Pacific Northwest National Laboratory

FY 2021 SITE SUSTAINABILITY PLAN

Successfully sustaining through a pandemic

PNNL

Pacific Northwest
NATIONAL LABORATORY

Site Sustainability Plan FY2021

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Executive Summary

At the Department of Energy's (DOE's) Pacific Northwest National Laboratory (PNNL), the mission is to transform the world through courageous discovery and innovation. PNNL delivers high-impact science and technology, manages programs with distinction, and forges strategic partnerships to tackle challenges of vital importance to the nation.

Fundamental to the science and technology outcomes that PNNL delivers every day is a commitment to sustainability—a serious responsibility. Sustainability at PNNL encompasses environmental stewardship in our operations, as well as how the Laboratory demonstrates social responsibility and advances economic prosperity—all in a manner that delivers lasting benefit to our sponsors, community, and the nation.

From innovative best practices in sustainable operations to environmentally focused scientific breakthroughs, PNNL is committed to making the world a better place to live for many generations to come. In fiscal year (FY) 2020, despite the unprecedented disruptions and challenges of the ongoing COVID-19 pandemic, staff at PNNL have remained productive. Key accomplishments and initiatives in advancing PNNL sustainability are highlighted below:

- **Reducing Energy Use**

  In March 2020, PNNL moved into curtailed operation to combat the COVID-19 pandemic and transitioned over 90% of PNNL's nearly 5,000 staff to telework. Since then, building operations have been modified to ramp up outside air flow to deliver maximum fresh air into applicable buildings following the Centers for Disease Control and Prevention (CDC) guidance. However, due to much reduced plug loads, PNNL was able to achieve an overall reduction in energy intensity of approximately 5% compared to FY 2019.

- **New Construction Project**

  PNNL started construction on the Office of Science's Energy Sciences Capability (ESC) project in early calendar year (CY) 2020. This facility will co-locate chemists, materials scientists, and computational scientists to advance catalysis and material syntheses for energy application. The ESC building will be PNNL's next sustainable building compliant with the 2016 Guiding Principles (GPs) and equipped with controls and sensors enabling Smart Labs operations.

  PNNL has begun the design of a Grid Storage Launchpad (GSL) building to consolidate and enhance the grid energy storage research capability. This building will meet the 2016 GP requirements.

- **Implementing Energy Conservation Measures through Utility Energy Service Contract**

  Cascade Natural Gas Corporation (CNGC) and its partner Johnson Control Inc. (JCI) have committed to enter into a Utility Energy Service Contract (UESC) with the Pacific Northwest Site Office (PNSO)/PNNL. A preliminary assessment report with a list of possible energy conservation projects will be available in mid-December 2020. A subsequent investment grade audit of the top projects will be performed in early spring of CY 2021.

- **PNNL is on Track to be 50001 Ready**

  In FY 2020, PNNL signed an agreement to support the DOE's *50001 Ready Cohort* initiative. This *50001 Ready* Energy Management System (EnMS), when implemented fully,

will improve PNNL's ability to continually identify, monitor, track, and improve energy conservation measures. PNNL is positioned to obtain the *50001 Ready* recognition from DOE by the end of 2021 or early 2022.

- **Elevating Energy/Water Resilience through Technical Resilience Navigator**

  The DOE's Federal Energy Management Program (FEMP) Technical Resilience Navigator (TRN) provides a systematic approach to examining resilience needs and goals, assessing on-site energy and water systems, evaluating risk, identifying resilience gaps, and developing and prioritizing solutions to resolve those gaps.

  In FY 2020, PNNL was selected by FEMP to pilot its TRN tool to determine the effectiveness of the methodologies and provide lessons learned/improvement opportunities. PNNL seeks to utilize the TRN process as a means of reviewing and improving its existing resilience posture. As a secondary objective, PNNL plans to share the lessons learned with other DOE sites. The TRN pilot is scheduled to be completed in FY 2021.

- **Better Building Smart Labs Accelerator Partner**

  PNNL participated in DOE's Better Building Smart Labs Accelerator Partner Program. In FY 2019, PNNL developed a Smart Labs evaluation tool to help with consistent review and qualifying buildings and laboratory spaces as "Smart Labs." To date, PNNL has qualified one building and 40 laboratory spaces using the PNNL Smart Labs check list. In FY 2021, PNNL plans to align the Smart Labs evaluation process with the Energy Independence and Security Act (EISA) commissioning/retro-commissioning requirements as a continuous improvement effort.

For additional information about these projects, please refer to the corresponding sections of this document. PNNL's FY 2020 performance status and projected performance in support of DOE goals are provided in the summary table below.

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution	Overall Risk of Non-Attainment
Energy Management			
30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1.0% YOY thereafter.	Current Performance: 5% reduction versus last year.	PNNL plans to build three new buildings and modernize several existing buildings and infrastructure. New buildings have highly innovative heating and cooling systems.	Medium Risk
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Compliant with EISA Section 432 requirements. Recently completed buildings are EMSL, BSF, CSF, and PSL.	PNNL will continue to complete EISA requirements.	Low Risk
Meter all individual buildings for electricity, natural gas, steam, and water, where cost effective and appropriate.	All individual buildings are metered for electricity, natural gas, steam, water, and chilled water, where	PNNL will continue implementing metering for applicable buildings. Metering progress will be documented	Low Risk

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution	Overall Risk of Non-Attainment
	cost effective and appropriate.	in the upcoming Meter Plan revision.	
Water Management			
20% potable water intensity (Gal per gross square foot) reduction by FY 2015 from a FY 2007 baseline and 0.5% YOY thereafter.	Current Performance: 64.6% reduction from FY 2007 baseline with a 10% decrease in WUI versus the FY 2019 revised WUI using last year's revised usage.	PNNL will continue to reduce potable water intensity as much as possible. Over one quarter of the potable water is used for cooling towers.	Low Risk
Non-potable freshwater consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA). YOY reduction; no set target.	Current Performance: 31% increase YOY.	Hot dry windy summer this year increased landscaping needs. Trending shows possible impact due to climate change. New buildings will impact ILA.	Medium Risk
Waste Management			
Reduce at least 50% of nonhazardous solid waste, excluding construction and demolition debris, sent to treatment and disposal facilities.	Diverted 55% through recycling.	Continue to implement and improve recycling program. Conduct assessment for waste reduction opportunities.	Low Risk
Reduce construction and demolition materials and debris sent to treatment and disposal facilities. YOY reduction; no set target.	Diverted 70% through recycling.	Continue monitoring C&D recycling performance and raising awareness on waste diversion requirements.	Low Risk
Fleet Management			
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline and 2.0 % YOY thereafter.	No information – pending FAST data upload to Dashboard.	Education will continue for vehicle custodians regarding the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible as COVID-19 Restrictions permit.	Low Risk

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution	Overall Risk of Non-Attainment
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter.	No information – pending FAST data upload to Dashboard.	Continue periodic checks on the local availability for alternative fuels. As older vehicles are replaced, PNNL will continue to work with General Services Administration (GSA) to determine if an alternative fuel vehicle (AFV) or electric vehicle (EV) is an option for replacement.	Low Risk
75% of light-duty vehicle acquisitions must consist of AFV.	PNNL only achieved 25% in FY 2020 due to limitations of GSA option available.	PNNL will continue to work closely with GSA to assure that all applicable PNNL vehicle orders are for alternatively fueled vehicles when available.	Low Risk
Clean & Renewable Energy			
"Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter.	Current Performance: 32% of electricity consumption is renewable, slightly exceeding the interim target of 30.5% for FY 2020.	REC purchases will be adjusted to meet new interim targets. PNNL will evaluate feasibility of renewable energy systems.	Low Risk
Continue to increase non-electric thermal usage. YOY increase; no set target but an indicator in the OMB scorecard.	Current Performance: 24% of total electricity and thermal energy is renewable.	REC purchases will be adjusted to meet new interim targets.	Low Risk
Sustainable Buildings			
At least 15% (by count) of owned existing buildings to be compliant with the *revised* Guiding Principles for Sustainable Buildings by FY 2021, with annual progress thereafter.	Current Performance: 52%.	All new construction will meet the Guiding Principles.	Low Risk

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution	Overall Risk of Non-Attainment
Acquisition & Procurement			
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and bio-based provisions and clauses are included in all applicable contracts.	Current Performance: 100% of eligible contracts contains the sustainable acquisition clause.	Continue being proactive with sustainable acquisition.	Low Risk
Measures, Funding, & Training (Jennifer/Patrick)			
Site set annual targets for sustainability investment with appropriated funds and/or financed contracts for implementation.	PNNL partnered with the Cascade Natural Gas (CNG) to explore potential energy savings projects for funding under a Utility Energy Services Contract (UESC).	Implement approved energy saving projects under UESC.	Low Risk
Electronic Stewardship			
End of Life: 100% of used electronics are reused or recycled using environmentally sound disposition options each year.	Current Performance: 100%.	Continue to reuse and recycle electronics.	Low Risk
Data Center Efficiency: Establish a power usage effectiveness target for new and existing data centers; discuss efforts to meet targets.	The normalized (weighted by information technology (IT) load) power usage effectiveness at PNNL is 1.30 for FY 2020	Continuing server and storage improvements along with removal of older devices has garnered a 19% decrease in overall ISB II/I Data Center IT Load.	Low Risk
Organizational Resilience			
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.	Currently conducting a pilot to identify improvement opportunities in energy/water resilience using the FEMP TRN tool.	Leverage the TRN pilot to improve integration of energy/water resilience in emergency response, workforce, and operations procedures and protocols.	Low Risk

Acronyms and Abbreviations

AFV	alternative fuel vehicle
API	application programing interface
BFT	Benton Franklin Transit
BIL	Battelle Inhalation Laboratory
BOCC	Building Operations Control Center
BPA	Bonneville Power Administration
BSF	Biological Sciences Facility
C&D	construction and demolition
CDC	Centers for Disease Control and Prevention
CMS	Chemical Management System
CNGC	Cascade Natural Gas Corporation
CSF	Computational Sciences Facility
DOE	U.S. Department of Energy
DSOM	Decision Support for Operations and Maintenance
ECM	energy conservation measure
EMSL	Environmental Molecular Science Laboratory
EnMS	Energy Management System
EPA	Environmental Protection Agency
EPRP	Environmental Protection & Regulatory Program
ESC	energy science capability
ESPC	Energy Savings Performance Contracts
EUI	energy use intensity
EV	electric vehicle
F&IO	Facilities & Infrastructure Operations
FAST	Federal Automotive Statistical Tool
FEMP	Federal Energy Management Program
FUA	Facility User Agreement
GHG	greenhouse gas
GP	Guiding Principles
GSA	General Services Administration
GSL	Grid Storage Launchpad
HEMSF	high-energy mission specific facility
HVAC	heating, ventilation, and air conditioning
IGA	Investment Grade Audit
ILA	industrial, landscaping, and agricultural
IT	information technology

JCI	Johnson Controls International
LCC	life cycle cost
LSL2	Life Sciences Laboratory 2
LSW	Laboratory Support Warehouse
MHP	managed hardware program
NREL	National Renewable Energy Laboratory
ODS	ozone-depleting substances
OMB	Office of Management and Budget
PA	preliminary assessment
PNNL	Pacific Northwest National Laboratory
PSL	Physical Sciences Laboratory
PV	photovoltaic
R&D	research and development
RCx	retro-commissioning
REC	renewable energy certificates
SA	sustainable acquisition
SC	Office of Science
TCG	Technology Conservation Group
TRN	Technical Resilience Navigator
UESC	Utility Energy Services Contract
UPS	uninterruptible power supply
VPN	virtual private network
WS&H	Worker Safety & Health
WUI	water use intensity
YOY	year over year

Mission Changes

Based in Richland, Washington, Pacific Northwest National Laboratory (PNNL) is one of 10 U.S. Department of Energy (DOE) Office of Science (SC) national laboratories operated by Battelle Memorial Institute.

Key projects associated with new construction and modernization of existing facilities, on the Richland and Sequim Campuses, to support PNNL's major initiatives and key programs over the next five years are summarized below. PNNL will strive to offset potential sustainability impacts by implementing energy and water conservation measures while conducting world class research.

- *The Energy Sciences Capability (ESC):* This facility will contain 52 laboratories, 200 workstations, and collaboration space. The ESC building will close the science capability gap in chemical and molecular science. This facility is scheduled to be complete in fiscal year (FY) 2021.
- *The Grid Storage Launchpad (GSL)*: This facility will enable validation, acceleration, and collaboration of next-generation grid-scale energy storage materials and technologies under realistic grid operating conditions. PNNL has obtained approval in FY 2020 to begin design of the GSL facility.
- *The Heat Transfer Building 1 (HTB1)*: To improve energy efficiency in ESC and GSL, this building will integrate EMSL's High Performance Computing (HPC) cooling system and provide waste heat to be used to temper single pass air needed at ESC and GSL facilities.
- *Richland North Office Building*: PNNL plans to begin construction, in FY 2022, on an approximately 26,000 gross square foot (gsf) office to support current and future mission needs on the northern end of the PNNL Richland Campus.
- *South Campus Office Building*: PNNL is proposing to construct an approximately 18,000 gsf office on the perimeter of the south end of the PNNL Richland Campus to support relocating support staff out of concentrated research focused areas of campus.
- *Laboratory Support Warehouse (LSW) High Bay*: PNNL is proposing to repurpose the existing LSW storage warehouse to high ceiling research space. This project will require adding additional power and potential ventilation to the existing facility. This project is anticipated to initiate in FY 2023.
- *Richland Storage Warehouse*: PNNL is proposing to construct a new general-purpose storage warehouse on the south end of the PNNL Richland Campus to replace the space lost to the creation of the high ceiling facility in LSW. This project is anticipated to initiate in FY 2021.
- *Sequim Campus Storage*: This general campus storage facility and associated outdoor laydown space will be constructed to accommodate proper storage and maintenance of large equipment when not in use. This building is expected to begin construction in FY 2023 or sooner.
- *Sequim Campus Revitalization*: PNNL is planning to revitalize the facilities at the PNNL Sequim Campus. This would include a new office/collaboration building, marine laboratory space, and large equipment/high ceiling space to support research activities.
- *Guest House*: The Guest House is currently configured as dormitory/hotel space to accommodate visitors to PNNL. This building was initially constructed in 2001 to support the EMSL user facility, as well as PNNL students and interns. Operating the Guest House as a hotel has become more difficult. In alignment with PNNL's strategic vision, dormitory wings of the facility will be converted to office space, creating roughly 50–60 new workstations, leaving the center of the facility as existing hotel space. This project was initiated in FY 2020 and expected to have a minimal increase in energy use.

In addition to the projects listed above, PNNL is evaluating the following projects to accommodate growing research capability in the following areas:

- *Nuclear Chemistry*: PNNL has identified a future need for additional nuclear chemistry space and is considering the construction of a new nuclear chemistry building to support forecasted growth in PNNL's Nuclear Engineering and Nuclear Radiochemistry core capabilities.
- *Quiet and Clean Chemistry*: PNNL continues to evaluate the amount and type of specialized chemistry space and the need for growth. One area of projected shortfall is in the specialized chemistry lab space needed to make the exquisitely precise chemical measurements that are a hallmark of PNNL's science. This could be accommodated through repurposing of existing lab space, additions to existing facilities, or a new chemistry lab.

In the next five years, PNNL plans to implement several general-purpose infrastructure improvement projects, as described below:

- *300 Area Waterline Replacement:* Originally designed to support the entire operating Hanford 300 Area, the existing potable water supply line that supports the remaining PNNL facilities is significantly oversized, which creates operational challenges. Rightsizing the waterline will help reduce PNNL's potable water usage. This project is proposed to be initiated within the 10-year planning horizon.
- *300 Area Steam-to-Hydronics Conversion:* PNNL is planning a steam-to-hydronics conversion project to replace failing heating infrastructure for three key Hanford 300 Area facilities. In addition to updating aging infrastructure, this project will attain institutional energy savings and, where feasible, increase the use of renewable energy sources. This effort will reduce PNNL's deferred maintenance by approximately $2.29M.
- *Richland Campus Steam-to-Hydronics Conversion:* PNNL is planning a steam-to-hydronics conversion project to replace failing heating infrastructure for six additional key Richland Campus facilities. In addition to updating aging infrastructure, this project will attain institutional energy savings and, where feasible, increase the use of renewable energy sources.

Energy Management

Performance Status

Energy Usage and Intensity

In FY 2020, PNNL's energy intensity was 165.5 KBtu/gsf, a net reduction of approximately 1% compared to the FY 2015 baseline, or a 5% year over year (YOY) reduction. Buildings excluded from the energy intensity goal, along with a copy of the exclusion self-certification letter, are included in the DOE Sustainability Dashboard. Provided below (Figure 1 and Figure 2) are PNNL's actual electricity and natural gas use in FY 2020 as well as the projection through FY 2025.

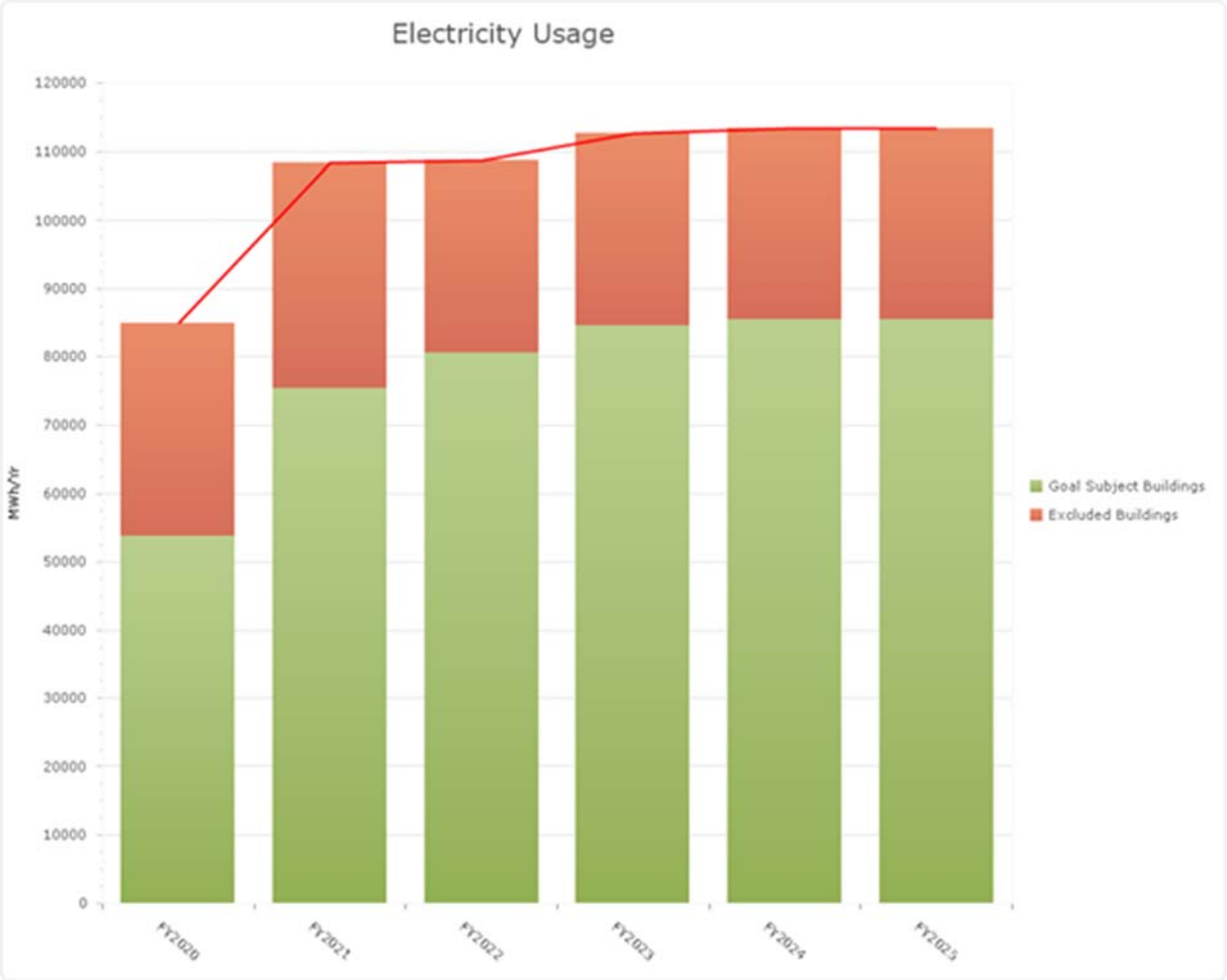

Figure 1. PNNL Electricity Usage (Actual and Projections) by Building Category Projection for the Next Five Years

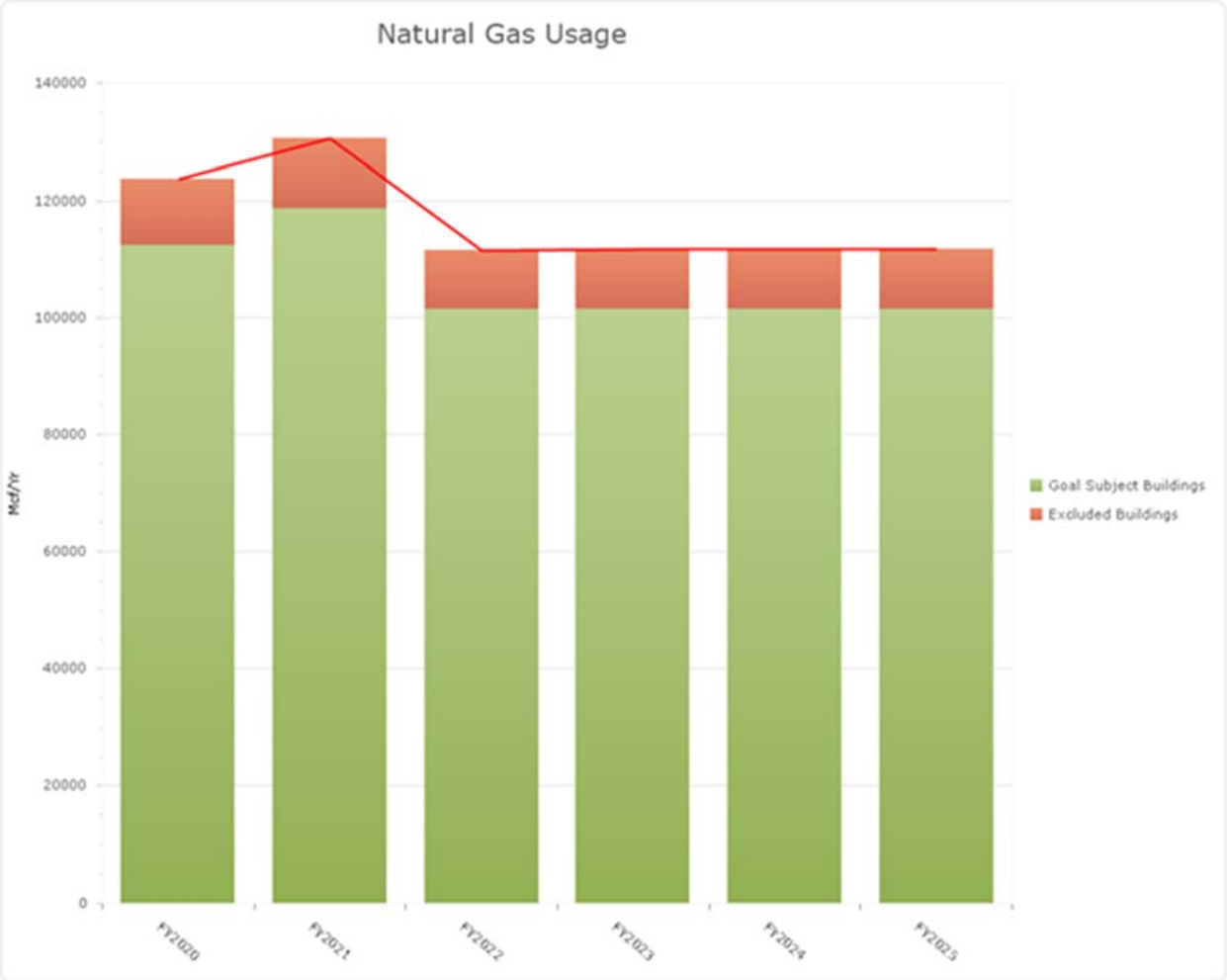

Figure 2. PNNL Natural Gas Usage (Actual and Projections) by Building Category Projection for the Next Five Years

In FY 2020, PNNL continues to reduce its energy intensity overall. PNNL's Building Operations Control Center (BOCC), staffed by engineers and power operators, avoided additional energy intensity increases by continuously monitoring building systems 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.

As a hub for energy tracking and control systems that connect building managers, building engineers, design engineers, and the building occupants, the BOCC is the integrator for assuring that energy and water targets 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 use, extend asset life, and enhance the reliability and efficiency of the PNNL operations. The BOCC leverages data from multiple platforms, including Decision Support for Operations and Maintenance tool (DSOM), 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.

In March 2020, due to the current COVID-19 pandemic, PNNL moved into essential operation and transitioned over 90% of PNNL's nearly 5,000 staff to telework. The building operations have been

modified to ramp up outside air flow to deliver maximum fresh air into applicable buildings following the Centers for Disease Control and Prevention (CDC) guidance. Throughout this time, PNNL was able to achieve an energy reduction through reduced plug load, low occupancy, and deployment of several energy saving projects, such as the replacement of chillers in the LSL2 buildings and new heat pumps in Building 350.

Other initiatives to improve energy performance are described below:

- In 2016, PNNL signed the DOE's Better Building Smart Labs Accelerator Partnership agreement and pledged to reduce energy use in laboratory buildings. PNNL has since established a Smart Labs program (during FY 2019) to deliver laboratory buildings that have energy performance and operation optimized for research tasks and the hazards associated with the work. The goal of the program is to implement an integrated partnership between the Environmental Protection & Regulatory Program (EPRP), Worker Safety & Health (WS&H), Research and Development (R&D), Facilities & Infrastructure Operations (F&IO), and Engineering to deliver demand-based ventilation, lighting, controls, and continuous commissioning.

  As part of this effort, PNNL has developed a set of checklists to standardize the Smart Labs evaluation process by analyzing performance in the areas of air, water, controls, and lighting. The checklist looked at physical elements that are available in the building and how these elements are being operated. Examples of these items include variable air volume and exhaust, building automation system controls, and occupancy sensors. Implementing Smart Lab capabilities allowed PNNL to reduce energy consumption by setting back temperature and airflow within the lab spaces, where appropriate. In FY 2019, PNNL qualified one building and 20 laboratory spaces. In FY 2020, PNNL qualified an additional 20 Smart Lab spaces. A goal has been set to add an additional 20 Smart Lab spaces in FY 2021.

- In FY 2020, PNNL signed an agreement to support the DOE's *50001 Ready Cohort* initiative. This *50001 Ready* Energy Management System (EnMS), when implemented fully, will improve PNNL's ability to continually identify, monitor, track, and improve energy conservation measures (ECMs). PNNL is positioned to obtain the *50001 Ready* recognition from DOE by the end of 2021 or early 2022.

EISA Section 432 Benchmarking and Evaluations

The PNNL Energy Program office successfully completed the comprehensive energy and water evaluation for the Biological Sciences Facility (BSF), Computational Sciences Facility (CSF), Physical Sciences Laboratory (PSL), and Environmental Molecular Sciences Laboratory (EMSL) buildings to achieve compliance with Section 432 of the Energy Independence and Security Act (EISA) 2007.

The comprehensive evaluation comprises an energy and water audit and a whole building commissioning assessment, with the objective of identifying ECMs and optimizing building systems operation.

As part of the EISA process, these facilities are benchmarked using Portfolio Manager as well as BuildingOS's Lucid software programs.

In FY 2020, PNNL partnered with the Cascade Natural Gas Corporation (CNGC) to explore potential energy savings projects for funding under a Utility Energy Services Contract (UESC). CNGC has partnered with Johnson Controls International (JCI) for completion of the audit and potential

implementation of ECMs. The UESC project is currently developing the preliminary assessment (PA) document and the investment grade audit (IGA) is expected in early FY 2021.

Over 1.4M square feet of building space was included in the initial scoping effort covering potential ECMs ranging from LED lighting retrofits to complete steam to hot water conversions. The PNNL team has leveraged its vast building data to provide multiple years of billing data and specific trending to the project team as requested. Past reports and studies have also been provided to the project team to document existing conditions and other ECMs evaluated by past projects.

Facility Metering

Individual building metering, as required by the Energy Policy Act (EPAct) of 2005 and EISA 2007, 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 2020 PNNL *Metering Plan* 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.

New guidance on metering is expected sometime in 2021. Once received, PNNL will update the Metering Plan as applicable.

Non-Fleet Vehicles and Equipment

Fuels used by non-fleet vehicles and equipment consist of mainly aviation gasoline 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 at PNNL. 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. This year, very little aviation fuel was used; this was because PNNL was in the process of selling the old research plane and purchasing a new plane, which was delivered just before end of FY 2020. The new research plane is in the process of being retrofitted with research equipment and sensors.

Plans and Projected Performance

Energy Usage and Intensity

PNNL plans to continue working toward reducing its energy intensity to meet annual energy reduction targets. To aid in this effort, PNNL’s Facilities & Infrastructure Operations organization is increasing collaboration with PNNL R&D research scientists and expanding the available tools and equipment specific to energy monitoring, control, and use.

Building energy/water audits will continue to be conducted across PNNL buildings to manually identify potential saving opportunities. These audits serve as a “boots on the ground” approach to identifying energy savings opportunities.

PNNL will also continue making real-time, informed decisions using advanced analytical tools and institutionalizing real-time commissioning of facility systems to increase attention on daily building operations versus periodic retro-commissioning (RCx) 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.

In FY 2021, PNNL is planning to review both existing and potential new software to aid in real-time building analytics. One of the main tools PNNL uses for real-time analytics of building performance, the DSOM tool, is intended to have its software infrastructure upgraded in FY 2021. This software maintenance upgrade will update the existing platform and expand DSOM's data gathering capability by establishing an application programming interface (API) connection to the Metasys Control System. In addition to this, PNNL will begin to evaluate the potential for expanding DSOM's building analytics capability.

Starting in FY 2021, PNNL is also planning to conduct a complete review of energy/water audits and RCx processes and procedures. The purpose of this review is to provide continuous improvement to the program, ensuring that PNNL is current with industry best practices.

To minimize PNNL's existing deferred maintenance and potential future deferred maintenance, PNNL is utilizing a two-pronged investment strategy. PNNL's planned major maintenance budget focuses on smaller expense opportunities and the facilities and infrastructure budgets focus on large expense and capital opportunities. In each approach, the reduction of deferred maintenance is a key factor in determining the priority of funding for maintenance activities. The proposed UESC project is also expected to target several potential opportunities to reduce deferred maintenance and renewal.

EISA Section 432 Benchmarking and Evaluations

PNNL will continue to conduct comprehensive energy and water evaluations for the Material Science and Technology Lab (3410), Radiation Detection Laboratory (3420), and Ultratrace Laboratory (3430) buildings.

With buildings being added each year, PNNL will continue to meet metering requirements by installing the most appropriate meter for each asset. As meter installations continue, PNNL will keep gathering and analyzing 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

By the end of FY 2020, PNNL reduced its water intensity by 64.6% compared to the FY 2007 baseline and achieved an 8.9% YOY usage reduction compared to the revised FY 2019 potable water usage. This is a 10% YOY reduction in the water use intensity (WUI).

Currently, the City of Richland provides potable water to all PNNL facilities in the vicinity of Richland, Washington. Prior to FY 2018, the reported water intensity included only water consumed in PNNL operated buildings. In FY 2018, PNNL took over operation and maintenance of the Hanford 300 Area water and sewer systems. PNNL began reporting all 300 Area water consumption, including the amount of water contributed from non-PNNL operated buildings (i.e., other Hanford contractors) as well as water used for water system operations, compliance, and losses.

In FY 2016, 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 Laboratory, performed a water balance analysis, and presented opportunities to improve water conservation and efficiency. The commitment to meet the Guiding Principles (GPs) for all new construction also helped with the reduction of potable water. PNNL's newest building, Discovery Hall, was designed to meet the GPs, and was expected to exceed a 20% reduction from the allowed baseline water usage. The actual usage was a 43% reduction compared to the baseline, which was more than double the expected reduction.

Table 1. Water Balance Analysis

Water Use Category	Estimated Percentage of Total Site Potable Water Use
Cooling Towers	28%
Lab Equipment	26%
Irrigation	17%
Domestic Fixtures	12%
Misc. Uses	17%
Steam Makeup	5%

According to the water balance analysis, only 17.5% of the total water used was potable, and almost half of that was used for cooling towers, process cooling, and irrigation (Table 1). A little over a quarter of the potable water was used in laboratories, about 11% was used for sanitary purposes, 5% was used for makeup water in steam systems, and the remaining amount was miscellaneous or losses. EMSL and CSF, both high-energy mission specific facilities (HEMSFs) with large supercomputer cooling loads and cooling towers, accounted for 37% of the potable water used at PNNL.

Industrial, Landscaping, and Agricultural Water

PNNL's total ILA water usage in FY 2020 of 229.6 million gallons is approximately 31% higher than the FY 2019 usage. This is primarily due to a hot, dry, windy summer compared to FY 2019, which, although it was also warmer than normal, was not as hot as 2020 and required less water.

Examination of the last five years of weather data seems to indicate that PNNL is experiencing longer, warmer, drier, and windier summers than in the past. Therefore, more ILA water for landscaping. In addition, PNNL is expanding with more research buildings, which demands a higher ILA water usage despite the use of more xeriscaping techniques.

PNNL also implements best practice in managing ILA water, such as utilizing soil moisture measurements and other soil analysis data for irrigation setting; and reviewing and adjusting irrigation water setting/schedule setting periodically, as needed.

The majority of PNNL's ILA water is supplied from the Columbia River, either through a PNNL river irrigation pumping plant or from a City of Richland river irrigation pumping plant. Only 4.1% of the Laboratory's irrigation uses potable water.

Plans and Projected Performance

Water Intensity

In FY 2021, PNNL plans to continue performing facility water audits, specifically on the EISA-covered facilities. The trending of water usage through the BOCC will help identify additional savings opportunities. The projection on potable water usage for the next five years is provided below (Figure 3).

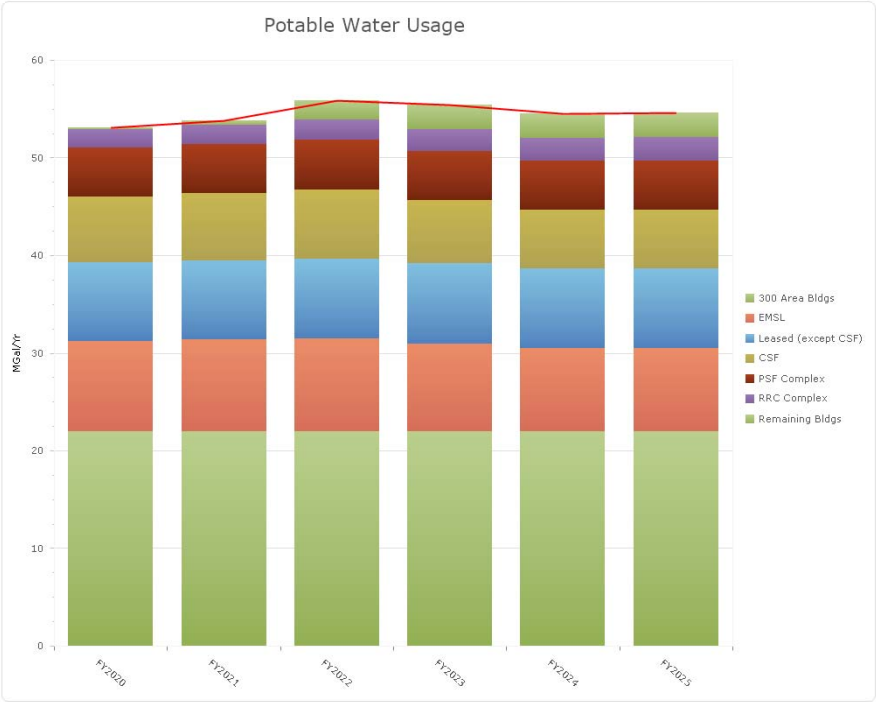

Figure 3. Potable Water Project for Next Five Years

Industrial, Landscaping, and Agricultural Water

As PNNL modernizes through new construction or major facility renovation, landscaping remains necessary for fire offsets, dust control, and heat island reduction. PNNL's approach in reducing irrigation water for new constructions is captured in an engineering design standard and performance

specification. Landscape plantings will be designed to incorporate a mix of traditional irrigated landscape as well as non-irrigated landscape with native grass, native shrub, and decorative rock groundcover to minimize maintenance water consumption and the use of chemicals while maintaining aesthetic beauty throughout the year. Possible alternative cooling options for the Richland Research Complex cooling ponds are also being investigated through UESC efforts. The projection on ILA water usage for the next five years is provided below (Figure 4).

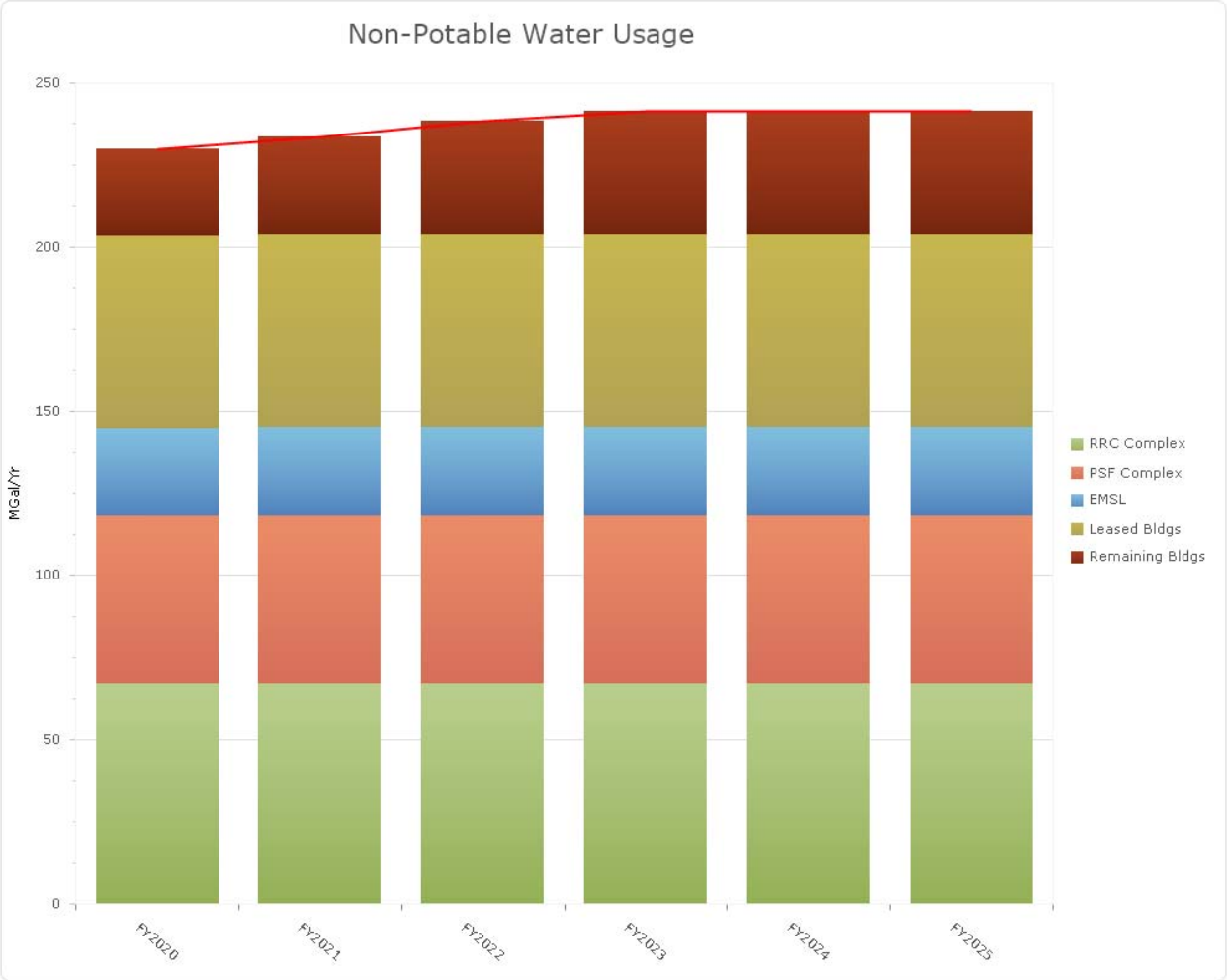

Figure 4. Non-Potable or ILA Water Projection for Next Five Years

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" (HDI), provides staff with requirements and instructions for releasing any materials or equipment from PNNL. HDI also provides instructions on waste minimization through recycling or redistribution.

In FY 2020, PNNL generated 333 tons of nonhazardous waste and diverted 402 tons (i.e., 55%) of nonhazardous sanitary waste through recycling and composting. 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 FY 2016. Prior to single-stream recycling, routine recyclables were separated into several different bins; the intention is to improve the recycling culture with this zero-sort recycling. In FY 2017, PNNL completed the transition from multi-stream recycling to single-stream recycling.
- A nitrile glove recycling program was initiated in FY 2015 to divert this high-volume, yet hard-to-recycle waste stream from laboratory spaces. Over 500 lbs. of gloves have been collected each year during FY 2019 and FY 2020. During FY 2020, the program was expanded to include several additional PNNL laboratory spaces, and shipping practices were expanded to improve the ability to support point source generation of nitrile gloves for recycling.
- Due to the pandemic, recycling pickup was suspended for approximately three months. However, despite the pandemic, PNNL remained committed to good recycling practices, and continued to facilitate single-stream recycling and nitrile glove recycling.
- In FY 2020, PNNL conducted a Pollution Prevention (P2) program assessment of the pilot program to collect laboratory glassware for recycling and of the Sustainable Acquisitions program. The assessment confirmed that the glass recycling program is successful and helped identify opportunities for improvement that should allow the program to expand into new labs during FY 2021. The assessment also concluded that sustainable acquisitions can be increased via better access to training and clear communications regarding program requirements for staff who purchase items.

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 FY 2020, PNNL generated 27 tons and diverted 63 tons (i.e., 70%) 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 the City of Richland. In

FY 2020, approximately 2.6 tons of green waste was diverted. Historically, management of the on-site composting program has been a group effort between the P2 program, the Battelle Garden Club members, and volunteer composting leads. Composting leads collect food scraps from building lunchrooms and empty them into composters, allowing Garden Club members to use the compostable materials as a natural fertilizer for their vegetable gardens. During FY 2020, this program was impacted by the COVID-19 pandemic and very little on-site composting took place.

Toxic Chemical Reduction

Chemical Management

PNNL's ChemAgain chemical redistribution program provides the primary means of collecting and redistributing usable chemicals internally. This program successfully redirected 286 containers of chemicals in FY 2020 through internal transfer or donation.

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 the following:

- 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 goal of 50% nonhazardous solid waste diversion, and has additional plans to expand existing recycling programs and increase the volume of sustainable product purchasing through the following:

- Continuing to expand nitrile gloves recycling in appropriate lab spaces, as appropriate
- Expanding laboratory glassware recycling to additional labs, as appropriate
- Assuring that sustainable acquisitions training is provided to all PNNL purchase card (p-card) holders
- Conducting a pilot test on at least one bio-based product in facility operations
- Distributing communications regarding sustainable acquisitions requirements to PNNL p-card holders and business-to-business (B2B) purchasing agents

- Improving program performance through periodic self-assessments.

During the next five years, one of the primary challenges facing PNNL's waste management program will be adjusting to changes in the Laboratory's on-site population. While the overall volume of recyclables may decrease with fewer staff on-site, PNNL plans to continue to support existing recycling programs that have established a strong culture at PNNL (e.g., single-stream recycling and nitrile glove recycling). Additionally, PNNL will seek targeted recycling programs (such as lab glass recycling) that serve lab spaces where staff are enthusiastic about additional recycling opportunities. PNNL's projections for the next five years for municipal solid waste and C&D waste are provided below (Figure 5 and Figure 6).

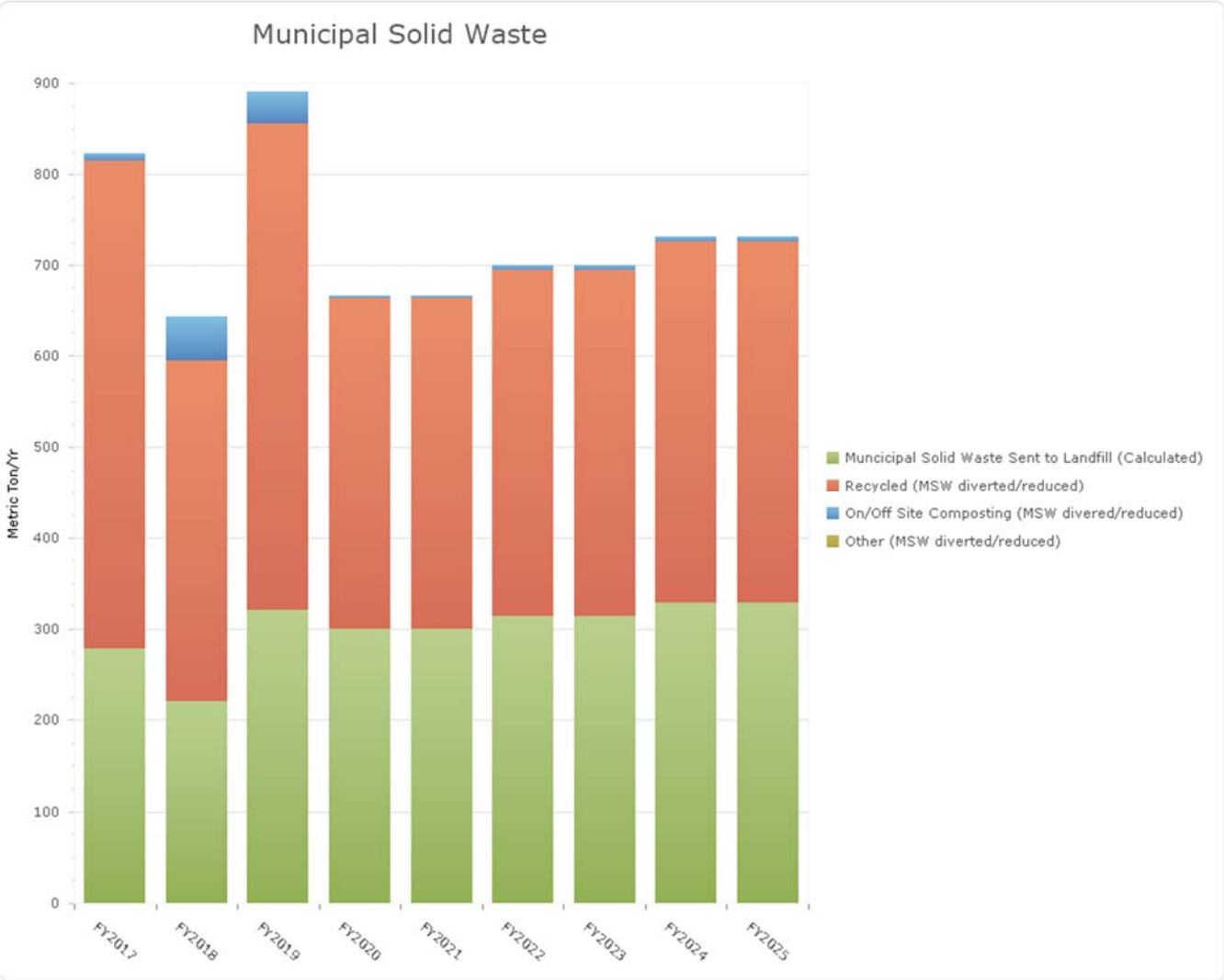

Figure 5. PNNL Municipal Solid Waste Projection for Next Five Years

Figure 6. PNNL Construction and Demolition Waste Projection for Next Five Years

Fleet Management

Performance Status

Reduced Petroleum

PNNL is estimated to be at a 37% reduction from the FY 2005 baseline. During FY 2020, the gallons of petroleum-based fuel used were decreased by over 5,000 gallons.

Alternative Fuel

PNNL has achieved over a 932% increase in alternative fuel use from the FY 2006 baseline. (Note: PNNL uses FY 2006 as a baseline year since FY 2005 had no alternative fuel available—that is, a baseline of zero gallons in FY 2005.)

Alternative Fuel Vehicles

A total of 25% of PNNL's light-duty vehicle acquisitions during FY 2020 were alternative fuel vehicles. This is due to limitations in availability from General Services Administration (GSA); in addition, the cost variance was not approved by DOE.

Plans and Projected Performance

Reduced Petroleum

PNNL will continue educating staff members on the importance of avoiding extra idling time, speed control, combining trips with other staff members when feasible as COVID-19 restrictions permit, and proper maintenance to help reduce their greenhouse gas (GHG) impact and meet the required goals for fleet used vehicles.

Alternative Fuel

PNNL plans to increase inventory of alternative fueled vehicles, including plug-in hybrid electric vehicles (EVs), and to continually educate staff on alternative fuel goals and the need to use alternative fuel when possible.

EPACT 2005 Section 701 Waivers

PNNL will continue to evaluate the availability of alternative fuels in areas in which fleet vehicles are operated. The Laboratory will continue to check for new locations that offer alternative fuels for its vehicles, and will reassign and relocate as needed when the situation presents itself for better fueling options.

Alternative Fuel Vehicles

When replacing a vehicle, the fuel type is always taken into consideration based on the availability of fuel types at the location where the vehicle is to be used.

Each year, PNNL holistically reviews the eligible vehicles for replacement and the current business requirements of the fleet, and requests replacement vehicles that meet DOE requirements and

business needs. Replacement vehicle orders are reviewed to meet alternative fuel vehicle requirements, by ensuring all light-duty vehicles acquired use alternative fuel when available, and all medium- and heavy-duty vehicles are as fuel efficient as possible (EISA Section 142; EPAct 1992, Section 303).

On-site Charging and Alternative Fueling

PNNL has a Construction Contract clause to include electrical vehicle charging infrastructure in the parking lots for all future new buildings. Charging stations will continue to be available for both fleet and personal staff use, with the capability to fully reimburse DOE for non-mission related cost.

Renewable Energy

Performance Status

In FY 2020, PNNL procured enough renewable energy certificates (RECs), combined with the on-site renewables, to offset 32% of its electrical use and 24% of its total electric and thermal energy.

Aside from RECs, PNNL has several on-site solar arrays. The solar hot water heater installed at EMSL produces approximately 160,000 Btu/hr peak 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 photovoltaic (PV) arrays power various air and water monitoring stations throughout the Richland Campus; these have not been counted toward the goal. In addition, PNNL operates a 125 kW PV array at the EMSL building, which is used for several R&D projects; the array also includes charging stations for electric fleet vehicles.

Plans and Projected Performance

PNNL annually assesses the necessary number of RECs based on projected need and GP requirements. The Laboratory's strategy of REC procurement will continue to meet the renewable energy goal of 7.5% of annual electrical consumption per 42 U.S.C. 15852.

PNNL is committed to finding ways to increase the amount of renewable power generated on-site. The Laboratory will periodically review the addition of new projects where economically feasible, although the latest National Renewable Energy Laboratory (NREL) assessment in 2017 indicated that there are limited opportunities for renewables that are economically viable based on the low electrical utility rates in the area. The UESC project is currently reviewing the feasibility of additional on-site solar PV and thermal projects. In addition, PNNL is examining the possibility of microgrids for increased reliability and business continuity due to grid interruptions. The projection for on-site renewable usage for the next five years is provided below (Figure 7).

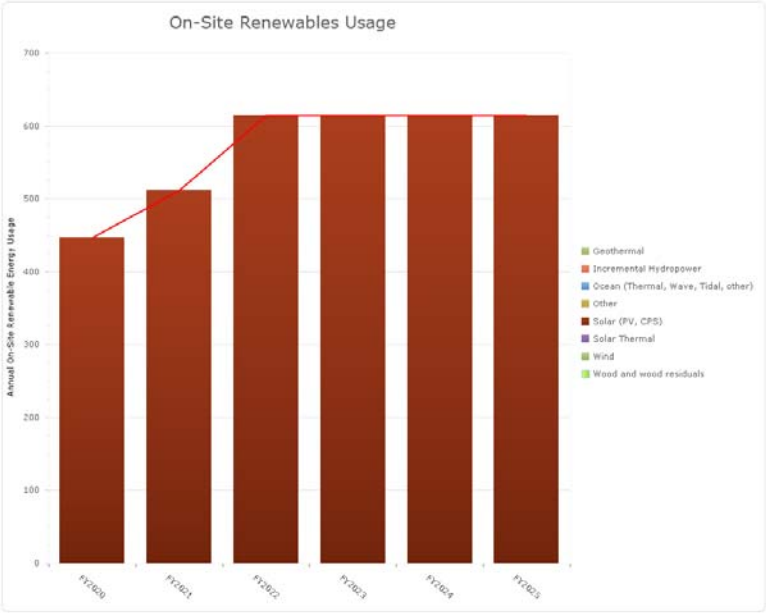

Figure 7. On-Site Renewable Usage Projection for Next Five Years

Sustainable Buildings

Performance Status

Currently, PNNL has 11 (or 517,841 gsf) of 21 (or 1,149,480 gsf) applicable buildings compliant with the GPs. This is 52% by building count, or 45% by total square footage.

In 2017, PNNL completed an assessment on four eligible existing buildings against the 2008 GPs. This assessment listed necessary steps and approximate costs to meet the GPs requirements for each appropriate building. In some buildings, investments needed to achieve sustainable building status may not be cost effective, based on facility age, mechanical equipment design, or specific and specialized research activities.

In late 2019, 10 privately owned buildings at PNNL transitioned to DOE ownership. Six of these buildings are greater than 10,000 gsf and will be reviewed against the 2016 GPs in FY 2021.

In FY 2020, PNNL completed the evaluation of the 3400 building (Discovery Hall) using the 2008 GPs. This is the second new facility at PNNL to use the GPs as a path toward sustainable building status. Sustainable design elements include 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.

Plans and Projected Performance

PNNL has committed that all new construction, major renovations, and alterations of buildings greater than 10,000 gsf will comply with the GPs. Planning for future facilities, including line item, general plant project, or leases, will consider these requirements.

The ESC building is currently under construction and expected to complete commissioning in late FY 2021 or early FY 2022. This will be the first new facility at PNNL to use the 2016 GPs as a path toward sustainable building status. To strengthen resiliency posture, this building will have a redundant power supply through a backup generator and uninterruptible power supply (UPS) to retain long-term study and protect restart-sensitive equipment during a power outage. The building will have redundant heating systems. The primary heating is provided by waste heat recovered from the nearby supercomputing facility, and high efficiency boilers will be installed as a backup.

Additionally, PNNL has begun the design of a GSL building to consolidate and enhance the grid energy storage research capability. This building will be designed to meet the 2016 GP requirements. Other key projects associated with new construction on the Richland and Sequim Campuses that will support PNNL's major initiatives and key programs over the next five years are provided in the Mission Changes section. The projection on sustainable buildings for the next five years is provided below (Figure 8).

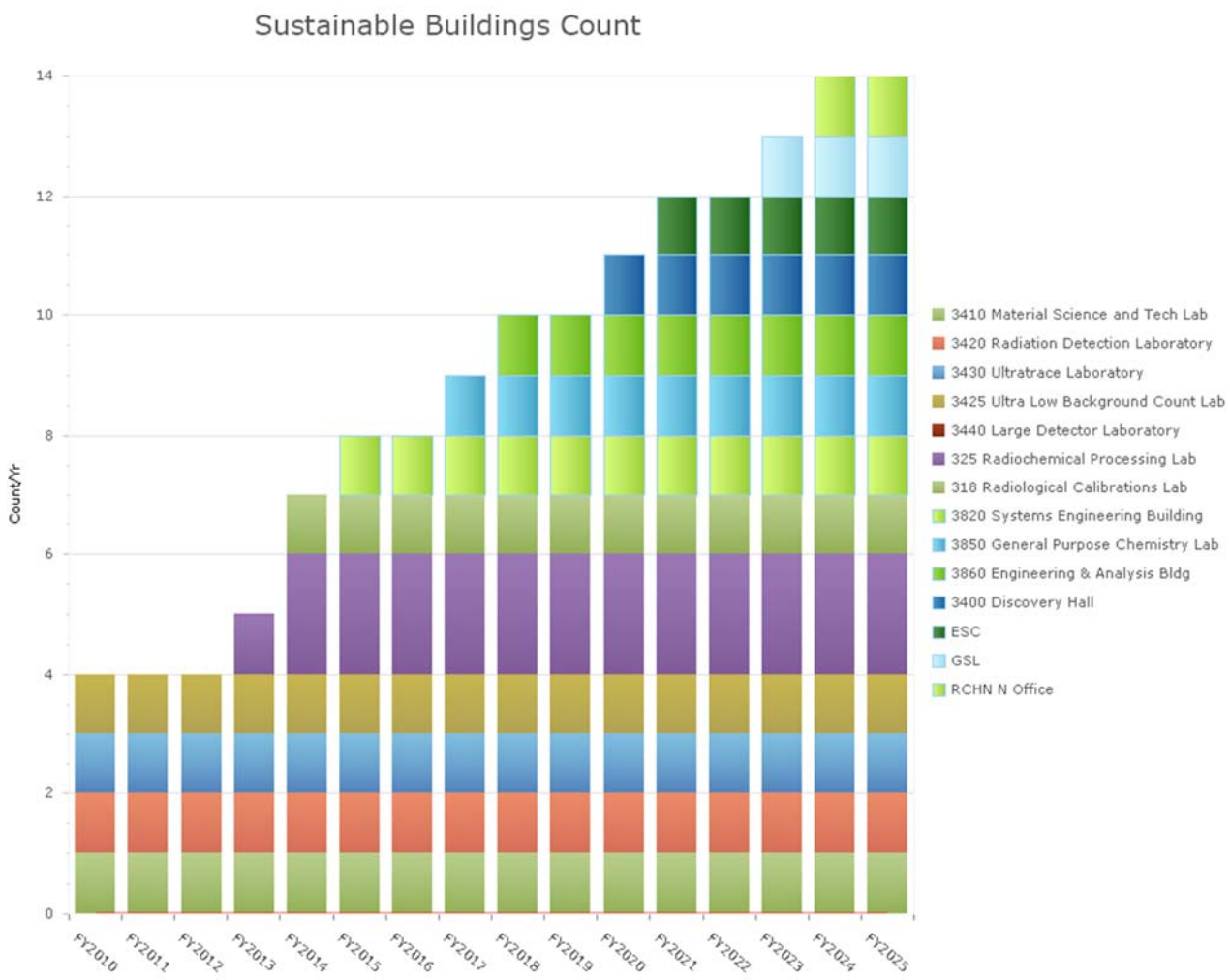

Figure 8. Sustainable Buildings Count Projection for Next Five Years

Acquisition and Procurements

Performance Status

During FY 2020, PNNL implemented several improvements to its acquisition system for sustainability compliance. Below are three highlights:

- Continuing education was provided to contracts specialists and technical oversight representatives regarding sustainable requirements and their roles and responsibilities for compliance through a variety of training methods.
- Education was provided to end users and management via product demonstrations at vendor shows and through a variety of training methods.
- A partnership with a local small business to coordinate ink cartridge recycling program was created to assure proper waste stream recycling of used ink cartridges.

Plans and Projected Performance

PNNL will continue increasing the awareness of staff regarding available sustainable products, encouraging participation in on-site events, and educating staff about sustainable acquisitions. Benchmarking with other federal agencies on best practices will also proceed. Planned activities for FY 2021 and beyond include the following:

- Guidance and training will be revised and updated to provide continuing education to contracts specialists and technical oversight representatives about sustainable requirements and their roles and responsibilities to comply with the requirements of PNNL's Site and Sustainability Plan and Prime Contract updates relative to sustainable acquisitions requirements.
- Education will be provided to end users and management via vendor product demonstrations and revamped training and procurement guidance material.
- PNNL will assure 100% of eligible contracts contain the sustainable acquisition clause. Application of sustainable acquisitions requirements will be continued for all eligible procurements and program oversight will be provided for purchases via the purchasing card method and eProcurement; opportunities for improvement will be reviewed.

Measures, Funding, and Training

Performance Status

PNNL successfully leveraged alternative financing in FYs 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 FYs 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.

Beginning in FY 2017, through a UESC, PNNL partnered with Bonneville Power Administration (BPA) and completed energy assessments in Buildings 318, 325, 331, 350, 3020, 3410, 3420, 3425, 3430, 3440, 3475, and 3820. BPA has identified several ECMs as a result of these assessments. However, BPA is transitioning its business away from offering UESC energy conservation and financing services for the federal installation in BPA's service territory; implementation of non-no/low costs ECMs has been put on hold until an alternative partner can be identified.

In FY 2020, PNNL was successful in partnering with CNGC, and outlined over 1.4M square feet of building space to have energy assessments completed. Currently, the UESC project is working on the PA document, with planned submission in December 2020. PNNL expects the UESC project to move forward into the IGA phase sometime in early CY 2021.

This UESC project will likely address several ECMs that were identified in the previous RCx reports. Lighting, additional building sensors, heat recovery, and steam to hot water conversion are a few of the ECMs being evaluated by the UESC project team that are also listed in the Dashboard.

Training & Education

During FY 2020, a total of 12 staff at PNNL virtually attended several sustainability related conferences, workshops, seminars, or courses, such as the International Institute for Sustainable Laboratories (I^2SL), DOE Energy Exchange, and the Smart Buildings conference. The cost associated with this training/education was approximately $4,644.

Plans and Projected Performance

PNNL will continue implementing low/no cost ECMs, where applicable. RCx of buildings will also continue to keep building energy consumption in check. PNNL is expecting to significantly reduce energy consumption by implementing projects through a UESC project with CNGC. The final size and impact of the project is still in development, but a healthy mix of projects has already been identified, with potential energy savings ranging from 10–25%.

Additionally, 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 in the latest building efficiency technologies and maintain or increase the number of qualified Energy Managers and Building Commissioning Professionals.

Staff at PNNL are also planning to provide training on UESC processes and requirements to key personnel involved in the project in late CY 2020 or early CY 2021. The goal of this training to inform the personnel on the makings and requirements of a UESC project as well as to help with the decision-making process during the IGA.

Travel and Commute

Performance Status

PNNL utilizes a multi-pronged approach to promote alternative commuting and reductions in air and ground business travel. PNNL took major steps in FY 2020 to enhance remote collaboration capabilities and to encourage staff to explore alternatives to business travel where possible. While many of these efforts were already planned and underway before the COVID-19 pandemic, they were greatly accelerated to enable teleworking of over 90% of staff at PNNL.

In early FY 2020, PNNL completed the deployment of the Connected Client project by replacing aging client hardware with energy efficient standardized laptops and deploying Microsoft 365. The completion of the Connected Client project allowed most PNNL employees to easily transition to full time telework at the onset of the COVID-19 pandemic. Part of the rollout of Connected Client provided staff with headsets or other standard portable audio devices that greatly assisted in maintaining staff productivity while teleworking full time. The dependency on Virtual Private Network (VPN) has been reduced and staff can securely use email, Microsoft Teams, and OneDrive without a VPN connection. Additionally, PNNL increased VPN capacity to assure a majority of staff could telework with minimal interruptions. The rollout of Microsoft Teams was accelerated due to the pandemic, allowing increased collaboration.

To improve pedestrian safety, PNNL worked with a local agency (City of Richland) to install several crosswalk/flashing light posts on one of the main roads (George Washington Way) at the Richland Campus. The City has also closed out three street entrances to PNNL's main campus to divert traffic to major roadways. This improvement will enable a more walkable campus and reduce intra-campus driving and emissions.

Typically, PNNL hosts an annual Bike-to-Work Day event to celebrate National Bike-to-Work Day each May. Because of the COVID-19 pandemic, this event was cancelled this year. The sustainability team did work with other PNNL organizations to support an at home wellness event that encouraged bike riding during the summer months.

PNNL continued its partnership with the local transit service, Benton Franklin Transit Services (BFT), to encourage alternative commute via bus service. BFT now serves the Richland Campus every 30 minutes during business hours, and all buses are equipped with Wi-Fi, which allows riders to work while traveling. Additionally, the route that serves the Richland Campus is now a direct route to a major, centrally located transit center, making the commute more convenient for those who do not live along the route.

Interest in and ownership of personal EVs grows stronger each year at PNNL. EV charging stations with ChargePoint software were first installed in 2010 and are now available throughout the Richland Campus to support PNNL's growing EV population. Employees may utilize pre-paid ChargePoint accounts that enable them to use the car-charging stations located on-site.

Plans and Projected Performance

PNNL's business travel reduction strategy will continue to encourage efficient traveling and alternatives when they are equally effective. PNNL is currently working to further improve collaboration abilities by upgrading conference room capabilities; improved video conferencing and the ability to share whiteboard content is being worked toward. Once staff return to campus, informing and encouraging

the use of these connection-ready rooms to work with off-site staff members, collaborators, and clients can lead to less business travel.

As a result of the COVID-19 pandemic, staff at PNNL have found solutions to effectively telework. PNNL expects that once it is safe to work on-site again there will be an increase in regular teleworking compared to pre-pandemic numbers. To continue to facilitate teleworking, PNNL is further decreasing VPN dependency and completing the full implementation of Microsoft Teams in FY 2021. Once staff safely return to campus, there will be improved lab tools that reduce the dependency of in-person staff in lab space and more “turnaround” workspaces will be provided for staff that wish to telework more frequently.

When commuting resumes, PNNL will continue efforts to support EV usage by assuring enough charging stations are available and encouraging EV charging etiquette among the users. Biking to work will also continue to be encouraged, and cyclists who bike to work will be celebrated on National Bike-to-Work Day each May.

Fugitives and Refrigerants

Performance Status

PNNL uses sulfur hexafluoride (SF_6) 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 a tracer gas). In FY 2011, PNNL worked with researchers who used SF_6 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 SF_6. For electron microscopes, SF_6 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. 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 assure 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, 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 SF_6 using the Chemical Management System (CMS) tool. Any new purchase of SF_6 will be reviewed on a case-by-case basis.

Electronic Stewardship

Performance Status

Acquisition

PNNL has a managed hardware program (MHP). Staff are required to procure standard personal computers, printers, and peripheral devices through PNNL's MHP. PNNL has moved to a laptop/mobile first policy for client systems. Procurement of non-standard items outside of MHP requires a documented business justification and is reviewed on a case-by-case basis.

Operations

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, such as for the PNNL legal department, where single-sided legal documents are required.

End of Life Management

In FY 2020, 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. PNNL entered into a new Scrap Electronics Recycle contract with Technology Conservation Group (TCG) Recycling, a Responsible Recycling (R2) certified electronics recycling facility, to improve process efficiency. For computing equipment located at off-site locations, PNNL uses the Federal Blue Earth program to reduce transportation costs while ensuring electronics are recycled to government standards.

Data Center Management

The normalized (weighted by information technology [IT] load) power usage effectiveness across PNNL is 1.30 for FY 2020. Continuing server and storage improvements, along with removal of older devices, has garnered a 19% decrease in overall ISB I/II Data Center IT Load. This is following last year's 25% energy decrease in the same data center.

Plans and Projected Performance

In early FY 2020, PNNL completed the deployment of the Connected Client project by replacing aging client hardware with energy efficient standardized laptops and deploying Microsoft 365. The completion of the Connected Client project allowed most PNNL employees to easily transition to full time telework at the onset of the COVID-19 pandemic. Part of the rollout of Connected Client provided staff with headsets or other standard portable audio devices that greatly assisted in maintaining staff productivity while teleworking full time.

During FY 2021, modernizing the datacenter will continue. PNNL plans to focus on retiring old storage, compute technology, network hardware, and operating systems. As the old equipment is retired, increased energy savings will be realized. Another project in FY 2021, titled “EIT Cloud Migration,” will begin to move currently virtualized servers to an Azure infrastructure as a service cloud environment. This project will begin to reduce compute and storage infrastructure required to host PNNL Enterprise IT workloads.

Resilience

Performance Status

Resilience Planning

Site resilience planning is an iterative process for PNNL, and is revisited as external hazards and threats, site missions and priorities, and local systems and conditions change. During FY 2015, PNNL developed a Climate Resilience Action Plan, which examined climate-driven hazards and their potential to impact various PNNL systems, including human, natural, and infrastructure. This is available on the PNNL Sustainability website.

Recognizing DOE's growing focus on ensuring the energy and water resilience of its critical sites, PNNL committed to piloting the FEMP Technical Resilience Navigator (TRN) in FY 2020. This gave PNNL the opportunity to examine, in greater detail, risk to PNNL operations from energy and water systems conditions, operations, procedures, and plans. PNNL's engagement with the TRN pilot is helping FEMP to validate and improve the tool, while identifying potential opportunities for improvements in PNNL's energy and water resilience. PNNL is also sharing lessons learned from this experience with other DOE offices and sites to help others enhance resilience at their own facilities.

PNNL initiated the TRN planning process and assessment of baseline conditions in FY 2020 and will continue into FY 2021. Specific actions included the following:

1. Establishing a resilience planning team and engaging stakeholders
2. Collecting and reviewing existing policies and plans, such as the Climate Resilience Action Plan, that could impact or intersect with resilience planning efforts
3. Defining the scope of the resilience assessment and identifying resilience priorities for the Richland Campus
4. Identifying critical functions with senior management
5. Collecting and reviewing sources of information used to establish the site's critical loads and their energy and water requirements, as well as the baseline conditions of those systems
6. Establishing energy and water requirements for critical loads
7. Establishing baseline conditions of energy and water systems that enable critical loads.

The internal stakeholder team in the TRN effort included a cross-cutting group of program managers and technical personnel with responsibility for employee safety, energy and water resource management, continuity planning, and facility engineering and design. The members of this group have direct responsibility for implementing energy and water management that must be maintained to assure successful lab operations.

In FY 2021, PNNL will use the baseline assessment to establish risk to critical missions from potential disruptions in critical energy and water utilities. PNNL will use that risk analysis to inform the development technological, operational, and institutional/policy solutions

Risks to Mission, Operations, and People

The FY 2015 Climate Resilience Action Plan established potential impacts from current and changing climate exposures on PNNL's core systems, considering current levels of preparedness. Higher priority areas, shown in Table 2, are the focus of PNNL's near-term climate resilience planning actions, and represent a starting point for PNNL's FY 2021 TRN pilot resilience planning effort.

Table 2. Potential Climate Exposures and Impacts on Core Systems

Climate Exposure/Core System	High Temperatures	Intense Precipitation	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

The two climate exposures of highest concern to PNNL's campus operations are the projected increase in the number of high-temperature days and the intense precipitation events that are experienced each year. Of particular concern is how these climate exposures could impact the Laboratory'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. A specific concern is the flood risk to a below-grade data center on the Richland 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 Table 3. These measures are well-established procedures and building operation best practices. Additional information on PNNL's climate resilience planning process is provided in the PNNL Climate Resilience Action Plan. PNNL will be identifying additional potential solutions to enhance Richland Campus energy and water resilience as a part of the TRN pilot in FY 2021.

Emergency Response Procedure

The PNNL Emergency Management and Business Continuity Plans 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). The 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 threats and hazards, and no further actions are necessary.

Changes to PNNL's operating structure based on COVID-19 lessons learned are being leveraged in the TRN pilot and will inform planned updates to PNNL Emergency Management and Business Continuity Plans.

Plans and Projected Performance

The TRN pilot team meets regularly to discuss progress toward understanding current campus resilience posture. The Sustainability Program team members responsible for resiliency planning will continue to consult with internal subject matter experts as warranted.

Table 3. Measures to Address High Priority Climate Impacts on PNNL Systems

Climate Exposure and System Impacts	High Temperature Impact on Building and Energy Systems	Intense Precipitation Impact on Building Systems
Measures	• Preventive maintenance plans are reviewed annually. • Cool roofs are the design default. • Use of light-colored materials for roofs and hard-paved areas is maximized. • Building orientation and window glazing are optimized. • Energy escalation rates will reflect risk in facility design and operations planning. • Equipment life cycle cost (LCC) is tracked via CostLab (PNNL's maintenance program software). Premature equipment failures due to climate are reviewed during annual assessment. Equipment LCC will be adjusted in CostLab. • PNNL has the ability to reduce power load if needed through its building control system (Metasys). Operation of this system is captured in a PNNL operating procedure. • Continuous commissioning and facility-tuning for EISA "covered facilities" is implemented. • All space temperatures are monitored using the DSOM tool for Facility User Agreement (FUA) compliance.	• Preventive maintenance procedures to clean roof drains. • Preventive maintenance measures associated with building drainage. • Five-year condition assessment, including drainage system integrity. • Preventive maintenance procedure to clean catch basins/storm drains.
Responsible Offices	• Sustainability Management & Operations (M&O) Program • BOCC & Energy • Plant Engineering	• Sustainability M&O Program • BOCC & Energy • Plant Engineering

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