

Washington's Green Economy



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REPORT TO THE LEGISLATURE

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Executive Summary

Overview



Communities and regions in Washington must respond to climate change by reducing emissions and preparing for a resilient future characterized by adapting to the current and foreseeable effects of climate change. Our state has strengths in key sectors that can be leveraged to help our state and others respond to the environmental challenges being experienced with climate change. Identifying the opportunities and creating connections are essential to simultaneously meeting the state's greenhouse gas emissions targets and achieving economic success.




To address requirements detailed in ESHB 1109 (see page four of this report), the Washington State Department of Commerce convened a working group regarding the development of Washington's green economy based on the state's competitive advantages in energy, water, natural resources and agriculture. The Green Economy Working Group was composed of a broad group of stakeholders, each with a unique perspective on the green economy and the sectors identified in the proviso. The wide range of expertise of the group resulted in the identification of multiple highly promising opportunities throughout the state to respond to the wide range of environmental challenges we face.

This final report serves as a foundation from which to build Washington's green economy. This foundation must also include ongoing work on industrial symbiosis, which is the collaboration between public and private businesses to foster the use of industrial by-products, including energy, water, materials and logistics. Additionally, this foundation will also include updates to the State Energy Strategy and a commitment to rethink traditional infrastructure financing models.

In its first meeting, the working group recognized that the requirements for this effort were very broad, with many opportunities for green economic development being cross-cutting in nature. Building upon the diverse range of expertise in the room, the working group proceeded to develop recommendations and opportunities by examining energy, agriculture, forestry and building materials, and water as key sectors of the green economy, across which all of the other required elements of the project were related.

The report's recommendations and opportunities are organized by these key sectors, using the legend below to demonstrate which of the required elements from the legislative proviso each particular recommendation addresses. In many cases, recommendations are cross-cutting and address multiple requirements, which is indicated in the report through the use of one or more of the icons provided in the legend.

Recommendations and opportunities	Total Recommendations	Legend
Investment opportunities in higher education, research and development, and workforce training	20	
How state government may serve as a clearing house, or economic center, to support private investments	18	

Recommendations and opportunities	Total Recommendations	Legend
Opportunities for integrating technology in energy, water, natural resources, and agriculture	19	
Create resource efficiencies including water and energy conservation and smart grid technologies	13	
Policies at the state and local government level to promote and accelerate development of the green economy in Washington state	22	

Key Findings or Highlights

The Green Economy can be an important element of the economic recovery.

The Green Economy Working Group began its efforts prior to the effects of the global COVID-19 pandemic, directing its attention to strengthening the economy through a focused examination of key opportunities and competitive strengths where Washington state is a recognized leader. Today the state of the economy has drastically changed with significant unemployment, and both public and private sector economic impacts that present immediate and urgent challenges that must be addressed. The group identified some ways that emerging opportunities in the next economy may support the green infrastructure and economic development opportunities:

- Trends and demand for the integration of information and communications technologies and artificial intelligence will increase.
- Interest in local sourcing and supply will be an emphasis as supply-chains adapt to be less reliant on globalization.
- Increased value placed on local production may result in opportunities in Washington state to produce more goods and services locally.

The working group felt strongly that elements of green infrastructure and economic development identified during this process have a potential to make a meaningful contribution to an economic recovery in the near-term while also responding to the environmental challenges brought about by climate change.

Recommendations are interrelated across sectors.

The Green Economy Working Group considered the strengths and capabilities of Washington state's private industries, research universities and workforce in developing a set of 44 recommendations and opportunities that hold strong potential to grow the state's economy while addressing environmental challenges. At its final workshop, members of the working group felt strongly that there were elements of all of the recommendations that could be acted on in the near term, and that could become an important component of any economic recovery. While some of the recommendations may represent longer-term objectives, there was strong interest to not lose sight that progress towards these objectives involves near-term action and progress that can help with the economic recovery of today while making significant progress to objectives addressing broad environmental challenges from climate change.

Furthermore, the working group recognized potential in examining these recommendations as sets of potentially interrelated opportunities that are not mutually exclusive to each sector as examined in the report. As these recommendations are acted upon, an effort should be made to consider areas of overlapping opportunity and objectives.

Addressing areas of economic inequality and access to opportunity is more imperative now than ever before. Inequalities related to race and income were identified as priority areas of focus for future green economic development at the outset of this process, with communities throughout the state still struggling to realize the benefits of a recovery from the previous recession. Faced with a new economic emergency, these inequalities will become only more pronounced. A concerted effort needs to be made to focus green economic development capacity in traditionally underserved and underrepresented communities and identify the barriers that prevent these communities from fully benefitting from emerging economic opportunities in sectors of the green economy.

Workforce development is a key strength for the green economy.

Washington state has a strong presence in its community and technical college system, including dedicated centers of excellence with an emphasis on building a future workforce that will be needed for the green economy across all sectors examined in this report. A key finding of this effort is that in many instances, programs are in place throughout the state that are either currently providing the skills for the green economy, or are well-positioned to do so, both in terms of expertise as well as in geographic reach in communities throughout the state. To ensure that opportunities in the green economy are available to traditionally underserved and underrepresented communities, efforts will need to be made to evaluate programs to ensure equitable access to opportunity. Increasing Washington's workforce development capacity may be an effective way to prepare communities throughout the state to contribute to, and benefit from, a sustainable economic recovery.

Introduction

Background

In March 2019, the Association of Washington Cities (AWC) released its report "Growing the Green Economy in Washington State: Exploring an Eco-Nomic Center."¹ The report focused on the energy, water and agriculture/forestry sectors by emphasizing activities, opportunities and policy recommendations that have strong potential for supporting Washington state businesses in these areas.

Following on this effort, ESHB 1109.SL (38) tasked Commerce with convening a work group to identify resources and opportunities that would support development of Washington's green economy. The Legislature appropriated \$150,000 for fiscal year 2020 to do this work.

What Does the Legislation Say?

The 2019-21 Supplemental Operating Budget, HB 1109.SL (38), directed Commerce to convene a work group regarding the development of Washington's green economy based on the state's competitive advantages. The work group must:

- Develop an inventory of higher education resources, including research, development and workforce training to foster green economic development in energy, water and agriculture.
- Identify investment opportunities in higher education research, development and workforce training to enhance and accelerate green economic development.
- Make recommendations for green economic development investment opportunities and how state government could serve as a clearinghouse, or economic center, to support private investments and build the green economy in Washington to serve national and global markets.
- Identify opportunities for integrating technology in energy, water, natural resources and agriculture, and create resource efficiencies, including water and energy conservation and smart grid technologies.
- Recommend policies at the state and local government level to promote and accelerate development of the green economy in Washington state.
- Submit an interim report with the work group recommendations to the appropriate legislative committees by Dec. 1, 2019.
- Submit a final report with the work group recommendations to the appropriate legislative committees by June 30, 2020.

Recent Related Efforts Commerce is Leading

Commerce is currently working to update Washington's State Energy Strategy with two broad goals in mind. First, the strategy must identify pathways to meet the state's updated greenhouse gas (GHG) reduction

¹ ["Growing the Green Economy: Exploring an Eco-Nomic Center," Association of Washington Cities, Center for Quality Communities, 2019.](#)

targets. Second, the strategy must align the pathways with the requirements of the state's 100% clean electricity law (Clean Energy Transformation Act²).

While achieving those goals, the strategy must maintain competitive energy prices that are equitable for consumers. A key connection point for the green economy work is the requirement that the strategy increase competitiveness by fostering a clean energy economy that enables GHG reductions and economic advancement through jobs and workforce development.

Aligning the green economy work with current efforts around industrial symbiosis represents another significant opportunity. Industrial symbiosis is the use by one company or sector of underused resources from another company. The broadly defined resources include waste, byproducts, residues, energy, water, logistics, capacity, expertise, equipment and materials.

Creating new connections to use these assets would keep resources in productive use longer. The systems approach to a more sustainable and integrated industrial economy would result in recommendations for specific projects and research and development efforts and would fit with the green economy mandate to identify sustainable business opportunities for Washington.

Key Recommendations and Conclusions

The Green Economy can be an important element of the economic recovery.

The Green Economy Working Group began its efforts prior to the effects of the global COVID-19 pandemic, directing its attention to strengthening the economy through a focused examination of key opportunities and competitive strengths where Washington state is a recognized leader. Today significant unemployment has drastically changed the state of the economy, and both public and private sector economic impacts present immediate and urgent challenges that must be addressed. The group identified some ways in which emerging opportunities in the next economy may support the green infrastructure and economic development opportunities:

- Trends and demand for the integration of information and communications technologies and artificial intelligence will increase.
- Interest in local sourcing and supply will be an emphasis as supply chains adapt to be less reliant on globalization.
- Increased value placed on local production may result in opportunities in Washington state to produce more goods and services locally.

The working group felt strongly that elements of green infrastructure and economic development identified during this process have a potential to make a meaningful contribution to an economic recovery in the near-term while also responding to the environmental challenges brought about by climate change.

Recommendations are interrelated across sectors.

The Green Economy Working Group considered the strengths and capabilities of Washington state's private industries, research universities and workforce in developing a set of 44 recommendations and opportunities that hold strong potential to grow the state's economy while addressing environmental challenges. At its final workshop, members of the working group felt strongly that there were elements of all of the recommendations that could be acted on in the near term, and that could become an important component of any economic

² <https://www.commerce.wa.gov/growing-the-economy/energy/ceta/>

recovery. While some of the recommendations may represent longer-term objectives, there was strong interest to recognize that progress towards these objectives involves near-term action and progress that can help the economic recovery of today while making significant progress to objectives addressing broad environmental challenges from climate change.

Furthermore, the working group recognized potential in examining these recommendations as sets of potentially interrelated opportunities that are not mutually exclusive to each sector as examined in the report. As these recommendations are acted upon, an effort should be made to consider areas of overlapping opportunity and objectives.

Addressing areas of economic inequality and access to opportunity is more imperative now than ever before. Inequalities related to race and income were identified as priority areas of focus for future green economic development at the outset of this process, with communities throughout the state still struggling to realize the benefits of a recovery from the previous recession. Faced with a new economic emergency, these inequalities will become more pronounced. A concerted effort needs to be made to focus green economic development capacity in traditionally underserved and underrepresented communities and identify the barriers that prevent these communities from fully benefitting from emerging economic opportunities in sectors of the green economy.

The working group established principles of equity at an early stage of the process, and made a deliberate effort to consider economic, racial, as well as geographic inequalities throughout the development of the report's recommendations. Points for consideration in this regard are included in many of the report's recommendations, with some addressing the issues directly. The intention is for the principles of equity to be considered as each recommendation is being acted upon, ensuring that communities that have particularly been underserved and underrepresented in the past are empowered to benefit from intentional efforts to grow the green economy in Washington state.

Workforce development is a key strength for the green economy.

Washington state has a strong presence in its community and technical college system, including dedicated centers of excellence with an emphasis on building a future workforce that will be needed for the green economy across all sectors examined in this report. A key finding of this effort is that in many instances, programs are in place throughout the state that are either currently providing the skills for the green economy, or are well positioned to do so, both in terms of expertise as well as in geographic reach in communities throughout the state. To ensure that opportunities in the green economy are available to traditionally underserved and underrepresented communities, efforts will need to be made to evaluate programs to ensure equitable access to opportunity. Increasing Washington's workforce development capacity may be an effective way to prepare communities throughout the state to contribute to, and benefit from a sustainable economic recovery.

Throughout the process, members of the working group and other stakeholders indicated that in many cases, there were insufficient new workers to fill in for an anticipated wave of retirements, potentially leaving critical roles inadequately filled in public water works, energy utilities, agriculture and forestry among others. This represents an urgent need that must be met, and is an opportunity to prepare Washington state residents to fill the workforce needs of tomorrow.

There is a recognized divide between leading research and development, and practitioners in the public and private sectors.

An area that was frequently cited as a significant issue is the difficulty in transferring a technology, tool, or process from leading areas of research and development, to implementation in the field. There are many

obstacles to implementation of innovative technologies with potential to make a difference in establishing a green economy. These can be institutional, legal, economic, or political in nature. Throughout this report are recommendations to establish incubator models, or feasibility studies that may help bridge this divide and bring into implementation effective new technologies, tools and processes that will help to strengthen Washington's green economy.

The transportation sector represents a tremendous opportunity and warrants its own dedicated process.

The working group felt strongly that a more robust examination of the transportation sector is warranted, despite it not being a particular focus for this work as established by the legislative proviso. The working group was supportive of a similar effort to the Green Economy process being conducted in the future specific to the transportation sector, given the great opportunity this represents in reducing statewide greenhouse gas emissions.

The transportation sector will also be covered in depth as part of the state energy strategy process. Commerce is leading the 2021 state energy strategy process that will lay out a plan to set the state on a path to decarbonization, describing the most urgent short- and long-term actions needed to reach our state's aggressive carbon neutrality and emissions reductions targets. The process of developing the strategy is structured around a deep, technical dive into high priority areas and sectors. The transportation sector is one of those. The process will lead to the identification of recommended policy actions -- including programs, regulations, incentives, and tools -- to be included in the state energy strategy itself. This data-driven, stakeholder-supported process and product will provide Washington a path to decarbonize the transportation sector as we work towards long-term climate targets.

Green Economy Working Group Process

To develop recommendations and a report for the Legislature by June 30, 2020, the group met in person for three group workshops between October 2019 and January 2020, with significant efforts undertaken in subgroups outside of these to contribute expertise to selected areas of the green economy. The group contributed directly to the development of this final report and participated in a virtual workshop in May 2020 to finalize the work and discuss ways in which this report can help shape Washington's changing landscape in the green economy.

The Green Economy Working Group began this effort with a review of the broad set of recommendations and opportunities outlined in the Association of Washington Cities' 2019 report "Growing the Green Economy: Exploring an Eco-Nomic Center."³ Through a facilitated process, these recommendations provided the initial building blocks for this process and helped to start a meaningful conversation about strategic ways to address the environmental and economic challenges Washington state is facing today and in the future.

Who Served on the Green Economy Working Group?

The complete list of Green Economy Working Group members is listed in [Appendix A: Green Economy Working Group Membership](#). The group consisted of members from 27 organizations representing diverse interests in Washington state related to the economic sectors examined in this effort. Work group membership draws from state government, educational institutions, private industry, regional government, local government, tribal government, nonprofits, labor, and energy and utility providers.

Definition and Purpose Statement

Following the initial meeting, a subgroup of members met separately to examine the results of the facilitated group process and put together a working definition for "green economy." A separate member subgroup met to build on the previous work to establish a purpose statement for the group.

Working Definition of "Green Economy"

Climate change is driving ecological, economic and social disruption across the globe and in Washington state, a leader in scaling existing and creating new solutions in response to these challenges. This presents significant economic opportunities, particularly for state businesses, workers, organizations and communities.

Washington's green economy makes, moves and uses goods and services for a cleaner footprint. The green economy produces strong and innovative businesses, good jobs, health, prosperity and resilience for all communities throughout the state.

Green Economy Working Group Purpose Statement

The purpose of the Green Economy Working Group is to identify opportunities and resources and to develop policy recommendations that grow and transform Washington state's economy and serve as a model and leader in the international marketplace.

Success in this will include cross-cutting policy recommendations in higher education, workforce training, public and private research, innovation, and greater opportunities for strategic investment. These

³ ["Growing the Green Economy: Exploring an Eco-Nomic Center," Association of Washington Cities, Center for Quality Communities, 2019.](#)

recommendations will be paired with specific strategies to deploy these tools and opportunities in an equitable and accessible manner for people and entities throughout the state.

Principles of Equity

Members of the Green Economy Working Group determined to make an effort to consider issues around equity as part of this effort, with a subgroup formed specifically to consider how to address this issue.






The Green Economy Working Group recognized that a comprehensive examination of equity issues would not be possible considering the time and available resources for the project. Instead, the group committed to promote equity as an overarching principle that must be considered for each recommendation in this final report. To achieve this, the group developed the following principles of equity to not only inform the work of the group, but for decision-makers to consider as recommendations for implementation in the final report:

- Acknowledge that many past policies and decisions created, and presently maintain, a system of injustice.
- Follow the leadership, knowledge and expertise of communities disproportionately impacted, particularly regarding issues of equity.
- Use best practices in racial and economic analysis to drive decisions.
- Use focused strategies that create benefits for all.
- Create net environmental and economic benefits for communities of color and people with lower incomes.

These principles are intended to guide the implementation of green economy efforts resulting from recommendations in this report to ensure future economic benefits are directed to those with the greatest needs, and that those with the least resources do not disproportionately bear environmental burdens or costs.

Working Group Recommendations and Opportunities

In its first meeting, the working group recognized that the requirements for this effort were very broad, with many opportunities for green economic development being cross-cutting in nature. Building on the diverse range of expertise in the room, the working group began to develop recommendations and opportunities by examining energy, agriculture, forestry and building materials, and water as key sectors of the green economy across which all of the other required elements of the project were related. The report organizes key recommendations and opportunities by these sectors, and uses the legend below to demonstrate which of the required elements are specifically addressed. In many cases, recommendations are cross-cutting and address multiple requirements, indicated through the use of one or more of the icons in the legend.

Recommendations and opportunities	Total Recommendations	Legend
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Overarching Recommendations and Opportunities

The Green Economy Working Group considered opportunities across many sectors of the future green economy and determined that many of these were overarching in nature, encompassing elements that applied to more than one of the sectors being examined as part of this report. These recommendations and opportunities highlight issues related to equity and social justice, workforce development and general infrastructure needs in the context of meeting the emerging environmental challenges as a result of climate change.



O-1 Center racial equity as investments and priorities are made in the green economy.

The Green Economy Working Group adopted the following set of principles to apply as a lens and guide the future implementation of all recommendations developed within this report:

- Acknowledge that many past policies and decisions created, and presently maintain a system of injustice.
- Follow the leadership, knowledge and expertise of communities disproportionately impacted, particularly regarding issues of equity.
- Use best practices in racial and economic analysis to drive decisions.
- Use focused strategies that create benefits for all.
- Create net environmental and economic benefits for communities of color and people with lower incomes.

A proactive effort must be made to ensure distributional equity of economic opportunities as part of the green economy; these opportunities should be available to all. The first of eight strategies that was developed by the Governor's Poverty Reduction Workgroup is to "Understand structural racism and historical trauma and take action to undo their harmful effects in state policy, programs and practice." A large body of research draws a direct, causal relationship among structural racism, historical trauma and the creation of policies, programs and practices that result in inequitable outcomes.⁴ The causes and consequences of poverty are experienced most profoundly among indigenous people and people of color nationally and in Washington state. Ensuring that all benefit from the green economy requires an approach that strategically centers indigenous, black and brown people in the implementation of recommendations that result in racial equity. State agencies must be leaders. Several current efforts will help support state agencies on these efforts. The recently established Office of Equity, which was started as a task force in 2019 legislation and funded as a full office in 2020, is designed to promote access to equitable opportunities and resources that reduce disparities, including racial and ethnic disparities and improve outcomes statewide across all sectors of government. The Environmental Justice Task Force will provide state agencies recommendations and best practices for incorporating environmental justice priorities into state agency work.

Racial equity must be included in all policy and budgets. As state revenues are secured for new or existing programs to support growth in key elements of Washington's emerging green economy, communities most

⁴ [Reducing Poverty and Inequality in Washington State, 10-Year Plan for the Future \(Coordinating Draft\), Poverty Reduction Workgroup, January 2020.](#)

affected by poverty and pollution must be a part of decision-making, particularly decision-making that affects them and to be positioned to benefit substantively from these decisions. The state must ensure that these communities not only benefit from the service delivered, but are poised and supported in sharing in any new economic opportunities. Washington must commit to promoting and supporting policies and programmatic efforts that prevent any adverse impacts and ensure that these highly impacted communities benefit from green economic development strategies through:

- Capacity building in these communities to organize their interests and participate in public processes
- Allocating decision-making roles to these historically underrepresented groups proportionate to their interests and sufficient to make an impact
- Identification of barriers to participation in the green economy to understand where resources can most effectively move the needle in terms of benefitting these communities.



O-2 Prioritize investments and identify barriers for traditionally underserved and underrepresented communities in participating in the future green economy.

Washington state should build green economic development capacity in traditionally underserved and underrepresented communities and identify the barriers that prevent these communities from fully benefitting from emerging economic opportunities in sectors of the green economy.

Washington state should consider a dedicated center or board to provide funding for building equitable economic development capacity in these communities to:

- Provide technical assistance and support integration of equity principles into green economy actions for state agencies as well as the community and technical colleges implementing workforce programs.
- Provide technical assistance for emerging green economy businesses to ensure equity, such as worker and community ownership models, recruiting diverse candidates, community benefit agreements.
- Advance solutions proven at the local level statewide including:
 - Priority hire
 - Development of green job internships and apprenticeships
 - Financing tools for access to capital
 - Support Just Transition program development and policies to ensure pathways for workers in declining industries into emerging green industries⁵
- Assess the needs of and provide support for Washington state's tribal governments that are bearing a disproportionate impact related to traditional resource-based economies such as fisheries and forestry.
- Have the Washington State Office of Equity provide oversight over green economy initiatives in the form of a biannual review of initiatives' effectiveness.
- Use tools, such as the city of Seattle's Racial Equity Toolkit, to develop quantitative metrics to inform policy choices, implementation tools and key investments and work in the green economy.
- Implement the recommendations of the Healthy Environment for All Act (SB 5489) as originally introduced to:

⁵ [Just Transition Alliance](#)

- Create a state definition of environmental justice.
- Require use of tools like the Environmental Health Disparities Map in the Washington Tracking Network and similar equity analysis.
- Explore methods for incorporating the precautionary approach to decision making regarding equity.



O-3 Understand the full economic potential of Washington's future green economy.

Washington's strengths in the green economy have the potential to benefit communities throughout the state. A greater understanding of how growth in the state's green economic sectors can benefit different regions throughout the state will help inform future decision-making.

To demonstrate the degree to which local economic benefits may be realized as a result of statewide efforts, Washington state should lead an effort to conduct a comprehensive economic impact analysis on recommendations in this report. A better understanding is needed regarding the economic benefits for all Washington state communities if green economy recommendations are implemented. There is a real opportunity for both rural and urban communities to benefit throughout the state.

- Ensure this economic impact analysis specifically takes into account the distribution of benefits and burdens of the policy intervention or budget allocation by census tract to compare against "Highly Impacted Communities (CETA)"⁶ and "Opportunity Zones" and by demographics like income, race, unemployment and education.
- Develop metrics to measure poverty, pollution reduction and other aspects related to quality of life and the economy.
- Include an analysis demonstrating the economic effects of climate change on key sectors of the natural resource economy, using frameworks established by the UW Climate Impacts Group and detailed in the U.S. Global Change Research Program's Fourth National Climate Assessment.⁷

⁶ RCW 19.405.020(23)

⁷ U.S. Global Change Research Program's Fourth National Climate Assessment, Chapter 24: Northwest



0-4 Expand broadband internet access statewide.

Quality broadband internet access is a basic utility that drives job creation, promotes innovation and expands markets for businesses that are key to the success of the green economy in Washington state. Broadband internet access is also a necessary precursor to training the workforce of the future in the energy, agriculture, forestry and water sectors, particularly to extend these opportunities for underserved communities and populations.

High-speed internet access must be considered as a precursor requirement for technology-dependent emerging industries in the green economy. To ensure that economic opportunities created as part of the emerging green economy are available to all communities, consideration must be made regarding the availability of broadband internet in communities that do not currently have access.

- Invest in the robust broadband internet infrastructure system that Washington state needs to support emerging green economic industries of the future, ensuring that access is equitably extended throughout the state, specifically to economically disadvantaged communities, particularly for minority populations and communities of color.



0-5 Invest in the workforce of the future - Prepare Washington's workforce of the future to be leaders in the nation in addressing emerging environmental challenges.



All sectors of the economy are experiencing challenging labor market conditions and workforce shortages intensified by increased retirements and the regular need to replace and replenish human resources. As an example, 32% of current waterworks operators are projected to retire within five years.⁸

New employees entering the workforce, as well as those seeking to update their skills, need critical technical skills (e.g., information communication technology and artificial intelligence) and cross-disciplinary knowledge to be successful in the emerging decarbonized, green economy. Investing in workforce education at our community and technical colleges and universities is essential. Providing environmentally focused workforce training in water, energy, forestry, agriculture, materials and construction will attract students and workers to enter Washington's workforce and contribute directly to the green economy.

Strategies for Investing in Washington's workforce:

- Expand customized, short-term and job-specific training for incumbent, mid-career workers through an increased investment in the Job Skills program that the State Board for Community and Technical Colleges administers. This program is poised to help in the greening and modernizing of the state's economy and co-invest with employers who need customized training due to growth, changes in technology and addressing skills shortages.

⁸ SYNC, Washington State Public Works Board

- Invest in four-year universities to enhance the ability to create online programs or certificates, particularly to help the current workforce stay on top of key changes in science and industry.
- Develop cross-disciplinary curriculum and training for the emerging green economy workforce. This would include integrating information communication technology (ICT) and artificial intelligence (AI) capabilities with new developments in decarbonized green energy, any new statewide framework for water resource management and the emerging industrial symbiosis and circular economy models.
- Strengthen investments in meaningful, work-based learning opportunities like registered apprenticeship and Career Connect Washington that transition our workforce to meet the demands of the future:
 - Renew investments in program intermediary grants administered by the Employment Security Department.
 - Continue expanding postsecondary enrollment in Career Launch-endorsed programs the State Board for Community and Technical Colleges administers to expand enrollment and provide funding for capital equipment needs.
- Invest in flexible, short-term workforce training programs as on-ramps to career pathways in the greening economy by fully funding community and technical college enrollments in high quality, industry-recognized credential pathways.
- Provide tuition waiver backfill to the State Board for Community and Technical Colleges for the registered apprenticeship related supplemental instruction.
- Extend the Washington customized employment training program tax credit and expand investment in the state’s workers by increasing the revolving loan fund.
- Create more apprenticeship programs that lower barriers to entry.
- Work with labor unions and other organized forms of workers.



0-6 Prepare the next generation in science, technology, engineering and math.

Washington should lead the nation in inspiring young people to pursue higher education and careers in science, technology, engineering and math (STEM). The next generation of green economy-focused scientists, engineers and technicians will need to possess the skills and knowledge required to consider and solve complex, multidisciplinary challenges. The expanding green economy will continue to present new technology-oriented economic opportunities that will require a larger pool of skilled, knowledgeable and motivated STEM workers than currently exists.

- Allocate increased funding for K-14 education, including the Office of Superintendent of Public Instruction and the Washington state community and technical college system, so a wider range of interactive and integrative learning activities can be developed, implemented and assessed. Washington should lead the nation in inspiring young people of all ages to pursue higher education and careers in STEM.
- Support increased funding for Washington State's Leadership and Assistance for Science Education Reform (LASER) program. LASER plays a key role in ensuring that state science leaders maintain a learning community and develop their skills to provide leadership and assistance in service of removing barriers and structures to improve STEM implementation at the school and district levels. LASER is

positioned to help school districts identify opportunities to better serve students who are systematically underrepresented in STEM.⁹

- Support associated undergraduate and graduate education in STEM to further develop these skills through active recruitment and specialized training opportunities that make Washington state an attractive place for people with these skills to stay.



0-7 Identify and address financial barriers for emerging technology and infrastructure development.

Washington state must develop financial strategies to address barriers in access to capital needed to maximize opportunity in the green economy. Significant financial resources will be required in infrastructure and technology to support a green economy across all sectors. For instance, stormwater management will be of increasing importance with new extreme weather patterns as a result of changing climate, putting significant constraints on vulnerable existing infrastructure. The sustainability of the green economy will depend on resilient infrastructure systems. Securing investments in infrastructure and technology will require the identification of new sources of capital, as well as a fresh examination of the eligibility and criteria for existing public investment programs to ensure these programs can fund opportunities in the green economy. Additionally, women-, minority- and worker-owned businesses in particular face steeper barriers to capital and need particular consideration as opportunities in the green economy are pursued.

The workgroup recommends the following strategies:

- Capitalize the Public Works Board funding by providing increased funding per biennium for infrastructure financing.
- Consider expanding the Public Works Board program to include green economy projects in water, energy and infrastructure projects and request that the Public Works Board develop mechanisms to incentivize projects that achieve excellent environmental-economic performance.
- Partner with nonprofit organizations to establish criteria and a certification mechanism to demonstrate the suitability of Washington projects for environmental, social and governance (ESG) fund investment as this sector of private equity and bond investment grows extremely rapidly and is searching for projects that incorporate environmental-social-governance factors.
- The state should identify a mechanism to provide low-cost capital to local entrepreneurs and businesses owned by low-income and minority populations at all lifecycles of their development for businesses in the green economy.
- Provide transition assistance loans for business succession or business conversion of green businesses to individual workers, communities of concern and for women- and minority-owned businesses.
- Ensure that new state infrastructure priorities consider the needs of all Washington residents, including those living in rural and unincorporated areas. These communities have the least capacity to plan, design, build and maintain infrastructure. Consideration of these communities will help them leverage the relationship between infrastructure and green economic development.



O-8 Explore a new comprehensive framework for understanding the nexus of food, energy, and water systems (FEW).

The relationship among food production, water consumption and energy consumption is an emerging area of research. Demand for food, energy and water is increasing with population growth, and the relationship between them is increasingly complex. Population growth and migration, changes in land use, economic factors, governance issues, as well as impacts from a changing climate affect existing food, energy and water systems. Researchers are examining this interconnected relationship in food, energy, and water systems known as FEW, to understand these from a single, systems perspective.

Examples of research and development in Washington state include work being done by the Center for Environmental Research, Education and Outreach (CEREO) at Washington State University. One example of FEW research led by CEREO was examining the relationship between food, energy and water in the Columbia River Basin, helping to understanding the tradeoffs in the management of these sectors from a broader, interrelated systems approach.

To develop a statewide framework for considering the interrelated systems of food, energy and water as one interrelated system, the state should consider:

- Fund and conduct a comprehensive feasibility study to determine what a statewide, systems-based framework for food, energy and water would look like for Washington state. The study should identify potential efficiencies to be gained through the optimization of these resources more holistically, along with the technologies needed to be developed and scaled in the public and private sector.
- Supporting a new integrated technology incubator model focused on technological development for food, energy and water applications as a system, rather than the prevailing model for supporting these functions separately.
- Supporting the state's research universities in pursuing new research in FEW, encouraging partnerships with practitioners in these sectors where existing relationships may not currently exist to bridge the gap between research and development, and industry practitioners.

Agriculture Sector Recommendations and Opportunities

Washington state's growing agricultural economy will produce more food and other agricultural products for both export and domestic markets, putting additional pressure on the land, water and energy resources that are already affected by the impacts of climate change. Washington state is a leader in efficiently using these resources in ways that strengthen the economy. Some of the following key opportunities highlight specific ways that Washington state may continue to lead in agricultural sector development while addressing the environmental challenges that result from climate change.



A-1 Develop the workforce to support regenerative and precision-farming practices.

Washington's newly authorized Sustainable Farms and Fields grant program provides financial assistance to farm, ranch and aquaculture operators who adopt practices that reduce their operations' carbon footprint and increase the quantity of carbon stored on their land. The state's new Soil Health Initiative, a statutory collaboration between Washington State University, the Washington State Conservation Commission and the Washington State Department of Agriculture, emphasizes practices that can help us adapt to a changing climate by restoring soil productivity to improve farm profitability, enhance human nutrition, make more water available in the soil for crops, improve water quality and other environmental functions, store carbon and reduce carbon emissions across Washington's diverse agricultural systems.

To strengthen these new programs and better leverage opportunities for career development, the state should consider supporting workforce training for the technicians needed to advance the emerging field of regenerative agriculture and precision. These trainings should be developed in close consultation with farmworkers responsible for the practices. Close coordination among WSU's Centers for Sustaining Agriculture and Natural Resources and Precision & Automated Agricultural Systems, the Washington State Conservation Commission, Washington State Department of Agriculture, USDA Natural Resources Conservation Service and Walla Walla Community College's Center of Excellence for Agriculture and Natural Resources will provide a better sense of the financial resources needed to:

- Develop, implement and evaluate the facilitation of technician-level training in regenerative and precision farming practices for farmers, conservation districts and other public and private lands managers.
- Convene a state-wide consortium of precision agriculture-focused businesses to standardize data collection and equipment integration practices to better assist producers.
- Support scholarships for students at public community and technical colleges and universities who major in programs with an emphasis on regenerative and precision agriculture and/or agricultural extension and education programs.
- Support farmworkers required to implement practices or affected by changes as needed after consultation with the farm workers.



A-2 Focus agricultural research and public engagement on differential impacts of climate change based on differences in the scale and types of agricultural operations across the state.

There is a critical need for basic higher education research and extension services throughout the state to better identify likely climate-related impacts and opportunities to create more resilient agricultural management regimes and production systems. Climate change threatens agricultural production and viability and will affect Washington's water supply, water quality (especially temperature), soil quality and condition and other elements of food production in different ways across our diverse region. Research and development promises to be a cost-effective means for supporting farmer responsiveness to an uncertain future, increasing the long-term sustainability of agricultural soils and lands and recognizing that, while the impacts of climate change create new stresses on agricultural soils and operations, climate change also creates potential new production opportunities. The recommended green economy priorities include agricultural research and engagement to:

- Promote agricultural innovation, technology adoption and management regimes that sequester carbon and reduce input costs, energy demand and greenhouse gas emissions and promote public support for such actions through public engagement.
- Identify current food and agricultural products that are most likely to be impacted by a changing climate and recommend specific strategies, like variety development, that can enhance adaptation.
- Continue to support the public-private partnerships with higher education in breeding, crop protection, precision agriculture and soil health that provide adaptable varieties, integrated pest management strategies and decision-support systems in the context of a changing climate.
- Increase Soil Health Initiative investments as a bank of resilience to climate change, improving the state's agricultural soils, storing carbon and reducing carbon emissions while promoting positive environmental, nutritional and agricultural outcomes across Washington's diverse agricultural systems.
- Research and identify agricultural strategies to reduce and adapt to climate impacts of sea level rise and prepare for and mitigate agricultural challenges related to salt and sea water intrusion into aquifers and drainage systems.



A-3 Support the state's regenerative agriculture sector through programmatic investments to meet the increasing challenges of a changing climate.

Existing conflicts between agricultural production systems and the environment, such as water quality impairments, water depletion and species and habitat declines, are projected to become more pronounced in coming decades. Agricultural production and associated infrastructure are important drivers of rural economic development, creating off-farm jobs and contributing to the economic viability of farming and rural communities. Public support for innovations and new technologies to reduce agricultural input needs and costs, reduce greenhouse gas emissions, sequester carbon and improve riparian habitats should be promoted, as well as development of environmental markets and funding streams that directly benefit working farms and ranches, rural economies and environmental functions.

The recommended green economy priorities include regenerative agriculture and technical assistance investments to:

- Develop or expand environmental markets, carbon credit programs, soil health programs and green incentive payment streams, including habitat farming payments for farmers to restore riparian habitats as a "specialty crop" that can concurrently improve critical environmental functions, increase agricultural resilience and support the viability of farm operations.
- Increase and improve access to technical assistance to meet increasing demands around climate adaptation.
- Increase organic matter in agricultural soils to improve the soil's water and carbon storage capacities, thereby reducing erosion and protecting water quality.
- Increase engagement of businesses and philanthropy to discuss what public-private partnerships are needed to ensure appropriate adaptation, with an understanding that there are benefits and challenges in terms of public research dollars and private benefits.
- Work to achieve the food waste reduction goals established by the legislature in 2019, recognizing that wasted food is also wasted water, and that wasted food creates the worst kind of greenhouse gas emissions, ones that have no corresponding benefits.



A-4 Secure legal reserves of agricultural water supplies critical to continued agricultural viability.

In addition to current barriers producers face, anticipated reductions in water supply and changes in its seasonal and regional availability will increase competition among industry, municipalities, food producers and natural systems. The long-term sustainability of agriculture in Washington will be impacted by how well our agricultural sectors adapt to climate impacts on water supply. The recommended green economy priorities include agriculture and water resource-related actions and investments to:

- Work with policy makers, university researchers, tribal governments and agencies to project future agricultural water availability needs across the state and to identify strategies to reduce water use conflicts.
- Use a cooperative approach to negotiations and build on demonstrated water management cooperation in programs like the Yakima Basin Integrated Water Management Plan and Office of Columbia River projects to ensure that integrated packages of water supply, storage, conservation, habitat or fish passage actions deliver neutral or positive outcomes that do not negatively impact agricultural viability or fish and other core environmental functions.
- Develop and implement a comprehensive strategy, through careful negotiation and immediate policy development and action, to secure water availability for agriculture across the state, including additional storage options or other strategies where feasible and environmentally workable.
- Consider an Office of Western Washington Water to coordinate a comprehensive agricultural water availability strategy for Western Washington, where competing uses will have the largest potential impacts on agriculture uses.



A-5 Protect agricultural land and assist farmers in transferring development rights, thereby supporting both agricultural viability and ecosystem benefits.

According to the most recent USDA Agricultural Census, in the last two decades the number of acres of agricultural land in production in Washington fell by over one million acres and the number of farms declined by 10%. Purchase of agricultural conservation easements provides funds directly to farms while simultaneously improving long-term ecosystem resilience and food security outcomes. As a recent Puget

Sound Partnership Action Agenda document notes: “The continued loss of farms in the region and conversion to non-farm uses is not only detrimental to individual farmers and to the regional farm economy; but is detrimental to the recovery of Puget Sound...Analyses indicate that one acre converted from agricultural to urban development produces 10 to 15 times the runoff and runoff-borne pollutants, including far higher concentrations of heavy metals, petroleum and other key pollutants...Farmland also provides habitat and food resources for migratory bird species, promotes aquifer recharge...(and) provides greater flood plain function than developed areas.”¹⁰ In the rapidly urbanizing regions of Washington, pressure from increasing residential, commercial and industrial development and rapid appreciation of land values are critical challenges that threaten agricultural land, access to land for farmers and environmental functions. Recommended green economy priorities include farmland protection and conservation actions to:

- Develop and expand mechanisms to support agricultural producers for the positive ecosystem impacts that agriculture provides, including benefits to water quality, carbon sequestration, wildlife habitat and other open space values.
- Prioritize investment in farmland preservation programs and technical assistance efforts that concurrently maintain and enhance agricultural viability while also protecting and enhancing functions and values of critical areas, such as fish and wildlife habitats, wetlands, aquifers and flood plains, including Growth Management Act (GMA) Critical Areas programs and the state Conservation Commission's Office of Farmland Protection, Conservation Reserve Enhancement Program, Voluntary Stewardship Program (VSP) and VSP-like programs.
- Robust investment in the state Conservation Commission's Agricultural Conservation Easement program to pursue voluntary agricultural conservation easements. Under this tool, a landowner voluntarily sells development rights to a qualified easement holder, eliminating most or all future residential development potential. The land is kept in agricultural production, the landowner receives compensation and the land can be more accessible to a new farm buyer because the development rights have already been sold.
- Ensure that the agricultural zoning code adequately protects agricultural land, agricultural communities and agricultural infrastructure. Ensure that agricultural areas are accurately designated, including assessment of areas that are not currently designated as agriculture, but having a high degree of actively farmed ground or having land suitable and available for agriculture, and considered for additional levels of agricultural protection.
- Establish standards for jurisdictions that permit and plan for development, conservation and other land use permitting actions within agricultural areas to minimize and mitigate for impacts to agricultural land, agricultural communities and associated agricultural infrastructure.



A-6 Support the next generation of Washington state farmers through targeted efforts to increase opportunities for young farmers to buy or lease agricultural land.

Nearly half of Washington’s agricultural land is set to change ownership in the next 20 years. This is because the average Washington farmer is near retirement, at over 58 years old. However, most Washington farmers do not have a succession plan to pass on the land and business to the next generation. As a result, large portions of Washington’s agricultural land base are vulnerable to fragmentation, conversion to non-agricultural uses and transfer of ownership to non-farmers. Young and beginning farmers have additional challenges and

¹⁰ Puget Sound Partnership, 2014.2015 Action Agenda for Puget Sound, 3A, 18-19,

consistently cite access to land as their number-one barrier. Young farmers in Washington are diverse, highly educated and strong entrepreneurs in their communities – but they face an uphill battle, with high debt and ever higher land prices. Most have a second, off-farm job. Recommended green economy priorities include next generation farmer actions and investments to:

- Develop streamlined, creative and low-cost loan financing in support of agricultural land protection and land access for new and beginning farmers. These programs would support, for example, purchase of agricultural land by nonprofits or other qualified entities to prevent conversion of farmland to other uses and transfer farmland to a new or beginning farmer and creative models for new and beginning farmers, such as agricultural and/or conservation easements, lease-to-own agreements and ground leases.
- Examine ways to encourage retention of an adequate number of farmers to operate small and mid-scale farms and support local food security, including meeting the educational needs for the next generation of farmers and providing for the continued economic viability of local food production, processing and distribution in the state.
- Invest in the Open Space Farm and Agriculture Program to increase small acreage participation and production, while updating the application process to better support small and mid-scale producers.
- Create Beginning Farmer tax credits that would provide a sales and use tax exemption for beginning farmers (less than 10 years) and a real estate excise tax exemption for transfer of ownership between landowners and new farmers. Young farmers consistently cite access to land as their top barrier.



A-7 Pursue locally focused food supply and food security solutions.

Washington is one of only five states in the nation without a state program to leverage “buy local” preferences by voluntarily labeling and promoting Washington food and agricultural products across state, regional, national and world markets. Expanding and promoting programs that bring healthy and nutritious Washington-grown foods to Washington residents can decrease the carbon footprint of our food system and reduce farm-to-table food miles traveled. Additionally, locally focused food supply solutions will promote the continued economic viability of local food production and rural economies while reducing food insecurity and hunger in the state. Recommended green economy priorities include market access and Washington-grown actions and investments to:

- Expand investment in WSDA's Regional Markets and Direct Marketing programs and similar public and private entities for which demand greatly exceeds capacity to provide technical market readiness assistance, resources and trainings to help small- and medium-scale farms and producer co-ops and distributors overcome market barriers and meet buyer needs, including schools and other public institutions.
- Increase capacity and investment in the WSDA Food Assistance Program's Farm to Food Pantry Initiative to improve purchasing power at the county level and expand participation to move more locally grown produce into food banks and food pantries for people in need. WSDA's Food Assistance Program provides food, funding, logistics and outreach to hunger relief providers and tribes.
- Establish a location-based labeling program to improve the promotional branding of Washington grown-and-raised products in the marketplace, thereby differentiating Washington's great reputation for producing high-quality products that are pure, safe and sustainable and making local food and agricultural products more visible to local, regional and international consumers.

- Expand funding and technical assistance to retailers such as farmers markets, farm stands, mobile markets, pop-up markets, ethnic grocers and other points of sale, to ensure success with providing the Supplemental Nutrition Assistance Program (SNAP); Farmers Market Nutrition Program; Women, Infants and Children (WIC) Program, and fruit and vegetable incentives programs.



A-8 Improve public procurement policies and purchasing incentives to decrease the carbon footprint of Washington's food system and bring more local, nutritious Washington-grown food to Washington residents.

Publicly funded nutrition assistance programs and social services work together to help stretch limited household food budgets, either by providing assistance to buy food or by providing food or meals to save on groceries and other food-buying costs. In Washington, one in nine people struggle with hunger; one in six people sought food assistance at a food bank or meal program, and one in six Washington children don't know where their next meal will come from.¹¹ Recommended green economy priorities include public procurement actions and investments to:

- Establish and deploy a Washington-grown labeling program to make it easier for procurement specialists to identify Washington foods and bring them into schools and other institutions like childcare facilities, hospitals, universities, state cafeterias, senior meal programs and food banks.
- Enhance funding to increase the capacity, incentives and abilities of schools and other public institutions to procure and use Washington-grown food products (models include grants, reimbursement or cost-share programs).
- Expand farm-to-school efforts through enhanced funding for WSDA's Farm to School Program, Office of the Superintendent of Public Instruction (OSPI), schools and other meal programs (child care, Summer Meals, etc.) so schools and other institutions have access to best practices on how to purchase and use local Washington products.
- Ensure the Department of Enterprise Services and Department of Agriculture work together to clarify and implement Washington-grown procurement policies and criteria in state food contracting and purchasing processes.
- Invest in Food Insecurity Nutrition Incentives (FINI) Program staffing, information technology capacity and benefits to broaden incentives for consumers with limited incomes to purchase more Washington fruits and vegetables in farmers markets, grocery stores and online. Increase the amount of benefits available per participant per season in the WIC Farmers Market Nutrition Program.
- Facilitate implementation of summer Electronic Benefit Transfer (EBT) options and integrate fruit and vegetable incentives into the SNAP program's EBT system (i.e., create a Fruit and Vegetable Incentives account on the EBT card).

¹¹ USDA, Washington State Department of Agriculture



A-9 Fund research and development to help Washington's shellfish aquaculture sector grow and adapt to climate change.

Washington state has been a leader in commercial shellfish aquaculture since the mid-1800s and today is the nation's leading producer of farmed clams, oysters, and mussels. Shellfish is an important component of marine ecosystems, and environmental changes affect shellfish aquaculture production. Washington state experiences ocean acidification, interfering with the development of many shellfish species and potentially impacting the ability for this sector to thrive in the face of changing environmental conditions. In addition to ocean acidification, climate change introduces changes to water temperature that interact with other environmental changes and need further study to completely understand the potential impacts to the state's shellfish aquaculture industry.

The complex challenges facing shellfish managers and growers have spurred interest in more comprehensive, ecosystem-based research that integrates environmental, social, economic and institutional information.¹²

Since 2011, the Governor's Shellfish Initiative has brought together a partnership among state, federal, and tribal governments, the shellfish aquaculture industry and nonprofit organizations to identify challenges and promote the industry. This partnership is in the second phase of this work with the following recommendations representing key priorities for the industry.

- Ensure clean water. Prevent and fix pollution problems and re-open shellfish beds.
- Embrace strategies to address ocean acidification's impact on shellfish. Implement strategies through the Marine Resource Advisory Council, the Washington Ocean Acidification Center, Washington Sea Grant, and other collaborative efforts.
- Advance shellfish research topics. Study diverse topics from harmful algal blooms to economic impacts and ecosystems services.
- Improve permitting processes to maintain and increase sustainable aquaculture. Increase predictability and timeliness in aquaculture permitting.
- Restore native shellfish. Grow and plant baby Olympia oysters and Pinto abalone in native habitat.
- Enhance recreational shellfish harvest. Connect people with shellfish and harvest experiences, protecting shoreline environments and restoring water quality around Puget Sound, Willapa Bay, Grays Harbor, and the outer coast.
- Educate the next generation about shellfish. Engage students and the public in understanding local shellfish resources, ecosystems services and water quality.

Further specific recommendations to support Washington state's shellfish aquaculture industry include:

- The state should create a dedicated fund to support select research, development and deployment projects focused on both mitigating ocean acidification and developing integrated net-zero carbon, ecological restoration and food production-based shellfish aquaculture systems (for both marine and freshwater).

¹² Shellfish Aquaculture in Washington State: Final Report to the Legislature, Washington Sea Grant, 2015.

- Ensure a continued active role in engaging tribal governments as active partners in new projects and business development efforts, as well as new developments in monitoring and assessment are implemented.
- Follow the recommendations outlined in the Puget Sound Partnership's 2018 Action Agenda for priorities for Washington state shellfish beds.

Forestry and Materials Sector Recommendations and Opportunities

Washington state has more than 22 million acres of forestland that provide important resources for economic development in rural economies, recreational opportunities, as well as environmental benefits such as carbon sequestration.¹³ New technological developments are opening up opportunities for clean sources of energy and building materials that can also help the state meet its objectives in addressing statewide forest health issues. Washington state is uniquely positioned to establish itself as a global leader in these developments by focusing on some of the following key opportunities.



F-1 Establish and promote new markets for the emerging biomass industry.

Washington state should help establish and support strong markets for low-grade woody biomass. Forest biomass refers to by-products of forest management activities or forest health treatments prescribed under the state's forest health law. Using forest biomass has a number of benefits. Increasing the production and use of renewable fuels and chemicals derived from biomass will improve ecosystem functions, reduce lifecycle carbon emissions, add employment in rural communities, reduce hazardous fuels in forests and generate energy products needed to displace fossil fuels. Immediate opportunities include industrial-grade wood pellets for thermal energy and possibly power production in remote communities; biochar for soil health, crop production enhancement and long-term carbon sequestration; smaller diameter trees removed as part of hazard reduction being incorporated as feedstock for cross-laminated timber; and gasification of biomass for distillate fuels, renewable natural gas and other value-added coproducts.

To support emerging markets for the state's biomass industry, the state should:

- Direct state and federal research institutions with experience in biomass processing technologies to work with private sector interests to identify the research and development priorities most likely to advance timely and productive biomass products that provide lifecycle environmental benefits.
- Prepare and offer packages of financial incentives and technical assistance to attract investment in multiple biomass processing and refining facilities. Packages should include coordinated permit review, market development assistance and as appropriate, public funding from industrial revenue and/or exempt facility bonds.
- Require that a certain percentage of biomass harvested annually from hazardous fuels reduction projects be used for production of renewable transportation fuels, industrial-grade wood pellets for thermal energy and/or biochar for soil remediation projects. Begin in 2024 with an initial percentage requirement, then increase the percentage over time to the degree that it doesn't constrain chip markets for existing pulp and paper demand.
- Support advancements in the efforts of the Northwest Advanced Renewables Alliance in developing aviation biofuel from forest products.

¹³ Washington State Department of Natural Resources



F-2 Fund forest fire prevention, including hazardous fuels reduction projects.

There are insufficient state, federal and tribal fire response and protection resources to meet growing fire-related threats to communities, economies and the environment. As climate change increases temperatures and alters weather patterns across the state, some areas are predicted to receive less moisture and experience more frequent drought conditions. As a result, forest and shrub steppe ecosystems will become more susceptible to wildfires. With more residential development occurring within and adjacent to these ecosystems, in what is termed the wildland urban interface (WUI), it is expected that fires will increase in frequency, intensity and with more area burned throughout the state. These fire events will strain our existing firefighting resources.

The Department of Natural Resources is the agency designated by the legislature as responsible for directing the work of forest fire suppression in the state (RCW 76.04). DNR recently developed both forest health and wildfire protection strategic plans that identify specific goals and strategies to reduce the losses and costs from catastrophic wildfires under current climate change predictions. These plans provide an “all lands, all hands” approach to coordinating activities across spatial scales and landscapes.¹⁴

Washington needs to provide increased revenue for fire suppression activities while also supporting efforts that help develop a state-wide understanding and effective coordinated response to changing fire regimes and the impact fires have on ecosystems and communities. An evaluation of the resulting impacts of wildfires, and efforts to reduce the frequency and extent of catastrophic wildfires should be conducted after a period of 10 years. Steps that should be taken in this near term could include:

- Prioritizing community education and extension programs about interconnections among climate change, forest management, forest fires, and water resources – in both the short- and long-term
- Use risk assessment to inform resilience and protection planning and establish priorities: Invest in the capacity and tools to quantify the state’s current and projected wildland fire risk. Use these tools to conduct state, regional, and local planning and strategically prioritize actions and investments.
- Increase the workforce and capacity across agencies and partners to address current and projected wildland fire management needs: Establish new positions for year-round fuels treatment and response capabilities.
- Increase resources for prevention and recovery strategies and invest in response infrastructure.
- Develop and deploy new methods and approaches to inclusively engage communities and foster behavior change: Conduct pilot projects, and engage limited English proficiency communities.
- Invest in resilience and community preparedness: With priorities identified, increased capacity, and engaged communities, ramp up investment in programs and actions to create resilient landscapes, and fire-adapted communities. Accelerate funding for, and implementation of, the 20-year Forest Health Strategic Plan for Eastern Washington.
- Address post-fire recovery needs: Create a taskforce to recommend solutions and establish a Burned Area Emergency Response (BAER) team.
- Invest in infrastructure, facilities and support to improve response: Increase wildland fire fighting workforce, expand training, increase air capacity, and improve facilities.

¹⁴ <http://www.dnr.wa.gov/ForestHealthPlan>; https://www.dnr.wa.gov/publications/rp_wildfire_strategic_plan

- Advance a sustainable funding solution: Convene a high-level task force to identify and recommend to the legislature a durable, robust funding mechanism for wildland fire protection and response capabilities, and investments in forest health, fire-adapted communities, and post-fire recovery. Engage the legislature to ensure sufficient funding to reduce risks and provide for the long-term safety and resilience of communities.
- Accelerate the pace and scale of forest health treatments.
- Strategically focus work to protect communities and values at risk.
- Promote rural economic development and use of restoration by-products.
- Monitor progress and adapt strategies over time to ensure treatment effectiveness.

University of Washington and Washington State University have different, complimentary expertise related to monitoring fire events and understanding near- and long-term impacts of fires on ecosystems and people that could help bring state-of-the-art science to those making decisions and policy in natural and human-inhabited spaces. Wenatchee Valley College Continuing Education, in partnership with Okanogan Conservation District, offers wildfire preparedness classes for those in the community who want to be better prepared for wildfires and to learn how thinning, grazing and prescribed fire can reduce wildfire risks while also maintaining quality wildlife habitat. Washington state should support the statewide expansion of these efforts in communities with high wildfire risk with a particular focus on communities with low employment, language barriers and other factors that may make them disproportionately impacted.



F-3 Support Washington state's new commitment to 'Industrial Symbiosis'.

"Industrial symbiosis is the use by one company or sector of underutilized resources broadly defined (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use for longer. It presents a systems approach to a more sustainable and integrated industrial economy that identifies business opportunities to improve resource utilization and productivity."¹⁵

A statewide industrial waste coordination program ("industrial symbiosis") would nurture collaborative opportunities to match underused resources from one company with the resource needs of another, thereby enhancing economic value, decreasing waste management needs and disposal costs and offering substantial environmental and energy efficiency benefits. The legislature strongly supported creation of such a program in 2020, but the bill was vetoed due to financial exigencies associated with the COVID-19 pandemic.

- Establish an industrial waste coordination program and provide adequate financial resources in future appropriations to ensure statewide success.
- The program should coordinate closely with the Recycling Development Center to identify collaborative opportunities and address significant challenges to waste management strategies and policies.
- Build a working database that contains examples of where industrial waste has been effectively used to promote a sustainable future, such as redirection of waste heat from data centers into heat for buildings or communities, which has been successfully applied in the state.

¹⁵ European Committee for Standardization Workshop CWA 17354:2018 (E). December 2018.



F-4 Expand opportunities for fiber recycling in communities with existing mill capacity.

To build a regenerative economy, more post-consumer office paper, newspaper and cardboard must be recycled within Washington boundaries. These activities reduce both waste and carbon emissions. Repulping mills in the state currently have excess cardboard recycling capacity and inadequate mixed office paper recycling capacity.

Washington state's recycling system has long depended on overseas markets for recyclables. Recent policy changes in China and elsewhere overseas have led to the prohibition or limitation for importing Washington's recyclables. Additionally, recycling services have increasingly had to contend with contamination in recycling that further serves to reduce the value of these as commodities in the marketplace. These significant challenges leave Washington state in need of redesigning methods for recycling and to seek out new market solutions for these materials.

Paper mills are increasing the capacity and capability to use recycled paper as feedstock, making use of old corrugated containers and mixed residential paper. Sorting and processing costs of mixed paper recycling are a significant barrier to the growth of recycling these materials domestically.

- Through implementation of the new Recycling Development Center, work with the pulp and paper industry to identify obstacles and opportunities to improve fiber recycling within the state.
- Support paper mills' capacity to sort mixed paper recyclables and to handle commingled recycled paper.
- Establish incentives to encourage the use of recycled mixed paper in green building products.
- Explore Washington's competitiveness in terms of attracting new manufacturing facilities interested in using recycled feedstock to locate within the state.
- Washington should develop incentives that encourage a certain percentage of these products will be recycled.



F-5 Support the new Recycling Development Center.

The Recycling Development Center is a new program spearheaded by Ecology, with support from Commerce, to create a more sustainable and cleaner recycling system for Washington. Contamination in the recycling stream has prompted major recycling trade restrictions, turning markets upside down and leading to growing piles of recyclables with nowhere to go but the landfill. To solve this problem, Washington must find new end markets and reduce contamination in its recycling stream.

The center is focusing on overcoming barriers that prevent full and productive use of secondary materials diverted from waste streams in the public and private sectors. The center is also working with businesses that transform or remanufacture waste materials into usable materials or products, especially those involving mixed waste paper and plastics.

- Provide adequate operational support for the center, including staffing and various forms of financial assistance for recycling businesses, outreach to manufacturers to increase use of recycled materials and promotion of manufacturing with recycling materials.
- Support efforts to find new buyers for Washington's recyclable materials that are no longer accepted from overseas buyers.
- Encourage partnerships to develop domestic markets, educate consumers, and identify other improvements to Washington's recycling system



F-6 Establish Washington as a leader in green buildings, clean industry and sustainable materials.

Washington state is home to a growing constellation of companies constructing green and smart buildings. The state boasts one of the most sophisticated manufacturing capabilities in the world with industries such as aerospace, technology, biomedicine, bioengineering and many more. Many of those same industries depend on materials derived from fossil fuels that contribute to degrading environmental conditions. At the same time, the state has a long history of leadership in waste management, recycling, materials science and sustainable materials management. Finding innovative ways to produce these materials is an important component to “greening” the consumption of products many of us use every day. Innovation in scaling existing and creating new solutions in buildings, industry and materials represents tremendous opportunities to grow Washington state’s green economy. The following actions would encourage the growth of these industries in Washington state:

- Develop a model building code that directly incentivizes the use of sustainably sourced cross-laminated timber, other mass timber products and biomass derived materials such as biomass derived carbon fiber 3D printed components.
- Create incentives that would make it economically viable for local jurisdictions to incorporate these Washington-sourced building materials as key to changing how we develop and grow while also allowing for streamlining of permitting processes.
- Direct incentive programs toward use of Washington-sourced sustainable building materials.
- Provide a 10-year suspension of the manufacturing B&O tax to companies in or that choose to re-locate to Washington state to manufacture sustainably sourced cross-laminated timber (CLT), other mass timber products and biomass derived materials.
- Identify and problem-solve around institutional structural barriers that block innovation in the green building sector such as federal limitations on the use of solar panels, as an example.



F-7 Expand the use of Washington's forest products as sustainable building materials, particularly in affordable housing projects.

Washington state should expand green building through the use of forest products, especially modular, panelized and cross-laminated timber and other mass timber products by analyzing and relieving barriers in building codes and permitting. The state should create incentives for expanded production of these products in Washington, particularly in affordable housing projects. Green building improves the economics of managing affordable housing, promotes environmental quality and enhances quality of life for residents. Forest products are a sustainable large-scale carbon sequestering option for building materials that Washington state is in a strong position to benefit from as their use becomes more commonplace in the

building industry. New technologies allow taller wood buildings, resulting in buildings with lower lifecycle carbon inputs than concrete or steel and more embodied carbon sequestration.¹⁶ As shown by the strong interest in mass timber products from rural, timber-dependent communities, there are significant economic development opportunities for both domestic and export markets.

Future investments in affordable housing projects offer an opportunity to promote sustainable building materials while addressing the urgent need for affordable housing. The Evergreen Sustainable Development Standard (ESDS) is a green building performance standard required of all affordable housing projects receiving capital funds from the state Housing Trust Fund.

The ESDS was developed in compliance with the law and contains criteria that safeguard health and safety, increase durability, promote sustainable living, preserve the environment and increase energy and water efficiency.

- Identify barriers for increased use of credible third party certified lumber in publicly funded affordable housing projects under ESDS that encourages the use of environmentally preferable materials including salvaged and post-consumer recycled materials, as well as materials that are harvested, generated or manufactured within 500 miles of the project site.
- Provide more up-front funding for the planning and architectural review costs associated with modular and sustainably sourced CLT construction. Ensure that guidance exists for careful harvesting of trees for CLT, capitalizing on the expertise of foresters to accomplish the parallel benefits of fire protection and forest product development. Require that construction on all new government buildings beginning in 2026 use at least 20% mass timber, biomass-derived materials and/or equivalent sourced materials from Washington forests.
- Incentivize designing buildings with materials designed intentionally for disassembly or reuse, so that component parts, such as CLT panels, may be salvaged and used in reconstruction of new buildings.



F-8 Invest in Washington's forestry workforce of the future.

Washington state has an opportunity to scale industrial workforce training programs to meet the emerging needs of forest product industries. Current and future demand for forest products, including cross-laminated timber, will increase demand for tradespeople such as millwrights, plant operators, electricians, machinists, log truck drivers, loggers and others who will need additional computer networking, programming and troubleshooting skills. Work with employers to identify and emphasize the need for community and technical college credentialing and certification programs, especially applied associate degrees.

Washington state should allocate funding to the State Board for Community and Technical Colleges to purchase training equipment through its existing competitive Workforce Development Fund grant program for which Washington state community and technical colleges can apply. These additional resources will be dedicated specifically for use by existing curricula re-designed to address emerging and required skills and knowledge in the green economy.

¹⁶ <https://www.sciencedaily.com/releases/2020/01/200127134828.htm>

Water Sector Recommendations and Opportunities

Nothing is more fundamental to our collective wellbeing than access to clean, fresh water. For humans and fish alike, both consumers and industries, water is a basic building block in our basic ability to survive and thrive. Water managers face unprecedented challenges across the globe and in Washington state related to water, wastewater and stormwater. A growing population and economy increase our demand for water while water quality and an evolving set of toxins present a parallel set of challenges. At the same time, climate change is disrupting historical hydrological patterns, leading to diminishing supply, increasing periods of drought, increasing frequency and intensity of storm and flood events and changing other weather patterns. Historic statistical frameworks no longer provide a reliable basis for predicting future events.



W-1 Washington state should examine a comprehensive new framework for managing water.

Washington state should form a multidisciplinary task force to explore the feasibility of establishing a statewide framework for water resource management. The multidisciplinary task force would be responsible for guiding a study and providing recommendations to the legislature on ways for the state to play a meaningful role in integrating standards in water resource management.

Key elements for the task force to consider will include:

- Develop a state water plan. Many states have developed water plans, however Washington state has not.
- Identify different roles that state, local and tribal governments play in water resource management.
- Consider problem-solving approaches that broadly consider a community's social and economic needs, values and opportunities in designing integrated solutions across all water management regimes.
- Identify the necessary regulatory changes needed for local public agencies to fully partner across jurisdictional lines to find more integrated, beneficial outcomes.
- Examine practices for sound asset management, to get the most out of existing or new infrastructure and avoid threats from pollution and climate change.
- Identify the changing nature of water resources as a result of climate change and, based on best available science, forecast these changes identifying competing resource demands, management and legal issues.
- Project future changes to water resources geographically, organized by Water Resource Inventory Areas in Washington state.
- Offer support for communities in their search for available and affordable capital for infrastructure development.
- Consider and address the size and quality of the "talent pipeline" for future infrastructure design and management and develop solutions for education and workforce development to ensure a sufficient number of infrastructure professionals are trained to find and implement integrated solutions.

New infrastructure management approaches are emerging that recognize natural systems as an asset, integrating supply treatment and surface water resource storage and management and cutting across traditional silos. New frameworks for approaching water systems management are being developed that include all the functions of water regardless of where it is in the cycle of use. Washington state should examine a framework that considers all water—drinking water, wastewater, stormwater, groundwater and gray water as resources that must be managed holistically and sustainably, including water rights, storage and development. Such a framework will help advance the water sector in the green economy through economic investment, strengthening communities and promoting a healthy environment.

One such approach is promoted by the U.S. Water Alliance in Washington, D.C. This new approach is known as the One Water movement and involves the treatment of water as one resource – from source to use to wastewater treatment and recycling back to the natural environment.

One Water is about integrating systems that have been managed in separate utility structures and silos. It provides an opportunity to rethink the fundamentals of how we manage resources with a holistic approach. The One Water concept expands the menu of technologies and solutions available to providers and consumers for water use (potable, irrigation, industrial, wastewater and natural resources), as well as for storage, transportation, recycling and reuse. It also benefits from collaboration among utilities, communities, agriculture, environmental groups and local and tribal governments to form partnerships that allow smarter, systems-based responses to water needs and challenges. The benefits of an integrated approach extend beyond water. The One Water concept allows for consideration of broader community objectives, like job creation or public amenities, and by pooling capacities, expands the menu of technologies, perspectives and resources available to power more integrated solutions.

Washington state’s water resources are managed across an array of public jurisdictions and authorities and private water service providers. One Water would examine water resources based on Washington’s 62 Watershed Resource Inventory Areas (WRIAs) as the logical foundation for building more integrated water management systems addressing water for drinking, industry, ecosystem health, irrigation and natural resources as well as stormwater and wastewater. One Water would integrate actions within WRIAs according to whole-system needs and opportunities and harmonize regulatory demands across local, state, tribal and federal authorities accordingly. Where conflicting regulations impede smart water management, policy makers should step in and provide needed changes.

Washington state should take steps to examine what a comprehensive framework for water systems management such as One Water would look like in this state.



W2 - Establish a clean-water-technology business accelerator and industry engagement program.

Provide resources and support to establish a clean-water-technology business accelerator and engagement program in partnership with the state of Washington Water Research Center at Washington State University, Puget Sound Institute at the University of Washington, Tacoma, collaborating state agencies, centers of excellence and related nonprofit organizations such as PureBlue.

The program will scale appropriate technologies for wastewater, stormwater, drinking water and receiving water bodies and develop small and medium-sized businesses. The program will leverage the existing network of incubators, accelerators and outreach and advocacy initiatives in allied industry and sectors from maritime

to clean energy. Specific recommendations for the new business accelerator and industry engagement program include:

- Create an expert advisory group to leverage existing coordination and landscape analysis initiatives and define a roadmap on both the outreach and accelerator components of the program.
- Formation of a Washington clean-water alliance with global reach. Using existing forums, the alliance will facilitate exchange between the research and development community, commercial entities with solutions, industrial and municipal end users facing water quality challenges, investors and policy leaders. Furthermore, the alliance will play a critical role in associated education and workforce development.
- Identification of new technologies through international requests for proposals based on identified needs and provide expert evaluation.
- Accelerate the development and commercialization for selected technology companies (startups), providing co-location with large water corporations that are incentivized to locate in the state.
- Scale application through public-private partnerships for a revolving loan or similar funding mechanism for pilot and full-scale technology solutions benefiting Washington state.

Washington state should finance and incentivize the initial steps, required to rapidly enhance the capacity of statewide commercialization and scale-up of available water technologies, addressing emerging challenges of clean-water availability and pollution in a changing climate. These actions leverage existing public-private partnerships and financing to address key barriers for water managers across fragmented sectors in Washington, from pharmaceuticals and other contaminants in drinking water to industrial and agricultural runoff, from methane emission reduction and revenue generation from biogas captured at wastewater facilities. The coordination of technology acceleration in three underserved segments of the water sector; wastewater, stormwater and drinking water will leverage efforts currently underway among municipalities, businesses, nonprofit organizations and research center.

An expanded program would complement the existing Commerce's Maritime Blue program. The co-location of supported water companies has been proposed for a Water Innovation Nexus at the Soundview Innovation Campus, where an allotted 100,000 square feet would be made available for a clean water center.

In support of a clean-water alliance and engagement effort, the Washington Water Research Center will leverage its existing leadership in integrative watershed-scale analysis and policy in Washington. Other Centers of Excellence that also specialize in integrative, multidisciplinary applied research include the Washington Stormwater Center (WSU) in Puyallup and the Puget Sound Institute (UW) at the Center for Urban Waters, Tacoma – each with key state roles in pollutant reduction with the Department of Ecology and the Puget Sound Partnership and direct engagement with stormwater and wastewater managers.



W-3 Engage Washington's local and tribal jurisdictions in a focused dialogue on water.

Many cities large and small face challenges upgrading and/or building infrastructure to meet future challenges including water source, infrastructure and workforce development. Most tribes have significant senior water rights, underscoring the importance of engagement in conversations around water and shared values of stewardship. To achieve sustainable use of Washington's water resources, local jurisdictions and tribes are critical partners toward a unified and collaborative approach.

Washington's cities, counties, tribes and other significant jurisdictions, such as port and school districts, are in positions to directly influence the future of the state's water resources. Local and regional water utilities serve millions of people and also play a key role in environmental stewardship and economic development. Water quality standards need to be created by local and tribal stakeholders to minimize the impacts that upstream and downstream users have on millions of acres of drainage into Washington's rivers and lakes.

Cities play a key role in water. Among the largest water utilities in Washington state are Seattle Public Utilities, Tacoma Public Utilities, Spokane Public Works, Cascade Water Alliance and the City of Everett Public Works. These and other city and water utility providers are at the cutting edge of best practices in water. Washington cities are laboratories for many of the practices needed in other parts of the U.S. and the world.

- Convene a task force to bring tribes and local jurisdictions together to sort through aligned values and how to achieve common goals as related to the future of the state's water resources.
- Conduct a statewide analysis to examine best practices among utilities throughout the state to seek out the most effective strategies for environmental stewardship and economic development.



W-4 Support workforce development efforts targeting the emerging needs of public works organizations.

Utility infrastructure is the foundation of social, economic and environmental health for every community in Washington. Public works or waterworks operators are the most important asset within water and wastewater systems. Our existing infrastructure is aging concurrently with the workforce operating, maintaining and repairing it. We are witnessing a mass of operator retirements while our infrastructure fails. We are also seeing new opportunities to organize, collaborate and take action by ensuring a highly trained, dedicated and experienced certified operator workforce is in place to protect the integrity of our infrastructure investments.

Washington state should support workforce development efforts targeted to public works to ensure that talented operators will be in place to service the changing needs of waterworks infrastructure brought on by a changing climate.

Some of the new and changing water quality requirements at the state and federal levels that are driving the need to emphasize workforce development for public works organizations include:

- Capacity demands for water resources.
- New or updated infrastructure systems with advanced technology.
- Evolving government regulations that require utilities to train and re-train operators.

Specific ways that Washington state can help to identify and address these challenges include:

- Engage public works organizations in a statewide effort to identify emerging challenges to developing and retaining a talented workforce.
- Support the Washington State Board for Community and Technical Colleges in assessing the changing need for technically skilled workforce through a focused identification of the emerging needs of this sector and matching those needs with the state's community and technical colleges to ensure that workforce development opportunities are available throughout the state, particular in low-income and minority communities.

Maritime Sector Recommendations and Opportunities

Washington state has brought together numerous maritime stakeholders representing industry, government, tribal governments, research universities and nonprofit organizations to develop a comprehensive economic development strategy known as Maritime Blue. Maritime Blue seeks to build upon strengths in areas such as ship design, clean technology, sustainable fishing practices and workforce development to ensure that Washington state will be home to a world-class maritime industry in the future. The Maritime Blue Strategy outlines a set of strategic goals and initiatives across a wide range of maritime strengths, many of which are strongly related to the definition and purpose of the green economy as determined by the Green Economy Working Group. Some selected areas to highlight from the strategy include but are not limited to the following.



WM-1 Washington state should accelerate the transition of Washington's maritime industry to a low-carbon future, pursuing technological innovations, infrastructure and incentives to enable the transition of local, coastal and international maritime activity.

Some specific areas to emphasize are related to securing funding to support vessels and shoreside infrastructure for electric operations and low carbon fuels. This includes:

- Funding for electrification of state/county/regional/private ferries and passenger services.
- Continuing and increasing funding for the Washington Clean Energy Fund, ensuring inclusion of maritime innovation.
- Securing an array of incentives and funding mechanisms to drive early-stage innovative clean fuel and electrification projects for ports, including bond funding, cap and trade revenues, grants, loans and other financing mechanism for capital investments.



WM-2 Washington state should establish itself as a global maritime technology innovation hub through strategic partnerships.

Some key opportunities to pursue should include:

- Designation of a maritime innovation validation zone to perform research and development, testing and evaluation of safety and performance for digitally assisted operations.
- Support for state agency efforts in adopting innovation and technology-based economic development activity for recruitment, retention, expansion, rural economic development and small business export assistance.
- Funding and developing incubation, research and development and commercialization platforms for maritime innovation facilities and research centers.
- Ensuring that any identified public funds directed toward clean energy and carbon mitigation are available for maritime clean technology applications.



WM-3 Washington state should grow as a region for imports, exports and maritime industrial activity, while leading the nation in efficient, clean and safe maritime activities.

To grow Washington's capacity as a national and international gateway, the following recommendations will emphasize strengths across all maritime communities and sectors of the industry. Washington state should consider:

- Investing in critical port and maritime infrastructure to maintain and increase modernization and competitiveness.
 - Secure funding for infrastructure and digitalization development for port terminal operations and freight mobility.
 - Secure funding to implement goals of Puget Sound Partnership recommendations and other mitigation/conservation priorities.
 - Secure port and state incentives for international and coastwise ship owners using established best practices and voluntary certifications.
- Aligning and simplifying the regulatory and permitting process to improve, speed, efficiency and predictability in shoreside maintenance, remediation and construction.
 - Work with regulatory agencies to create pilot permitting process for blue innovation projects that meet sustainable economic development criteria.
 - Secure regulatory predictability and transparency for maritime infrastructure development.
 - Promote authority within Office of Regulatory Innovation & Assistance (ORIA) to improve permitting timelines and efficiency.
 - Secure maritime industrial lands through integrated planning for industrial zoning and economic development (Growth Management Act and Shoreline Master planning). Use "Industrial Sanctuary" and "Essential Public Facilities" designations.
- Developing regional collaborations and partnerships that promote competitiveness and reduce ecological impact.
 - Support inclusion of west coast/Asia air emission targets/incentives.
 - Support participation in collaborative approaches to align on ecological goals (global, regional, local).
 - Coordinate with other ports in the region (West Coast) to increase use of incentives to decrease emissions and impacts (including noise).



WM-4 Washington state should develop an inclusive and diverse future generation of the maritime workforce, providing access to clean, healthy and living-wage jobs to Washington residents of all economic and racial backgrounds.

Ensuring that the maritime workforce of the future is prepared to meet the changing needs of the maritime sector means investing in developing skill in Washington state. To accomplish this, Washington state should consider:

- Dedicating funding for maritime specific training, education and workforce development at the K-12, community college and the four-year universities, including expansion of registered apprenticeships in youth programs.
 - Leveraging existing registered apprenticeship programs to increase training across the maritime supply chain.
 - Securing changes in Washington state law to include port investments in workforce development.
 - Supporting federal designation and funding for Domestic Maritime Center of Excellence for Maritime Workforce Training and Education.
 - Securing Washington State University funding for marine electrical engineering program.
- Supporting initiatives for statewide workforce development that encourage alignment and efficiency of programs according to community and industry sector based priorities.
 - Align with initiatives from the State Board for Community and Technical College (SBCTC), Office of Superintendent of Public Instruction (OSPI), Workforce Training Board (WTB), Career-Connect Washington Task Force and Workforce Development Council (WDC).
 - Secure funding according to the Workforce Training Board (WTB) proposal for incumbent worker training.
 - Develop training certification that is more consistent across the state and preferably across multiple states.
- Adopting recommendations of Career Connected Washington and regional efforts to define and support maritime career pipeline development.

Energy Sector Recommendations and Opportunities

The foundation for a green economy strategy is clean energy. Washington's economy will grow stronger as the state displaces expensive, imported natural gas and petroleum with renewable energy harvested locally using technologies developed and commercialized here. The task, however, is not a mere substitution of one energy form for others. It requires a transformation of the energy system, especially the electricity grid. To accomplish this transformation, the state must innovate and invest end-to-end – from the fundamental science of renewable energy, energy efficiency, and smart networks to the skilled workers who will build and operate the clean energy systems. These innovations become their own economic engine as the state supplies clean technologies to support global transformation. These technologies are supported by key clean energy policies that will set the stage for continued growth in these sectors. The Clean Energy Transformation Act requires that utilities transition to renewable and nonemitting energy sources starting in 2030, and the Clean Buildings standard requires that all commercial buildings over 50,000 square feet lower their overall energy use and meet new code requirements.



E-1 Build the clean energy sector workforce of the future.

According to the E2 Clean Jobs America 2020 report, at the start of 2020, clean energy employment increased for the fifth straight year, increasing to over 3.3 million workers nationwide.¹⁷ Clean energy storage and grid modernization jobs had the fastest growth by sector and energy efficiency added the most jobs overall, with over 50,000 nationwide. The clean energy transformation requires a workforce with the skills and education to design, build, operate and maintain the electric sector of the future, such as net zero buildings, renewable energy systems and new transmission and distribution for grid modernization.

For Washington to continue to lead on its aggressive climate goals, it must invest in a workforce pipeline that provides training and opportunities for all clean energy sectors to help bridge the gap from today's operations to tomorrow's technologies. This investment will create a skilled workforce to drive strategic legislative initiatives while providing high-wage jobs with strong labor standards and opportunities for advancement and support:

- established renewable energy sources such as hydropower, wind and solar and will continue to require a trained workforce to operate these systems in conjunction with the systems currently operating
- tribal energy sovereignty through tribal energy projects and hiring
- an increasingly reliable and flexible energy grid by focusing on energy storage, advanced grid technologies, including advanced metering infrastructure, smart grid technologies and microgrids among others
- technical position such as data scientists, information and communications technology developers, clean energy engineers and more
- energy efficiency jobs, including green building design and building retrofits and maintenance.

¹⁷ Clean Jobs America, E2, 2020

Our clean energy work force must reflect the residents of Washington. Access to clean energy jobs must ensure that opportunities in workforce training in the efficiency, renewable and clean energy sectors are available in communities with a high proportion of low-income or highly impacted communities. Training must be accessible to all and must prioritize diverse hiring practices to help close the current gender gap.

The Pacific Northwest Center of Excellence for Clean Energy provides an example of how the state can meet its clean energy workforce development needs. Housed at Centralia College, the center is a nationally recognized model that provides strategic coordination for the energy industry's skilled workforce in the Pacific Northwest. It bridges the gap between new community college graduates and the market for a highly skilled workforce. The center offers 20 community college energy-sector programs that support the industry's diverse workforce needs as well as technological advances in areas of energy such as smart grid, solar, energy efficiency, hydro and wind energy technology, while continuing to support the core curriculum of power generation, transmission and distribution programs.¹⁸



E-2 Modernize the state's electrical grid to deliver safe, reliable, efficient and clean energy to the consumer.

The state's electrical power grid is a complex system that generates electricity and distributes it through transformers, substations, transmissions lines, sensors, and poles over distance to be distributed to homes, offices and schools. This infrastructure requires significant upgrades to address the evolving needs of the energy sector. Nationwide, approximately 70% of the grid's transmission lines and power transformers are over 25 years old, and the average age of power plants is more than 30 years old. Today's electricity needs are more sophisticated and have put a significant strain on the grid. The Brattle Group estimates that nearly \$2 trillion will be spent by 2030 on upgrades to the grid just to maintain reliability, including upgrading existing transmission lines to include distributed resources and meet load in expanding urban centers¹⁹.

Washington state must create the grid of the future by coordinating with the state's research universities, utilities, and Pacific Northwest National Laboratory (PNNL) to evaluate open source distributed energy architectures and identify benefits and risks for Washington state as these technologies are being implemented. Therefore, we need to both update the grid of the past and replace it with the grid of the future by focusing on:

- creating new grid architectures that have the flexibility to support clean energy technologies and energy management systems
- how to site and size energy storage technologies to maintain and build resilience, especially for critical infrastructure
- protect consumer data and maintain grid security as we continue to adopt smart meter infrastructure and devices
- cultivating the political will and regulatory frameworks to support new systems.

¹⁸ <https://www.cleanenergyexcellence.org/>

¹⁹ Brattle Group, *Why Are Electricity Prices Increasing?* (Washington, D.C.: The Edison Foundation, June 2006)

The grid not only needs to be maintained but also made smarter. Electric utilities' operational technologies were built on legacy architectures designed to address the operational requirements of central generation stations delivering energy to end-use consumers. With the proliferation of inverter-based technologies and internet of things (IoT) devices, (i.e., smart thermostats, water heaters, etc.), this legacy architecture is not capable of meeting the needs of the new clean energy economy. Power flow can now be bi-directional, creating operational challenges that may increase cost for consumers while decreasing reliability. New tools are needed including distributed energy resource management systems (DERMS) and a modern solution architecture.

There also must be political support to ensure that grid enabled technologies can be deployed. Strengthening and updating the grid with new technology can prevent outages, help with cyber-security, and permit real-time data sharing that can improve the efficiency of the entire system.²⁰ But there are also many concerns about security that have slowed the proliferation of some critical pieces of the smart grid. Advanced metering infrastructure is one of the key components of a smart grid and yet has not reached far enough within Washington. There must be political and regulatory support to ensure that these technologies are adopted in a way that both enables new capabilities of the grid and ensures its security.

Here in the Pacific Northwest, PNNL is leading this effort to deliver a new grid architecture that can incorporate new technologies and maintain reliability. This architecture is founded on existing national and international standards to ensure that the grid can support new clean energy technologies and can communicate with energy management and other platforms that will be critical to ensure its operation. PNNL recently completed five reference architecture specification sets that provide new concepts on how to structure grids to achieve specific technical, economic and market outcomes. PNNL's Grid Architecture work is used in at least 26 states and in multiple countries around the world. The architectural concepts have also been adopted by several U.S. electric utilities, including Hawaiian Electric Company, which is pursuing an ambitious grid modernization initiative to enable the transition to 100 percent clean energy by 2045.

We must lean on open source based platforms to ensure that a modernized grid is accessible to all parts of Washington and flexible enough to be as innovative as the technology we create. In Washington the work to develop this open software platform is already underway, driven by thought leadership in our universities, Avista Utilities and PNNL. One example is OpenDSP, which is a peer-to-peer, data centric, micro-service based architecture similar to the architectures being currently deployed and promoted in the consumer goods, IoT and defense industry market spaces. Recently, open source distributed platforms have been demonstrated at industry trade shows and will start to appear in the market place by 2021. As these new platforms are being developed, there will also be a critical need to consider cyber-security issues related to the electrical grid under new open source architectures as currently under development.

Washington must find ways to help tribes, local governments, utilities and industry finance this new grid. The Clean Energy Fund, a competitive grant supported by the Washington State Department of Commerce, has spent nearly a decade leveraging funds and research into issues like energy storage, transactive networks and clean energy deployment while deploying investments into local projects and catalyzing job creation in the clean energy sector. By supporting a coordinated, engagement with both private and public entities, Washington can prioritize resilient, place-based strategies to build a robust grid that also supports local economic development.

²⁰ Energy.gov, Infographic - Understanding the grid.



E-3 Continue the low-carbon and energy conservation achievements in building operations through innovative energy management.

Other than hydropower, energy conservation is the largest clean energy resource in the Pacific Northwest. In 2014, Pacific Northwest utilities developed 262 average megawatts of [new energy savings](#), enough to power 180,000 homes each year. The Northwest Energy Coalition estimates these accumulated savings have saved consumers nearly \$3.73 billion and lowered carbon emissions by 22.2 million metric tons²¹. Cumulative conservation investments in our region, including energy efficiency, utility-funded programs, and improved building codes, have saved enough to power Seattle five times over and been able to meet 57% of the region's load growth.

However, the utility rate structure that has been designed to encourage energy conservation at our utilities does not always translate to incentives for consumers to offset their demand peaks, meaning there is still opportunity to increase conservation efforts. In order to encourage developments to be “net zero” and “carbon free,” the energy market should have the appropriate price signals to encourage behavior to minimize demand on the system during peak loads.

Washington state should continue to promote new utility business models to incentivize building owners, tenants and developers to actively engage in energy conservation, net zero and carbon free developments. Washington is already moving steadily toward the electrification of building systems, and the utilities sector will need to closely collaborate, as that shift will result in additional demands on our existing system. Specific recommendations for the state of Washington to consider include:

- funding pilot projects, such as the Spokane based Eco-District, to evaluate the performance of these projects for potential best practices that could be scaled up at a statewide level
- ensuring that the costs of low- and no-carbon infrastructure and technology integration do not disproportionately impact those least able to incur that additional expense

Within Washington state, a variety of pilot projects are currently evaluating utility business models. The pilot projects extend beyond technology platforms to include economic assessments that address stranded assets, cost shift, fixed asset recovery and fairness. One such pilot project funded by the Washington State Department of Commerce’s Clean Energy Fund is the Spokane based Eco-District. The Eco-District is experimenting with regulatory rate design to incentivize net-zero and carbon free developments to operate in a manner to reduce their impact to utility infrastructure cost. In addition, the Eco-District project is evaluating programmatic mechanisms to breakdown conventional barriers that prevent the utility to enable customer energy efficiency performance.

The built environment contributes approximately 40% of carbon emissions. Today, the ability to effect change is constrained by the barrier of the meter and lease. By reviewing new operational business models, the utility can help the building owner optimize the performance of the building management system, as well as passing incentives to the tenants in the building through programs like active energy management.

²¹ <https://www.nwcouncil.org/news/northwest-energy-savings-now-second-largest-resource> accessed on 5/8/2020



E-4 Bridge the critical gap between innovative research and professional practice in the energy sector.

Washington has been a leader in energy innovation in the past decades and has pursued transformative work to commercialize energy technology and grid. State support for energy innovation has been motivated by a nexus of research institutions, utilities, private entities and government programs with the underlying targets of reducing greenhouse gas emissions and shifting to increasingly cost-competitive clean energy technologies. Leading research institutions are driven by a desire to publish innovative research around cutting-edge methodologies and technology platforms to address the clean energy transformation. The ability to operationalize these research outcomes for deployment on the electric distribution system. A gap exists between the published research and what is practical to implement certify and deploy on the grid. Energy utilities on the other hand have market and regulatory constraints that hinder innovation. Utilities are required to deliver their product at the lowest cost with no service interruptions and do not currently have clear authority and funding to pursue.

To support the state's commitment to increase innovation in the energy sector, including within utilities, there must be a clear pathway that enables innovation and moves research tools and methodologies from the lab to testing, certification and training facilities in use by practitioners in the field. The state must also support an ecosystem that keeps scientists and innovators in the state to help lead technologies in deploying grid scale technologies out of the lab and onto the grid. Washington state should take a proactive effort to promote the development of energy delivery programs that bridge the gap between research and development to professional practice. A specific step the state should consider includes to:

- Convene representatives from the state's higher education research universities, PNNL and other leading private nonprofit research organizations with practitioners including the state's utilities to gain an understanding of where the gaps between research and professional practice are most pronounced and highlight the greatest opportunities to bridge this gap and encourage the advancement of clean energy technologies and practices throughout the state

This work will be partly supported by the work of the Energy and Climate Policy Advisory Committee (ECPAC), a committee that formed under the Clean Energy Transformation Act (CETA). The committee's charge is to review and analyze the historical distributions and benefits from the Clean Energy Fund (CEF) programs, and recommend programmatic adjustments to the CEF investments to better meet the state's climate goals and to take full advantage of opportunities to boost the state economy.

The overarching goal is to create an ecosystem that supports a road map from research concept to product deployment on the grid. Supporting state development of research ideas can be done through early stage research such as the work at the University of Washington's Clean Energy Test Beds, where entrepreneurs can perform rigorous tests on materials as they attempt to scale up technology.²² There is also support for early stage commercialization, such as the Cascadia Clean Tech Accelerator²³ and further funding for early stage clean tech from angel funding or CEF grants supporting research development and deployment of new clean

²² <https://www.cei.washington.edu/facilities/testbeds/>

²³ <https://cascadiacleantech.org/>

energy technology.²⁴ Providing support at various stages in this pipeline, teaching entrepreneurs how to leverage this money and providing other training and professional development can help transform ideas in the lab to Washington state businesses. Organizations like the Clean Tech Alliance and GridForward also provide places where the nexus of research, innovation and policy can come together to catalyze solutions for the next generation of grid and distributed technology.



E-5 Design and establish market mechanisms to encourage development of distributed generation of electricity.

The development of small-scale, distributed electricity generation projects is hampered in Washington by the lack of a market mechanism for that electricity. This represents a missed opportunity for the state, because distributed generation has the potential to benefit the firm or household that installs that system, the other customers on the electricity grid, and the state's broad energy and climate goals.

Distributed generation includes multiple technologies that operate at smaller scale than traditional central generating stations and are located at or near the point of consumption. Common examples include solar photovoltaic systems in a neighborhood or at a commercial site and combined heat and power systems at an industrial facility. A distributed generation system may serve a single site, such as a home or business, or it may operate within a microgrid at an industrial facility, a military base, or a college campus. Distributed generation holds the potential to strengthen the reliability of the electricity grid, reduce the need for transmission capacity and the resulting electrical losses, and accelerate the replacement of fossil fuel generation with renewable energy.²⁵

A market mechanism for distributed generation is important for two reasons. First, existing retail rates and utility purchase mechanisms often do not adequately value the output of the distributed system. A distributed system could contribute value to the regional power grid but be connected to a utility that already has sufficient resources and no reason to purchase more. Second, the scale and operating characteristics of a distributed generation system may not align with the energy requirements of the host facility. A well-sized distributed system may generate more electricity than a single customer uses, or it may generate at different times or seasons than the customer requires. The excess generation would have value to other customers, but there is no readily available mechanism to capture that value.

Specific ways that Washington can help to identify and address these challenges include:

- Explore regulations and incentives that capture fully the energy and non-energy benefits of distributed generation.
- Encourage and support development of a regional distribution market model to accelerate the adoption and economic efficiency of demand and renewable resource programs.
- Coordinate with organizations such as PNNL that are national leaders in distributed energy efforts to identify best practices that may be most effective for the state of Washington.
- Examine additional potential benefits to moving energy production closer to consumption, such as limiting exposure to the state's forests as wildfire threats due to climate change are increasing.

²⁴ <https://www.e8angels.com/>

²⁵ [United State Environmental Protection Agency. Distributed Generation of Electricity and its Environmental Impacts](#)

- Explore issues related to equity and economic opportunity. Distributed energy can decentralize the economic benefits of renewables through community ownership models and through creation of smaller scale projects with potential to benefit smaller businesses and communities throughout the state.

The Pacific Northwest National Laboratory (PNNL) is leading the nation with respect to transactive energy markets, which would use advanced communications and control systems to automate electricity transactions regardless of size or duration. PNNL developed a software platform called VOLTTRON, which is designed to enable customer loads to participate with and respond to market signals. Transactive energy research is advancing in both our region and nationally, however, a gap still exists whereby regulatory structure and market definition are not synchronized nor complete.



E-6 Work with local governments and the State Building Code Council to develop energy codes and sustainability standards for buildings and building materials.

Washington state is a national leader in energy codes. The State Building Code Council (SBCC) provides independent analysis and objective advice to the legislature and the Governor's Office on building code issues and sets minimum code standards. Most are national model codes adopted by reference and amended at the state level. Others, such as the Washington State Energy Code, are state-written state-specific codes. The Washington State Energy Code has been updated to the 2018 code series (to be in effect July 1, 2020), positioning the state well for continued efficiency gains. Energy code development is supported by the Department of Commerce's Energy Division, the Northwest Energy Efficiency Alliance, local government and many building professionals who volunteer to participate in the code development process.

Beginning under 2031 Washington State Energy Code, residential and nonresidential construction permitted under the must achieve a 70% reduction in annual net energy consumption (compared to the 2006 state energy code).²⁶ A further goal is to construct increasingly efficient homes and buildings that help achieve the broader goal of building zero fossil-fuel greenhouse gas emission homes and buildings by the year 2031.²⁷

Specific ways that Washington state can help to encourage modernization of building codes include:

- Identify best practices to move new methods, materials or products through the market development chain, including development of product or system certifications, demonstration projects, early adopter incentive programs, marketing, education efforts and code adoption.
- Acknowledge that a key market transformation issue is the education of contractors, trades and local government officials in the application of the energy codes.
- Provide funding for and encourage the state's community and technical colleges to provide workforce training in the application of efficient building envelope techniques and new equipment installation and commissioning protocols.
- Provide funding for and encourage local government code administrators for training related to design review and inspections to ensure that objectives of updated building codes are being implemented uniformly on a statewide basis.

²⁶ RCW 19.27A.160,

²⁷ RCW 19.27A.020.

- Recognize that adding clean energy to codes and standards is an equitable way to ensure that all are benefitting from the transition to sustainable buildings.²⁸ Living in a state-of-the-art building should be available to renters and residents in multifamily buildings and low-income and affordable housing units as well.

To date the development of the state energy code has focused on adopting building features that provide cost-effective energy savings designed to meet the 70% energy reduction goal by 2031. Washington should consider enhancements to this strategy that assure the codes align well with state carbon emissions reduction targets²⁹ and the opportunities the Clean Energy Transformation Act creates³⁰. Passive strategies such as passive solar heating and daylighting have high potential for further development and integration in energy codes to encourage implementation in new and renovated buildings. Increasing the application of such strategies in buildings can help meet the 70% goal, especially since 36% of end-use energy consumed by buildings in the U.S. is for space heating and 7.5% is for electric lighting³¹. Additionally, 31percent of residential buildings end-use energy consumption in our region is for space heating, the largest among all end uses.³² Codes should further encourage demand reduction and the types of advanced control systems noted in the section below. This may require structural changes to the way codes are written and implemented.

To achieve the long-term objectives of energy codes, Washington needs market transformation programs. Efforts are required to move new methods, materials or products through the market development chain. This includes development of product or system certifications, demonstration projects, early adopter incentive programs, marketing, education efforts and finally code adoption. The Northwest Energy Efficiency Alliance provide leadership in market transformation, and its members have been key partners in the development of new code efforts. They accomplish this work through coordination with state and local government, engineering, marketing and education organizations. The Northwest Energy Efficiency Alliance is an alliance of more than 140 northwest utilities and energy efficiency organizations and should be further leveraged to support energy efficiency, conservation and weatherization efforts.



E-7 Promote growth in connected buildings by developing new information and communication technology applications that maximize energy and systems management efficiencies.

Connected buildings use an integrated set of technology, systems and infrastructure to optimize performance and occupant experience.³³ The commercial real estate industry rightly sees connected buildings as a pathway to improve performance, reduce energy consumption and minimize the life-cycle cost of assets. Connected buildings provide an opportunity for building owners to participate in future transactive energy markets.

²⁸ <https://www.aceee.org/white-paper/solar-and-ee-042519>

²⁹ ESSHB 2311, AN ACT Relating to amending state greenhouse gas emission limits for consistency with the most recent assessment of climate change science, state of Washington 66th Legislature, 2020. <http://lawfilesexternal.wa.gov/biennium/2019-20/Pdf/Bills/House%20Passed%20Legislature/2311-S2.PL.pdf?q=20200316155246>

³⁰ ESSSB 5115, Clean energy – electric utilities – various provisions, state of Washington 66th Legislature, 2019.

<https://lawfilesexternal.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/Senate/5116-S2.SL.pdf>

³¹ <http://web.archive.org/web/20130215152046/http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.1.5>

³² <https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce3.5.pdf>

³³ Connected building definition provided by the Telecommunication Industry Association’s smart Building Working Group 2020

Owners are increasingly demanding that commercial buildings demonstrate similar functionality as smart homes and cars have realized in the past decade.

Washington state can lead the market for smart building transformation through thoughtful policy and research investment. The state was an early leader in design-build construction methodology, unlocking higher building performance and enabling better owner outcomes through the construction process. A similar opportunity exists for Washington to lead the development of standards, open protocols and demonstration cases to unlock innovation in the digital transformation of the built environment.

To promote a statewide increase in connected buildings, Washington state should:

- Evaluate pilot projects for best practices that may be effectively be scaled to other communities throughout the state.
- Invest in demonstration projects linking smart buildings and smart cities with the goal of generating greater investment with proven results.
- Enable greater neighborhood scale or decentralized energy resource sharing.
- Support development of protocols and standards for building data.
- Enable market signals for real-time utility services to better align supply and demand of energy resources.

Washington should be a leader in piloting projects demonstrating the unique value created by smart and connected buildings. Pilots could provide a test case for the following:

- Leveraging clusters of smart buildings to create broader community services, i.e., leveraging data to enable energy sharing between entities
- Extracting richer data sets and communication layers that allow buildings to better mimic natural resource flows and better align their consumption of resources with real-time availability
- Presenting data from smart building systems to provide feedback to tenant and occupants to optimize behavior and better manage resources
- New thought leadership around design and build of interconnected smart building systems that not only have the ability to provide critical information for decision-making, but also automated response to external signals
- Enabling commercial buildings, the onsite energy plants serving them, building operators and operations and building tenants to respond to grid-based market signals to optimize the delivery and flow of energy resources.

Today, buildings and the technology within them are designed, procured and operated in silos. Each system serves a singular task (control HVAC system, control elevator system, fire alarm system, lighting control system) and operates within a siloed communication infrastructure. Advancements in building wireless communication technology, aligned with mass rollout of 5G networks, will enable the implementation of a new common information and communication layer within buildings. This communication platform must be accompanied by new protocols and data standards in order to unlock scalable, cost-effective solutions.

An open source platform will be essential to deploy dispatchable demand response and distributed energy resources in a plug-and-play and cost-effective manner. The energy providers will require a technology architecture to springboard the clean energy transformation for Washington and the rest of the nation.

The state of Washington is uniquely postured to lead the nation in the development of a DERMS platform, with its national labs, university research institutions, utility providers, technology industry leaders and adopted climate policy goals. This energy platform will enable an ecosystem for different third party applications and off-the-shelf renewable energy systems and services to seamlessly interconnect and participate in the delivery of clean energy. Empowered by this platform, electric energy prosumers (those both producing and consuming energy) will be able to participate in regional distribution markets that license the trading of renewable, energy and demand products.



E-8 Prioritize cyber security as information and communication technology is increasingly integrated throughout sectors of the green economy.

Cyber security threats are potentially enormous. They will become even larger concerns as we move to integrate information and communication technology (ICT) in sectors of the green economy. As systems move toward greater interoperability and communications, they open portals for hacking and disruption. Washington is home to some of the top technology companies in the world with the talent to help protect the ICT systems that sectors of the green economy will increasingly depend upon. Cyber security should be a top priority for state and national security, utilities and water and energy industries.

Washington state should:

- Research existing federal agencies' support programs and develop a Washington state energy and utilities cyber clearinghouse to provide both public agency and private industry partners the access to training resources that are available. Access and knowledge will enable the safe and cyber-secure adoption of the infrastructure while ensuring the wide-scale interconnected grid operating, delivery and transmission systems are securely operated.
- Regularly coordinate and develop the appropriate training for Wi-Fi and mesh network endpoint risk identification with appropriate state and regional agencies.
- Maintain a database of cyber-secure compliant products and provide public agencies access to expert guidance and appropriate training for personnel. Ensure administrative and political decision makers get timely information that will enable budgetary allowances for systemic and endpoint upgrades for telecommunication systems that interface with critical infrastructure.
- Educate public agencies, utilities, planning and building departments on cyber systems risks and solutions. Email, web-based and insider personnel risks include counter-cyber human resource training to spot and identify personnel and intern candidates whose behavior puts their client agencies or employers at risk. Safe, mirror systems and hard storage of information systems backups combat ransomware-related crimes that can render networks inoperable and data inaccessible.



E-9 Identify and avoid statutory barriers to the development of renewable energy facilities.

Washington state should take a proactive role in reviewing energy siting statutes at the state and local level to promote early identification and avoidance of land use conflicts with the development of utility-scale renewable energy facilities.

Washington state's aggressive renewable energy goals, accompanied by the continued downward trend in the cost of renewable energy, will result in an increasing market for renewable energy projects, including wind farms and utility-scale solar energy installations. Local opposition and conflicts with other critical state and local policy priorities have the potential to slow the adoption of needed renewable energy capacity. Energy facilities have faced opposition over changes to rural visual character, loss of farmland and obstruction of critical military training routes. With good advance planning, a well-designed facility in the right location can produce the needed energy and avoid these conflicts.

- Commerce, the Energy Facility Site Evaluation Council, local governments and affected stakeholders should review project development processes to identify ways to streamline project review while avoiding land use conflicts involving renewable energy facilities.

Energy - Transportation Sector Recommendations and Opportunities

In Washington state, greenhouse gas emissions from the transportation sector account for 46% of the state's total greenhouse gas emissions compared with approximately 27% for the nation as a whole.³⁴ This difference is largely attributed to Washington relying heavily on hydroelectric power plants whereas many areas of the country depend heavily on non-renewable energy sources. For Washington state, decarbonizing the transportation sector must be a strong priority to reduce statewide greenhouse gas emissions. A more complete assessment of opportunities throughout the entire transportation sector is warranted, yet outside the scope of this report. Some key energy recommendations for the transportation sector are included here as examples of opportunities for consideration, but are not intended to represent a comprehensive analysis of the transportation sector.



E-10 Develop smart grid energy infrastructure needed for the future clean energy transportation system.

A significant statewide shift to electric vehicles will greatly reduce greenhouse gas emissions from the transportation sector. Battery technologies are rapidly advancing, which will lead to the availability of many new electric vehicles (EVs) in the next few years. While over time EVs offer significant operational savings over internal combustion engine vehicles, the initial purchase price is often higher and federal tax incentives are beginning to phase out. Washington state should continue to provide financial incentives, direct investments and technical assistance to support the electrification of fleet and personal vehicles, including the installation of public charging infrastructure.

Ongoing development and advancement of the smart grid is essential to facilitate widespread adoption of electric vehicles. A typical electric passenger car uses an average of 30 kWh to go 100 miles (nearly as much energy as an average home uses daily), highlighting the need to develop a smart, resilient, reliable and affordable clean energy system to support widespread electrification of the transportation sector.³⁵



E-11 Prioritize transportation programs and investments that move Washington state toward a carbon-neutral transportation sector.

Washington state has received a one-time \$140 million state settlement from Volkswagen for violating state and federal clean air laws. The state is directing the funds to investments that improve air quality and reduce emissions, primarily nitrogen oxides, from transportation. As new funding sources become available, Washington should consider building on these as well as other investments and programs making progress

³⁴ Deep Decarbonization Pathways Analysis for Washington State, 2015

³⁵ www.fueleconomy.gov

toward decarbonization of the state's transportation sector. Below are examples of projects or programs that the state should consider expanding or increasing resources for:

- Transit. To date, over \$34 million in settlement funds and state appropriations has been awarded for electric hybrid buses and charging infrastructure at transit agencies in 11 counties. Awards of up to \$500,000 per bus contribute to cover the costs to switch from diesel to all-electric.
- Ferries. WSDOT is moving forward with plans to convert two of the largest ferries in the fleet to diesel-electric hybrid propulsion and to construct a third. Running just one of the state's biggest ferries primarily on electricity as compared to diesel will cut carbon dioxide emissions by 172,000 tons and nitrogen oxide emissions by 1,540 tons over its operational.
- Electric vehicle. Based on Executive Order 20-01 and existing law in WAC 194-28, executive agencies in Washington must prioritize purchase of battery-electric light and medium-duty vehicles. As of 2020, the state has set a goal that at least 50% of all new state government passenger vehicle purchases be electric. Up to \$5.5 million in state VW settlement funds will go to add electric vehicles to state agency fleets, and \$1 million from the 2020 supplemental transportation budget will support associated charging infrastructure. Department of Ecology is currently reviewing applications from state and local governments for an additional \$2,250,000 in federal VW settlement funds. Completing the purchase and installation of chargers at state-owned and leased facilities alone will require an estimated \$4 million in additional funds. These investments will achieve significant savings in fuel and maintenance costs, while reducing greenhouse gases and air pollution. Finally, a reduction or elimination of or credit toward the state sales tax on vehicles should be implemented to continue to incentivize a consumer shift to electric vehicles.
- Freight and goods movement. To improve air quality and reduce diesel emissions in communities around seaports, \$1.2 million in state VW settlement funds was awarded to the Northwest Seaport Alliance to help scrap and replace aging drayage trucks with clean diesel technology. An additional \$3.6 million in federal VW settlements funds will be awarded to ports in the summer of 2020 to install shore power for ocean-going vessels.
- School buses. More than 3,000 school buses in Washington are 17 years old or older. These buses use technology that emits substantially more pollution than today's options. To date, \$12 million in state VW settlement funds has been awarded to purchase 336 buses statewide in 83 school districts. Each \$35,000 award roughly covers the costs to purchase clean diesel technology or upgrade to a clean propane engine.³⁶ Additional progress has been made in recent years, thanks to funding from state and federal diesel emission reduction programs. Electrification of school buses is the obvious next step, and Ecology will soon issue awards of \$12 million in federal VW settlement funds to purchase new, all-electric buses. The Office of the Superintendent of Public Instruction and the Office of Financial Management should closely consider electrification as they conduct their review of K-12 transportation funding, including alignment with existing statute, during the summer of 2020.
- Aviation. WSDOT was directed to identify up to six airports in Washington state that may benefit from a pilot program once electrically propelled aircraft become available for commercial use. The six sites will allow for performance evaluations as electric aircraft technology matures and may offer communities the opportunity to restore, expand or establish commercial air service. The state should further leverage the expertise of University of Washington's Clean Energy Institute (CEI) whose mission is to reduce or eliminate carbon, including that caused by fuel powered aircraft.

³⁶ Washington State Department of Ecology, <https://ecology.wa.gov/Air-Climate/Air-quality/Vehicle-emissions/Volkswagen-enforcement-action/VW-state-enforcement-action>

- Partner with the CEI to influence international electric aircraft manufacturers to design, develop and launch these aircraft in Washington.
- Create a progressive business environment where international aircraft companies are selecting Washington state as a center of excellence for electric aviation.
- Support the buildout of a testing facility in Washington state for electric aircraft that includes a state-of-the-art wind tunnel.
- Invest in upgraded infrastructure to provide ground-based and air-based testing for electric aircraft.

Appendix A: Green Economy Working Group Members

Table 1: Green Economy Working Group Membership

Organization	Name	Title
Association of Washington Cities	Andy Meyer	Special Projects Coordinator
AVISTA	John Gibson	Chief R&D Engineer
Center for Sustainable Infrastructure	Rhys Roth	Executive Director
Chelan County PUD	Justin Erickson	Managing Director, Shared Services
CleanTech Alliance	Tom Ranken	President and CEO
Dept. of Agriculture	Evan Sheffels	Senior Policy Advisor to the Director
Dept. of Commerce	Michael Furze	Assistant Director, Energy Division
Dept. of Natural Resources	Anne Nelson	Executive Policy Advisor
Economic Alliance of Snohomish County	Patrick Pierce	Executive Director
Front and Centered	Deric Gruen	Program Director
HDR	Genesee Adkins	Director of Infrastructure Initiatives and External Affairs
McKinstry	Dale Silha	Vice President – Pacific Northwest Region
Puget Sound Energy	Ben Farrow	Manager New Product Development
Puget Sound Regional Council	Jason Thibedeau	Principal Economic Development Manager
Pure Blue	Ryan Vogel	Executive Director
Spokane Tribe	Mike Tedesco	Executive Director
South Puget Sound Community College	Jason Selwitz	Dean of Applied Technology
TRIDEC	David Reeploeg	Vice President for Federal Programs
Washington State Association of Counties	Paul Jewell	Policy Director
Washington Farm Bureau	Tom Davis	Director of Government Relations

Organization	Name	Title
Washington State Board for Community and Technical Colleges	Nate Humphrey	Director, Workforce Education
Washington State Forest Protection Association	Jason Callahan	Director of Government Relations
Washington State Labor Council	Larry Brown	President
Dept. of Transportation	Anthony L. Buckley	Director, WSDOT Innovative Partnerships Program
Washington State University	Brad Gaolach	Director, Metropolitan Center for Applied Research and Extension
Paul Roberts & Associates LLC	Paul Roberts	Lead Author of Growing the Green Economy in Washington State: Exploring an Eco-nomic Center

Appendix B: Higher Education Resources

This is an inventory of higher education development resources to foster green economic development in energy, water, agriculture, and forestry.

School	Description (quoted from school's program materials)	Web Link	Degree
Central Washington University	CWU is the first university in the Pacific Northwest with an institute that addresses energy issues from both conventional and alternative energy sources, with a special focus on energy management. The Institute for Integrated Energy Studies provides a unique interdisciplinary approach to provide education, research, and training in the areas of conventional and renewable energy resources.	https://www.cwu.edu/programs/integrated-energy-management-1#2879	BS Integrated Energy Management
Central Washington University	Environmental Geosciences focuses on the interactions between solid Earth and the atmosphere and hydrosphere, including groundwater, soils, and climate.	https://www.cwu.edu/programs/geology#2861	BS Environmental Geosciences
Central Washington University	Environmental Studies helps you understand the challenges facing our environment. The interdisciplinary program incorporates biology, geography, and geology to offer a comprehensive view of the world and how we can ensure it continues to thrive.	https://www.cwu.edu/programs/environmental-studies	BS Environmental Studies
Central Washington University	The Ecology and Evolution Specialization is designed for students broadly interested in basic and applied biology, natural resource management, agriculture, ecological restoration, conservation biology, disease dynamics, animal behavior, and biological research.	https://www.cwu.edu/programs/biological-sciences#2893#2893#2893	BS Ecology & Evolutionary Biology Specialization
Central Washington University	The public health profession focuses on preventing disease, addressing inequities and developing policies and programs that help communities achieve optimal health and wellbeing. Our program aims to educate and empower the emerging generation of public health leaders.	https://www.cwu.edu/programs/health-sciences#2931	BS Public Health
Central Washington University	Want to improve your understanding of the world around you? Want to learn the details behind current important topics like climate, hydrogeology, environmental and geologic hazards? Then geology is a good fit for you.	https://www.cwu.edu/programs/geology#2862	BA Geology

School	Description (quoted from school's program materials)	Web Link	Degree
Central Washington University	You might say you take your life in your hands when you study biology. That's because it is literally the study of life—all life—from one-celled organisms to multi-species habitats. And when you study the biosphere at CWU, you will receive hands-on learning from award winning professors. Gain an understanding of biological concepts relevant to the individual and to society and gain an appreciation of scientific inquiry. Studying biology helps us decipher many social and economic issues and is at the forefront of environmental issues.	https://www.cwu.edu/programs/biological-sciences#2893#2893	BS/ BA Biological Sciences
Eastern Washington University	Environmental Science is an interdisciplinary field that combines physical, chemical and biological sciences with social, political and economic understanding needed to study the environment and address environmental problems. The Environmental Science program integrates classroom work in biology, chemistry, geology and social sciences (economics and planning) with extensive field, lab and research experience. All students take a core of Environmental Science courses complemented by a concentration in one of the three core sciences (biology, chemistry, and geology).	https://www.ewu.edu/cstem/environmental-science/environmental-biology-option-bs/	BS Environmental Science with Biology option
Evergreen State College	Areas of study include sustainable development, environmental policies, ethics, ecology, landscape architecture, city and regional planning, economics, natural resources, sociology, and anthropology.	https://www.evergreen.edu/studies/sustainability-studies	BA/BS/BAS Sustainability
Evergreen State College	Geology integrates a range of scientific disciplines to gain a comprehensive understanding of the Earth, the relationships between rocks, water, chemistry, biology, and the environment, in the context of a changing world.	https://www.evergreen.edu/studies/geology	BA/BS/BAS Geology
Evergreen State College	In this program, students learn introductory plant biology in an integrated way with cultural studies. You'll learn about plant anatomy, morphology, evolution, and systematics. Lectures based on textbook readings supplement the laboratory work. The learning community explores how present form and function inform us about the evolution of major groups of plants such as mosses, ferns, conifers, and flowering plants. Gain hands-on experience studying plants under microscopes and in the field. You'll also learn how to maintain a detailed and illustrated nature journal to develop basic identification skills of local native species of plants. We'll cover basic botanical illustration skills to support this work. This program also focuses on people's relationships with plants through seminar texts, films, and lectures. We'll examine ecological interactions and cultural factors that shape the relationships plants have with the environment, including humans and other organisms.	https://www.evergreen.edu/catalog/offering/botany-20767	BA/BS/BAS Botany

School	Description (quoted from school's program materials)	Web Link	Degree
Evergreen State College	This interdisciplinary field brings together the natural and social sciences to give you skills to study the environment in all its complexities, and engage with government to develop policy to effectively solve environmental problems.	https://www.evergreen.edu/studies/path/environmental-studies	BA/BS/BAS Environmental Studies
Evergreen State College	This program will focus on intensive group and individual field research on current topics in ecological science. These topics will include forest structure, ecosystem ecology, effects of forest management, ecological restoration, riparian ecology, fire history, bird abundance and monitoring, insect-plant interactions, and disturbance ecology. Students will be expected to intensively use the primary literature and student-driven field research to address observations about ecological composition, structure, and function. Multiple independent and group research projects will form the core of our work in local forests of the south Puget Sound lowlands, national forests, national parks, state forests, and other relevant natural settings.	https://evergreen.edu/catalog/offering/field-ecology-16325	BA/BS/BAS Ecology
Evergreen State College	We all eat food. But how is good food raised, grown, or foraged, by whom, and at what cost? How does food get from the farm to our table? What is the connection between soil, food, health, and the languages used to describe our experiences of it? This interdisciplinary Path provides not only an intellectual exploration of food and agriculture, but also practical hands-on approaches to food production and the science of post-harvest processing. Learn to read the land and weather, get field-based learning, understand sustainable food production, follow entire growing season from seed to harvest to market and put the science of soils, plants and resource management into practice.	https://www.evergreen.edu/studies/path/food-and-agriculture	BA/BS/BAS Food & Agriculture
Evergreen State College	You'll learn to grow food for yourself and others in the broader community, using ecologically informed methods of farming while also learning management and business skills appropriate for small-scale production. You'll focus on Northwest crop and livestock species—including orchard fruit, potatoes, sheep, and poultry—and be able to study chemistry, microbiology, and anatomy in a highly practical and experiential context.	https://www.evergreen.edu/studies/agriculture	BA/BS/BAS Agriculture

School	Description (quoted from school's program materials)	Web Link	Degree
Northwest Indian College	We are pleased to offer one of the only Bachelor of Science in Native Environmental Science programs in the world. Our cutting-edge program is designed to support students in becoming leaders in their fields and in their communities. Our curriculum is place-based, experiential, and culturally-grounded. That is, we draw on the deep and sustained connections to place and commitment to environmental protection to guide our programming. Our students excel in understanding the changing world around them by working within Indigenous Knowledge Systems and utilizing cutting-edge scientific methods, technology, and tools.	https://www.nwic.edu/life-on-campus/degrees-and-certificates/b-s-in-native-environmental-science/	BS Native Environmental Science
University of Washington	Atmospheric sciences is a wide-ranging discipline that includes topics as diverse as weather forecasting, global warming, air quality, Pacific Northwest weather and climate, mountain weather, marine weather, El Nino, the ozone hole, ice ages, and the weather of Mars. It considers problems that are both scientifically challenging and critical for the welfare of modern society. These problems are addressed with theory, measurements, and computer simulations.	http://www.washington.edu/students/genocat/academic/atms.html	BS/MS Atmospheric Sciences
University of Washington	Building on a foundation of natural science, social science, and humanities courses, the curriculum offers students flexibility in choosing an individual course of study. Internship, research, and study abroad opportunities develop skills and leadership for careers in environmental policy, sustainability, conservation, education, or consulting.	http://www.washington.edu/students/genocat/academic/envir.html	BA Program on the Environment

School	Description (quoted from school's program materials)	Web Link	Degree
University of Washington	<p>Civil and environmental engineering is a profession which interfaces closely with society in the planning, design, construction, and management of facilities serving the needs of people. These activities focus on: transportation infrastructure and construction; heavy construction; hydrology and hydrodynamics; structures, mechanics, and geotechnical engineering; drinking water and wastewater treatment, and water quality management; solid- and hazardous-waste disposal; and air quality management.</p> <p>A civil engineer may specialize in one or several of these activities and may further specialize in a particular function, such as design or management. The work frequently provides close associations with the legal profession, urban and regional planners, economists, public officials, biologists, chemists, financial consultants, architects, and system analysts. Education and practice require a consideration not only of the technological-science aspects of a particular problem but also of its relationship to social, economic, political, and environmental constraints. Civil and environmental engineers create and maintain infrastructure in a heavily human-influenced ecosystem.</p> <p>To accommodate these wide interests, the department is organized into six academic areas: construction engineering; transportation engineering; geotechnical engineering; structural engineering and mechanics; environmental engineering; and hydrology and hydrodynamics.</p>	http://www.washington.edu/students/gencat/academic/cive.html	Bachelor/Masters of Science in Civil or Environmental Engineering
University of Washington	<p>Environmental health focuses on identifying, evaluating, and controlling environmental conditions that may have an adverse impact on human health. Examples of problem areas requiring environmental health expertise are assuring adequate quality and quantity of food and drinking water, safe treatment and disposal of domestic and industrial waste materials, limiting or reducing air and noise pollution, limiting occupational exposure to hazardous substances and unsafe conditions, assuring safe and healthful housing, controlling the spread of insect- and rodent-borne illness, proper selection and use of pesticides, and understanding the effects of global changes in climate and the atmosphere on human health.</p>	http://www.washington.edu/students/gencat/academic/envh.html	BS/MS Environmental Health/ MPH Environmental & Occupational Health/MPH Occupational & Environmental Medicine/MS Occupational & Environmental Exposure Sciences

School	Description (quoted from school's program materials)	Web Link	Degree
University of Washington	<p>Landscape architecture is a professional design discipline that addresses both the built and natural environments. It focuses on the design, analysis, and planning of outdoor spaces across a wide range of scales, with the intent of creating places that are both meaningful and functional. Landscape architects design everything from infrastructure elements, such as roadways, drainage systems, and parks, to prominent cultural monuments and gardens for public and private housing units. The education of a landscape architect includes aesthetic design skills, the development of social and environmental ethics, technical design skills, knowledge of a wide range of natural processes, an awareness of design history, and skills for working with other people. At the University of Washington, the focus is on urban ecological design education, which allows students to make a difference in the future of cities and urban regions all over the world.</p>	<p>http://www.washington.edu/students/gencat/academic/larch.html</p>	<p>Bachelor/ Masters of Landscape Architecture</p>
University of Washington	<p>Oceanography - study of the marine environment and its interactions with the earth, the biosphere, and the atmosphere - is prompted both by the intellectual desire to understand how the oceans move and how life develops in a salty, cold environment, and the need to use wisely the ocean's resources for the benefit of humanity. As an interdisciplinary science, oceanography integrates the basic principles of biology, chemistry, geology, physics, geophysics, mathematics, botany, zoology, meteorology, and geography. Applications of high technology to oceanographic instrumentation and vessels, increasingly sophisticated computers, satellite remote sensing, and innovative methodologies are rapidly opening new possibilities for exploration and study. Oceanography is divided into four areas of emphasis: Biological, chemical, marine geology and geophysics, physical.</p>	<p>http://www.washington.edu/students/gencat/academic/ocean.html</p>	<p>BA/ BS/ MS Oceanography</p>

School	Description (quoted from school's program materials)	Web Link	Degree
University of Washington	<p>The School of Aquatic and Fishery Sciences (SAFS) encompasses multi-disciplinary programs at the interface between the traditional fields of natural history, environmental biology, and natural resource management. Primary foci are the management of sustainable fisheries of commercially important species; biocomplexity and ecosystem-based management; and sustainable aquaculture. In addition, human-induced effects on natural ecosystems (including habitat change and restoration, impacts of climate change, emerging diseases, the effects of invasive species, and processes affecting endangered species and declining populations) are major areas of research. In pursuit of these objectives, a variety of basic sciences are used, including ecology and evolution, population biology, behavior, physiology, microbiology, and genetics. The scope of aquatic systems ranges from watersheds, rivers and lakes, to estuarine and near-shore shelf, open ocean systems and culture facilities. Graduates of the School of Aquatic and Fishery Sciences are uniquely qualified for careers in universities as well as other educational settings, natural resources management agencies at the local to international levels, environmental consulting, and non-profit organizations with an environmental focus.</p>	<p>http://www.washington.edu/students/gencat/academic/fish.html</p>	<p>BS/ MS Aquatic and Fishery Science</p>
University of Washington	<p>The school's programs focus on the sustainability and functionality of complex natural resource and environmental systems, using an integrated, interdisciplinary approach across multiple scales involving the urban-to-wildland gradient. Its programs serve society generally, and natural resource professions in particular, with graduates well equipped to contribute to discussions and solutions to resource problems facing the region and the world. Interdisciplinary research and outreach centers and cooperatives include the Center for International Trade in Forest Products (CINTRAFOR), the Water Center, the UW Botanic Gardens, which include the Center for Urban Horticulture and the Washington Park Arboretum, the Olympic National Resources Center (ONRC), the Stand Management Cooperative (SMC), and the Precision Forestry Cooperative.</p>	<p>http://www.washington.edu/students/gencat/academic/sefs.html</p>	<p>BS/ MS of Science or Master of Environmental Horticulture or Master of Forest Resources Management</p>
University of Washington	<p>The bioresource science and engineering (BSE) degree is for students seeking training in chemical and physical sciences and chemical engineering as applied to manufacturing fiber products, fuels and chemicals from biomass resources. It emphasizes the application of mathematics, chemistry and engineering to paper and bioresources-based industries.</p>	<p>https://sefs.uw.edu/students/undergraduate/bse-major/</p>	<p>Bioresource Science and Engineering (BSE) Major</p>

School	Description (quoted from school's program materials)	Web Link	Degree
University of Washington Tacoma	As one of the first such degrees in the nation, students will be prepared to address recent initiatives that have called for a significant “greening” of urban development, both locally and internationally. Graduates will be prepared for careers in planning agencies, corporations adhering to sustainability practices, consulting firms, nonprofit organizations, and environmental/resource related agencies at the local, state, and federal levels of government.	https://www.tacoma.uw.edu/urban-studies/sustainable-urban-development	BA Sustainable Urban Development
University of Washington Tacoma	The bachelor of arts degree in Environmental Sustainability prepares students to understand, analyze, and solve environmental and sustainability challenges. Interdisciplinary foundations in environmental sciences, including natural and social sciences, combine with training in communications, writing, law, critical perspectives, and emerging sustainability science. Students also choose one of four options for in-depth study: Environmental Policy and Law; Environmental Communication; Business/Nonprofit Environmental Sustainability; or Pre-Environmental Education. A capstone course or certificate links students to real-world projects, internships, and/or research. An organizing theme throughout the major is coupled human and natural systems.	https://www.tacoma.uw.edu/node/46527	BA Environmental Sustainability
University of Washington Tacoma	The bachelor of science degree in Environmental Science provides students with a strong science background with a focus on the environmental issues of the future. Through lecture, lab and field classes, you will get hands-on experience with biology, chemistry, the geosciences, physics and math. In this program students learn how to draw connections between these disciplines needed to solve the complex environmental problems facing the local community and society at large. As part of the School of Interdisciplinary Arts and Sciences, this degree allows you to combine diverse approaches to the environment which incorporate humanities and the social sciences.	https://www.tacoma.uw.edu/node/40367	BS Environmental Science
Washington State University	Environmental and natural resource sciences comprise an association of several areas of study at WSU. These sciences focus on factors related to the understanding and management of the environment and therefore have a commonality of interest. The Ph.D. program provides opportunities for doctoral study that involve integration and interaction among these various fields of science.	https://gradschool.wsu.edu/degrees/factsheet/doctor-of-philosophy-environmental-and-natural-resource-sciences/	PhD Philosophy in Environmental & Natural Resource Science

School	Description (quoted from school's program materials)	Web Link	Degree
Washington State University	From earth science to ecology, from global change to environmental sustainability, School of the Environment (SoE) undergraduate students master both scientific tools and practical skills that kick start a meaningful career in a rapidly changing world with majors in: Earth Science, Environmental & Ecosystem Sciences, Forestry or Wildlife Ecology& Conservation Sciences	https://environment.wsu.edu/undergraduate-studies/	BS Earth & Environmental Sciences
Washington State University	IPS majors explore the science of plant development and production from the perspectives of a variety of disciplines. All students in the program take a core set of interdisciplinary courses selected specifically to give them a solid foundation on which they can build expertise in a specific discipline. There are seven majors from which to choose: Agricultural Biotechnology, Field Crop Management, Fruit & Vegetable Management, Landscape, Nursery & Greenhouse Management, Turf grass Management or Viticulture & Enology.	http://ips.wsu.edu/	BS Integrated Plant Sciences
Washington State University	The Agricultural and Food Systems degree program is an exciting, college-wide, interdisciplinary program that offers a Bachelor of Science degree with five majors from which to choose: Agricultural Technology & Production Management, Agricultural Education, Organic & Sustainable Agriculture, Agricultural & Food Business Economics or Agriculture & Food Security.	http://afs.wsu.edu/	BS Agricultural & Food Systems
Washington State University	The department of Biological Systems Engineering integrates the biological sciences and engineering for the development of engineering solutions to agricultural, food and natural systems.	https://gradschool.wsu.edu/degrees/factsheet/master-of-science-in-biological-and-agricultural-engineering/	MS Biological & Agricultural Engineering
Washington State University	The department offers the PhD degree with four research areas of emphasis: Bioenergy and Bioproducts Engineering; Food Engineering; Land, Air, Water Resources and Environmental Engineering; and Agricultural Automation Engineering.	https://gradschool.wsu.edu/degrees/factsheet/doctor-of-philosophy-biological-and-agricultural-engineering/	PhD Philosophy in Biological & Agricultural Engineering
Washington State University	The Graduate Certificate in Sustainable Agriculture increases knowledge and employment potential in any position focused on sustainability. This will include educational, commercial, and research endeavors for production, processing, or policy.	https://gradschool.wsu.edu/degrees/factsheet/graduate-certificate-in-sustainable-agriculture/	Graduate Certificate in Sustainable Agriculture

School	Description (quoted from school's program materials)	Web Link	Degree
Washington State University	The M.S. in Agriculture program is designed to provide practitioners and professionals with an opportunity to strengthen and diversify their expertise in agriculture-related disciplines.	https://gradschool.wsu.edu/degrees/factsheet/master-of-science-in-agriculture/	MS Agriculture
Washington State University	The MS degree is an interdisciplinary program with the flexibility for elective classes in the student's own area of specialization. In consultation with their advisor, students may select classes from a wide variety of areas (i.e., ecosystem science and management, ecological planning, land and water conservation, air quality management, water quality management, energy and carbon policy, etc.).	https://gradschool.wsu.edu/degrees/factsheet/master-of-science-in-environmental-science/	MS Environmental Science
Washington State University	The School of the Environment offers a program of graduate study and research leading to a master of science in natural resource sciences. The M.S. in natural resource sciences emphasizes original research by the student. This degree provides an atmosphere of scholarship coupled with research opportunities that produces people capable of responding to the complicated issues of use, management, and protection of the environment and its natural resources.	https://gradschool.wsu.edu/degrees/factsheet/master-of-science-in-natural-resource-sciences/	MS Natural Resource Sciences
Washington State University	The School of Biological Systems Engineering offers PhD and MS degrees in four general research emphasis areas: Agricultural automation engineering - Develop engineering solutions for processes and equipment to meet the needs of specialty crop production. Bioenergy and bioproducts engineering - Develop engineering processes to produce useful, high-value products from the byproducts of agricultural operations and other sources of plant biomass. Food engineering - The application of engineering to the production of safe, nutritious food. Land, air, water resources and environmental engineering (LAWREE) - Engineering applications related to hydrologic processes at the field level or at the scale of large watersheds. Application of engineering and biological principles to the study the environmental impact of managed biological systems, including agriculture, confined animal operations, aquaculture, and natural resources.	https://bsyse.wsu.edu/	MS, PhD in Biological and Agricultural engineering

School	Description (quoted from school's program materials)	Web Link	Degree
Washington State University	WSU's Master of Science in Agriculture degree, Plant Health Management option combines WSU's world-renowned plant science graduate programs with business course in organizational management. The result is a high-quality MS degree to help advance your career. You will be qualified to manage commercial-scale agricultural or horticultural operations and address problems with plant pathogens, insects, and weeds, as well as environmental factors that affect plant health. You will be equipped to serve in decision-making roles and have essential skills for maximizing plant health using modern, scientifically sound methods.	https://gradschool.wsu.edu/degrees/factsheet/master-of-science-in-agriculture-plant-health-management/	MS Agriculture-Plant Health Management
Washington State University	The School of Economic Sciences in the College of Agricultural, Human, and Natural Resource Sciences is a general economics program with especially strong and deep expertise in natural resource and environmental economics and policy, renewable energy economics, agricultural and food systems economics. The school offers a PhD in Economics and in Agricultural Economics, as well as a Masters of Sciences in Applied economics and undergraduate degrees in economics with various relevant foci.	http://ses.wsu.edu/	BS, Economic sciences; BS, Agricultural and Food Business Economics MS in Applied Economics Ph.D. Economics; Ph.D. Applied Economics.
Washington State University	Data Analytics tools and techniques are used by many different industries to create, manage, explore, and analyze large, complex datasets, in order to evaluate past performance, predict future trends, and make better decisions. There has been an explosion of demand for skilled data analysts who can communicate, solve problems, and work effectively in teams.	https://data-analytics.wsu.edu/	B.S. offered jointly by the Department of Mathematics and Statistics and the School of Electrical Engineering and Computer Science
Washington State University	All around us, massive amounts of digital data are being captured through the Internet, sensors, sequencers, simulations, and other similar technologies. Data science is a rich interdisciplinary field aimed at extracting knowledge and insight from such data. It is a field at the intersection of a variety of disciplines, including computer science, statistics, mathematics, and engineering, and requires unique skills to create effective solutions. Researchers at WSU are developing models, algorithms, systems, and technologies needed to advance data science research and practice in both industry and academia. Our faculty are actively developing a solid data science curriculum aimed at educating the next-generation of data scientists.	https://school.eecs.wsu.edu/research/data-science/	School of Electrical Engineering & Computer Science - DATA SCIENCE sub-specialty

School	Description (quoted from school's program materials)	Web Link	Degree
Washington State University	The GridStat project is developing fundamental data delivery technologies that will enable the smart electric power grid to make use of thousands of sophisticated sensors and control devices. GridStat is a collaborative effort of distributed systems and electric power researchers at WSU, with strong connections to national research programs such as Trusted Cyber Infrastructure for the Power Grid (TCIPG). In this project we work on performance-related aspects of data delivery as well as on techniques for ensuring secure communications and trustworthy communicating entities.	https://school.eecs.wsu.edu/research/distributed-systems/	School of Electrical Engineering & Computer Science - DISTRIBUTED AND NETWORKED SYSTEMS (Cyber security and electrical grids)
Washington State University	As a core college in a Research University with Very High research activity, as well as a land-grant university, our mission is threefold: To conduct fundamental and applied disciplinary and cross-cutting research that leads to new knowledge, transformative technology, and innovative designs. To educate and prepare students through state-of-the-art programs, preparing them for professional careers and leadership in engineering and design professions. To engage people, industry, and communities to improve quality of life and enhance economic development.	https://vcea.wsu.edu/	BS, MS and PhD degrees in Civil & Environmental Engineering, as well as Landscape Architecture within the School of Design & Construction
Washington State University	Civil and environmental engineers are responsible for improving living standards and serving the communities in which they live. Graduates are prepared to tackle challenges related to transportation infrastructure and construction, hydrology and hydraulics, structures, geotechnical engineering, drinking water, wastewater treatment, hazardous-waste disposal, surface and groundwater quality, and air quality management. The degree also prepares graduates to communicate technical concepts to lay audiences, perform economic analyses, be involved with project planning and management, and understand the financial, ethical, legal and environmental contexts in which engineering design is occurring. The department has tracks that specialize in Civil/construction engineering, environmental engineering, infrastructure engineering, structural engineering, and water resource engineering.	https://ce.wsu.edu/	Bachelor of Science in Civil Engineering, Bachelor of Science in Construction Engineering, Master of Science in Civil Engineering, Master of Science in Environmental Engineering, Doctor of Philosophy in Civil Engineering

School	Description (quoted from school's program materials)	Web Link	Degree
Western Washington University	Environmental Science draws on basic knowledge of the physical, chemical, biological, and quantitative aspects of natural systems. The knowledge of how natural systems work is applied to solving problems largely created by human activities. Often these problems are represented by disturbances in the functioning of natural systems as humans alter their own life-support systems – the air, the water and soil. The scale of disturbance ranges between molecular and cellular to individuals, populations, ecosystems, and regional and global levels. Committed to creating a space for students to value, change, and study the environment. Students in the program gain proficiencies in applying quantitative and critical thinking skills to environmental issues, writing and speaking effectively to professional audiences about issues in the field, using theoretical knowledge of environmental sciences in real world applications, and incorporating multiple disciplines into environmental sciences.	https://www.wwu.edu/majors/environmental-science-bs	BS Environmental Science
Western Washington University	Environmental Science draws on basic knowledge of the physical, chemical, biological, and quantitative aspects of natural systems. The knowledge of how natural systems work is applied to solving problems largely created by human activities. Often these problems are represented by disturbances in the functioning of natural systems as humans alter their own life-support systems – the air, the water and soil. The scale of disturbance ranges between molecular and cellular to individuals, populations, ecosystems, and regional and global levels.	https://www.wwu.edu/majors/environmental-science%E2%80%9494marine-ecology-bs	BS Environmental Marine Science
Western Washington University	Prepares students to enter professional fields concerned with the sustainability of the human and natural environment. Studies in Environmental Policy concentrate on public policy development, governance, law, and the methods and processes of planning and decision making. By solving problems and implementing shared visions in both natural settings and urban communities, Environmental Policy promotes positive change in the environment.	https://www.wwu.edu/majors/environmental-policy-ba	BA Environmental Policy

School	Description (quoted from school's program materials)	Web Link	Degree
Western Washington University	<p>Students who are passionate about making positive environmental choices and excited about teaching people about the environment will thrive in the Environmental Education program. By examining interacting social and natural systems through social sciences, natural sciences, and humanities, Environmental Education students make intellectual connections while gaining the practical skills necessary for building socially and environmentally sustainable futures. Environmental Education at Western consists of four distinct parts: students acquire an understanding of the content of environmental studies; examine the process of education for an environmental perspective; investigate ways of applying environmental education content and techniques in the professional roles they may pursue; and participate in internships, a field practicum, or research. Students studying Environmental Education become problem solvers who are able to meet the environmental challenges of our time.</p>	<p>https://www.wwu.edu/majors/environmental-education-ba</p>	BA Environmental Education
Western Washington University	<p>Students, faculty, and staff in the Department of Environmental Studies approach environmental understanding and problem solving through diverse programs that examine the interaction of social and natural systems to promote positive change in the environment. Western's interdisciplinary Environmental Studies curriculum is designed to help students make intellectual connections and gain the practical skills necessary for building socially and environmentally sustainable futures. The Department's undergraduate programs include a variety of major specializations. A range of minors, including Disaster Risk Reduction (DRR), Geographic Information Science (GIS), and Sustainable Design, are also available.</p>	<p>https://www.wwu.edu/majors/environmental-studies-ba</p>	BA Environmental Studies
Western Washington University	<p>The Energy Policy and Management program fosters interdisciplinary thinking, learning and problem solving and integrates courses in economics, environmental studies, environmental science, and various other disciplines. Students gain knowledge and develop analytic skills in the policy and management aspects of today's diverse energy business, along with broad exposure to the science, environmental, business and policy aspects of the energy system that drive the formation and analysis of energy-related policies.</p>	<p>https://www.wwu.edu/majors/energy-policy-and-management-ba</p>	BA Energy Policy & Management

School	Description (quoted from school's program materials)	Web Link	Degree
Western Washington University	The goal of the Energy Science and Technology degree is to give students knowledge and analytic skills in the science and technology of today's diverse energy systems and industries. The degree is designed to prepare graduates to become leaders in Washington's emerging clean energy economy with an interdisciplinary education that emphasizes applied science and technology, complemented by energy policy and business practices, that industry experts have prioritized among Washington's energy workforce needs.	https://www.wwu.edu/majors/energy-science-technology	BS Energy Science & Technology
Western Washington University	The MA degree in Environmental Studies prepares students to address complex environmental problems using a highly interdisciplinary approach. The program prepares students in the analysis, development, conservation, and management frameworks of environmental resources for careers in business, government, planning, consulting, teaching, and research.	https://gradschool.wwu.edu/environmental-studies	MA Environmental Studies

Appendix C: Workforce Training Resources

This is an inventory of workforce training resources to foster green economic development in energy, water, agriculture, and forestry.

School	Description (quoted from school's program materials)	Web Link	Degree
<p>Bellingham Technical College</p>	<p>According to the US Energy Information Administration, global energy consumption has significantly increased and is expected to continue rising through 2035 (Energy Outlook, 2012). The energy industry is working to increase energy efficiency and looking toward innovative technologies to meet the growing demand. Prominent energy companies like BP and Phillips 66 are starting new departments focused on alternative energy and investing in technology development and production. New energy technology career categories are emerging at an unprecedented pace, and skill sets associated with energy technology cut across both traditional and emerging industries. The number of green jobs in Washington rose 32% in the last few years, and these trends are expected to continue as the demand for energy increases and resources decrease.</p>	<p>https://www.btc.edu/DegreesClasses/Programs/ProgramDetails.aspx?ID=145&tab=tab2</p>	<p>Certificate of Clean Energy Technology</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Bellingham Technical College	The Water and Wastewater Treatment program will train you for top jobs at water and wastewater treatment plants, including positions as water and wastewater treatment operators. WWT operators work to ensure that the safety, environmental and water quality standards for an employer's treatment system are met. BTC's Water and Wastewater Treatment program gives you training in technical skills and interpersonal skills to get you ready for top jobs in the field of water treatment.	https://www.btc.edu/DegreesClasses/Programs/ProgramDetails.aspx?ID=153	AAS Water & Wastewater
Bellingham Technical College	You can prepare for a rewarding career as a fish hatchery specialist, fish culturist, fisheries technician, net pen worker, shellfish hatchery worker, scientific aide, water quality technician, or habitat restoration specialist. In BTC's Fisheries and Aquaculture Science programs, you'll learn top skills such as fish culture, aquaculture, and fish spawning that will position you for the best aquatic science jobs in the fisheries industry.	https://www.btc.edu/DegreesClasses/Programs/ProgramDetails.aspx?ID=88&tab=tab3	AAS Fisheries & Aquaculture Science
Big Bend Community College	BBCC provides students interested in Agricultural Technology and Management a comprehensive Associate in Applied Science (AAS) degree with three customized pathways intended to provide graduates with the skills needed to independently operate or support local, regional and national agriculture industries.	https://www.bigbend.edu/academics/programs/agriculture/advising/	AAS Agriculture Technology & Management/ Agricultural Agronomy Certificate/ Agricultural Business Certificate/ Agricultural UAS Certificate

School	Description (quoted from school's program materials)	Web Link	Degree
<p>Cascadia College</p>	<p>Sustainability is a concept, a discipline, an ideal. It is the recognition that the prosperity of our planet, our people, and our economy are inextricably linked. By blending coursework in natural sciences, social sciences, management, and technology, Cascadia College's Bachelor of Applied Science in Sustainable Practices provides a pathway to careers in the green industry. Graduates will learn the skills necessary to plan and implement sustainable approaches to how we live and work by managing complex projects for government agencies, private and non-profit organizations, water, energy, and agriculture industries, construction management firms, and educational institutions</p>	<p>http://www.cascadia.edu/programs/degrees/bassp.aspx</p>	<p>BAS Applied Science in Sustainable Practices</p>
<p>Cascadia College</p>	<p>The Associate in Applied Science-Transfer degree in Environmental Technologies and Sustainable Practices is a comprehensive technical degree that provides industry-specific knowledge and professional skills that are vital to staking a claim in the emerging green economy. Governments and businesses in this state and around the world are looking for professionals who can “pioneer innovative pathways” as we rethink and redesign how we consume resources; students in this program will have the chance to be a part of that as professional practitioners as well as in roles as informed consumers and political citizens.</p>	<p>http://www.cascadia.edu/programs/certificate/default.aspx</p>	<p>AAS Environmental Technologies and Sustainable Practices</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Centralia College	The Associate in Arts degree with an emphasis in Environmental Studies is intended for students who plan a career in an environmental field in areas such as environmental policy and law, urban planning, environmental ethics, and environmental advocacy.	https://www.centralia.edu/academics/arts-sciences/enviro-science.aspx	AA Environmental Science
Centralia College	The Associate in Science degree with an emphasis in Environmental Science is intended for students who plan a career as a scientist or technician in an environmental field such as conservation biology, environmental chemistry, environmental geology, energy resources, environmental planning, agro-ecology or atmospheric sciences.	https://www.centralia.edu/academics/arts-sciences/enviro-science.aspx	AS Environmental Science
Centralia College	The Natural Resources Management program prepares students for transfer into a program in forestry, fisheries, or wildlife management.	https://www.centralia.edu/academics/arts-sciences/natural-resources.aspx	AA Natural Resources Management
Centralia College	This program is for students who wish to complete a bachelor's degree in such disciplines as general or molecular biology, zoology, microbiology, genetics, entomology, botany, horticulture, soil science, phycology, ecology, marine biology, fisheries biology, or wildlife management. This program assumes a student is prepared to start college-level math and English courses.	https://www.centralia.edu/academics/arts-sciences/biology.aspx	AA in Biology

School	Description (quoted from school's program materials)	Web Link	Degree
Centralia College	<p>This program is for students who wish to complete a bachelor's degree in such disciplines as general or molecular biology, zoology, microbiology, genetics, entomology, botany, horticulture, soil science, phycology, ecology, marine science, fisheries or wildlife management.</p>	<p>https://www.centralia.edu/academics/arts-sciences/biology.aspx</p>	AA in Science
Clark College	<p>Environmental Science is the study of physical and biological properties that make up the environment and their relationship to living organisms on the planet. This interest area is an interdisciplinary field that combines foundational knowledge in a variety of earth sciences. As society explores new ways to live sustainably on the planet, research and creative solutions will build upon knowledge of natural systems. Environmental scientists apply mathematic and scientific principles to solve environmental issues and develop ways to reduce, correct, or prevent damage to the environment.</p>	<p>http://www.clark.edu/academics/programs/dept/environmental_science/index.php</p>	AS Environmental Science

School	Description (quoted from school's program materials)	Web Link	Degree
Clover Park Technical College	<p>With the constant population growth and development of new technologies, environmental impact is a vital focus. Students in CPTC's Environmental Sciences & Technology program train for a wide range of career opportunities in the field of environmental science. Some of the training opportunities include hands-on water-quality monitoring; soil, water, and air sampling; mineral identification; wetland delineation and restoration; geographic information system mapping; and simulated hazardous waste site cleanup operations. This program takes advantage of CPTC's 110-acre outdoor learning laboratory at Flett Creek, across the street from our Lakewood Campus. If you love the outdoors and have a passion for nature, this program and career path might be your perfect fit.</p>	<p>http://www.cptc.edu/programs/environmental</p>	<p>Certificate of Environmental Sciences & Technology</p>
Columbia Basin College	<p>Agri-Food Systems give you a broad, interdisciplinary understanding of agriculture systems and allow you to develop specialized knowledge of business management in agriculture and related areas. The program prepares not only aspiring growers of crops, but also students who are interested in related industries, such as global marketing, direct marketing, or food production to contribute to the changing field of agriculture.</p>	<p>http://www.columbiabasin.edu/index.aspx?page=407</p>	<p>BAS Applied Science</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Columbia Basin College	<p>Agri-Food Systems give you a broad, interdisciplinary understanding of agriculture systems and allow you to develop specialized knowledge of business management in agriculture and related areas. The program prepares not only aspiring growers of crops, but also students who are interested in related industries, such as global marketing, direct marketing, or food production to contribute to the changing field of agriculture.</p>	<p>http://www.columbiabasin.edu/in dex.aspx?page=407</p>	AA Sciences in Agriculture
Columbia Basin College	<p>Agri-Food Systems give you a broad, interdisciplinary understanding of agriculture systems and allow you to develop specialized knowledge of business management in agriculture and related areas. The program prepares not only aspiring growers of crops, but also students who are interested in related industries, such as global marketing, direct marketing, or food production to contribute to the changing field of agriculture.</p>	<p>http://www.columbiabasin.edu/in dex.aspx?page=407</p>	AA Sciences in Crop & Soil Science
Columbia Basin College	<p>Agri-Food Systems give you a broad, interdisciplinary understanding of agriculture systems and allow you to develop specialized knowledge of business management in agriculture and related areas. The program prepares not only aspiring growers of crops, but also students who are interested in related industries, such as global marketing, direct marketing, or food production to contribute to the changing field of agriculture.</p>	<p>http://www.columbiabasin.edu/in dex.aspx?page=407</p>	AA Applied Science

School	Description (quoted from school's program materials)	Web Link	Degree
Columbia Basin College	Environmental Science offers both science and non-science students the necessary background to understand the environmental problems that have arisen due to human activities. Courses deal with the interrelationships of soil, air, and water as they are affected by human activities. Students are challenged to think critically about their lifestyle choices and how these choices affect their immediate environment in the short term and the biosphere in the long run. Education of students is the key that opens their minds to the possibility that humans do, in fact, cause changes to their environment by using resources at rates that exceed the system's ability to replenish them.	http://www.columbiabasin.edu/index.aspx?page=419	AS Environmental Science
Edmonds Community College	Environmental Science combines information from biology, chemistry, physics, and geology, stressing a scientific approach towards understanding the nature and scope of current environmental issues.	https://www.edcc.edu/programs/stem/envsc/default.html	AS Environmental Science
Edmonds Community College	The Associate in Science (AS-T) degree is designed to prepare science majors for transfer to a four-year institution with junior standing. The AS-T degree will generally provide the transferring student with at least 90 quarter (60 semester) credits upon entry to a four-year institution. This degree will satisfy some, but not all, of the general education requirements at the receiving institution.	http://catalog.edcc.edu/preview_program.php?catoid=52&poid=10423	AS Environmental Science, Geology, Earth Sciences

School	Description (quoted from school's program materials)	Web Link	Degree
Edmonds Community College	<p>This certificate provides a theoretical foundation in urban agriculture through the study of environmental sustainability principles, ecology in agricultural systems, and plant and soil sciences. There is also a practical focus on the study and hands-on cultivation of organic food crops for year-round production and harvest in the maritime climate of the Puget Sound bioregion. Students explore career options and apply knowledge, skills, and techniques through internship, practicum, or research experience. This certificate may be combined with the Urban Agriculture Enterprises Certificate to achieve the larger Urban Agriculture Systems Certificate.</p>	<p>http://catalog.edcc.edu/preview_program.php?catoid=53&poid=10683</p>	<p>Certificate of Urban Agriculture Production Certificate</p>
Everett Community College	<p>Geologists study the composition, processes and history of the Earth. They try to find out how rocks were formed and what has happened to them since formation. They also study the evolution of life by analyzing plant and animal fossils. Geophysicists use the principles of physics, mathematics and chemistry to study not only the Earth's surface, but also its internal composition; ground and surface waters; atmosphere; oceans; and its magnetic, electrical and gravitational forces.</p>	<p>https://www.everettcc.edu/programs/math-science/physical/geoscience/</p>	<p>AS/ AAS Geoscience</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Grays Harbor College	Demonstrate field identification of regionally important plant species and their communities; Interpret how ecological relationships influence plant succession and biodiversity in forested ecosystems; Recognize silvicultural treatments used in the growing and culturing of trees; Explain how forest management practices are applied to forestland ownership within the context of multiple resource uses; Identify and solve problems in natural resources through the application of mensuration and/or remote sensing techniques while utilizing appropriate equipment; Differentiate harvest systems in relation to site and stand characteristics; Recognize and resolve potentially hazardous situations in the forested environment and related operations.	https://www.ghc.edu/academics/degrees-and-certificates/natural-resources-forestry-technician-aas	AAS/ Certificate Natural Resources- Forestry Technical
Grays Harbor College	The Associate in Science - Track 1 degree prepares you for upper division study in the areas of: Biological Sciences, Environmental Sciences / Resource Sciences, Geology, Earth Science	https://www.ghc.edu/academics/degrees-and-certificates/associate-science-direct-transfer	AS

School	Description (quoted from school's program materials)	Web Link	Degree
Grays Harbor College	The Bachelor of Applied Science in Forest Resources Management (BAS-FRM) degree prepares students to engage professionally as Foresters in public and private companies, Conservation Scientists, Wildland Fire Supervisors, Surveyors and other environmental activities. If you love nature and the outdoors Washington State is one of the main forester centers in our country and there are many roles you can take to make a better world right here in Grays Harbor.	https://www.ghc.edu/academics/degrees-and-certificates/bachelors/forestry	BAS Forest Resource Management
Green River College	Washington Environmental Training Center - Located at Green River College WETRC is a non-profit, self-supported training organization founded in 1974 under the direction of the Environmental Protection Agency. WETRC provides specialized training and continuing education for water or wastewater personnel as well as backflow assembly testers. Our program allows students and professionals to maintain and upgrade their certification, meeting state training requirements.	https://www.greenriver.edu/students/academics/degrees-programs/water-wastewater-technology/	Wastewater Technology AAS, Water Supply Tech AAS, Municipal Wastewater Treatment Tech Cert, Water Distribution Tech Cert
Green River College	Earth science includes the sciences used to study the lithosphere - the solid portion of Earth, the atmosphere - the gaseous envelope surrounding Earth, the hydrosphere - the ice, water and water vapor at or near Earth's surface, the biosphere - the zone at or near Earth's surface that supports life, and space beyond the atmosphere.	https://www.greenriver.edu/students/academics/degrees-programs/earth-science/	AS Earth Science

School	Description (quoted from school's program materials)	Web Link	Degree
Green River College	The Bachelors of Applied Science in Forest Resource Management degree prepares students to directly enter employment in several Natural Resources areas. By developing academic skills in mathematics, science, English, humanities, and natural resource courses, the student can apply directly for jobs in natural resources management, forest engineering, water quality or wildlife biology.	https://www.greenriver.edu/students/academics/degrees-programs/bachelor-of-applied-science/bachelor%E2%80%99s-in-forest-resource-management/	BAS Forest Resource Management
Green River College	The study of Environmental Science is concerned with natural and modified environments and their interactions with biological systems, including human. Students gain an understanding of the environmental and ecological context, including positive and negative impacts, and methods to analyze, interrelate, and resolve these complex systems. This program is designed to meet a wide variety of academic goals.	https://www.greenriver.edu/students/academics/degrees-programs/environmental-science/	AS Environmental Science
Green River College	This certificate program prepares graduates for entry-level positions operating and maintaining public drinking water distribution systems. The program is designed for a fall quarter start, depending upon student composition, computation and computing skills; please contact an advisor for skill assessment information.	https://catalog.greenriver.edu/preview_program.php?catoid=3&poid=565	Certificate of Water Distribution Technology

School	Description (quoted from school's program materials)	Web Link	Degree
Green River College	<p>This degree program prepares graduates for positions in municipal drinking water distribution and treatment facilities. Along with appropriate operating experience, this degree provides a foundation for positions with responsibilities beyond the entry level. The requirements build on those for the Water Distribution Technology Certificate of Proficiency, which should generally be completed first.</p>	<p>https://catalog.greenriver.edu/preview_program.php?catoid=3&poid=564</p>	AAS Water Supply Technology
Green River College	<p>This degree program prepares graduates to work in a variety of outdoor careers. Graduates monitor stream, lake, and wetland systems for water quality and functions of physical, biological, and chemical parameters. They identify plants and animals using taxonomic keys. They assist wetlands delineation and GPS/map their location. Graduates also apply and follow environmental regulations regarding stream and wetland protection.</p>	<p>https://catalog.greenriver.edu/preview_program.php?catoid=3&poid=552</p>	AAS Natural Resources- Water Quality

School	Description (quoted from school's program materials)	Web Link	Degree
Green River College	<p>This degree program prepares graduates to work in a variety of outdoor careers. The growing awareness of water quality, wetland protection, reforestation, and environmentally sensitive timber harvest requires the services of technicians with a broad knowledge base. People who are trained to measure and sample the forest, its wildlife, streams and wetlands will enhance their employment opportunities. Wildlife biologists and professional foresters need technicians to efficiently produce accurate data. Park managers need knowledgeable personnel to perform maintenance duties and interpret wildland ecology for the public. Wildland firefighters are needed with current certificates of knowledge and skills.</p>	<p>https://catalog.greenriver.edu/preview_program.php?catoid=3&poid=549</p>	AAS Natural Resources-Forestry
Lake Washington Institute of Technology	<p>Students learn plant identification, plant propagation, sustainable landscape practices, soil science, practical pruning and botanical concepts. Through time spent in practical hands-on training, students will learn to propagate, seed, transplant, design landscape plans, and maintain a variety of plants. Students will participate in an industry based training experience. Graduates find jobs with nurseries, greenhouses, landscape firms, garden centers, and park departments. The classroom setting includes individual and small group instruction with a hands-on focus of horticultural practices. The program emphasizes a sustainable approach to horticultural principles.</p>	<p>http://catalog.lwtech.edu/preview_program.php?catoid=9&poid=2190&returnto=439</p>	Certificate of Proficiency Environmental Horticulture

School	Description (quoted from school's program materials)	Web Link	Degree
<p>Lake Washington Institute of Technology</p>	<p>Students who complete the Sustainable Landscape Technologies certificate will be able to manage outdoor spaces in an ecological and sustainable manner. Focuses on emerging technologies and best management practices in modern residential & commercial landscapes including topics like: reduction of landscape water usage through modern irrigation technologies, BMP's related to irrigation systems maintenance and installation, BMP's regarding "right plant, right place: planting concepts and soil management, installation and use of ecologically responsible hardscape materials such as permeable materials, green roofs, living walls, and sustainably sourced woods or introduction to plant health care principles including a broad understanding of common cultural, insect and disease problems in the landscape and how to assess and address them.</p>	<p>http://catalog.lwtech.edu/preview_program.php?catoid=9&pooid=2259&returnto=439</p>	<p>Certificate of Sustainable Landscape Technologies</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Lake Washington Institute of Technology	<p>The Environmental Horticulture AAS degree provides students with knowledge and skills needed for jobs with nurseries, greenhouses, landscape firms, garden centers, and park departments. Students learn plant identification, plant propagation, sustainable landscape practices, soil science, practical pruning and botanical concepts. Through time spent in practical hands-on training, students will learn to propagate, seed, transplant, design landscape plans, and maintain a variety of plants. Students will participate in an industry based training experience.</p>	<p>http://catalog.lwtech.edu/preview_program.php?catoid=9&pooid=2189&returnto=439</p>	AAS Environmental Horticulture
Lower Columbia College	<p>Knowledge about the planet we inhabit, the surrounding universe and the natural forces that impact our world adds value to our daily lives and provides the basis for interesting careers in a broad range of disciplines: astronomy, earth sciences, geography, geology, meteorology and oceanography. Begin studies for an advanced degree leading to positions with government agencies or private industry as an independent consultant, teacher, or researcher.</p>	<p>https://lowercolumbia.edu/programs/natural-science.php</p>	AS/AA Earth Sciences

School	Description (quoted from school's program materials)	Web Link	Degree
Lower Columbia College	<p>Today's environmental problems call for people who are educated in more than one discipline, highly trained in scientific and technical skills, and aware of the ecological, political, economic, and social dimensions of environmental decisions. The Associate in Science-Transfer (AS-T) degree in Environmental Science provides a foundation in basic physical, biological, and social sciences, and also addresses the human element in environmental issues. This curriculum prepares students to transfer and complete a BS or BA in an Environmental Science field for subsequent graduate study in MS, PhD, and law degree programs and careers in government agencies or the private sector.</p>	<p>https://lowercolumbia.edu/programs/natural-science.php</p>	AS Environmental Science
North Seattle College	<p>Intended for students planning to transfer to a four-year college or university and major in biology, environmental/resource sciences, chemistry, geology or earth sciences. This degree is designed to allow students to complete approximately 70 math/science credits required or recommended for admission into these majors. The remaining 20 credits of the 90-credit degree include 5 credits of ENGL&101 (composition) and 15 general education credits (humanities and social sciences).</p>	<p>https://northseattle.edu/degrees/associate-science-degree-option-1</p>	AS Option 1

School	Description (quoted from school's program materials)	Web Link	Degree
North Seattle College	<p>The Sustainable and Conventional Energy and Control Technology (formerly, Industrial Power & Control) Certificate prepares students for immediate employment and future advancement, in companies or government organizations that manufacture, service, sell, design or support electrical and electronic systems that control machinery, automation, and/or processes.</p>	<p>https://northseattle.edu/certificates/sustainable-and-conventional-energy-and-control-technology-certificate</p>	<p>Sustainable & Conventional Energy & Control Technology Certificate</p>
Olympic College	<p>Biotechnology is a fascinating field which is at the cutting edge of science using living cells and materials produced by cells to create pharmaceutical, diagnostic, agricultural, environmental, and other products to benefit society. People working in this field make groundbreaking discoveries that fight disease, improve food production, clean up the environment and make manufacturing more efficient and profitable. Because of the various levels of occupations associated with biotechnology, students have several options. Associate degrees are available at a number of community colleges in Washington State that focus on the technical side of biotechnology. Bachelor's and graduate degrees are also available that prepare students for careers in biotechnology associated with research and development and quality control.</p>	<p>https://www.olympic.edu/biotechnology-associate-arts-aa-or-associate-science-track-2</p>	<p>AA/AS Biotechnology</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Olympic College	<p>Environmental Studies is an interdisciplinary field which studies the earth's natural systems in the context of human social and economic constructs. It is a broad discipline that includes basic principles of ecology and environmental science, as well as associated subjects such as ethics, policy and planning, law, economics, philosophy, environmental justice, pollution control and natural resource management. Choose from:</p> <p>1.Environmental Science, which focuses on the use of the scientific method to investigate chemical, biological, and quantitative aspects of natural systems; or</p> <p>2.Environmental Policy, which focuses on environmental policy development and the economic aspects of natural resource issues.</p>	<p>https://www.olympic.edu/environmental-studies-associate-arts-aa</p>	AA Environmental Studies
Olympic College	<p>Geologists study the structure, composition, and history of the Earth. Their concerns include locating water, fuels, and minerals resources; determining appropriate land usage; and diagnosing natural hazards such as floods, volcanoes, and earthquakes.</p>	<p>https://www.olympic.edu/geology-associate-arts-aa-or-associate-science-track-1</p>	AA/AS Geology

School	Description (quoted from school's program materials)	Web Link	Degree
Olympic College	<p>This degree is intended for students with an interest in transferring to a baccalaureate institution within the State of Washington in one of the targeted disciplines. Typically, the Associate in Arts degree is best suited for transfer to certain baccalaureate institutions. Students should meet early in their matriculation at Olympic College with an academic faculty advisor to determine the degree suitable for them.</p>	<p>https://www.olympic.edu/associate-science-track-1-ast-1</p>	<p>AS Biological Sciences, Environmental/ Resource Sciences/ Earth Sciences</p>
Peninsula College	<p>Designed for students interested in continuing their education in Biological Sciences, Environmental/Resource Sciences, Chemistry, Geology, and Earth Sciences. Designed to fulfill the requirements of four-year degree-granting institutions for transfer with junior standing.</p>	<p>http://pencol.edu/degrees</p>	<p>AS Environmental Science</p>
Peninsula College	<p>The Sustainable Agriculture and Food Systems Short Term Certificate of Completion is designed for both aspiring farmers and community leaders interested in learning how to work in a regional food system in the areas of advocacy, education, production, and nonprofit service. Students who complete the certificate program will gain foundational knowledge and skills to work on a farm or operate their own farm business. The program will also benefit those seeking careers in local and community food systems.</p>	<p>http://pencol.edu/proftech/sustainable-agriculture</p>	<p>Short-Term Certificate of Sustainable Agriculture and Food Systems</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Pierce College at Fort Steilacoom	<p>Biology Transfer I (Pre-professional): This track is recommended if you are interested in pursuing careers or further education in the medical, dental, chiropractic, veterinary, microbiology, botany, environmental science, fisheries, zoology, cell biology or related fields. If you are wishing to prepare for allied health careers, such as nursing, physical therapy, or occupational therapy, see those other pathways in the Healthcare category.</p> <p>•Biology Transfer II (Natural Resources): This is the recommended track if you are interested in the forestry, wildlife, marine biology, environmental studies, and related fields.</p>	https://www.pierce.ctc.edu/biology	AS/ AA Biology
Pierce College at Fort Steilacoom	<p>Explore a wide range of environmental subjects, including water quality, weather and environmental biology, as you earn an associate's degree in environmental science for transfer to a four-year college.</p>	https://www.pierce.ctc.edu/environmental-science	AS/ AA Environmental Science
Pierce College at Fort Steilacoom	<p>Geology includes the study of minerals, rocks, the dynamic processes that shape the Earth's surface over time, the history of life, dinosaurs, and mass extinction events. These include such topics as Earth's tectonics, volcanism, earthquakes, landslides, streams, and coastlines. Topics such as resources or climate change may be included.</p>	http://catalog.pierce.ctc.edu/previous_program.php?catoid=7&pooid=1948&returnto=317	AS Geology

School	Description (quoted from school's program materials)	Web Link	Degree
Seattle Central College	The Sustainable Agriculture Education (SAGe) Emphasis, Associate of Arts (A.A.) or Associate of Science (A.S.) degree integrates the study of food production methods and food systems models for sustainable bioregions. Study and apply an ecological approach to small-scale agriculture from a bioregional perspective while analyzing and evaluating the cultural, political, and economic dynamics that influence the sustainability of food systems.	https://seattlecentral.edu/programs/college-transfer/degrees/sustainable-agriculture	AA/ AS Sustainable Agriculture Education
Seattle Central College	With an Environmental Science background, you can focus on environmental policy, collecting data or monitoring compliance on environmental issues. Some students who major in environmental science work outdoors monitoring water quality, tracking endangered species, introducing children to the natural environment, or advocating for new policies and better enforcement of policies that protect the environment and human health.	https://seattlecentral.edu/programs/college-transfer/college-transfer-programs/stem/environmental-science	AS Environmental Sciences
Shoreline Community College	Designed to meet the first two years of requirements for most science bachelor's degrees, including core science sequences in math, chemistry, biology, and/or physics, the Associate of Science – Transfer, Track 1 (AS-T1) in Shoreline's Natural Sciences Transfer program offers small class sizes in a supportive environment to prepare you for successful transfer to university.	https://www.shoreline.edu/programs/natural-sciences-transfer/environmental-health-pre-major.aspx	AS Environmental Health Pre-Major

School	Description (quoted from school's program materials)	Web Link	Degree
Shoreline Community College	Designed to meet the first two years of requirements for most science bachelor's degrees, including core science sequences in math, chemistry, biology, and/or physics, the Associate of Science – Transfer, Track 1 (AS-T1) in Shoreline's Natural Sciences Transfer program offers small class sizes in a supportive environment to prepare you for successful transfer to university.	https://www.shoreline.edu/programs/natural-sciences-transfer/environmental-sciences-pre-major.aspx	AS Environmental Sciences Pre-Major
Shoreline Community College	Environmental Studies integrates knowledge across the natural sciences, social sciences and the humanities to explore the effects of human activities on the natural world. Students learn to identify environmental problems, analyze causes and develop solutions to promote preservation, sustainability and stewardship of the environment.	https://www.shoreline.edu/programs/general-transfer/environmental-studies-pre-major.aspx	AA Environmental Studies
Shoreline Community College	Master clean energy fundamentals while gaining knowledge of sustainable business practices and entrepreneurship. Learn through practical design projects and hands-on training activities. Study solar electric systems, building science, energy efficiency best practices and more.	https://www.shoreline.edu/programs/clean-energy-technology/clean-energy-technology-and-entrepreneurship-aaas.aspx	AAAS/ Certificate Clean Energy Technology and Entrepreneurship

School	Description (quoted from school's program materials)	Web Link	Degree
Shoreline Community College	Sustainable business is a commitment to ecologically sustainable business practices, such as renewing energy, recycling products, building green, investing green and using our resources efficiently. This short-term certificate in Sustainable Business Leadership focuses on sustainable business practices to include marketing and business strategies that promote green business. Courses compliment other advanced degrees or working professionals interested in sustainable business leadership.	https://www.shoreline.edu/programs/business-administration/sustainable-business-leadership-certificate.aspx	Certificate of Sustainable Business Leadership
Skagit Valley College	Have you always wanted to work in the natural environment? Interested in studying and managing our wildlands, lakes, rivers and coastal waters, managing for parks and recreation lands, or focusing on the impacts caused by urbanization, forestry practices or agriculture? Enroll in SVC's Bachelor of Applied Science in Environmental Conservation program today!	https://www.skagit.edu/academic/areas-of-study/science-technology-engineering-math-stem/environmental-conservation/bas-environmental-conservation/	BAS/AAS/ Certificate Environmental Conservation
Skagit Valley College	Our Sustainable Agriculture program is designed to provide you with knowledge and skills in agro-ecological sciences, natural resource management, and environmental conservation. With an emphasis on 'small farm' agriculture, you will learn how to sustainably manage production and operations as the foundation of a resilient and local food system.	https://www.skagit.edu/academic/areas-of-study/food-beverage-management/sustainable-agriculture-education/	AAS Environmental Sustainable Agriculture Education
South Puget Sound Community College	AS-T Track 1 focuses on chemistry, biology, environmental and natural resource sciences and geology and earth sciences.	https://spscc.edu/areas/science/associate-science-transfer-track-1	AS Track 1

School	Description (quoted from school's program materials)	Web Link	Degree
South Seattle College	<p>Biology is an increasingly complex and exciting field, one that overlays other critical subdisciplines from anatomy, pathology and ecology to chemistry, genetics and botany. Each of these intersects with the study of life and living organisms. And of course, medical and scientific innovation continue to drive biology into new and thrilling directions. This means that your biology education will touch on issues impacting human, animal and plant life far and wide, including subjects like genetic engineering, transhumanism, GMO farming, and global climate change.</p>	<p>https://southseattle.edu/programs/biology</p>	AS Biology Track 1
South Seattle College	<p>Environmental Science scholars ask questions such as: How can colony collapse disorder be prevented? Should genetically modified food be labeled as such? How does intensive farming impact plant biodiversity? Environmental Science uses a multidisciplinary approach to understand the changes in our natural and human environment. During the course of your studies, you'll draw on fundamental scientific knowledge in mathematics, chemistry, physics, and biology coupled with specialization in a particular area of science to provide advanced scientific and quantitative understanding of contemporary environmental challenges.</p>	<p>https://southseattle.edu/programs/environmental-science</p>	AS Environmental Science Track 1

School	Description (quoted from school's program materials)	Web Link	Degree
South Seattle College	Whereas the environmental science pathway is designed for students who want to focus on scientific careers in fields such as pollution abatement, water resources, ecosystem protection, environmental restoration, and environmental management, the environmental studies pathway is broader in focus.	https://southseattle.edu/programs/environmental-studies	AS Environmental Studies Track 1
Spokane Community College	If you are interested in agribusiness and farming, the agriculture business program could be for you. Whether you are looking to expand your career in agriculture to the next level or want training to gain entry-level employment in our region's large agribusiness and farming industries, the program's comprehensive training is designed to prepare you for success.	https://scc.spokane.edu/What-to-Study/The-Natural-World/Agriculture	AAS/ Certificate Agriculture Business/ Technology
Spokane Community College	If you are interested in the world around you and understanding and solving environmental problems, a career in environmental or resource sciences may be right for you. Courses in this discipline will examine varying environmental concepts including the atmosphere, ecology, geology, and environmental chemistry.	https://scc.spokane.edu/What-to-Study/The-Natural-World/Environmental-Resource-Sciences	AS Environmental/ Resource Sciences Track 1

School	Description (quoted from school's program materials)	Web Link	Degree
Spokane Community College	If you enjoy working outside and are passionate about planting, pruning and protecting trees in urban areas, then the arboriculture/urban forestry program is right for you. In this program, you will learn theory and skills in the science of arboriculture. You'll gain hands-on experience identifying, designing, planting, pruning and maintaining trees. You'll also learn how to diagnose pests and problems as well as how to protect the trees and treat for problems.	https://scc.spokane.edu/What-to-Study/The-Natural-World/Arboriculture-Urban-Forestry	AAS Arboriculture/ Urban Forestry
Spokane Community College	In this program, you'll learn to grow and care for landscape plants and vegetables as a horticulture professional. Through both classes and hands-on practice in the greenhouse, you'll study plant propagation, greenhouse construction, climate control, postharvest crop care, and greenhouse business management.	https://scc.spokane.edu/What-to-Study/The-Natural-World/Greenhouse-Nursery	AAS/ Certificate Greenhouse Nursery
Spokane Community College	In this program, you'll prepare for a career in one of three areas: forestry, fish and wildlife management, or parks and recreation. Much of your learning will take place out in nature, where you'll learn skills in timber cruising, forest management, forest insect and disease identification, data sampling techniques, electro fishing, bird identification, GPS\GIS tools and much more.	https://scc.spokane.edu/What-to-Study/The-Natural-World/Natural-Resource-Management	AAS Natural Resources Management

School	Description (quoted from school's program materials)	Web Link	Degree
Spokane Community College	The Associate in Science Transfer (AS-T) Degree #1 is designed to prepare students for upper division study in the areas of biological sciences, environmental/resource sciences, chemistry, geology, and earth science. Completing the AS-T degree will prepare students for upper division study; it does not guarantee students admission to the major. Track 1 degrees offered at SCC and/or SFCC include:	https://scc.spokane.edu/What-to-Study/Transfer-Options	AS Environmental/ Resource Science
Tacoma Community College	Environmental science is the study of the interaction of humans and the physical and biological systems of the earth, and the dependence on natural resources by humans. It involves the study of the interaction and co-evolution of human, physical, and biological systems.	https://www.tacomacc.edu/academics-programs/programs/environmentalscience	AS Environmental Science
Tacoma Community College	Forestry work involves the management and protection of forests and other natural areas, such as wildlife habitats, wetlands and parks. Foresters direct recreational activities and conservation efforts in both public and private forests.	https://www.tacomacc.edu/academics-programs/programs/forestry	AA Forestry
Tacoma Community College	The study of Aquatic and Fisheries Sciences is dedicated to sustaining healthy marine and freshwater environments. It has a wide focus from the organism to the ecosystem scale. We examine human-induced effects on ecosystems, such as habitat change and restoration, climate change and effects of invasive species on marine and freshwater ecosystems.	https://www.tacomacc.edu/academics-programs/programs/aquatic-fisheries-science	AS Aquatic & Fisheries Sciences

School	Description (quoted from school's program materials)	Web Link	Degree
<p>Walla Walla Community College</p>	<p>Agricultural systems science is an interdisciplinary science, which systematically analyzes the interactions between the natural, human, climatic, political and economic components of the agroecosystem. The Agricultural Systems degree at WWCC provides successful students with a broad and complete understanding of these complex interactions. Students will learn to adjust current pathways as well as identify new pathways to minimize the many potential negative effects on environmental, societal and human health. In addition to classes in foundational agricultural knowledge, like that of basic soil, plant and animal science, students will be engaged in topics such as agroecology, policy, technology and sustainability to develop their critical thinking skills.</p>	<p>https://www.wwcc.edu/bas-sas/</p>	<p>BAS Agricultural Systems</p>

School	Description (quoted from school's program materials)	Web Link	Degree
Walla Walla Community College	Agriculture Science combines the fields of biology and chemistry with a practical understanding of crop management. The primary objectives of the program are to offer students technical knowledge in the areas of soils and fertilizers, pests and control procedures, and crop management. These objectives are accomplished with lecture/discussion periods, lab exercises, and field trips to production enterprise areas. Many courses are available for distance learning for students. The Agriculture Science curriculum is reviewed by an advisory committee composed of local and regional industry members and adheres to national and state skill standards.	https://dept.wwcc.edu/agscience/	AAS/ Certificate Agriculture- Plant & Soil Science
Walla Walla Community College	Focuses in: Watershed Management, Water Resources Management & Irrigation Management, Wildlife Ecology & Conservation Science, Environmental & Ecosystem Science, Forestry & Earth Science	http://portal3.wvcc.edu/OCATemplates/DegreeSequence.html?epc=165U	AAS/ Certificate Water Technologies & Management
Walla Walla Community College	There is increased demand for technicians and operators with robust electrical, mechanical, and bio-chemical skills and knowledge. Graduates of the Energy Systems Technology degree program are in high demand by public works, power generation, food & beverage processing, pulp & paper milling, manufacturing, agriculture, irrigation, and renewable energy operations! Focuses in: Precision Agriculture, Renewable Energy, Facilities Energy Management	https://dept.wvcc.edu/energy/department-overview/	AAS Energy Systems Technology

School	Description (quoted from school's program materials)	Web Link	Degree
Wenatchee Valley College	<p>An education grounded in the study of the natural world provides the intellectual skills to make life decisions and is an important reason why natural and physical sciences are part of a liberal arts education.</p> <p>Understanding the natural world is part of being an educated person. The natural and physical sciences teach discipline and organization of knowledge and require each student to learn important critical thinking skills that can be applied in other disciplines and in other aspects of their lives.</p>	https://www.wvc.edu/academics/sciences/index.html	AAS/ AST Natural & Physical Sciences
Wenatchee Valley College	<p>Graduates of this pathway will be able to choose between advanced studies in a four-year natural resources program and a broad range of technical natural resources careers, including seasonal and full-time positions in which they collect natural resources field information. In professional and personal functions, graduates will be able to draw on a basic understanding of aquatic and terrestrial ecosystems, safe and accurate measurement techniques, and the social context of natural resources management.</p>	https://www.wvc.edu/academics/natural-resources/index.html	AAS-T Natural Resources
Wenatchee Valley College	<p>The ATS degree prepares students for employment in agriculture and related fields. The pathways are General Agriculture, Horticulture/Tree Fruit Production, Sustainable and Organic Agriculture, and Agriculture Technology.</p>	https://www.wvc.edu/academics/agriculture/index.html	ATS Agriculture

School	Description (quoted from school's program materials)	Web Link	Degree
Whatcom Community College	An efficient pathway for students to complete the majority of prerequisites for certain science and engineering majors such as atmospheric science, biology, earth sciences, environmental science and geology.	https://www.whatcom.edu/academics/degrees-certificates/associate-degrees	AS
Yakima Valley College	Biology – this program focuses on cellular biology, microbiology, anatomy, physiology, botany, ecology, and evolution.	https://www.yvcc.edu/academics/life-sciences/	AA Biology
Yakima Valley College	The mission of the Agriculture Program is to serve as a partner with the diverse agriculture industry to provide students with the attitudes, abilities, and problem-solving capabilities to meet career responsibilities and lead agriculture into the future.	https://www.yvcc.edu/academics/agriculture/	AAS Agribusiness

Washington State Centers of Excellence

Housed within many of Washington state's community and technical colleges, Washington state's Centers of Excellence provide education targeted at specific economic sectors throughout the state. With a focus on workforce training from an industry and economic development perspective, each center works closely with the state's community and technical colleges, industry businesses, and stakeholders from areas such as government, education, labor, and many others. Centers with programs that are directly supportive of sectors of the green economy represented in this report are listed in the table below.

Center of Excellence	Description (quoted from center's program materials)	Colleges
Center of Excellence Aerospace and Advanced Manufacturing	The Center of Excellence for Aerospace and Advanced Manufacturing provides leadership and resources to support economic growth, focusing on aerospace and advanced manufacturing. Working strategically with our industry partners and educational institutions, we assist in developing the talent pipeline for the next generation of future workers within the aerospace industry sector	Olympic College, Everett Community College, Peninsula College
Agriculture and Natural Resource Center of Excellence	The Agriculture & Natural Resource Center of Excellence (ANR), housed at Walla Walla Community College, enhances the agricultural and natural resource industry in Washington State by supporting programs offered at community and technical colleges—serving 23 of the state's 34 colleges. ANR services ensure the efficient use of resources for workforce development activities and initiatives by nurturing a culture of cooperation within the college system, and is a resource to promote agriculture and natural resource education, expand and strengthen degree/certificate programs, and facilitate professional development for college faculty	Big Bend Community College, Columbia Basin College, Spokane Community College, Walla Walla Community College, Wenatchee Valley College, Yakima Valley Community College
Construction Center of Excellence	The Construction Center of Excellence (CCE) provides statewide leadership in creating a skilled and diverse workforce to meet the needs of the construction industry. With emphasis on equity and access, the CCE partners with stakeholders across the state to support pathways from K-12 to apprenticeship, community and technical colleges and on to 4 year degree options.	Renton Technical College

Center of Excellence	Description (quoted from center's program materials)	Colleges
<p>Center of Excellence for Global Trade and Supply Chain Management</p>	<p>40% of all jobs in Washington State are connected to trade, making this region the most trade-engaged. Washington-based companies like Boeing, Microsoft, Starbucks, Amazon, Chateau St. Michelle, and Eddie Bauer consider supply chain management a key factor in their success. Supply chain management enables them to build and deliver products more competitively...better, faster, and cheaper.</p>	<p>Highline College</p>
<p>NW Center of Excellence for Marine Manufacturing & Technology</p>	<p>The Center supports the growth and development of the marine industries workforce. We do this by engaging in multiple strategies: professional development for industry and faculty; updating skills standards; outreach to underserved and underrepresented communities; conducting research to capture real time data addressing wage and benefit rates, occupational profiles, skill sets, knowledge and education/training/certification/credentialing requirements. The Center stays on top of industry developments such as emerging technologies, materials, best practices, market changes, and trends to develop strategies to meet workforce needs. The Center actively works with industry, association, labor, educational and system partners to do this work.</p>	<p>Skagit Valley College</p>
<p>Pacific Northwest Center of Excellence for Clean Energy</p>	<p>The Center is a statewide resource that represents the interests of the energy industry, and our labor partners, within the Washington State Community and Technical Colleges system. We exist to narrow the gap between employers' demands for a highly skilled workforce and the colleges' ability to supply work-ready graduates. We convene industry and labor to help drive workforce development initiatives – and coordinate community college resources after industry and labor set the direction.</p>	<p>Centralia College</p>

Appendix D: Higher Education Research and Development

This is an inventory of higher education research resources within Washington's two public doctoral research universities to foster green economic development in energy, water, agriculture and forestry. Table 1 contains research programs within the University of Washington, and Table 2 contains research programs within Washington State University. Research conducted in these sectors at Washington state's public university graduate and undergraduate university programs is reflected in Appendices A and B on higher education development and workforce training.

Table 1: University of Washington

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Boeing Advanced Research Center (BARC)	Improve manufacturing and assembly of aircraft and spacecraft structures through collaborative basic and applied research and education-related activities.	https://depts.washington.edu/barc/	Boeing
Center for Advanced Materials in Transport Aircraft Structures (AMTAS)	The mission of the Center for Advanced Materials in Transport Aircraft Structures (AMTAS) is to lead the aviation community by researching new ideas in advanced materials, educating and training aviation professionals, and facilitating knowledge transfer among industry, government, and academia.	http://depts.washington.edu/amtas/	Washington State University; Oregon State University; Edmonds Community College; Florida International University; University of Utah
Center for Conservation Biology	Using innovative research, education and public outreach to address human impacts on threatened and endangered species around the world.	http://www.conervationbiology.uw.edu/	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Center for Ecosystem Sentinels	<p>The Center for Ecosystem Sentinels is the umbrella organization for The Magellanic and Galápagos Penguin Projects, iGalapagos.org, iArgentina.org, and student research and education programs. The Center works to understand what sentinel species are telling us, protect their environment, and inspire others to take action. We train the next generation of scientists and make a positive contribution to sentinel species and their habitats through field studies, long-term datasets, scientific publications, persuasive communication of conservation science to the general public, mentorship of early-career scientists, and use of science to inform the public and guide policy.</p>	<p>https://ecosystemsentinels.org/</p>	<p>see website for supporters</p>
Center for Education and Research in Construction (CERC)	<p>The Center for Education and Research in Construction (CERC) is the locus of research, scholarship, and discovery at the UW's Department of Construction Management (CM). CERC's Leadership and Operation Team is responsible for the development and implementation of the Center to meet the needs of the CM faculty, students and the Center's many industry partners.</p>	<p>http://cerc.be.uw.edu/</p>	<p>see website for past and ongoing partnerships</p>
Center for Global Field Study	<p>The mission of the Center for Global Field Study is to facilitate and provide field-based research, training, and outreach education opportunities for students and professionals from the University of Washington and partnering institutions around the world in areas relating to environmental and global health – at the human-environment interface.</p>	<p>http://depts.washington.edu/cgfs/</p>	<p>Michigan State University; Central Oregon Community College; College of Coastal Georgia; One Earth Institute; Trinity University; +various international institutions</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Center for Health and the Global Environment (CHanGE)</p>	<p>CHanGE collaboratively develops and promotes innovative approaches to understanding and managing the risks of global environmental change. CHANGE conducts research and policy analysis, education and training, and technical assistance and capacity building, integrating health, environmental, and social sciences. CHANGE focuses on health outcomes associated with the consequences of global environmental changes, such as extreme weather and climate events, water and food security, and infectious diseases.</p>	<p>http://globalchange.uw.edu/</p>	
<p>Center for Integrated Design</p>	<p>The University of Washington Center for Integrated Design (CID) promotes a healthy, energy efficient built environment through research, education and outreach initiatives. Located at the Bullitt Center in Seattle, WA, the Center serves as a hub for interdisciplinary research teams to collaborate, share resources and improve knowledge on high performance building design. The Center is composed of the Integrated Design Lab (research, technical assistance, and outreach) and the Carbon Leadership Forum.</p>	<p>http://cid.be.uw.edu/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Center for Intelligent Materials and Systems (CIMS)</p>	<p>Center for Intelligent Materials and Systems (CIMS) was established in 2000 by a group of faculty in the College of Engineering and the Department of Botany with an aim of accelerating the research and educational program in the area of design of actuator materials, actuators and bio-inspired design of intelligent materials and systems. The goals of CIMS are multi-fold, (1) design a series of actuator materials and their devices, (2) learn intelligent sensor and actuation mechanism inherent in biological species, thus inspiring our brains while the bio-inspired knowledge will be transferred to designing man-made materials and systems, and (3) our research subjects and products remain to be compatible with healthy functions of surrounding natural environment.</p>	<p>http://depts.washington.edu/cims/</p>	
<p>Center for International Trade in Forest Products (CINTRAFOR)</p>	<p>CINTRAFOR helps forest products exports by: Collecting & distributing information on rapidly changing foreign markets, including consumption trends, distribution channels, trading systems, codes/standards & the regulatory environment. Applying research findings to technical, environmental, economic, social & resource management problems that impede exports of specific products Training forest products professionals by providing funding for graduate level research on the international trade of forest products.</p>	<p>http://www.cintrafor.org/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Center for Preservation and Adaptive Reuse (CPAR)</p>	<p>The Center for Preservation and Adaptive Reuse (CPAR), in the College of Built Environments at the University of Washington, seeks to support innovative interdisciplinary research, advocacy and education of our existing, historic and culturally rich built environments. Realizing that preserving and adapting our built fabric is both socially and environmentally sustainable, the center seeks to find new, innovative and collaborative methods to address how we can preserve and reuse our diverse built environments for more vibrant cities, towns and landscapes.</p>	<p>http://centerforpreservationandadaptiveuse.org/</p>	<p>Historic Seattle; Washington Trust for Historic Preservation; National Trust for Historic Preservation; 4Culture</p>
<p>Center for Studies in Demography and Ecology</p>	<p>The Center for Studies in Demography and Ecology (CSDE) supports population research and training at the University of Washington. It also functions as a regional center that gives population scientists at affiliated institutions in the Pacific Northwest access to cutting-edge demographic infrastructure and services.</p>	<p>http://csde.washington.edu/</p>	<p>Battelle; Bill and Melinda Gates Foundation; Portland State University; Seattle Pacific University; Seattle University; Simon Fraser University; University of Victoria; Washington State University; Western Washington University</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Center for Sustainable Forestry at Pack Forest	The mission of the Center for Sustainable Forestry at Pack Forest is to actively advance the concept and practice of sustainability and to engage students, scientists, professionals, policy makers, and community members through research, demonstration, service, and continuing education and outreach in natural resources and environmental science and management. The Center seeks to identify the boundaries of sustainable forest ecosystems that include extraction of forest products, while maintaining ecosystem integrity.	http://www.packforest.org/	
Center for Urban Horticulture (UW Botanic Gardens)	Sustaining managed to natural ecosystems – and the human spirit – through plant research, display, and education.	http://depts.washington.edu/uwbg/	Washington State University
Center for Urban Waters	The Center for Urban Waters is highly collaborative university-led applied science program dedicated to finding globally-applicable solutions to urban water quality problems in the Pacific Northwest. The center provides an intellectual environment where people with a diverse mix of skills can collaborate to develop innovative approaches to environmental restoration and protection and to sustainable urban development.	http://www.tacomauw.edu/cuw	City of Tacoma; Puget Sound Partnership; Port of Tacoma; Puyallup Tribal Fisheries; RAIN Incubator; Stormwater COI

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Clean Energy Institute (CEI)	<p>The Clean Energy Institute (CEI) at the University of Washington was founded in 2013 with funds from the state of Washington. Its mission is to accelerate the adoption of a scalable clean energy future that will improve the health and economy of our state, nation, and world.</p> <p>To accomplish this mission, CEI supports the advancement of next-generation solar energy and battery materials and devices, as well as their integration with systems and the grid. The institute creates the ideas and educates the people needed to generate these innovations, while facilitating the pathways to bring them to market.</p>	<p>https://www.cei.washington.edu/about/</p>	
Climate Impacts Group	<p>The Climate Impacts Group supports the development of climate resilience by advancing understanding and awareness of climate risks, and working closely with public and private entities to apply this information as they act to shape society's future. We develop and deliver scientific information that is both useful to and used by the decision making community by fully integrating research with stakeholder engagement.</p>	<p>https://cig.uw.edu/</p>	<p>City of Tacoma; Puget Sound Partnership; Port of Tacoma; Puyallup Tribal Fisheries; RAIN Incubator; Stormwater COI</p>
Columbia Basin Research	<p>Columbia Basin Research (CBR) is an interdisciplinary research center under the joint leadership of James Anderson, Research Professor, and John Skalski, Professor of Biological Statistics. They provide quantitative approaches to issues involving endangered salmonid stocks in the Columbia River Basin.</p>	<p>http://www.cbr.washington.edu/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Design Machine Group	<p>The Design Machine Group (DMG) is a collaborative research group. Its mission is to explore and facilitate development of a new generation of design software, application of simulation, analysis, and fabrication processes in the design process, and utilization of digital technologies to create smart environments. Students from many disciplinary backgrounds join our faculty to pursue research in areas that include design methods, simulation and analysis, collaboration and community, digital fabrication, human computer interfaces for design, smart environments, augmented and virtual reality and other related topics.</p>	<p>http://dmg.be.washington.edu/</p>	
eScience Institute	<p>The mission of the eScience Institute is to support data-driven discovery in all fields – to ensure that UW is a leader in advancing the techniques and technologies of data-driven discovery, and in making them accessible to researchers across the campus.</p>	<p>http://escience.washington.edu/</p>	<p>Cascadia Data Alliance; West Big Data Innovation Hub; MetroLab Network; Moore - Sloan Data Science Environments; University of California - Berkeley; New York University; Bill & Melinda Gates Foundation; International Neuroinformatics Coordinating Facility; Institute of Translational Health Sciences; Cascadia Urban Analytics Cooperative</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Friday Harbor Laboratories	<p>Friday Harbor Laboratories (FHL) is a research center in the College of the Environment with a mission of Marine research, teaching and outreach. FHL is world renowned for research on marine biology, oceanography and fisheries. The waters around San Juan Island are relatively free from pollution with swift tideways as well as quiet bays and lagoons. A tidal range of about three meters exposes diverse intertidal areas of rock, sand and mud. The flora and fauna are exceptionally rich. Representatives of nearly all major groups of marine algae, invertebrates and fish can be collected at the shore and depths down to 300 meters can be explored by dredging and other collecting techniques. The 490-acre tract of land on which the Laboratories are located, and the marine waters of the region are biological preserves. The Laboratories also manage other nearby biological preserves, also rich with diverse flora and fauna.</p>	<p>https://fhl.uw.edu/</p>	
Green Futures Lab	<p>The Green Futures Lab works with the University of Washington, local communities and international partners to provide education and collaboration that promotes application and development of urban green infrastructure.</p>	<p>http://greenfutures.washington.edu/</p>	<p>see website for professional affiliates, partners, sponsors, and funders</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Institute for Hazard Mitigation Planning and Research</p>	<p>Institute for Hazards Mitigation Planning and Research is an interdisciplinary academic Institute housed in the College of Built Environments. We are dedicated to exploring ways to enhance Community Resilience. Our faculty and researchers are involved in numerous innovative and path-breaking research initiatives with the ultimate goal of enhancing community capacity to anticipate, respond to, cope with, and recover from natural and man-made hazard events.</p>	<p>http://mitigate.be.uw.edu/</p>	<p>Hazard Reduction and Recovery Center; Center for Texas Beaches and Shores; Institute for Sustainability; Texas A&M University; University of Hawaii; FEMA</p>
<p>Integrated Design Lab</p>	<p>The Integrated Design Lab's mission is to provide regional design teams access to the best building-performance knowledge available, project-by-project support, and education and training on how to design, construct and operate the healthiest, most productive and energy efficient buildings in North America.</p>	<p>http://idlseattle.com/</p>	<p>Seattle City Light; Puget Sound Energy; AIA National; AIA Seattle; City of Seattle - Office of Sustainability and Environment; National Science Foundation; U.S. Department of Energy; Bullitt Foundation</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Joint Center for Aerospace Technology Innovation (JCATI)</p>	<p>The Joint Center for Aerospace Technology Innovation (JCATI) was established in 2012 to support the aerospace industry in Washington State by:</p> <ul style="list-style-type: none"> pursuing joint industry-university research in new technologies that are relevant to aerospace firms; providing aerospace industry-focused research opportunities for engineering and computer science students at the University of Washington, Washington State University, and Washington's other public four-year institutions of higher education, through assisting the development of internship programs and undergraduate and graduate student research opportunities that give students hands-on experience with aerospace firms; and in concert with aerospace firms and aerospace industry associations, identifying research needs and opportunities for technology transfer that benefit the State's aerospace industry. 	<p>https://jcati.org/</p>	<p>see website for JCATI funded research at Washington's four-year institutions of higher education</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Joint Institute for the Study of the Atmosphere and Ocean (JISAO)</p>	<p>The Joint Institute for the Study of the Atmosphere and Ocean (JISAO) is a collaborative research institute between the University of Washington and the National Oceanic and Atmospheric Administration (NOAA). Its mission is two-fold: To conduct multi- and interdisciplinary research in atmospheric, oceanic, and fishery sciences, and on impacts and policy that provides understanding of climate and ecosystem interactions, the way in which these interactions are affected by natural variability and anthropogenic perturbations, and the consequences for natural systems and human society. To participate in the education both of a new generation of students who are environmentally literate, understand the interlocking complexity of environmental problems, and are trained in solution methods, and of the citizenry of the Pacific Northwest and the nation to enable them to understand the competing demands of environmental and societal health and resource and economic sustainability.</p>	<p>https://jisao.uw.edu/</p>	<p>National Oceanic and Atmospheric Administration</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Molecular Engineering and Sciences Institute	<p>The Molecular Engineering & Sciences Institute (MoES) was founded in 2011 to bring together faculty teams from across the University of Washington campus. MoES catalyzes cross-cutting, translational research in the areas of Biotech and Clean Tech by serving as an intellectual accelerator and physical incubator. Through the Institute, researchers from different disciplines have opportunities to come together in a shared space, interact, exchange ideas and form collaborations resulting in new ideas to address complex societal challenges.</p>	<p>https://www.moes.washington.edu/</p>	<p>University of Queensland; Japan's National Institute for Materials Science</p>
Northwest Center for Livable Communities	<p>Recognizing a fundamental web linking peoples' quality of life to ecology, long-term economic vitality and affordable housing, social vibrancy, diverse transportation options, and a coherent and integrated built environment, the Northwest Center for Livable Communities seeks to promote awareness of these connections and affect the creation of more livable communities through applied research and community initiatives.</p>	<p>http://depts.washington.edu/nwclc/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Olympic Natural Resources Center</p>	<p>Our mission is to develop widely applicable methods and systems to revitalize the environment and rural communities, by connecting and integrating people with the forests, rivers, and coastlines of Washington that local and state residents love and depend on. The Olympic Peninsula, and the Olympic Experimental State Forest in particular, provide a natural laboratory for developing this human-ecosystem perspective. The new goal is to develop optimal levels of ecosystem wellbeing that can be sustained through time through community engagement and field studies and experiments that evaluate innovative win-wins for both community and environment wellbeing. The Olympic Natural Resources Center is located on the Olympic Peninsula in Forks, Washington.</p>	<p>http://www.onrc.washington.edu/</p>	<p>Olympic Forest Collaborative</p>
<p>Pacific Marine Energy Center</p>	<p>Our mission is to facilitate the responsible commercialization of marine energy technologies, inform regulatory and policy decisions, and close key gaps in scientific understanding with a focus on student growth and development. We work closely with a variety of stakeholders, including marine energy technology developers, community members, ocean users, federal and state regulators, and government officials to conduct research on wave, current, and off-shore wind energy conversion.</p>	<p>http://depts.washington.edu/pmec</p>	<p>University of Alaska – Fairbanks; Oregon State University</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Pacific Northwest Agricultural Safety and Health Center	The Pacific Northwest Agricultural Safety and Health Center conducts research and promotes best safety and health practices for producers and workers in farming, fishing, and forestry.	https://deohs.washington.edu/pnash	
Pacific Northwest Cooperative Ecosystems Studies Unit (CESU)	The Pacific Northwest Cooperative Ecosystems Studies Unit (PNW CESU) is a cooperative venture between 17 leading academic institutions in the Pacific Northwest region, one state agency and ten federal land management and natural resource research organizations. The University of Washington serves as host to the PNW CESU. To date the United States had been divided into 17 biogeographic regions, each served by a distinct CESU, with all regions connected in one national network. The overarching goal of the CESU network is to improve the scientific base for managing federal lands by providing resource managers with high-quality scientific research, technical assistance, and education. Since beginning in October 2000, over 450 projects have been funded through the PNW CESU Cooperative Agreement.	https://depts.washington.edu/pnwcesu/	see website for partner academic institutions, agencies, NGOs, and non-profits

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>Pacific Northwest Transportation Consortium (PacTrans)</p>	<p>Pacific Northwest Transportation Consortium (PacTrans) at the University of Washington is a Regional University Transportation Center (UTC) administered by the United States Department of Transportation (USDOT) through its Research and Innovative Technology Administration (RITA). PacTrans focuses on developing data-driven solutions for the diverse mobility needs of people, goods, and data, in the Pacific Northwest.</p>	<p>http://www.pactrans.org/</p>	<p>Oregon State University; University of Alaska – Fairbanks; University of Idaho; Washington State University; Boise State University; Gonzaga University</p>
<p>Polar Science Center</p>	<p>The Polar Science Center (PSC) is a unit of the Applied Physics Laboratory at the University of Washington. Polar Science Center researchers observe and model the physical processes that control the nature and distribution of sea ice and polar ice sheets, the structure and movement of high-latitude oceans, and the interactions between air, sea, ice and biota. The Center has made major contributions to the understanding of how the arctic system has undergone important changes during the past four decades.</p>	<p>http://psc.apl.washington.edu/</p>	<p>see website of affiliate scientists</p>
<p>Precision Forestry Cooperative</p>	<p>To develop advanced technology solutions to improve the quality & reliability of information needed for planning, implementation, & monitoring of natural resource management, to ensure sustainable forest management.</p>	<p>http://sites.uw.edu/uwpfc</p>	<p>USDA Forest Service – PNW Station; see website for advisory board</p>
<p>Program on Climate Change</p>	<p>Help society tackle climate change by providing a framework of intense cross-disciplinary collaboration that furthers research and education in climate science.</p>	<p>https://pcc.uw.edu/</p>	<p>National Oceanic and Atmospheric Administration</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Puget Sound Institute	<p>At the University of Washington Puget Sound Institute (PSI), our goal is to provide Puget Sound policymakers with relevant and timely analysis of the best and latest findings from the science community, allowing often-difficult choices to stand on solid, vetted science.</p> <p>Since its founding in 2010, PSI has advanced our understanding of Puget Sound through synthesis, original research and communication in support of state and federal agencies, tribes and other organizations. PSI receives major funding from the U.S. Environmental Protection Agency.</p>	<p>https://www.puget-soundinstitute.org/</p>	USEPA
Quaternary Research Center	<p>The 50-year-old QRC is a community of scholars collaborating and fostering interdisciplinary environmental research at the University of Washington through strategic investments in seed grants, expeditions, seminars, workshops, and the publication of the journal, Quaternary Research.</p>	<p>http://depts.washington.edu/qrc/</p>	
School of Aquatic and Fishery Sciences (SAFS)	<p>Founded in 1919, the School of Aquatic and Fishery Sciences (SAFS) is dedicated to sustaining healthy marine and freshwater environments. Our faculty conduct innovative research from the organism to the ecosystem scale and are recognized leaders in aquatic biology, sustainable fisheries management, aquatic resource conservation, and resource management. We study natural systems and species and present solutions to foster the sustainable use of aquatic resources.</p>	<p>https://fish.uw.edu/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Stand Management Cooperative (SMC)	The mission of the Stand Management Cooperative (SMC) is to provide a continuing source of high quality information on the long-term effects of silvicultural treatments and treatment regimes on stand and tree growth and development of wood and product quality.	http://apps.sefs.uw.edu/research.smc/	B.C. Ministry of Forests; FP Innovations FORINTECK; NW Tree Improvement Co-op; Oregon State University; University of British Columbia; U.S. Forest Service Pacific Northwest; +multiple land managing organizations, suppliers, and analytical organizations
Superfund Research Program	The mission of the Superfund Basic Research Program is to characterize human health and ecological risks associated with neurotoxic chemicals that occur at Superfund hazardous waste sites, and to develop methods to remediate exposures to these agents.	http://deohs.washington.edu/srp/	see website for external advisory committee
Supply Chain and Transportation Logistics Center	The Supply Chain Transportation & Logistics Center is a world leader in supply chain, transportation, and logistics research and education serving the powerful nexus of industry, transportation infrastructure agencies, and policy makers. The Center integrates in-depth consultation with industry and the public sector, transformative research, and executive education.	https://depts.washington.edu/sctlctr/node/1	see website for advisory board and research project funders and partners

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Urban Ecology Research Laboratory	<p>The Urban Ecology Research Laboratory (UERL) is directed by Professor Marina Alberti, and includes interdisciplinary PhD students, post-doctoral research associates, research scientists, and affiliate faculty from diverse disciplines who collaborate to study coupled human-natural systems. As part of the University of Washington's innovative leadership in urban ecology research and education, the UERL transcends traditional disciplinary boundaries to address some of society's most challenging problems.</p>	<p>http://www.urbane.co.washington.edu/</p>	
Urban Form Lab	<p>Urban Form Lab research aims to affect policy and to support approaches to the design and planning of more livable environments. The UFL specializes in geospatial analyses of the built environment using multiple micro-scale data in Geographic Information Systems (GIS). Current research includes the development of novel GIS routines for performing spatial inventories and analyses of the built environment, and of spatially explicit sampling techniques. Projects address such topics as land monitoring, neighborhood and street design, active transportation, non-motorized transportation safety, physical activity, and access to food environments.</p>	<p>http://depts.washington.edu/ufl/</p>	<p>Kaiser Permanente Washington Health Research Institute; University of Oklahoma; Washington State University</p>
Urban@UW	<p>Urban@UW connects people across disciplines and sectors to work together to build and steward future cities. We seek to improve the sustainability, resilience, justice, and the human and environmental health and wellbeing of cities.</p>	<p>https://depts.washington.edu/urbanuw/</p>	<p>Association of Washington Cities; City of Seattle; Microsoft; MacArthur Foundation</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
<p>UW Molecular Engineering Materials Center (UW MEM-C)</p>	<p>The UW Molecular Engineering Materials Center (MEM-C) is integrating cutting-edge collaborative materials research with training, education, diversity, outreach, and knowledge/technology transfer to accelerate the development of future energy conversion, information processing, and sensing technologies, enhance the scientific experiences of trainees and senior investigators alike, and inspire STEM engagement in the broader community. MEM-C's research program comprises two synergistic Interdisciplinary Research Groups (IRGs) that share the common goal of engineering complex photoactive electronic materials but take very different approaches.</p>	<p>http://www.mem-c.washington.edu/</p>	<p>Pacific Northwest National Laboratory</p>
<p>Washington Cooperative Fish and Wildlife Research Unit</p>	<p>The Washington Cooperative Fish and Wildlife Research Unit (WACFWRU) is one of 40 comparable units within the United States established to facilitate cooperation between the Federal Government, colleges and universities, the states, and private organizations in improving the management of the nation's fish and wildlife resources. Units accomplish this by conducting natural resource management research, educating persons to intelligently manage natural resources, and providing research findings to individuals or agencies that put this information to practical use.</p>	<p>https://depts.washington.edu/wacfwru/</p>	<p>U.S. Geological Survey; U.S. Fish and Wildlife Service; Washington State University; Washington Department of Ecology; Washington Department of Fish and Wildlife; Washington Department of Natural Resources; Wildlife Management Institute</p>

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Washington Sea Grant Program	Washington Sea Grant serves communities, industries and the people of Washington state, the Pacific Northwest and the nation through research, education and outreach by: Identifying and addressing important marine issues; Providing better tools for management of the marine environment and use of its resources; and Initiating and supporting strategic partnerships within the marine community.	http://www.wsg.washington.edu/	National Oceanic and Atmospheric Administration; see website for advisory committee
Washington State Transportation Center (TRAC)	Coordinates transportation research efforts – both state and commercial, public and private – and develops research opportunities both nationally and locally	http://depts.washington.edu/trac/	Washington State University; Washington State Department of Transportation
Western Regional Aquaculture Center (WRAC)	The mission of the Western Regional Aquaculture Center (WRAC) is to support aquaculture research, development, demonstration, and education to enhance viable and profitable U.S. aquaculture production for the benefit of consumers, producers, service industries, and the American economy.	http://depts.washington.edu/wracuw/	United States Department of Agriculture; see website for participating universities from Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming

Table 2: Washington State University

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Bioproducts, Sciences, and Engineering Laboratory (BSEL)	The Bioproducts, Sciences, and Engineering Laboratory (BSEL) provides space for critical research to advance research in identifying useful non-energy products that can be used to promote energy sustainability.	https://tricitie.wsu.edu/research/bsel/	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Center for Bioplastics and Biocomposites	The Center for Bioplastics and Biocomposites is bringing together university researchers and industry members to push the boundaries of renewable resources and establish new revenue creating processes and products. The center will focus on developing high-value biobased products from agricultural feedstocks.	http://www.cb2.iastate.edu/	Iowa State University
Center for Environmental Research, Education, and Outreach (CEREO)	The Center for Environmental Research, Education, and Outreach (CEREO) is a progressive network of more than 350 faculty, staff, students, and industry leaders working to resolve environmental issues through collaborative partnerships. Guided by a roster of distinguished scientists, CEREO seeks to apply innovative technologies and management tools to the ever-growing challenges of global climate change and environmental sustainability.	https://cereow.su.edu/	
Center for Precision and Automated Agricultural Systems (CPAAS)	Our mission is to develop a world preeminent and Washington relevant research and educational program in the areas of agricultural automation and precision farming, providing a venue for: (1) High impact research outcomes for our stakeholders (2) True trans-disciplinary collaboration within Washington State University and world-wide stake-holders (3) High quality educational and research experiences for our students (4) The incubation and development of new ideas relevant in an entrepreneurial climate	http://cpaas.wsu.edu/	
Center for Sustaining Agriculture and Natural Resources (CSANR)	CSANR leads efforts in sustainable agriculture, food, and natural resource systems that are economically viable, environmentally sound, and socially responsible.	http://csanr.wsu.edu/	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Center of Excellence for Alternative Jet Fuels and Environment (ASCENT)	ASCENT works to create science-based solutions for the aviation industry's biggest challenges. A coalition of 16 leading US research universities and over 60 private sector stakeholders committed to reducing the environmental impact of aviation, ASCENT also works in partnership with international research programs, federal agencies and national laboratories to create an all-inclusive research capability for whatever environmental impact obstacle the aviation industry faces.	https://ascent.aero/	See website for coalition universities
Claudio Stockle	WSU Lead for multi-state team working on agriculture and AI	stockle@wsu.edu	
College of Agricultural, Human, and Natural Resource Sciences	CAHNRS discovers, develops, and transfers knowledge that contributes to a safe and abundant food supply; promotes sustainability of agricultural and economic systems; supports energy innovations; encourages careful stewardship of natural resources and ecological systems; and enhances the well-being of individuals, families, and communities.	https://cahnrs.wsu.edu/	
Composite Materials & Engineering Center (CMEC)	Scientists at the Composite Materials & Engineering Center (CMEC) develop new building materials and fuels from a range of recycled and virgin resources. They also design structural systems that utilize the new materials effectively. Rigorous structural testing ensures that innovations are efficient, economically viable, and safe.	https://cmec.wsu.edu/	
Energy Systems Innovation Center	Research, education, and outreach to solve challenges for modern power systems.	https://esic.wsu.edu/	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Food Systems Program	<p>The Washington State University Food Systems Program delivers multidisciplinary expertise across academic, research, and extension, providing specialized resources for farmers and food systems contributors. We seek to work with communities throughout the state to foster viable farm businesses, optimize sustainable natural resource stewardship, and to promote scaled processing and distribution, always in the pursuit of access to healthy food for all.</p>	<p>https://foodsystems.wsu.edu/</p>	
Freight Policy Transportation Institute	<p>The following are key goals and objectives for the Freight Policy Transportation Institute: Improve understanding of the importance of efficient and effective freight transportation to both the regional and national economy Address the need for improved intermodal freight transportation, as well as policies and actions that can be implemented to lower operating costs, increase safety and lower environmental impacts of freight transportation nationwide Improve freight transportation performance to specific industries and sectors of the economy</p>	<p>http://ses.wsu.edu/fpti</p>	
IMPACT Center	<p>The IMPACT Center, located in the School of Economic Sciences at Washington State University, seeks to address economic, social, political, and technical problems that affect the competitiveness of Washington's agriculture and related sectors. Being positioned in a major land grant university enables IMPACT to draw on expertise and knowledge from an array of researchers in a wide range of fields.</p>	<p>http://ses.wsu.edu/impact-center/</p>	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Laboratory for Advanced & Sustainable Cementitious Materials (ASCM)	Developing "greener" pervious concretes made from recycled materials and nano-/micro-sized materials	https://sites.google.com/site/greensmartinfrastructure/laboratory-of-advanced-sustainable-cementitious-materials	University of Alaska – Fairbanks; Airport Cooperative Research Program; American Coal Ash Association Educational Foundation; Washington State Department of Transportation; Simpson Strong-Tie, Inc.
Laboratory for Atmospheric Research (LAR)	Conducting air quality research, emphasizing biosphere/atmosphere interactions and regional air quality measurements and modeling	http://www.lar.wsu.edu/	University of Michigan; Massachusetts Institute of Technology; University of New Hampshire; Montana Institute of Technology; University of Washington; Purdue University; Aerodyne Research, Inc.; National Center for Atmospheric Research
Low Impact Development Program	The mission of the WSU Puyallup Low Impact Development (LID) Research Program is to reduce the impacts of stormwater on streams, lakes, wetlands, coastal areas and food through effective, research-based application of LID principles. These approaches are part of a larger suite of land and water management tools. We also provide education and outreach to the community on sustainable stormwater practices.	https://www.wastormwatercenter.org/low-impact/	
Multi-Scale Land Surface Hydrology Hydro Lab	Conducts research on the connections between climate, hydrology, land use, and ecological (natural and agricultural) processes	https://labs.wsu.edu/hydro/	

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
Northwest advanced renewables alliance (NARA)	This was a USDA research project on aviation biofuels and co-products that has now ended. Final research products and reports are available at WSU Research Exchange site	https://nararenewables.org/ https://research.libraries.wsu.edu/xmlui/handle/2376/5309	Oregon State University; Thomas Spink Inc.; University of Washington; Weyerhaeuser; Pennsylvania State University; Western Washington University
Office of Clean Technology	Strives to highlight WSU's broad research portfolio that addresses the issues around of air and water quality, biofuel and bioproducts development, advanced materials, sustainable infrastructure design, precision agriculture, and smart grid.	https://cleantech.wsu.edu/	
School of Design and Construction	The School of Design and Construction (SDC) is committed to a transformative integrated design and construction education that spans across the professional disciplines.	https://sdc.wsu.edu/	
School of Mechanical and Materials Engineering	MME has research activities in additive manufacturing; materials engineering with applications spanning over nuclear materials, bio-implants and microelectronics, among others; control systems; energy systems including batteries, fuel cells and hydrogen power for space-flight; sports engineering; and mechanics and thermo-fluid applications in traditional and emerging areas.	https://mme.wsu.edu/	
Smart Grid Demonstration and Research Investigation Lab	Develop power system operation and control algorithms utilizing smart grid data and real time validation of these developed algorithms	https://sgdril.eecs.wsu.edu/	
Soil Health Initiative	CSANR project that funds research, extension, and demonstration of soil health best management practices through a network of long-term agroecological research and extension (LTARE) sites across Washington state's diverse agricultural systems.	http://csanr.wsu.edu/program-areas/soil-health-initiative/	see website for citizen advisory committee

Center, Institute, Lab, or Faculty Member	Description (quoted from school's program materials)	Web Link	Joint Partnerships
State of Washington Water Research Center (WRC)	<p>The WRC has a threefold mission: To oversee and conduct applied water-related research To foster the education and training of our Nation's future water professionals To serve as a nexus within the academic community by transferring research results to those who manage or use the Nation's water resources</p>	https://wrc.wsu.edu/	<p>see website for partner organizations and research collaborators</p>
Washington Oilseed Cropping Systems Project (WOCS)	<p>An internal grant program / teams in CAHNRS that, in partnership with the Washington State Department of Agriculture, is committed to supporting the grower and industry-based movement to diversify cropping system agronomics and markets through increased adoption and production of oilseed crops.</p>	http://css.wsu.edu/oilseeds/	<p>see website for WOCS Team collaborators and affiliates</p>
Washington Stormwater Center	<p>We provide stormwater leadership through research, training, and education.</p>	https://www.wastormwatercenter.org/	<p>University of Washington</p>
WSU Applied Bioenergy Research Program ("Appendix A")	<p>Internal grant program / teams in CAHNRS targeting applied bioenergy research.</p>	https://cahnrs.wsu.edu/research/grant-resources/internal-competitive-grants/applied-bioenergy-research-program-appx-a/	<p>Washington State Department of Agriculture</p>
WSU-PNNL: Advance Grid Institute	<p>Create and implement a national-scale simulation platform and data framework to enable advanced grid controls and operations for complex power systems of the future.</p>	https://natlab.wsu.edu/grid/	<p>Pacific Northwest National Laboratory</p>
WSU-PNNL: Bioproducts Institute	<p>Leverage cutting-edge science, engineering, and analysis to transform engineered plants and industrial, agricultural and municipal waste into valuable materials and chemicals, and develop a pipeline of talent to meet future workforce needs.</p>	https://natlab.wsu.edu/bioproducts/	<p>Pacific Northwest National Laboratory</p>

Table 3: Pacific Northwest National Laboratory

Center, Institute, Lab, or Faculty Member	Description	Web Link	Joint Partnerships
Energy Sciences Capability	The facility will offer a collection of state-of-the-art research instrumentation to support fundamental research in chemistry, materials science, and computational science and collaboration with academic partners. (Coming 2021)	https://www.pnnl.gov/energy-sciences-capability-project	UW, WSU, and other partner universities
Environmental Molecular Sciences Laboratory	A national scientific user facility funded by the U.S. Department of Energy with a diverse range of instrumentation made available to researchers through a peer review process.	https://www.pnnl.gov/environmental-molecular-sciences-laboratory	Academic researchers may apply
Marine Sciences Laboratory	Marine-based research and underwater testbed focused on helping the nation achieve coastal resilience and sustainable energy for coastal and maritime applications.	https://www.pnnl.gov/marine-sciences-laboratory	UW, PMEC, and other collaborators
Energy Infrastructure Operations Center	An interactive utility control room and platform for researching, developing, and testing technologies to improve grid operations and cybersecurity.	https://www.pnnl.gov/electricity-infrastructure-operations-center	
Grid Storage Launchpad	The DOE's Office of Electricity has selected PNNL as the site for a new, national grid energy storage R&D facility to accelerate the development of the next generation of grid energy storage technologies. (Coming 2023)	https://www.pnnl.gov/grid-storage-launchpad-pnnl	
Building Operations Control Center	Enables researchers and operations staff to connect to intelligent infrastructure from the smart grid, allowing access to extensive data from PNNL campus buildings, systems, and components.	https://www.pnnl.gov/building-operations-control-center	

Center, Institute, Lab, or Faculty Member	Description	Web Link	Joint Partnerships
Connected Lighting Testbed	This research facility, in Portland, OR, is used to study and advance energy-efficient connected lighting systems.	https://www.pnnl.gov/connected-lighting-test-bed	
Systems Engineering Building	A unique laboratory space with equipment to advance research in electricity markets, generation, transmission, distribution, and end use, including buildings-grid integration.	https://www.pnnl.gov/systems-engineering-building	
Bioproducts, Sciences, and Engineering Laboratory	Located at Washington State University Tri-Cities, this facility is devoted to the science and engineering of deriving energy from agricultural and forest residues, municipal and industrial waste streams, and other renewable resources.	https://www.pnnl.gov/bioproducts-sciences-and-engineering-laboratory	WSU

Appendix E: Acknowledgments

Many staff at Commerce, as well as subject matter experts from other organizations, made this report possible through consultation, technical, and organizational assistance throughout the project.

Table 1: Commerce staff acknowledgments

Name	Title
Dave Andersen	Managing Director Growth Management Services
Joshua Berger	Director of Economic Development - Maritime Sector
Karin Berkholtz	Executive Director Public Works Board
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Robin Toth	Director of Economic Development, Aerospace Sector
Sarah Vorpahl	Senior Energy Policy Specialist
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Table 2: External subject matter expert acknowledgments

Name	Title
Stefano Mazzilli	Senior Research Scientist, Puget Sound Institute
Melanie Roberts	Director of State and Regional Affairs, PNNL
Ted Sturdevant	Center for Sustainable Infrastructure