



ECONOMIC IMPACT

OF PACIFIC NORTHWEST NATIONAL
LABORATORY ON THE STATE OF
WASHINGTON IN FISCAL YEAR 2019

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, **makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

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

Printed in the United States of America

Available to DOE and DOE contractors from
the Office of Scientific and Technical
Information,
P.O. Box 62, Oak Ridge, TN 37831-0062
www.osti.gov
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
or (703) 605-6000
email: info@ntis.gov
Online ordering: <http://www.ntis.gov>

ECONOMIC IMPACT

OF PACIFIC NORTHWEST NATIONAL LABORATORY ON THE STATE OF WASHINGTON IN FISCAL YEAR 2019

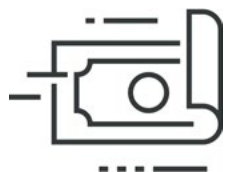
June 2020

JM Niemeyer

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

Pacific Northwest National Laboratory
Richland, Washington 99352

HIGHLIGHTS



\$1.01B

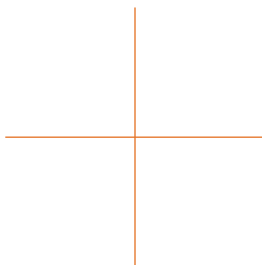
Annual spending



\$487M

Total payroll

\$449M in Washington State



4,722

Staff members

92% (4,351) living
in Washington State in 2019

34% growth in employment 2000–2019



\$27.1M

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



\$1.67B

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

\$856M in Washington State wage income

8,197 total jobs generated in Washington State



\$482M

Domestic purchased goods and services

\$173M in Washington State



194

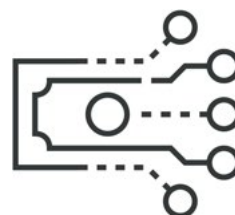
Companies formed with PNNL roots since 1965

In Washington:

15 started in the last 10 years and are still in business

-\$29.3M revenue

140+ employees



\$809K

Value of Battelle, PNNL, and PNNL employee cash contributions to philanthropic and civic organizations, including **\$213K** corporate support for STEM education



Pacific Northwest National Laboratory's (PNNL's) fiscal year (FY) 2019 Economic Impact Analysis report was prepared by PNNL Economist Michelle Niemeyer, with communications and graphic support provided by Jennifer Blake, Julie Fisher, Jeff London, and Andrea Starr; key contributions throughout the report were provided by Christopher Larmey.

Other PNNL and Battelle staff members who provided the data used in this report include: James Blount, Peggy Braxton, Andrea Brown, Sean Clausen, Robin Conger, Tracie Cowen, Frederick Davis, Danielle Deichman, Timothy Doyle, Jeffrey Enger, Jodi Hamm, Mark Hattrup, Karen King, Karen Kniep, Jennifer Knotts, Terry Law, Paula Linnen, Jim Mather, Vanessa Moore, Jason Nanni, David Oates, Corlissa Pardini, Megan Peters, Stacey Petersen, Annette Schutzenhofer, Bruce Simanton, Jeannie Strasser, Christie Sylvester, Lisa Wright, and Linda Wierenga.



ACRONYMS AND ABBREVIATIONS

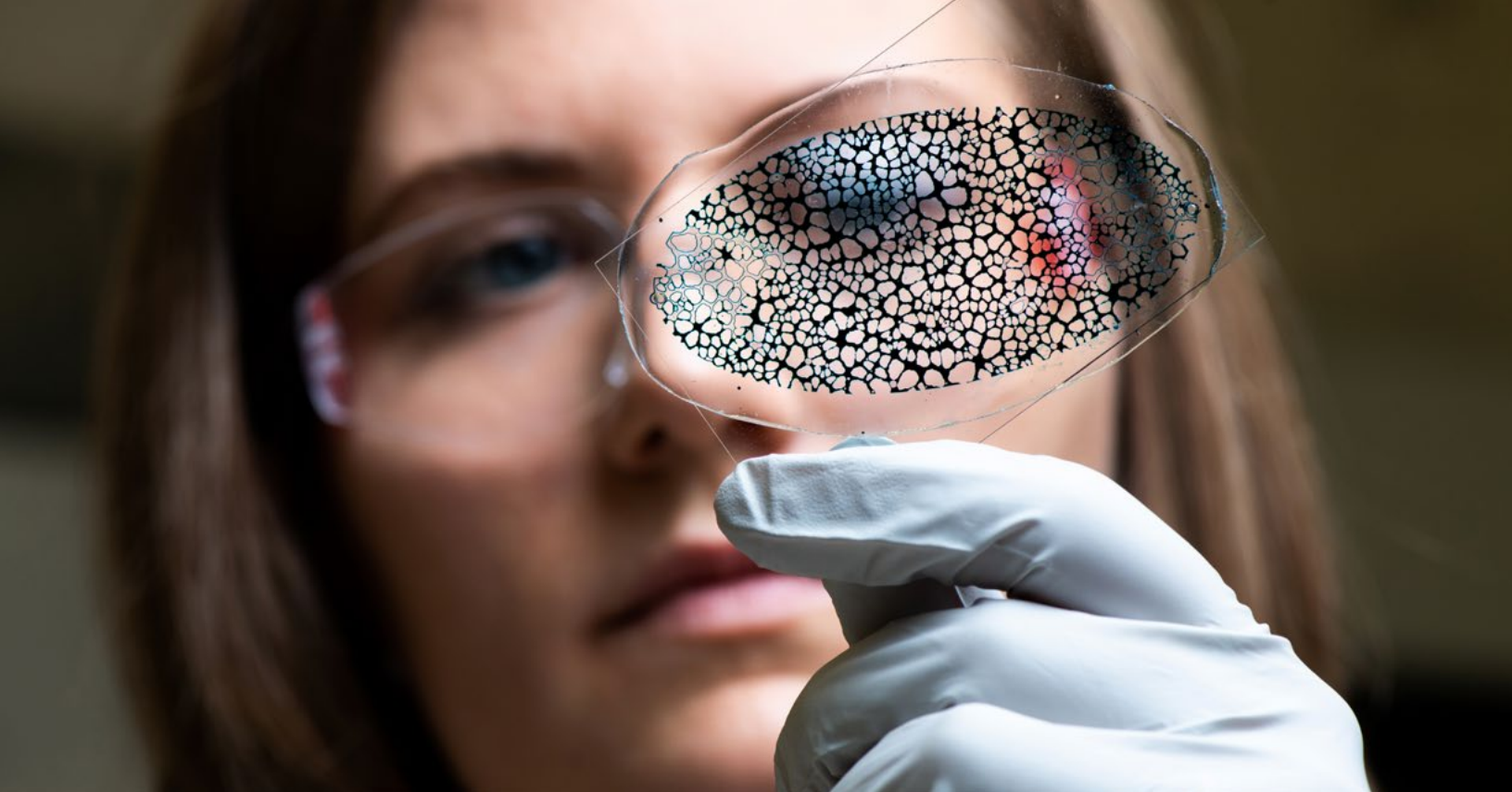
ARM.....	Atmospheric Radiation Measurement
B.....	billion
BER.....	DOE's Office of Biological and Environmental Research
DHS.....	Department of Homeland Security
DOE.....	U.S. Department of Energy
EMSL.....	Environmental Molecular Sciences Laboratory
FY.....	fiscal year
GSP.....	Gross State Product
IMPLAN®.....	Impact analysis for PLANning
IP.....	intellectual property

K.....	thousand
M.....	million
OASI.....	Social Security Old Age and Survivors' Insurance
PNNL.....	Pacific Northwest National Laboratory
R&D	research and development
SC.....	Office of Science
STEM.....	science, technology, engineering, and mathematics
U.S.	United States
WA.....	Washington State
WBL	Work-Based Learning
YVTC MESA.....	Yakima Valley/Tri-Cities Mathematics, Engineering, and Science Achievement



CONTENTS

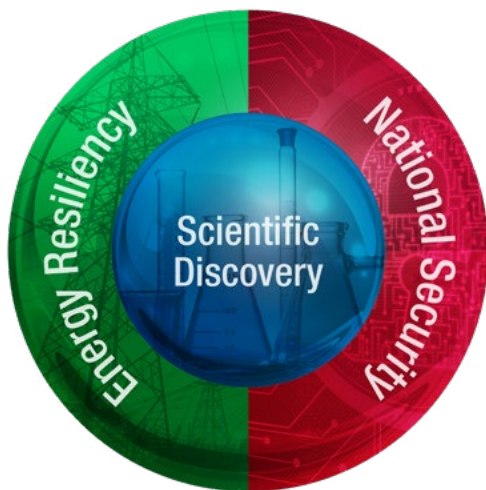
WHO WE ARE	1
EXECUTIVE SUMMARY	2
THE ECONOMIC IMPACT OF SCIENCE	3
Funding and Spending	3
Our Staff.....	4
Payroll and Benefits.....	5
Purchased Goods, Services, and Investments.....	6
Economic Impact of PNNL Operations.....	7
Expenditures for New Construction and Renovations.....	8
State and Local Taxes.....	9



PNNL: BEYOND THE SCIENCE.....	10
Economic Impact of Closely Related Activity	10
Healthcare Expenditures	12
Retirees	13
Visitors to PNNL	14
EMSL and ARM Users	15
Technology Transfer	17
Technology Commercialization: New Products and Companies with PNNL Roots	17
Intellectual Property	19
INVESTING IN THE FUTURE	20
Education and Community Contributions	20
Science, Technology, Engineering and Mathematics Education.....	21
Work-Based Learning.....	21
Community Investments and Assistance	23
CONCLUSION	25

WHO WE ARE

Pacific Northwest National Laboratory (PNNL), based in Richland, Washington (WA), is one of 10 United States (U.S.) Department of Energy (DOE) national laboratories. Founded in 1965, PNNL is operated by Battelle for DOE and is working to address some of the most pressing challenges of our time.



Fundamental research is the centerpiece of what we do at PNNL. From exploring the impact of clouds and aerosols on Earth's climate, to developing new catalysts and advanced materials, we take on some of the greatest research challenges to advance scientific discovery.

Our scientists and engineers are improving and modernizing U.S. energy systems, making them more efficient and more resilient in the face of extreme weather events, physical features, and cyberattacks. Our researchers work in many areas, including advanced power grid modeling, energy storage and renewable energy integration, and grid cybersecurity, to realize our vision of a U.S. energy system that is more efficient, flexible, and sustainable.

PNNL develops science-based solutions that keep America safe. We are focused on securing our nation's critical infrastructure, combatting global terrorism, detecting concealed threats, and protecting our citizens from cyber, nuclear, chemical, and biological weapons of mass effect and other forms of proliferation and terrorism.

PNNL is home to more than 20 specialized and unique research facilities, including dedicated laboratories for power grid operations, coastal sciences, data analytics, and atmospheric sciences. These resources equip researchers to expand the frontiers of scientific understanding and technological possibility in areas of national importance. PNNL plays important roles in the management and operation of 2 DOE Office of Science (SC) user facilities, the Environmental Molecular Sciences Laboratory (EMSL) and the Atmospheric Radiation Measurement (ARM) user facility, which serve more than 2,000 researchers worldwide, annually.

EXECUTIVE SUMMARY

Impacting and investing in the future, both from a scientific and economic standpoint, starts today. PNNL is known for contributing science and technology to address national challenges. What's not as well known is that we also contribute significantly to the local, regional, state, and national economy. To calculate the economic impact of PNNL on the state of Washington, PNNL used IMPLAN® (IMpact analysis for PLANning), a widely accepted economic input-output model, to estimate funding, employment, and labor income impacts. The Washington State data file for 2016 was used in this analysis with gross domestic product deflators within the model used to convert impacts to 2019 dollars.

In FY 2019, PNNL conducted more than \$1 billion (B) in scientific research, drawing upon signature capabilities in chemistry, Earth sciences, and data analytics.

In fiscal year (FY) 2019 we also

- Directly and indirectly supported more than \$1.67B in total economic output, in-state payrolls of \$856 million (M), and 8,197 jobs through our operations in the state
- Employed 4,722 people who work at PNNL, and 92 percent lived in Washington
- Spent \$482M on goods and services; 36 percent from companies in Washington
- Contributed \$809K to philanthropic and civic organizations (including \$213K corporate support for science, technology, engineering, and mathematics [STEM] education).

THE ECONOMIC IMPACT OF SCIENCE

\$1.09B
FY 2019 FUNDING

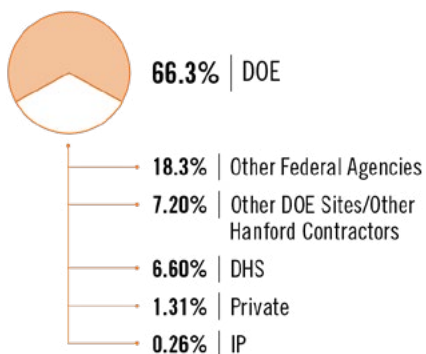
\$1.01B
FY 2019 SPENDING

Funding and Spending

PNNL is a large and vital economic entity with 4,722 employees, \$1.01B in total spending (see Figure 1) and \$1.09B in total funding (see Figure 2).

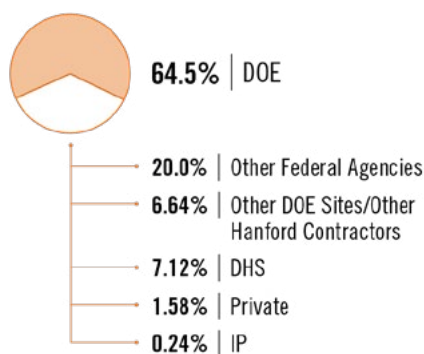
We use the term “funding” or “sales” to refer to the total revenue that was received for projects conducted at PNNL. It’s an indicator of the total amount of work that was done at the Laboratory over a given fiscal year—in this case, FY 2019. We use the term “spending” or “business volume” as a measure of total costs, or expenditures, charged to third-party clients and include direct costs such as labor, travel, and procurements, as well as some necessary overhead costs.

We perform the majority of our work for DOE. Our 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 Spending in FY 2019



Detail may not sum to total due to rounding.

Figure 2 | PNNL's Funding in FY 2019

10%
EMPLOYMENT GROWTH
FY 2014–2019

4,722
STAFF MEMBERS

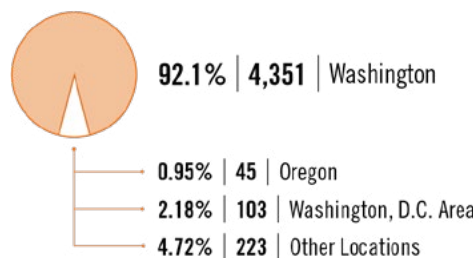
92%
(4,351)
EMPLOYED & RESIDING
IN WASHINGTON

Our Staff

PNNL's many accomplishments are a tribute to the expertise and experience of 4,722 scientists, engineers, and support professionals. In FY 2019, our staff members held 2,298 advanced degrees. Each bright mind and innovative spirit plays a role. Our researchers and mission support staff members work side-by-side. Together, they enable the mission and success of PNNL.

At PNNL, our strength is in our people. We are committed to fostering a work environment that fully embraces and values diversity and inclusion. We believe that this diversity, depth, and breadth in our people enables 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. We respect and value individual differences among colleagues and neighbors. Nearly 92 percent of our workforce, 4,351 people, are residents of Washington, working mainly on our Richland, Seattle, and Sequim campuses.¹ Of those, 81 percent lived in Benton County and 12 percent in Franklin County.²



Detail may not sum to total due to rounding.

Figure 3 | Location of Employees Who Work at PNNL

1. Outside of Washington, 103 staff members reside in the Washington, D.C. area; 45 staff members reside in the Corvallis and Portland, Oregon area; and 223 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, 53.6 percent reside in Richland, 19.0 percent in Kennewick, 12.5 percent in Pasco, and 12.1 percent in West Richland, and the remaining 2.8 percent reside elsewhere in the two counties.



\$487M
IN PAYROLL

\$449M
PAYROLL FOR
WASHINGTON RESIDENTS

Payroll and Benefits

PNNL's payroll in FY 2019 was \$487M, of which \$449M went to staff members employed in Washington.

At the end of FY 2019, the average annual wage for our Washington staff members was \$103,245; whereas, the state average occupational wage for the same timeframe was \$60,331.³ Because we are a research and development 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 provides a benefits package that costs \$106M 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 that 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 is \$66,833.



\$173M

IN PURCHASES FROM
WASHINGTON FIRMS

Purchased Goods, Services, and Investments

During FY 2019, PNNL spent \$482M on goods and services to support operations. Table 1 shows the variety of goods and services purchased, including small scientific equipment and subcontracts with universities, consultants, and research firms. Of the total, 36 percent (\$173M) of the purchases were from Washington-based firms.

Table 1 | FY 2019 PNNL Purchased Goods and Services Spending
(total U.S. domestic and in Washington)

Type of Expenditure	Total (\$M)	In WA (\$M)
Construction	\$41.0	\$11.5
Finance, Insurance, Real Estate	\$115	\$108
Computers, Lab Equipment, Software, Services, Retail Trade	\$90.9	\$18.6
Utilities, Transportation, Publishing, Management, Business Services	\$120	\$12.1
Technical and Scientific Subcontractors	\$61.7	\$11.9
Medical and Health Services	\$1.25	\$1.12
All Other	\$51.4	\$9.21
Total*	\$482	\$173

* Detail does not sum to total because of rounding.

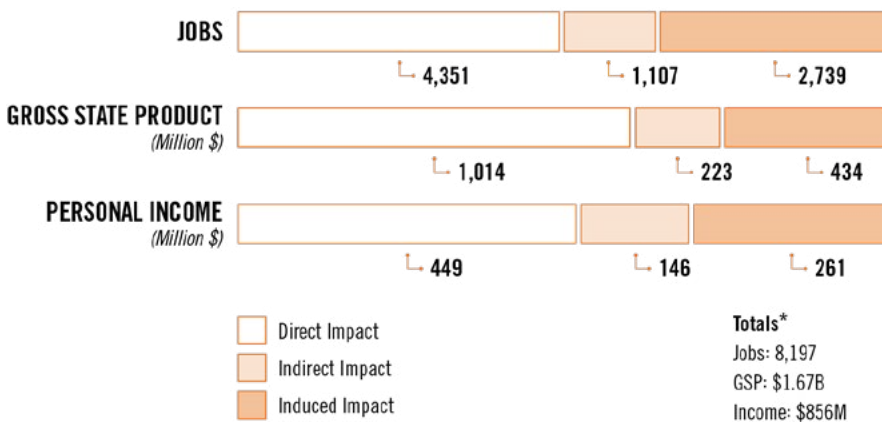
Economic Impact of PNNL Operations

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 GSP, and the ratio of total to direct impact is called the multiplier effect.⁴

Figure 4 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 \$1.67B in GSP, 8,197 jobs, and \$856M in total wages for Washington.

Total Impacts of FY 2019 PNNL Payroll, Non-Payroll, Purchases, and Investment



*Detail may not sum to total because of rounding.

Figure 4 | FY 2019 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 healthcare purchases were compiled and translated into IMPLAN inputs.

\$1.67B

GROSS STATE PRODUCT
(GSP) FY 2019 PAYROLL
& NON-PAYROLL PURCHASES

8,197

JOBS

\$856M

IN WASHINGTON WAGES

24

CONSTRUCTION PROJECTS
SUPPORTED BY

\$9M

IN-STATE SUBCONTRACTOR
CONSTRUCTION SPENDING

Expenditures for New Construction and Renovations

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

To stay relevant as a large scientific enterprise and continue our leadership in key research areas, we must periodically renovate facilities and procure major scientific equipment as scope of work, scientific knowledge, and sponsor missions and deliverables change.

For example, in FY 2019, we began construction of the Energy Sciences Capability project. This facility will house 200 staff members and state-of-the-art instruments for fundamental research in chemistry, materials science, and computational science. Another planned facility will translate these discoveries into energy storage solutions for the grid.

We made investments in facilities and infrastructure worth \$14M (see Table 2). All major renovations were performed on buildings located in Washington, and 71 percent (\$9.9M) included reimbursements to subcontractors working on PNNL buildings.⁵ The vast majority of the subcontractor reimbursements (91 percent) were earned by Washington-based subcontractors, at a total of \$9M.⁶ An estimated 24 construction projects were supported by in-state subcontractor construction spending and are included in the total impacts detailed in Table 2 and Figure 4.

Table 2 | PNNL Construction Spending in FY 2019

FY 2019 Renovations	Total Spending (\$M)
PNNL Labor Costs	\$3.8
Miscellaneous Procurements	\$0.3
Disbursements to Subcontractors <i>Item: Disbursements to Washington Subcontractors = \$9M</i>	\$9.9
Total Renovation Spending	\$14

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's economy.

6. Total costs related to these renovations, other than PNNL labor, are included in the \$482M non-payroll purchases listed in Table 1.



State and Local Taxes

PNNL paid \$1.38M in taxes, and its staff members paid an additional \$25.7M in taxes,⁷ for a total of approximately \$27.1M, which includes sales and use taxes, property taxes, and other types of taxes (e.g., motor fuel taxes).⁸ The estimated tax payments by employees are shown in Table 3.⁹

\$27.1M
PAID IN LOCAL AND
WASHINGTON TAXES

Table 3 | FY 2019 Washington State and Local Taxes Paid by PNNL and Its Employees

Washington Tax Category	Paid by PNNL in FY 2019 (\$K*)	Estimated Paid by PNNL Employees in FY 2019 (\$K*)
Sales and Use Taxes	\$383	\$11.7
Business and Occupation Taxes	\$136	\$0
Property Taxes	\$861	\$13.0
Other State and Local Taxes	Negligible	\$1.03
Total	\$1.38M	\$25.7M

*K = thousand

7. Employee taxes were based on the total \$449M in wages of employees at PNNL who work in Washington (for the purpose of this analysis, they are assumed to live in Washington, as well) and the 2018 state and local governments' collection rates (for every dollar of personal income). The rates are an estimated \$0.026 in sales, use, and other production-related taxes by individuals; \$0.029 in state and local property tax collections; and \$0.002 in other taxes per dollar of personal income.
8. Washington does not have a personal or corporate income tax.
9. In addition, PNNL paid \$3.6M 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.



\$273M
IN GSP

1,737
PNNL-DEPENDENT
EXTERNAL JOBS GENERATED

\$110M
IN LABOR INCOME

PNNL: BEYOND THE SCIENCE

While not strictly a PNNL activity, there are certain expenditures, such as spending on healthcare, that bolster the economy and would not occur in Washington 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 companies with PNNL roots—also creates significant additional economic activity in the state. Taken together, these activities directly employ 683 people and generate a Gross State Product (GSP) of \$101M. The IMPLAN® model calculates that, when the indirect and induced economic impacts are taken into account, a total of \$273M in GSP, 1,737 jobs, and \$110M in labor income depend on these activities (see Figures 5 and 6 for more detail).

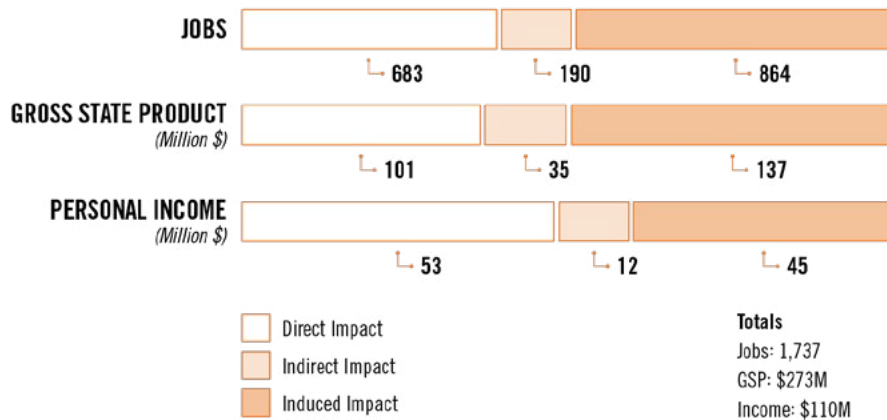


Figure 5 | Total Impact of Healthcare Spending, Companies with PNNL Roots, Visitor Spending, and Retirees on the Washington State Economy in FY 2019



HEALTHCARE

\$74M, which produces an estimated statewide total impact of 880 jobs, \$132M in GSP, and \$65M in labor income.



IN-STATE VISITORS

\$3.9M per year, which generated a total economic impact of \$6M in GSP, 58 jobs, and \$2M in labor income.



COMPANIES WITH PNNL ROOTS

In-state employment of 140+ and estimated revenue of \$29.3M. As a group, this category generated a statewide total economic impact of \$49M in GSP, 258 jobs, and \$24M in labor income.



RETIREEES

\$107M in pension and Social Security income in FY 2019, the spending from which generated a total economic impact of \$86M in GSP, 541 jobs, and \$28M in labor income.

Figure 6 | Estimate of Closely Related Activities Spending Impacts Using the IMPLAN® Model on the Washington State Economy in FY 2019



\$74M

HEALTHCARE
EXPENDITURES

880

JOBS ESTIMATED
STATEWIDE IMPACT

\$132M

IN GSP

Healthcare Expenditures

Health insurance expenditures in Washington for our 4,351 staff members residing in the state, 2,166 retirees, and their households totaled an estimated \$74M in FY 2019.¹⁰ PNNL's direct medical and dental insurance expenditures on behalf of in-state employee households were estimated at \$46M (see Figure 7).



Figure 7 | Estimated Healthcare Spending of Employees at PNNL and Retirees, in Washington in FY 2019

10. Total costs of more than \$27.6M for retired households were based on Kaiser Family Foundation estimates of per capita expenditures by type for healthcare in Washington in 2014, adjusted to 2019 dollars.

Retirees

74 percent of our retired former employees continue to live in Washington.¹¹ 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 2019, the Battelle-defined benefit pension plan for our employees paid a total of \$67M to 2,924 retirees and their beneficiaries. The PNNL pension benefit was an average of \$2,030 per month, per person, in Washington.

Information in Table 4 assumes that our in-state retirees receive 1.37 times the OASI payment of the average retiree in the state, or about \$2,073 per month, for a total estimated \$54M.¹² Combined, pensions and Social Security total \$144M, of which \$107M is estimated to be spent within Washington on goods and services.¹³

2,924

RETIREES

\$4,103

ESTIMATED
MONTHLY PAYMENT

\$107M

TOTAL ANNUAL INCOME

Table 4 | Estimated Washington State PNNL Retiree Income in FY 2019

FY 2019 Renovations	Estimated Average Retiree Monthly Income in FY 2019	Total Retiree Annual Income in FY 2019 Income (\$M)
Pension	\$2,030	\$53
OASI (Social Security)	\$2,073	\$54
Total	\$4,103	\$107

11. Direct data from the pension administrator were available on PNNL retiree locations for FY 2019. Of 2,924 retirees, 2,166 had Washington addresses.

12. The estimated average monthly payment per OASI retired beneficiary in FY 2019 was \$1,514 in Washington. Because PNNL retirees have had salaries about 1.5 times the state average salary, Social Security calculator software shows that their average OASI payment would be 1.37 times the Washington average.

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



PNNL is renowned for its catalysis research which has led to longer-lasting, more efficient, and safer batteries. Our researchers contributed to the first biofuel approved by the Federal Aviation Administration, performed in collaboration with industry partners. Closer to home, our capabilities in actinide science, subsurface flow and transport, and glass science support Hanford cleanup.

Visitors to PNNL

At PNNL, we host thousands of business visitors each year, many of whom are from outside the state and contribute their spending to the state's visitor economy.¹⁴

Statistics for out-of-town visitors to our facilities in FY 2019 are shown in Table 5, identified through PNNL visitor badges.¹⁵ Visitors contributed an estimated \$3.9M 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.

Table 5 | Number of Out-of-Town Visitors and Visitor Days to PNNL Facilities

PNNL Visitor Statistics	
Number of out-of-town visitors	5,445
Estimated total visitor days	25,930
Estimated tourism expenditures	\$3.9M

14. 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.

15. Several 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 that includes, but is 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 that 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.

EMSL and ARM Users

EMSL is a DOE-SC user facility sponsored by DOE's office of Biological and Environmental Research (BER). It is operated by and located on the campus of PNNL. Many of EMSL's users are from Washington companies or educational institutions (shown in Table 6).

We also provide overall technical direction for the ARM user facility on behalf of BER. Both user facilities have a variety of users from the national and international science community.

577
EMSL USERS

980
ARM USERS

ENVIRONMENTAL MOLECULAR SCIENCES LABORATORY

EMSL provides a collaborative team research environment that includes high-performance computational capabilities linked directly to suites of state-of-the-art experimental instruments. By shortening the time required to gather, analyze, store, process, and disseminate experimental and computational data, EMSL users can accelerate scientific innovation.

Through EMSL, scientists gain a predictive understanding of biological and environmental systems across temporal and spatial scales—a necessary step in the development of sustainable solutions to the nation's energy and environmental challenges.

Table 6 | FY 2019 EMSL Users

	Total EMSL Users	Total Users
EMSL	577	278
International (foreign) users	47	0
U.S. users	530	278
Non-PNNL U.S. users	297	45



ARM USER FACILITY

The ARM user facility is a multi-platform scientific user facility designed to improve the 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 2019, the 980 unique ARM scientific users included 626 from universities, 52 from industry, 163 from DOE laboratories, 87 from other federal agencies, and 37 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, 183 accessed ARM's on-site assets, 52 used off-site services, and 745 used data services. ARM employs approximately 65 people at PNNL, some of whom are less than full-time.



265
INVENTION DISCLOSURES

58
PATENTS GRANTED

\$2.66M
IN LICENSING REVENUE

Technology Transfer

Technology Commercialization: New Products and Companies with PNNL Roots

Many of PNNL's research activities generate ideas and inventions (i.e., intellectual property [IP]) that have commercial value. PNNL prides itself on rapidly deploying this IP into the marketplace in partnership with new or existing firms.

Since 1965, 194 new companies were started that had technological or managerial roots at PNNL, and 99 of those are still in business. Table 7 provides a breakdown of the activity over the last 10 years. Fifteen of the 30 companies are located in Washington, still in business, employ more than 140 people, and have estimated sales of \$29.2M.

Table 7 | Companies with Ties to PNNL (established in last 10 years and still operating)

	Total	In WA
Number of Firms	30	15
Estimated Sales (\$M)		\$29.2
Employment	>280	>140

Software Developed at PNNL Forms Foundation for Washington-based Company

In 2016, Champion Technology Company Inc., based in Richland, Washington, was launched through an entrepreneurial leave program offered by PNNL that provides a pathway for researchers to take promising innovations out of the laboratory to form a private business.

In this case, the product developed by PNNL and commercialized by Champion was an analytical software called Columnar Hierarchical Auto-associative Memory Processing in Ontological Networks—or CHAMPION—was created to bridge the gap between machine learning and other

data science analytics to help protect organizations against economic and reputational losses.

Today, the company—now officially renamed and known as DarkLight, Inc. (DarkLight)—has expanded its reach to locations in Seattle and Denver, Colorado. Developers at DarkLight have further advanced CHAMPION. The software, renamed DarkLight Cyber, is an artificial intelligence platform available through a cloud-based subscription service.

This is just one example of the many ways in which PNNL's Technology Deployment and Outreach programs help move innovation from the national laboratory to the marketplace.

Intellectual Property

While undoubtedly there is 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 research and development activities. PNNL transfers technologies—primarily through IP options and licenses—at a rate of almost one technology licensed every 10 days, including 37 new license agreements in FY 2019.

PNNL continues to lead all other DOE laboratories in implementation of Agreements for Commercializing Technology, having 91 agreements with 66 different private organizations. In FY 2019, we had 18 active Cooperative Research and Development Agreements and 230 non-federal Strategic Partnership Project agreements.

Often, federally funded research results in scientific and engineering solutions that have intellectual property value. Table 8 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. We collected \$2.66M in licensing revenue in FY 2019 and reinvested a significant portion of these funds at PNNL for additional commercialization-focused development work.

1
LICENSE
NEARLY EVERY
10
DAYS

Table 8 | PNNL Statistics on Inventions, Patents, Technology Transfers, and License Income

	New FY 2019	Cumulative 2000–2019
Invention Disclosure	265	4,670
Patent Applications	67	1,420
Patents Granted	58	997
Licenses and Options	37	669
Total License Revenue Received	\$2.66M	\$71.4M



PNNL mathematicians and computer scientists are advancing machine learning and artificial intelligence, as well as demonstrating their potential in real-world applications. They are using machine learning to improve climate models, identify novel molecules for energy storage, and support national security needs. In the future, we hope to imbue critical infrastructure, such as the power grid, with artificial intelligence to keep it safe and sound.

INVESTING IN THE FUTURE

Education and Community Contributions

Whether contributing to local organizations, facilitating community volunteerism and leadership, or further 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.

Science, Technology, Engineering and Mathematics Education

The Office of STEM Education aligns PNNL's education efforts with national, state, and local initiatives to spearhead change in STEM education and to address workforce challenges in the Northwest and beyond. In partnership with DOE's Office of Workforce Development for Teachers and Scientists, we connect our resources with community, regional, and national STEM education stakeholders to help meet the research, diversity, and education priorities of DOE. We focus on building and expanding relationships with educators, educational and community-based foundations, government sponsors, and others to improve and accelerate the growth of STEM education and workforce preparation.

Work-Based Learning

The Office of STEM Education and Work-Based Learning (WBL) intersect in their goal to increase STEM opportunities for students. In FY 2019, DOE-SC provided project funding, and PNNL invested \$794,000 in post-secondary student and faculty programs. PNNL's Intern and Fellowship Management and Administration pool was \$1,464,000. PNNL spent \$1,075,000 in overhead funds to support WBL (high school and post-secondary), STEM education, and outreach efforts (K-16). In FY 2019, 7,684 pre-college, undergraduate, graduate, post-graduate, and faculty researchers benefited from STEM education or WBL programs or participated in PNNL's STEM workforce.

We are incredibly proud of the impact we're seeing from our ongoing partnerships in this effort.

"I never considered STEM until participating in the YVTC MESA program. I was inspired to become an engineer, and I hope to mix the beauty of art with the elements of engineering in the future."

Kimberly

Chiawana High School
MESA Student



Solving Tomorrow's Problems By Inspiring Innovation and Creativity in Students

PNNL's Office of STEM Education aims to inspire our youth—the future, diverse workforce in STEM fields—by making science fun and accessible. Here's one example: since 2018, we've led the Yakima Valley/Tri-Cities Mathematics, Engineering, and Science Achievement (YVTC MESA) Center program. YVTC MESA currently reaches more than 400 students in grades 6–12 from 5 school districts, with an emphasis on students from underrepresented STEM populations, rural communities, or low-income families.

We delivered hands-on STEM learning opportunities for students, culminating in a regional MESA Day competition. Teams compete and showcase their engineered solution that solves a human need. For

example, to increase bicyclist safety, our national student team created a series of devices to alert bicyclists of oncoming traffic and stop the bike.

Our YVTC MESA program is proud of achieving 63 percent year-over-year growth in students served during the first year and that, in 2019, 74 percent of our students were from historically underrepresented populations in STEM and 45 percent were female. In 2018 and 2019, a YVTC MESA team won the statewide round and advanced to the national competition. We're excited to continue this collaboration in developing an internship pipeline for YVTC MESA students.

Our goal is to raise awareness, inspire, and increase students' interest in STEM and STEM careers, so they can be a part of solving tomorrow's greatest challenges.

Community Investments and Assistance

Since 1965, Battelle has invested more than \$28.5M to improve science, education, and quality of life in Washington. Over the past 10 years, staff members at PNNL have volunteered 347,000 hours to community projects, including more than 42,000 hours to over 50 local organizations in FY 2019, 30,000 hours of which were through our own volunteer program, Team Battelle. A few of the organizations that benefited from our involvement include: Mid-Columbia Science and Engineering Fair Association, Boys & Girls Club, Chaplaincy Cork's Place, Junior Achievement, and the Mid-Columbia Ballet.

PNNL leadership serve on key organization and educational boards that promote and impact economic development for our local community and region. A sampling of these boards include the Tri-Cities Regional Chamber and the MyTRI2030 Regional Affairs Committee, Association of Washington Business, Washington Roundtable, Washington State University Tri-Cities Advisory Committee, Tri-Cities Development Council, the REACH Foundation, Washington Clean Tech Alliance, the Washington State STEM Education Foundation, and the West Sound STEM Network.

Table 9 shows quantitative measures of PNNL and Battelle's community assistance, including corporate and individual financial giving.

Table 9 | PNNL and Battelle Community Assistance Statistics for FY 2019

Washington State Community Assistance	Total (\$K)
Battelle cash donations to health, human services, and other philanthropic and civic organizations	\$520
PNNL memberships in Washington civic organizations	\$105
Staff member contributions to United Way	\$184
Total	\$809

\$28.5M

INVESTED BY BATTELLE
SINCE 1965

\$809K

IN COMMUNITY
ASSISTANCE FROM
BATTELLE AND STAFF
AT PNNL

347K

HOURS VOLUNTEERED
BY STAFF AT PNNL
OVER THE PAST 10 YEARS



Battelle Gives Back to Our Communities

Battelle, the operator of PNNL, is a nonprofit charitable trust that gives back to the communities in which its employees live and work. Annually, Battelle invests more than half a million dollars in the community where PNNL is located, with more than 50 percent going toward the advancement of STEM education, as well as other investments in civics, arts, culture, and important health and human services programs. In addition to the significant financial donations Battelle's PNNL-based staff members personally made to a multitude of worthy causes, they also gave of their time and talent.

For example, in FY 2019, Battelle made a \$10,000 philanthropic contribution to Columbia Basin College, matching a \$10,000 grant from Washington State's Office of Superintendent of Public Instruction. The funding will give K-12 teachers the chance to explore new, creative educational ideas by giving them access to upgraded technology, innovative workshops, and relevant, fun training through activities like cyber challenge scenarios and a computer science job shadow program. Our staff collaborated with Columbia Basin College to establish the local Computer Science Teachers' Association Chapter, a partnership that makes all these opportunities possible.

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, more prosperous, and more secure. As we advance the nation's and state's body of scientific understanding and technological solutions, we are also building the economy of tomorrow for the nation and the state of Washington.

In FY 2019, PNNL positively impacted the economic activity in Washington with \$1.01B in total spending, 4,351 resident employees, in-state payroll of \$449M, and approximately \$173M in purchases from Washington businesses. This economic activity, in turn, supports a total economic output of \$1.67B, as well as in-state payrolls of \$856M and 8,197 jobs throughout the state.

The growing number of commercial companies in Washington that were formed based on PNNL ideas and assistance has added more than 140 employees and an estimated \$29.3M in funding, proving the success of our model for interagency collaboration and technology transfer and commercialization, all of which has won numerous awards. An additional \$273M in output, in-state payrolls of \$110M, and 1,737 jobs are supported through closely related activities such as companies with PNNL roots, retirees, visitors, and healthcare spending.

Now, more than ever, it is important for PNNL to continue to be a vital component of our state's economy. That's exactly what happens when impact and innovation converge.

\$1.67B

TOTAL ECONOMIC
OUTPUT SUPPORTED
BY PNNL PAYROLL
AND DOMESTIC PURCHASED
GOODS AND SERVICES

\$856M

WASHINGTON STATE
WAGE INCOME

8,197

TOTAL JOBS
GENERATED IN
WASHINGTON STATE

WHERE SCIENTIFIC
INNOVATION AND
ECONOMIC IMPACT
MEET, YOU'LL
FIND PNNL.





For more information, contact:

Christopher Larmey, chris.larmey@pnnl.gov

Michelle Niemeyer, michelle.niemeyer@pnnl.gov

