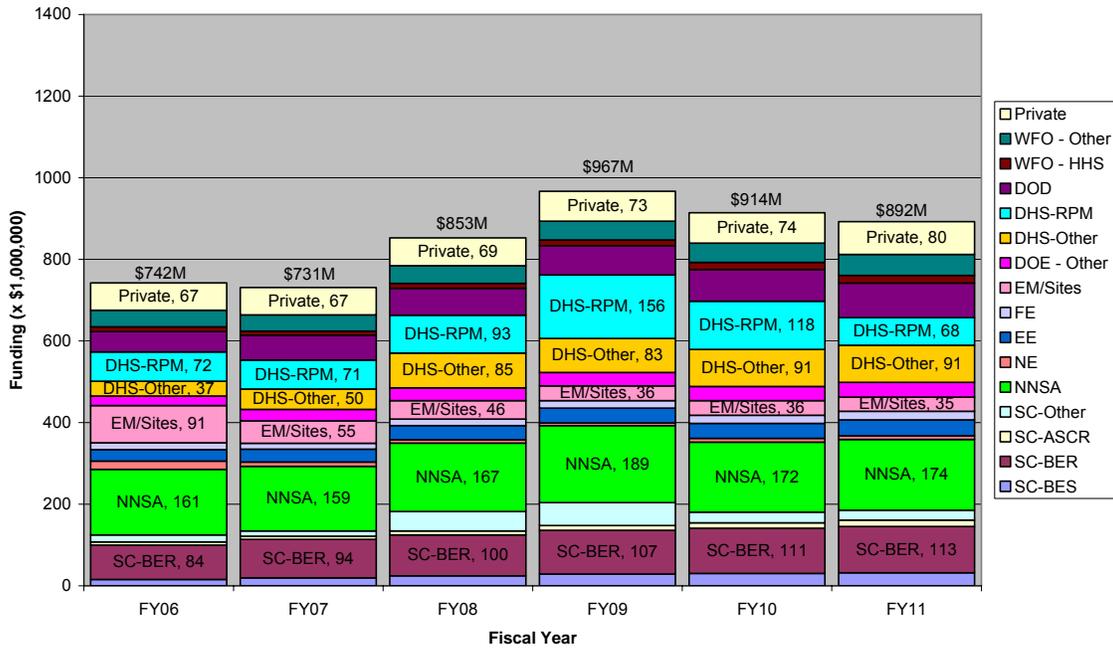
## Financial Outlook

PNNL serves a diverse customer set that demand both basic and applied R&D results, and this requires PNNL to excel at science and technology integration. This competence serves PNNL's multi-program funding base and yields strong customer support. The demand for PNNL's services over the next five years will result in funding growth across most of PNNL's business lines and missions. The two funding scenarios shown below represent increasingly optimistic funding levels for PNNL from FY07–FY11. A brief discussion of these scenarios is also offered from the perspective of DOE-SC programs. PNNL anticipates modest funding increases across the DOE and NNSA business, and a steady increase in DoD and DHHS (NIH) Work for Other (WFO) programs. The DOE-SC will provide ~17% of the PNNL funding in FY07. In FY11, PNNL anticipates DOE-SC will grow to become 20 to 22% of PNNL's funding, based on the scenarios below. NNSA will maintain 15 to 19% of PNNL's funding base in these scenarios. The general DHS trend includes a planned, significant increase in the Radiation Portal Monitor Project (RPMP) through FY10, followed by a managed funding decline of RPM by FY11. The non-RPMP work for DHS will increase modestly and partially offset the managed decline in the RPMP funding.

### Level-of-Effort Funding Scenario

The level-of-effort funding scenario (see Figure 5) represents modest PNNL budget growth for DOE-SC programs over the next five years. The balance of the forecasted funding under this scenario (i.e., all non-DOE-SC programs) is reported at the funding level anticipated with high confidence (95% likely). The figure below shows the aggregate funding by fiscal year under the level-of-effort funding scenario. The amount of work for DOE-SC programs under this scenario will effectively increase 5 to 10% annually. PNNL has strong programs that serve BER, BES, ASCR, and other SC offices, and PNNL management will work with DOE-SC program managers to sustain the most critical and valuable research to support the national needs and missions. PNNL anticipates modest growth in BES and ASCR programs funding under this scenario. Furthermore, funding from most other agencies either sustains or grows over the next five years, with steady increases in NNSA, DHS S&T programs, DoD (including the intelligence community), NIH, other federal agencies, and PNNL's private industry and government business. The only anticipated funding decline over this same period is in DOE-EM (nearly all of which is currently received through Hanford contractors).

**Level-of-Effort Funding Scenario  
PNNL Work Plan FY07-FY11**

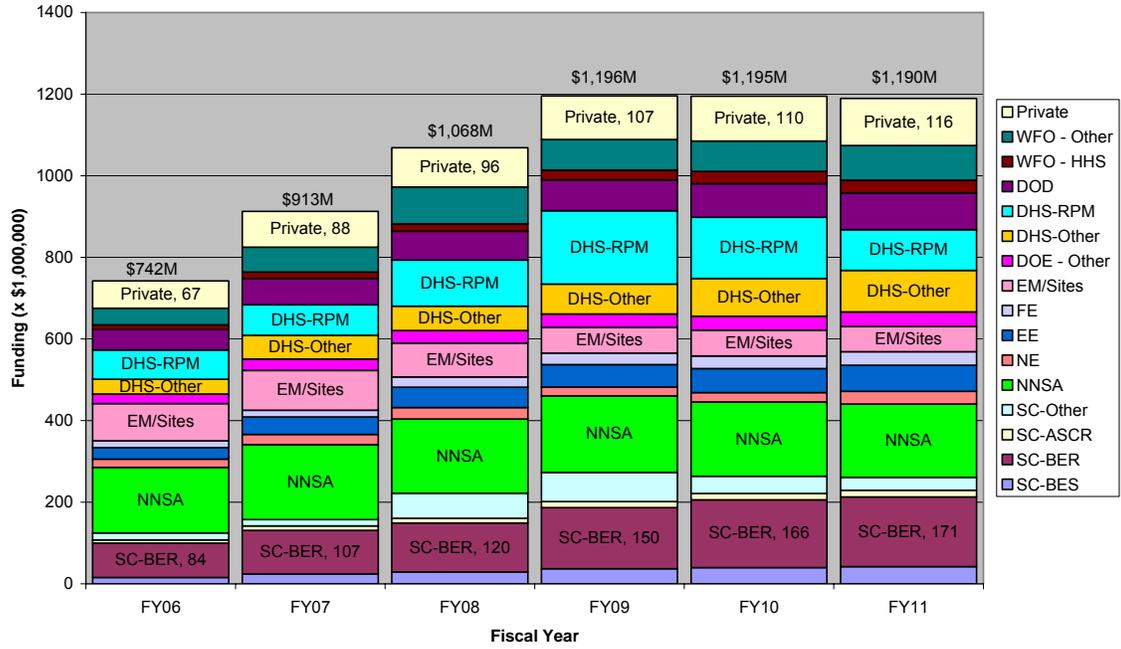


**Figure 5.** Level-of-effort funding scenario, FY06–FY11  
(FY06 numbers are year-end estimates)

### Constrained-Ideal Funding Scenario

The constrained-ideal funding scenario (see Figure 6) represents significant PNNL budget growth for DOE-SC programs over the next five years. The figure shows the aggregate funding by fiscal year under the constrained-ideal funding scenario, which represents DOE-SC annual funding to PNNL growing over five years from \$130 million to \$261 million to enhance existing activities and support significant new activities. For DOE-SC-BER, PNNL would enhance the global climate change modeling and assessment activities and enhance the EMSL user facility operating budget. In addition, for BER, PNNL would launch major new efforts in a Genomics:GtL Bioenergy Center and computational capability required for DOE-SC research. PNNL would launch a collaborative research facility in catalysis supported by BES. PNNL also anticipates growth in DOE-SC-ASCR funding by successfully responding to solicitations for Advanced Computation Research Test Bed and SciDAC related solicitations. Finally, in support to the DOE-SC-NP program, PNNL would launch/enhance a neutrino research program. These new and enhanced programs are outgrowths of major PNNL investments, draw upon core competencies, and serve unmet needs of DOE-SC. The funding for these new and enhanced programs at PNNL would come from enhanced DOE-SC budgets and would need to compete with other potential national priorities. In addition to increases in DOE-SC funding, this constrained-ideal scenario includes substantial increases in DHS science and technology program funding beyond the level-of-effort scenario. PNNL’s strategy for securing the anticipated funding is to continue to invest in core competencies and sustain/establish world leadership position in these programs.

**Constrained-Ideal Funding Scenario  
PNNL Work Plan FY07-FY11**



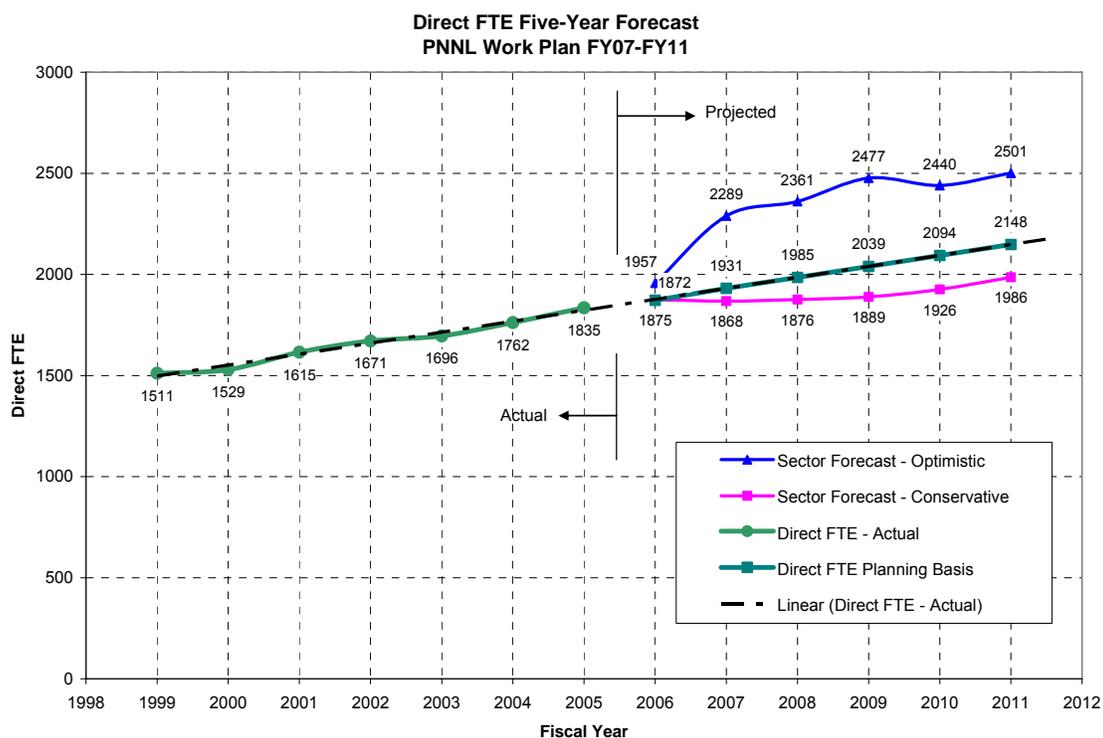
**Figure 6.** Constrained-ideal funding scenario, FY06–FY11 (FY06 numbers are year-end estimates)

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## Laboratory Capabilities: Staffing Outlook

PNNL is critically dependent on scientists and engineers to deliver the high impact science and science-based solutions demanded by its customers. These staff skills are one of the primary capabilities of PNNL that comprise core competencies.

The staff members who perform the R&D directly charge their time against projects. The labor-hours charged directly to projects results in the determination of the number of direct full-time-equivalents (direct FTEs). PNNL undertakes Laboratory-wide, grass-roots direct FTE forecasting on an annual basis. The forecast entails asking sector (or business line) managers who interface with customers to forecast the number of direct FTEs that will be required to staff projects for these clients over the five-year planning period. Two forecasts are collected as part of this activity: 1) conservative forecasts that are 95% certain to materialize and 2) optimistic forecasts that are 20% certain to materialize. These two forecasts for FY07–FY11 are shown in Figure 7. Figure 7 also includes seven years of historical direct FTE data. PNNL has steadily grown by ~54 direct FTEs per year since FY99. This growth rate appears consistent with the future-year forecasts. Projecting the historical growth trend to FY11 yields a reasonably conservative planning basis for PNNL over the next five years. Figure 7 illustrates the projected five-year trend, and the PNNL planning basis. PNNL’s five-year planning basis is to increase direct FTEs at PNNL from 1,872 in FY06 to 2,148 in FY11.



**Figure 7.** PNNL Five-year Forecast of Direct FTEs  
(1 FTE = 1,832 hours/year)

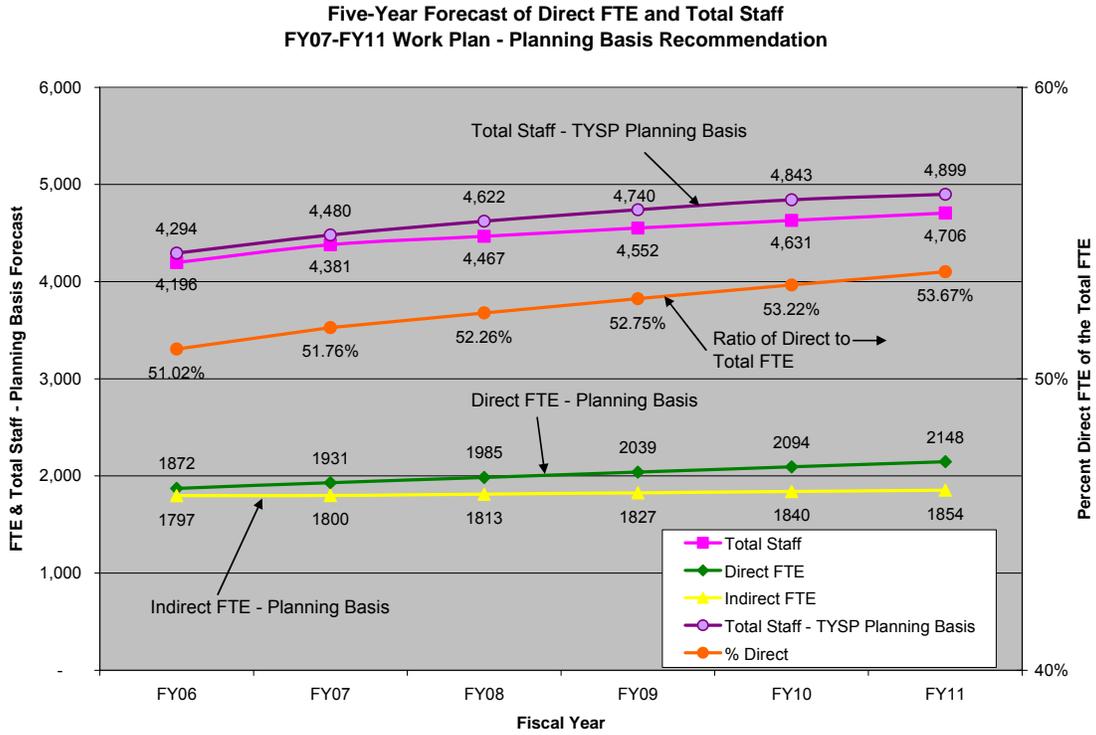
Direct FTEs are a critical part of delivering S&T to customers. However, additional labor is necessary to provide the management and operational support in order to effectively steward the Laboratory. These non-direct labor hours are calculated as indirect FTEs. The sum total of direct FTE, indirect FTEs, and other staff (e.g., part-time employees and graduate students) is referred to as *total staff*.

Figure 8 shows direct FTEs, indirect FTEs, the ratio of direct to total FTEs, and total staff. Over time, the Laboratory is planning to improve the efficiency of providing indirect support relative to the direct work on projects. This improved efficiency increases the percent of staff hours focused on research activities and reduces the total staff necessary to provide a given research scope. PNNL intends to increase the ratio of direct FTEs to total FTEs (direct and indirect) from 51.0% in FY06 to 53.7% by FY11.

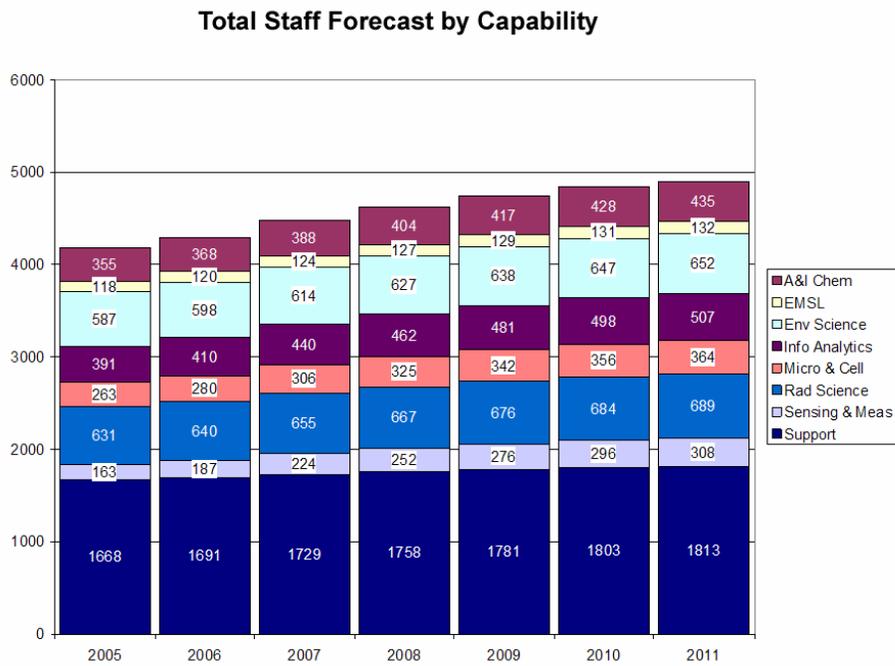
Figure 8 shows two separate projections for total staffing at PNNL over the next five years: 1) total staff projections reported in the PNNL Ten Year Site Plan (TYSP) and 2) current total staff projections. The TYSP projections are consistent with the DOE budget submittal in February/March of 2006 and are the official total staff forecasts for multi-year facilities and business planning within DOE. However, Figure 8 shows that the recently updated PNNL planning basis for total staff is 4% lower than the TYSP projections in FY11 (4,706 instead of 4,899). This minor shift in the total staff planning basis is part of PNNL's normal forecast variations. However, the total staff projections in the remainder of this document will remain consistent with the DOE budget submittal and the PNNL TYSP for consistency in PNNL planning. The total staff forecasts will be updated and used as a planning basis during the DOE budget process in FY07.

Given the total staff forecasts in the TYSP, PNNL is projecting an increase to total staffing from 4,196 in FY06 (end-of-year estimate) to 4,899 in FY11. This forecast explains the change in the total staff according to the PNNL planning basis. However, greater granularity of this growth is required for the purposes of Laboratory management, particularly to define the facilities and space requirements. Therefore, PNNL further refines the five-year total staff forecast by capability groups. The five-year planning basis for total staff by capability group over the five-year period is shown in Figure 9.

The collective skills of the staff members form the basis of PNNL's core competencies, as well as the knowledge and responsibility to steward PNNL effectively. Most of the growth in these core competencies will be a result of executing the Laboratory strategy and focusing on the Mission Outcomes defined within the strategy. PNNL intends to manage the staff according to these plans in order to deliver the Mission Outcomes while serving a diverse research base.



**Figure 8.** PNNL’s Five-year Planning Basis for Direct FTEs and Total Staff (FY06 numbers are year-end estimates)



**Figure 9.** PNNL’s Five-year Planning Basis for Total Staff by Capability (FY06 numbers are year-end estimates)

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## Laboratory Capabilities: Facilities Outlook

PNNL recently delivered a Ten Year Site Plan (TYSP) to the DOE Office of Science. The purpose of the TYSP is to provide the DOE-SC a single, comprehensive plan that provides a sense of the real property assets of PNNL and describes how these will be managed, maintained, and enhanced to support the DOE strategic plan, the Secretary of Energy's five-year planning guidance, and the DOE-SC annual program direction and guidance. The TYSP is prepared in response to DOE Order 430.1, Real Property Asset Management, and supports the preparation of DOE's Asset Management Plan, a requirement of Executive Order 13327, Federal Real Property Asset Management (February 2004).

*This PNNL Work Plan will provide a subset of the information contained in the FY06 PNNL TYSP. While the TYSP is the planning case used in the formulation of this Work Plan, it is important to recognize direction provided by DOE during FY06 to assess alternative options for the Capability Replacement Laboratory (See Appendix A, 16 August 2006, P. Kruger; PNSO to L. Peters, PNNL). In response to this direction, PNNL has provided an options analysis for DOE consideration that includes the retention of some of the 300 Area laboratories as an alternative to meeting the criteria supporting the approved Critical One decision (CD-1) to meet DOE mission needs. PNNL understands that following review of this options analysis by the DOE Deputy Secretary, a final option will be accepted by DOE prior to the end of the first quarter of FY07. Existing facilities plans will be revised once new DOE guidance has been issued and to the extent possible in the normal annual cycle for planning updates. As the TYSP still represents our most current planning basis, this Work Plan has been formulated around the PNNL FY06 TYSP content.*

PNNL must plan and provide facilities space to accommodate existing and expanding mission requirements. As discussed in the staff outlook section, PNNL plans to add 500 to 700 total staff during FY06–FY11. The growth of 500 staff is consistent with the PNNL planning bases from August 2006, and the growth of 700 staff is consistent with the DOE Budget submittal and the TYSP from January 2006. The difference in these two forecasts reflects the variation PNNL periodically experiences due to changes in customer demand for PNNL programmatic activities. These variations in forecasts are material, since they are used to determine the facilities and infrastructure plans at PNNL to meet the needs of customers. PNNL will update these staffing forecasts during the first quarter of FY07, and use the new forecasts during the update of the TYSP and Work Plan during the second quarter of FY07. Meanwhile, the staffing forecasts and associated facilities demand are consistent with total staffing growth to 4,899 by FY11.

Figure 9, shown previously, details the anticipated changes in the number of staff members by capability from FY06–FY11. Given this projected staff growth, PNNL projects the increase in laboratory space demand to accommodate this staff growth by capability. The amount and type of laboratory space required for each staff member fundamentally varies by core competency. For example, Analytical and Interfacial Chemical Sciences is generally lab-intensive and demands wet labs with fume hoods and large counter spaces. Alternatively, Information Analytics is computer-intensive and generally demands labs for high-performance computers with intense cooling systems. The result of multiplying the number of anticipated new staff by capability times the space demand by each staff in these core competencies at PNNL generates the planning basis for total laboratory space demand at PNNL. Beyond the laboratory space, office space and common space demand are estimated based on factors associated with total staff

and net-to-gross space efficiencies. All these calculations were based on the PNNL planning basis of total staff growth to 4,899 by the end of FY11. However, in order to understand the incremental growth in facilities demand, it is necessary to understand the current facilities at PNNL.

## Real Property Assets

The facilities and infrastructure of PNNL were initially established in 1965 during the reorganization of the original Hanford Works contract. PNNL “inherited” use of many of the facilities in the Hanford 300 Area. In addition, Battelle constructed numerous facilities on Battelle-owned property adjacent to the land south of the 300 Area. Table 2 provides a summary of the location/category, sizes, and the number of buildings that comprise the current PNNL facilities. PNNL is a unique array of facilities differing in age, condition, and ownership because of this history.

**Table 2.** PNNL Facilities by Type as of May 2006

Location/Category	Area (ft <sup>2</sup> ) Millions	Number of Individual Buildings or Complexes <sup>(a)</sup>
DOE-Owned	0.764	21
Battelle-Owned (Richland)	0.450	31
Battelle-Owned (Sequim)	0.043	9
Leased Facilities	0.793	22
Other	<u>0.033</u>	<u>1</u> <sup>(b)</sup>
Total	<b>2.083</b>	<b>84</b>
(a) For the purposes of this table, a complex of sub-buildings is considered one building. FIMS data capture individual buildings and structures.		
(b) The Consolidated Information Center.		

PNNL currently occupies 21 DOE-owned buildings (complex of sub-buildings is considered one building), with 1 being the DOE-SC-owned EMSL. EMSL is a 200,000-gross-square-foot (gsf) national scientific user facility.

In the future, DOE plans to close and clean up the Hanford 300 Area, and PNNL must vacate the approximately 550,000 gsf of facilities it currently occupies there during the FY08–FY11 timeframe. The combination of total staffing growth and the loss of the 300 Area facilities create exceptional pressure to procure new and expanded facilities at PNNL. Therefore, PNNL’s TYSP is based on the following key requirements:

- Effectively transition mission-essential capabilities impacted by Hanford cleanup of the 300 Area into new or existing facilities.
- Provide laboratory and office space for expanding mission requirements and program growth.
- Maintain and efficiently operate facilities and infrastructure in a compliant and “mission ready” state.

## Real Property Asset Strategy

This strategy and plan have been developed consistent with the DOE-SC Facilities and Infrastructure (F&I) Plan. To meet the above key requirements, PNNL has established an integrated and comprehensive facilities and infrastructure plan consisting of a combination of federally funded, Battelle funded, and third-party funded acquisitions and leases of facilities and infrastructure along with upgrades and modifications.

PNNL's first priority is to secure facilities to house mission-essential capabilities currently located in the 300 Area facilities and being displaced in the FY08–FY11 timeframe. In September 2004, a Mission Need (Critical Decision-0) for the Capability Replacement Laboratories (CRL) Project was approved by Deputy Secretary McSlarrow; and in February 2005, this Mission Need was revalidated. The acquisition strategy approved in December 2005 as part of the Critical Decision-1 (CD-1 *Approve Alternative Selection and Cost Range*) included four research facilities, listed in Table 3. In addition to these research facilities, smaller support facilities are planned and described in Table 3. The CRL facilities are essential to PNNL's ability to meet the science and technology needs of the Laboratory's mission customers over the next decade and beyond.

**Table 3.** Capability Replacement Laboratories Approved Acquisition Strategy

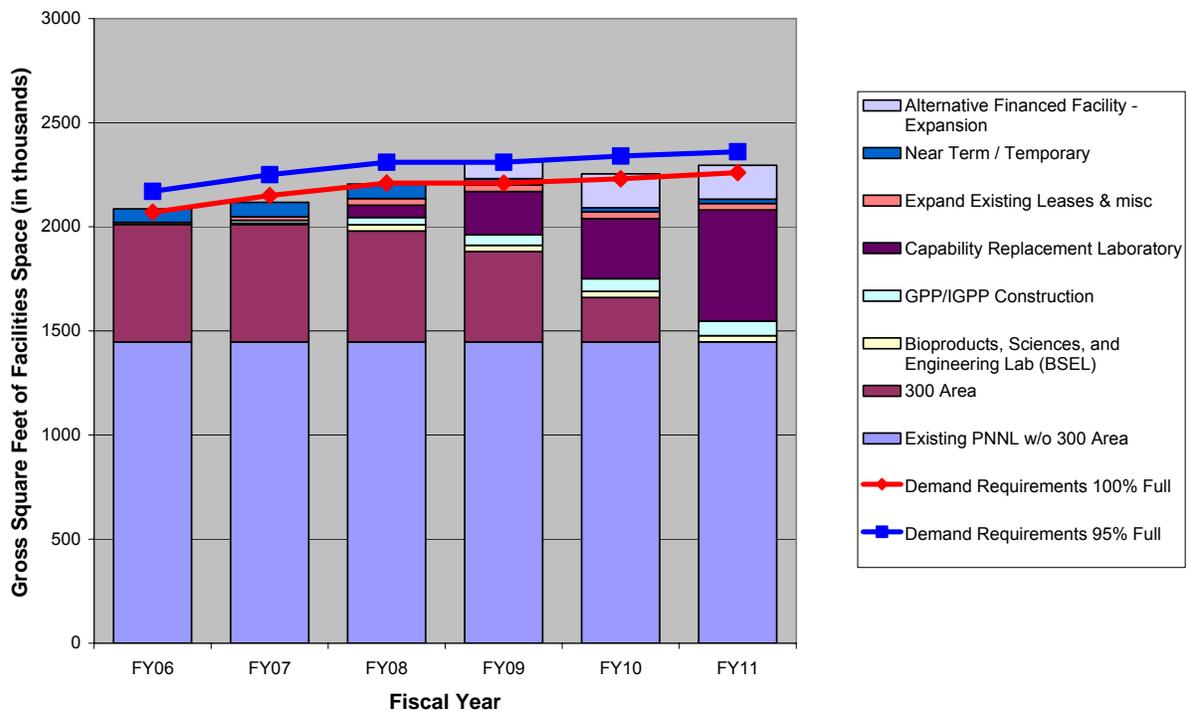
Funding Source	Facility	Estimated Acquisition Cost	Gross Square Feet
Federal Line Item (SC, NNSA, DHS)	Physical Sciences Facility (PSF)	\$224M	~ 335,000
Private – Third Party	Biological Sciences Facility (BSF) Computational Sciences Facility (CSF)	\$99M to \$132M (PNNL lease)	~ 74,000 BSF ~ 74,000 CSF
Private – Battelle <sup>(a)</sup>	Life Sciences Facility (LSF)	\$30M to \$35M	~ 40,000
Laboratory Overhead (IGPP)	Maintenance & Fabrication	\$5M to \$10M	~ 15,000
(a) Pending final investment decision by Battelle.			

In addition to the actions being taken to replace the 300 Area facilities, a complementary set of actions to provide for decompression of existing space and to accommodate mission/customer future requirements is also underway. The State of Washington is constructing the BSEL, a facility that will be jointly shared by WSU and PNNL. Expansion of existing leases and construction of additional alternatively financed facilities are planned to address space needs for PNNL program growth within the next 3 to 5 years. Federal facility investment will be needed to meet user needs as well as PNNL needs beyond 5 years. Table 4 provides a brief summary of facilities for expanding research programs within the next 5 years.

**Table 4.** Facilities for Expanding Research Programs (Provides space for both PNNL staff and users)

Funding Source	Facility	Estimated Acquisition Cost	Gross Square Feet
Washington State	BSEL	\$24M (PNNL lease)	57,000 (31,000 PNNL)
General Plant Projects (multiple)	EMSL office addition, computer expansion, small research facilities (tbd)	\$25M	Up to 50,000
Private – Third Party	Small additions to existing leased facilities	PNNL lease	30,000 to 40,000
Private – Third Party	Alternative financed facility expansion – need computer, dry lab, wet lab, and office space	~\$100M (PNNL lease)	150,000 to 180,000
Federal Line Item	EMSL North (lab and office) <i>User facility</i>	\$27M	~55,000

Clearly, PNNL faces a significant facilities challenge over the next 5 years and beyond. Figure 10 provides an integrated plot of facilities space supply and demand from FY06–FY11. This figure shows the anticipated growth in space demand at PNNL resulting from forecasted staff growth to meet the demand by mission customers for PNNL’s core competencies (95% and 100% full space utilization cases are shown). The plot also shows that beginning in FY08 and ending in FY11, PNNL plans to exit the 300 Area facilities. Simultaneously, PNNL plans to build and occupy the CRL and several other new and modified facilities described in Tables 3 and 4.



**Figure 10.** PNNL Five-Year Plan of Space Demand and the Facilities Supply at PNNL

PNNL faces significant challenges caused by Hanford clean-up, the current needs of mission customers, and expanding mission customer needs over the next 10 years. PNNL has an integrated and coherent plan to steward the facilities and infrastructure that includes building the CRL to house the mission-critical capabilities being displaced by 300 Area closure, and acquiring facilities necessary to meet the future needs of mission customers. This facilities and infrastructure plan will enable PNNL to perform basic and applied research to deliver energy, environmental, and national security for the nation.

## **Facilities Capital Plan**

The new facilities described above require capital of various origins and types in order to execute this plan. Table 5 provides a summary table of planned new facilities at PNNL over the next five years. Although the supply of facilities involves a mixture of financial approaches (including third-party funded facilities that will be leased), PNNL does have several actions that require programmatic or overhead capital funding. The major capital line item funded project is the PSF, which presently involves ~\$224 million of funding spanning FY04 through FY11. The PSF is a facility jointly funded by capital allocations from the DOE-SC, NNSA, and DHS. The PSF capital plan currently includes site preparation and construction beginning in the first quarter of FY08, with startup and occupancy projected near the end of FY10. This capital investment is critical to sustaining PNNL as a world leader and national leader status in core competencies that involve the physical sciences that serve diverse research customers, particularly in projects for DOE-SC, NNSA, and DHS.

EMSL North expansion is also a line item-funded project that is scheduled to begin in FY09. The project would include the construction of two laboratory modules on the north end of the building with an accompanying office pod extending east from the existing facility. In addition, Battelle Memorial Institute (BMI), as the PNNL M&O contractor, is also planning to invest capital funding for the Life Sciences Facility as a privately financed activity.

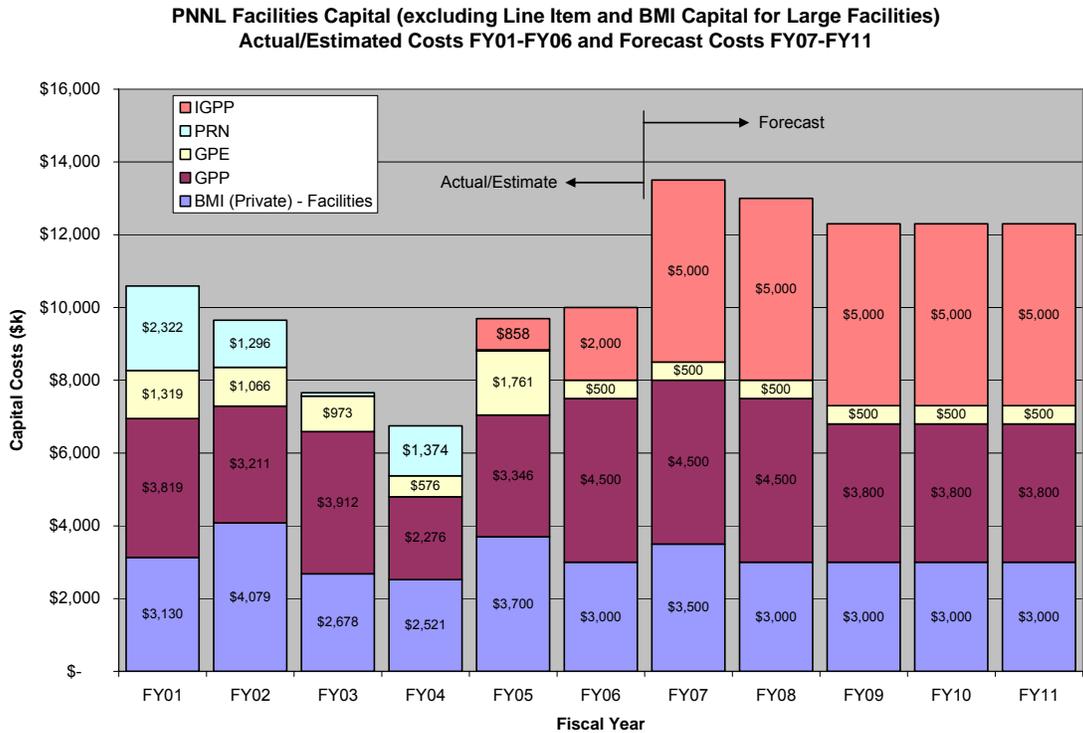
Beyond the line item-funded projects and the BMI capital projects, PNNL has several smaller capital projects that are focused on facilities. The funding for these capital projects has five separate and distinct origins depending on the type of capital investment being made:

- General Plant Projects (GPP)
- Institutional General Plant Projects (IGPP)
- General Purpose Equipment (GPE)
- Line Item capital (PRN)
- BMI capital.

**Table 5.** Summary Table of Planned New Facilities at PNNL

Acronym – Name	Gross Square Feet	Funding Source	Building Ownership	Location	Break Ground	Occupancy Year	Status (per order DOE M 413.3)
PSF – Physical Sciences Facility	335,000	Line Item	DOE	DOE Land	2008	2010	Execution (CD-1)
EMSL – North Lab and Office Addition	55,000	Line Item	DOE	DOE Land	2009	2011	Initiation
BSF – Biological Sciences Facility	74,000	3 <sup>rd</sup> Party	Lease	BMI Land	2007	2008	Execution (CD-1)
CSF – Computational Sciences Facility	74,000	3 <sup>rd</sup> Party	Lease	BMI Land	2007	2008	Execution (CD-1)
BSEL – Bioproducts, Sciences and Engineering Laboratory	57,000	3 <sup>rd</sup> Party	Lease	WSU/ State Land	2006	2007	Execution
Alternative Financed Facility Expansion	150,000 to 180,000	3 <sup>rd</sup> Party	Lease	BMI Land	2008	2009	Initiation
LSF – Life Sciences Facility	40,000	BMI Capital	BMI	BMI Land	2008	2009	Execution (CD-1)
EMSL – Computer Room Addition	4,000	GPP	DOE	DOE Land	2005	2006	Execution
EMSL – Office Addition	15,000	GPP	DOE	DOE Land	2006	2007	Execution
General Purpose Research Facility	10,000	GPP	DOE	DOE Land	2007	2008	Definition
Large Equipment Facility	10-15,000	GPP	DOE	DOE Land	2007	2008	Initiation
General Purpose Research Facility #2	10,000	GPP	DOE	DOE Land	2008	2009	Initiation
EMSL – Conference Room Addition	5,000	GPP	DOE	DOE Land	2009	2010	Initiation
Phone/Server Computer Facility	7,000	IGPP	DOE	DOE Land	2007	2008	Initiation
MFSF – Maintenance & Fabrication Support Facility	15,000	IGPP	DOE	DOE Land	2008	2009	Initiation
Storage Facility	20,000	IGPP	DOE	DOE Land	2009	2010	Initiation

Figure 11 illustrates the historical costs (FY01–FY06) for each of these capital types and the anticipated budgets for each capital type during FY07–FY11. The anticipated investments made with each of these types of capital are discussed below. In addition, Table 5 details several specific facilities that are planned using GPP and IGPP capital funding.



**Figure 11.** PNNL Facilities Capital Plan FY06–FY10  
(excluding Line Item and BMI capital funding for Large Facilities)

GPP are miscellaneous, minor new construction projects of a general nature, the total estimated cost of which cannot exceed the congressionally established limit of \$5 million. GPP includes – but is not limited to – landlord stewardship projects that address the life-cycle issues involved in adapting facilities to effect economies of operations and upgrading to reduce or eliminate health, fire, and security problems. These projects provide for design and/or construction, additions, and improvements to land, buildings, and utility systems, replacements or additions to roads, and general area improvements. PNNL has several GPP projects planned from FY07–FY11. Many of the current or proposed GPP projects involve upgrades and/or expansion in EMSL, which are critical to the EMSL recapitalization and refreshment plans. Other planned GPP capital projects primarily focus on sustaining or enhancing the information analytics and analytical and interfacial chemical sciences core competencies.

IGPP are miscellaneous minor new construction projects of a general nature, the total estimated cost of which cannot exceed the congressionally established limit of \$5 million. IGPP includes all general infrastructure needs (excluding an initial complement for a new building), such as utilities and telecommunications, corridors, parking lots, pedestrian walkways, landscaping projects, and road systems. Also included are general purpose facility needs where the major occupants are support staff (i.e., support buildings) providing services such as maintenance support, fabrication, waste treatment and disposal, records storage and warehousing, and general office support. The Maintenance and Fabrication Support Facility (MFSF), Phone/Server Computer Facility, and Storage Facility are the three major IGPP projects planned over the next five years.

GPE is DOE-owned equipment, including administrative computing equipment, duplicating equipment, furniture, case work, ventilation, and other equipment provided and maintained by Facilities and Operations primarily for the operation of facilities. GPE equipment is of a general-use or institutional nature, benefiting multiple cost objectives and required for general-purpose needs. Over the past five years, the GPE capital costs have varied from \$576k to \$1,761k. In the future, PNNL anticipates a modest drop in GPE availability, based on latest guidance from DOE-SC.

BMI facilities capital is provided by BMI to fund activities that involve private Battelle facilities that are part of the PNNL campus. Battelle has historically allocated a total of \$4 million per year of BMI capital to PNNL, which is divided between facilities and research equipment. This capital is used to maintain facilities that are Battelle owned, and make any capital improvements necessary to meet mission needs. PNNL anticipates investing ~\$3.0 million per year of BMI facilities capital over the next five years.

Line Item capital (PRN) pertains to the EMSL facility stewarded by PNNL. PRN funding has varied from \$91k to \$2,322k over the past five years. PNNL may have the opportunity to sustain a modest amount of PRN spending in the future (if authorized) to support the EMSL facility, pending DOE guidance and funding availability. The PRN is not currently forecasted by PNNL.

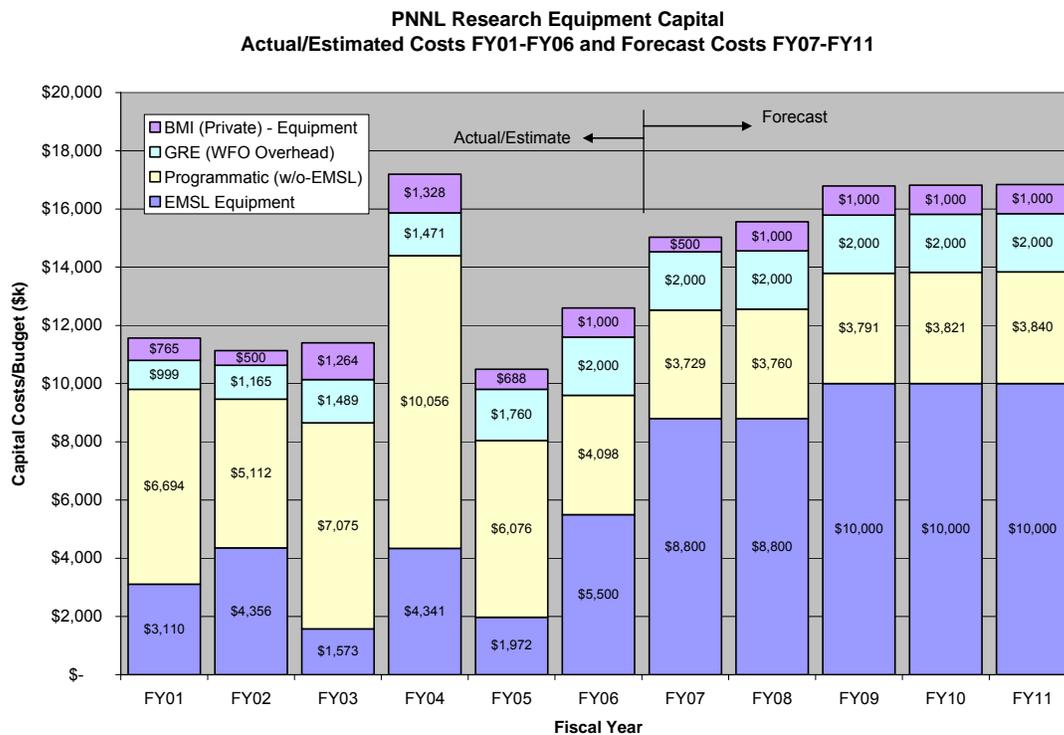
In summary, PNNL is facing a critical challenge to the Laboratory's capabilities from a facilities perspective over the next five years, largely as a result of the closure of the 300 Area on the Hanford Site. These facilities are a major part of capabilities and the basis of the S&T PNNL delivers to customers; and sustaining and enhancing PNNL facilities is critical.

## Laboratory Capabilities: Research Equipment Outlook

The R&D performed at PNNL requires state-of-the-art research equipment. Obtaining and maintaining equipment at PNNL is a vital part of the Lab's ability to deliver unique and valuable research to a diverse customer base as a multi-program national laboratory. The type of research equipment required depends heavily on the individual customer needs and the training and skills of the scientific staff. PNNL's research equipment ranges from small-scale or bench-top lab equipment for everyday analytical work to such large-budget items as the first-ever 900-MHz wide-bore nuclear magnetic resonance spectrometer system and Supercomputers. The funding to continually revitalize PNNL research equipment originates from a variety of sources, but can generally be described in two main categories: capital research equipment and non-capital research equipment. The distinction between capital and non-capital research equipment is not related to the type of research equipment being purchased but to changes in the financial policy required above a certain expense threshold.

### Capital Research Equipment

The capital equipment threshold is \$50,000 for FY06 and beyond. The acquisition of DOE-owned capital research equipment requires capital equipment funding from either a customer or from specific capital overhead accounts. Figure 12 contains the FY07–FY11 forecast of capital research equipment funding at PNNL, and, for reference, the historical FY01–FY06 actual and estimated costs.



**Figure 12.** PNNL Research Equipment Capital Plan FY07–FY11

Figure 12 shows two primary elements of programmatic capital funding directed to PNNL from particular sponsors: EMSL equipment and programmatic-funded equipment. EMSL equipment is research equipment that is directed specifically to the EMSL User Facility to revitalize its assets. The EMSL equipment forecasts for future capital research equipment funding at EMSL are \$8.8 to \$10 million per year from FY07–FY11. These forecasts are significantly above historical budgets as a result of plans at DOE-SC-BER to invest in EMSL recapitalization and revitalization. However, the actual budgets will be determined through timely interactions between the EMSL leadership team within PNNL and the DOE-SC-BER management team.

The programmatic-funded capital research equipment shown in Figure 12 is the total amount of programmatic capital equipment funding (not including EMSL). This funding is primarily provided by the DOE-SC. However, other major PNNL customers periodically provide research equipment funding to better enable PNNL to serve their mission. The exact equipment purchased using this programmatic capital funding is determined by the customer that is providing the funding, in conjunction with PNNL staff and management that are receiving the capital funding. This programmatic capital and EMSL capital research equipment are acquisitions directed by customers.

PNNL maintains two other sources of capital research equipment funding that are directed by the Laboratory: General Research Equipment (GRE) capital and BMI capital. GRE is DOE-owned equipment that enhances the Laboratory's research capabilities, potentially allowing PNNL to enter new and strategically important research areas. Funding for GRE is accumulated through a fee applied to other federal agencies funding at PNNL. Currently, about \$1.8 to \$2.0 million is spent annually purchasing equipment using GRE capital. PNNL anticipate a modest rise to \$2.0 to \$2.3 million in this funding over the next five years due to anticipated increases in WFO funding at PNNL. BMI capital is funding provided by Battelle and is allocated similar to GRE.

The GRE and BMI funding are allocated annually through a Lab-wide competitive process. The annual business planning process yields requests for GRE and BMI capital research equipment from throughout the Lab. A multi-disciplinary capital allocation team then evaluates each request and rank-orders the submissions. The rank list of potential equipment is then submitted to the PNNL Chief Research Officer for final approval. The approved list of research equipment is then purchased by the staff members who requested the funding.

## **Non-Capital Research Equipment**

The acquisition of DOE-owned non-capital research equipment can also be made using general programmatic funding from customers and organizational overhead funding. PNNL does not explicitly forecast these acquisitions but relies on the individual project managers, business line managers, and product line managers to negotiate with customers and line managers (with appropriate overhead budgets) to acquire equipment that best serves the long-term interests of PNNL and its customers.

## Conclusion

PNNL performs basic and applied research to deliver energy, environmental, and national security for the nation. Given this explicit mission, PNNL has an established set of business lines, product lines, and core competencies responsible for delivering value to its customers. The understanding of PNNL's customers and S&T strengths and the needs of the nation yields Mission Outcomes, which are the primary strategic focus at PNNL.

Mission Outcomes define the areas where PNNL intends to provide science, technology, and leadership that contribute to solutions of major national challenges over the next five years and beyond. Delivering these Mission Outcomes is the principal focus of the PNNL strategy. Overall, PNNL intends to provide the scientific and technical basis to predict behavior of complex systems (for example, the global climate system), prevent the proliferation of weapons of mass destruction and acts of terrorism, sustain a healthy environment, and reduce U.S. dependence on imported oil. Over the next decade, PNNL will remain strategically focused on delivering real, sustained economic value to the nation by providing the scientific tools, methods, and technologies to:

- Strengthen U.S. Scientific Foundations for Innovation
- Increase U.S. Energy Capacity and Reduce Dependence on Imported Oil
- Prevent and Counter Acts of Terrorism and the Proliferation of WMD
- Reduce Environmental Effects of Legacy Waste and Energy Use

In order to deliver these scientific and technical values to the nation, PNNL requires funding commitments from customers. PNNL's financial outlook includes increasing the overall funding at PNNL from \$742 million in FY06 (estimate) to between \$892 million (conservative scenario) and \$1,190 million (optimistic scenario) by FY11. The anticipated funding growth is the result of changes across the diverse customer set at PNNL. PNNL anticipates modest to moderate funding increases across the DOE and NNSA business and a steady increase in Work for Others (WFO) programs – including DoD and DHHS (NIH). DOE-SC will provide ~17% of the PNNL funding in FY07 and will grow to provide a total of 20 to 22% of PNNL's funding by FY11. NNSA will grow modestly or maintain 15 to 19% of PNNL's funding base. Beyond science and technology funding, PNNL anticipates external commitments that include sustained financial and DOE management commitment during FY07–FY11 to build facilities to offset the imminent closure of 300 Area facilities due to DOE's accelerated cleanup of the Hanford Site. These external commitments are necessary for success, but must be coupled to a detailed plan for sustaining and enhancing PNNL's capabilities (including staff, facilities, and research equipment) over the next five years in order to serve the mission needs of PNNL's customers.

PNNL currently has six science and technology core competencies (skills and capabilities) that differentiate the Lab from other national laboratories and competitors: Microbial and Cellular Biology, Environmental Sciences, Analytical and Interfacial Chemical Sciences, Radiological Sciences, Information Analytics, and Sensor and Measurement Technology. The staff outlook at PNNL includes increasing the number of direct FTEs charging to projects at the Laboratory from 1,872 to 2,148 from FY06–FY11. In an effort to improve operational efficiency, PNNL plans to simultaneously constrain the growth of indirect FTE (support and other personnel), and effectively increase the ratio of direct FTEs to total FTEs from 51.0% in FY06 to 53.7% in FY11. This staffing growth translates into an increase of

total staff at PNNL of approximately 700 from FY06–FY11, which increases total staff to 4,899 by FY11. The primary staff growth is anticipated in the Microbial and Cellular Biology, Information Analytics, and Sensor and Measurement Technology core competencies over the next five years.

The staff outlook, combined with the pressure of 300 Area closure plans, results in PNNL experiencing an unprecedented facilities-related challenge over the next five-years. PNNL's TYSP provides the comprehensive multi-year plan for facilities and infrastructure at the Laboratory (and is the basis for the information in this Work Plan). PNNL plans to build several new facilities using combinations of line item capital, third-party-funded facilities (that will be leased), and other capital sources. The five-year facilities plan will realize many new facilities at PNNL, offset by the loss of 300 Area facilities, and increase PNNL's total space from ~2.1 to ~2.4 million gross square feet between FY06 and FY11 in order to accommodate the research PNNL plans to perform over the next five years.

Beyond staff and facilities, the Laboratory capabilities are also defined by PNNL's research equipment. PNNL generally attains funding for research equipment from customers or from internal overhead accounts, with the funding being either capital or non-capital funding. The capital equipment forecast is conservatively estimated to include ~\$13 million of programmatic capital and \$3 million of overhead capital per year during FY07–FY11. The majority of PNNL's programmatic capital is directed to the acquisition of new equipment for EMSL, which is forecast to receive \$8.8 to \$10 million per year over the next five years as part of the EMSL refreshment and revitalization plan. The overhead capital funding is allocated through internal competition that is brokered by an internal review committee and PNNL's Chief Research Officer. This capital funding (combined with non-capital funding allocated by project and line managers) represents the primary capacity at PNNL to expand or revitalize the research equipment at PNNL over the next five years.

PNNL's principal strategic intent is to Be World Class by delivering the Mission Outcomes defined in the PNNL strategy and to steward the Laboratory's assets by optimizing investment in the Lab and building the research campus of the future. PNNL intends to deliver on these strategic objectives by building world-class capabilities and operating the Lab with excellence. The overall plan is to deliver real, sustained value to the nation, and PNNL appears poised for five years of outstanding performance.

**Appendix A – Letter**

**Contract No. DE-AC05-76RL01830- Options Assessment for  
Physical Sciences Facility**

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Dr. L. K. Peters  
06-MGR-0127

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- Any additional on-going operational costs associated with retention of the 300 Area facilities should be included (to compare with operational costs associated with the currently defined PSF).
- All options should consider the previously provided funding profile, or identify where this profile would be exceeded. The final recommendation should not exceed a total project cost of \$224M.

The results of this options assessment has been requested by DOE Headquarters (HQ) by August 31, 2006. In order to meet this date, please coordinate your assessment with the PNSO Capability Replacement Laboratory (CRL) Project Office. A draft evaluation is due to PNSO by August 25, 2006, so that adequate staffing and concurrence can be obtained prior to submittal to HQ. HQ expects the cost evaluation/estimate to be of "CD-1 Quality," so please include in your evaluation an assessment of the level of quality of this document.

If you have any questions, please call me, or your staff may contact Julie Erickson, CRL Project Manager, on (509) 372-4005.

Sincerely,



Paul W. Kruger  
Manager

MGR:JKE

cc: M. E. Jones, SC-23.2, HQ  
J. K. McClusky, PNNL