

PACIFIC NORTHWEST NATIONAL LABORATORY FY 2018 SITE SUSTAINABILITY PLAN

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Executive Summary

At the United States (U.S.) Department of Energy's (DOE's) Pacific Northwest National Laboratory (PNNL), we have long recognized that excellence in scientific discovery, technological innovation, environmental stewardship, and social responsibility is foundational to delivering solutions to some of America's greatest challenges.

Over the last several years we have achieved many successes, including impactful contributions to our sponsors' missions, strong programmatic growth, and investment in our campus and people. We also manage operations with distinction, including improved safety and reduced costs. Together with our academic and industry partners, we are building innovative solutions to protect the environment and reduce energy, waste, and water use through smarter technologies.

Going forward, PNNL is positioned to make even greater contributions, delivering more impactful science and technology and providing solutions for more affordable and environmentally friendly operations. We will continue our focus on creating a culture of creativity and innovation, strengthening partnerships with our sponsors and the scientific community, and becoming more widely recognized as a world-class scientific research institution.

Our plan includes actions to conserve energy, water, and financial resources and improve the comfort and productivity of our staff members. In fiscal year (FY) 2017, we achieved several sustainability milestones, as highlighted below.

- **Utility Energy Services Contract**

Working toward the performance contracting goals outlined in this Site Sustainability Plan (SSP), PNNL solicited interest from utility providers in partnering on a Utility Energy Services Contract. This type of arrangement utilizes outside energy management services to perform energy and water evaluations at PNNL, recommend energy and water conservation measures (ECMs), and provide funding by way of low-interest loans and incentives to implement projects that are life cycle cost effective. PNNL solicited interest from serving utilities and selected Bonneville Power Administration (BPA) to provide a customized UESC program based on their energy management services offerings, experience, and qualifications. Engineers from BPA began to evaluate both laboratory and office facilities at PNNL in FY17 and will continue in FY18 to identify potential ECM projects for implementation.

- **Single-Stream Recycling Prompts Cultural Shift**

Single-stream recycling was implemented campus-wide in FY17. Moving to single-stream recycling was an important step in sustaining and exceeding the waste diversion goal. Prior to using single-stream recycling, a suite of recycling bins were scattered throughout each facility to support the collection of common recyclable materials (mixed paper, plastic, aluminum, tin, and glass). Staff found the old "multi-stream" version of recycling confusing and it often resulted in recyclables being placed in the wrong bin or in the trash. Single-stream recycling was initiated to streamline the recycling process, by eliminating the need for users to sort their recyclables and to optimize bin placement. Single-stream recycling has not only vastly improved staff recycling participation, it has also changed the perception of recycling. Based on the positive feedback, recycling has moved from being a confusing chore to an easy task.

- **Guiding Principles for Sustainable Construction**

In FY17, PNNL finished the certification process for the Lab's recently completed high performance and sustainable building (HPSB), the 3850 General Purpose Chemistry Laboratory (GPCL), using the Guiding Principles for Sustainable Construction. The GPCL included sustainable design elements such as a heating, ventilation, and air conditioning (HVAC) system that uses advanced controls and incorporates energy recovery in both the heating and cooling season, low-flow plumbing fixtures, light emitting diode (LED) lighting, and water efficient landscaping. With the addition of this building, PNNL has over 60% of applicable buildings compliant with the Guiding Principles, far exceeding the 17% goal by 2025. PNNL is concluding HPSB certification on another new facility, the 3860 Engineering Analysis Building, and construction is underway on Discovery Hall, a collaboration center on the PNNL campus designed to meet the Guiding Principles.

For additional information about these projects, please refer to the corresponding sections of this SSP.

DOE Goal	Current Performance Status	Performance & Plans
Multiple Categories		
50% Scope 1 & 2 GHG emissions reduction by FY 2025 from a FY 2008 baseline.	Auto from Comprehensive Scorecard Interim Target: -25% Current Performance: -18.1%	Continue REC purchases for near-term GHG reduction goal and implement energy conservation measures where cost-effective.
25% Scope 3 GHG emissions reduction by FY 2025 from a FY 2008 baseline.	Auto from Comprehensive Scorecard Interim Target: -9% Current Performance: -3.8%	Continue promoting telework and use of video conferencing to reduce travel; encourage staff through bus and carpool promotions and incentives.
Energy Management		
25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2025 from a FY 2015 baseline.	Auto from Comprehensive Scorecard Interim Target: -5% Current Performance: 8.5%	Pursue funding for large, high-impact projects through the utility energy services contract with Bonneville Power Administration.
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Completed energy and water evaluations on buildings 3410, 3420, and 3430 in FY17 to stay compliant with EISA Section 432.	Perform energy and water evaluation on building 325 in FY18.
Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate.	All individual buildings metered for electricity, natural gas, steam, and water, where cost-effective and appropriate.	Improve building performance through data analysis.
Water Management		
36% potable water intensity (Gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline.	Auto from Comprehensive Scorecard Interim Target: -20% Current Performance: -77.2%	Continue to implement site water management plan opportunities for additional reductions.
30% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline.	FY11 Baseline: 176,248,000 gal FY17 Actual: 173,280,000 gal Interim Target: -14% Current Performance: -1.7%	Continue to implement site water management plan opportunities for additional reductions.
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.	Auto from Comprehensive Scorecard Interim Target: 50% Current Performance: 60.1%	Continue to expand nitrile glove recycling program and continue conducting assessments for waste reduction opportunities.
Divert at least 50% of construction and demolition materials and debris.	Auto from Comprehensive Scorecard Interim Target: 50% Current Performance: 88.4%	Continue monitoring C&D recycling performance and raising awareness on waste diversion requirements.
Fleet Management		
30% reduction in fleet-wide per-mile GHG emissions reduction by FY 2025 from a FY 2014 baseline.	Auto from Comprehensive Scorecard Interim Target: -4% Current Performance: 1.4%	Continue to look at optimizing routes traveled by vehicles and consolidating deliveries where applicable. Staff will continue to be provided education on the importance of avoiding extra idling time, speed control, and combining trips with other staff members when feasible.

Fleet Management		
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter.	Auto from Comprehensive Scorecard Interim Target: -20% Current Performance: -10.1%	Education will continue for vehicle custodians regarding the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter.	Auto from Comprehensive Scorecard Interim Target: 10% Current Performance: 0%	Continue periodic checks on the local availability for bio-diesel fuel. As older vehicles are replaced, PNNL will continue to work with GSA to determine if an alternative fuel vehicle (AFV) or fully EV is an option for replacement.
75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV).	77% of PNNL acquisitions during FY17 were alternative fuel vehicles.	PNNL will continue to work closely with GSA to ensure that all applicable PNNL vehicle orders are for alternatively fueled vehicles.
50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025.	No passenger vehicle acquisitions were made in FY17.	Continue to work closely with GSA to acquire zero-emission or plug-in hybrid vehicles for all newly acquired passenger vehicles.
Clean & Renewable Energy		
“Clean Energy” requires that the percentage of an agency’s total electric and thermal energy accounted for by renewable and alternative energy shall be not less than 25% by FY 2025 and each year thereafter.	Auto from Comprehensive Scorecard Interim Target: 10% Current Performance: 21%	Continue to meet the clean energy goal through onsite generation and RECs.
“Renewable Electric Energy” requires that renewable electric energy account for not less than 30% of a total agency electric consumption by FY 2025 and each year thereafter.	Auto from Comprehensive Scorecard Interim Target: 10% Current Performance: 30.4%	Continue to meet the clean energy goal through onsite generation and RECs.
Green Buildings		
At least 17% (by building count) of existing buildings greater than 5,000 gross square feet to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.	Auto from Comprehensive Scorecard Interim Target: 15% Current Performance: 64.3%	Continue trending toward 100% of facilities meeting HPSB.
Net Zero Buildings: 1% of the site’s existing buildings above 5,000 gross square feet intended to be energy, waste, or water net-zero buildings by FY 2025.	Continuing to participate in DOE effort to establish guidance on Net Zero building requirements.	Continue to work with Net Zero community on guidance development.
Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	Continuing to participate in DOE effort to establish guidance on Net Zero building requirements.	Continue to work with Net Zero community on guidance development.
Increase regional and local planning coordination and involvement.	Collaborated with City of Richland (COR) Energy Services on new buildings at PNNL.	Continue partnering with regional and local groups to obtain SSP goals.

Acquisition & Procurement		
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts.	Auto from Comprehensive Scorecard Interim Target: 95% Current Performance: 100%	Continue being proactive with sustainable acquisitions.
Measures, Funding, & Training		
Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693.	Selected Bonneville Power Administration (BPA) to provide a customized UESC program. Began energy and water evaluations.	Continue performing energy and water evaluations, and review energy conservations measure projects proposed by UESC contractor.
Electronic Stewardship		
Purchases – 95% of eligible acquisitions each year are EPEAT-registered products.	Auto from Comprehensive Scorecard Interim Target: 95% Current Performance: 96.3%	Continue to purchase EPEAT-registered products when available.
Power management – 100% of eligible PCs, laptops, and monitors have power management enabled.	Auto from Comprehensive Scorecard Interim Target: 100% Current Performance: 100%	Continue to implement power management features on initial setup.
Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled.	Auto from Comprehensive Scorecard Interim Target: 100% Current Performance: 93.9%	Continue to use duplex printing as default configuration.
End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year.	Auto from Comprehensive Scorecard Interim Target: 100% Current Performance: 100%	Continue to reuse and recycle electronics.
Data Center Efficiency. Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers.	The normalized (weighted by IT Load) power usage effectiveness across the PNNL Campus is 1.42 for FY17.	Continue performing energy assessments and profiling of data centers.
Organizational Resilience		
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.	Climate resilience integrated into response and operations through Climate Resilience Action Plan.	The climate resiliency planning team will continue to meet to ensure we have followed up on our commitments to improve PNNL's resiliency, review metrics that could indicate changes in our vulnerability, and determine the need to revise plans and procedures.

Energy Management

Performance Status

Scope 1 & 2 GHG Reduction of 50% by FY25 from FY08 Baseline

PNNL has achieved a reduction of 18.1% in Scope 1 & 2 greenhouse gas (GHG) emissions since the fiscal year (FY) 08 baseline. This has been accomplished by purchasing renewable energy credits (RECs) on the open market each year.

Energy Intensity

Between FY15 and FY16, PNNL's energy intensity fell from a baseline of 167,612 British thermal units (Btu) per gross square foot (GSF) to 167,066 kBtu per GSF—a net reduction of 0.3 percent. However, due to the hard winter during FY17, PNNL's energy intensity increased back up to 181,889 kBtu/GSF—a net increase of 8.5 percent from the baseline.

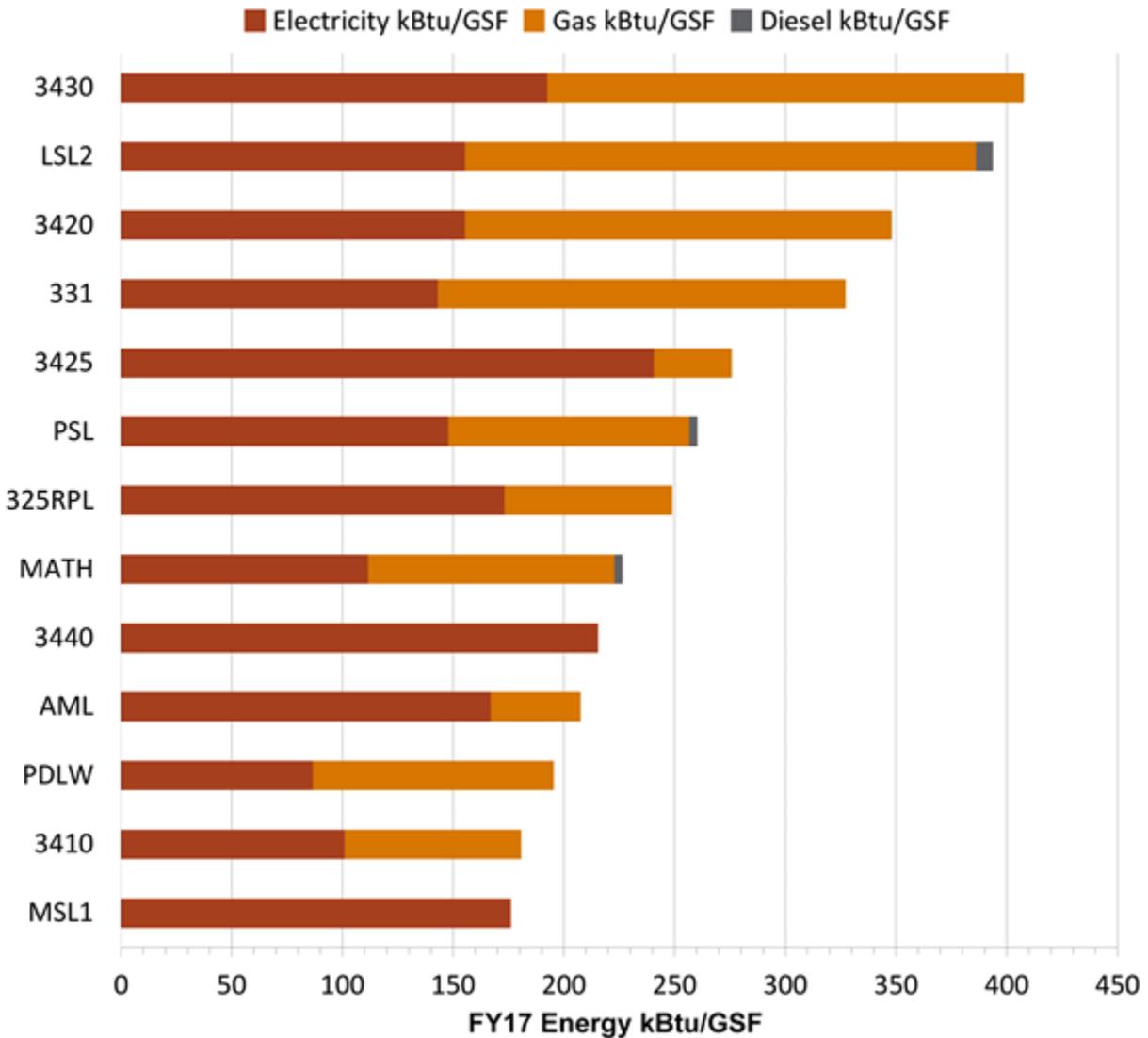
With the replacement of several large chillers in FY17 and the implementation of a new utility energy service contract (UESC) contract in the fall of 2017, PNNL is poised to successfully reduce its energy intensity in FY18. The accomplishments of PNNL's Building Operations Control Center (BOCC), staffed by sustainability and commissioning engineers, along with three student interns and a power operator, avoided additional energy intensity increases by continuously monitoring building systems on the campus and optimizing their efficiency. The BOCC staff analyze data from PNNL's advanced meters and building control systems, while also performing functional testing of building systems with the operations staff.

PNNL remains aggressive about reducing its energy intensity. To meet reduction goals, the BOCC monitors and reports using benchmarking, energy and water meetings, and energy and water conservation measures. As a hub for energy tracking and control systems to connect with building managers, building engineers, design engineers, and the building occupants, the BOCC is the integrator for ensuring that energy and water goals are met through continuous monitoring and reporting. Specifically, the BOCC links historical data and real-time monitoring and diagnostics with analytics to optimize energy and water, extend asset life, and enhance the reliability and efficiency of the PNNL campus. The BOCC leverages data from multiple platforms, including Lucid Design Group's BuildingOS, EnergyCAP, Inductive Automation's Ignition, Johnson Control's Metasys®, and the U.S. Environmental Protection Agency's (EPA's) Portfolio Manager® to perform diagnostics, trending, and analytics.

While the target of a 5 percent reduction by FY17 was not achieved, PNNL was aggressive about reducing its energy intensity overall. Mission-driven increases in energy use were offset through a combination of energy-saving projects, operational efficiencies, construction of high-performance buildings, improvements to the Engineering Standards, and Specifications (ESS), and promotion of conservation behavior among occupants.

Buildings excluded from the energy intensity goal, along with a copy of the exclusion self-certification letter, are included in the DOE Sustainability Dashboard, a tool used for data reporting, maintaining historical data, and analyzing data for improved sustainability management.

PNNL's Highest Energy Intensity Bldgs > 5,000 ft² and with EUI's > 150 kBtu/ft²



EISA Evaluations

The PNNL Energy Program Office successfully completed comprehensive energy and water evaluations for multiple buildings (Physical Sciences Facilities 3410, 3420, and 3430) to achieve compliance with Section 432 of EISA 2007. These comprehensive evaluations include a commissioning assessment and energy and water audit, with the objective of identifying energy conservation measures (ECMs) and optimizing building systems operation. ECMs identified at the 3420 and 3430 buildings to rebalance airflow have received the initial phases of lab rebalancing. Further balancing is required to achieve the completed ECMs along with the 3410 building complete rebalance.

An EISA program self-assessment was performed by the Energy Program Office and follow up actions assigned to ensure evaluations are completed per EISA requirements.

Metering

Individual building metering, as required by the Energy Policy Act (EPAct) of 2005, EISA, and Executive Order (EO) 13693, for electricity, natural gas, and water has been completed for all buildings where “appropriate” per DOE’s November 2014 *Federal Building Metering Guidance*. With real-time meter data, PNNL’s BOCC has all the necessary information to

perform system analyses on facilities. The 2016 PNNL *Metering Plan*¹ details the successful completion of the metering goal and the many uses of meter data. The *Metering Plan* also includes details on funding, personnel, and energy tracking systems.

Non-Fleet Vehicles and Equipment

Fuels used by non-fleet vehicles and equipment consist of mainly aviation and jet fuels for the atmospheric research plane and drone with a lesser amount of gasoline and diesel used by the grounds equipment to maintain the landscaping around the PNNL campus. The aviation fuel used each year is determined by the type and location of research for the atmospheric studies that are undertaken based on the research sponsor's requirements.

Plans and Projected Performance

Scope 1 & 2 GHG Reduction of 50% by FY25 from FY08 Baseline

Since PNNL's facility energy usage comprises the vast majority of its GHG emissions, our strategy to reduce Scope 1 & 2 GHG emissions is to replace existing equipment with more efficient chillers, lighting, controls, and boilers where lifecycle cost effective, and/or buying additional RECs. Based on National Renewable Energy Laboratory's (NREL's) screening recommendations, renewable energy sources such as wind or solar photovoltaics (PVs) are not yet life cycle cost effective for the large quantities of electricity needed 24/7 to run PNNL based on the fairly inexpensive electricity available from the local City of Richland electrical utility.

Energy Intensity

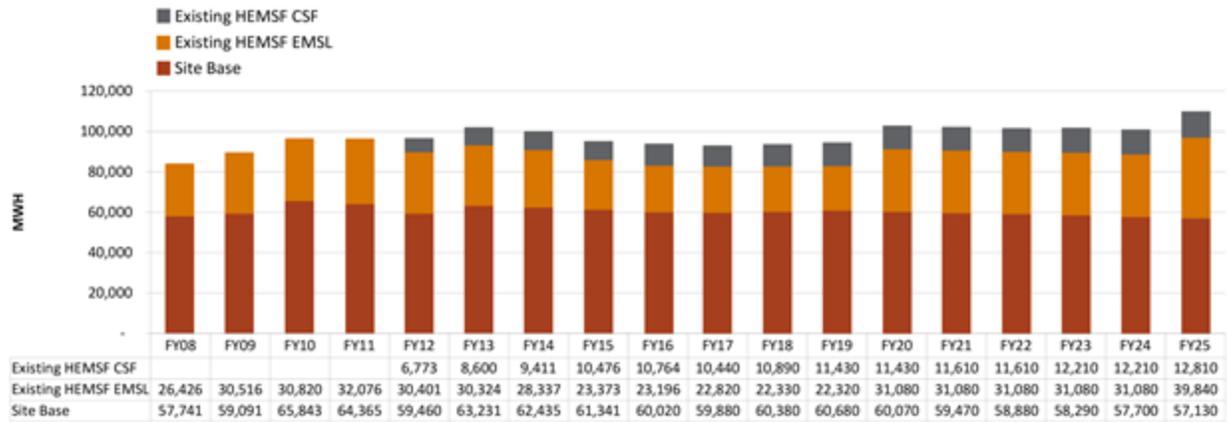
Continuing in FY18, PNNL will work toward the new goal to reduce energy use intensity 25 percent by FY25 from a FY15 baseline. PNNL is targeting a 1 percent energy use intensity (EUI) reduction in FY18, while pursuing funding for large, high-impact projects, especially through the new UESC with Bonneville Power Administration (BPA). PNNL intends to work toward goal attainment by establishing annual energy reduction goals within directorate business plans, increasing collaboration with research scientists, and expanding the tools and equipment available. Plans to implement Metasys Connected, which will bring information and control to operators in the field using tablets, will advance this effort. PNNL will continue making real-time, informed decisions using advanced analytical tools and institutionalize real-time commissioning of facility systems to increase attention on daily building operations versus periodic retro commissioning efforts. As seen with the BOCC, the ability to monitor, perform diagnostics, and make informed decisions enhances the overall performance of PNNL facilities, leading to increased energy savings and greater operational performance. Implementation of conservation projects through the new UESC between DOE and BPA has the potential to significantly reduce energy intensity at PNNL. The UESC process enables the significant investment needed to implement large projects with high up-front costs.

Maintaining the core competencies of PNNL's highly qualified staff is vital to the long-term success of the Sustainability Program and, ultimately, the completion of the goals outlined herein. PNNL will continue to train staff regarding the latest building efficiency technologies and maintain or increase the number of qualified Certified Energy Managers and Certified Building Commissioning Professionals.

It is anticipated that achieving the 25 percent energy intensity reduction goal by FY25 will continue to be challenging. Projected business growth in key areas of PNNL's portfolio may result in energy intensity increases, which the Lab will strive to offset by aggressively managing energy usage in other areas. PNNL will continue to look for additional ways to reduce energy while conducting world-class research.

¹ Pope JE. 2016. *Metering Plan: Intelligent Operational Strategies Through Enhanced Metering Systems*. PNNL-25587, Pacific Northwest National Laboratory, Richland, Washington.

Electricity Usage, Actual and Projections, by HEMSF's at PNNL



EISA Evaluations

PNNL will continue to conduct energy and water evaluations in the EISA-covered facilities. In FY18, the 325RPL building will be evaluated and ECMs outlined in previous evaluations implemented. This will keep PNNL on track to complete evaluations in 100 percent of covered facilities over the four year schedule, allowing PNNL to distribute workload and funding. Identified ECMs will be tracked, with funding requests integrated into the planning process. The PNNL administrative procedure that outlines requirements for the BOCC will be revised in early 2018; this procedure details the specific requirements and process for EISA evaluations along with roles and responsibilities for achieving completion.

Metering

With buildings being added to the PNNL campus each year, PNNL will continue to meet metering requirements by installing the most appropriate meter for each asset. As meter installations continue, PNNL will continue to gather and analyze data while striving to meet the energy and water reduction challenges. Using meter and sensor data, operational improvements or maintenance corrections can be easily identified and corrected in real time.

Water Management

Performance Status

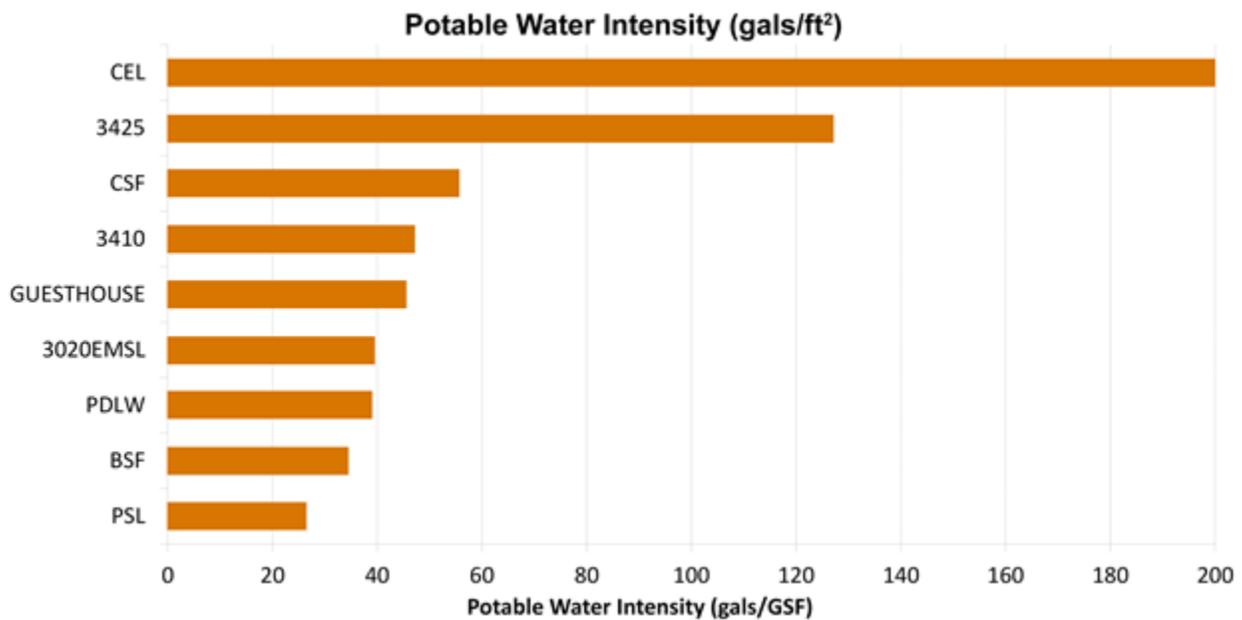
Water Intensity

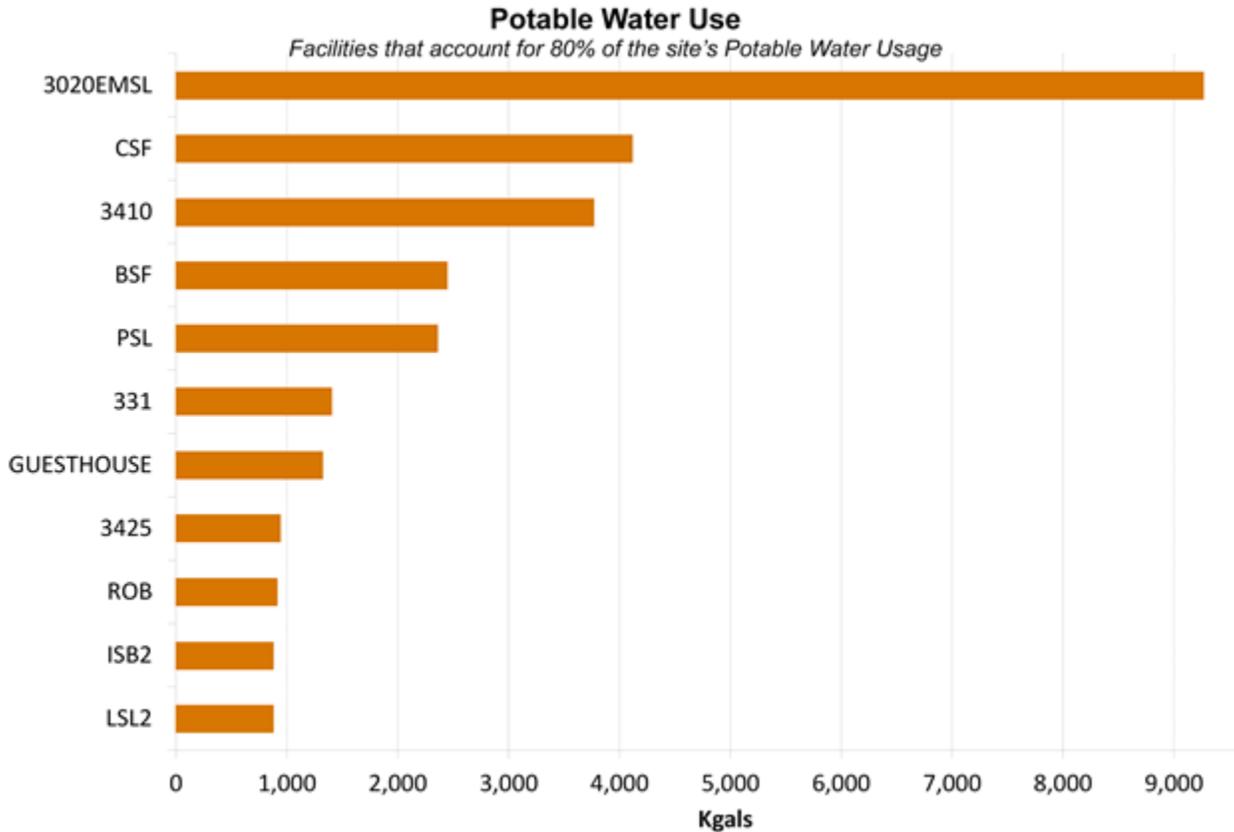
PNNL has met and exceeded the FY25 potable water reduction goal and, as of FY17, has reduced its water intensity by 77 percent. In FY16, the Sustainability Program commissioned the water efficiency research team at PNNL to develop a comprehensive water management plan. This plan examined water consumption at the Lab, performed a water balance analysis, and presented opportunities to improve water conservation and efficiency. A copy is attached to the Site Sustainability Plan (SSP).

According to that water balance analysis, as of FY15, only 17.5% of the total water used was potable, and almost half of that was used for cooling towers, process cooling, and irrigation. A little over a quarter of the potable water was used in laboratories, about 11 percent was used for sanitary purposes, 5 percent was used for makeup water in steam systems, and the remaining amount was miscellaneous or losses.

The Environmental Molecular Sciences Laboratory (EMSL) and Computational Sciences Facility, both high-energy mission specific facilities (HEMSFs) with large supercomputer cooling loads and cooling towers, accounted for 37 percent of the potable water used at PNNL.

The Research Technology Laboratory complex, was closed down for decontamination and decommissioning in mid FY17, eliminating a cooling tower and the last of PNNL's once through process cooling equipment. The Lab has already observed a noticeable amount of potable water reduction.





Industrial, Landscaping, and Agricultural Water

ILA water at PNNL is withdrawn from the Columbia River, supplied from both the PNNL and City of Richland (COR) river irrigation systems, and used primarily for landscaping, cooling ponds, and aquatics research (mostly sand filter backflush). In addition, 9.28 million gallons of potable water from the City of Richland is used for irrigation in three leased facilities, separately metered; this was removed from reporting in the potable water intensity data starting this year and was included in the ILA water reporting data instead. Despite this additional irrigation water being included, as well as additional acres being irrigated due to new building construction on new ground, PNNL's total ILA water use in FY17 of 173.28 million gallons was still less than the FY11 usage of 176.25 million gallons, which is the Lab's actual baseline year. Recommendations from the *2016 Water Management Plan* highlighted opportunities for ILA water savings, which has contributed to PNNL effectively reducing ILA consumption by 1.7 percent since FY11, or by 7 percent if the newly added 9.28 million gallons of potable irrigation water is not included in the calculation.

Plans and Projected Performance

Water Intensity

In FY18, PNNL plans to continue performing facility water audits, specifically on the EISA-covered facilities. The Lab believes that the trending of water usage through the BOCC will help identify additional savings. Projects that are determined to be cost effective will be completed.

In the soon-to-be completed collaboration center, the newest building on the PNNL campus, the building is designed to meet the Federal Guiding Principles and the expectation is the requirement of a 20 percent reduction from the baseline requirement will be exceeded.

In addition, new high-efficiency chillers installed at EMSL should reduce the total heat load rejected, thus saving some potable water used by the cooling towers.

ILA Water

As PNNL modernizes through new construction or major facility renovation, landscaping remains necessary for fire offsets, dust control, and heat island reduction. In FY18, PNNL will continue using the *Landscape Master Plan* and implement recommendations made in the *2016 Water Management Plan*. Even with integrated ILA water reduction, meeting this goal will be a challenge, especially as new buildings are added to the campus in areas that are currently semi-arid desert.

Waste Management

Performance Status

Waste Diversion

Solid Waste

PNNL has integrated a recycling and excessing program for multiple waste streams, including electronics, batteries, research equipment, furniture, office products, scrap metal, wood, paper, plastic, glass, aluminum, tin, and cardboard. A procedure guide in PNNL's online instructional portal, "How Do I", provides staff with requirements and instructions for releasing any materials or equipment from PNNL. PNNL's "How Do I" also provides instructions on waste minimization through recycling or redistribution.

In FY17, PNNL diverted approximately 60 percent of nonhazardous sanitary waste. This success is attributed to innovative program communication and infrastructure/process improvements as highlighted below:

- Recycling at PNNL has become easier with "single-stream recycling," launched in late FY16. Prior to single-stream recycling, routine recyclables were separated into several different bins; the intention is to improve the recycling culture with this new, zero-sort recycling. In FY17, PNNL completed transitioning from multi-stream recycling to single-stream recycling.
- Modeled after the success from the FY15 "Rock the Watt – Building Energy Challenge" campaign, the Sustainability Team recruited additional Building Sustainability Champion (BSC) volunteers to identify sustainability opportunities by engaging in conversations about conservation and recycling with fellow staff members, adding a personal, peer-to-peer approach to the program.
- A nitrile glove recycling program was initiated in 2015 to divert this high-volume, yet hard-to-recycle waste stream from laboratory spaces. Nearly 700 lbs of gloves have been collected and recycled since FY15.
- Annually, PNNL celebrates Earth Month with sustainable actions. In FY17, nearly 670 lbs. of bound books were recycled by the Lab's staff in celebration of Earth Month. Staff are encouraged to donate used books to local charities or to share them with colleagues.
- In FY15, PNNL began evaluating opportunities to reduce sanitary waste dumpster sizes and collection frequency by the COR. The incremental successes in recycling over the following two years was a contributing factor to allow PNNL to reduce the average sanitary waste collection frequency from nearly four times per week to less than two times per week.

Construction and Demolition Waste

PNNL has a wide variety of construction and demolition (C&D) work activities that vary from large construction projects to smaller scopes of work. Reuse and recycling strategies are integrated with project planning, enabling continued success in C&D waste diversion. During FY17, PNNL diverted 88 percent (or over 400 tons) of C&D waste through recycling or reuse.

Composting

PNNL's composting program consists of both off-site and on-site composting. Typically, yard waste is collected in a designated yard waste container for off-site composting through COR. In FY17, approximately 7 tons of green waste was diverted. PNNL has six plastic hot composters to support the on-site composting activities. Management of the on-site

composting station is a group effort between the PNNL Pollution Prevention (P2) program, the Battelle Garden Club members, and volunteer composting leads. Composting leads collect food scraps from building lunch rooms and empty them into the hot composters, allowing Garden Club members to use the compostable materials as a natural fertilizer for their vegetable gardens. Annually, approximately one ton of food scraps waste is diverted from the landfill through on-site composting.

Toxic Chemical Reduction

Chemical Management

PNNL's ChemAgain chemical redistribution program provides the primary means of collecting and redistributing usable chemicals. This program successfully redirected 640 containers of chemicals in FY17 through internal transfer or donation. PNNL also leverages its P2 Pays and Sustainability Pays programs to promote staff-initiated opportunities in reducing chemicals and waste.

Integrated Pest Management

PNNL's ground maintenance staff use state-licensed, commercial-grade pesticide applicators. These professionals are required to complete annual continuing education training to learn about the latest trends in pest control, current chemical and biological control agents, and updated legislative changes. The grounds maintenance staff is committed to integrated pest management principles, where applicable.

The grounds staff recognizes the responsibility to provide a clean, low-pest environment at PNNL and strives to limit control efforts to those absolutely required for optimal results. Pest control methods begin with the lowest impact, only escalating, when required, to the level necessary for acceptable control.

Best practices include:

- Using wasp traps in lieu of spraying
- Removing unwanted cardboard and wood pallets
- Using sticky and metal traps for mouse control
- Using netting and spikes to reduce bird issues

Plans and Projected Performance

PNNL has achieved DOE's 50 percent nonhazardous solid waste diversion and 50 percent C&D waste diversion goals. PNNL plans to reduce sanitary waste through the following:

- Continuing to expand nitrile gloves recycling from a pilot program to a Laboratory-wide program, as appropriate.
- Encouraging the removal of personal printers in an effort to reduce printing.
- Evaluating the opportunity to recycle glass and plastic containers from laboratory spaces.

Fleet Management

Performance Status

Vehicle Greenhouse Gas Emission Reduction

FY17 Actual results show a slight increase of gCO₂e/mile relative to the FY14 baseline. This performance is a shift from our recent trend of 1% reduction and places additional challenge on meeting the target set out in EO 13693. PNNL will continue education to staff members on the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible, and proper maintenance to help reduce their GHG impact.

Reduced Petroleum

After reaching the 20% reduction goal during FY15 and maintaining that progress through FY16, PNNL experienced an increase in petroleum use during FY17. The overall performance to baseline shows an 11% reduction in petroleum use (PNNL uses a baseline of 38,824 vs. data supplied by the dashboard. Date reported in FY05 was found to be incorrect but we are unable to update prior years date in the dashboard creating an inconsistency in reporting data). The FY17 increase is driven by limitations on available replacements when ordering General Services Administration (GSA) vehicles. PNNL has recently received non-alternative fueled vehicles when alternative fueled vehicles were ordered, increasing the Lab's petroleum based fuel usage. This shift of fuel type usage on replaced vehicles has created a decrease in PNNL's percentage of fuel reduction. If trends continue, PNNL will need to implement additional alternatives, such as expanded electric vehicle (EV) utilization, to return to 20% petroleum reduction.

Alternative Fuel

Through continued training and proactive management, PNNL has far exceeded the goal of increasing alternative fuel use from the original FY06 baseline of 456 gasoline gallon equivalent (GGE) (PNNL used FY06 as a baseline year due to FY05 had no alternative fuel available so providing a 0 gallon amount for a baseline in FY05). PNNL operates within an area that has a very limited availability of alternative fuel filling stations. During FY18, an interruption of alternative fuel availability is expected due to reconstruction efforts at the privately held fueling station that services the PNNL fleet. PNNL continues to work with local fuel stations to secure additional filling locations to ensure a continued supply of E85 fuel.

Alternative Fuel Vehicles

When ordering vehicles, PNNL always requests that all vehicles are alternatively fueled vehicles. Due to limitations of the manufacturers, 77% of PNNL acquisitions during FY17 were alternative fuel vehicles.

Zero-Emission/Plug-in Hybrid Acquisitions

PNNL did not have any passenger vehicle acquisitions for FY17. PNNL will work closely with GSA to acquire Zero Emission or Plug-in Hybrid vehicles for all newly acquired passenger vehicles. Consideration for Zero Emission or Plug-in Hybrid vehicles will also be taken into account when ordering other vehicle classes.

Plans and Projected Performance

Vehicle Greenhouse Gas Emission Reduction

PNNL will continue to look at optimizing routes traveled by vehicles and consolidating deliveries where applicable. Staff will continue to be provided education on the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible, and proper maintenance to help reduce their GHG impact.

Reduced Petroleum

Due to the reduction in the number of gas combustible vehicles, PNNL will continue to promote the sharing of vehicles among staff and short-term rentals (where viable) to reduce petroleum consumption. Education will continue for vehicle custodians regarding the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible, and proper maintenance.

Alternative Fuel

PNNL periodically checks the availability in the local area for bio-diesel fuel. Also, as older vehicles are replaced, PNNL works with GSA to determine if an alternative fuel vehicles (AFV) or fully EV is an option for replacement. It is anticipated that there will be a temporary change in trend in FY18 due to limited availability of the alternative fueling station. This situation is expected to be temporary and only affect FY18.

Alternative Fuel Vehicles

PNNL will continue to work closely with GSA to ensure that all PNNL vehicle orders are for alternatively fueled vehicles.

Zero-Emission/Plug-in Hybrid Acquisitions

PNNL will work closely with GSA to acquire zero-emission or plug-in hybrid vehicles for all newly acquired passenger vehicles. Consideration for zero-emission or plug-in hybrid vehicles will also be taken into account when ordering other vehicle classes.

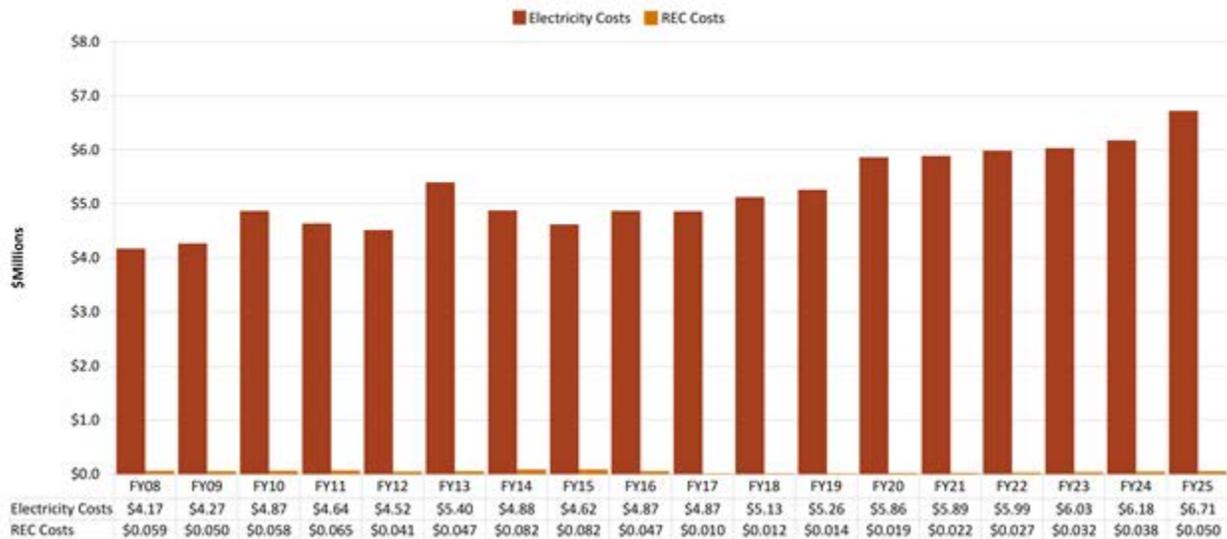
Clean & Renewable Energy

Performance Status

In FY17, PNNL procured enough RECs to offset 30.1% of its electrical use, which is already meeting both the FY20 goal (20%) and the FY25 goal (30%) for annual electrical consumption. Combined with the on-site renewables, PNNL has achieved a total offset of 30.4% of its electrical use and 21.5% of its total electric and thermal energy. Thus, PNNL is exceeding both the FY17 renewable electric energy goal and the FY17 clean energy goal.

Aside from RECs, PNNL has several on-site solar arrays. The solar hot water heater installed at EMSL produces approximately 160,000 Btu/hr. of hot water and is dedicated to the lunchroom and associated restrooms, fulfilling the majority of that area’s hot water needs. Several small solar PV arrays power various air and water monitoring stations throughout the campus; these have not been counted toward the goal. In addition, PNNL operates a 125 kW PV array at the EMSL building, which includes charging stations for electric fleet vehicles and is used for several R&D projects.

Electricity & REC Costs - Actual and Projected



Plans and Projected Performance

PNNL annually assesses the necessary number of RECs based on growth, LEED commitments, and desired GHG Scope 1 and 2 renewable energy reductions. The Lab’s strategy of REC procurement will continue to meet (and likely exceed) the renewable electric energy goal of 30% of annual electrical consumption.

PNNL is committed to finding ways to increase the amount of renewable power generated on-site. The Lab will periodically review the addition of new projects where economically feasible, although the latest NREL assessment last year indicated that there are limited opportunities for renewables that are economically viable based on low COR electrical rates.

Green Buildings

Performance Status

High Performance and Sustainable Buildings

In FY17, PNNL finished the certification process for the Lab's recently completed HPSB, the 3850 General Purpose Chemistry Laboratory (GPCL), using the Guiding Principles for Sustainable Construction. This was the first new facility at PNNL to use the Guiding Principles as a path toward HPSB status. The GPCL included sustainable design elements such as a heating, ventilation, and air conditioning (HVAC) system that uses advanced controls and incorporates energy recovery in both the heating and cooling season, low-flow plumbing fixtures, LED lighting, and water efficient landscaping. With the addition of this building, PNNL has over 60% of applicable buildings compliant with the Guiding Principles, far exceeding the 17% goal by 2025.

PNNL is concluding HPSB certification on another new facility, the 3860 Engineering Analysis Building, and construction is underway on Discovery Hall, a collaboration center on the PNNL campus designed to meet the Guiding Principles. All existing Facilities Information Management System buildings have been assessed against the HPSB Guiding Principles using the checklist provided in the EPA's ENERGY STAR Portfolio Manager.

Regional and Local Planning

Work on development of 1,641 acres transferred in 2016 from the Tri-Cities Washington Economic Development Council to the COR, Port of Benton, and Energy Northwest, for the purpose of non-federal land development, continued in FY17. PNNL is a contributor to the committee working to assemble a Master Plan for the land, and COR is redefining its urban growth boundary as a result. PNNL also released a new Campus Master Plan in 2017.

Continued expansion of the PNNL campus, including construction of the new 3860 Engineering and Analysis Building in 2017 and the new collaboration center currently under construction, have prompted coordination with COR for new city services, including electrical, water, sewer, and fire response.

In FY17, PNNL worked to finalize the transfer of 300 Area water and sewer services from Mission Support Alliance (MSA). Transfer to PNNL was effective at the start of FY18.

Net Zero

Researchers in PNNL's Energy and Environmental Directorate performed a needs assessment for meeting NetZero requirements in Executive Order (EO) 13693. They interviewed multiple sites, collecting information needed to advise DOE's Sustainability Performance Office (SPO) on guidance needs related to NetZero requirements. PNNL was one of the sites selected to participate in the interviews, along with eight other DOE sites. PNNL's sustainability manager, engineering manager, strategic planning manager, and chief engineer all provided input on existing and planned HPSBs, anticipated challenges in meeting NetZero requirements, existing guidance available, and needs for additional guidance and support.

Plans and Projected Performance

High Performance and Sustainable Buildings

An assessment in FY17 detailed the path to 100 percent conformance with the Guiding Principles. This assessment listed steps necessary and approximate costs to complete the Guiding Principle requirements for each appropriate building. In some buildings, investments needed to achieve HPSB status may not be cost effective, based on facility age, mechanical equipment design, or specific and specialized research activities.

Construction is currently underway on a new collaboration center at PNNL. PNNL has committed that all new construction, major renovations, and alterations of buildings greater than 5,000 GSF will comply with the Guiding Principles. Planning for future facilities, including line item, general plant project, or leases, will consider these requirements.

Regional and Local Planning

PNNL will continue conversations with DOE, other Hanford contractors, and the COR regarding changes to the 300 Area fire service provider. COR has incorporated increased fire service within their capital improvement plan and has identified two new city fire stations at the north end of Richland that would benefit PNNL and the land transfer area. COR is also in the process of updating its comprehensive land use plan; the new fire stations will be part of this effort. PNNL will remain active on a committee working with the Port of Benton and COR to establish a program to utilize an existing rail line near the PNNL campus, exploring the concept of an inland port on 30 acres next to the existing rail loop that would expand the inland sea port facilities.

In 2018, PNNL will continue coordination with COR on new electrical, water, sewer, and fire response services for the new collaboration center on the PNNL campus (presently under construction).

PNNL is also optimistic about the possibility of involvement in the new solar project currently underway between COR and regional energy producer Energy Northwest. A Memorandum of Understanding for the solar project between COR and Energy Northwest was signed in FY17.

Net Zero

PNNL is looking forward to additional guidance from DOE's SPO on meeting NetZero requirements. While PNNL is committed to meeting the goals outlined in EO 13693, constructing a NetZero building while meeting the test of lifecycle cost effectiveness with the low-energy rates in the Northwest will be a challenge. PNNL is eager to participate with the NetZero community to meet this challenge.

Acquisition & Procurement

Performance Status

During FY17, PNNL implemented several improvements to its acquisition system for sustainability compliance. Below are two highlights:

- Guidance surrounding the purchase of items with sustainable acquisitions requirements was revised with new requirements surrounding energy-efficient equipment and laboratory-grade, ultra-low temperature freezers. Continuing education was provided to contracts specialists and technical oversight representatives regarding sustainable requirements and their roles/responsibilities to comply through a variety of training methods.
- Guidance surrounding other acquisition methods was updated with new requirements surrounding energy-efficient equipment and laboratory-grade, ultra-low temperature freezers. Education was provided to end users and management via product demonstrations at vendor shows and through a variety of training methods.

Plans and Projected Performance

PNNL will continue increasing the staff's awareness regarding available sustainable products, encouraging participation in on-campus events, and educating staff about sustainable acquisitions. Benchmarking with other federal agencies on best practices will also proceed. Planned activities for FY18 include the following:

- Provide continuing education to contracts specialists and technical oversight representatives about sustainable requirements and their roles/responsibilities to comply with the requirements of PNNL's SSP and Prime Contract updates relative to sustainable acquisitions requirements.
- Provide education to end users and management via vendor product demonstrations, as well as a focused, small order initiative promotion aimed toward reducing supplier GHGs.

Measures, Funding, & Training

Performance Status

PNNL successfully leveraged alternative financing in 1996, 1997, and 2002, utilizing Energy Savings Performance Contracts (ESPCs) worth several million dollars. The projects targeted the replacement of outdated building infrastructure, including boilers, chillers, standby generators, air compressors, lighting, variable air volume units, and building controls. The upgrades eliminated significant amounts of deferred maintenance and improved the overall building efficiency and reliability.

Three additional projects were evaluated for the use of alternative financing in 2005, 2008, and 2011 and were found to not be financially viable. Conservation measures investigated during these evaluations included upgrades to systems, such as compressed air, lighting, HVAC, and building controls, as well as installation of photovoltaics.

Working toward the performance contracting goals outlined in this SSP, PNNL solicited interest from utility providers in partnering on a Utility Energy Services Contract. This type of arrangement utilizes outside energy management services to perform energy and water evaluations at PNNL, recommend ECMs, and provide funding by way of low-interest loans and incentives to implement projects that are life cycle cost effective. PNNL solicited interest from serving utilities and selected BPA to provide a customized UESC program based on their energy management services offerings, experience, and qualifications. Engineers from BPA began to evaluate both laboratory and office facilities at PNNL in FY17 and will continue in FY18 to identify potential ECM projects for implementation.

Summary of Sustainability Project Funding (\$K)			
Category	FY17 Actual	FY18 Planned/ Request	FY19 Projected
Sustainability Projects	925	296	300
Sustainability Activities other than projects	2,520	2,137	2,150
SPO Funded Projects (SPO funding portion only)	0	0	0
Site Contribution to SPO Funded Project	0	0	0
ESPC/UESC Contract Payments (if applicable)	1,115	1,164	1,210
Renewable Energy Credits (REC) Purchase Costs (if applicable)	10	50	50
Total	4,662	3,647	3,710

Plans and Projected Performance

In FY17 and beyond, BPA will continue to perform on-site energy and water evaluations at PNNL. BPA will then develop preliminary ECMs and water conservation measures, which PNNL will evaluate. Selected measures will undergo an investment-grade audit and engineering design. Consideration will be given to strategies that support Net Zero building goals. Projects that are determined to be lifecycle cost effective will be candidates for implementation, provided they are compatible with the Laboratory strategy moving forward.

Travel & Commute

Performance Status

All Scope 3 Emissions

Scope 3 emissions totaled 23,215 MTCO₂e, representing a 3.8 percent reduction from the FY08 baseline. Business travel was the largest contributor to these emissions (63.2 percent), followed by employee commuting (28.7 percent), and transmission and distribution (T&D) losses and contracted solid waste disposal and wastewater treatment contributing 6.6 and 1.5 percent, respectively. Reducing Scope 3 emissions continued to be a strategic priority at PNNL in FY17, as evidenced by the reductions highlighted below. An overall Scope 3 increase can be attributed to a reduction in REC procurement combined with an increase in energy use in FY17 that resulted in an increase in T&D loss contribution. Specific activities are discussed in more detail below.

Business Air and Ground Travel

In FY17, total emissions resulting from business travel were 14,669 MTCO₂e, a decrease of 1.7 percent compared with FY16. Air travel alone totaled 14,036 MTCO₂e, which was 96 percent of total business travel emissions, and decreased 1.4 percent compared with FY16. Business ground travel accounted for 633 MTCO₂e, a decrease of 9.1 percent from the previous year. Emissions from business travel continue to exceed the baseline, at 13.2 percent above FY08 levels.

Employee Commuting

PNNL's employee commute emissions in FY17 totaled 6,666.5 MTCO₂e, a decrease of 9.1 percent from FY16. The decrease in employee commute emissions can be attributable to the slight decrease of PNNL staffing levels compared with FY16 as well as increased amounts of teleworking due to adverse weather conditions that led to Lab closures. Employee commute emissions are calculated using the results of the GSA Scope 3 Commuter Survey. The survey is conducted bi-annually; for years in which the survey is not conducted, results from the prior year are extrapolated based on changes in the total employee population and collected telework data at PNNL. The most recent bi-annual survey was conducted in October 2016, and over 50 percent of PNNL staff members participated. FY17 employee commute emissions were calculated using the results of this survey, then applying changes in employee headcount and applying the days that employees worked from their homes. The telework data is collected automatically through the information technology (IT) department at PNNL. Employee commute emissions in FY17 were 21.1 percent below the FY08 baseline.

A reduction in emissions associated with employee commuting will largely come from PNNL staff members participating in alternatives to a single-occupant personal-vehicle commute. Alternatives to this traditional commute include teleworking (a popular alternate commute option), biking or walking to work, using public transportation, or carpooling. PNNL staff members teleworked 87,099 days in FY17, based on data provided by the time billing system. In addition to teleworking, the employee commute survey results in FY16 showed an increased use of bicycling, walking, intercity rail, and commuter rail when commuting to PNNL, compared to the 2014 survey.

A Laboratory alternate commute advocate helps raise staff member awareness of commute alternatives through directorate-level and all-staff communications, including articles in PNNL's twice-weekly employee e-newsletter, websites, quarterly sustainability e-newsletter, monthly safety and health newsletters hung in rest rooms, and seasonal challenges like Bike to Work Month. In addition to the month-long Bike to Work challenge, which PNNL placed 5th among all federal facilities, national Bike to Work Day had an impressive turnout at the Richland PNNL campus in 2017. Employees can join social rides and other cycling activities through the PNNL cycling club and may use the Whiteboard (an electronic bulletin board for staff) to connect with other PNNL riders and to organize events. Wellness at PNNL also promotes cycling and walking rather than driving during the annual wellness challenge. PNNL staff members are represented at the Three Rivers Bicycle Club, which works with the Richland City Council to set plans for continued road

safety improvements and developing a more bike friendly community. PNNL also worked with the Benton Franklin Transit (BFT) this year to encourage ridership of PNNL employees. This engagement included making monthly bus passes available for purchase on the Richland campus, showcasing the electric bus on take your sons and daughters to work day, and promoting the improved bus routes serving the Richland campus.

Plans and Projected Performance

To achieve the 25 percent reduction in Scope 3 emissions by 2025, PNNL will need to reduce annual emissions by another 5,123.60 MTCO₂e over the next seven years. This decrease will be achieved through a combination of activities aimed at reducing business travel, employee commuting, and T&D losses associated with electricity use. PNNL will continue advancing the programs conducted in FY17 and will pursue additional activities to further decrease Scope 3 emissions.

Business Travel Emissions

PNNL's business travel emission reduction strategy will continue to encourage efficient traveling and alternatives when they are equally effective. Many PNNL conference rooms have been made collaboration-ready and work seamlessly with Skype for Business meetings, while being equipped with high-definition web cameras and large video displays for presentations. Informing and encouraging staff to efficiently use these connection-ready rooms to work with off-site staff members and clients can lead to less business travel emissions and help achieve Scope 3 emission reduction goals.

Employee Commute Emissions

PNNL's commute emissions reduction strategy will continue to emphasize alternative commute options in FY18 and beyond. A large part of this strategy will include continued promotion of the teleworking option to staff. PNNL established a goal of 20 percent of all employees teleworking one day per week on average by FY20; achieving this goal will contribute to meeting the goal of a 25 percent reduction in commute emissions by FY25. PNNL is also working closely with the public transportation provider in the area to encourage PNNL staff ridership; this promotion and collaboration will be continued in FY18. Additional strategies include encouraging the use of public transportation by making monthly bus passes easily available for purchase on the Richland campus and encouraging staff members to build relationships with colleagues, while saving money by carpooling to work.

Fugitives & Refrigerants

Performance Status

PNNL uses sulfur hexafluoride (SF₆) for research, which contributes to Scope 1 GHG emissions. PNNL has inventoried existing sources and has a good understanding of its uses (e.g., as an insulator in electron microscopes and as tracer gas). In FY11, PNNL worked with researchers who used SF₆ as a tracer to adopt a substitute gas, nitrous oxide, which has a lower global warming potential. This replacement has continued, and no new project work has included SF₆. For electron microscopes, SF₆ is relatively stable, and year-to-year fluctuations are primarily due to use of a mass balance inventory method.

Fugitive refrigerant emissions are determined based on leak rate data recorded in refrigeration appliance service records. Results are for DOE facilities, that is, only those for which DOE has control over refrigeration management. Estimates include emissions from all equipment serviced or disposed of irrespective of appliance size. Repairs to refrigeration appliances are performed as soon as possible, minimizing fugitive refrigerant emissions. Priority is given to appliances with a refrigerant charge of ≥50 pounds to ensure leak rates and leak repairs are in compliance with 40 CFR 82 Subpart F requirements.

Plans and Projected Performance

PNNL's approach to reducing the use of ozone-depleting substances (ODS) includes using ODS substitutes approved by EPA for the intended uses (<http://www.epa.gov/ozone/snap/index.html>), if approved substitutes exist and restricting the purchase of a Class 1 ODS for research purposes to one of the EPA approved essential laboratory or analytical uses listed in 40 CFR 82 Subpart A, Appendix G.

PNNL will continue tracking SF₆ using the Chemical Management System (CMS) tool. Any new purchase of SF₆ will be reviewed on a case by case basis.

Electronic Stewardship

Performance Status

Purchases

PNNL has a managed hardware program (MHP). All personal computer, printers and peripheral device procurements are to go through MHP by policy.

Power Management

All managed Windows and Mac systems ship with power management capabilities enabled. Staff only change these settings if they deem there to be a valid business need, such as monitoring a long running experiment.

Automatic Duplexing

The default printer software is configured to use automatic duplex printing. Customers have the option to manually select single-sided printing for individual jobs on their computers when printing. Customers are able to set the default to be single-sided if they deem it necessary.

End of Life

In FY17, all assets identified as electronics to be disposed of as excess were reused or recycled using environmentally sound disposition options. This is enforced by policy.

Data Center Efficiency

The normalized (weighted by IT Load) power usage effectiveness across the PNNL Campus is 1.42 for FY17. For FY17, plans were set in motion that will allow for the implementation of new datacenter architecture and an updated client experience. These plans were put in motion and hardware and software was purchased. These strategic purchases set up the full scale deployment in FY18.

Plans and Projected Performance

For FY18, two major initiatives are planned that will modernize the datacenter and the client desktop environment. The first major initiative is DataCenter 4.0. This will significantly reduce the power consumption in the datacenters by reducing the number of legacy storage arrays and replacing them with smaller, more power efficient flash hard drives. This project should be fully implemented by the end of FY18. For the client experience, PNNL is moving to a laptop/mobile first policy. This allows for better control over power settings, and reduces the number of devices needed per person to perform their work, thus reducing the overall power consumption per person.

Organizational Resilience

Performance Status

Vulnerability Assessment Approach

During FY15, PNNL completed a robust vulnerability assessment and developed a [Climate Resilience Action Plan](#), which is available on the [PNNL Sustainability website](#). The Lab’s approach drew from established methodologies and practical experience supporting other agencies in conducting vulnerability assessments. PNNL’s methodology involved:

1. Creating a core project team and work plan.
2. Securing the commitment from an internal stakeholder team of 10 to 15 decision-makers.
3. Understanding locally relevant climate exposures and what PNNL “core systems” could be impacted by those exposures.
4. Assessing existing internal and external plans and identifying potential vulnerabilities to highlighted exposures.
5. Prioritizing vulnerabilities during an internal stakeholder workshop and engagement with select external stakeholders.
6. Establishing a resiliency action plan, an approach to integrating actions into PNNL’s ongoing operations, and a limited set of metrics to monitor future changes in resilience.
7. Sharing findings with key external stakeholders.

The climate resilience planning framework and guiding questions are depicted in Figure 1. The initial phase of the project focused on internal stakeholder engagement with outreach to select external groups, as needed, to fill information gaps. The internal stakeholder team included a cross-cutting group of program managers and technical personnel with responsibility for employee safety, environmental management, energy and water resource management, IT systems, emergency planning, facility engineering and design, and campus master planning. The members of this group have direct responsibility for plans, infrastructure, and systems that are potentially vulnerable to climate impacts. Subject matter experts in climate impacts assessment, risk assessment, and resiliency planning were also engaged as part of the planning team.

Risks to Mission, Operations, and People

The assessment of potential climate exposures, impacts on core systems, and current levels of preparedness highlighted both strengths and opportunities in the Lab’s current plans and procedures. Higher priority areas, shown in the figure below, are the focus of PNNL’s near-term climate resiliency planning actions.

Climate Exposure/Core System	High Temperatures	Intense Precipitations	Wildfire	Drought	Storms and Winds	Ice Storms
Buildings	Higher	Higher	Medium	Medium	Medium	Medium
Energy	Higher	Lower	Lower	Medium	Medium	Lower
IT Services	Medium	Medium	Lower	Lower	Medium	Lower
Worker Safety & Health	Lower	Lower	Medium	Lower	Lower	Lower
Water Resources & Infrastructure	Lower	Lower	Lower	Lower	Lower	Lower
Transportation	Lower	Lower	Lower	Lower	Lower	Lower

Figure 1. Potential Climate Exposures and Impacts on Core Systems

The two climate exposures of highest concern to PNNL’s campus operations are the projected increase in the number of high-temperature days and intense precipitation events that are experienced each year. Of particular concern is how these climate exposures could impact the Lab’s building infrastructure and energy systems. For example, an increased number of high-temperature days in the decades ahead could raise costs and decrease reliability as building exteriors and HVAC systems degrade at a faster rate, energy use increases as cooling systems work harder, and facility maintenance costs increase due to the added stress on systems. An increase in the number of intense precipitation events could lead to flood damage to roofs and damage to ground-level and below-grade facilities. Of particular concern is the flood risk to a below-grade data center on the PNNL campus.

See the [Climate Resilience Action Plan](#) on the PNNL Sustainability website for more information on climate exposures and core system vulnerabilities rated medium or low priority.

Actions to Building Resilience

PNNL’s current measures to help strengthen resiliency to high priority climate exposure are provided in the table below. These measures are well-established procedures and building operating best practices. Additional information on PNNL’s climate resilience planning process is provided in the [PNNL Climate Resilience Action Plan](#).

Climate Exposure and System Impacts	High Temperature Impact on Building and Energy Systems	Intense Precipitation Impact on Building Systems
Measures	<ul style="list-style-type: none"> • Preventative maintenance plans are reviewed annually • Cool roofs are the design default • Maximize use of light-colored materials for roofs and hard-paved areas • Optimize building orientation • Plans for a mobile chiller to boost systems stressed by heat • Ensure energy escalation rates reflect risk in facility design and operations planning <p>Track equipment life relative to life expectancy and adjust in lifecycle cost (LCC) analyses if needed</p> <ul style="list-style-type: none"> – FY17 Status: Equipment LCC is tracked via MARS (PNNL’s maintenance program software). Premature equipment failures due to climate are reviewed during annual assessment. Equipment LCC will be adjusted in MARS. <ul style="list-style-type: none"> • Use building control systems to alternate operating schedules and reduce power load if needed – FY17 Status: PNNL has the ability to reduce power load if needed through its building control system (Johnson Controls Metasys). Operation of this system is captured in a PNNL operating procedure. Additionally, Facility Operation is partnering with research and development to enable automating power load reduction program, VOLTTRON, in several buildings. • Implement continuous commissioning and facility-tuning to reduce energy demand – FY17 Status: Implemented a continuous commissioning and facility-tuning for EISA “covered facilities” to reduce energy demand. 	<ul style="list-style-type: none"> • Preventative maintenance procedures to clean roof drains. • Preventative maintenance measures associated with building drainage. • Five-year condition assessment will include drainage system integrity. • Preventative maintenance procedure to clean catch-basins/storm drains.
Responsible Offices	<ul style="list-style-type: none"> • Sustainability Program • Facilities Strategic Planning • Facilities Engineering • Facilities & Grounds Maintenance 	<ul style="list-style-type: none"> • Sustainability Program • Facilities Engineering • Facilities & Grounds Maintenance

Table 1. Measures to Address High Priority Climate Impacts on PNNL Systems

Additionally, as part of the FY15 climate resilience planning effort, PNNL defined a set of metrics that could be tracked over time to help gauge changes in climate risk. The effort to integrate these metrics into the Sustainability Management and Operations Program management system began in FY16. Based on further conversations with data holders and other stakeholders, some of the indicators have been modified or refined. The revised metrics are provided in the table below. Status of the metrics were provided to the internal climate resilience planning team in FY17.

For the next few years, the Lab will use this information to better understand baseline conditions. Over time, PNNL will be in a better position to understand whether risk thresholds have been crossed, which may necessitate new policies, procedures, or plans for adoption.

Risk	Indicator
High Temperature Risk	Number of days over 100°F per year
	Cooling season utility costs, sustained year-over-year
	Total water use during cooling season for cooling
Wildfire Risk	Cost of responding to (managing) wildfire events
Intense Precipitation Risk	Number of rainfall events per year that exceed 1" in 24 hours
	Number of flood incidents per year that affect facilities and infrastructure (e.g., vaults)
	Cost of responding to flood events
	Number of times catch-basins are clogged per year and require maintenance (beyond planned annual preventative maintenance)

Table 2. Risk Indicators

Emergency Response Procedure

The PNNL Emergency Management and Business Continuity Plans adequately address most hazards that could result from long-term climate variability and change through the Emergency Preparedness hazards surveys, conducted on a triennial basis, which cover a multitude of natural phenomena events (e.g., flood, wildfire, earthquake). Both PNNL Emergency Management and Business Continuity Plans utilize an all-hazards-based approach to include response processes that are flexible and adaptable to a multitude of scenarios. These plans are considered sufficient to address any climate change concerns and no further actions are necessary. The Sustainability Program will continue to engage this office as part of the Lab’s internal stakeholder team that conducts a bi-annual climate resilience review, and will adjust accordingly in the future.

Health and Safety Procedures

Worker health and safety represents one of PNNL's "core systems" that were evaluated for potential climate impacts. As part of the FY15 vulnerability assessment, the Lab identified six potential regional climate exposures that could influence worker health and safety, as depicted in Figure 1. Based on an assessment of the vulnerabilities associated with each exposure and current or planned measures in place to manage those vulnerabilities, PNNL applied a "high, medium, or low" priority rating.

Five of the six exposures were deemed low concern, with no additional actions required. For example, "heat stress, heat stroke, and dehydration of outdoor maintenance personnel" was identified as a vulnerability from having an increased number of high-temperature days each year. However, current procedures in place (e.g., educating staff to take breaks, drink fluids, and know symptoms of heat stress and heat stroke, as well as starting shifts of outdoor workers two hours earlier in hot months) were deemed adequate for managing this risk.

Worker health and safety concerns associated with wildfires were assessed to be of medium concern. Specific vulnerabilities identified included potential health effects from smoke pulled into buildings through ventilation systems and driving hazards posed by low visibility on campus roads. Current measures in place will help mitigate this risk to a great extent. For example, the Lab's fire response plans already look at air filter loading during fire events, and PNNL maintains a high-efficiency particulate air intake filter inventory. For driving hazards, a hazard advisory system and Laboratory workday closures/delays encourage staff to stay off roads when unsafe, and PNNL's flex time and telework policies help to reduce commuting risks in such circumstances.

In late FY16, PNNL revised the approach in identifying and assessing risks associated with field work. Leveraging PNNL's Electronic Prep and Risk (EPR) tool, project teams performing field work are required to document mitigations in an Off-Site Risk Management Plan. Site conditions, including weather, must be addressed as part of the project assessment/review process. More information on the worker health and safety assessment can be found in the [PNNL Climate Resilience Action Plan](#).

Management Commitment

The climate resiliency planning internal stakeholder team established during FY15 comprised senior managers of programs deemed critical to PNNL's climate resiliency, as described above. This team meets annually to ensure that the Lab has followed through on commitments to improve PNNL's resiliency to climate impacts, review metrics that could indicate changes in PNNL's vulnerability, and determine the need to revise plans and procedures. The climate vulnerability assessment and resiliency planning process helped increase awareness and commitment of the staff to this process on an ongoing basis.

Use of Best Available Climate Change Science

PNNL's research on atmospheric processes and the interconnections among energy, climate, and other human and natural systems is helping to inform sustainable solutions to the nation's energy and environmental challenges. Having subject matter experts on-site puts PNNL in a good position to stay on top of the best available science and to understand how regional climate dynamics could impact the Lab's own campus operations.

The *National Climate Assessment*, which includes a series of reports on the Northwest² was a key resource consulted during the FY15 vulnerability assessment process. Furthermore, one of PNNL's senior research scientists delivered an assessment of key regional risks and helped the internal stakeholder team understand how those exposures may play out at a local scale during the Lab's first stakeholder workshop.

² Dalton M., P.W. Mote, and A.K. Snover, eds., 2013: Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. 224 pp. Island Press, Washington, D.C.

The Sustainability Program team members responsible for climate resilience planning will continue to review updates to national plans as they occur and consult with internal subject matter experts, as warranted, to discuss evolving climate change scenarios. The team has also started using the U.S. Climate Resilience Toolkit to help understand climate issues and improve PNNL's climate change resilience strategy.

Climate Change Resiliency Survey

Inputs to the climate change resiliency survey are provided through the DOE Sustainability Dashboard.

Plans and Projected Performance

The climate resiliency planning internal stakeholder team will continue to meet to ensure that we have followed through on our commitments to improve PNNL's resiliency, review metrics that could indicate changes in our vulnerability, and determine the need to revise plans and procedures.

The Sustainability Program team members responsible for climate resiliency planning will review updates to national plans as they occur and will continue to consult with internal subject matter experts as warranted to discuss evolving climate change scenarios.

Appendix - List of Uploaded Documents

Energy Management

2016 Metering Plan Final.pdf
Excluded Buildings memorandum.pdf
Standard Report - EUI Excluded Facilities PNNL 2017.pdf

Water Management

PNNL_WMP_Report_FINAL_3-30-16_v2_med.pdf

Organizational Resilience

PNNL_CRP_Results.pdf