Pacific Northwest
NATIONAL LABORATORY

ECONOMIC IMPACT REPORT

OF PACIFIC NORTHWEST NATIONAL LABORATORY ON THE STATE OF WASHINGTON IN FISCAL YEAR 2022

U.S. DEPARTMENT OF ENERGY

DISCLAIMER

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operated by
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for the
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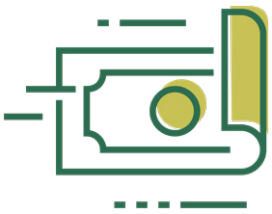
September 2023

JM Niemeyer
JL Blake

Prepared for
the U.S. Department of Energy
under Contract DE AC05 76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

HIGHLIGHTS



$1.34B

Annual spending

$635M

Total domestic payroll

$554M in Washington State

>5,700

Staff members

84.1% (4,795) living in Washington State in 2022

27% growth in employment 2017–2022

$31.9M

Estimated taxes paid by PNNL and its employees to Washington State and local governments

$1.93B

Total economic output supported by PNNL payroll and domestic purchased goods and services

$756M in Washington State wage income

>7,500 total jobs generated in Washington State

$683M

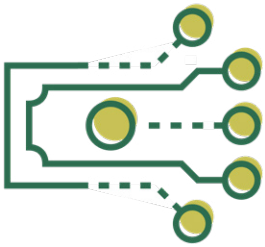
Domestic purchased goods and services

$93M in Washington State

207

Companies formed with PNNL roots since 1965

In Washington State:
11 started in the last 10 years and are still in business with **$11.1M** revenue and **>53** employees



$618K

Cash contributions to philanthropic and civic organizations, including **$285K** corporate support for STEM education, by Battelle

This report was stewarded by Dana Storms, chief risk officer and executive director of the Office of Performance Management. The team was guided by Chris Larmey.

The following staff were key to gathering the data used within this report and providing reviews to ensure its accuracy: Dave Anderson, Miriam Blake, Karen Kniep Blanton, Colleen Carter, Robin Conger, Ty Creer, Dani Deichman, Mary Foraker, Mindy Frankenfield, Hanna Goss, Jacquelin Gurung, Jodi Hamm, Kate Hankins, Pamela Harrington, Mark Hattrup, Trish Herron, Breanna Hughes, Jarrod Jones, Kathleen Judd, Karen King, Jennifer Knotts, Matt Little, Ali Madison, Jim Mather, Jason Nanni, Beth Norris, Eric Poehlman, Jena Reynolds, Paul Runci, Melanie Roberts, Amanda Schoch, Jaime Shimek, Evangelina Shreeve, Jacob Skeels, Rick Washburn, Linda Wierenga, and Dawn Zimmerman.

The authors appreciate the efforts of Jeff London for his graphic design support, Melanie Johnston for Communications support, and Andrea Starr for providing the images contained within this report.

ACRONYMS AND **ABBREVIATIONS**

ARM	Atmospheric Radiation Measurement
B	billion
DOE	U.S. Department of Energy
DOE-SC	DOE Office of Science
EMSL	Environmental Molecular Sciences Laboratory
FY	fiscal year
GSL	Grid Storage Launchpad
GSP	Gross State Product
IMPLAN®	IMpact analysis for PLANning
IP	intellectual property
K	thousand
M	million
OASI	Social Security Old Age and Survivors' Insurance
PNNL	Pacific Northwest National Laboratory
QIS	Quantum Information Science
R&D	research and development
SSA	Student STEM Ambassadors
STEM	science, technology, engineering, and mathematics
U.S.	United States
WA	Washington State
WDTS	Workforce Development for Teacher and Scientists
WSSEF	Washington State STEM Education Foundation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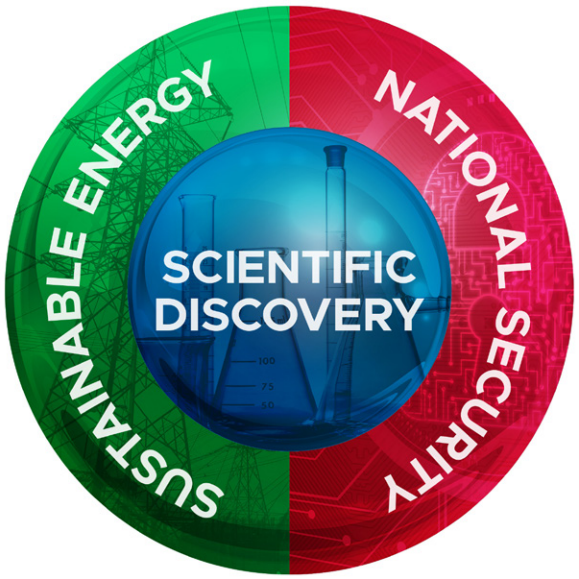
CONTENTS


DUMONT
SWITZERLAND

WHO WE ARE

Pacific Northwest National Laboratory (PNNL) is one of 17 Department of Energy (DOE) national laboratories, a network of science and technology powerhouses addressing some of the most complex and consequential problems facing society. At PNNL, we tackle some of the largest and most challenging research questions, from the origins of the universe to Earth's changing climate.

PNNL, which is based in Richland, Washington (WA)—with additional campuses in Seattle; Sequim; Portland, Oregon; and College Park, Maryland—has deep roots in the Pacific Northwest, originating in support for the Cold War mission of the Hanford Nuclear Site. Battelle Memorial Institute manages PNNL on behalf of DOE, supporting the department's missions in scientific discovery, energy, national security, and environmental stewardship.



PNNL is stewarded by DOE's Office of Science (DOE-SC)—the nation's largest sponsor of basic research in physical science. With distinctive strengths in chemistry, Earth sciences, biology, and data science, our research strives to advance the frontiers of knowledge and apply that knowledge to solve major problems. We are also committed to sharing knowledge and partnering across sectors to ensure our discoveries and technologies benefit the nation and prepare the next generation of scientists and engineers.

At PNNL, scientists and engineers are improving and modernizing energy systems, both in the United States (U.S.) and internationally, making them more resilient in the face of increasingly frequent extreme weather events and cyberattacks, and developing grid-scale energy storage technologies to accelerate the expansion of carbon-free renewable electric power production. Our work modernizing the U.S. energy system includes research in advanced power grid modeling, development of energy storage materials and technologies, renewable energy integration, and grid cybersecurity. We strive to realize the vision of a U.S. energy system that is more efficient, flexible, and environmentally sustainable.

We develop science-based solutions that safeguard the United States against many national security threats. Our research supports federal agency sponsors' missions to secure U.S. critical infrastructure, combat global terrorism, detect and analyze existing and emerging threats, and prevent the use of cyber, nuclear, chemical, and biological weapons of mass effect.

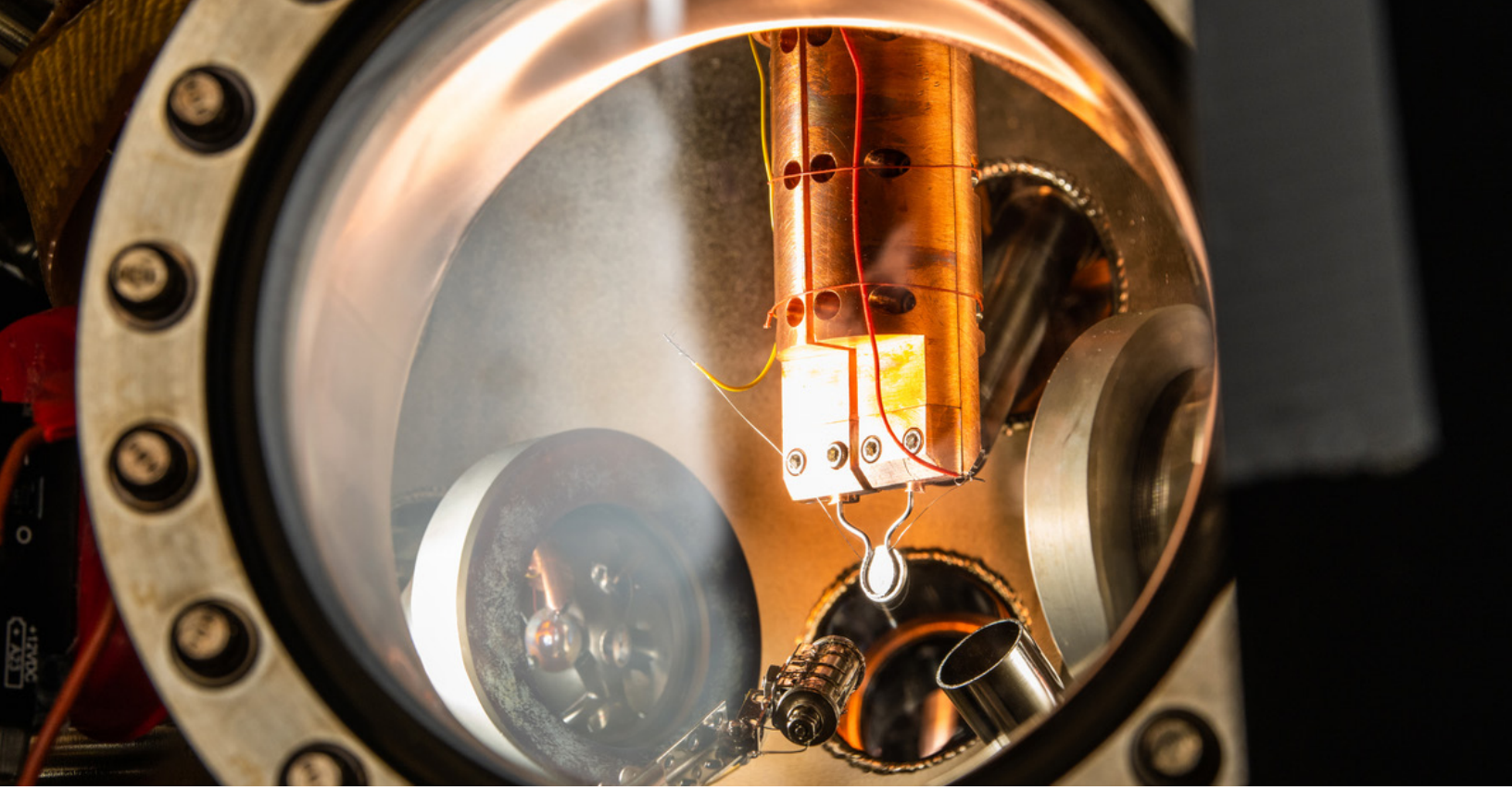
PNNL is home to more than 20 specialized research facilities, including dedicated laboratories for power grid operations, coastal sciences, data analytics, energy sciences, and atmospheric sciences. These resources equip researchers to expand the frontiers of scientific understanding and technological possibility in areas of national importance.

We play important stewardship roles in the management and operation of two DOE-SC national scientific user facilities: the Environmental Molecular Sciences Laboratory (EMSL) and the Atmospheric Radiation Measurement (ARM) user facility. The instruments and expertise housed in these facilities are available to the research community on a merit basis and enable the research of more than 2,000 scientists worldwide, annually.

LETTER FROM **THE DIRECTOR**

Pacific Northwest National Laboratory and our talented staff advance the frontiers of knowledge and take on some of the world's greatest scientific and technological challenges, with a focus on advancing scientific discovery, enabling energy sustainability, and enhancing national security. The scientific impact we deliver to the nation and world also contributes significantly to the economic vitality of Washington State. PNNL and its operator, Battelle, have an enduring commitment to support the prosperity and growth of Washington and the communities in which we live and work.

In fiscal year (FY) 2022, despite lingering pandemic-related challenges, our staff was extremely productive, enabling PNNL to deliver on its commitments to our many sponsors. In fact, their exceptional ideas and winning proposals resulted in yet another record year of funding. Similarly, it was another record year for hiring, resulting in 627 new hires and 725 interns, for a total of more than 5,700 employees.



The tremendous year we had at PNNL translated into positive economic impact for Washington State. For example, the total economic output of PNNL's payroll and domestic goods and services exceeded $1.93 billion (B), we generated more than 7,500 total jobs, our annual spending was $1.34B, and the contributions to philanthropic and civic organizations from Battelle, PNNL, and our staff members totaled $618 thousand (K).

I am extremely proud of the contributions that the innovative and dedicated staff at PNNL make to our state, region, and nation. I invite you to read this report to learn how their talent and passion for scientific discovery, technological innovation, and driving solutions to market contributes to the economic vitality of Washington State.

Best regards,

Steven F. Ashby

Dr. Steven Ashby
Director, Pacific Northwest National Laboratory

THE ECONOMIC **IMPACT OF SCIENCE**

$1.55B
FY 2022 FUNDING

$1.34B
FY 2022 SPENDING

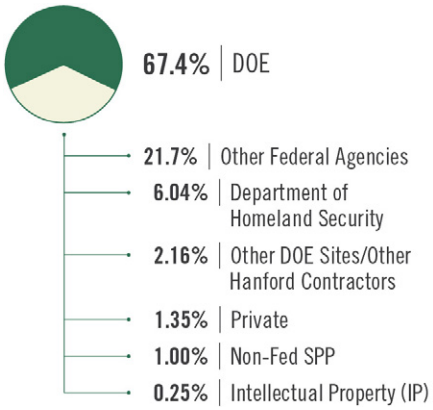
Beyond our scientific impact, the economic impact of our presence in the state and community is significant. This includes the amount of revenue we receive; costs we incur, along with purchased goods, services, and investments; our staff and their spending in the communities in which they reside; and our direct and indirect economic activity.

Funding and Spending

PNNL is a large and vital economic entity, with more than 5,700 staff members, $1.55B in total funding (*see Figure 1*), and $1.34B in total spending (*see Figure 2*), making it a top research institution in Washington State. Of these totals, our Washington State funding was $7.3M and spending was $5.3M.

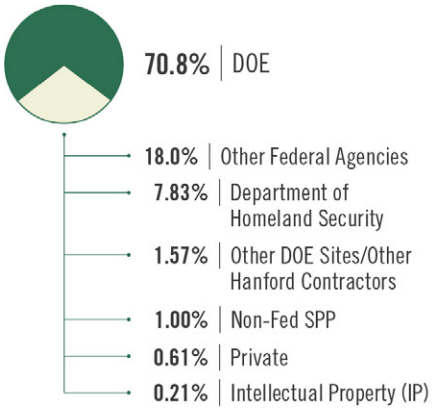
We use the terms "funding" or "sales" to refer to the total revenue received for projects conducted at PNNL. It is an indicator of the total amount of work done at the Laboratory over a given fiscal year—in this case, FY 2022. We use the terms "spending" or "business volume" as a measure of total costs, or expenditures, charged to third-party clients, and it includes direct costs, such as labor, travel, and procurements, as well as necessary overhead costs.

We perform the majority of our work for DOE. The DOE contract also allows us to perform work for several other federal and private agencies, as shown in *Figures 1 and 2*.



Detail may not sum to total due to rounding.

Figure 1 | *PNNL's Funding in FY 2022*



Detail may not sum to total due to rounding.

Figure 2 | *PNNL's Spending in FY 2022*

>5,700
STAFF MEMBERS

627
NEW HIRES

725
INTERNS

Our Staff

Our scientific and technical accomplishments are a tribute to the expertise of more than 5,700 scientists, engineers, and support professionals who work at PNNL and who collectively hold 2,773 advanced degrees. Over the course of the year, we hired 627 staff, in addition to 725 interns.

Our researchers and mission support professionals work side-by-side to enable the mission and success of PNNL. Under DOE leadership, staff at the 17 national laboratories worked together to identify near-term actions to address urgent needs, as well as longer-term research and development (R&D) efforts. This work is at the core of our mission—to keep the nation and the world safe and secure.

At PNNL, we recognize our strength is in our people. We are committed to fostering a work environment that fully embraces and values diversity, equity, and inclusion. We believe the diversity, depth, and breadth in our people enable the innovation and creativity expected of a DOE national laboratory.

We aspire to be a model organization and a valued partner in the communities where we live and work. Since 84 percent of our workforce are residents of Washington State, working mainly on our Richland, Seattle, and Sequim campuses, significant corporate contributions were allocated to Washington (*see Figure 3*).[1] Of those staff living in Washington, 76 percent lived in Benton County, 13 percent in Franklin County, 5 percent in King County, 1 percent in Clallam County, and about 5 percent were distributed across the rest of the state (*see Figure 4*).[2]

84.1%
(4,795)
EMPLOYED & RESIDING IN WASHINGTON STATE

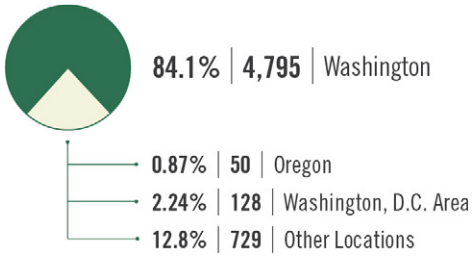


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Figure 3 | *Location of Staff Who Work at PNNL*

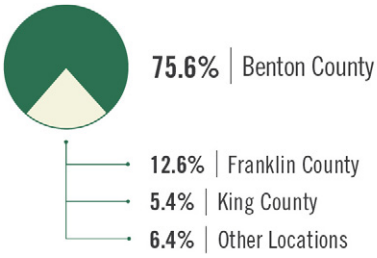

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Figure 4 | *Location of Staff Who Work in WA at PNNL*

1 Outside of Washington, 128 staff members reside in the Washington, D.C., area; 50 staff members reside in Oregon; and 729 staff members reside in other locations in the United States or in foreign countries.

2 Of the staff members residing in Benton and Franklin Counties, 50.7 percent reside in Richland, 19.6 percent in Kennewick, 14.2 percent in Pasco, and 12.5 percent in West Richland, and the remaining 3.0 percent reside elsewhere in the two counties.

$635M
IN DOMESTIC PAYROLL

$554M
PAYROLL FOR WASHINGTON RESIDENTS

Payroll and Benefits

PNNL's domestic payroll in FY 2022 was $635M, of which $554M went to staff members living or residing in Washington State.

At the end of FY 2022, the average annual wage for our Washington staff members was $115,528; the state average occupational wage for the same time frame was $74,520.[3] Because we are an R&D organization, we have a large percentage of high-wage professions. As a result, staff members at PNNL likely spend at a higher level and have a larger impact on the state economy compared to the average Washington worker.

While not directly part of wages, benefits packages also contribute to PNNL's economic impact. PNNL's benefits package costs $134M per year and includes an employer-provided health insurance package, employer matching of a portion of employee 401K contributions, a defined-benefit pension plan, disability, tuition refunds, and group life insurance. Our benefits package not only helps us recruit and retain exceptional staff, but we also know the health and well-being of our staff is vital to our collective scientific impact and, in turn, our ability to give back to our community.

3 Weighted average for all occupations that published both average annual wage and number of workers.

Purchased Goods, Services, and Investments

During FY 2022, PNNL spent $683M on goods and services to support research and operations. *Table 1* shows the variety of goods and services purchased, including construction, small scientific equipment, and subcontracts with universities, consultants, and research firms. Of the total, 13.6 percent ($93.0M) of the purchases were from Washington-based firms.

$683M
IN GOODS & SERVICES
TO SUPPORT OPERATIONS

$93.0M
IN PURCHASES FROM
WASHINGTON FIRMS

Table 1 | FY 2022 PNNL Purchased Goods and Services Spending
(total U.S. domestic and in Washington)

Type of Expenditure	Total ($M)	In WA ($M)
Construction	$138.7	$22.9
Finance, Insurance, Real Estate	$45.3	$18.8
Computers, Lab Equipment, Software, Services, Retail Trade (almost all computer-related)	$135.1	$6.30
Utilities, Transportation, Publishing, Management and Business Services	$229.8	$25.0
Technical and Scientific Subcontractors	$77.3	$5.14
Medical and Health Services	$1.62	$1.62
All Other	$55.5	$13.2
Total*	**$683.3**	**$93.0**

**Detail may not sum to total because of rounding.*

$1.93B
TOTAL ECONOMIC OUTPUT SUPPORTED BY PNNL PAYROLL & DOMESTIC PURCHASED GOODS & SERVICES

>7,500
TOTAL JOBS GENERATED IN WASHINGTON STATE

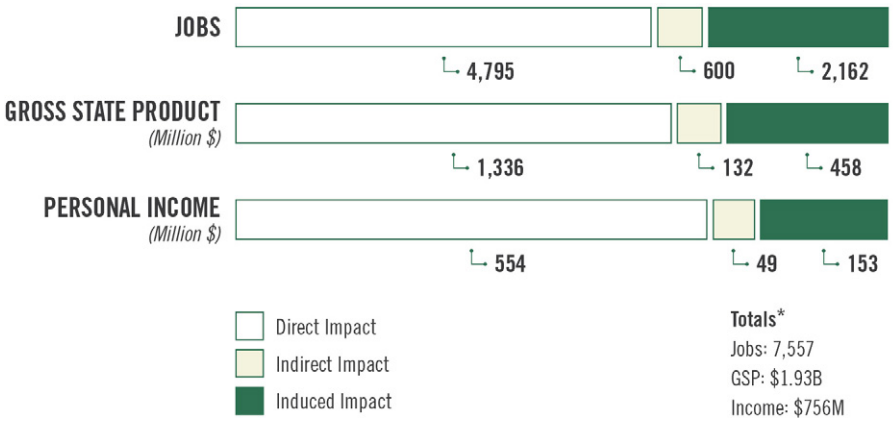
$756M
IN WASHINGTON WAGES

PNNL Operations

PNNL's output, employment, and wages are measurements of what are considered PNNL's *direct* economic activity. In turn, companies that supply goods and services to PNNL and its staff also buy goods and services, producing *indirect* economic activity. Since many of the indirect purchases are made in Washington, much of the indirect economic activity also occurs in the state. When employees of the firms who are either direct or indirect suppliers spend their wages on goods and services, they induce additional output, employment, and wages in retail and services firms and their suppliers.

The sum of direct, indirect, and induced impacts is the total impact on output, employment, or income. The total value of output (goods and services) produced in the state is also called Gross State Product (GSP), and the ratio of total to direct impact is called the multiplier effect.[4]

Figure 5 shows estimates of direct, indirect, induced, and total impacts of PNNL payroll and non-payroll procurement spending in Washington, based on the multiplier effect. The total impacts, including indirect and induced impact, are $1.93B in GSP, more than 7,500 total jobs, and $756M in total wages for Washington.



**Detail may not sum to total because of rounding.*

Figure 5 | *FY 2022 Economic Impact of Washington Payroll and Purchased Goods and Services Expenditures by PNNL*

4 PNNL data on purchases of goods and services, associated companies output, employee payroll, retiree income, visitor spending, and health care purchases were compiled and translated into IMPLAN inputs *(see Appendix for more information about the IMPLAN model used in this report).*

Expenditures for New Construction and Renovations

Our primary campus, located in Richland, includes land owned by DOE, Battelle, and commercial parties.

PNNL's campus strategy is driven by a need to enable PNNL's major initiatives, sustain the health of our core capabilities, and support key programs and sponsors.

The Grid Storage Launchpad (GSL) is an example of a large construction project enabled by both state and federal investments. GSL will accelerate innovation in energy storage, a key technology in the transition to resilient, clean energy in Washington and beyond. The $75M facility, funded by DOE's Office of Electricity, will host an in operando battery characterization center housing $8.3M in state-funded, advanced imaging equipment. Construction of GSL is expected to conclude in 2024.

86
CONSTRUCTION PROJECTS SUPPORTED

$20.4M
WASHINGTON-BASED SUBCONTRACTOR REIMBURSEMENTS

IMPACT HIGHLIGHT

PNNL Helps Washington State and the Nation Reach Clean Energy Goals

Washington State has enacted multiple laws that set ambitious targets for reducing carbon emissions across sectors, with the goal of becoming carbon neutral by 2050.

PNNL is well-aligned to help Washington State meet its clean energy goals. On our campuses, we are striving to achieve net-zero emissions and energy-resilient operations in alignment with our long-standing commitment to sustainability. Known as NZERO, this initiative also allows our campuses to serve as a living laboratory—testing new technologies and approaches and using the knowledge we gain to shape a model for others.

We also work closely with utilities, communities, companies, and tribes in the region and across the nation to support reliable, equitable decarbonization. This includes providing unbiased technical expertise and multidisciplinary studies to help decision-makers, planners, and industry clarify needs and identify solutions to reduce carbon emissions while minimizing costs and burdens on communities.

For example, we support DOE's Energy Transitions Initiative Partnership Project, which is focused on helping island and remote communities reduce their carbon footprint and bolster their energy resilience. We are working with Bainbridge Island and Makah Tribe—communities interested in exploring their marine energy resources—to improve energy resilience and increase their renewable energy production.

Through DOE's Connected Communities projects, we are partnering with a Spokane-based consortium to make homes and commercial buildings more efficient by connecting with the grid in a way that coordinates their energy consumption, reduces costs and carbon emissions, improves grid reliability, and increases use of clean energy sources. The consortium, led by the demand-and-optimization company EDO, also includes a high-performance building company (McKinstry), a utility (Avista), and a non-profit company (Urbanova) focused on driving place-based solutions for communities.

Our grid experts are developing and applying tools that allow utilities and decision-makers to answer regional questions regarding resource adequacy and resilience to wildfires and extreme events, as we electrify buildings and transportation.

In addition, with the help of Washington State investments in state-of-the-art research equipment, we have attracted large federal investments for new national research facilities to advance clean energy research and innovation that will benefit the region and the nation.

The $90-million DOE Energy Sciences Center, completed in 2022, is accelerating scientific discovery in chemistry and materials science to inform design of new energy materials, more efficient manufacturing methods, and recycling of waste into new products.

On the horizon, PNNL will complete another state-of-the-art facility, DOE's $75-million GSL, which will accelerate the development and deployment of next-generation grid energy storage technologies. GSL will facilitate collaborations with industry, academia, utilities, and regulators to advance technology development and prepare the workforce to enable safer, more cost-effective, and durable energy storage solutions.

PNNL made investments in facilities and infrastructure worth $73.4M *(see Table 2)*. All major renovations were performed on buildings located in Washington State, and 70 percent ($51.2M) included reimbursements to subcontractors working on PNNL buildings.[5] Approximately 40 percent of the subcontractor reimbursements were earned by Washington-based subcontractors, at a total of $20.4M.[6] An estimated 86 construction projects were supported by in-state subcontractor construction spending and are included in the total impacts detailed in *Table 2*.

Table 2 | PNNL Construction Spending in FY 2022

FY 2022 Renovations	Total Spending ($M)
PNNL Labor Costs	$14.7
Miscellaneous Procurements	$7.5
Disbursements to Subcontractors *Item: Disbursements to Washington Subcontractors = $20.4M*	$51.2
Total Renovation Spending	**$73.4**

5 Renovations of PNNL building space or other construction activities conducted in other states (Oregon; the Washington, D.C., area; and other places where PNNL may be conducting research or other activities) are assumed not to affect Washington State's economy.

6 Total costs related to these renovations, other than PNNL labor, are included in the $683M non-payroll purchases listed in *Table 1*.

$31.9M
TAXES PAID

State and Local Taxes

PNNL and its staff members paid $31.9M in taxes, which include business and occupation taxes (PNNL only), sales and use taxes, property taxes, and other types of taxes (e.g., motor fuel taxes).[7] Employee taxes were based on the total $554M in wages of employees at PNNL who work in Washington State (for the purpose of this analysis, they are assumed to live in Washington) and the 2022 state and local governments' collection rates (for every dollar of personal income). The rates are an estimated $0.027 in sales, use, and other production-related taxes by individuals; $0.027 in-state and local property tax collections; and $0.002 in other taxes per dollar of personal income.

7 PNNL paid $1.1M in taxes, and its staff members paid an additional $30.9M in taxes. Washington does not have a personal or corporate income tax. In addition, PNNL paid $4.43M into the state's unemployment and workers' compensation insurance systems during the fiscal year. This payment is not included in the total, as it is not considered a tax.


PURE SOLV

PNNL: BEYOND **THE SCIENCE**

While not strictly a PNNL activity, there are certain expenditures—such as spending on health care, the investments of our retirees, the visitors we attract, and the transfer and commercialization of technologies—that bolster the economy and would not occur in Washington State without our presence.

Economic Impact of Closely Related Activity

Spending in the four closely related economic activities—health-related services, retirees, visitors to PNNL, and the commercialization and transfer of technology—also creates significant additional economic activity in the state. Taken together, these activities directly employ more than 600 people and generate a GSP of $105M. The IMPLAN® model calculates, when the indirect and induced economic impacts are taken into account, a total of $298M in GSP, more than 1,500 jobs, and $131M in labor income depend on these activities *(see Figures 6 and 7 for more detail)* and can be attributed to PNNL.

$298M
IN GSP

>1,500
PNNL-DEPENDENT EXTERNAL JOBS CREATED

$131M
IN LABOR INCOME

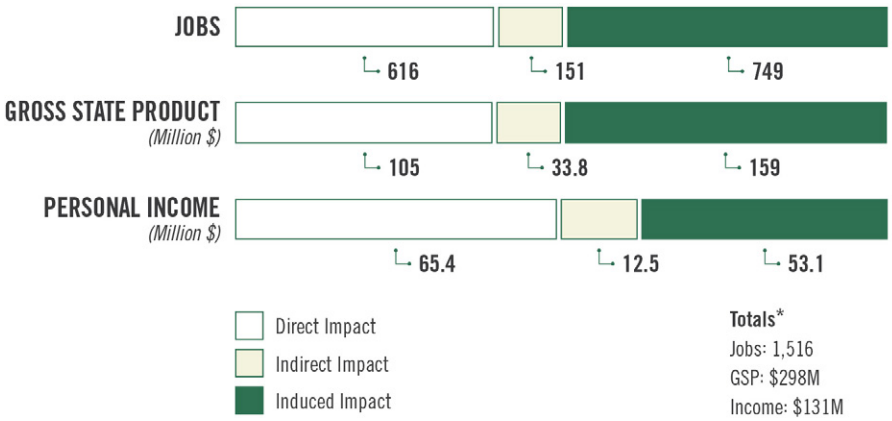


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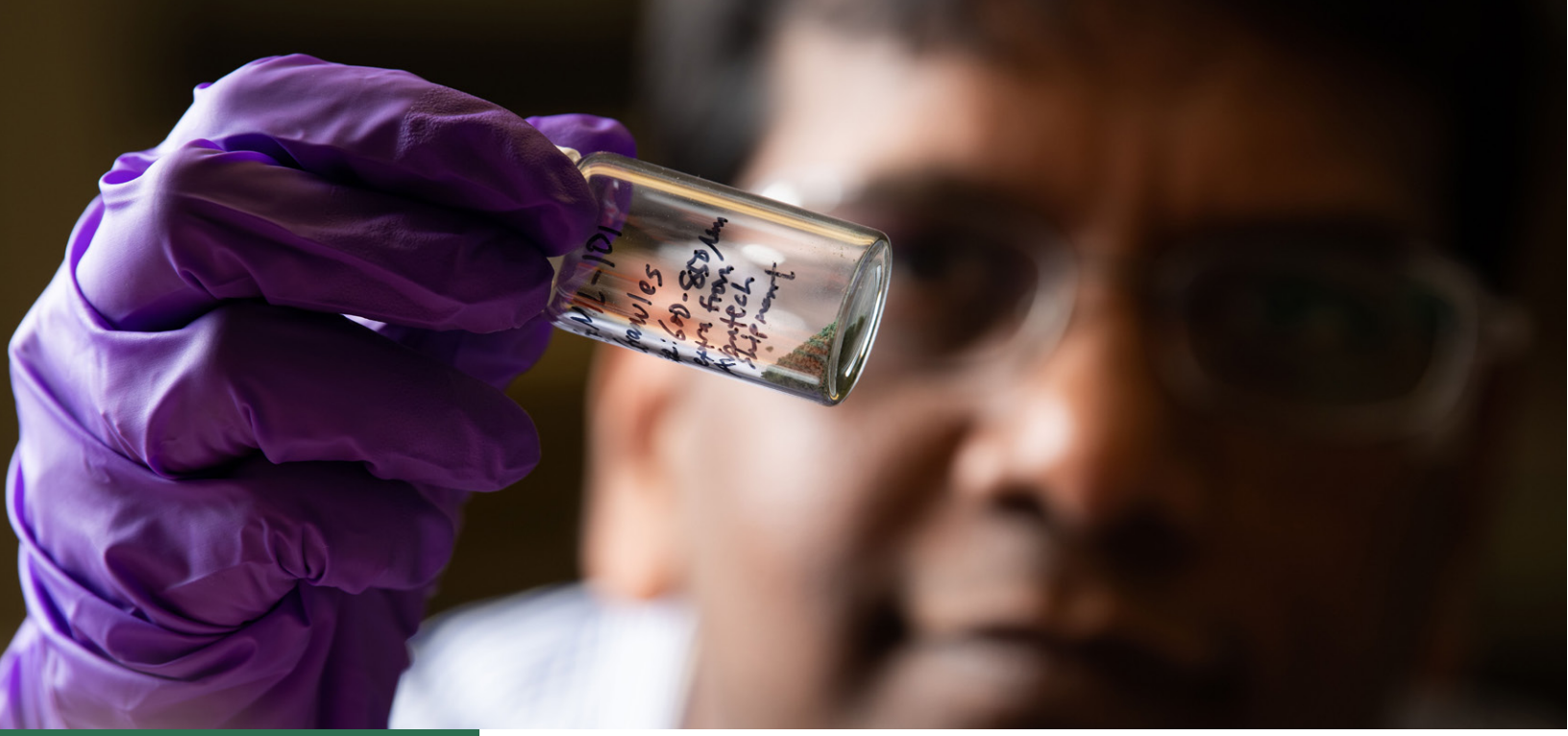
Figure 6 | *Total Impact of Health Care Spending, Companies with PNNL Roots, Visitor Spending, and Retirees on the Washington State Economy in FY 2022*



$98.8M
HEALTH CARE EXPENDITURES

$174M
GSP

>928
JOBS

$86.4M
LABOR INCOME

Health Care Expenditures

Health insurance expenditures for our 4,795 staff members residing in the state, 2,300 retirees, and their households totaled an estimated $98.8M in FY 2022.[8] PNNL's direct medical and dental insurance expenditures on behalf of in-state employee households were estimated at $55.6M *(see Figure 7)*. These direct expenditures, when the indirect and induced economic impacts are taken into account, create a total of $174M in GSP, more than 928 jobs, and $86.4M in labor income.

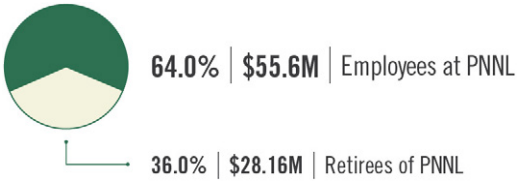


***Figure 7** | FY 2022 Estimated Health Care Spending of In-State Employees at PNNL and Retirees*

8 Total costs of more than $43.3M for retired households were based on Kaiser Family Foundation estimates of per capita expenditures by type for health care in Washington in 2020, adjusted to 2022 dollars.

Retirees

Seventy-three percent of our retired former employees continue to live in Washington.[9] They represent a significant source of consumer spending in the economy. There are three principal sources of income that support this spending: pension benefits, federal Social Security Old Age and Survivors' Insurance (OASI) benefits, and accumulated personal savings.

In FY 2022, the defined-benefit pension plan for our employees paid a total of $90M to 3,147 retirees and their beneficiaries. The PNNL pension benefit was an average of $2,384 per month, per person, in Washington.

Information in *Table 3* assumes our in-state retirees receive 1.37 times the OASI payment of the average retiree in the state, or about $2,368 per month, for a total estimated $65.4M.[10] Combined, pensions and Social Security total $179M, of which $131M is estimated to be spent within Washington on goods and services.[11] These direct expenditures, when the indirect and induced economic impacts are taken into account, create a total of $99.8M in GSP, more than 470 jobs, and $33.4M in labor income.

$131M
PENSION & SOCIAL SECURITY INCOME

$99.8M
GSP

>470
JOBS

$33.4M
LABOR INCOME

Table 3 | Estimated Washington State PNNL Retiree Income in FY 2022

Income Type	Estimated Average Retiree Monthly Income in FY 2022	Total Retiree Annual Income in FY 2022 Income ($M)
Pension	$2,384	$65.8
OASI (Social Security)	$2,368	$65.4
Total	**$4,752**	**$131.2**

9 Direct data from the pension administrator on PNNL retiree locations for FY 2022 indicated, of the 3,147 retirees, 2,300 had Washington addresses.

10 The estimated average monthly payment per OASI retired beneficiary in FY 2022 was $1,730 in Washington. Because PNNL retirees have had salaries about 1.5 times the state average salary, Social Security calculator software shows their average OASI payment would be 1.37 times the Washington average.

11 No estimate is available for spending of personal savings by PNNL retirees.

$2.33M
ESTIMATED TOURISM EXPENDITURES

$3.58M
GSP

>24
JOBS

$1.21K
LABOR INCOME

Visitors to PNNL

PNNL hosts thousands of visitors each year, many of whom are from outside Washington State and contribute to the state's visitor economy.[12]

Statistics for out-of-town visitors to our facilities in FY 2022 are shown in *Table 4*, identified through PNNL visitor badges.[13] Visitors contributed an estimated $2.33M to the state's economy based on statewide traveler spending averages, adjusted for Benton County's lower-than-average accommodation costs as a proportion of total spending. These direct expenditures, when the indirect and induced economic impacts are taken into account, create a total of $3.58M in GSP, more than 24 jobs, and $1.21K in labor income.

Table 4 | Number of Out-of-Town Visitors and Visitor Days to PNNL

	PNNL Visitor Statistics
Number of out-of-town visitors	2,445
Estimated total visitor days	13,110
Estimated tourism expenditures	$2.33M

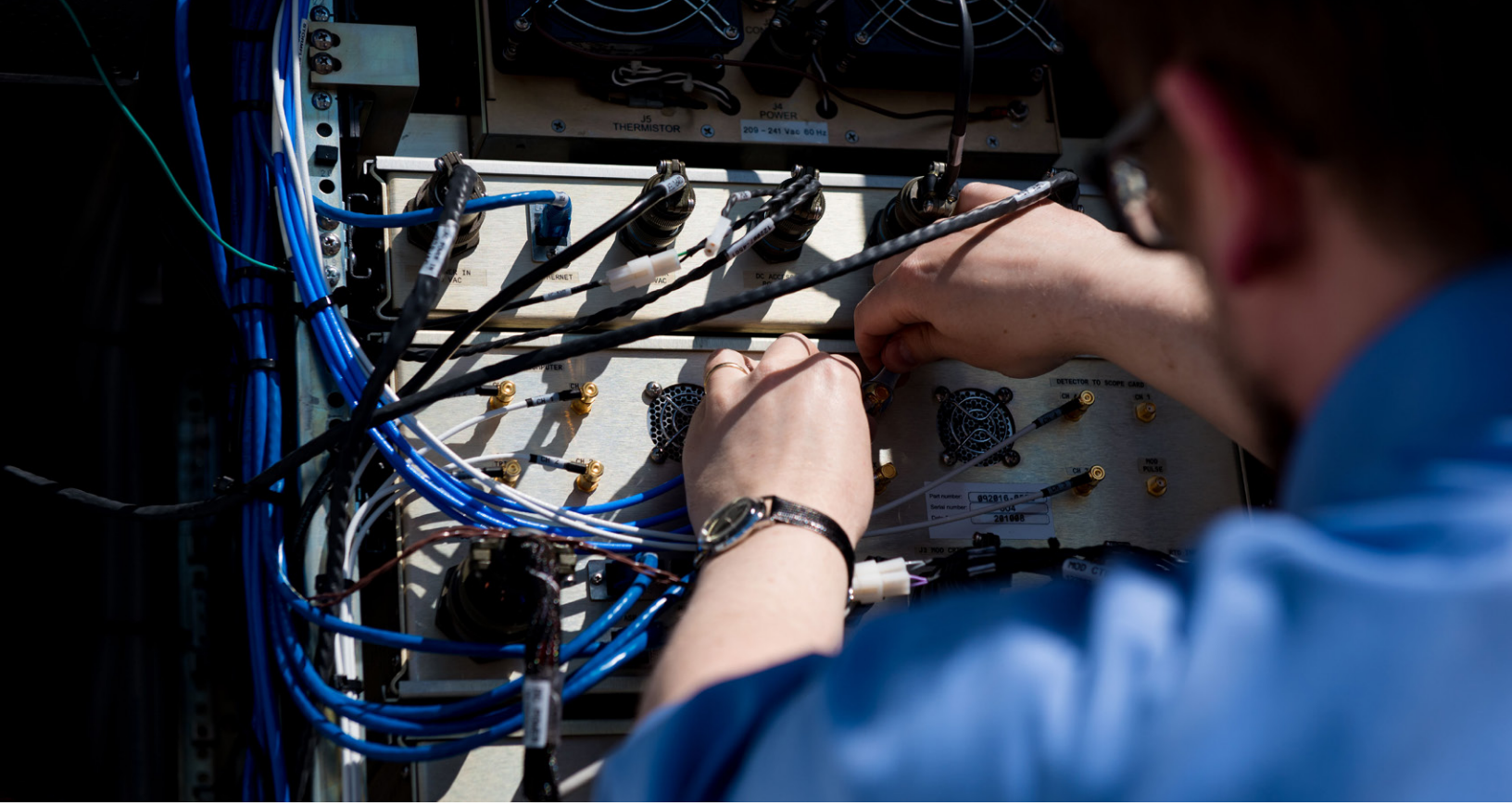
EMSL Users

EMSL is a DOE-SC user facility sponsored by DOE-SC's Biological and Environmental Research program. It is operated by and located on the PNNL-Richland campus. Many of EMSL's users are from Washington companies or educational institutions.

In FY 2022, EMSL supported 744 scientists from around the world who were able to take advantage of outstanding laboratory space, expertise, and equipment to extend the frontiers of biological and environmental science. Forty-seven users were from foreign institutions, and 697 users were from the United States.

12 Direct impact of PNNL visitor spending was estimated from 2018 county-level per capita visitor spending statistics compiled by Dean Runyan Associates, 2019, Washington State Travel Impacts & Visitor Volume, 2000–2018p.

13 A couple hundred individuals from DOE, other national laboratories, and subcontractors that visit PNNL each year have recognized credentials and do not require visitor badges. No count exists for visits by these individuals, but they also add to the economic impact. Badges are issued for a period of time including, but not restricted to, the dates when visitors are actually at PNNL. This results in an overestimate of the number of days per visitor when visitors are present on-site. In the case of badges issued for site tours and on-site meetings, the raw numbers of days were adjusted downward to better reflect the number of days visitors actually spend on-site. A similar adjustment was made for badges issued to visitors such as university researchers working at PNNL or needing access to laboratory space. Direct impact of PNNL visitor spending was estimated from 2018 county-level per capita visitor spending statistics compiled by Dean Runyan Associates, 2019, Washington State Travel Impacts & Visitor Volume, 2010–2018p.



ARM Users

We also provide overall technical direction for ARM on behalf of DOE. ARM is a multi-platform scientific user facility designed to improve understanding and representation in climate and Earth system models, as well as clouds and aerosols, and their interactions and coupling with Earth's surface.

ARM provides the international research community with unparalleled infrastructure for obtaining precise observations of key atmospheric phenomena needed to advance scientific understanding of atmospheric processes and climate models.

In FY 2022, the 1,113 unique ARM scientific users included 548 from universities, 28 from industry, 200 from DOE national laboratories, 64 from other government agencies, and 273 from foreign institutions. The vast majority of ARM users don't visit PNNL but interact with the facility by downloading data or by visiting one of the remote ARM field sites. Of the total users, 205 accessed ARM's on-site assets at PNNL, 206 used off-site services, and 702 used data services. ARM employs approximately 64 people at PNNL.

Technology Deployment and Outreach

Technology Commercialization: New Products and Companies with PNNL Roots

Many of PNNL's research activities generate ideas and inventions (i.e., IP) that have commercial value. PNNL prides itself on rapidly deploying this IP into the marketplace in partnership with new or existing companies. Our scientific discoveries can be converted into competitive products or solutions that contribute to creating new jobs, diversifying the U.S. economy, and making a positive societal impact.

One important way PNNL delivers both intellectual and economic value is through effective engagement with entities outside the Laboratory—through partnerships, collaborative research, and the transfer of technologies and software solutions.

The partnerships we forge sharpen our science, attract talented staff, and inform the Laboratory's strategic priorities. PNNL pursues each industry partnership as an opportunity to advance the Laboratory's missions in scientific discovery, decarbonization, and national security, while maximizing the positive impact on the U.S. economy and protecting our critical intellectual assets.

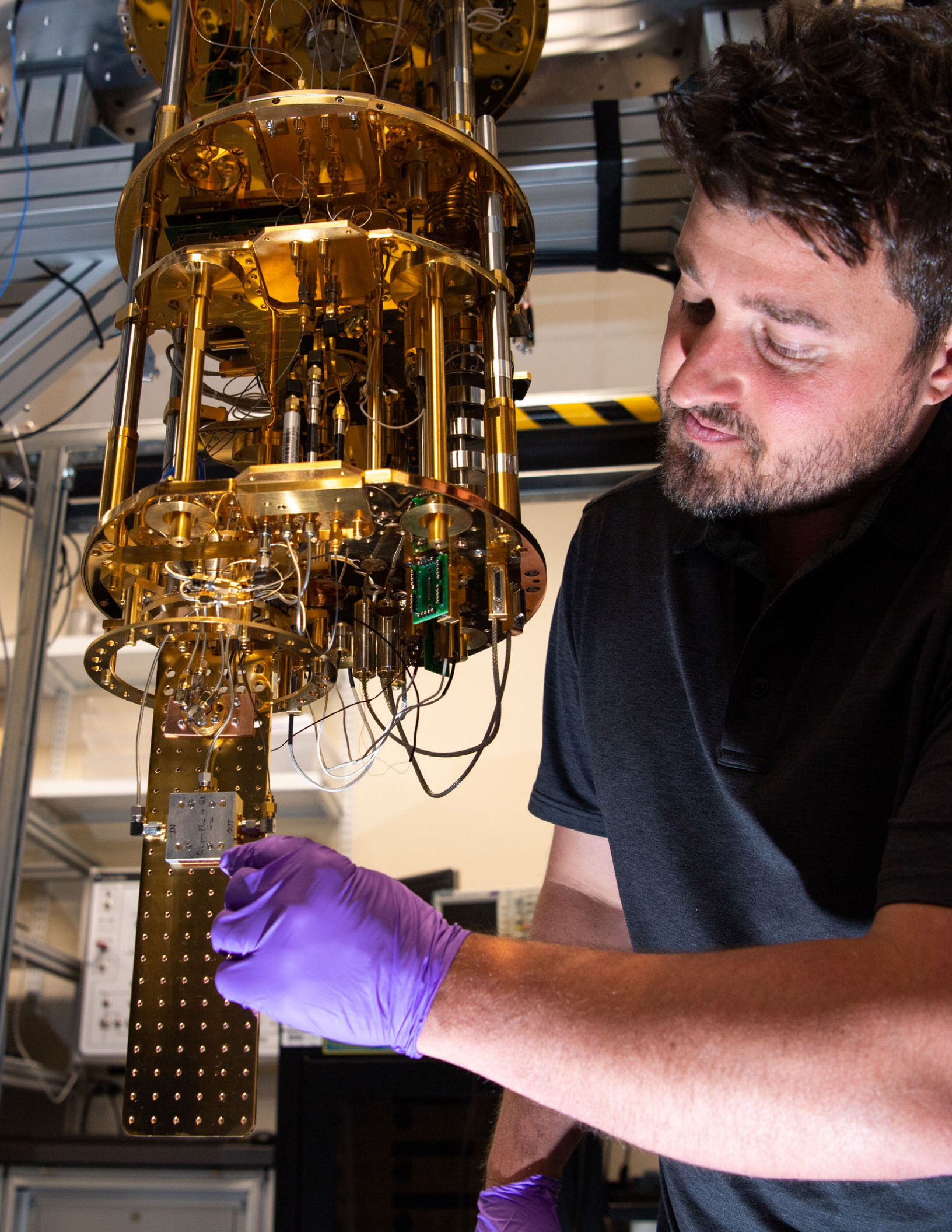
To facilitate effective partnerships, PNNL provides several ways to work with the Laboratory, including the transfer of rights to use IP developed at PNNL, direct sponsorship of research, or engagement in Cooperative Research and Development Agreements.

Since 1965, 207 new companies were started with technological or managerial roots at PNNL, and 99 of those are still in business today.

Table 5 provides a breakdown of the activity over the last 10 years. As a national laboratory, we patent and license our technology across the nation and the world. However, place matters when it comes to innovation, which is why a third of the companies created within the last 10 years were located right here in Washington. Eleven of the 35 companies still in business are located in Washington and collectively employ more than 53 people, with estimated sales of $11.1M. This economic activity of $11.1M, in turn, supports a total economic output of $20.1M, as well as in-state payrolls of $16.9M and 93 jobs throughout the state.

Table 5 | Companies with PNNL Roots (established in last 10 years and still operating)

	Total	In WA
Number of Firms	32	11
Estimated Sales ($M)		$11.1
Employment	>306	>53



IMPACT HIGHLIGHT

Creating a Quantum Ecosystem in the Pacific Northwest

Quantum computers take a radically different approach to processing information that overcomes some limitations of the classical computers we have been using for eight decades. They are part of a growing revolution in quantum information science (QIS) that could open the door to solving problems beyond the reach of any classical supercomputer.

With the ability to compute many possible states simultaneously, quantum computers could deliver the computing power needed to fundamentally alter almost every aspect of science and engineering.

This is why PNNL and many others are creating the novel hardware, software, and applications that could transform how we address problems impossible to solve today. From quantum simulations and developing algorithms for quantum chemistry to creating precision materials for quantum devices, PNNL supports a broad range of quantum-related research.

In addition, PNNL has joined a growing quantum ecosystem in the Pacific Northwest connecting government, academia, and industry to accelerate quantum research and develop a QIS-trained workforce through the Northwest Quantum Nexus (NQN). The NQN synergizes partnerships between companies, such as Microsoft and IonQ, as well as the University of Oregon, the University of Washington, and Washington State University.

"I am proud that PNNL is not only helping enable this powerful new kind of computing, but also will put its power to use," said Laboratory Director Steven Ashby after NQN's inaugural summit in Seattle. "I look forward to seeing how it dramatically changes the way we do research and the promising new solutions it will make possible."

Mathematicians and computer scientists at PNNL are working with colleagues to identify the types of problems that best lend themselves to quantum computing. One area of interest is quantum chemistry, a rich field well-known for its computational complexity and widespread application. For example, the ability to accurately simulate how molecules interact is important to designing catalysts for energy production and storage. As the number of molecules increases, the computational complexity grows exponentially in a way that is well-suited to the power of a quantum computer.

To solve these types of problems, PNNL and Seattle-based Microsoft teamed to develop a chemical simulation library for the Microsoft Quantum Development Kit—a collection of tools for programmers developing algorithms and code for quantum applications.

Researchers can use this new library in NWChem—PNNL's open-source, high-performance computational chemistry software—to solve chemistry problems faster and with greater precision than ever before.

James Ang, chief scientist for computing and PNNL's sector lead for the DOE Advanced Scientific Computing Research program, said, "PNNL's cultivation of both industry and university collaborations are building a foundation for quantum computing in the Pacific Northwest that sets the stage for future hybrid classical-quantum computing."

$3.29M
COLLECTED IN
LICENSING REVENUE

1
TECHNOLOGY
LICENSED EVERY
20
DAYS

Intellectual Property

While there is undoubtedly value in investing in both our current and future quality of life, there are other aspects of PNNL's presence in Washington that are much more difficult to calculate in terms of the state's GSP or employment, such as the IP created by PNNL R&D activities. Technologies are transfered—primarily through IP options and licenses—at a rate of almost 1 technology licensed every 20 days, including 18 new license agreements in FY 2022.

In addition, PNNL implemented 80 agreements for commercializing technology with 64 different private organizations. In FY 2022, we had 97 active Cooperative Research and Development Agreements and 320 non-federal Strategic Partnership Project agreements.

Often, federally funded research results in scientific and engineering solutions with IP value. *Table 6* provides additional highlights of our commercialization and technology deployment efforts, including invention disclosures, patent applications, patents issued, commercial options and licenses issued, and license revenues earned. In FY 2022, we collected $3.29M in licensing revenue and reinvested a significant portion of these funds at PNNL for additional commercialization-focused development work.

Table 6 | PNNL Statistics on Inventions, Patents, Technology Transfers, and License Income

	New FY 2022	Cumulative 2000–2022
Invention Disclosures	272	5,526
Patents Granted	50	1,155
Licenses and Options	18	774
Total License Revenue Received	**$3.29M**	**$80.0M**

Giving back is our culture. Whether through charitable giving—from staff members at PNNL or Battelle corporate dollars—or the numerous hours volunteered, we are making a difference.

INVESTING IN **THE FUTURE**

Whether contributing to local organizations, facilitating community volunteerism and leadership, or furthering science, technology, engineering, and mathematics (STEM) education, PNNL has built a strong and enduring foundation of external engagement and outreach. Giving time, money, and talent to help others in the communities where we work and live is our culture.

1,587
STUDENTS AND INTERN & RESEARCH ASSOCIATE POSITIONS

STEM Education and Workforce Development

PNNL's pledge to inspire and develop the future STEM workforce is rooted in the belief that teams of diverse individuals—especially comprising those who have been historically underserved in STEM—will address our nation's most challenging scientific issues and ensure America's competitiveness. PNNL's staff participates in STEM programs and outreach activities, allowing students to interact with technical staff from similar cultural or ethnic backgrounds and see themselves in STEM fields and careers.

PNNL carries out DOE's commitment to inspire, train, and support the next generation of diverse scientists, mathematicians, and engineers through purposeful alignment of STEM outreach and workforce development activities with our PNNL talent strategy and scientific priority areas.

In FY 2022, DOE-SC provided $2.33M direct project funding through DOE's Workforce Development Teachers and Scientists (WDTS) program and Office of High Energy Physics to support WDTS student programs, faculty programs, and diversity and outreach efforts, as well as a new Office of High Energy Physics partnership to develop an innovative model that increases the diversity of the future nuclear participle physics workforce through strategic partnerships with Minority Serving Institutions at the community college and university levels.

PNNL invested $1.87M to support STEM workforce and outreach efforts and invested $5.46M in overhead funds to support the STEM workforce development strategy and deployment of PNNL internships and research associates, STEM equity and inclusion, Teacher-Scientist Partnerships, and STEM outreach efforts like the PNNL STEM Ambassadors (SSA) program. More than 30,000 pre-college, undergraduate, graduate, post-graduate, and faculty researchers benefited from STEM education programs or participated in PNNL's STEM workforce.

Throughout FY 2022, PNNL delivered STEM programs that provide immediate impact and assistance while demonstrating our near- and long-term commitment to our community and the value DOE places on building our future workforce. Notable efforts included the following highlights:

- **PNNL hosted 1,587 students in intern and research associate positions,** the highest number ever hosted during a 12-month period at the Laboratory. We continued to deliver a suite of professional development and enrichment activities to elevate the intern experience, and, in FY 2022, the WayUP organization named PNNL's internship program as one of the Top 100 Internship Programs in the nation. This was determined by a panel of industry experts who considered factors such as public votes, how the program is helping interns build a professional community and grow in their careers, and the program's commitment to advancing diversity, equity, and inclusion. The Top 100 Internship Programs list was especially competitive this year, and PNNL is the only national laboratory to be included.
- **PNNL expanded the SSA program and disseminated the framework to nine other DOE national laboratories** with support from DOE-SC's WDTS. SSAs seek to inspire their peers, especially those who are also underrepresented in STEM, to apply for WDTS internships. Despite ongoing COVID-19 pandemic challenges, SSAs reached thousands of students through online presentations at their campuses and Minority Serving Institutions, virtual outreach fairs, WDTS application workshops, and social media campaigns.

To grow the cybersecurity workforce needed to build more resilient and secure space systems, PNNL partnered with U.S. Space Force's Space Systems Command to create the Cyber Halo Innovation Research Program—or CHIRP. This comprehensive program specifically partners with Minority Serving Institutions to provide students a direct, two-year pathway to a cybersecurity career at PNNL, Space Systems Command, or industry partners.

- **PNNL partnered with the University of Washington to deliver two GenCyber summer camps.** The camps were held in mid-July and engaged 162 Washington State middle school and high school students in hands-on learning about cybersecurity. Approximately 74 percent of participants came from backgrounds traditionally underrepresented in computer science, with half identifying as female.
- **An oversight committee for the STEM Nexus Initiative advanced equity in STEM education for our local community and underserved populations.** With PNNL's leadership, the oversight committee was established as a collaboration between the STEM Nexus Initiative, the Washington State STEM Education Foundation (WSSEF), and myTRI2030 Education Council, comprising education leaders and community members. The committee identified several impactful STEM education projects, and WSSEF awarded approximately $300K for five K–16 STEM education advancement community projects, focused on serving underrepresented students.

Community Investments and Assistance

While operating PNNL, Battelle has invested a total of $30.9M to improve science, education, and quality of life in Washington State, including investments in the arts and culture, as well as health and human services programs that are important to our community.

In FY 2022, PNNL and Battelle contributions to philanthropic and civic organizations, including corporate support for STEM education, totaled $618K.

Over the past 10 years, staff members at PNNL have volunteered 283K hours to community projects.

Financial contributions of $285K were made in support of advancing STEM education programs in our community. Grants were awarded to the West Sound STEM Network to improve career pathways in critical skill sets like cybersecurity. Washington State University Tri-Cities and Columbia Basin College received funds to purchase badly needed equipment to continue providing students in STEM classes with access to cutting-edge research techniques. Investments were also made to aid in diversifying the future STEM workforce with grants to Heritage University, a university rooted in the Yakama Nation in Toppenish, Washington, and the University of Washington Office of Minority Affairs and Diversity.

$30.9M
INVESTED BY BATTELLE
WHILE OPERATING PNNL

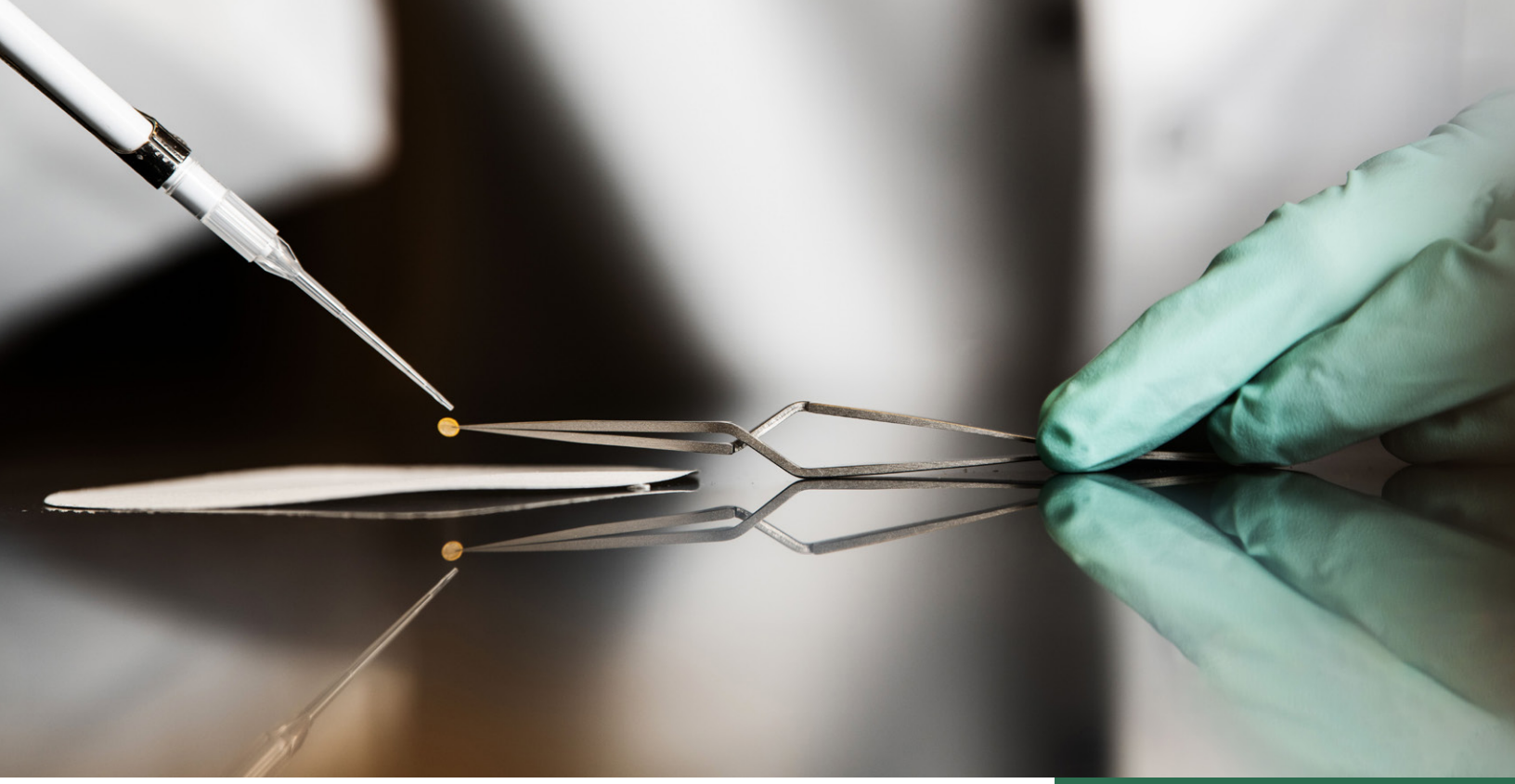
$618K
IN FY 2022
COMMUNITY ASSISTANCE
FROM BATTELLE & PNNL

283K
HOURS VOLUNTEERED
BY STAFF AT PNNL
OVER THE PAST 10 YEARS

Funds were also granted to several health and human service organizations for continued community relief efforts related to mental health, housing, and food insecurity. These donations included funds to support Cork's Place Grief and Compassion Fatigue Training; critical facility improvements at Grace Kitchen, allowing them to expand their job-training program to more women in crisis; Tri-City Habitat for Humanity to provide housing for families in need within our community; and Second Harvest Tri-Cities, an organization dedicated to bringing community resources together to feed people in need.

In addition to monetary donations, staff at PNNL also donated their time throughout the community. One way they did this was by serving on community boards, including the Tri-City Regional Chamber of Commerce, Association of Washington Business, Washington Roundtable, Washington State University Tri-Cities Advisory Committee, Columbia Basin College Foundation, Tri-City Development Council, The REACH Foundation, Clallam Economic Development Council, Visit Tri-Cities, WSSEF, and West Sound STEM Network.

Financial support and sponsorship for several community events was provided, as well, including the Association of Washington Business Manufacturing and Energy Summits, Tri-City Regional Chamber of Commerce Women in Business Conference, North Olympic Peninsula Energy Futures Initiative Conference, Tri-City Development Council Mid-Columbia Clean Energy Summit, Washington STEM Summit, and the Tri-City Hispanic Chamber of Commerce Annual Gala.



CONCLUSION

Where scientific innovation and economic impact meet, you'll find PNNL. Scientists, engineers, and support professionals at PNNL contribute scientific knowledge, new ideas, novel inventions, innovative technologies, and processes that help make the world safer, cleaner, and more prosperous. From advancing scientific discoveries to enabling sustainable energy and enhancing national security, PNNL is committed to addressing critical national and global challenges. As we advance scientific understanding and technological solutions, we also are building the economy of tomorrow for the nation and the state of Washington.

In FY 2022, PNNL positively impacted the economic activity in Washington with $1.34B in total spending, 4,795 resident employees, in-state payroll of $554M, and approximately $93.0M in purchases from Washington businesses. This economic activity, in turn, supports a total economic output of $1.93B, as well as in-state payrolls of $756M and more than 7,500 total jobs throughout the state.

$1.93B
TOTAL ECONOMIC OUTPUT SUPPORTED BY PNNL PAYROLL & DOMESTIC PURCHASED GOODS & SERVICES

$756M
WASHINGTON STATE WAGE INCOME

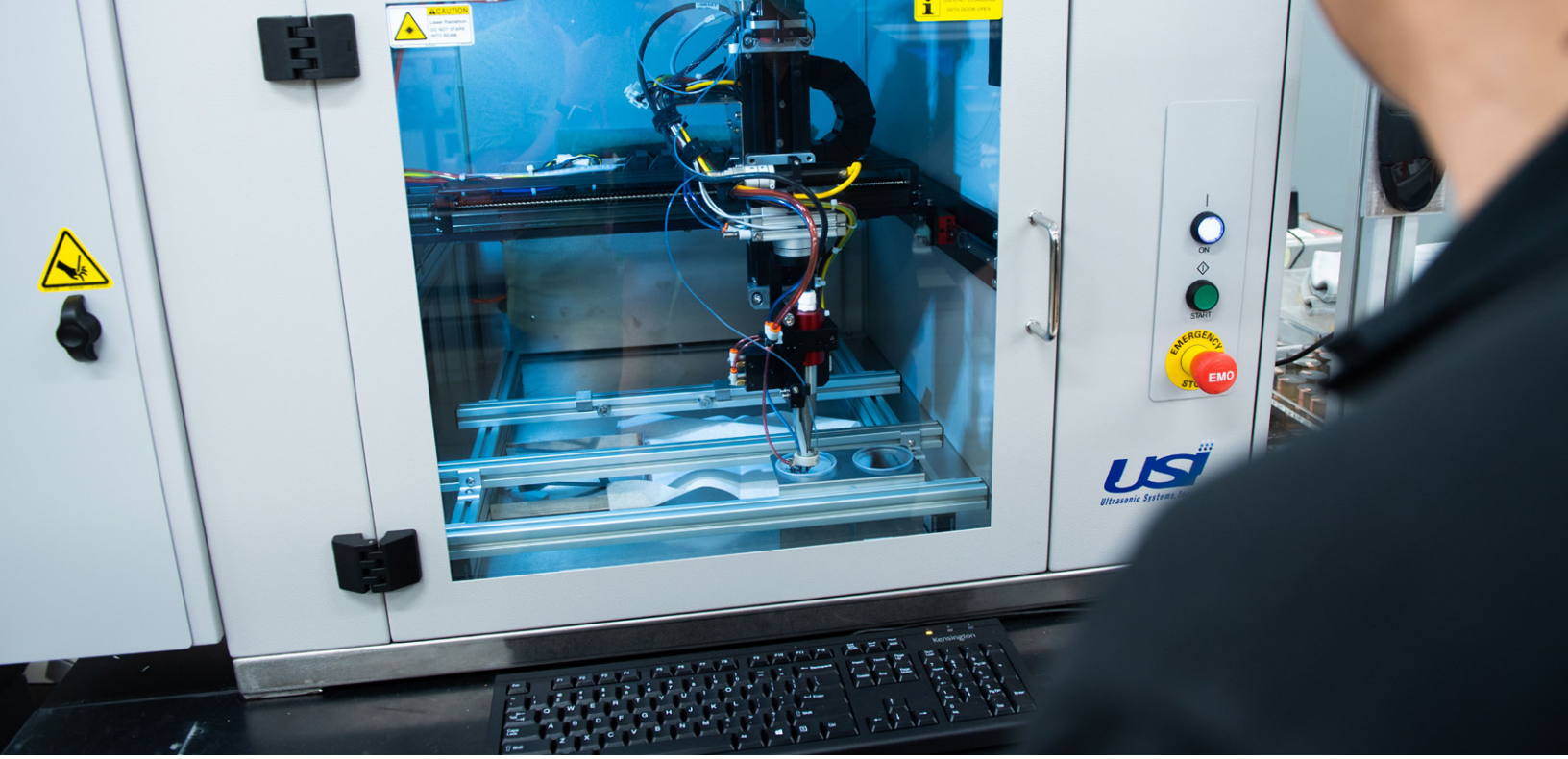
>7,500
TOTAL JOBS GENERATED IN WASHINGTON STATE

The growing number of commercial companies in Washington that were formed based on PNNL research includes 207 businesses since 1965, with 99 still operating today, proving the success of our technology transfer and commercialization, which has won numerous awards.

In addition, there are certain closely related activities—such as spending on health care, the investments of our retirees, the visitors we attract, and the transfer and commercialization of technologies—that bolster the economy and would not occur in Washington State without our presence. This includes an additional $298M in output, in-state payrolls of $131M, and more than 1,500 jobs.

In FY 2022, we were happy to begin inviting staff members back to campus and deployed a new work model that embraced hybrid workspace options. We hired 627 new staff and provided 725 internship opportunities to expose the next generation's workforce to the caliber of expertise offered only at a national laboratory. We also donated about $618K within Washington.

PNNL's impact on Washington State's economy is more vital than ever, but our efforts to change the world are what truly set us apart. Our unified vision is bigger than any one of us. Together, we have the power to create a safer, cleaner, more prosperous, and more secure world.



APPENDIX

To calculate the economic impact of PNNL on the state of Washington, PNNL used IMPLAN® (IMpact analysis for PLANning),[14] a widely accepted economic input-output model, to estimate funding, employment, and labor income impacts. IMPLAN®, a product of IMPLAN® Group LLC, Inc., contains highly disaggregated data on regional economic indicators based on data from a variety of sources, such as the U.S. Bureau of Economic Analysis, and then aggregates the entire economy into 546 sectors. It is based on social accounting between industries and within the distribution chain and contains numerous economic multipliers to quantify direct, indirect, and induced output; employment; and labor income impacts. Output from IMPLAN® is in the form of direct, indirect, and induced economic output (gross funding); jobs; and labor income created or supported, as well as their associated multipliers.

14 IMPLAN®. 2021 Data. Huntersville, NC: IMPLAN® Group LLC, Inc. *www.implan.com.*

Each sector that produces goods and services generates demand for goods and services in other sectors. This iterative process is the multiplier effect. Multipliers can be described through the following definitions:

- Direct effects are the initial change to the industry or institution in question.
- Indirect effects are the changes in inter-industry purchases as they respond to the new demands of the directly affected industries. The direct change creates increases in economic activity for downstream businesses that support these direct industries.
- Induced effects are the increases in household income expenditures generated by the direct and indirect effects.

The Washington State data file for 2021 was used in this analysis, with gross domestic product deflators within the model used to convert impacts to 2022 dollars. PNNL data on purchases of goods and services, associated companies' output, employee payroll, retiree income, visitor spending, and health care purchases were compiled and translated into IMPLAN® inputs. *Table A.1* characterizes the IMPLAN® inputs.

Table A.1. | IMPLAN® Input Characterization

Expenditures	Input Characterization
Purchases on Goods and Services	Expenditures were assigned a North American Industry Classification System (NAICS) code and then translated to their respective IMPLAN® sector using the IMPLAN® NAICS bridge. Expenditures were calculated as an industry change and retail margins used where needed. Purchases are dominated by the construction, real estate, engineering services, medical and diagnostic laboratories, computer systems design services, and university sectors.
Companies with PNNL Roots	Each company was assigned an IMPLAN® sector. IMPLAN® data were used to derive an output per employee and each company's output was subsequently calculated in IMPLAN®. The dominant sector was battery storage manufacturing.
Employee Salaries	Payroll data are calculated in IMPLAN® as a change in employee compensation. IMPLAN® derives the impact from the model's income expenditure patterns.
Health Care Spending	Health care expenditures from employees and retirees were assigned a NAICS code and translated to one of the five primary medical IMPLAN® sectors and one retail sector supplying medical-related items and then calculated as an industry change. Margins were used for the retail sector.
Retiree Income	Retiree income was calculated in IMPLAN® as a change in employee compensation. IMPLAN® derives the impact from the model's income expenditure patterns.
Visitor Spending	Visitor spending was aggregated into day-visitor and overnight-visitor spending and calculated in IMPLAN® as a change in sectors typically affected by visitor spending, such as accommodation, food establishments, and retail gasoline sectors.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Pacific Northwest
NATIONAL LABORATORY

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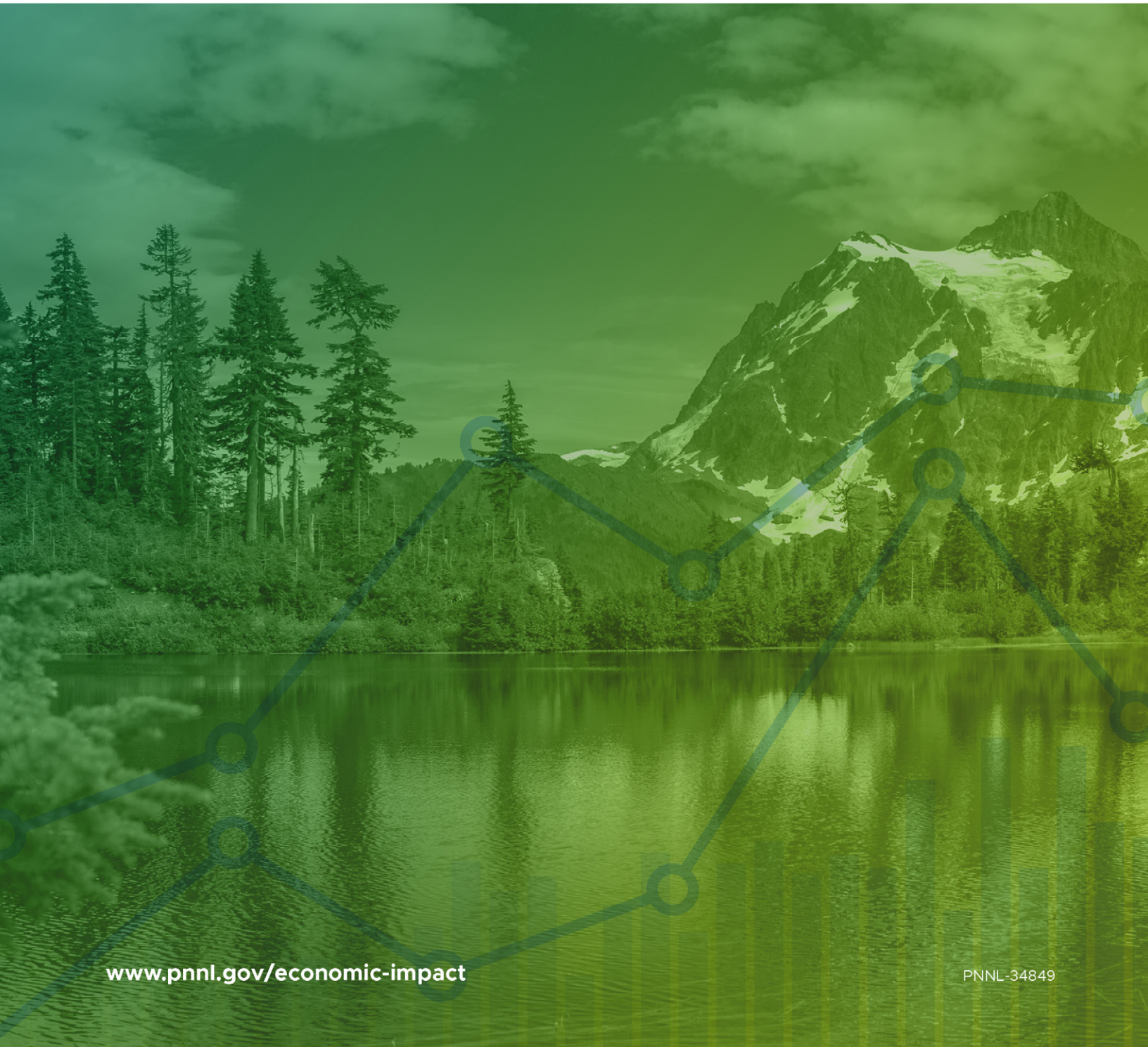

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