The CleanTech Alliance's Final Report for the Washington State Department of Commerce

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Introduction

This report was commissioned by the Washington Department of Commerce and was created by the CleanTech Alliance and its consultants. It is an endeavor to better understand the roadblocks and challenges to creating a more robust cleantech economy. We recognized that there are unique aspects to the cleantech sector. Some of these aspects present roadblocks for development in this sector, particularly for entrepreneurs. We wanted to better understand the dynamics of this sector, advance the dialog about how to advance a cleaner economy, and suggest mechanisms for achieving that goal.

Sections

The CleanTech Ecosystem Assessment, written by CleanTech Alliance consultant Ann Goos, provides an in-depth analysis of the strengths, weaknesses, opportunities, and threats facing the CleanTech sector. It includes both qualitative interviews with industry leaders as well as a quantitative literature review to draw conclusions about the CleanTech ecosystem.

The Clean Energy Fund white paper was written by CleanTech Alliance staff member Lindsay McCormick with the help of Carl Seip, the Director of Marketing and External Affairs for Craft3 and CleanTech Alliance consultant Ann Goos. It gives an overview of the Washington State Clean Energy Fund. It goes more in depth by breaking down how much money was allocated to each of the four cycles of funding, what projects were funded with that money, and how much private funding was leveraged from the state's investment.

The Green Jobs Summary highlights the key points of the Green Jobs In-Depth Report, which was written by Lindsay McCormick. The Green Jobs In-Depth Report is a comprehensive literature review of peer-reviewed studies and government data that sought to estimate the number of green jobs in the Seattle metro, state of Washington, Pacific region, country, and world.

The Board of Directors Survey Summary outlines the results of a survey conducted by the CleanTech Alliance. The survey aimed to determine how the CleanTech Alliance should operate in light of the COVID-19 pandemic and included questions about daily operations, videoconferencing preferences, whether upcoming events should be moved online or rescheduled, and other topics.

The OED Survey was conducted by the Office of Economic Development and commissioned by the CleanTech Alliance to see how the COVID-19 pandemic impacted our members. The survey gauged the financial impact of the pandemic on CleanTech Alliance members to assess the damage and see what we can do to help.

The CleanTech Ecosystem Appendix is the final item in the report and it complements the CleanTech Ecosystem Assessment written by Ann Goos. The Appendix contains

the responses to interview questions from CleanTech leaders as well as the literature and resources that Ann used to write the CleanTech Ecosystem Assessment.

Conclusions

Over the course of this report, we leaned several invaluable lessons about the CleanTech Ecosystem, Green Jobs, and the needs of our members in light of the COVID-19 pandemic.

- The CleanTech Ecosystem Assessment found that Washington is a clean energy leader in R&D thanks to our research institutions like UW, WSU, and PNNL. Outside of Washington, the greater region benefits from other strong research institutions in British Columbia, Idaho, and Oregon, particularly Idaho National Laboratory.
- The Assessment also found that Washington faces increased competition from the Pacific Rim and California in particular, but thanks to policies passed by the Washington state legislature, our state's CleanTech ecosystem continues to thrive.
- The Clean Energy Fund white paper demonstrated that the state's investment in clean technology has leveraged millions of dollars in private financing and has helped projects to get off the ground that otherwise might never have happened.
- The Clean Energy Fund white paper also showed how the CEF's unique public/private framework allowed for innovation and proved that funding clean energy projects was valuable for both the environment and the economy.
- The Green Jobs Report looked at peer-reviewed studies and government data to conclude that there are around 85,000 green jobs in Washington, with 47,000 of those green jobs located in the Seattle-Tacoma-Bellevue metro area.
- The Green Jobs Report also quantified green jobs on a national and worldwide scale and found sector-specific employment data.
- The Board of Directors Survey showed that the CleanTech Alliance Board members overwhelmingly favor moving events online and trying to adjust to the new normal of life with the coronavirus pandemic.
- The OED Survey found that CleanTech Alliance members are in decent shape to handle the short-term impacts of the COVID-19 crisis, but temporary or permanent layoffs might need to happen for some of our members depending on how long the pandemic lasts. The survey showed that adjustments were being made by mid-April 2020, but most respondents had not made drastic changes…yet. There was clear concern for the future.
- The entirety of the report shows that Washington has a growing CleanTech sector that, if properly fostered, will lead to a stronger and healthier environment and economy.

CleanTech Ecosystem Assessment

The CleanTech Alliance launched as a trade association in 2007. The organization boasts over 1,000 members located in eighteen U.S. states, Canadian provinces, and the District of Columbia. The Alliance represents a wide array of industries and business models that create the technologies, products, processes, and services that reduce environmental impacts of business operations and result in a cleaner and greener economy and marketplace for consumers. The CleanTech Alliance works to advance clean technologies through policy advocacy, commercialization programs, business services and signature events that educate, enlighten, and enhance profitability of member companies and the economic success of the sector.

The CleanTech Alliance started at the same time as the policy and the investor worlds signaled calls to action to address climate change and invest in cleantech.[1] In the twelve years since the CleanTech Alliance's launch, the sector has experienced the highs and lows of the broader economy, the lack of growth stage investors, and the inherent challenges in creating new energy markets when competing against the well-established energy sector.

Though progress in the regional cleantech sector's growth was challenged in part due to the Great Recession of 2008, cleantech was also a significant beneficiary of the American Recovery and Reinvestment Act (Recovery Act): The largest single investment in clean energy in history, providing more than $90 billion in strategic clean energy investments and tax incentives and leveraging approximately $150 billion in private and other non-federal capital for clean energy investments. In the state of Washington, the funding reached almost all aspects of the value chain for numerous key clean energy technologies, batteries, carbon capture and sequestration, and technologies to enhance energy efficiency and advance the smart grid. However, infrastructure-dependent cleantech companies continued to struggle to gain the support of venture capitalists who are less enamored with the capricious macroeconomics of energy markets, and chilled by the huge up-front costs required to manufacture many clean technologies, products, and services.

During this same timeframe, the state of Washington has been an exemplary strategic partner in supporting the state's and regional cleantech sector even in the face of less than robust investor interest. The Clean Energy Fund, first launched in 2013, provides strategic clean-energy and high-technology funds to help advance the sector. Indeed, the state actively supports and engages in programs to provide commercialization and incubation support for startup companies. The state has also consistently invested in cleantech related research, development, and testing facilities at the state's two research universities and Pacific Northwest National Laboratory. Finally, in addition to the accustomed policy tools available to states and local government to spur innovation

[1] It has been opined that the popularity of the Al Gore's 2006 documentary, "An Inconvenient Truth" and venture capitalist John Doerr's steering of the venture capital firm Kleiner, Perkins, Caufield, and Byers (KPCP) into cleantech investing in 2007, reflected the passion, need, and excitement for cleantech as a new and exciting market that could tackle significant risks to the planet Earth.

and technology development, the state has offered both quantitative and qualitative assistance to the CleanTech Alliance in advancing the cleantech sector, including sustainability demand policies and environmental regulations.

Together, the CleanTech Alliance membership and the state of Washington have spent the last 12 years working - through both good and challenging markets - to create a successful cleantech sector that helps the state and region contribute to the reduction of greenhouse-gas emissions. This has been done in part by existing industries relying on technology development and process improvements to transition to a more sustainable future. What has been more challenging has been the steady growth of a competitive cleantech sector, related jobs, and successfully addressing the lack of institutional support for cleanup start-ups in raising capital.

Identifying the challenges to the growth of cleantech companies and jobs became a focus of discussion for CleanTech Alliance in the summer of 2018.

Identifying the Challenges and Opportunities for the CleanTech Sector

In June 2018, CleanTech Alliance members noted that the growth of the cleantech sector in the state and region has not reached its potential, particularly related to the growth of cleantech companies and employee numbers. It was decided that the association should embark on a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analyses and literature review evaluating the current cleantech ecosystem. The focus of the SWOT analysis was primarily on the state of Washington yet included regional insights and input. The goal was to aggregate perceptions and assessments of the current opportunities and barriers that are defining the growth and health of the cleantech sector in the Pacific Northwest region—and beyond.

The SWOT analysis was based on qualitative interviews of 24 entrepreneurs, influencers, and policy leaders from an array of disciplines, sectors, and representing private/public entities. Relevant quantitative data and documentation on the topics of cleantech innovation, business development, and regional competitiveness were reviewed and evaluated (see resources section, Appendix A). The literature review was used primarily to further inform and affirm qualitative observations and provide additional data and documentation to provide context to the information gathered during the qualitative interviews.

The information was gathered into this working report. The report and its findings and recommendations will help guide CleanTech Alliance and other stakeholders in supporting the growth of the cleantech sector, further developing a vibrant cleantech ecosystem and entrepreneurial tools, and establishing the Pacific Northwest as one of the leading regions in cleantech innovation and application.

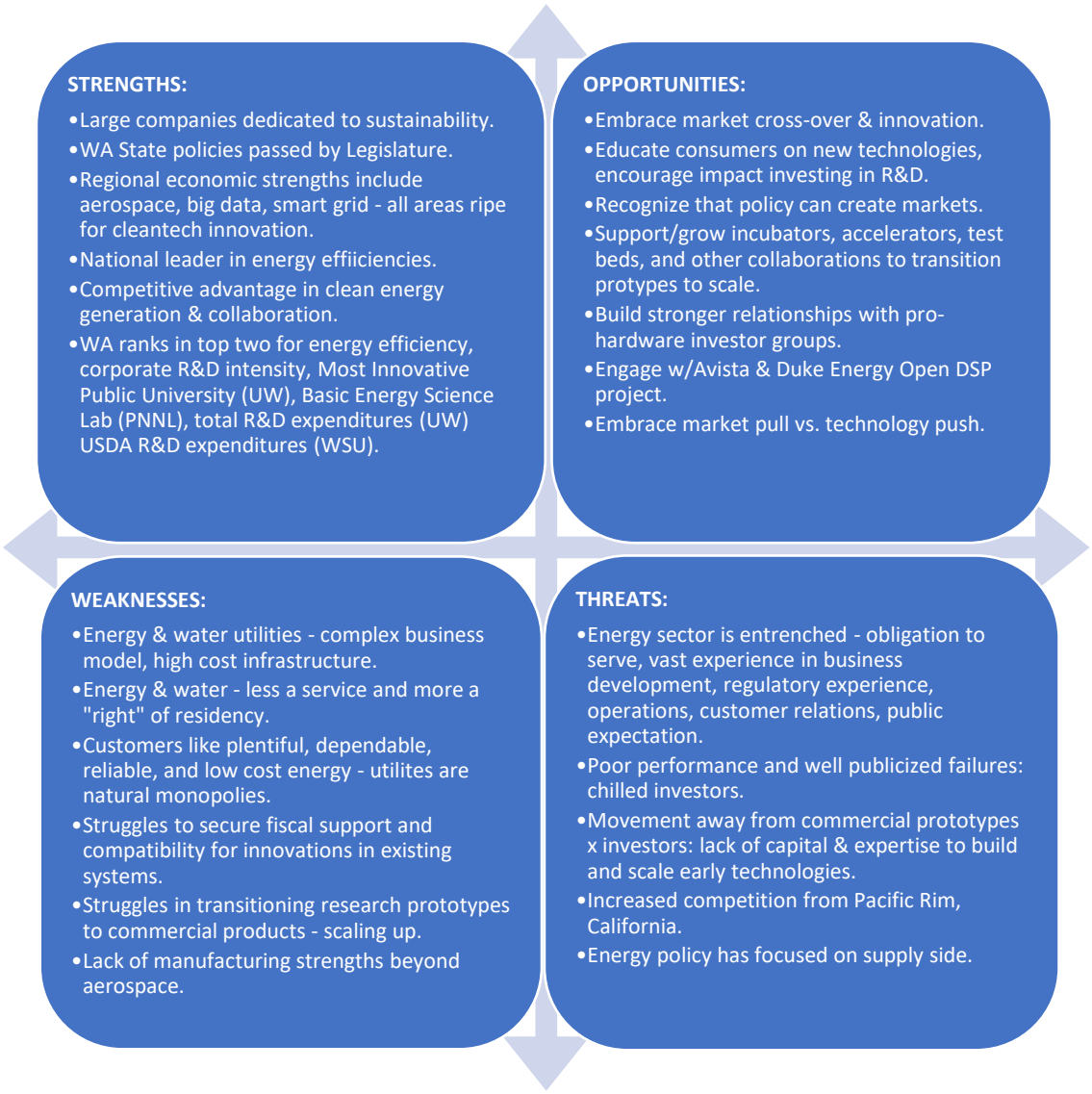
Key Findings Synopsis

The key findings from the 24 qualitative interviews include:

- **The Pacific Northwest is a leader in cleantech:**
    - The region boasts first-rate, top-ranked research institutions, including research universities and U.S. Department of Energy national laboratories.
    - The entrepreneurial culture of the region is extraordinary as evidenced by the number of Fortune 5 and 100 companies that have been established and grown in the last several decades.
    - The large manufacturing and IT companies (Boeing, Microsoft, Amazon) are leaders in sustainability and cleantech adoption.
    - Governor Jay Inslee of Washington is a recognized and passionate leader in cleantech.
    - The culture and ethos of the region values the environment and sustainability as well as innovation and technology.
    - The region's utilities are national leaders in the implementation of energy efficiency technologies.
- **There is a need to improve the visibility of cleantech through improved marketing & communications, including the following suggestions:**
    - Interviewees articulated a need to enhance the "brand" of the cleantech technological prowess and impact from our regional research institutions.
    - There is a need to seize opportunities to build broader support for the cleantech sector with political leadership and influencers, including building awareness of subsector strengths, e.g., storage, smart grid, etc.
    - The region should seize opportunities to rebuild support for the state of Washington's Clean Energy Transition Fund, and highlight the program as a key policy strategy to build on strengths and reduce weaknesses in supporting a robust cleantech ecosystem.
- **Selling to utilities and creating new energy markets is challenging:**
    - Entrepreneurs can be naïve about the realities of the energy market and fail to build the business case for their technologies with utility customers and within related public mandates because:
        - Utilities have very long sales cycles.
        - Utilities must have resilience in the system.
        - Regulation restricts the ability of utilities to innovate.
        - Cleantech is relatively "infrastructure-dependent".
        - As one entrepreneur put it, "The utility model is not disrupt-able."
    - However, others note that electricity markets are transforming, which will result in utilities further innovating and evolving to deal with the disruptions. This is due to changes in:
        - Public policy
        - Consumer preferences
        - Technological advances
        - Industrial convergence
        - Consumption patterns, and
        - Energy "prosumer" emergence

- **Large, established companies in the region are dedicated to sustainability and cleantech adoption:**
    - Large companies in the region view sustainability as a core competency for both competitiveness and longevity in the marketplace.
    - Demand for improved sustainability emanates from regulatory compliance, supply chain expectations, and global markets as well as from employees, customers, and investors—and it is increasingly incorporated into business strategies, employee compensation, and brand management/marketing.
    - The pathway for entrepreneurs to sell innovations into large companies can be challenging. When we asked larger organizations how an entrepreneur could introduce a product or service, the answers were either “I don’t know” or “You can’t.”
- **Policy can be powerful:**
    - Policy has been an important driver of cleantech research, development and deployment and helps spur both job creation and economic growth. To date, cleantech RD&D has benefitted from regulations and compliance requirements, direct expenditures, tax expenditures, and subsidies associated with loan guarantees.
    - The state of Washington has used a number of federal and state policy-oriented tools to support a thriving cleantech sector including a specialized recognition of cleantech with the state’s Department of Commerce and the Clean Energy Transition Fund. Other examples include
        - The state is home to the Center of Excellence for Alternative Jet Fuels and Environment, which is funded by the FAA, NASA, the Department of Defense, Transport Canada, and the Environmental Protection Agency.
        - The University of Washington’s Clean Energy Institute (CEI) created the Washington Clean Energy Testbeds to increase the rate at which breakthrough science and engineering discoveries turn into market-adopted clean energy technologies.
- **Emerging expertise**:
    - Several interviewees noted that storage and nuclear technologies may well become an area of emphasis and focus in the coming decade
- **Collaborative models for innovation have proven to be effective in the region:**
    - The collaborative research model where companies work with research institutions has tended to be more effective in advancing innovation than the patent-alone model. Collaborative research done in concert with industrial partners from the private sector appear to have worked well in advancing corporate competitiveness and developing new markets, as contrasted with spawning new companies along.

Figure 1. Identified "Strengths, Weaknesses, Opportunities, Threats" or SWOT of the Regional and Washington State Cleantech Ecosystem (Based on both qualitative interviews and quantitative literature review)



Encouraging Growth of the Cleantech Sector

Through the qualitative interviews, literature review, and SWOT analysis, a common theme emerged regarding how challenging it has been to secure capital to commercialize cleantech, limiting both the growth and economic success of the cleantech sector. Venture capital—private equity provided by firms or funds to small, early-stage, companies considered to have strong growth potential—has played only a small role over the last 15 years in accelerating the commercialization of new energy technologies and boosting the competitiveness of emerging clean technologies.

Many interviewees mentioned, and the literature is replete with the lament that regional cleantech startups have limited internal cash flow to draw upon, limited access to debt finance, and have been unable to secure capital to grow their businesses and bring their technologies into the marketplace and gain market share.

Several factors have chilled venture financing in cleantech, including the struggles and failures of some heavily funded cleantech companies—in some cases over a decade ago. In addition, the onset of cheap natural gas, which makes some renewable energy projects less economical and other factors have caused investors to lose confidence in the cleantech sector and rein in investment, particularly since 2007 through today. Bottomline, investments in clean energy technologies have proven to be riskier than investments in other technology sectors and cleantech companies have been less likely to be acquired or exit through an IPO, especially when compared to software or medical technologies.

Innovation Models and Implications for Growth of the Cleantech

Cleantech innovation, unlike the medical and software technology sectors prominent in our region, relies on a more diverse set of innovation models and funding sources. For the purposes of this analysis, innovation models or pathways are generally defined as the processes through which cleantech-related products, services, and business methods are developed, deployed and able to penetrate and compete in the marketplace. Furthermore, cleantech innovation is defined in broad terms: innovation models or pathways can encompass improvements to cleantech-related goods and services, as well as to operational processes and business models. To facilitate our analysis, we describe innovation models both in terms of innovation activities and the innovation ecosystem that supports those activities and how these factors have interacted and lead to the slow, but steady growth of cleantech innovation in the region.

Generally, cleantech innovation and adoption in the region has been driven by the need of existing businesses and utilities to cost-effectively address regulations, operational and certification standards, and permit-driven directives aimed at confronting climate change and increasing the sustainability of natural resources. The role of policy in spurring cleantech innovation enables the accelerated adoption of best available technology in cleantech and applied, often public and privately funded research, development, and deployment. This kind of innovation tends to be incremental, collaborative, and adaptive. The result has been the creation and adoption of sustainable technologies that allow a business sector, utility, and/or corporation to incrementally improve its operations and customer satisfaction on a predictable

timeframe. It has also tended to create smaller cleantech companies that are either acquired or stay in the small to mid-sized range based on income and employee numbers.

Less evident are cleantech companies driven by disruption-oriented innovation and the more radical development and deployment often led by venture capital investment. Importantly, this paper distinguishes disruptive innovation as differentiated from disruptive technology: we opine that disruptive innovation focuses more on the use of the technology rather than the technology itself. Hence, as defined, disruptive innovation is an entirely new development that dramatically changes the way a structure or industry functions, such as how the internet fundamentally changed the marketplace (Amazon being a local example of a disruptor using the internet in the selling and delivery of products to consumers). In cleantech, artificial intelligence has the potential to be a significant disruptive innovation in the decade ahead. But, we have yet to see the kind disruptive innovation in cleantech that results in fast growing and highly profitable companies such as Amazon, Facebook, Netflix, and Google.

The main proposition is that cleantech innovation models to date have been more incremental, interdependent, and driven in part on government policy synchronizing with market development and industry evolution. These more incremental and adaptive innovation pathways for cleantech have provided the opportunities, resources, and the broad set of complementary capabilities necessary for cleantech productivity. To date, regional cleantech innovation tends to best be supported by the co-evolution of government policy and business strategies that depend on collaboration and integration with existing markets.

Key Learnings for Cleantech Entrepreneurs

For entrepreneurs, these findings suggest that cleantech start-up success could be enhanced by:

- Identifying and participating in collaborative development efforts.
- Seeking a broader set of funding sources than just venture capital.
- Organizing cross disciplinary teams filled with both technical and commercial skills.
- Seeking an active role in public/private partnerships and R&D consortia.
- Strongly supporting, participating in, and advocating for more cleantech-oriented incubators, test beds, and accelerators to advance product development and marketplace deployment while reducing capital expenditures.
- Advocating for both federal and state policies that enable or improve the opportunities for the private sector to invest in cleantech. Entrepreneurs should consider leveraging federal and state grants to advance technology development before raising substantial funding and in anticipation of investor return expectations

Trade associations for cleantech should organize stakeholders to promote and support the funding of cleantech innovations and commercialization. This includes more active partnering with corporations and exploring new networks of private investors, e.g., mission-based or impact investors and supporting fiscal, monetary, trade, and regulatory policies that enhance and incentivize private investment and keep state and regional clean energy financing options vibrant and fully funded.

These findings also suggest that the optimal strategy for promoting both carbon reduction and economic development goals is to place emphasis on promoting the creation of cleantech innovation that can be commercialized through large organizations. The state may want to further incentivize regional partnerships between large corporations, startups, and incubators/test beds along with collaborating with and supporting favorable technology transfer terms from both of the region's two national laboratories. The Center for Advanced Material and Clean Energy Technology (CAMCET) is a promising example of how the state can enable entrepreneurs to develop technologies by using shared public resources in this instance, state funding and a public research university and negating the reliance for VC-styled investment.

For detailed descriptions of the qualitative interviews and SWOT analyses, see Appendix A of the report.

Recommendations Based on the identified Strengths, Weaknesses, Opportunities, and Threats

Short-term Considerations

There are ample opportunities for cleantech advocates, entrepreneurs, and related trade associations to actively participate in policy development that will help advance RD&D and related cleantech innovation and adoption.

The state of Washington has recently passed a comprehensive set of laws that are creating a suite of demand-pull policies and environmental regulations that will help to build market capacity for cleantech products including increasing the use of clean renewable energy and requiring energy efficiencies. These new policies and regulations will likely require the introduction of more innovative products and test markets.

Hence, it is more important now than ever to ensure that complementary policies are supporting the development of cleantech businesses along with energy-transition demand policies. The business-development or supply side of innovation policy will need to be considered and consistently articulated and supported.

The following recommendations reflect an array of administrative forums where cleantech business development representation is vital. We have also identified partnership/engagement opportunities for ensuring complementary supply side policies, programs, and investment are supported.

Actively Participate in Policy Development – rulemaking to implement the Clean Energy Transformation Act:

In 2019, the Washington State legislature passed and Governor Jay Inslee signed into law the Clean Energy Transformation Act (CETA) (E2SSB 5116), which commits Washington to an electricity supply free of greenhouse gas emissions by 2045.

The policy goals include the premise that clean electricity will allow the state to replace fossil fuels in other end uses, especially transportation, and achieve long-term climate goals. The Washington Department of Commerce is the key leader in implementing CETA. Working with utilities, other state agencies and multiple stakeholders, Commerce will develop rules, reporting procedures and regular assessments to ensure success.

Actively Participate in Policy Development – Development of Washington's 2021 Energy Strategy:

Washington State is developing the 2021 State Energy Strategy to support the state's goals to protect climate and consumers and promote economic vitality. Washington's state energy strategy was last updated in 2012.

The mandate for a new state energy strategy is part of the state's 2019 legislation establishing a new clean electricity standard for Washington, the Clean Energy Transformation Act of 2019 (SB 5116). The legislation directs the Department of Commerce to review and update the state's energy strategy by the end of 2020. Among other things, the updated state energy strategy may inform legislative proposals for the 2021 session of the Legislature and is an excellent forum to advance the need for complementary business-development, supply-side policies.

Indeed, the Legislature has directed that the 2021 state energy strategy identify policies and actions to balance the three goals:

- Maintaining competitive energy prices.
- Fostering a clean energy economy.
- Meeting greenhouse gas reduction obligations.

Opportunities for public involvement will be provided throughout the development of the 2021 state energy strategy. The advisory committee will meet multiple times during 2020. Meetings will be open to the public and will be accessible remotely. Also, a public hearing will be held before the submission of the final report.

Actively Participate in Policy Development – Support the Clean Energy Fund in 2021:

As discussed, successful cultivation of cleantech industries requires targeted business-development policies in addition to general-demand policies such as CETA. Research funding and adequate capital investment in cleantech innovation are vital to the success of the new clean energy laws and regulations. The state will need to continue to provide ample support for access to finance, including dedicated clean energy funds, as well as supporting cleantech commercialization and incubation, and for research, development, and testing.

The state of Washington's Clean Energy Fund is an essential and complementary partner to CETA. Building acknowledgement of the complementary nature of these funds to CETA and the 2021 Energy Policy as well as advocating to maintain and/or grow the Fund are essential ingredients not only to advancing the development of the cleantech sector, but also to help strengthen public opinion in favor of energy-transition policies. A strong cleantech sector

provides a guaranteed constituency whose jobs and businesses are linked to policies that support clean energy and sustainability policies.

Actively Participate in Policy Development – Support Federal ARPA-E funding:

Since 2009, ARPA-E has provided approximately $2 billion in R&D funding for approximately 800 transformational energy technology projects. ARPA-E is fostering technological breakthroughs, particularly in energy storage, transportation fuels, and industrial efficiency. As of 2019, 136 of more than 340 completed projects supported by ARPA-E have attracted over $2.6 billion in private sector follow-on funding, and 71 projects have gone on to form new companies. The CleanTech Alliance should explore how to work with the Washington Congressional Delegation as well as local stakeholders to ensure robust funding of the ARPA-E program.

Advocate for Funding of Cleantech Research Capabilities:

- **UW CAMCET**. The state of Washington, through the two research universities, has supported the development of clean energy research "hubs." One exciting opportunity for ongoing public/private partnership is the University of Washington's Center for Advanced Materials and Clean Energy Technologies (CAMCET). The Center received state funding in the 2018 and is set to be complete in late 2022 or sometime in 2023.

  The building will house space for research, learning and cleantech prototyping, testing and validating. Specifically, CAMCET will feature:
  - Research:
    - UW Clean Energy Institute: The CEI supports the advancement of next-generation solar energy and battery materials and devices, as well as their integration with systems and the grid.
    - Northwest Institute for Materials Physics, Chemistry, and Technology, or NW IMPACT: A joint research collaboration of the U.S. Department of Energy's Pacific Northwest National Laboratory and the UW.
    - Wet, dry, and computational lab space for advanced materials and clean energy research and training.
    - Market-rate leasable research spaces.
  - Industry/ Government/ NGOs:
    - Washington Clean Energy Testbeds: The CEI's open-access, fee-for-use facility for prototyping, testing, and validating clean technologies. The facility takes no intellectual property from external users. It also hosts Entrepreneur-in-Residence and Investor-in-Residence programs available to cleantech innovators across the region.
    - Startup lab modules and hot desks.
    - Market-rate leasable spaces.

  Advocating support for this center will assist in providing entrepreneurs opportunities, through publicly available facilities, to test and develop new innovations. Building a constituency to support this facility will be an important consideration for cleantech advocates.

- **UW-PNNL (NW IMPACT) and WSU-PNNL Institutes**. In 2018, the two public research universities partnered with PNNL to form four separate research institutes, but all related to clean energy innovation, collaborative research, and providing learning opportunities for graduate students. Advocates for cleantech innovation and entrepreneurship should become familiar with the partnership potential with the institutes and discover if there is a need to support funding or provide collaborative research ideas.

- **Public/Private Research Consortia.** There are a number of clean energy research consortia that reside in the research institutions that serve the region. Many of these research consortia welcome private partners and conduct collaborative applied research. Identifying the most active consortia and strategically emphasizing building relationships and strategic partners could be a priority over the next year, particularly for the CleanTech Alliance.

Support and Grow Regional Cleantech Incubators, Accelerators, and Test Labs:

The Cascadia Accelerator, which is partnered with Oregon-based VertueLab, is in its fifth year of helping local clean entrepreneurs bring new technologies to market. These organizations, along with the suite of resources provided by the UW Clean Energy Testbeds, provide lab space and specialized equipment, business expertise, industry mentors, introductions to investors, and opportunities to test and demonstrate technologies. Cleantech startups need more of these kinds of resources and programs to get innovations into the marketplace. Advocating for the growth and expansion of these types of programs should be part an approach to work with the state of Washington and with the Congressional delegation on funding the business development "supply-side" elements of clean energy transformation.

Connect with Organizations that provide equity-based resources:

Launched in 2017, Breakthrough Energy Ventures, is designed to inject patient capital into the technologies needed to address climate change. It has several Pacific Northwest business and non-profit leaders on the Board and active in the organization, including Bill Gates (who spearheads the effort) and Jeff Bezos.

Activities Specific to the CleanTech Alliance:

- Add sustainability officers/directors/managers from various economic sectors to the board of directors.
- Grow the Cascadia Accelerator and build broader fiscal support to expand the program.
- Offer more reverse pitch opportunities to connect innovators with established companies and organizations.

Long-term Considerations

After review of the SWOT, the literature review, and the awareness of cleantech innovation models, the CleanTech Alliance, along with key stakeholders, can address threats/weaknesses to the cleantech ecosystem and seize on the sector's strengths/opportunities, including:

- Define a set of common goals and measures of shared success in advancing the regional cleantech ecosystem and prioritizing related strategic activities in advancing cleantech: "What do we want, and how will we know when we get it."
- Develop, fund, and implement a public affair-styled strategic communications and engagement plan to support public/private partnerships, link cleantech innovation to leading economic sectors, and market the state and region as a global cleantech innovation leader.
- Build collaborative, public/private stakeholder and investor engagement through joint cleantech projects, partnerships and consortia, and strongly support, advocate, and communicate for the growth of current and future regional incubators, accelerators and testbeds.

This kind of long-term action plan will develop shared goals and harmonize public and private interests to address conflicts, find solutions, and honor best business practices yielding a better state and regional cleantech marketplace. The outcomes of such an action plan will help to grow the regional economy, create more jobs in the sector, and increase public and private investments in clean technology R&D and startups in the region. Below is a suggestion-only set of long-term goals and objectives that could guide the action plan moving forward.

Proposed Goals:

- Alleviate the deleterious effects of climate change in the Pacific Northwest and beyond.
- Reaffirm the ability of the region's private and public sectors to collaborate and implement clean energy, transportation, and building policies and deliver essential research and development in clean technologies.
- Establish the investment and market conditions under which new and existing companies can sell and/or incorporate efficient, cost-effective, and reliable clean technology-oriented services and products successfully into the economy.
- Promote the region as a world leader in advancing clean technology innovations through talent development, research capacity, entrepreneurial success, and increased access to capital.

Proposed Objectives:

- Improve R&D in clean technologies, private sector investment, adoption and/or selling of cleantech products and services, and customer satisfaction.

- Unite our region's economic sectors in advancing and adopting clean technologies across the states and provinces of the Pacific Northwest (Alaska, British Columbia, Idaho, Oregon, and Washington).
- Ensure, by the acceptance of policies and instituting clean technologies into the marketplace, the region is a world leader in addressing climate change.
- Employ public and private sector collaboration and investment for promoting the economic and social benefits of reducing climate change by adopting efficient and cost-effective clean technology innovations.

One proven process for developing, refining, and building effective action plans and implementation is collaborative policy making or problem-solving. It could be advantageous to organize a multi-stakeholder, cleantech collaborative forum and formalize a region-wide coalition that will address the key barriers and opportunities to grow the cleantech marketplace for both startups and established businesses. The collaborative could also work together to advocate for and secure additional public and private funding for cleantech productivity, support ongoing research & development, and position the region as a leader in cleantech innovation.

Finally, such a group could host an ongoing stakeholder conference dedicated to the development of a shared strategy to advance cleantech.

Possible Topics for the Stakeholder Conference:

- Describe and document the new laws, local and state policies, and assess the political landscape going into the 2020 campaign season that together may further drive reduction of carbon emissions and incentivize cleantech innovation, particularly in PNW.
- Identify the current cleantech innovation capabilities and needs in the major economic sectors of the region:
    - Aerospace
    - Agriculture
    - Energy
    - Forest Products & Rural Economic Development
    - Information and Communication Technology
    - Life Sciences and Global Health
    - Maritime
    - Military & Defense

The Clean Energy Fund:

Leverages State Investments: The Clean Energy Fund requires awardees to secure matching funds for at least 50% of the total cost of a project. The required match generates creative partnerships, ensures projects leverage state dollars to assist state-based businesses, utilities, homeowners, and communities and catalyzes additional public/private investments in research, development, commercialization, and adoption of clean energy technologies.

In the first two cycles of CEF funding alone, Washington invested $76.4 million and attracted $166 million in matching funds: A $2.47 return for every $1 the state invested. While the minimum non state-to-state funding match ratio is 1:1, several projects have seen a greater than 10:1 ratio. Zunum Aero's hybrid aircraft project boasted an investment of $45.07 of non-state funding for every $1 of state funding.

Sparks Innovation for the Future: From finding new ways to recycle composite fiber material to generating electricity from supercritical carbon dioxide to developing bio-derived plastics for the food products industry, the Research, Development, and Deployment Program is sparking clean energy and clean tech innovations that support the state's key economic sectors and communities.

The CEF assists in strategic RD&D partnerships in sectors such as renewable energy, cleantech manufacturing, energy efficiency, recycling, and applied projects. Funded projects have advanced knowledge and accelerated innovation in energy storage and generation, recycling, waste management, manufacturing, and more.

Creates Clean Energy Innovation, Businesses, and Jobs: The Clean Energy Fund has created and retained thousands of high-quality, family-wage jobs in our state. Washington is home to over 82,800 clean energy jobs equating to 13x more clean energy jobs in Washington as compared to fossil fuel jobs. These jobs put dollars back into local economies and help to revitalize communities.

CEF investments and the matching public and private investments play complementary roles in the commercialization of new clean energy technologies, industry competitiveness and development of new businesses. The CEF incentivizes higher risk, longer-term investments required for our state's future in clean energy, building, and transportation infrastructure and related jobs.

Builds Energy Efficient Communities: Through the Energy Revolving Loan Fund, nonprofit lenders have leveraged millions of state CEF dollars to support homeowner and local business projects that make residential homes and commercial buildings more energy efficient. These loans also help to drive down energy costs and facilitate greener communities.

Improves Our Electric Power Grid: CEF funded grid modernization projects have led to ground-breaking innovations such as the development of ride-through technology, which allows for microgrids within the electricity grid to sync and un-sync seamlessly to improve efficiency. Microgrids provide backup power storage in the event of unplanned emergencies such as storms and earthquakes and allow for reliable energy when it's needed most.

Other projects have focused on improved energy storage and ways to better absorb sudden spikes in energy demand. These improvements result in a more resilient electricity grid that provides reliable power to businesses and residential communities alike.

Keeps Washington Evergreen: Washington's CEF investments ensure our state continues to lead in the following areas:

- Conducting energy research, development, and demonstration/ deployment.
- Implementing effective energy efficiencies, and
- Supporting globally competitive businesses dedicated to supplying clean energy products and processes. This includes improved energy storage, waste reduction, recycling, and related areas of clean technology development that will benefit the state now and in the future.

The CEF provides a unique public/private funding framework and demonstrates that funding clean energy isn't just good for the environment, it's good for the economy.

Clean Energy Fund Projects

Beta Hatch Waste-Heat Recovery

Beta Hatch insects are grown indoors, in controlled environments that are kept warm and humid. The CEF project supports the development of a novel waste-heat recovery approach, using low-grade waste heat from a neighboring data center to heat the Beta Hatch insect farming operation.

In the United States, waste heat represents 5-13 quadrillion British thermal units per year of potential energy to be harvested (Department of Energy). With the cheapest electricity in the country, Washington hosts millions of square feet of data centers, many concentrated in Chelan and Douglas counties. These facilities often have extremely high energy capacity and consumption rates (with an average of 9 MW/facility) but provide very few jobs. For this and other reasons, in 2018 Chelan County passed a moratorium on cryptocurrency mining and other high-density load applications. Co-locating Beta Hatch insect production with data centers would remove some of these energy-economy tradeoffs by creating jobs in conjunction with server facilities.

Beta-Hatch

Mission Statement: Beta Hatch creates insect-rearing technology that converts mealworms and their waste into high-value proteins, oils, and nutrients for agriculture. Beta Hatch's IP enables insects to cost-effectively meet the global scale of demand for animal feed and crop fertilizer.

Location: Wenatchee, Washington

Number of Employees: About six employees

Funding: Beta Hatch has raised over $4.8 million in grants and investments

Total Match to CETF funded project(s): $937,800

Impact Bioenergy Food Waste Biocycling

Impact Bioenergy will implement systematic, community-scale food waste biocycling on Vashon Island, WA. The decentralized system will eliminate the need to ship out food waste materials and bring in amendments like compost and fertilizer. Food waste will be converted to energy for heat, power and alternative fuel vehicles, liquid organic fertilizer and sequestered CO2 used in agriculture and horticulture.

The goal is to demonstrate a highly repeatable model for hyperlocal food "waste" conversion to renewable resources at a community scale (up to 5,000 lbs./day), that stimulates climate action and a circular economy, while promoting food and energy independence.

Impact Bioenergy

Mission Statement: Impact Bioenergy™ launched in 2013, with the mission to construct and deliver the best bio-conversion technologies and services available, which will empower communities by making renewable energy and soil products locally through organic materials recycling

Location: Headquarters are located in Shoreline, Washington

Number of Employees: Approximately 15

Annual Revenue: $4.3 million in estimated annual revenue

Total Match to CETF funded project(s): $936,800

Orcas Power and Light Co-Op Decatur Island Microgrid

The grant will help fund integration of a .5 MW (or 2 mWh) vanadium flow battery into OPALCO's grid, to condition and time-shift community solar array output, improve load shape, absorb sudden spikes in energy demand, and backup critical substation and fiber optic systems. This will help the co-op save money and improve grid reliability.

The energy storage and community solar systems on Decatur Island generate seven discreet benefits to OPALCO: demand charge reduction, load shaping charge reduction, transmission charge reduction, transmission deferral, energy cost reduction, Volt-VAR/CVR, and outage mitigation.

Orcas Power and Light Co-Op

Mission Statement: Orcas Power & Light Cooperative (OPALCO) serves its membership with safe, reliable, sustainable and cost effective essential utility services with a commitment to the utilization of renewable resources and carbon reduction.

Location: They have offices in Eastsound, Friday Harbor, and Lopez Island, Washington but provide service to over 20 of the San Juan Islands.

Number of Employees: 51

Customers Served: 11,316

Total Match to CETF funded project(s): $3,600,000

Energy Northwest

Mission Statement: Energy Northwest's provides its public power members and regional customers with safe, reliable, cost-effective, responsible power generation and energy solutions.

Location: Richland, Washington

Number of Employees: Over 1,100

Customers Served Their consortium of 27 public utility districts and municipalities across Washington takes advantage of economies of scale and shared services that help utilities run their operations more efficiently and at lower cost, to the benefit of more than **1.5 million customers.**

Total Match to CETF funded project(s): $7,053,262

Energy Northwest Horn Rapids Project

The Horn Rapids Solar, Storage & Training Project in Richland provides Washington state its first opportunity to integrate a large-scale solar and storage facility into its clean mix of hydro, nuclear and wind resources. This first-of-its-kind facility combines solar generation with battery storage and technician training.

The site is just north of Richland, on land owned by the International Brotherhood of Electrical Workers. The project will be a 4-megawatt electric, 20-acre solar generating array of photovoltaic panels that will provide enough energy to power 600 Richland homes. The project will also include a 1-MW battery storage system; and serve as a training ground for solar and battery technicians throughout the nation. The combination of photovoltaic solar with battery storage will provide a predictable, renewable generating resource.

Pacific Northwest National Lab (PNNL) Transactive Campus Energy Systems Project

The fundamental purpose of transactive energy management is to seamlessly coordinate the operation of large numbers of new intelligent assets—such as distributed solar, energy storage and responsive building loads—to provide the flexibility needed to operate the power grid reliably and at minimum cost, particularly one filled with intermittent renewable generation such as the Pacific Northwest. It addresses the key challenge of providing smooth, stable, and predictable "control" of these assets, despite the fact that most are neither owned nor directly controlled by the power grid.

Pacific Northwest National Lab (PNNL)

Mission Statement: PNNL advances the frontiers of knowledge, taking on some of the world's greatest science and technology challenges. Distinctive strengths in chemistry, earth sciences, and data analytics are the heart of our science mission, laying a foundation for innovations that improve America's energy resiliency and enhance national security.

Location: Their main campus is located in Richland, Washington and includes two dozen facilities including a Marine Sciences Laboratory located in Sequim and a Bioproducts, Sciences, and Engineering Lab located on Washington State University's Tri-Cities campus.

Number of Employees: PNNL employs 4,414 scientists, engineers, and professional staff

Research Funding: PNNL has an annual operating budget of $960 million

Total Match to CETF funded project(s): $4,190,134

Avista

Mission Statement: Avista is an energy company involved in the production, transmission and distribution of energy as well as other energy-related businesses.

Location: Based in Spokane, Washington, Avista has a service area that covers 30,000 square miles across four states.

Number of Employees: 1,982 employees

Customers Served: Avista provides electricity to nearly 340,000 customers and natural gas to about 300,000 customers

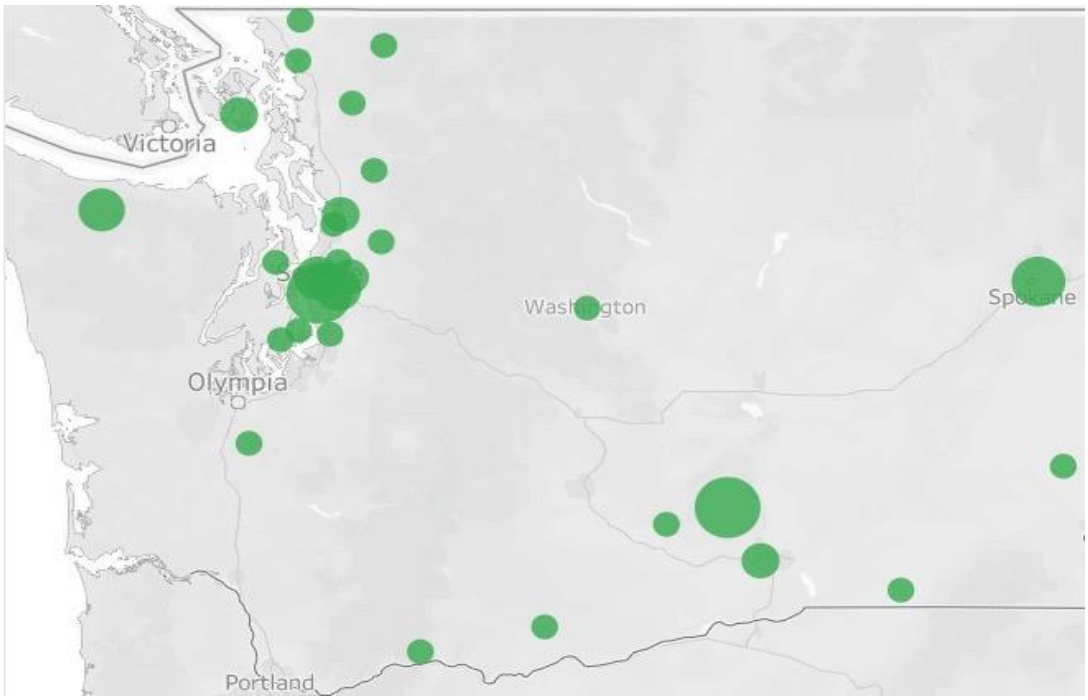
Total Match to CETF funded project(s): $16,018,494

Avista Energy Storage Project in Pullman

Avista's Energy Storage project is testing new batteries that can store power when it's abundant and distribute energy when it's needed, providing reliable energy regardless of weather patterns. The goal of the project is to explore how energy storage can help our electrical grid become more flexible, more reliable, and more resilient. When the project went online in 2015, it was the largest- capacity, vanadium-flow battery system in North America and Europe. The one- megawatt, 3.2 MWh large-scale battery storage system has the capacity to power 750 homes for 3.2 hours.

Impact and Map of Sites

- Over $110 million in CEF funding has already been deployed and leveraged to advance the state's clean energy economy. An additional $42 million was appropriated for the fourth round of Clean Energy Transition Fund (CETF4) – but has yet to be invested by the state.
- In CEF1-3, the Grid Modernization program has allocated around $37 million to seven utility companies for 13 projects. These projects have led to ground-breaking innovations such as the development of ride-through technology, which allows microgrids within the electricity grid to sync and un-sync seamlessly to improve efficiency.
- The RD&D program has resulted in over $25 million in awards over 2 rounds of funding to 23 innovative projects, many of which are being conducted by researchers at the University of Washington and Washington State University. The state's investment was critical to attracting additional federal and private research dollars.
- The Grants for Nonprofit Lenders program provides critical access-to- capital for clean energy projects undertaken by businesses, nonprofits, affordable housing developers, and individual homeowners. Three recipients have now deployed a total of $30.3 million as loans, which – as they are repaid – will revolve and continue to benefit the state.
- Two newer programs, Electrification of Transportation and Solar Deployment, will see investment before the close of calendar year 2020.



Grid Modernization

Overview

Modernization of the electric grid is an area where Washington state is already a global research and development leader. Investments through the Clean Energy Fund's Grid Modernization program to public and private utilities have improved our understanding of battery chemistry, implemented microgrids, and integrated solar and other renewable power into the grid.

In CEF1, during the 2013 biennium, three electric utilities were awarded a total of $14.3 million to evaluate different battery and storage systems and deploy both Lithium Ion and Vanadium Redox Flow battery systems.

In CEF2, during the 2015 biennium, five electric utilities were awarded a total of $12.5 million to develop microgrids that combined solar power generation with storage, load controls and other elements. These projects provide energy resiliency while further expanding the innovations in battery energy storage first demonstrated in CEF1.

In CEF3, during the 2017 biennium, four electric utilities were awarded a total $10.67 million to fund projects focusing on the advancement of clean and renewable energy technologies, transmission and distribution control systems, support of renewable energy source integration, deployment of distributed energy resources, sustainable microgrids, and increased utility customer options for energy sources, energy efficiency, energy equipment and utility services.

In CETF4, during the 2019 biennium, $7.7 million will be awarded to yet-to-be-named electric utilities to further the objectives outlined in CEF3.

Notable Projects

The Puget Sound Energy (PSE) Glacier Battery Storage project in Glacier, WA included the installation of a two-megawatt (MW)/ 4.4 megawatt-hour (MWh) lithium-ion battery system. The battery system is tied to PSE's electric distribution power grid and serves as a short-term backup energy source during power outages and aims to reduce system load during periods of high demand and balance energy supply and demand. The project received $3.8 million in CEF1 funding, which was matched by $7.4 million in capital from PSE. The battery system is now fully functional, and two phases of testing have been performed by the Pacific Northwest National Laboratory (PNNL) to determine the benefits of the battery and to identify future applications.

Energy Northwest's Horn Rapids Project in Richland, WA received a $3 million investment from CEF2, which was matched by an additional $3.5 million in non-state funding. The funding will be used to construct a first-of-its-kind facility that combines solar generation, battery storage, and technician training. Construction will be completed by early 2020. The result will be a 1MW/4MWh battery storage system with

the capacity to power 150 homes for four hours. The training program will cover plant construction, operations, maintenance and hazard prevention and is expected to generate over $3 million in economic benefit to the Tri-Cities annually.

Research, Development, & Demonstration (RD&D)

Overview

The RD&D program supports and leverages the University of Washington, Washington State University, Pacific Northwest National Lab, and a host of other state institutions and clean energy organizations to conduct research that advances:

- Energy storage and solar and other renewable energy technologies.
- Bioenergy and biofuels.
- Understanding of new earth abundant materials or lightweight materials, engineering advanced energy storage materials.
- Innovative approaches for recycling of battering components, developing new renewable energy and energy efficient technologies.

CEF investments into individual researchers and research programs leverage highly-competitive federal R&D funds and private matching dollars – and demand has far outstripped availability.

In CEF2, during the 2015 biennium, eight projects were awarded a total of $10 million to support clean energy research and development.

In CEF3, during the 2017 biennium, funds for RD&D attracted 52 applicants and $51 million in proposed projects for only $8.2 million in available capital. Out of the 52 applicants, ten applicants have been conditionally awarded grants.

CETF4 has $8.1 million allocated for RD&D in the 2019 Capital Budget. Awardees have not yet been announced.

Notable Projects

University of Washington Mechanical Engineering Department MEBARC program received $1.1 million in funding from CEF3 to help make composites manufacturing more-economically viable by improving quality, reducing energy costs, and minimizing waste and scrap. The program is also developing college graduates with skills in advanced manufacturing, a vitally important economic sector to the state of Washington.

Corumat, a materials science company, has been conditionally awarded $2.3 million from CEF3 to develop bio-derived plastics for the food industry. The company intends to replace solid plastic with as little as one-third of the material, which will lower material costs and dramatically reduce the carbon emissions through the use of bioplastic pellets.

Grants to Nonprofit Lenders

Overview

To grow a robust cleantech ecosystem and reduce energy use, entrepreneurs, nonprofits, and homeowners alike require access to capital. The Clean Energy Fund's Grants to Nonprofit Lenders program provides capital to competitively- selected, mission-focused nonprofit lending institutions. Those institutions then invest in proven building energy efficiency and renewable energy technologies that currently lack access to capital – whether in the residential or commercial sectors.

The Clean Energy Fund has allowed lenders to leverage other private financing from utilities, contractor incentives, and other sources to allow homeowners and businesses to complete clean energy projects that reduce energy usage and improve quality of life including the installation of efficient windows, insulation, ventilation, and high-efficiency water heaters, seal ducts, and boiler replacement.

Over three rounds of funding, three lenders have received investments – Craft3, Puget Sound Cooperative Credit Union, and Washington State Housing Finance Commission.

Notable Projects

Craft3 is a regional nonprofit that makes loans in Oregon and Washington that strengthen the resiliency of businesses, families, and nonprofits, including those without access to traditional financing. With Clean Energy Fund capital, it offers affordable home energy upgrade loans to homeowners that live in Seattle City Light's, NW Natural's, and Pacific Power's service territories. It also has invested CEF dollars in twenty-five small business and nonprofit projects that have reduced energy consumption, generated renewable energy, and boosted cleantech manufacturing. Those commercial loans–made with over $14 million in CEF capital–were matched by $9.7 million in Craft3's own funds and leveraged $68.4 million in private capital.

Washington State Housing Finance Commission (WSHFC) is a publicly accountable, self-supported organization that is dedicated to increasing housing access and affordability in Washington. In 2009, the state legislature empowered WSHFC to create a Sustainable Energy Trust (SET) to help non-profit facilities and multi-family become more energy efficient. Thanks to two separate CEF investments that totaled $1.9 million, WSHFC has already leveraged an additional $2 million to help eight non-profit organizations perform substantial energy efficiency retrofits to their outdated facilities. These retrofits free up a significant amount of operating revenue that can subsequently be used for an organization's mission instead of their utility payments. For example, a SET/CEF loan helped Valley Cities rebuild their Seattle Recovery Center, where utility costs are now approximately 70% less than their Auburn facility.

Puget Sound Cooperative Credit Union (PSCCU) received $2.9 million for residential energy upgrades in the 2013 biennium from CEF1. Recently, they received additional CEF grant money for loan loss reserves to support energy- smart loans, which includes renewables and electric vehicles. PSCCU leverages funds at a ratio of 20:1 and has turned over $8.5 million in funds to nearly $75 million in loans. These loans have put money back into our local economies, created living wage jobs, and have helped homeowners, farmers, and small business owners from Aberdeen to Zillah. Every day, PSCCU is using Clean Energy Fund capital to make an impact on Washingtonians by making someone more comfortable in their home, helping a small business use less energy, creating a job, and protecting our environment for future generations.

CEF1 Breakdown

$36 million total to fund three competitive programs from the 2013-2015 Capital Budget. Smart Grid Grants to Utilities ($15 million). Energy Revolving Loan Fund Grants ($15 million). Federal Clean Energy Matching Funds ($6 million).

Grid Modernization:

- Snohomish County PUD MESA1 and MESA2- **$7.3 million** total for two demonstration projects. The PUD is working with Seattle-based 1Energy Systems to implement Modular Energy Storage Architecture, a set of nonproprietary design and connectivity standards that provide a scalable approach for energy storage control system integration and optimization.
- Avista- **$3.2 million** grant to field test a 1-MW, 3.2-MWh UniEnergy vanadium flow battery assembly in a three-year demonstration project at a substation in Pullman.
- Puget Sound Energy- **$3.8 million** to help deploy a 2-MW, 4.4-MWh lithium-ion/phosphate battery assembly in Glacier.

Federal Clean Energy Matching Funds:

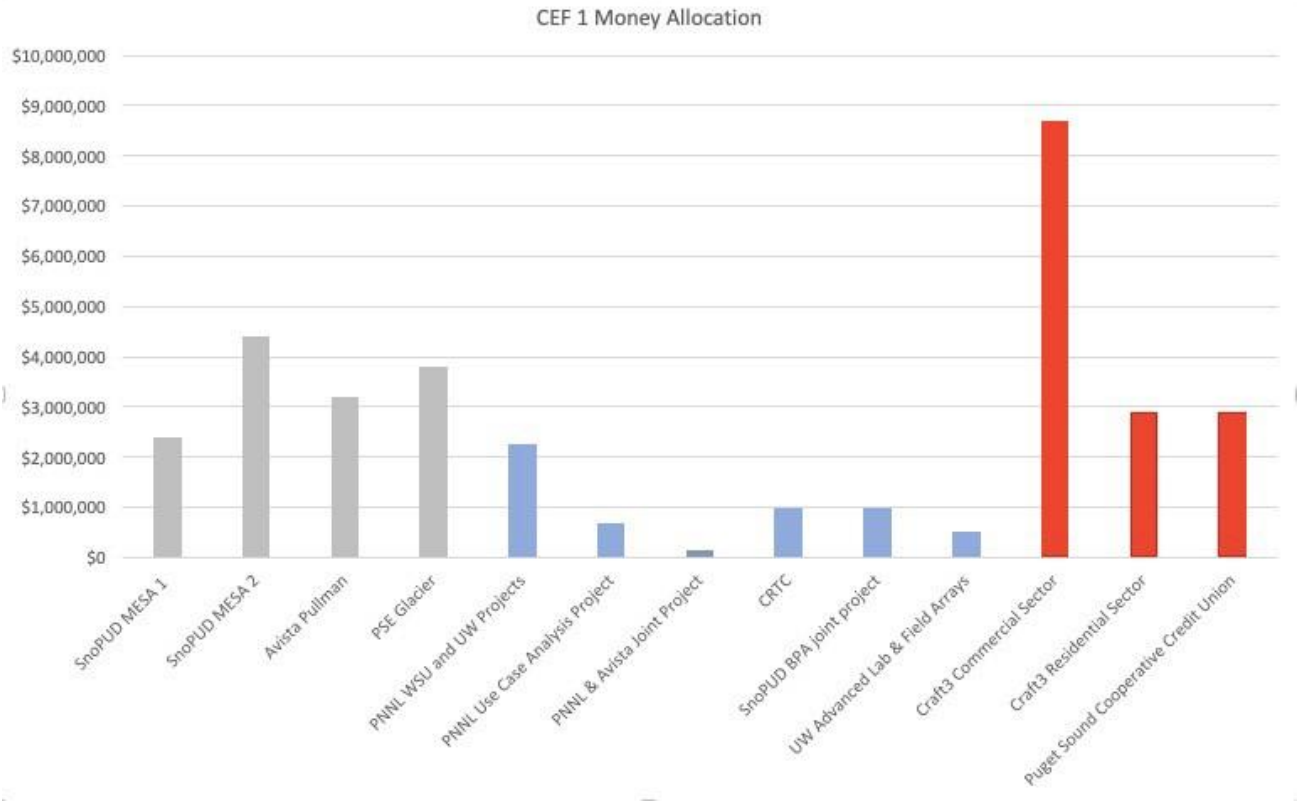
- Pacific Northwest National Lab (PNNL)- Pacific Northwest National Lab (PNNL)- **$2.25 million** ($1.1 million to WSU, $783,000 to UW.
- $367,000 to PNNL) to address the key challenge of providing smooth, stable, and predictable “control” of PNNL, UW, and WSU “smart” assets via a regional renewables integration resource and R&D testbed.
- PNNL - **$695,000** to collect data from Avista, PSE, & SnoPUD Smart Grid battery projects and perform the analytics on the Smart Grid Use Case Analysis further documenting the economic viability and grid resiliency values of energy storage systems (batteries).
- PNNL - **$145,000** joint project with Avista for development of energy storage control strategies through controls optimization for the battery control software algorithms.
- Composite Recycling Technology Center- **$1 million** to renovate their industrial & workforce training facility used to recycle composite materials.
- SnoPUD BPA joint project- **$1 million** for a joint project with Bonneville Power Administration (BPA) entitled, “Support Using Distribution-Level Energy Assets to Help Optimize Regional Transmission Systems”. This project provides pricing schemes that could incentivize utilities to respond to BPA congestion and renewable power loads by Using Distribution-Level Energy Assets to Help Optimize Regional Transmission Systems.
- University of Washington - **$518,000** accelerate the development of next-generation arrays of wave energy conversion (WEC) and tidal energy conversion (TEC) devices through a suite of field-focused R&D activities by the Northwest National Marine Renewable Energy Center developed Advanced Laboratory and Field Arrays.

Grants to Nonprofit Lenders:

- Craft3- **$8.7 million** for commercial sector; **$2.9 million** for residential sector.
- Puget Sound Cooperative Credit Union (PSCCU)- **$2.9 million** for residential sector.

CEF1 Money Allocation		
Project	Amount Awarded	Total per Program
SnoPUD MESA 1	$2,400,000	$15,000,000
SnoPUD MESA 2	$4,400,000	
Avista Pullman	$3,200,000	
PSE Glacier	$3,800,000	
PNNL WSU and UW Projects	$2,250,000	$6,000,000
PNNL Use Case Analysis Project	$695,000	
PNNL & Avista Joint Project	$145,000	
CRTC	$1,000,000	
SnoPUD BPA joint project	$1,000,000	
UW Advanced Lab & Field Arrays	$518,000	
Craft3 Commercial Sector	$8,700,000	$15,000,000
Craft3 Residential Sector	$2,900,000	
Puget Sound Cooperative Credit Union	$2,900,000	
Grand Total in CEF1		**$36,000,000**

Key
Grid Modernization
Federal Clean Energy Matching Funds
Research, Development and Deployment (RD&D
Grants to Nonprofit Lenders
Electrification of Transport Program
Solar Deployment Program
Greenhouse Gas Reduction Program
Shore Power Electrification at Terminal 5
Dairy Digester Biofertilizer Projects
Washington Maritime Innovation Center
PNNL
Port of Grays Harbor
Credit Enhancement... Program
John Day Pool (reappropriation)



CEF2 Breakdown

$36 million to fund four competitive programs from the 2015-2017 Capital Budget. Grid Modernization ($13 million). Research, Development, and Demonstration ($10 million). Grants to Nonprofit Lenders ($13.6 million). Credit Enhancement for Renewable Energy Manufacturing Funds ($200,000).

Grid Modernization:

- Snohomish County PUD - **$3.5 million** for a micro-grid & clean energy technology center in Arlington.
- Avista - **$3.5 million** for a micro transactive grid project called Spokane Urbanova.
- Energy Northwest **$3 million** for the Horn Rapids Solar, Storage & Training Project.
- Seattle City Light - **$1.5 million** for the resilience focused Miller Community Center solar & storage microgrid pilot.
- Orcas Power & Light Co. **$1 million** for the Decatur Island solar & storage microgrid project.

RD&D

- Composite Recycling Technology Center (CRTC) **($1.7 million**) to demonstrate viable commercial processes for recycling carbon fiber.
- Edaleen Cow Power (**$273K**) for an advanced solids and nutrient recovery system converting manure into fertilizer and cow bedding.
- Impact Bioenergy (**$550K**) to demonstrate conversion of food waste into biogas.
- Janicki (**$283K**) for a bio-digester that will produce clean water and renewable natural gas and from farm waste.
- Polydrop (**$449K**) for conductive polymer additives to improve the fuel efficiency of vehicles and planes.
- Microsoft (**$675K**) for fuel cells in a data center environment.
- Oscilla Power **($1 million**) to build and test community scale wave energy conversion
- Dresser Rand (**$870K**) will test HydroAir™, a variable radius turbine system that generates electric power from ocean waves.
- Demand Energy (**$630K**) to develop a platform that will help evaluate new battery technologies and optimize renewables and energy storage.
- Battery Informatics (**$135K**) for next generation lithium ion battery management systems to maximize battery efficiency.
- Zunum Aero ($800K) to develop the first commercial-class hybrid aircraft.
- Battelle (Pacific Northwest National Lab) ($2 million) to further develop transactive technology allowing building owners to dynamically control energy use.

Grants to Nonprofit Lenders:

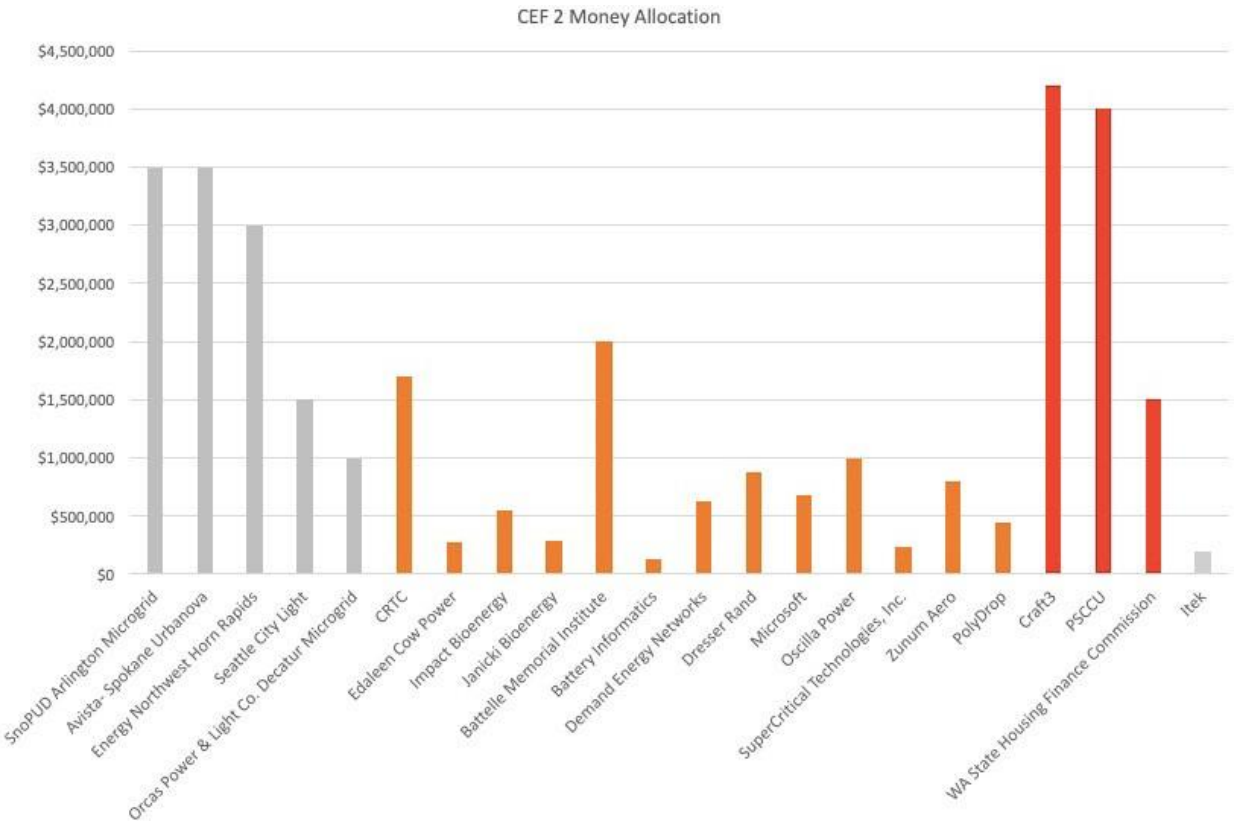
- Craft3- **$4.2 million.**
- PSCCU- **$4 million.**
- Washington State Housing Finance Commission- **$1.5 million.**

Credit Enhancement Grants:

- Itek - **$200,000** providing credit enhancement incentive for the enlargement of an advanced energy technology manufacturing site.

CEF2 Money Allocation		
Project	Amount Awarded	Total per Program
SnoPUD Arlington Microgrid	$3,500,000	
Avista- Spokane Urbanova	$3,500,000	
Energy Northwest Horn Rapids	$3,000,000	$13,000,000
Seattle City Light	$1,500,000	
Orcas Power & Light Co. Decatur Microgrid	$1,000,000	
CRTC	$1,700,000	
Edaleen Cow Power	$273,360	
Impact Bioenergy	$550,000	
Janicki Bioenergy	$283,158	
Battelle Memorial Institute	$2,000,000	
Battery Informatics	$135,000	
Demand Energy Networks	$630,000	$10,000,000
Dresser Rand	$870,000	
Microsoft	$675,000	
Oscilla Power	$1,000,000	
SuperCritical Technologies, Inc.	$238,158	
Zunum Aero	$800,000	
PolyDrop	$449,000	
Craft3	$4,200,000	
PSCCU	$4,000,000	$13,600,000
WA State Housing Finance Commission	$1,500,000	
Itek	$200,000	$200,000
Grand Total in CEF2		**$36,800,000**

Key
Grid Modernization
Federal Clean Energy Matching Funds
Research, Development and Deployment (RD&D)
Grants to Nonprofit Lenders
Electrification of Transport Program
Solar Deployment Program
Greenhouse Gas Reduction Program
Shore Power Electrification at Terminal 5
Dairy Digester Biofertilizer Projects
Washington Maritime Innovation Center
PNNL
Port of Grays Harbor
Credit Enhancement... Program
John Day Pool (reappropriation)


CEF 2 Money Allocation
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
SnoPUD Arlington Microgrid
Avista- Spokane Urbanova
Energy Northwest Horn Rapids
Seattle City Light
Orcas Power & Light Co. Decatur Microgrid
CRTC
Edaleen Cow Power
Impact Bioenergy
Janicki Bioenergy
Battelle Memorial Institute
Battery Informatics
Demand Energy Networks
Dresser Rand
Microsoft
Oscilla Power
SuperCritical Technologies, Inc.
Zunum Aero
PolyDrop
Craft3
PSCCU
WA State Housing Finance Commission
Itek

CEF3 Breakdown

$36 million to fund five competitive programs from the 2017-2019 Capital Budget. Grid Modernization Grants to Utilities ($11 million). Electrification of Transportation Systems ($11 million). Research, Development, and Demonstration ($7.85 million). Solar Deployment ($4 million). Greenhouse Gas Reductions ($2.4 million). ***All awards inclusive of final grant amount are contingent on grantee requirements and are subject to renegotiation.**

Grid Modernization

- **Avista** is involved in developing Spokane's University District, including the 150,000-square-foot Catalyst Building. The building will generate the energy it uses through solar panels and other renewable energy technologies – a "net zero" design. It will be connected to an eco-district powered by a centrally located power plant. Avista's shared energy economy pilot allows buildings to share energy resources to more efficiently generate and use energy, and to store excess energy created by the buildings for future use. This Clean Energy Fund grant will support further evaluation of this and other similar grid utilization strategies. It expands on a separate solar plus microgrid research, development and demonstration project funded in part with a $3.5 million grant in 2017. The new work will assess how this cluster of buildings performs and what infrastructure will be needed for these types of developments in the future.

- **Orcas Power & Light (OPALCO)** proposes to develop a hybrid energy storage system Combined with state-of-the-art switch gear, the system will use a mix of flow (longer lasting) and lithium ion (more rapid responding) battery technology to provide rapid response and long life at moderate cost. A prior community solar project enabled with a $1 million grant from the Clean Energy Fund in 2017 was used to demonstrate a similar microgrid application on remote Decatur Island. The new project will be co-located with a community solar project (separately funded) near the Lopez Island town center, providing opportunities for customers to participate in new service programs around green energy. Additionally, OPALCO seeks to maximize economic benefit to the community and will look at a variety of other uses, including back-up power to improve outage response.

- **Puget Sound Energy** is planning an innovative microgrid project in Tenino, Thurston County. PSE's Blumauer substation will be the host site for the first utility scale solar plus storage microgrid project in PSE's service area. In partnership with the Tenino School District, PSE will use solar power, along with new energy storage and customer load controls, to increase reliability and resilience for Tenino High School. Another battery will also be installed at the end of a distribution feeder line in the rural community, which will enable the demonstration of reliability improvement. With funding from a Clean Energy Funds grant, PSE previously deployed a battery energy storage solution to provide a variety of grid support services including back-up power to customers

in the rural community of Glacier, near Mt. Baker.

- **Tacoma Power** proposes partnering with a large industrial customer, to construct an 850,000-gallon liquid nitrogen storage tank for use as liquid air energy storage. It will have equivalent large capacity for a 15 megawatt/450-megawatt hour demand response. Combined with automation and control strategies, the liquefied air tank will benefit both the company and Tacoma Power by unlocking new ways to deliver the consistent, reliable, high power loads needed. This type of thermal energy storage system can provide many economic and grid benefits for utilities and their industrial customers.

RD&D

- **Beta Hatch** to design and build Washington's first commercial insect farm, with air handling systems to optimize waste heat use from a data center. The project will develop modular insect farms as a novel end-use for low- value waste heat in rural Washington.

- **Corumat** for development of bio-derived plastics relevant to the food industry. This project allows the replacement of solid plastic with as little as 1/3 the material.

- **Composite Recycling Technology Center (CRTC) t**o develop lightweight products from recycled aerospace scrap for multiple applications to include marine cabling and lightweight advanced cross- laminated timber.

- **Insitu** for development of a transportable hydrogen generation and liquefaction system to produce clean hydrogen from a renewable power source.

- **Oscilla Power** to determine the optimal system configuration and parameters of the Triton wave energy converter (WEC) needed in order to be able to capture energy from ocean waves at the lowest level cost of electricity (LCOE) possible.

- **Pacific Northwest National Laboratory (Solid Phase)** to scale up ShAPE processing of Mg and other lightweight alloys, a severe plastic deformation-assisted method that results in a fine and uniform grain structure and requires less energy than state of the art methods for extrusion of lightweight alloys.

- **Sironex Composite** to convert waste products of thermal power plants containing impurities that are hazardous to the environment, into fire resistant light weight structural materials.

- **Spokane Eco** for developing machine-learning-based control methods that would enable optimal use of multiple energy conversion and storage devices

in managing a building complex.

- **University of Washington Applied Physics Laboratory** to demonstrate an improvement in wave energy converter (WEC) performance (efficiency and peak to average ratio) utilizing future wave excitation information provided by state-of-the-art measurement and control techniques during testing in the ocean.

- **University of Washington Mechanical Engineering Department (MEBARC)** to make composites manufacturing economically viable by ensuring high part quality, lowering energy costs, and minimizing waste and scrap. The project will demonstrate how to predictably design and produce complex (hi-contour) thermoplastic composite parts using automated robotic systems.

Solar Deployment Program: A second competitive round is under development

- **One Energy Development** to support the Sunnyside Solar Project. The Project will provide power to the distribution side of PacifiCorp's network in, reducing the need to acquire additional electricity to meet peak demand.

- **Peninsula Light Company** to use grant funds to support the Peninsula Light Company's solar power system. Located in the Peninsula Light service area on the Gig Harbor Peninsula, the Project will provide subscriptions with no upfront participation costs to multiple low-income members along with billing credits.

- **TUUSSO Energy** to use grant funds to support the Urtica Solar project. The Project is a solar panel power project, currently under development in Ellensburg, WA. Once operational, the project will supply power to Puget Sound Energy.

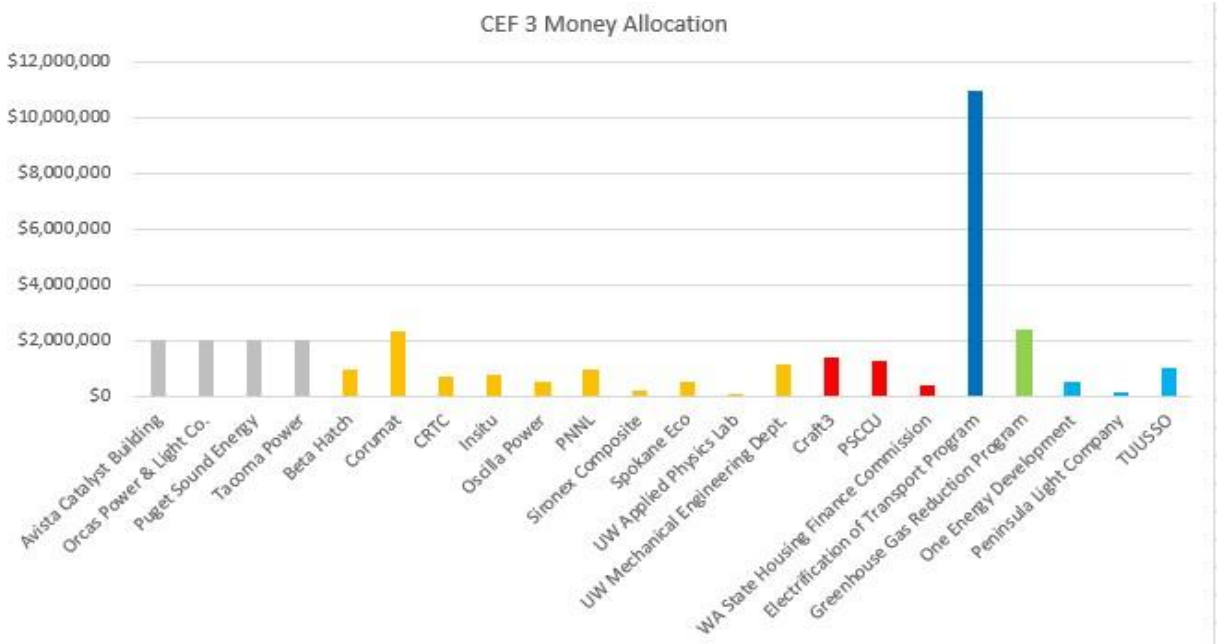
Electrification of Transport Program– Currently in development

Greenhouse Gas Reduction Program– Applications for competitive round are currently in review

Grants to Nonprofit Lenders- $3 million total to 3 financial institutions.

- Craft3- **$1,431,735**
- PSCCU- **$1,295,611**
- Washington State Housing Finance Commission- **$376,654**

CEF3 Money Allocation		
Project	Amount Awarded	Total per Program
Avista Catalyst Building	$2,000,000	$10,600,000
Orcas Power & Light Co.	$2,000,000	
Puget Sound Energy	$2,000,000	
Tacoma Power	$2,000,000	
Beta Hatch	$937,800	$7,850,000
Corumat	$2,344,500	
CRTC	$707,570	
Insitu	$803,196	
Oscilla Power	$555,737	
PNNL	$937,800	
Sironex Composite	$234,450	
Spokane Eco	$515,790	
UW Applied Physics Lab	$93,309	
UW Mechanical Engineering Dept.	$1,125,360	
Craft3	$1,431,735	$3,000,000
PSCCU	$1,295,611	
WA State Housing Finance Commission	$376,654	
Electrification of Transport Program	$11,000,000	$11,000,000
Greenhouse Gas Reduction Program	$2,400,000	$2,400,000
One Energy Development	$500,000	$4,000,000
Peninsula Light Company	$139,860	
TUUSSO	$1,000,000	
Grand Total in CEF3		**$38,850,000**



CEF4 Breakdown (latest cycle of funding)

$42 million to fund seven programs from the 2019-2021 Capital Budget. Grid Modernization Grants to Utilities ($7.7 million). Research, Development, and Demonstration Matching Funds ($7.1 million). Energy Revolving Loan Fund ($7.907 million). Northwest Sea Port Alliance Electrification at terminal five ($4.4 million). Washington Maritime Innovation Center ($5 million). PNNL ($8.3 million). Grays Harbor ($593,000).

Grid Modernization–Program under development

RD&D–Program under development

Grants to Nonprofit Lenders–Program under development

CETF4 Money Allocation			
Project	Amount Awarded	Total per Program	
Grid Modernization projects TBA		$7,700,000	
Shore Power Electrification at Terminal 5		$4,400,000	
RD&D Program		$7,100,000	
Grants to Nonprofit Lenders TBA		$7,907,000	
Dairy Digester Biofertilizer Projects		$1,000,000	
Washington Maritime Innovation Center		$5,000,000	
PNNL		$8,300,000	
Port of Grays Harbor		$593,000	
Solar Deployment Prgm (reappropriation)	$4,000,000		
Greenhouse Gas Reduction Program (reappropriation	$2,400,000		
John Day Pool (reappropriation)	$1,100,000		
Grand Total in CETF4		**$42,000,000**	***Programs still in development***

Green Jobs

How many ‘green jobs’ are there in Seattle? In Washington? In the US? In the world? To find the answer to these questions and more, we pored over dozens of peer-reviewed studies, looked at data from different governmental organizations, and sifted through reports from nonprofits and other organizations.

The 9 studies and reports linked below were selected out of dozens of potential studies.

The biggest challenge when comparing disparate studies is that many of them use different methodologies and have a different definition of what counts as a ‘green job’. Throughout this project, we made an effort to compare reports with similar methodologies in order to draw more accurate conclusions and compare ‘apples to apples’ numbers.

- E2 and Clean Jobs Count Clean Jobs Report
- Estimating the scale of the US green job economy within the global context
- Bureau of Labor Statistics Green Goods and Services Survey
- Characterizing green employment: The impacts of ‘greening’ on workforce composition
- Fact Sheet - Jobs in Renewable Energy, Energy Efficiency, and Resilience (2019)
- International Renewable Energy Agency (IRENA) Renewable Energy and Jobs Annual Review
- In Demand: Clean Energy, Sustainability, and the New American Workforce
- Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times
- 2018 US Energy and Employment Report

Based on the information in those reports, we were able to make the following estimates of how many green jobs there are in the metro, the state, the country and the world.

- **47k** Green Jobs in the Seattle-Tacoma-Bellevue Metro area.
- **85k** Green Jobs in Washington State.
- **3.5 million** Green Jobs in the USA.
- **12 million** Green Jobs worldwide.

The most commonly used definition of a ‘green job’ is the one created by the Bureau of Labor Statistics, which states the following:

Green jobs are either:

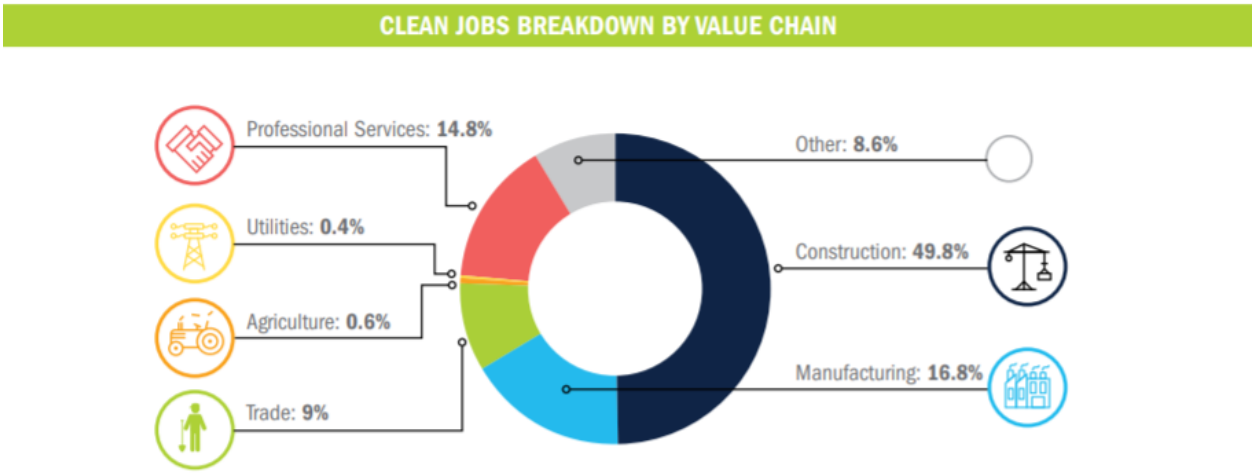
- Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources.
- Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources.

Another reliable definition of a ‘green job’ comes from the E2 Clean Jobs Count report, which includes employment in solar energy, wind energy, energy efficiency, combined heat and power, bioenergy, non-woody biomass, low-impact hydro power, geothermal, clean vehicle

technologies, clean energy storage, smart grid, micro grid, grid modernization, and advanced biofuels. Other industries commonly associated with clean energy — such as corn ethanol, woody biomass, large hydropower, and nuclear — were not included in their jobs numbers.

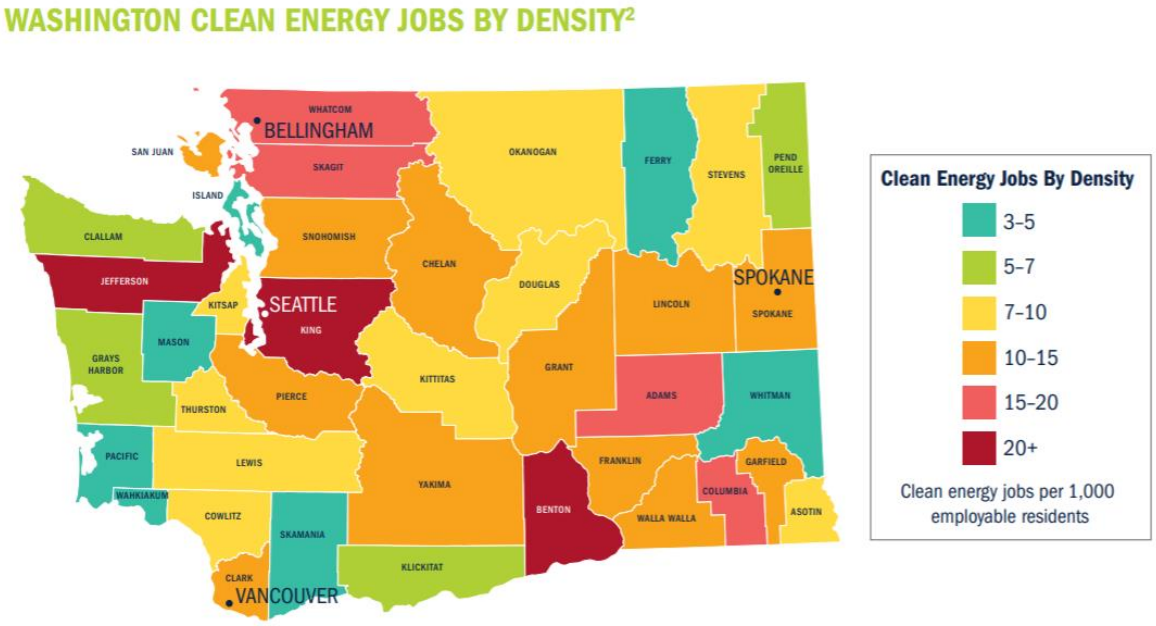
Additionally, many studies use the definition and methods outlined in The United States Energy Employment Report. The United States Energy Employment Report or USEER is an annual report put out by the Department of Energy and the National Association of State Energy Officials. It examines four sectors of the economy: Electric Power Generation and Fuels; Transmission, Distribution, and Storage; Energy Efficiency; and Motor Vehicles. The first two of these sectors—Electric Power Generation and Fuels and Transmission, Distribution, and Storage—make up what are generally considered the Traditional Energy sectors.

Other reports used a wide variety of methodologies including transactional and operational business data triangulation, supplemental surveys, input-output modeling and employment factor calculations.

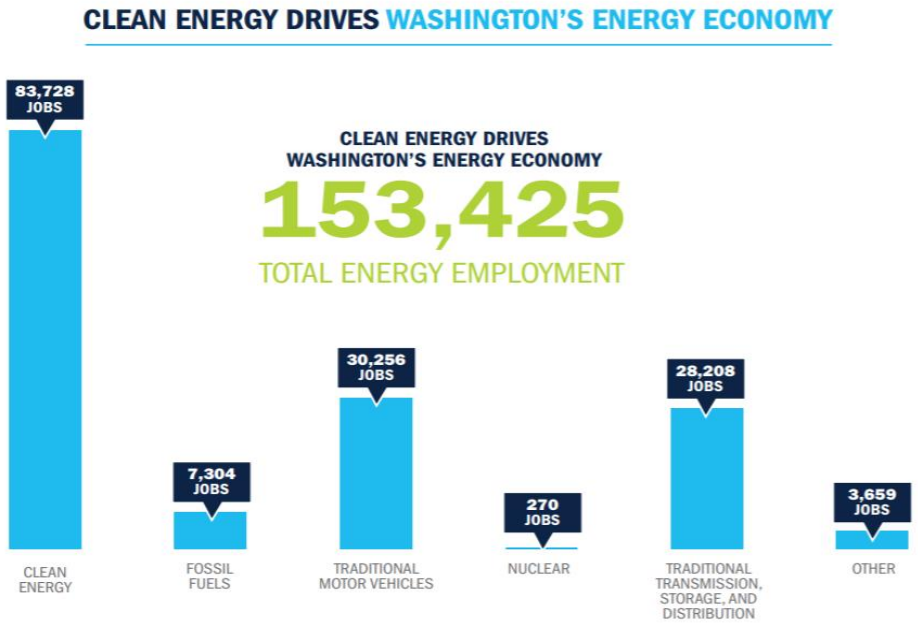


This figure was taken from the E2 Clean Jobs Count 2019 report specific to Washington state. It breaks down the clean jobs by value chain and shows that construction is by far the most common sector at 49.8%. This is good for Washington because construction jobs are highly local and can't be easily outsourced.

The E2 report found 45,820 clean jobs in the Seattle-Tacoma-Bellevue metro area in 2018 and the same report found 46,804 jobs in the metro in 2019, an increase of 984 jobs. No other report looked specifically at the Seattle metro area but given the year to year increase in clean jobs, we think it's safe to say that there are at least 47,000 jobs in the metro today.

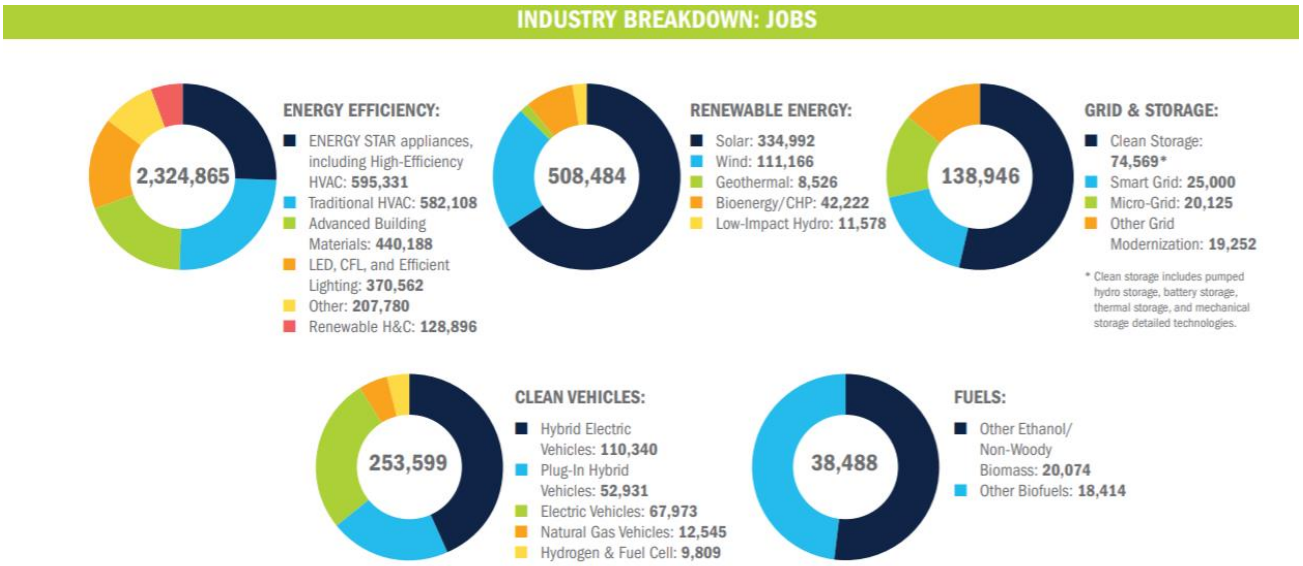


This figure from the 2019 E2 report shows which counties have the highest density of clean energy jobs and it's clear that King county is a leader with over 20 clean energy jobs per 1,000 employable residents.



The E2 report also shows that clean energy drives Washington's energy economy with over 83k of the 153,425 energy jobs in clean energy.

In 2018, the E2 Clean Jobs Count Report found 82,859 clean jobs in Washington and 83,728 jobs in 2019, an increase of 869 jobs. The Bureau of Labor Statistics Green Goods and Services Survey was discontinued in 2013 due to budget cuts but counted 95,769 GGS jobs in 2010 and 101,593 GGS jobs in 2011. While BLS's definition was a bit more generous than E2's we feel confident that there are at least 85,000 green jobs in the state today.



This figure is also from the E2 Clean Jobs Count Report, but it looks at the industry breakdown for clean jobs across all of America, not just Washington.

Numerous studies focused on quantifying clean jobs in the United States and had a wide range of estimates. The E2 report found 3,176,839 green jobs in 2018 compared to 3,264,383 in 2019. BLS found 3.2 million GGS jobs in 2010 compared to 3.4 million in 2011 and the Georgeson and Maslin 2019 study estimated 9.5 million workers in the Low Carbon Environmental Goods and Services sector, which had a broader definition of a clean job.

The International Renewable Energy Agency or IRENA found 555,168 direct renewable energy jobs in 2018 and 855k indirect energy jobs with more than 3 million jobs in energy efficiency. The same IRENA study found 887,100 jobs in solar, installation, wind, manufacturing, ethanol, biodiesel and biomass in 2017.

Lastly, the Environmental Defense Fund study found 4 million people work in clean energy and the sustainable economy in 2016. Although these numbers can vary between studies, looking at them as a whole, we concluded that there were about 3.5 million green jobs in the United States.

To find out how many green jobs there are worldwide, we focused on the IRENA annual report. IRENA is an intergovernmental organization that is the preeminent source for worldwide jobs numbers. No other organization that we could find keeps reliable year to year data of green jobs worldwide, which makes IRENA an invaluable resource.

They estimated 8.1 million green jobs in 2015, which jumped up 1.7 million jobs to 9.8 million in 2016. In 2017 they counted 10.3 million jobs and in IRENA's most recent report, they found 11 million green jobs worldwide. The 2019 report has not yet been released but with China driving growth along with other countries around the world, we estimate that there are at least 12 million green jobs worldwide today.

For context, the bullet points below show the total number of jobs in the metro, state, country, and world compared to how many of those are considered green jobs:

- 2.2 million jobs in the Seattle-Tacoma-Bellevue metro area (BLS)
    - 47k Green Jobs in the Seattle-Tacoma-Bellevue metro area (E2)
- 3.96 million jobs in Washington state (BLS)
    - 85k Green Jobs in Washington state (E2)
- 152.5 million people employed full-time in USA in February 2020 (St. Louis Fed)
    - 3.5 million Green Jobs in the US (E2 and EDF Study)
- 3.3 billion people employed worldwide in 2019 (ILO)
    - 12 million Green Jobs worldwide (IRENA)

Green Jobs Quick Facts

- 94,161 jobs in Electric Vehicle Design, Development, and Manufacturing (GSP).
- 83,728 clean energy jobs across Washington vs 7,394 fossil fuel jobs (E2 report).
    - Breakdown by industry:
        - Energy Efficiency: 63,877 jobs
        - Renewable Energy: 11,106 jobs
        - Grid and Storage: 3,457 jobs
        - Clean Vehicles: 3,452 jobs
        - Fuels: 1,813 jobs
- 70% of clean energy workers are employed by businesses with fewer than 20 employees.
- 36,592 clean energy jobs in King County, WA (E2 report).
- 4,433 renewable energy jobs in King County, WA (E2 report).
- 29,235 energy efficiency jobs in King County, WA (E2 report).
- 46,804 clean energy jobs in the Seattle, Tacoma, Bellevue Metro area (E2 report).
- 6,905 renewable energy jobs in the Seattle, Tacoma, Bellevue Metro area (E2 report).
- 35,101 energy efficiency jobs in the Seattle, Tacoma, Bellevue Metro area (E2 report).
- 45% of Washington's clean energy workforce is located outside the Seattle metro area.
- 82,859 clean energy jobs in WA in 2018 → 83,728 in 2019 (869 more jobs).
- 13,000 jobs are located in counties with populations less than 200,000 (E2).
- 3,176,839 clean energy jobs in the country (Clean Jobs Count/ E2 study).
- Estimated 4% of working age population has a job in the Green Economy (Georgeson & Maslin).
- US green economy employs nearly 9.5 million workers nationwide, up 20% from 2012-16.
- In 2011, there were 3.4 million Green Goods and Services (GGS) jobs, accounting for 2.6% total US employment.
- In 2010, there were 3.2 million jobs in the US associated with the production of Green Goods and Services (GGS), accounting for 2.5% total US employment.
- In 2011, Washington had 101,593 GGS jobs according to the BLS survey compared to 95,769 in 2010.
- In 2010, GGS jobs account for 3.4% of all jobs in Washington vs 3.6% in 2011
- Using O*NET's definition of green jobs, the proportion employed in the US green economy, using the broadest definition of green jobs, could be as much as **19.4%** of the total workforce.
- A large proportion of this estimated employment would be 'indirectly' green, with **10.3%** of the total workforce actually using any specifically green tasks in their jobs and **1.2%** employed in jobs that are unique to the green economy.
- **555,168** Direct Jobs in US in Q2 of 2018.
- **855,000** Indirect Jobs in US compared to, 4,078,000 in China, 1,125,000 in Brazil, 719,000 in India and 1,235,000 in the European Union.
- In 2016, **employment in energy storage increased 235%** from the previous year to reach 90,800 jobs, with battery storage accounting for over half of these jobs (EDF study).
- As of 2016, the US employs over 4 million workers in the clean energy and sustainability economy (Environmental Defense Fund study).

Studies Reviewed

Name of the Study: E2 and Clean Jobs Count Clean Jobs Report

Background on Organization Conducting the Study: E2 (Environmental Entrepreneurs) is a national, nonpartisan group of business leaders, investors, and professionals from every sector of the economy who advocate for smart policies that are good for the economy and good for the environment. Our members have founded or funded more than 2,500 companies, created more than 600,000 jobs, and manage more than $100 billion in venture and private equity capital.

Methodology:
Q: What counts as a "clean job" according to this report?
Employment in solar energy, wind energy, energy efficiency, combined heat and power, bioenergy, non-woody biomass, low-impact hydro power, geothermal, clean vehicle technologies, clean energy storage, smart grid, micro grid, grid modernization, and advanced biofuels. Other industries commonly associated with clean energy, such as corn ethanol, woody biomass, large hydropower, and nuclear, are not included in these jobs numbers.
These include jobs involved in construction, manufacturing, wholesale trade, transmission and distribution, and professional services. Jobs in retail trade, repair services, water or waste management, and indirect employment or induced employment are not included.
The job numbers come from the national **2019 U.S. Energy and Employment Report (USEER),** which focuses on all energy jobs. The USEER analyzes data from the U.S. Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) to track employment across many energy production, transmission, and distribution subsectors.
In addition, the 2019 USEER relies on a unique supplemental survey of 30,000 business representatives across the U.S. Created and conducted by BW Research and approved by the Office of Management and Budget and U.S. Department of Energy (DOE), this survey is used to identify energy-related employment within key subsectors of the broader industries as classified by the BLS and to assign them into their component energy and energy efficiency sectors.

Summary of Findings:

- **Jobs in King County:** 35,592 clean**,** 4,433 renewable energy and 29,235 energy efficiency.
- **Jobs in Seattle Metro:** 46,804 clean, 6,905 renewable energy and 35,101 energy efficiency.
- **Number of clean energy jobs in WA:** 83,728 clean jobs as of 2019.
- **Number of clean energy jobs in USA:** 3,176,839 clean energy jobs total in the US.
- **Total Energy Employment in WA:** 153,425
    - There are 11 times more clean energy jobs than fossil fuel jobs
    - 7 in 10 clean energy employees work at companies with fewer than 20 employees
    - 55% of Washington energy sector jobs are in clean energy
    - Over 8,300 rural Washington residents work in clean energy

Name of the Study: Estimating the scale of the US green job economy within the global context

Background: Peer reviewed study in Palgrave Communications by Lucien Georgeson and Mark Maslin. Lucien is a researcher at Oxford with a focus on the Green Economy and sustainable development and Mark is a researcher and professor at University College London

Methodology: The methodology triangulates transactional and operational business data to estimate economic values, frequently where government statistics are not available. It can estimate the sales and employment in the green economy, the share of the country's economy taken up by the green economy, growth in the green economy and the green economy sectors that are leading that growth. This can estimate the contribution to the country's economy of the green economy, the progress made and national priority areas.
The methodology, developed by kMatrix Ltd, uses a number of different data sources and data types (transactional, procurement, insurance, industrial benchmarking) to arrive at estimates of economic value that would not be possible from a single data source. Each data point requires at least 7 data sources for 'triangulation', but in the Low Carbon and Environmental Goods and Services Sector (LCEGSS) dataset, the average number of data sources for each observation is 56. The transactional triangulation methodology has been used to: estimate climate change adaptation within ten megacities (Georgeson et al., 2016b), provide data on global private sector investment in clean energy R&D (Georgeson et al., 2016a), analyze global provision of climate and weather information (Georgeson et al., 2017a), and estimate global climate change adaptation spending relating to health (Watts et al., 2017). It has also been assigned official statistics status in order to provide trade statistics to the UK Government's Defense and Security Organisation (Department for International Trade Defense and Security Organisation, 2015).

Summary of Findings: Through the Low Carbon and Environmental Goods and Services Sector (LCEGSS) dataset, the US green economy is estimated to represent $1.3 trillion in annual sales revenue and to employ **nearly 9.5 million workers**; both of which have grown by over 20% between 2012/13 and 2015/16. Comparison with China, OECD members and the G20 countries suggests that the US is estimated to have a greater proportion of the working age population employed (4%) and higher sales revenue per capita in the green economy.

The estimated scale of the green economy ($1.3 trillion and employing over 4% of the working age population) strongly suggests that it is a significant contributor to US economic development and the economic well-being of millions of people across the US. It was also a key contributor to the US recovery after the 2007 financial crisis (Aldy, 2013). Existing federal policies to support the private sector (including clean energy initiatives) have assisted US businesses to grow and create jobs (Obama, 2017), and the data herein suggests that growth in jobs in the green economy may be faster than growth in estimated sales value in some sectors of the green economy. Economic initiatives and environmental regulations can, potentially, drive innovation and economic development (Ambec et al., 2013; Porter and van der Linde, 1995), rather than holding it back.

Name of the Study: Bureau of Labor Statistics

Background on the Organization: US agency tasked with collection of employment data. Note: On March 1, 2013, President Obama ordered into effect the across-the-board spending cuts (commonly referred to as sequestration) required by the Balanced Budget and Emergency Deficit Control Act, as amended. In order to achieve some of the savings required by the order, BLS eliminated all "measuring green jobs" products. These products included: data on employment by industry and occupation for businesses that produce green goods and services; data on the occupations and wages of jobs related to green technologies and practices; and green career information publications. Data only goes up to 2011

Methodology: Green jobs are either:

- Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources.
- Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources.

To implement the output approach, BLS will collect data on jobs associated with producing green goods and services through a mail survey of a sample of establishments identified as potentially producing such products and services based on their NAICS classification. The purpose of the Green Goods and Services (GGS) survey is to identify whether the establishment is producing any green goods and services and, if so, to measure the number of associated jobs in the establishment.
The BLS methodology will estimate the number of green jobs for a NAICS industry based on the green jobs found at individual establishments classified within the industry. The methodology does not simply designate an industry as "green" and count all jobs in that industry as green jobs, since establishments in the industry may also produce goods and services that are not considered green.

Summary of Findings:

- In 2011, there were 3.4 million Green Goods and Services (GGS) jobs, accounting for 2.6% total US employment.
- In 2010, there were 3.2 million jobs in the US associated with the production of Green Goods and Services (GGS), accounting for 2.5% total US employment.
- In 2011, Washington had **101,593 GGS jobs** according to the BLS survey compared **to 95,769 in 2010.**
- GGS employment accounted for 2.3% of private sector jobs and 4.2% of public sector jobs in 2011. The private sector had 2,515,200 GGS jobs, while the public sector had 886,080 GGS jobs. Among private sector industries, construction had the largest employment rate increase, from 7.0 to 8.9 percentage points, while manufacturing had the most GGS jobs (507,168).
    - 2010 GGS jobs: 3,243,533
    - 2011 GGS jobs: 3,401,279
    - 2010: GGS jobs account for 2.5% of all jobs in US.
    - 2011: GGS jobs account for 2.6% of all jobs in US.
- In 2010, GGS jobs account for 3.4% of all jobs in Washington vs 3.6% in 2011.

Name of Study: Characterizing green employment: The impacts of 'greening' on workforce composition

Background on Organization Conducting the Study: The Grantham Research Institute on Climate Change and the Environment was established by the London School of Economics and Political Science in 2008 to create a world-leading center for policy-relevant research and training on climate change and the environment, bringing together international expertise on economics, finance, geography, the environment, international development, and political economy.

About the Authors:

- **Alex Bowen:** Alex is now a special adviser to the Grantham Research Institute, working part-time. Until December 2016, he was a Principal Research Fellow at the Institute. Before joining the London School of Economics and Political Science, Alex worked at the Bank of England, his final post being as a Senior Policy Adviser on monetary policy issues. Alex's current research interests were stimulated by his sabbatical year away from the Bank working as senior economic adviser to 'The Economics of Climate Change: The Stern Review.'
- **Karlygash Kuralbayeva:** Karlygash is a Lecturer in Economics at the Department of Political Economy at King's College London. Previously she was a teaching fellow at London School of Economics, a research officer at Grantham Research Institute at LSE and a research fellow at the University of Oxford. Her research interests include macroeconomics, development, climate change economics and environmental economics. Karlygash holds a PhD in Economics from the University of Oxford.

Methodology: Green job or green occupation is defined as any job classified by O*NET to be affected by 'greening,' which could involve increased demand, changes in worker requirements, and the use of new worker requirements. All other jobs are considered non-green.

Summary of Findings: Using O*NET's definition of green jobs, the proportion employed in the US green economy, using the broadest definition of green jobs, could be as much as **19.4%** of the total workforce. However, a large proportion of this estimated employment would be 'indirectly' green, with **10.3%** of the total workforce actually using any specifically green tasks in their jobs and **1.2%** employed in jobs that are unique to the green economy. While there is a large proportion of employment in jobs that are closely related to green jobs, there is also a substantial proportion of employment in jobs that are not closely related to green jobs, which limits the potential short-term labor market benefits of the green transition.

The use of green tasks and types of skills required varies greatly across the green job subcategories defined by O*NET, which suggests that 'green' should be considered as a continuum rather than a binary characteristic. Between the two 'directly' green job categories, Green New and Emerging jobs are 'greener' than Green Enhanced Skills jobs, i.e. involve a higher proportion of green tasks to non-green tasks and use green tasks more frequently, and also rely more heavily on non-routine skills. It is also important to recognize that non-green jobs fall into two distinct subcategories: aside from their connection to green jobs, Green Rival and Other jobs also differ in standard skill measures and skill content. It is important to account for this heterogeneity within green and non-green job categories when defining green employment and designing re-training programs.

Name of the Study: Fact Sheet - Jobs in Renewable Energy, Energy Efficiency, and Resilience (2019)

Background on the Organization: Founded in 1984 by a bipartisan group of members of Congress to inform the debate and decision-making on energy and environmental policies, **the Environmental and Energy Study Institute (EESI)** is a 501(c)(3) non-profit organization dedicated to promoting sustainable societies. Our primary goal is to accelerate the transition to a new, low-emissions economy based on energy efficiency and renewable energy.

Methodology: The U.S. Bureau of Labor Statistics (BLS) defines green jobs as either "jobs in businesses that produce goods and provide services that benefit the environment or conserve natural resources" or as "jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources." These definitions include employment in 1) renewable energy; 2) energy efficiency; 3) pollution reduction and removal, greenhouse gas reduction, and recycling and reuse; 4) natural resources conservation; and 5) environmental compliance, education and training, and public awareness.

Summary of Findings: This fact sheet focuses on employment in the renewable energy and energy efficiency sectors in the United States and around the world. According to the 2019 U.S. Energy Employment Report (USEER), **611,000 people worked in zero-emission technology industries**, including renewables and nuclear in the United States. The International Renewable Energy Agency (IRENA) recorded even higher renewable energy employment in the United States at **855,000 direct and indirect jobs in 2018.** Jobs in energy efficiency experienced significant growth—the sector now employs more than **3 million people** in the United States. IRENA reports that, globally, the renewable energy sector employed **11 million people in 2018, 700,000 more than in 2017.**

- **555,168** Direct Jobs in Renewable Energy in the US in Q2 of 2018.
- **855,000** Indirect Jobs in US compared to, 4,078,000 in China, 1,125,000 in Brazil, 719,000 in India and 1,235,000 in the European Union.
- The Renewable Energy and Jobs annual Review 2019 estimates that there were approximately 11,000,000 direct and indirect jobs in the renewable energy sector across the world in 2018. This is an increase from 10.3 million jobs in the sector in 2017.
- According to USEER, 611,000 employees worked in zero-emission technology industries, including renewables and nuclear.
- The International Renewable Energy Agency (IRENA) recorded that renewable energy employment in the United States reached 855,000 direct and indirect jobs in 2018. IRENA reports that the biofuels, solar, and wind power industries provide the most renewable energy jobs in the United States. According to USEER, jobs in electrical power generation, which includes both renewable and nonrenewable energy sources, declined nearly one percent in 2018. In this sector, USEER reports solar power supporting 242,343 jobs, coal supporting 86,202 jobs, and natural gas supporting 43,526 jobs. Renewable energy firms surveyed for the USEER report highlight that a substantial barrier to increasing employment is finding skilled labor to fill positions.

Name of the Study: International Renewable Energy Agency (IRENA)

Background on the Organization: The International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a center of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

Methodology: Prominent methodologies include input-output modelling, industry surveys and employment-factor calculations, with varying degrees of detail and sophistication. For the most part, the employment numbers in this report cover direct and indirect (supply chain) jobs.

Summary of Findings:

- Since at least 2012, these factors have quietly driven the growth of companies focused on producing renewable energy, efficient technologies, and electric vehicles. According to the International Renewable Energy Agency (IRENA), the global number of jobs in cleantech reached the impressive figure of 10.3 million in 2017. Growth in cleantech jobs means that an economy based on sustainable energy could soon gain political and financial support across the globe.
- China alone accounts for 43% of all renewable energy jobs. Its share is particularly high in solar heating and cooling (83%) and in the solar photovoltaic (PV) sector (66%), and less so in wind power (44%).
- The PV industry was the largest employer (almost 3.4 million jobs, up 9% from 2016). Expansion took place in China and India, while the United States, Japan and the European Union lost jobs
- Including its onshore and offshore segments, the wind industry employs 1.15 million people worldwide, a 0.6% decrease from 2016
- Renewable energy employment worldwide has continued to grow since IRENA's first annual assessment in 2012. During 2017, the strongest expansion took place in the solar photovoltaic (PV) and bioenergy industries. In contrast, jobs in wind energy and in solar heating and cooling declined, while those in the remaining technologies were relatively stable.
- Globally, the solar PV industry had another banner year, with record installations of 94 gigawatts (GW) during 2017, up from 73 GW in 2016, and significant new job creation.
- IRENA's analysis suggests that jobs in the sector could rise from 10.3 million in 2017 to 23.6 million in 2030 and 28.8 million in 2050, in line with IRENA's more sustainable energy pathway.
- IRENA estimates that global employment in the solar heating sector stood at 807,000 jobs in 2017, a 2.6% decrease from the previous estimate.
- The renewable energy sector employed 10.3 million people, directly and indirectly, in 2017. Excluding large hydropower, employment increased by 6.3% to reach 8.8 million in 2017.
- Overall, renewable energy employment continued to shift towards Asian countries, which accounted for 60% of jobs in 2017, compared with 51% in 2013.

Name of the Study: In Demand: Clean Energy, Sustainability, and the New American Workforce

Background on the Organization: Environmental Defense Fund (EDF) is one of the world's largest environmental nonprofit organizations, with more than two million members and a staff of over 500 scientists, economists, policy experts, and other professionals around the world. EDF finds practical and lasting solutions to the world's most serious environmental problems. Working with leading businesses, scientists, and academics, EDF is taking a leading role in minimizing the environmental, economic, and human health risks associated with rising greenhouse gas emissions.

Methodology: The Department of Energy defines Energy Efficiency Employment as "the production or installation of energy efficiency products certified by the Environmental Protection Agency's ENERGY STAR ® program or installed pursuant to the ENERGY STAR ® program guidelines or supporting services thereof."

The Brookings Institution defines jobs in energy efficiency to include those related to: "appliances, battery technologies, electric vehicle technologies, energy-saving building materials, energy-saving consumer products, fuel cells, green architecture and construction, HVAC and control systems, lighting, professional energy services, public mass transit, smart grid, water efficient products," and is therefore larger than the Department of Energy's definition.

Summary of Findings:

- As of 2016, the US employs over 4 million workers in the clean energy and sustainability economy.
- Wind and solar energy jobs now outnumber coal and gas industry jobs in 30 states, with California and Texas employing the most workers in those industries.
- Wind employment exceeded 100,000 jobs in 2016 and grew 16 percent from the previous year.
- The fastest growing jobs in the solar and wind industries pay wages that meet or exceed national averages.
- The Bureau of Labor Statistics project that solar PV installers and wind turbine service technicians will be the two fastest growing jobs in America from 2016 to 2026, roughly doubling during that period.
- The energy storage market grew 46 percent between 2016 and 2017, with 28.6 megawatts deployed in Q3 2016 and 41.8 megawatts deployed in Q3 2017. Additionally, the market is projected to grow nine times between 2017 and 2022.
- In 2016, employment in energy storage increased 235% from the previous year to reach 90,800 jobs, with battery storage accounting for over half of these jobs.
- A study by The Brookings Institution found that 49.3 percent of jobs in energy efficiency required a high school diploma or less and 75 percent of positions within the energy sector were considered "green collar" or "middle-wage" jobs.
- The majority of energy efficiency workers are in construction, representing 21 percent of the 6.5 million jobs in the construction industry, and cannot easily be outsourced due to the local nature of these positions.
- Globally, in 2026, the market for energy efficient building technologies is expected to have grown by 58 percent from 2017 levels—reaching over $360 billion.

Name of the Study: Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times

Background on the Organization: The Global Commission on the Economy and Climate, and its flagship project the **New Climate Economy**, were set up to help governments, businesses, and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change. It was commissioned in 2013 by the governments of Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden, and the United Kingdom. The Global Commission, comprising 28 former heads of government and finance ministers and leaders in the fields of economics, business and finance, operates as an independent body and, while benefiting from support of the partner governments, has been given full freedom to reach its own conclusions.

Methodology: This Report was prepared by teams from the following institutions: the Brookings Institution, the Energy Transitions Commission (ETC), the Coalition for Urban Transitions, the Food and Land Use Coalition (FOLU), the Grantham Research Institute on Climate Change and the Environment, the Overseas Development Institute (ODI), SYSTEMIQ, and World Resources Institute (WRI).

Summary of Findings:

- The Report finds that taking ambitious climate action could generate over **65 million** new low-carbon jobs in 2030, equivalent to today's entire workforces of the UK and Egypt combined, as well as avoid over 700,000 premature deaths from air pollution compared with business-as-usual.
- "Transitioning to this low-carbon, sustainable growth path could deliver a direct economic gain of US$26 trillion through to 2030 compared to business-as-usual, according to analysis for this Report."
- The next 10-15 years are a unique 'use it or lose it' moment in economic history. We expect to invest about **$90 trillion USD** in infrastructure to 2030, more than the total current stock. Ensuring that this infrastructure is sustainable will be a critical determinant of future growth and prosperity. The next 10-15 years are also essential in terms of climate: unless we make a decisive shift, by 2030 we will pass the point by which we can keep global average temperature rise to well below 2 degrees C.
- "Coordinated, compact, and connected cities could result in **$17 trillion USD in economic savings** by 2050."
- Improving energy efficiency in buildings creates jobs. Each investment of $1 million USD generates an average of **14 job years of net employment**—up to three times the number of jobs for the same investment in fossil fuels.
- In 2017, renewable energy companies employed **10.3 million people worldwide**, and they are the fastest growing source of jobs in several countries. Based on E3ME modelling results, more than 65 million additional jobs can be created in low-carbon activities by 2030 from actions identified in this Report, relative to the baseline, which would more than offset an expected loss of about 28 million jobs in high-carbon activities (i.e. coal; oil and gas; manufacturing of fuels; and the supply of electricity, water, and gas) for the same period.

Name of the Study: 2018 US Energy and Employment Report

Background on the Organization: This work was prepared under a Memorandum of Understanding between the Energy Futures Initiative (EFI) and the National Association of State Energy Officials (NASEO) and a contract between EFI and BW Research Partnership. The survey instrument and underlying methodology is identical to that used in the primary data collected on behalf of the U.S. Department of Energy (OMB Control No. 1910-5179) for the 2017 U.S. Energy and Employment Report and secondary data from the United States Department of Labor's Quarterly Census of Employment and Wages for the second quarter of 2017.

Methodology: The USEER examines four sectors of the economy: Electric Power Generation and Fuels; Transmission, Distribution, and Storage; Energy Efficiency; and Motor Vehicles. The first two of these sectors—Electric Power Generation and Fuels and Transmission, Distribution, and Storage—make up what are generally considered the Traditional Energy sectors.

Current labor market data from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) track employment across many energy production, transmission, and distribution subsectors. To enhance QCEW data, BLS conducts two supplemental surveys. The first is the Multiple Worksite Report (MWR), which is collected each quarter to disaggregate the employment and wages of numerous establishments owned by a single employer into their individual worksite locations. This survey allows the employment and wages for each worksite location to be placed in their correct industrial and geographical category, thereby improving the accuracy of QCEW data.

Summary of Findings:

- Based on a comprehensive analysis of employer data collected in the fourth quarter of 2017, the 2018 USEER finds that the Traditional Energy and Energy Efficiency sectors in 2017 employed **approximately 6.5 million Americans** out of a workforce of approximately 145 million.
- Employment in these sectors increased in 2017 by over 2 percent from the previous year, adding **133,000 net new jobs**, nearly 7 percent of all new jobs nationwide.
- Electric Power Generation and Fuels directly employed more than 1.9 million workers in 2017, up 15,000 jobs from 2016. In 2017, 55 percent, or 1.1 million, of these employees worked in traditional coal, oil, and gas Electric Power Generation and Fuels, while almost 800,000 workers were employed in low-carbon emission generation technologies, including renewables, nuclear, and advanced/low-emission natural gas.
- Battery storage added almost 6,000 new jobs for a 12% growth rate in 2017.
- Energy Efficiency employed 2.25 million Americans, in whole or in part, in the design, installation, and manufacture of Energy Efficiency products and services, adding 67,000 net jobs in 2017.
- Motor Vehicles (including component parts) employed over 2.46 million workers, excluding automobile dealerships, adding 29,000 jobs in 2017.
- Transmission, Distribution, and Storage employed more than 2.3 million Americans, with just over 1 million working in retail trade (gasoline stations and fuel dealers) and another 869,000 working across utilities and construction. This represents a net increase of 50,000 jobs.

Board of Directors Survey Summary

During the first week of April, the CleanTech Alliance sent out an anonymous survey to its Board of Directors to gauge how the organization should operate in light of the COVID-19 outbreak.

With 39 responses, the preliminary results of the survey are summarized below.

79.4% of respondents want to see the Breakfast Series Panels move online with 7.6% wanting to reschedule them and 7.6% saying it's too early to make a decision. 2 respondents provided additional feedback under the 'other' category with one person wanting to move them online only as necessary and another wanting us to clarify how ticketing will work if we move them online.

The majority of respondents (56.4%) would like to see the CleanTech Innovation Showcase rescheduled to a date where we can meet in person while 17.9% would like to move it online and 20.5% said it was still too early to make a decision regarding the June 24 Showcase. Two Board members commented under 'other'. One of them would be interested in knowing more about the online format before supporting a move online and another warned that changing plans would require more lead-time and would prefer not to move or reschedule it.

The overwhelming majority of respondents (89.7%) want to see Board and Committee meetings moved online with only one individual wanting to reschedule them. Three people left comments with one reading that the immediate meetings for the next two months should be moved online but it's too early to tell for future meetings and another person echoed that sentiment and said we should move online temporarily but noted that face to face meetings are more valuable than online meetings. The third suggested that we use Zoom as the platform for our meetings.

66.6% of respondents want us to cover normal webinar topics and 63.8% want us to cover coronavirus government programs to aid businesses. 36.1% want to see individual company responses with 33.3% wanting to see policy debate webinars. Only 19.4% want to see coronavirus updates and experts and 16.6% want to see specific speakers. Three Board members left comments with one wanting us to stick to normal speakers but throw in information about coronavirus as part of their webinar, another one wants to see more clean tech content and the third wants to see reverse pitch video sessions.

Zoom is the clear winner when asked 'which video conferencing platform is your favorite?' with 61.5% preferring Zoom compared to 10.2% for Microsoft Teams and no preference, 5.1% for WebEx and 2.5% for GoToMeeting and Google Hangouts Meet. One individual prefers Skype, and another prefers Uber Conference with one person not having a preference 'as long as it actually works.'

On a scale of 1-10 with 10 being high, the average score for satisfaction with video conferences was 7.6 out of 10.

Of the 39 respondents, only 19 answered the question regarding significant issues with video conferencing. Of the 19 that answered the question, 14 expressed that they have NOT experienced significant issues with video conferencing while only 5 responded that they have.

When asked what long term impacts the health crisis will have on their business, 51.3% said they would not be able to meet projected profit goals with 13.5% projecting long term layoffs and another 13.5% projecting no long-term impacts. 1 respondent answered, ‘going out of business’ and various ‘other’ comments included sentiments that it’s still too early to tell, projects and product launches are delayed, and general anxiety about the future of their business.

22 respondents provided feedback when asked ‘what should we be doing differently for our members?’ While the question was open ended and the feedback varied, the sentiments fell into four main categories. 7 respondents think we should continue with ‘business as usual’ to the best of our ability given this new reality. 8 respondents want us to focus on aid to small businesses and breaking down federal funding and relief packages for them. 4 respondents want us to focus more on COVID-19 specific issues and news coverage and 3 people want us to continue to have an open dialogue with our members and ask them what they need.

We received 25 open ended responses to the question ‘should we change the way we operate? (be more active, hibernate, etc.). 15 respondents want us to be more active, with many wanting to see more information on public policy and how we can publicize federal aid packages. 9 people want us to maintain the same level of activity and many mentioned that we should stay as active as we can, contingent on resources, and only hibernate if we don’t have the finances to stay active. Only one person thought that outright hibernation was the best course of action.

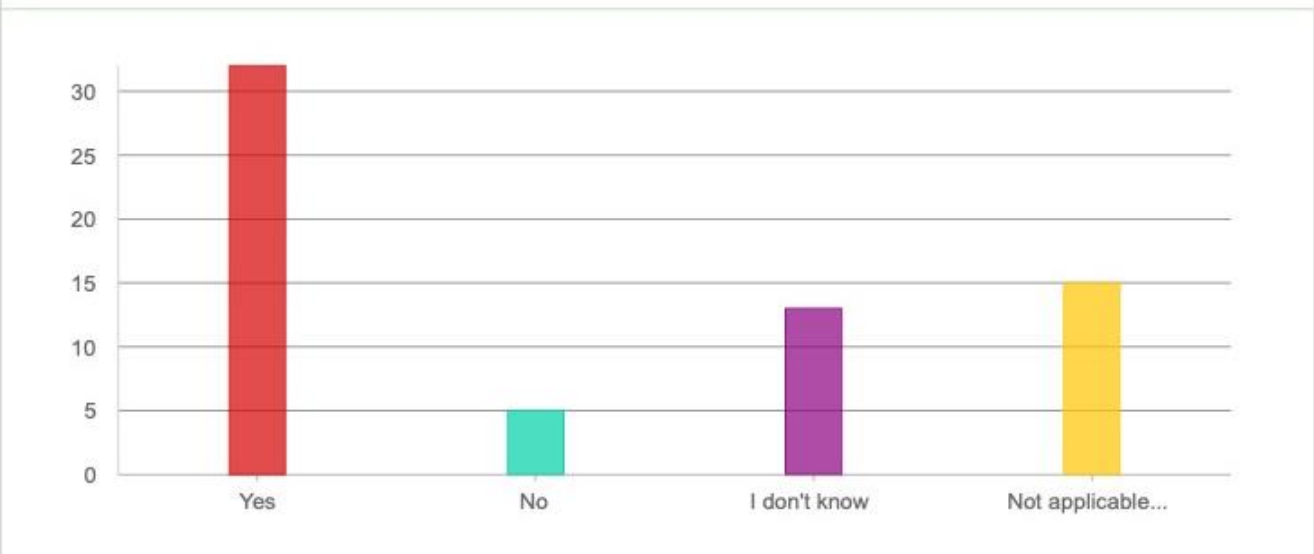
For the final question, we got 17 responses about how the CleanTech Alliance can help our members. 4 people couldn’t think of anything we should be doing differently right now but will inform us if something comes up later, 2 people wanted to see more about understanding federal aid and how to access it, and 6 respondents want us to continue to communicate and stay engaged online with our members. Lastly, 5 respondents want us to continue posting CleanTech topics to our website and want more information and one respondent even suggested highlighting member stories about how they’re dealing with the crisis.

OED Survey Results

During the first two weeks of April 2020, the Office of Economic Development administered a survey on behalf of the CleanTech Alliance to gauge how our members are being impacted by the COVID-19 pandemic.

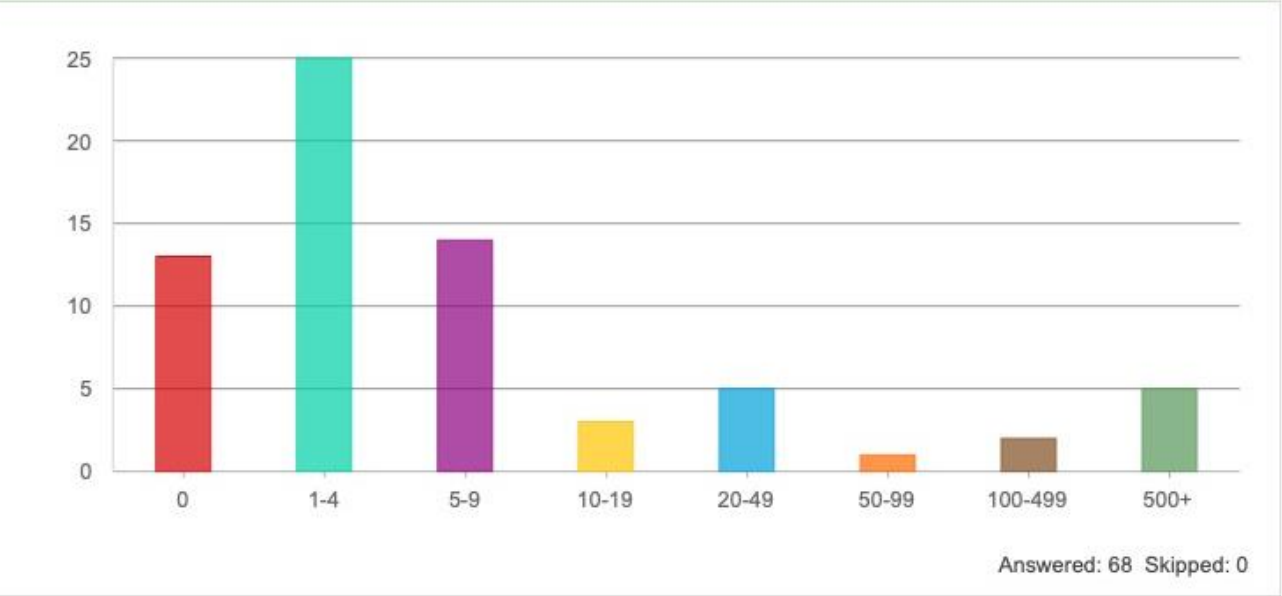
As of April 15, 2020, the survey had 68 respondents. The survey yielded many useful graphs and word clouds. The most interesting ones are broken down below.

Will you be able to make rent payments (or property payments if you own your building)?



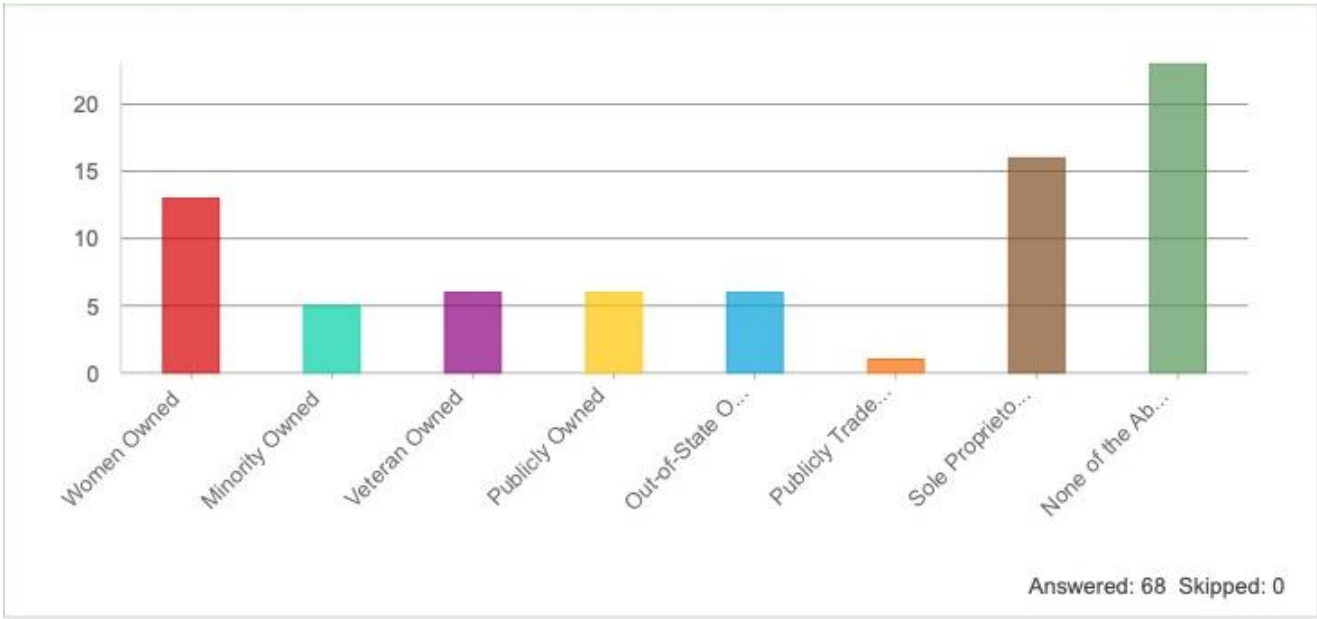
47.06% of respondents anticipate that they will be able to make rent or property payments on their building despite the heath crisis with only 7.35% predicting that they won't be able to pay and the rest either don't know yet or they don't own a building. Over twenty percent indicated concern.

Number of employees



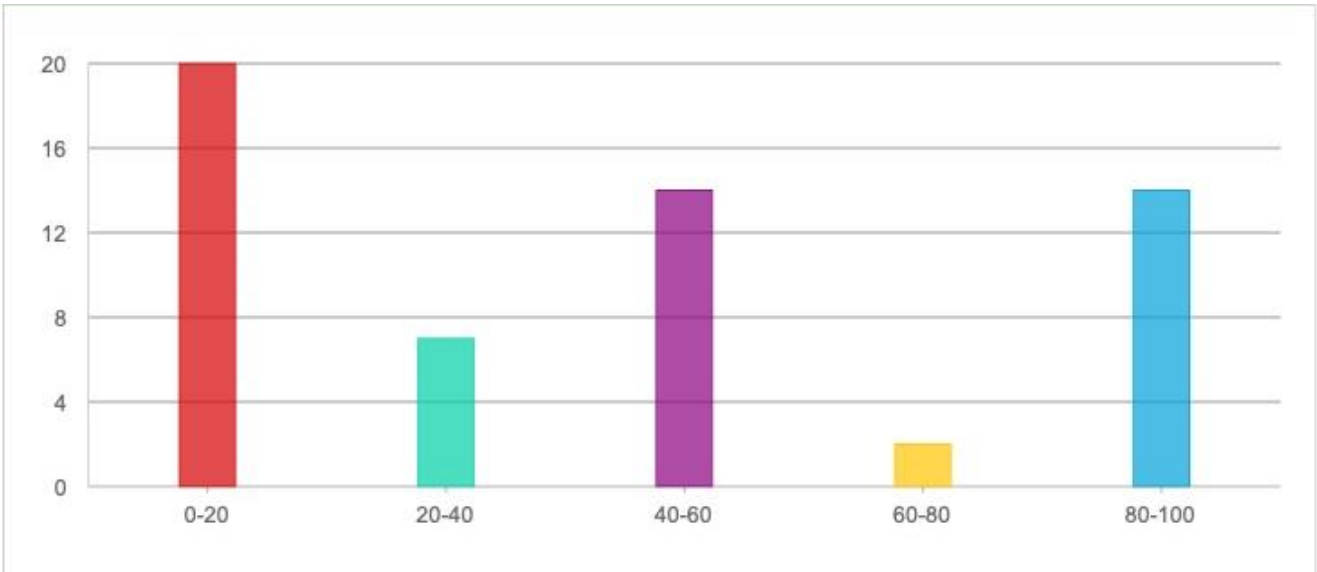
The majority of our members are small businesses, according to the survey, with 1-4 as the most common number of employees. Five respondents work at businesses or organizations with over 500 employees but the vast majority of respondents work at much smaller businesses.

Business Ownership



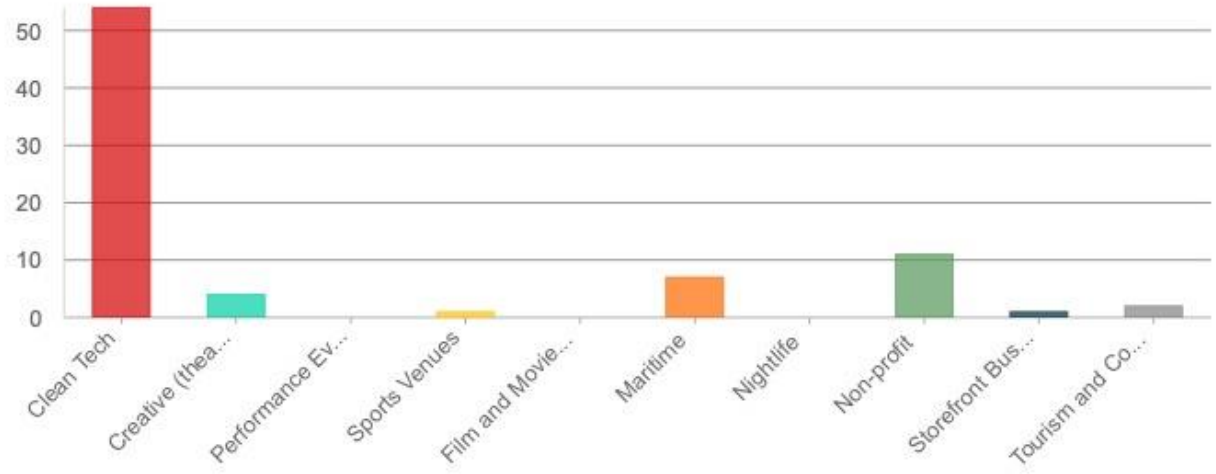
Over 20% of members surveyed don't fall into any of the special categories listed above. The next highest categories were 'women owned businesses' and 'sole proprietor'.

How much has your income declined compared to this month last year?



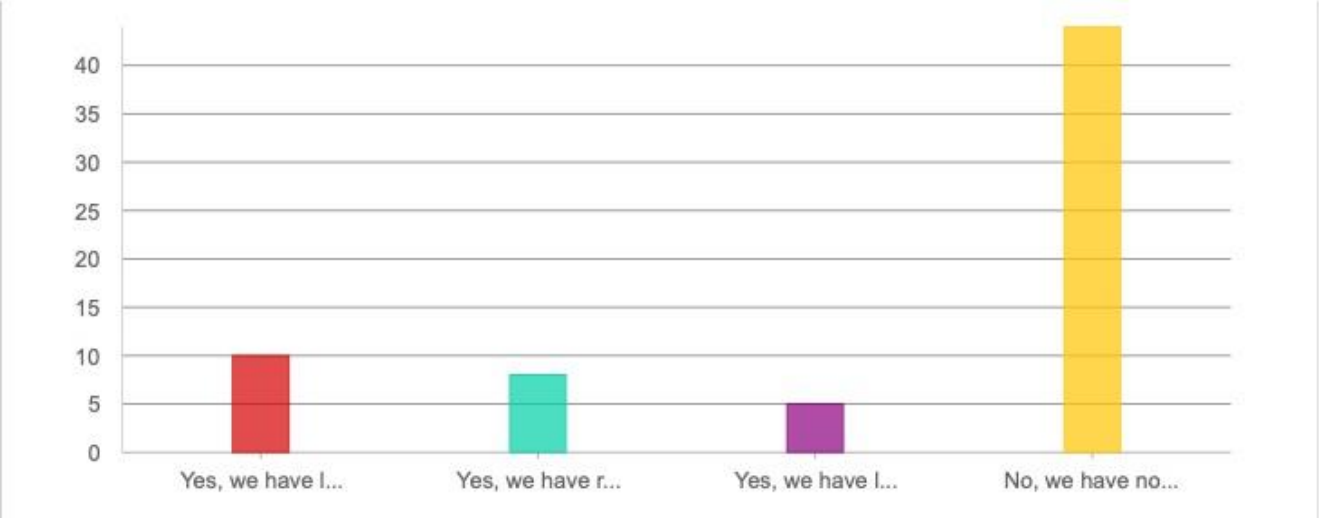
Most respondents surveyed saw their income decline 0-20% compared to last month but a fair number saw a drastic decline in income of 80-100% in the past month.

Industrial Sector



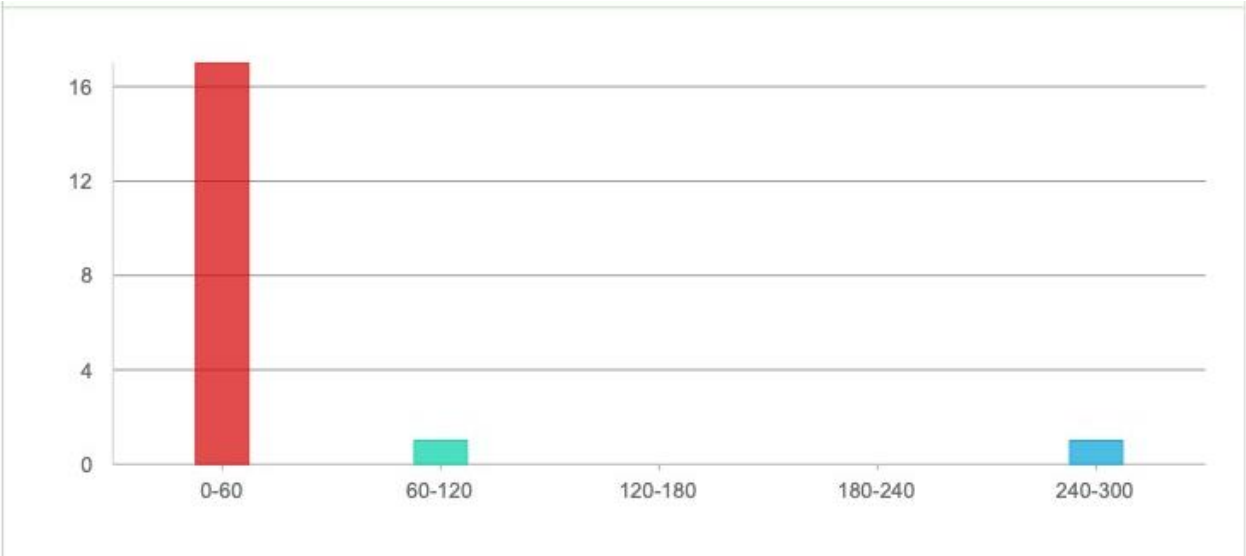
It's no surprise that 79.41% of CleanTech Alliance members surveyed self-identify as CleanTech businesses. The second most common category, however, is nonprofit at 16.18%. Maritime was the third most common category at 10.29%.

Staffing Reductions



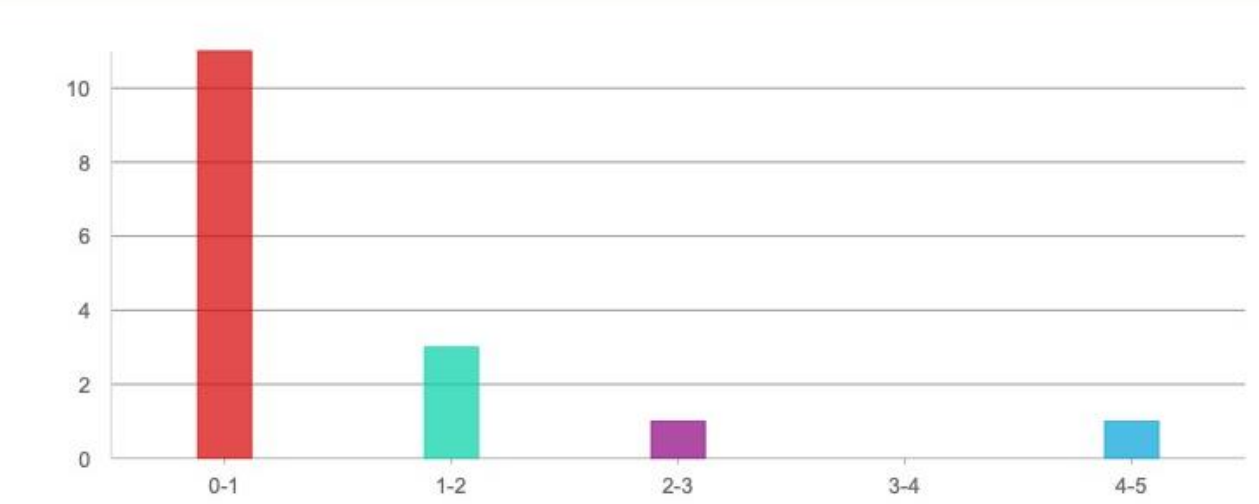
One piece of good news from the survey is that when they asked if they had to reduce staffing capacity, 64.71% said no. 14.71% have had to lay off employees or contract workers, 11.76% have had to reduce employees' hours and 7.35% have had to lay off employees and reduce hours.

Temporary Layoffs



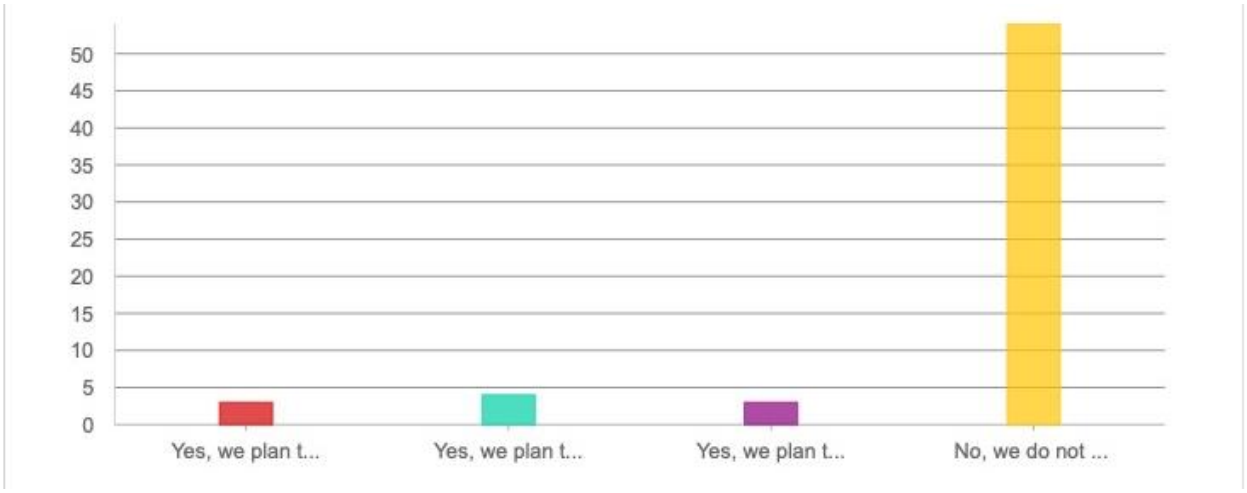
Of the 19 people that responded that they would have to layoff staff, 17 said it would be a temporary layoff of 0-60 employees with one respondent laying off 60-120 employees temporarily and one laying off 240-300.

Permanent Layoffs



16 respondents answered that they would have to make permanent layoffs in light of the COVID-19 pandemic with a maximum of 5 people getting permanently laid off and an average of 0.625 employees permanently out of work.

Future Layoffs



In response to the question ‘do you anticipate reducing staffing in the future?’ 79.41% don’t have any plans to reducing staffing in the future. One caveat to this good news though is that no one knows how long the pandemic will last and while most people don’t anticipate having to reduce staff, they may be forced to lay people off.

How can the CleanTech Alliance help your business?

Lastly, here is a word cloud of how the 68 respondents believe the CleanTech Alliance can help their business. It's clear that we need to keep our members up to date with the latest federal and state loan programs and we plan to continue to support our members through these difficult times.

Overall, the survey has some reasons for optimism, but that optimism is contingent on how long the health crisis goes on for and how long our economy is shut down. We hope this pandemic comes to an end sooner rather than later and we anticipate a speedy recovery once things are open again but until then, the CleanTech Alliance is here to support and connect our members in whatever ways possible.

Until these difficult times are behind us, the CleanTech Alliance is here to inform and connect our members to resources and to each other as we work to make our sector stronger and more resilient than ever before.

The Qualitative Interview Process and Results – detailed deep dive

The selection of 24 interviewees for gaining insights into the opportunities and challenges facing the regional clean tech ecosystem was based in part on the expertise, experience, and knowledge of each individual. Care was taken to ensure an array of authoritative voices were interviewed and represented thought leaders in energy, entrepreneurship, policy, and investing. Importantly, the interviewees were selected to help better understand the challenges and opportunities facing the regional clean tech sector in light of market frictions, economic recession, and policy whiplash that have compounded the clean tech sector growth over the last 12 years. For a bullet point list of key findings from the interview process, please see Appendix A.

Questions posed to each interviewee

Though discussions at times, were often more free form in style and resulted in conversations, the following 10 questions were asked in each of the 24 interviews:

- Is the growth of CleanTech important?
- Is CleanTech a success in the Northwest?
- What are the barriers to creating fast growing CleanTech companies?
- Are big companies such as Amazon, Boeing, and Microsoft implementing CleanTech independent of the startup ecosystem?
- Does the Northwest have the capacity to be a CleanTech leader? Do we have a comparative advantage to other regions in the United States and/or globally?
- What are the barriers to the growth of commercial CleanTech?
    - Capital
    - Federal Policy
    - Intellectual Property
    - Markets/Customers/Utilities
    - Regulation
    - Talent
- Are there other opportunities that aren't being pursued?

The following reflect the 24 interviews, key takeaways, and important insights.

Ron Howell, WRF Capital and Washington Research Foundation
Jeff Clark, Energy Innovation Partners
David Benson, K&L Gates
Kristi Growdon, E8
Kirk Washington, SDE3 Engineering

- Collaborations between research institutions often fail. They require support throughout each organization to succeed—Administrators and researchers
- Universities are in poor fiscal shape
- Improving deal flow has real value for all kinds of investors
- Streamlining time to market and lowering investor risk has value
- Investors don't fund research
- Canada should be part of this (investor perspective)
- Capital is King
- Investors prefer market pull to technology push investments.
- There are some means whereby accelerators can be investible.
- Strategic investors are predatory
- Need to have some commercial successes—and make them visible
- Corporate buyers (utilities) prefer reliability to innovation
- This may be a seventy-year transition which makes investment difficult
- Investors prefer the IT model: Low capital costs, quicker exits (capital efficiency)
- The NEIA is too research based, needs more commercial leadership
- We should create a success stories paper/story
- We need visible local capital involved to make this credible
- The NEIA idea is not investible—focus should be grants/philanthropy
- Joint technology development agreements are seen as revenues

Craig Husa, CEO, SuperCritical Technologies

Key Insights

- Cleantech is important for many constituencies, but a toxic term for investors.
- Cleantech in the Northwest is not a success, but we are a player.
- Branding universities is important—investors are more likely to invest in MIT and Stanford
- Four pillars to cleantech growth:
    - Access to innovation: NW very good
    - Access to talent: NW very good
    - Access to policy:
    - Access to capital: NW worst
    - Access to customers:
- Traditional customers are conservative (utilities)

Discussion

Clean tech important, but most start-ups require capital investment, which is not particularly attractive to angel investors. Noted challenges in venture capital investments in clean tech startups, which peaked in 2008 and have been mired in a slump for the next 10 years.

Noted that cleantech startup founders and employees usually have experience in areas like inventing new materials and devices but may lack experience in manufacturing or operating a business. Further noted the differences between cleantech and information technology startups who often create new markets, whereas clean energy ventures are trying to capture a share of an existing market.

The region could do a better job at "branding" its competitive advantages, particularly in relation to other cleantech innovation regions such as Boston and California. Branding the region should focus on the strengths of the research and development coming from the two research universities and PNNL. Better sharing of R&D from the public universities/federal labs could help inform investors and entrepreneurs when a particular technology is ready for commercialization and support educating consumers about new options in the market.

As technologies develop, cleantech investors can identify strong teams to support its commercialization. Investors are best at identifying entrepreneurs in a way that the public R&D labs are not. Early investment is often a bet on the founder and the team as much as on the technology itself – the business side of the equation takes time and understanding of markets. Branding to the differing, but compatible realms of the ecosystem – publicly funded R&D and accelerating and supporting commercialization through venture capital is a good regional recipe for success and needs to be communicated/marketed.

Brian Young, Director of Economic Development for the Clean Technology Sector – WA Department of Commerce

Key Insights

- Can startups sell into utilities?
- Governor is highly motivated on climate.
- Amazon, Microsoft, etc. are doing amazing things, but they don't see the region as a resource and don't engage locally.
- Big wins require consumer plays.
- Big buyers are not incented due to costs and regulation. Permitting is a barrier: Deep state, "Seattle way."
- Need to brand the sector, need more big wins.

Discussion

Emphasized the strengths – historically, the state of Washington has been a leader in energy. Opportunity continues for the economic development benefits of cleantech, particularly in big infrastructure projects related to grid modernization.

Suggested "branding" clean tech as more than clean energy. More overtly include cleantech innovations in the built environment, transportation as well as make communications about clean technology more consumer facing.

Suggested creating more reverse pitch opportunities, particularly having large, public projects pitch to innovators to assist with the knowledge and procurement of clean technologies. Could lead to government-sponsored projects supporting clean tech

companies/innovations with contracts at competitive prices. Suggested the notion of creating test lab concept with public R&D entities and connected to large projects.

Suggested that the state and local government could support creating markets by building demand for clean energy. Identified ways government could better incent: carbon pollution fees on greenhouse gas emissions (e.g., Initiative 1631), providing tax credits for energy efficiencies and other conservation, renewable energy and/or innovations to reduce the reliance on fossil fuels, further setting efficiency standards for appliances and lightbulbs, and regulatory permitting.

Keith Warner, Enterprise Utilities Manager, FAM Go4Zero Program Manager, Boeing

Key Insights

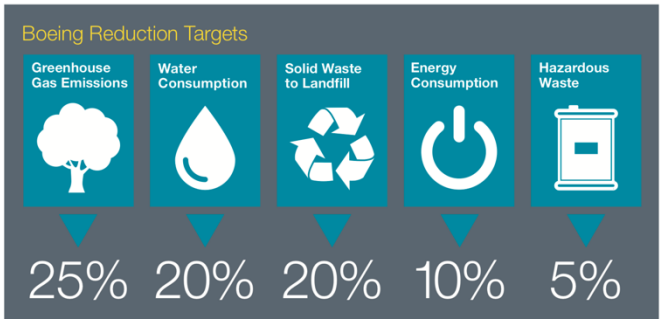
- Boeing wants to be a global industrial champion. A true leader.
- Boeing sees environmental stewardship/cleantech as an area in which a leader needs to excel.
- Cleantech branding is important to the company; executive leadership has been clear and longstanding.
- Cleantech in aerospace is a core competency, not outsourced.
- Utilities on the west coast are very progressive; Boeing works well with local utilities.
- Cleantech is being led by big business in many areas.

Discussion

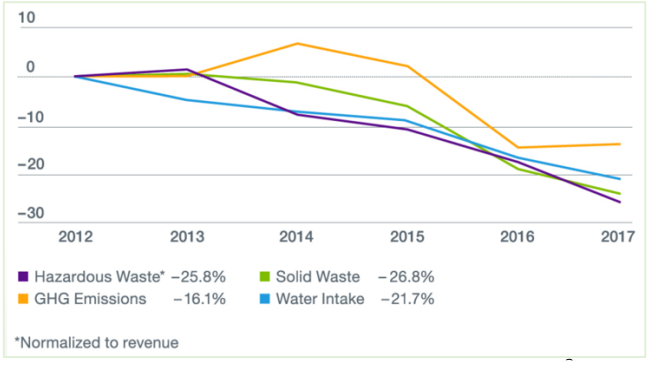
Clean technologies and uses in improving environmental performance of global companies -- like Boeing -- are key aspects of doing business. Since 2007, Boeing's commitment to improving the environmental footprint of its factories, offices and other facilities has been formalized through the **2025 Strategy for Environmental Leadership** including the following goals:

Innovate for Performance	Excellence in Sustainability	Inspire Global Collaboration
- Reduce product lifecycle footprint - Accelerate technology; biofuels; electric - Proactively manage chemical restrictions	- Reduce operations and supply chain footprint - Sustain environmental compliance excellence - Remediate and restore at-risk sites	- Advance global sectoral standards - Capitalize on focused investments - Advocate for environmental leadership

Reduction targets include:



From 2012 to 2017, Boeing reported on results in reducing greenhouse gas emissions, water usage, solid waste to landfills and hazardous waste and reduction.



Environmental performance is a growing demand by both domestic and global customers. Boeing, like other large corporations headquartered in the Pacific Northwest, views environmental performance not only as a part of compliance in meeting local, state, and federal environmental laws/regulations but as critical indicators of competitive advantage in attracting customers, talent, and capital investments.

Indeed, it was noted that 75% of Boeing's R&D funds are invested in efficiency and environmental performance.

Discussion also focused on Boeing's internal accelerator titled the ecoDemonstrator program, now in its fifth iteration and boasting the testing of 95 technologies. The program serves as a series of flying test beds designed to improve the environmental performance of commercial aviation and safety of future airplanes. Program goals include harvesting new technologies and accelerating development of innovations aimed at getting innovations more quickly applied in airplanes. As an example, flight testing on a FedEx-owned 777 Freighter this Spring gathered data on 40 separate technologies, including using 100 percent biofuel to reduce emissions and burn more efficiently.

General comments about the clean tech ecosystem included the inherent value of relationship building and partnerships, including the collaboration between Boeing and local utility companies. Additionally, noted the collaborative clean tech-based research relationships with the University of Washington and Washington State University.

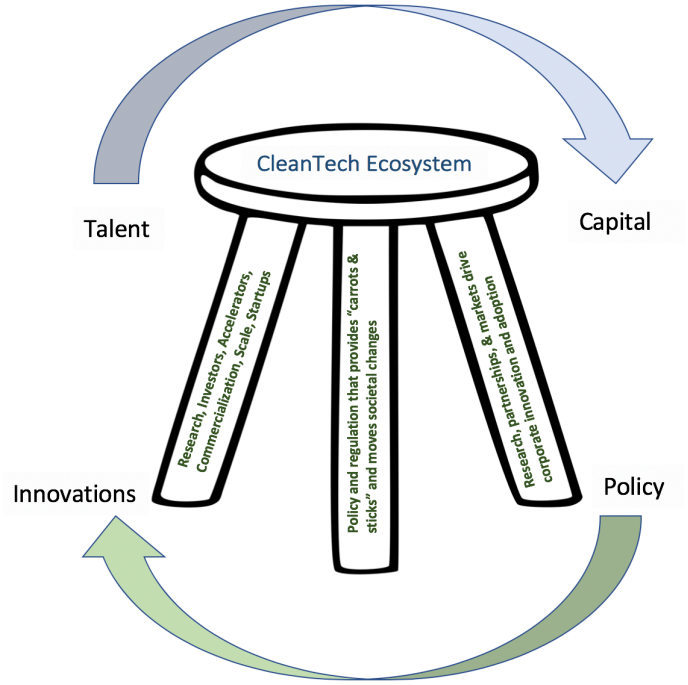
Mike Wolcott, Regents Professor and Associate Vice President for Research, Washington State University

Key Insights

- Cleantech is absolutely a success in the Pacific Northwest.
- Land grant model: Focus less on patents, and more on partnerships and collaborative research.
- Cleantech is way too broad a term. Perhaps focus more intentionally in discrete areas of economic strengths in the state: Renewable energy, ag/cleantech innovations, aerospace, etc.
- Useful trade associations are DC-based and industry focused – those that are most useful provide great networking opportunities for relationship building, particularly at the national level. Raised concerns for a "cleantech critical mass" in the Pacific Northwest for trade association.

Discussion

The land grant model of extending research and education to the public and private sectors was discussed as an important "leg" of a clean tech ecosystem. The other legs include commercialization and startups companies and the policy/regulatory arena that helps induce new technologies, solutions, and consumer preferences and also support, reward, and celebrate adoption.



The ASCENT collaborative model was noted as an indicator of regional clean tech success. ASCENT, led by WSU and Massachusetts Institute of Technology, works to create science-based solutions for the aviation industry's biggest environmental/sustainability challenges and includes a coalition of 16 leading US research universities and over 60 private sector stakeholders committed to reducing the environmental impact of aviation. ASCENT partners 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. ASCENT is an example of collaborative research, involving public and private entities that helps drive solution-oriented innovations into the marketplace.

ASCENT also represents the traditional "land grant" model of solution-oriented research that is based more on research partnerships than a research institution "spinning" out patents leading to a commercial entrepreneurs and startup businesses.

Concerns were raised about how to best organize a clean tech trade association when the clean tech sector is vast in scope. Suggestions included focusing on clean tech innovations and the reductions of environmental impact in alignment with regional economic strengths: renewable energy, aerospace, agriculture and food manufacturing, information technology, maritime, life sciences/human health, and military/defense.

Discussions also noted that the "attractiveness" of a clean tech trade association is its ability to convene and continuously feed the clean tech network of interconnecting and intersecting elements of small business, large business, research institutions and labs, and policy leaders. Discussion ensued on the value of trade associations that help demonstrate the passion for the sector, promote engagement across partners, create opportunities to share time and expertise, actively convene members, create public celebration of success, and welcome and engage new members.

Will Einstein, Director of New Product Development, Puget Sound Energy

Key Insights

- The CleanTech Alliance should be more engaged in lobbying, particularly on regulations, government purchasing, etc.
- The State doesn't do much to help businesses grow.
- California's cleantech ecosystem has a lot going for it—not least of which is better policy certainty. They aren't changing things every few years (like solar incentive policy). Ambitious efforts plus the investments and political will to make it happen.
- It is hard for utilities to invest in new technology:
    - Operating expense recovery: three-year delay plus no time value of money recovery.

  - Inherent risk of new technology.
  - Cultural issues (different organizations resist change at different levels—public vs. private).
  - Utilities don't buy widget 1.0. They want to see it proven in the marketplace first.
  - Established vendors are less risky than new small companies.
- Utilities aren't the best route for entrepreneurial technology adoption. Players like McKinstry and Itron are better partners in technology adoption.
- How can the CleanTech Alliance connect with sustainability managers? REI. Starbucks, Boeing. Reverse pitches?
- We need public policy that supports businesses that want to implement cleantech, but where the economics don't yet justify implementation.

Discussion

Notes that the region has the right "ingredients" for being a clean tech leader: innovative, tech-based, globally-minded, research-driven economy and a citizenry with a strong green ethos. What's missing is that clean tech startups still face major obstacles. Some obstacles are inherent with new technologies and the gaps between technologies coming out of labs and being ready for customer use; others are the result of a skewed regulatory framework and marketplace. Raised specific concerns on policy leaders setting clear outcome-driven goals for both advancing clean tech innovation and adoption as well as supporting the startup economy. Leaders should offer bold policies to support growing our region's economy and its clean energy sector.

Barriers to clean tech innovation and commercialization include:

- A perceived lack of manufacturing prowess outside of aerospace
- Capital costs and the upfront expense of renewables and related technologies – can be significant lag between expensing the technology and recouping investments through revenue and/or savings. Policies could assist in helping utilities take on the risks
- Notes that utilities tend to gravitate towards products and companies they know have reliable reputations

To address barriers, policies could encourage more pilot projects that engage utilities and customer adoption. Regulatory reforms could reduce the risk associated with new pilot projects, through a combination of:

- More favorable treatment of rate-basing pilot projects that include new technologies
- Mandates with related goals for adoption of new technologies
- Financial incentives to ensure project viability

Discussed opportunities and new ways of approaching organizational design:

- Suggests engaging more with sustainability/environmental managers of large companies and related organizations
- Perhaps organizing more towards a "chamber" model in comparison to a "trade association" model. This could include redefining or morphing the scope of the mission using the following considerations and differentials:
  - Scope
    Identify the CleanTech Alliance more as an array of business interests and affiliated stakeholders and using its diversity to create/sustain the robust, three-legged stool of a clean tech ecosystem as contrasted as a trade association consisting of business firms/affiliated stakeholders operating in the trade of clean tech
  - Nature of member-firms
    Organize the CleanTech Alliance less on its essential nature – an association primarily made up of competitors -- and more towards an all member organization – competitors and non-competitors - committed to creating and growing a regional cleantech ecosystem in the Pacific Northwest
  - Representation
    Organize the CleanTech Alliance to represent the interests of the regionally-based cleantech ecosystem community in general as contrasted with a more traditional role of a trade association in protecting and promoting the interests of the clean tech sector, particularly, but not solely, on startups
  - Structure
    Identify the CleanTech Alliance more as the regional organization devoted to building the "three legs" important to advancing the cleantech ecosystem in the Pacific Northwest as contrasted as being organized on the trade or competitiveness of the clean tech sector
  - Name
    Identify the CleanTech Alliance more by the region or community it represents as contrasted as being known most by the industry sector. Just as an example, the *Pacific Northwest Eco-Energy Alliance*

Tony Usibelli/Peter Moulton – State of Washington Department of Commerce

Key Insights

- The success of the energy efficiency policy is phenomenal. It is off the charts successful. We are real leaders
- The northwest is weak in manufacturing
- Outside of energy efficiency, cleantech success is 'hit-and-miss'
- Storage is emerging
- Timber technology: cross-laminated timber
- Low prices of electricity have consistently impeded investments
- Markets have been impacted by regulation: Window energy performance, construction, Energy Star, Northwest Energy Efficiency Alliance
- Awards and public recognition make a difference
- We need regulatory reform—lots of regulations are obsolete and multiple jurisdictions

Discussion

Emphasized Washington's competitive advantage in committing to and demonstrating the cost-savings and efficiencies in energy conservation. Specifically called out the state's commitment through the State's energy strategy adopted in 2010.

Noted that some of the challenges in other elements of the clean tech sector has been:

- A lack of manufacturers outside of aerospace
- A lack of laser focus on, and solutions for waste management
- A lack of Investment in energy storage
- Lack of stability in regulatory incentives

Recognized the regional opportunities in basic and applied research from the universities and PNNL but lamented some of the challenges for commercializing innovations and support for the related startups, particularly the current tax structure support for such companies, including the loss of R&D tax credits. Discussed the value of regulatory reform to support innovation.

Called out opportunities in the clean tech ecosystem for value-added forestry and related bio-based plastics and other material (cross-laminated wood, etc.) and the maritime industry.

Recognized the successes of the market transformation model used by the NW Energy Efficiencies Alliance and its strategic process of influencing/intervening in the market to create systemic change in market behavior by removing barriers or seizing opportunities to accelerate the adoption of cost-effective energy efficiency as a matter of standard practice. Discussed the merits of such coordinated efforts to accelerate the market penetration of more energy efficient products and practices.

Discussed the need to get a better handle on acquisitions of small clean tech companies by larger corporations. Also mentioned that the state could be more intentional on "rewarding" large corporations' commitment to sustainability and energy efficiencies, waste reduction, etc.

David Giuliani, Director and Co-Founder, WA Business Alliance / Low Carbon Prosperity Institute

Key Insights

- I-1631 could be a key to enhancing cleantech development. Decisions will need to be watchdogged.
- If I-1631 doesn't pass, offset markets might need to be developed

Discussion

Noted the challenges inherent between "carbon politics" and "carbon policy," which reflects the notion of winners/losers, pitting environmental sustainability against jobs and costs.

Discussed the need for framing carbon reduction in a more user-friendly approach – demonstrating and communicating the cost-saving benefits of a cleaner economy. Emphasized the following tactics to further foment a local clean tech, low carbon economy:

- Improve electrical grid, by cutting coal and enabling power companies to build low-carbon capacity through cost-effective investments
- Switch from fossil fuels to lower-carbon alternatives, such as electricity and natural gas, through retrofitting and new equipment purchases

- Accelerate vehicle electrification. Transportation accounts for half of the region's carbon emissions and emerging automation could help ease economy-choking congestion, a deep concern to most residents of the region – linking the value-added benefits to quality of life by reducing congestion AND carbon reduction
- Increase carbon absorption by forests and agricultural lands, which already offset about a third of our emissions
- Unleash the power of innovation, the cost-effective pathway to a low-carbon economy
- Build and fund a state "carbon reduction market" to provide predictable targets for our innovators and their investors – could be in the form of a pilot in creating a carbon reduction fund

Shared information on the six-month old Low Carbon Prosperity Institute. Noted the opportunities that will come if Initiative 1631 passes or if it fails. The initiative provides another impetus for collaboration in the clean tech sector. Called out a late November seminar, THE FUTURE OF CARBON POLICY AFTER I-1631, which the Institute and Audubon Society are hosting.

Discussed the need for startup companies based on new innovations -- based on his success in both Sonicare and Clarisonic – to grow in phases and smartly leverage assets to grow in the market.

Jenni Harper, Business and Programs Developer at Energy NW

Key Insights

- Need to have more regional interaction—particularly resources for startups
- There is good talent in the sector, but it needs access to investment capital
- Big companies are driven by driving down costs. There needs to be a return on investment
- The drive for efficiency is omnipresent in business—and it is a core competence of large business
- There is very little toleration for risk--nuclear
- The Northwest is the leader in cleantech—lot of really smart people, great tech
- State has done a lot: CEF. There needs to be better mechanisms to get smaller players engaged

Discussion

Believes that the PNW is a leader in clean tech and a very important ethos to Energy NW, other companies in the Tri-Cities, and throughout the state of Washington – "we have a sense of place, and an environment that is worth protecting." Noted the importance of the carbon free energy sources of hydropower and nuclear power.

Noted the partnerships developed through the Tri-Cities Research District. The TCRD connects private sector companies, entrepreneurs and investors to a highly educated workforce of engineers and scientists to further develop, innovate and commercialize new products.

Unique facilities with direct application to clean tech innovation and commercialization that are available in the district include:

- The **Applied Process Engineering Laboratory** (APEL), a 90,000 square foot high technology business incubator
- WSU-TC's **Bioproducts, Sciences and Engineering Laboratory** (BSEL), a "collaborator" with PNNL devoted to scientific R&D and process engineering from bio-based product manufacturing
- PNNL's **Environmental Molecular Sciences Laboratory** (EMSL) and unique **Electricity Infrastructure Operations Center** (EIOC) facility

Suggested for the CTA to build stronger, more intentional working relationships with clean energy entities in the Tri-Cities.

Barriers for more commercialization can rest on entrepreneurs sometimes not knowing the resources that are available to assist them in startups. Called for a "one Washington" approach whereby startups could look at locating in the Tri-Cities to take advantage of its hub of energy expertise and innovation. Suggested hosting some CTA events in the Tri-Cities and considering asking municipalities and county government to join the CTA.

Applauded the state for programs like the Clean Energy Fund, but worried about the relatively large scope of projects that are funded, which limits smaller pilot-styled projects. Pointed to public/private partnerships that Energy NW developed through funding from the WA State Department of Transportation, which is a pilot program to strengthen and expand the West Coast Electric Highway network by deploying electric vehicle (EV) fast charging infrastructure and stations along highway corridors in Eastern Washington.

Jessica Matlock, Director, Government & External Affairs, Strategic Accounts and New Energy Initiatives, Snohomish PUD

Key Insights

- Entrepreneurs need to develop customers outside of Washington—seek bigger markets
- Cleantech entrepreneurs are pushy and aggressive, particularly in comparison to other startup sectors
- Cleantech entrepreneurs don't listen to or understand their (utility) customers.
- High capital costs aren't a limiting factor for utilities.
- Companies need to merge and create bigger platforms.
- The reverse pitch is great.
- Word of mouth marketing is essential—and it is national.
- The Clean Energy Fund is the best thing that has happened to Washington State.

Discussion

Clean tech is a very important sector to the region. The state has all the right ingredients for ongoing innovation in the sector due to its history of innovation, culture and ethos, smart, well-educated people, and the research institutions and national labs.

Less concerned about the relative strength of startups – shared that startups naturally begin, fail, and have a natural cycle of evolution of a startup culture. Strongly suggested that local startups look for customers outside the state of Washington. In the state, more focus should go towards building lasting relationships, partnerships, and establishing and maintaining good customer relations. Raised concerns about the "passion" that some clean tech entrepreneurs exude that can compromise listening to customer needs.

Within the framework of being more aware of the needs of customers - like utilities - applauded CTA-related activities such as the reverse pitch to assist innovators/entrepreneurs in listening to what customers need as contrasted with imposing solutions that may not be desired. Called for longer-term thinking and analyzing future trends and needs in the energy space. Noted successes of bringing a problem to a research university and working together to solve the issue – this also has the added-value benefit of helping to train and educate future talent in the STEM-related fields.

Also mentioned successful pilot projects with entrepreneurs, which again, focused on direct problem-solving driven by customer needs.

From the policy perspective, believes the state is generally moving in a good direction. Did note the challenges created by mandates and supports ongoing policies that are technology neutral when it comes to achieving energy/clean tech related goals.

Applauded CTA for re-engaging and re-inventing as a core principle for any company or association.

Dan Schwartz, Boeing-Sutter Professor of Chemical Engineering and Director, Clean Energy Institute, University of Washington

Key Insights

- Investor returns are not competitive with other investment sectors
- Big corporates are very good on cleantech in the Pacific Northwest

- The Bay Area is the leader in cleantech—everyone else is tier 2, particularly with regard to capital. The Pacific Northwest leads in:
    - Data center technology
    - Aerospace
- Cleantech is a race between innovation and development: Will new innovation be deployable in time to benefit ongoing capital projects?
- Carbon pricing and utility compensation policies are key.

Discussion

The development, commercialization, and adoption of clean technologies is the challenge of our generation. Trillions of dollars in transactions are poised to come on line due to aging infrastructure across the globe, particularly in rapidly growing regions such as China and India. The pace of innovation and a more significant flow of capital are needed to meet the challenge, yet notes that big revenue multiples are not likely to be realized by investors in cleantech when compared to other sector startups.

Policy has yet to really price the externality of carbon emissions. And, compensation strategies for entities such as utilities to accept risks in the reliability of using new technologies in energy generation and distribution are lacking. Large corporations are developing creative and innovative partnerships with utilities along with inculcating the market and customer values of greening processes, incorporating sustainable practices through improved innovation, and a commitment to renewable energy.

For the regional cleantech startup sector, Dan notes that success should be measured by both IPO and mergers/acquisition. Additionally, the regional cleantech sector should look to innovation opportunities based on the economic strengths of the region, including aerospace, smart grid, and information technology. Discussion particularly focused on the need for constant evolution in the reliability, efficiency, and security of data centers that serve local companies such as Amazon and Microsoft, and the growing footprint locally of Facebook and Google. Innovation in technical equipment that support data centers also requires a significant amount of facilities infrastructure to keep the hardware and software up and running. This includes power subsystems, uninterruptable power supplies, ventilation and cooling systems, fuel cells, backup generators and cabling to connect to external network operators. Noted that the UW is committed to focusing in on the growing demand for carbon-free power for data centers and building ongoing partnerships in the sector.

Bob Cowan, Director of Facilities and Engineering, Fred Hutchinson Cancer Research Center

Key Insights

- Cost savings through energy efficiency is incredible: $40 million since early 1990s on $9.9 million invested
- There is no way innovators can get to Bob. Exceptions:
    - Through partnerships with utilities
    - Through partnerships with building design teams
- Management pretty much does as Bob recommends—clear financial track record of project success
- Right-sizing energy usage is key—doesn't over load energy devices to provide huge margins for error. Just-in-time energy delivery. Puget Sound climate is important to moderating energy demand.

Discussion

Fred Hutch, under the leadership and management direction of Bob, is an exemplary demonstration of clean tech in action by a global leader in cancer research. Primarily focused on efficiencies associated with electricity, gas, and water, Bob and his team have saved the research institution $2.3 million dollars annually in utility costs since 1993. Indeed, Fred Hutch has spent less on utilities in 2018 than the institution did in 2008, while undergoing expansion of physical space -- including the additions of new labs and a data center -- to conduct medical research.

Saving money is the driver for the over 200+ conservation projects, primarily related to the use of electricity and gas and treatment of water. The 25+ years of projects, which have cost $9.9 million, have saved Fred Hutch $36 million dollars over the same length of time, including $4 million in rebates ($40 million total). Smart fiscal management of utilities and facilities has been the incentive to address energy and water usage and waste.

Fred Hutchinson Cancer Research Center (Selected Sites)
Site Energy Use Comparison -- Year Ending 12/2018

Site	Electricity (kWh)	Natural Gas (Therms)	Total Energy (MBtu)	% Chg	SqFt	kBtu/SqFt
Weintraub/Hutchinson/Thomas	18,431,203	654,335	128,321	-30.4%	538,733	238
SCCA	7,673,170	171,133	43,294	-18.3%	218,936	198
Arnold Building	8,044,038	100,758	37,522	-16.9%	409,984	92
Yale	2,592,806	N/A	9,008	-41.9%	131,592	68
Company Totals:	36,741,217	926,226	218,145	-26.8%	1,299,245	168

Bob and his team have a set of principles that drive their dedication to cost-effective energy and water use and treatment as well as inhouse innovations that are consistent with the specialized needs of a medical research institution:

- Deliver the right amount of energy
- Deliver the energy just in time
- Deliver the energy as efficiently as possible
- Take advantage of excess energy
- Right size your equipment
- Take advantage of the temperate climate in the PNW
- Educate users/operators, constantly commission and monitor

In addition, Bob's and his team's forward thinking includes a 50-year plan for numerous systems around the Fred Hutch campus -- including world-class laboratories -- extending the operational life cycles for many of them.

Fred Hutch partners with the local utilities, including Seattle City Light, Puget Sound Energy and Seattle Public Utilities. Bob and his team are highly innovative and encouraged to be trouble-shooters, problem-solvers, idea-generators, and innovators. He does not "mix" much within the broader cleantech startup community, which in part seems to be because of his laser-like focus on continuous improvement in the facilities he and his team manages.

Bottomline, communicating the cost savings from adopting clean technologies and implementing best management practices related to energy conservation could be a powerful motivator for other businesses and consumers. And, it provides another example of clean tech innovation in action, being driven by large customers of utilities who hire the inhouse talent to drive industry-specific clean technologies and conservation practices.

Josh Henretig, Senior Director, Environmental Sustainability, Co-leader AI for Earth, Microsoft

Key Insights

- Very committed to cleantech as a corporate value and source of savings
- No opinion on cleantech ecosystem in the Northwest
- One of Microsoft's bigger challenges: Deploying early stage technology from startups
- Microsoft has long history of accepting outside technology
- Doesn't know how an entrepreneur could get a hearing internally, due in part to the size of the company
- Partners need to use Microsoft platforms

Discussion

Josh shared the Microsoft, as a company, is committed to sustainability and addressing climate change. He emphasized that the company is most interested in clean technologies and supporting the clean tech ecosystem where Microsoft can derive shared value, makes business sense, and aligns with the company's various technology platforms.

As an example, Josh co-leads AI for Earth, a $50 million program that takes Microsoft's investments in artificial intelligence research and technologies and promotes the use of the technology and delivering its AI resources to organizations working at the intersection of climate change, agriculture, water and biodiversity. In this instance, Microsoft is making its resources available for free to primarily non-government organizations that can benefit from the artificial intelligence in the company's cloud infrastructure. AI for Earth is an example of how Microsoft is using and promoting what has made the company successful to date and how it derives value by helping others to succeeds in the cleantech ecosystem. The technology company and its products make other people and organizations within the broad climate change ecosystem more effective, efficient and successful by using Microsoft products.

Josh shared some insights about how to improve the clean tech ecosystem, clean tech innovation, and commercialization. He noted that the PNW region – relatively speaking – is more evolved in a maturity model when it comes to clean energy and related innovations. He notes that as an information-based economy, the region is familiar with the benefits on information systems and data driven improvements in energy tools. He also believes that the PNW is poised to be a "flywheel" when it comes to clean tech innovation and commercialization. He recognized that the region has all the right puzzle pieces to reinforce each other in clean tech innovation, partnerships, and accelerating change.

Dave Curry, CEO, NextWatts

Key Insights

- Successful Innovation normally must involve simple concepts that scale
- Public policy drives innovation in cleantech. Policy drives it all
- To be successful in cleantech, one must have access to committed deep, deep pockets
- "The utility industry is not disruptable." The utility model must change. You can sell to utilities if you don't disrupt the model.

Discussion

Noted that the challenges inherent for startup companies in cleantech is not soley a Pacific Northwest phenomena, but a problem across the nation. To be a successful energy startup, the entrepreneur must build a company that is disruptive to the status quo and must be able to scale up an innovation or market idea to reach a lucrative customer base while turning a profit, preferably, a big profit! For cleantech, this is hard to do as innovation and disruption in clean tech are taking on the entrenched status quo ways of doing business and customer expectations, particularly in the energy sectors.

Dave referenced that changes in policy, including the pricing of carbon, are driving the need for innovation in energy efficiencies and may challenge the traditional, consolidated models on power generation, transmission, and distribution. He noted policies in New York City are specifically impacting the real estate and building sectors and the requirement to reduce their carbon footprint. The *New York City's Roadmap to 80 x 50* is compelling radically new thinking and discovery of new tools when it comes to reducing CO2 emissions from buildings, particularly in residential buildings.

Bottomline, Dave suggested that all cleantech entrepreneurs need to remember the fundamentals in an energy marketplace that is dependent on arguably entrenched players who may be reluctant to adopt new technologies if too disruptive to the status quo. Policies related to decarbonization will end up driving more innovation in the energy systems. One can anticipate decentralization and digitalization of the energy sector, which will drive a new future for energy systems and acceptability of disruptive innovations.

Aaron Block, Allumia Efficiency Solutions

Key Insights

- Utilities react to customers and regulation.
- Energy is stupidly cheap everywhere except Hawaii.
- There aren't many investors in this space that aren't affiliated with utilities (strategic investors)
- Political changes haven't altered the strategic investment market.
- The Northwest is ahead of the country as a whole; on a par with competing regions.
- We need an AVATAR.

Discussion

Allumia -- a startup company -- is securing investment, but more as a tech company and less as an efficiency-as-a-service company as originally envisioned. Finding it challenging to address some fundamental barriers in the energy ecosystem. As long as there is little to no return on innovation in the energy market due to a lack of an inducement to innovate and the low price of energy, it is difficult for a small company startup aimed at saving energy and reducing costs. Also noted the challenges inherent in the energy ecosystem: Lots of players and intricacies that make disruption difficult. "*With energy incredibly cheap, it is hard to motivate or make a case for disruption*."

On the upside, Aaron notes that there are investments being made in start-ups that are similar to Allumia, including from several investor-based utilities, emerging technology investors, and oil companies. The company itself is focusing far more on corporate and strategic investors than well-meaning impact investing. He notes that the venture capital world is "getting back in the game" as well.

Aaron noted some opportunities for the region's energy ecosystem:

- Best brains – innovative, technology savvy
- Best nerds – challenge in that good engineers may not be as savvy in marketing
- There is a real need for reducing carbon emissions -

He also noted some opportunities:

- Perceived lack of a champion for the issue
- Have yet to find a way to speak of the need for disruption in energy that is accessible and motivational to the general public and customers
- Need the "cleantech avatar" – a charismatic figurehead that embodies advancing cleantech innovation as a way of life.

Curt Kirkeby, Technology Strategist, Avista

Key Insights

- The electric utility is the most complex machine every made by man. Most reliable product ever made.
- Retirement of southeast Montana's Colstrip power plant by 2525 could be a significant challenge, particularly for eastern Washington customers.
- There is a 12-day period during the winter that presents huge concerns without coal—no wind, no sun.
- California is a prime example of a system gone awry due to regulations. No flexibility. Electricity is 3-7x times more expensive than Washington per kwh.
- Concerns that Washington State will not achieve the 100% goal established by policy makers.
- For entrepreneurs: climate change does not sell to customers who react mostly to costs and reliability as drivers. Lead with how the product will benefit the buyer. Entrepreneurs do not know how to sell to utilities. "Half baked" ideas or disruptions will not be received well
- Utilities are becoming more innovative.
- There might be a window opening for entrepreneurs: New open source software coupled with retiring assets will require significant new capacity to be added in the Northwest.

Discussion

Avista continues to be concerned about policies that are aimed at disrupting utilities and the reliable delivery of power – "electricity delivery by utilities is the most complex machine ever created by man." If policy makers choose to disrupt, must ensure a reliable, cost-effective product i.e., energy that consumers consider as a right, not a privilege.

In specific relation to bringing on more renewable power sources (solar & wind) into the grid, concerns were raised about the affordability of utility-scale storage to help address the imbalance of power production from these intermittent sources. The challenges inherit with matching electricity demand and the amount of available from renewable energy sources throughout the day or seasons are continuing to create a challenge for utilities to balance supply and demand on the grid.

Bottom-line, and due to a series of factors, storage is still not competitive as a source for stable, baseload generation. It was noted this was particularly true for the eastside of the state of Washington. Referencing the so-called "duck curve," utilities continue to have challenges in incorporating wind and solar due in part to the increased need for electricity generators to ramp up energy production quickly when the sun sets or winds cease and the contribution

from these renewables fall. Additional challenges with renewable energy adoption is the potential for wind and/or solor to produce more energy than can be used at one time, or over-generation. This leads utility system operators to curtail renewable generation, reducing its economic and environmental benefits.

When it comes to innovations that help move utilities/regions to a 100 percent clean power grid, innovators should understand utility customers' expectations and value proposition: New innovation should make life easier and save dollars. Customer-based surveys and qualitative focus groups continue to demonstrate customers are driven less by concerns over climate change, and more by kitchen table realities of ease, reliability and costs. Innovators in cleantech that is energy focused should always start with what does the product/service do for the customer.

Avista is aiming to create more opportunities for innovation when it comes to energy demand-response and distributed renewables on a smart grid. The utility is partnering with Duke Energy to create OpenDSP, an open source, utility defined, operating system for the grid. It is aimed at solving the challenge utilities have had in advancing grid operations with technology innovations that have been costly, difficult to integrate, typically built on antiquated information architectures and focused solely on centralized solutions. Past efforts to deliver smart grid solutions for utilities and customers in the region have exposed the opportunity for OpenDSP.

OpenDSP's goal is to provide a foundational code base or operating system, much like iOS or Android is for smart phones, from which any utility or vendor can deliver solutions that will inherently work with each other. The partnership will hopefully define the open source business model, the functional requirements, and the underlying architecture for use by utilities and a new platform to encourage smart grid-based solutions.

Jud Virden, Associate Laboratory Director for the Energy and Environment Directorate, Pacific Northwest National Lab

Key Insights

- Some aspects of the Northwest ecosystem are 'absolutely top tier:' Energy efficiency. Software. Big companies. Renewables. Research.
- Tennessee and California policy leaders are more proactive in shaping energy research. Washington tends to be more reactive and needs to step up to leadership and driving energy technology. We need a major research initiative.
- Why aren't companies growing up? Low profit margins. Sunk assets with fifty year life spans. Regulatory restrictions.
- New IT solutions can be integrated relatively quickly: Battery management, cyber-security, streamlining operations.

Discussion

The Pacific Northwest is a success particularly in terms of energy efficiency. In fact, one could argue the PNW is the leader across the nation in energy efficiency innovation and application, particularly in further development and implementation of low-cost, turn-key, interoperatble, and cyber-secure energy control systems in housing and commercial buildings.

From the aspect of cleantech jobs, he cautions against looking solely at job-creation-metrics from the lens of startups. If one includes the thousands of jobs in cleantech that are produced by large corporate entities and research institutions – including PNNL – the impact of the sector in economic development has been a success. He also noted that other regions like California have tended to include more state funding in cleantech and R&D than what one commonly sees in the state of Washington, as an example. He did note local success stories in energy companies that have been successful, less in disrupting energy generation and distribution, and more within the utility framework: Itron, Schweitzer are all success stories of innovation-driven growth, market competitiveness, and job creation. He also mentioned the benefits of the Clean Energy Fund as a positive example of state investment.

Spent considerable time talking about other models to grow an innovation ecosystem that includes public and private sectors coming together to create a bigger whole. In particular, discussion focused on the state of Tennessee, the University of Tennesse Knoxville and the OakRidge National Lab. The technology commercialization program has spun off more than 90 new companies in the east Tennessee region. Next generation talent development is gaining ground through the Governor's Chair program and the Bredesen Center, which launched in 2011 and is a first-of-its-kind joint Ph.D. program focused on talent development in energy and data science and technology. The region works seamlessly to "think big" and matches state funding, research priorities, and federal dollars to generate an

ecosystem hub of innovation that supports economic development from startups to supporting large, global corporations to seek expertise, talent, and locating.

In further discussion on the value proposition of bringing the cleantech ecosystem together, Virden mentioned the Pacific Northwest Smart Grid Demonstration (PNWSGD), a $179 million project that was co-funded by the U.S. Department of Energy (DOE) in late 2009, which was one of the largest and most comprehensive demonstrations of electricity grid modernization ever completed. The project was funded by the American Recovery and Reinvestment Act and was the only regional demonstration project across the country that included multiple states and cooperation from multiple electric utilities, including rural electric co-ops, investor-owned, municipal, and other public utilities. It was an example of how the private sector-public entities-research institutions all pulled together to match leverage dollar-for-dollar and leverage innovation. Policy makers came together with regional energy leaders to compete and implement a project that was focused on infrastructure innovation in energy. It is worth thinking through other opportunities where we bring the **entirety of the cleantech ecosystem** – all of the pieces and players - to come together and work on big projects that drive markets.

Within this framework, he noted that the energy infrastructure is relatively stable – arguably, difficult to disrupt. With low profitability, the utilities are mostly interested in cutting energy costs and bringing better efficiencies. However, utilities are needing to manage changes in demand and increases in efficiencies as they shift to cleaner generation, which is often mandated (as it will be in the state of Washington.) The new electricity paradigm may be to match flexible, diverse, low-carbon supply with increasingly controllable demand, through sophisticated real-time sensing and software as well as infrastructure improvements.

The biggest opportunities for startups in the energy market trend towards new IT solutions and/or hardware solutions, including batteries. He noted that the PNW may be at the tipping point when it comes to energy storage. There may be growing interest and reasons for storage in the energy ecosystem with new policies and mandated goals of producing energy at low cost, relying on informed risk, ensuring environmental responsibility, power reliability and a diversity of power supply and flexibility to address changing energy market conditions. In the end, keeping costs of energy low is a significant economic development tool for this region, and the cleantech sector has the potential to further bring energy efficiencies, integration of renewables into the grid, and enhance reliability.

Brad Boswell, Boswell Consulting

Key Insights

- The Clean Energy Fund is in trouble. It is under-performing. Not all of the allocations have been spent. The Legislature's enthusiasm has diminished.
- Legislative initiatives may drive more cleantech development:
    - 100% Clean: Requires utilities to be more aggressive. Utility scale resources and storage will be required. New technology is anticipated to achieve the goals by 2045.
    - Clean Buildings: Energy efficiency mandates
- We need to develop a PR campaign to re-sell the Clean Energy Fund to the legislature prior to the next capital budget round in 2021.
- Problem: NO breakthrough technology successes.

Discussion

2019 marks the year that the state of Washington significantly advanced clean technology policies. With the so-called "100% Clean Legislation" signed into law, the state of Washington now has comprehensive legislation that sets standards for utilities to eliminate coal-fired electricity from utility portfolios by the year 2025. Utilities must also achieve a carbon neutral electricity supply by 2030, and service customers with 100% carbon free electricity by 2045, or face penalties. The new law benefitted from significant industry and stakeholder engagement and general utility support.

In addition, new clean buildings legislation sets new standards for energy efficiency in commercial buildings in spite of challenges from the building and development trades. The law will allow, but does not require natural gas conservation and renewable standards. Also passing was a green transportation package that raises registration fees on electric vehicles and hybrids to pay for EV and alternative fuel vehicle incentives, amongst other elements.

Two bills regarding solar energy were also passed, including net metering and allows many more customers to receive full utility compensation for the energy they generate through their panels. Another bill will allow utilities to begin planning for their distributed energy resource (DER) futures.

Finally, the Clean Energy Transition was funded in the final Capital budget at $32.6 million for the biennium. This includes funding for the following:

- Grid Modernization: $6,107,000 (including the Northwest Seaport Alliance shore power electrification: $4,400,000)
- Research, Development, & Deployment: $8,100,000 (including Bioenergy: $1,000,000)
- Loan Programs: $3,00,000
- Pacific Northwest National Laboratory grid scale storage facility: $8,300,000
- Grays Harbor wave energy: $593,000
- Guemes Ferry electrification: $1,500,000

Arguably, the two most significant sweeping clean tech-related laws include the 100% Clean Legislation and the green building laws. Both could help move the energy sector in the state and drive innovation and adoption of new technologies and services.

The biggest challenge of the state's 2019 budget session could be the perceived loss of support for the Clean Energy Fund by the legislature. Tied tightly to the Governor, there are numerous concerns that have been shared including, but not limited to the fact that the fund's dollars have not all been spent and is generally considered by some to be "underperforming." Concerns are that the CleanTech Fund could go the way of the Life Sciences Fund, and its impact could be problematic during a time of other sweeping legislative action to induce growth in the cleantech sector.

Recommendations were made to improve strategic communications by identifying "wins" made by the state of Washington's investments and perhaps in the form of an aggressive outreach "coordinated communication campaign" model: clear identification of intended audiences, appropriate channels, and tight coordination of message delivery and consistency across both "grassroots" and "grass-tops."

The Honorable Sally Jewell, former U.S. Secretary of Interior (2013-2017), former CEO, REI, Interim CEO, Nature Conservancy

Key Insights

- Both customer and business demand (reducing costs) are driving clean tech innovation and adoption forward
- There are lots of big projects and big companies that are doing considerable work in sustainability and carbon reducing business practices
- There is great risk to businesses that fail to appropriately deal with cleantech/climate issues: Brand identity and reputation and customer relationships are among the most important
- Big picture trends: Globalization, urbanization, diversity, technology, climate.
- Corporations can have impacts on reducing energy use, adopting green building practices, reducing paper & forestry products, waste, and ensuring supply chain is sustainable, carbon reducing
- Oil and gas have 30 existing governmental subsidies – policy should ensure fairness in inducing carbon reduction
- Sustainability managers might have insights and influence on the growth of cleantech.
- Big collaborative projects can be powerful

Discussion

Posited the philosophy and practice that global companies need to embrace sustainability to address risk management and growing trends related to conscience capitalism. As she said, companies who ignore corporate responsibility when it comes to addressing carbon and waste reduction, energy and water use, and the impact of the business "footprint" on sustainability does so at "one's peril." She encouraged innovators to look to corporations for supporting clean tech innovations and noted that sustainability managers are great people to meet and engage with.

She discussed how several years ago, REI adopted and is now implementing a strategy based on the looking 25 years into the future. The company's board and leadership targeted five trends that the company needs to address in its business practices, product lines, and ethos to protect and deliver on REI's brand promise:

- Globalization

- Urbanization
- Demographics
- Technology – tools
- Climate change. Within the category of climate change, REI teams identified the following elements of its business that was contributing to climate change and needed to be evolved or disrupted:
    - Energy use
    - Buildings
    - Paper and forest product usage
    - Waste reduction
    - Product stewardship

The strategies are currently being implemented and reflect a growing trend Sally is seeing in many corporations.

Sally also discussed the historical impacts of public policy on topics akin to advancing carbon reduction. In particular, she noted the role California played in addressing clean air back in the 1960s and 70s. Ultimately, it was the the federal regulations that required new cars to have catalytic converters that helped to clean up over thirty years of smog and brought cleaner, healthier air to southern California. Sally pointed to the history of laws and regulations that addressed the health impacts of a deteriorating air shed in the Los Angeles basin. She noted that it served as a living laboratory of how policies can drive technological change and innovation. This includes, but is not limited to, the Clean Air Act of 1960 and 1970, national emission standards for cars, roadside inspections by Californian Highway Patrol and the use of smog detection devices, among other policy and related technological innovations.

She also noted that those who question the use of "thoughtful, collaboratively developed regulation that has clear environmental and achievable outcomes," do not always recognize the tax incentives provided to oil companies and others who produce carbon emissions. The "playing field" should be even when it comes to policies that incent the use of carbon production as contrasted with those that are aimed at reducing carbon emissions. The equity in competing policies should be assessed, evaluated and addressed.

Finally, she described how impactful public and private collaborative processes can be in addressing environmental and sustainability issues and encouraging innovation and new technologies. She noted a project she help lead during her time as Secretary of the Interior: Desert Renewable Energy Conservation Plan (DRECP). Bringing together a vast array of renewable energy and land use stakeholders, state, local, and federal governments, engaged citizens and NGOs, and working to address multiple local, state, and federal laws and usual and accustomed practices and land use history, the DRECP is a great example of how collaborative efforts can lead to innovation and new ways of conducting business. The DRECP is a major component of California's renewable energy planning efforts, and will help provide protection and conservation of desert ecosystems while allowing for the appropriate development of renewable energy projects.

Jeff Harris, Chief Transformation Officer, Northwest Energy Efficiency Alliance

Key Insights

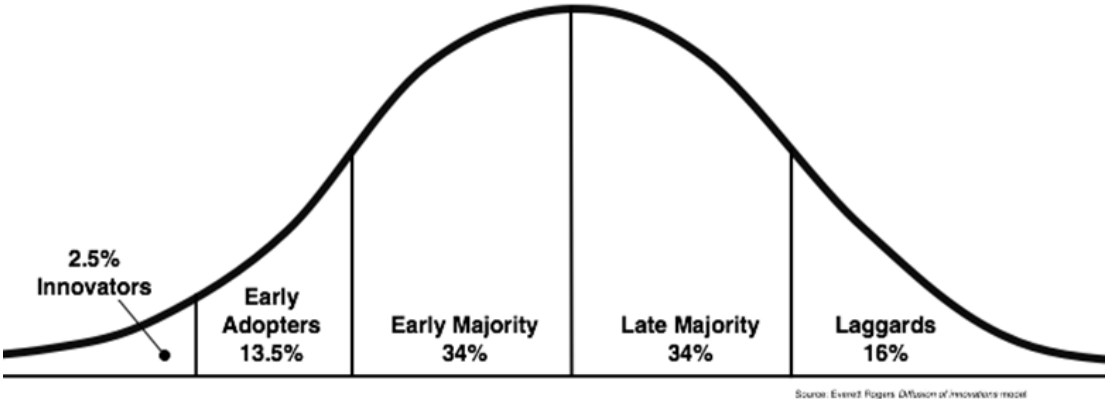
- Scaling businesses in cleantech/energy is an omnipresent issue. Not new.
- The concepts in Crossing the Chasm, Geoffrey Moore (early adopters, valley of death) are entirely applicable in this space.
- Understanding the needs of utilities and figuring out how to sell them is key; these sales take a long time and entrepreneurs need to be capitallized to withstand these adoption periods.
- Policy can be a successful driver.
- Certainty is important for businesses. Businesses would often rather have bad, but certain, policy rather than changing policy. Business can adapt to bad policy but cannot create long-term strategy if policy is constantly changing.

Discussion

Jeff placed cleantech innovation into a broad context: *any* innovation is difficult; *really* difficult. It is hard work to go from a conceptual idea and "widget made in a garage" and grow the idea or scale the widget into a successful company that has a robust customer base and market share. He noted the particular challenges inherent with scaling clean technologies that require manufacturing processes. He then described the challenges of cleantech innovation within the context of one of the oldest and most researched of behavioral change models: Everett Roger's Diffusion of Innovation theory (1962).

In relation to finding cleantech customers, building markets, and growing the cleantech ecosystem, Jeff pointed to the theory's identification of the general way people and organizations adapt to change: When promoting an innovation to a target population, there is value in understanding the characteristics of the target population that help or hinder adoption of the innovation. He described the five established adopter categories, and while the majority of the general population tends to fall in the middle categories, he suggested it is desirable to understand the characteristics of the target population and promote new technologies accordingly. He noted there are different strategies used to appeal to the different adopter categories:

- Innovators – These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks, and are often the first to develop new ideas. Very little, if anything, needs to be done to appeal to this population.
- Early Adopters – These are people who represent opinion leaders. They enjoy leadership roles, and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas. Strategies to appeal to this population include how-to manuals and information sheets on implementation. They do not need information to convince them to change.
- Early Majority – These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it. Strategies to appeal to this population include success stories and evidence of the innovation's effectiveness.
- Late Majority – These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority. Strategies to appeal to this population include information on how many other people have tried the innovation and have adopted it successfully.
- Laggards – These people are bound by tradition and very conservative. They are very skeptical of change and are the hardest group to bring on board. Strategies to appeal to this population include statistics, fear appeals, and pressure from people in the other adopter groups.



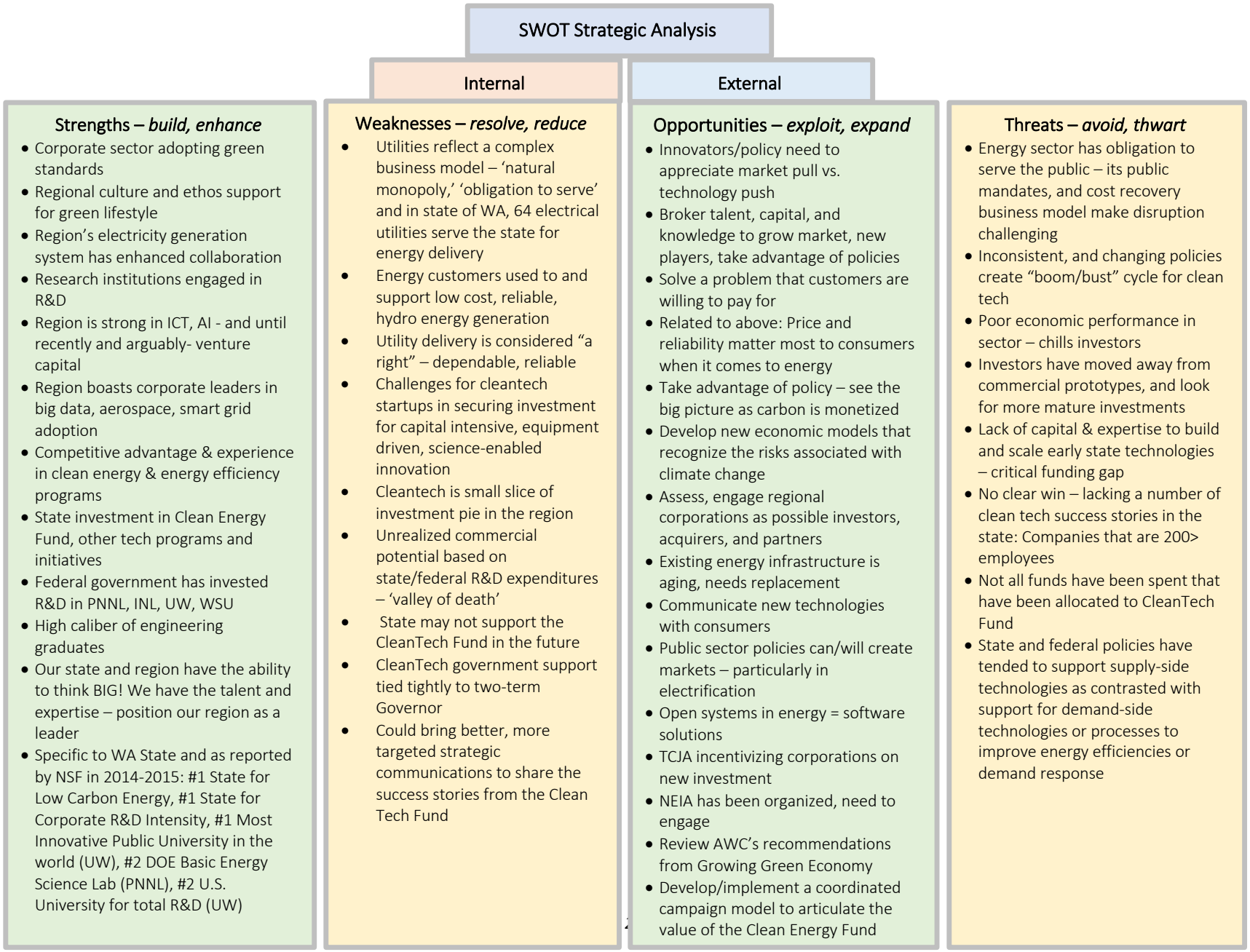
Within the context of the cleantech ecosystem, he posited that utilities, due to their public and private mandates and customer base, may be viewed as laggards within the context of the theory. However, this is understandable due to regulatory oversight and authorizing statutes and regulations that make utilities (and its customers) risk adverse when it comes to disrupting energy demand. Jeff suggests that the theory and its applications could frame a strategic approach for innovators and finding early acceptance of new products and/or processes.

Within this vein, he suggests innovators collaborate with utilities that are more adventuresome when it comes to engaging in pilot projects and/or creative partnerships to test new technologies and/or processes. He also suggests looking to working with corporate partners who embrace an "early adopter"culture. Finally, the theoretical approach informs strategic communications when messaging clean tech innovation – this has implications for how to market clean tech and public relations tactics moving forward.

Jeff noted that policy can and has "disrupted" or moved markets along the "diffusion of innovation" categories. Similar to Sally Jewell, Jeff discussed that "good" energy policy is outcome oriented and provides a timeline to achieve clear performance standards. This speeds up acceptance of innovation due to necessity and the natural inclination of organizations and businesses to address risks associated with regulatory instability, uncertainty and changing customer preferences.

As decarbonization policies are adopted, it is anticipated that the market will welcome innovation on the demand side of the energy equation. Policy will likely quicken innovation in flexible technologies within the electrical system to better accommodate variable sources of energy like wind and solar as coal power is regulated out of the energy mix and coal power plants shut down in response to changing policies. According to a 2019 report by General Electric, energy storage will be an increasingly attractive option for integrating variable wind power into the transmission system, and to complement distributed PV systems, as a reaction to changing energy policies and regulations. And, as policy encourages widespread electrification, innovation will be necessary to help utilities meet and mitigate the costs of the rapidly growing demand for electricity while simultaneously reducing carbon emissions and increase end-use efficiencies.

SWOT Analysis Graphic – detailed deep dive



Four identified pathways and types of clean tech innovation development and adoption – detailed deep dive

Incremental innovation that align with utilities' customers' benefits	Architectural innovation that aligns with economic sectors' & corporate market needs	Disruptive innovation that is advanced through formal collaborative infrastructure and partnership	Innovation that is supported & advanced through prescriptive and goal-oriented policy
Align innovation *within* utilities' natural monopoly status, public mandates, business models, customer benefits, and new performance outcomes (clean energy by 2045) Seize opportunities to collaborate with utilities to deliver innovative energy outcomes and consumer benefits that drive energy supply and infrastructure Work collaboratively with utilities to find solutions – energy outcomes - that work to solve today's energy service needs and address policy evolution– cost reliability, security, resilience, distributed energy sources, and sustainability **Local examples** – Itron, Schweitzer, Avista & Duke Energy's OpenDPS project	Engage with established corporations dedicated to improving operations in energy efficiencies, decarbonization, waste reduction, product stewardship, etc. Recognize strategic investment opportunities by working with and 'solving' sector- and/or company-specific challenges in sustainability, customer-based expectations in sustainable and green operations, develop bio-based products and processes to increase market competitiveness, and/or assist companies adapt to and function with proven clean technologies that align with corporate goals and markets **Local examples** – Microsoft Investment for Homelessness, McKinstry Innovation Ctr. Microsoft Ventures, Boeing HorizonX **National examples** - P&G's connect + develop, Samsung, Phillips and its High Technology Campus and Simply Innovate, Unilever, PACCAR Innovation Center, etc.	Engage with collaborative models supporting disruptive innovation and related R&D Seek external partnerships, collaborative idea generation models, and companies and/or institutions that are less protective of intellectual property. Seek collaboration that will satisfy customers and consumers up and down the value chain **Local examples**: Cascadia Clean Tech, CleanTech Open, Startup Seattle, UW Co-Motion, Mobility Innovation Ctr, Pacific Marine Energy Ctr, Energy Systems Innovation Ctr, ASCENT (FAA Center of Excellence) and its focus on clean technology R&D in aerospace, UW Clean Energy Test Beds and CAMSET, to be built in the UW West Campus Innovation District, Joint institutes at PNNL & WSU, and PNNL & UW Seek/engage in partnerships like Urbanova (Spokane) or non-profit driven Forterra (Hamilton), ZeroWaste Vashon, etc.	Support additional policy inducements to increase the pace of innovation in clean tech. This could include: Support policies and private/public funding to advance collaborative, center-based R&D consortiums with an applied or commercial bent, focused on energy and other clean technologies Engage in government-driven initiatives, e.g., Maritime Blue, Support state funding in applied R&D e.g., Clean Energy Fund Support federal funding in DOE focused specifically on clean tech

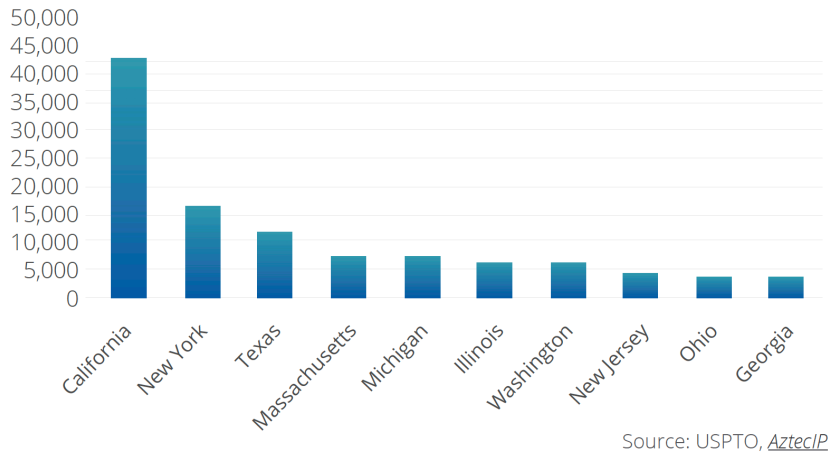
*The type of disruption is generally described as follows: **Incremental innovation** refers to relying on existing technologies and processes that increase the value to the customer (improved features, design changes, etc.) within an existing market. **Architectural innovation** refers to lessons, skills and overall technology and applying them within a different market. Architectural innovation can increase new customers as long as market is receptive - risk involved in architectural innovation is relatively low due to the reliance and reintroduction of proven technology. **Disruptive innovation** involves applying new technology or processes to a company's current market and newer tech will often be inferior to existing market technology. The newer technology may be more expensive, has fewer features, is harder to use, etc. It is only after a few iterations that the newer tech surpasses the old and disrupts all existing companies. **Radical innovation** gives birth to new industries (or swallows existing ones) and involves creating revolutionary technology (2015. Lopez, Constant Contact Tech Blog)*

SWOT Narrative – detailed deep dive

Strengths:

- The Pacific Northwest region generally, and Washington State specifically, enjoy a public and private sector who will respond to actions required to reduce carbon emissions, increase energy efficiencies, improve water quality, ensure clean air, reduce waste, and support green buildings. Other strengths:
    - A corporate and business sector with global markets and supply relationships, and actively funding and/or supporting innovation and R&D including, but not limited to: Amazon, Boeing, Costco, Expeditors International, Intel, Micron, Microsoft, Nike, Nordstrom, Paccar, REI, Starbucks, Weyerhaeuser, etc.[1]
    - A regional culture and ethos generally dedicated to environmental and sustainability values
    - The electricity system and river flow naturally connect the region with a history of collaborative regional and policy governance institutions
    - Higher education research and academic universities with strong engineering academic degree programs and cleantech-related research and innovation centers - as well as leading national research institutions like PNNL and INL - engaged in cleantech R&D efforts, including those that fund, develop, and commercializes intellectual property
    - Strong capacity in internet and communications technology, digitalization and big data analytics, artificial intelligence, and until recently and arguably, in venture capital.[2] Both the number of the funds that have been raised and the total capital raised has decreased relatively significantly since 2015 in the greater Seattle area.

Figure 1. Number of Patents Issued by State (2018)



Source: USPTO, *AztecIP*

- Competitive advantage in clean energy generation due to the use of hydropower
- Regional leader in energy efficiency innovation, adoption, and program

- State of Washington is immensely strong in sectors that are interested in cleantech innovation and adoption, which innovators should leverage, including aerospace, big data, smart grid
    - State of Washington has invested in clean energy through the Clean Energy Fund and other clean technology programs and initiatives, including funding/investment in the pending Center for Advanced Materials and Clean Energy Technologies (CAMCET), which if fully approved would house the open-access, fee-for-use Washington Clean Energy Testbeds, the NW Institute for Materials Sciences (UW & PNNL joint institute).
    - Federal government – DOE, DOD, EPA, NSF, DARPA, as example funding agencies – have invested in R&D through competitive grants awarded to research institutions including PNNL, INL, UW, and WSU
    - High caliber of software, mechanical, electrical, chemical, and power engineering graduates

[1] According to a *PwC Study*, Microsoft ranked #4 globally in R&D spending with $11.4 billion in 2015, and Amazon #7 with $9.3 billion in 2015. As a result, Washington State is the only state with two of the top 10 corporate R&D spenders

[2] A 2017 Seattle Business article noted the following: *"(T)he Seattle region is rated the second-best tech market in the nation after the Bay Area, according to real estate services company CBRE. But when it comes to launching startups, the region resides in a "second tier" of venture capital ecosystems, suggests the 2017 Venture Ecosystem Factbook from Seattle-based PitchBook Data."*

- As reported by the National Science Foundation in 2014-2015, the state of Washington ranks in the top two across a suite of activities that help to spur and support innovation, including
    - **#1 State for Low Carbon Energy**
    - **#1 State for Corporate R&D Intensity**: The National Science Foundation reports that the Seattle combined statistical area has the second highest corporate R&D expenditures among U.S. cities---over $10 billion per year---and, overall, the State is the most intensive for corporate R&D per capita
    - **#1 Most Innovative Public University in the world (UW)**: Using a variety of patent success metrics, along with industry research collaboration metrics, Thomson-Reuters found UW to be the top global public university for innovation
    - **#2 DOE Basic Energy Science Lab (PNNL)**: The Pacific Northwest National Laboratory (PNNL) is the second largest DOE basic energy science laboratory in the Nation, with an R&D portfolio of roughly $1 billion dollars per year
    - **#2 U.S. University for total R&D (UW):** The University of Washington is second in overall R&D expenditures and third in federally funded R&D, with overall expenditures of nearly $1.3 billion per year. Materials science and technology (MS&T) is critical to cleantech innovations; Thomson-Reuters ranked UW #1 in the world for MS&T impact over 2000-2010.

Weaknesses:

- Energy and water utilities reflect complex business models, requiring high-cost infrastructure to provide reliable, safe and secure services – power and water on commodity-styled demand are now viewed by established customers not only as a public service, but as *a right* of residency
- Regionally, there are over 150 consumer-owned public/people's utility districts, electric cooperatives, municipalities and Crown corporations in the Western states and Canada. In Washington, there are 28 different not-for-profit, community-owned utilities - providing electric, water, sewer and wholesale telecommunications services. (See Figure 2)
- Though developments in technology and trends in public policy have eroded some of the 'natural monopoly' aspects of traditional utilities, the infrastructure used to distribute utility products and services have fundamental dynamics that are tough to disrupt (think 4 P's – product, price, place, and promotion)
- Energy customers in the state and PNW are used to relatively plentiful, dependable, highly reliable, and low-cost hydropower – a clean energy source. This not only makes customer less likely to accept higher energy costs, it provides a competitive advantage to living and working in the region and state, which homeowning and business customers are loath to disrupt
- Innovators in clean energy face significant challenges in securing financial support and in demonstrating the compatibility of new technologies in existing systems
- Since the Great Recession, venture capital in the region has reduced its engagement in clean energy innovation and the comparative chart below demonstrates the quite small slice of the local investment pie that include investments in energy, materials, and resources (See Figure 3)

Figure 2. PUDs in Washington

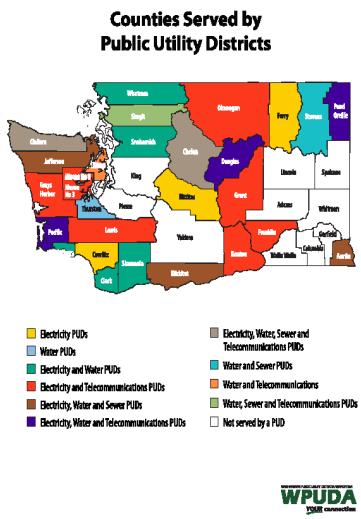
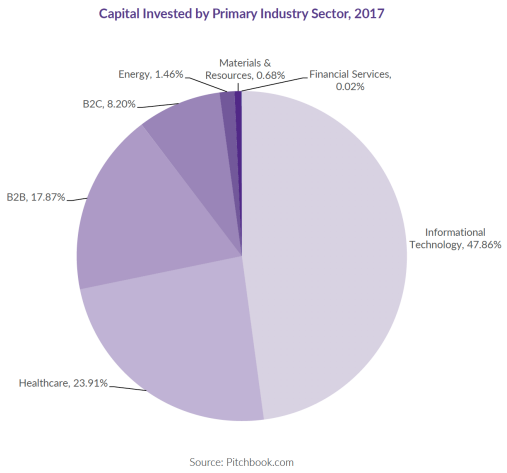


Figure 3. Capital Invested by Primary Industry Sector, 2017



Source. Pitchbook
Total Raised in Seattle area in 2017: >$1.5 billion[3]

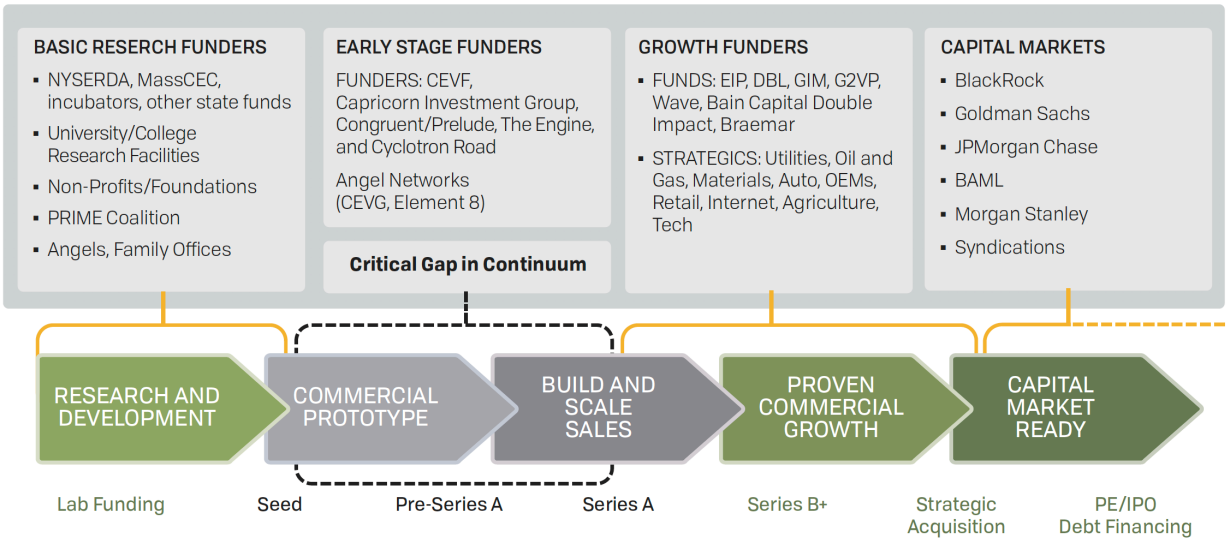
[3] For 2017, over $1.5 billion of capital was invested in the Seattle area. Almost half of the total capital, $759 million, was invested in the information technology industry sector. Healthcare and business to business industries had $379 million and $283 million invested, respectively, representing, in

- As reported by the Northwest Energy Innovation Alliance SWOT Analysis in 2018, there is significant unrealized commercial potential from public investment in regional and state-driven R&D and the challenges in transitioning a research prototype to a commercial product e.g., the valley of death concept
- Haven't had an 'unicorn' cleantech company breakthrough to help define the sector and/or region
- Haven't plainly identified the success of the CleanTech Fund and it's ROI for the state of Washington

Threats:

- The traditional energy sector is entrenched and powerful due to an obligation to serve the public and hasn't/can't change much because of various factors – publicly accepted mandates and vast experience, expertise, and success in manufacturing, infrastructure, business development, operations, customer relations and public expectations, etc.
- Inappropriate and changing policies have created a boom/bust in cleantech investment
- Poor performance and well-publicized failures of the cleantech startup sector has chilled institutional investors
- The movement of investors away from commercial prototypes -- as well as the lack of capital and expertise to build and scale sales of early stage technology -- has created a critical funding gap in the clean energy financing continuum (See Figure 4 below):

Figure 4. Clean Energy Financing Continuum as Described by Ceres



Note: The list of funders is illustrative as representative of major investors for each stage. It is not intended to be comprehensive.

- Other states e.g., California, have potential to lure talent and startups away from the state due to policies and regulations supporting the clean tech sector
- Increased competition from the Pacific Rim
- State may not support the CleanTech Fund in the future – not all funds have been spent
- Both federal and state energy policies have tended to focus more on supply-side technologies as contrasted with focusing on demand-side technologies or processes to improve energy efficiencies or demand-response

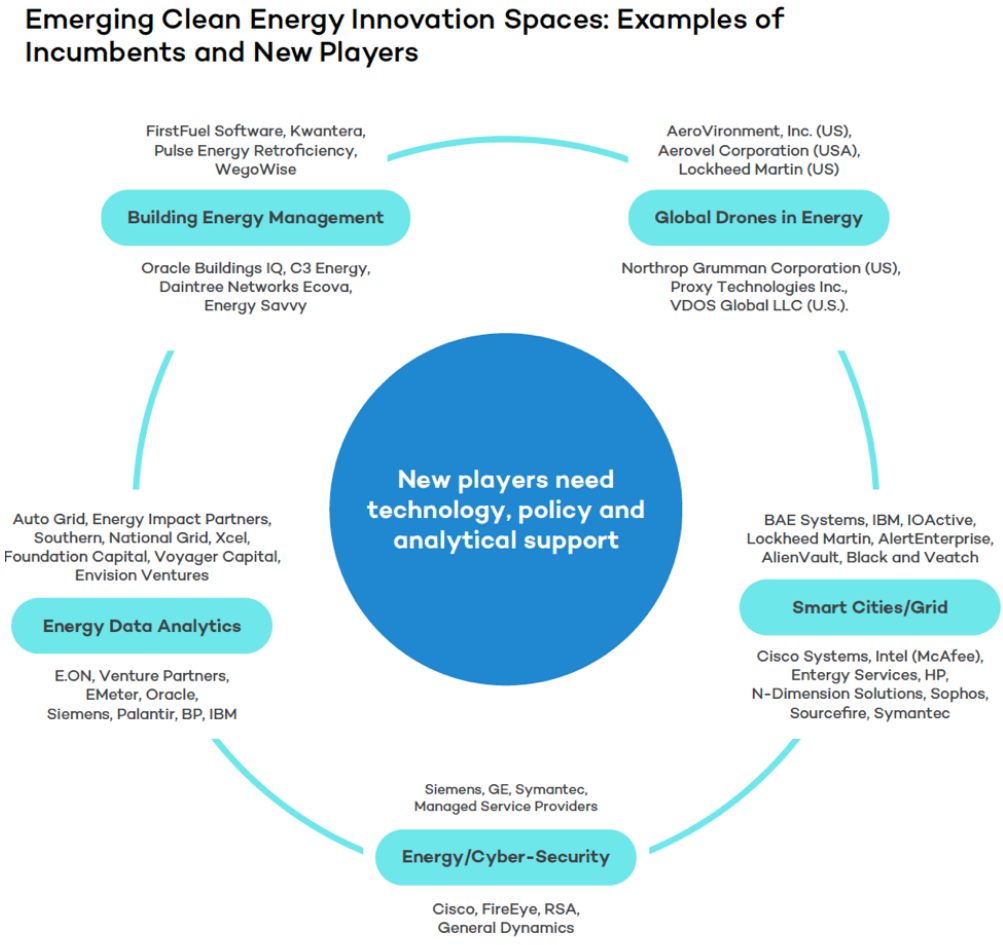
Opportunities

- Innovators and policy leaders should appreciate market pull versus technology push in cleantech innovation: Focus on brokering talent, capital, and knowledge to further market creation and recognize non-traditional, technology-centric players who are entering the clean energy space. (See Figure 5, below)
- Continue to grow cohort participants and outside funders in the Cascadia CleanTech Accelerator and open-access testbeds such as those at the UW
- Encourage and develop CleanTech Alliance programming that supports more interactions with out-of-state customers that reflect large corporate or industrial users of energy. In turn, innovators should pay attention to the needs of industrial partners and by the past performance of innovation efforts

aggregate, 41.7% of the total capital invested. Last, about 10% of the total capital, or approximately $164 million, was invested in the business to consumer, energy, materials & resources and financial services industries. (2019. Greater Seattle Technology Ecosystem)

- Understand that cleantech angel investors and innovators have ample opportunity to focus on clean energy technology solutions within existing business models, building good teams, creating strong business models, and understanding the energy market and regulatory regimes for utilities – solve a problem and ensure customers are willing to pay for solutions that will supply safe, dependable reliable energy on demand
- Akin, cleantech innovators need to understand the energy marketplace – price and reliability matter, particularly in the regional energy market.
- Take advantage of policy – see the big picture as policy monetizes carbon emissions: Opportunity to further develop new economic models and recognize the risks associated with climate change as a significant socio-economic issue
- Akin, new Washington State legislation with mandates and timing deadlines requiring 100% renewable energy targets and clean building requirements may speed up innovation and adoption
- Assess and engage corporations and industrial sectors *as customers* for innovation, possible investors and strategic partners – global companies accept that clean energy technologies are essential to for their business models to be successful. Walmart, for instance, has a goal to reach 100 percent renewables across its global network, and currently sits around 25 percent renewable at the global scale, and 12% in the U.S., in part due to the regulatory environment, pricing environment, infrastructure, and technology.

Figure 5. Emerging Clean Energy Innovation Spaces.



Non-traditional, technology-centric players are beginning to enter the clean energy space, which could unlock significant innovation opportunities throughout the energy value chain.

Source: Energy Futures Initiative (EFI), 2017

Data show a growing commitment of Fortune 500 companies (many located in the PNW) to establish renewable energy targets. This will increase demand for clean energy solutions. According to the Carbon Disclosure Project, 53 of these companies – roughly 10% of the index – are setting public targets in 2017, as compared with 42 companies in 2014. Notably, more than 48% of the 2017 Fortune 500

companies (240 companies) have a greenhouse gas reduction target, a renewable energy target, and energy efficiency target, or some combination of thereof

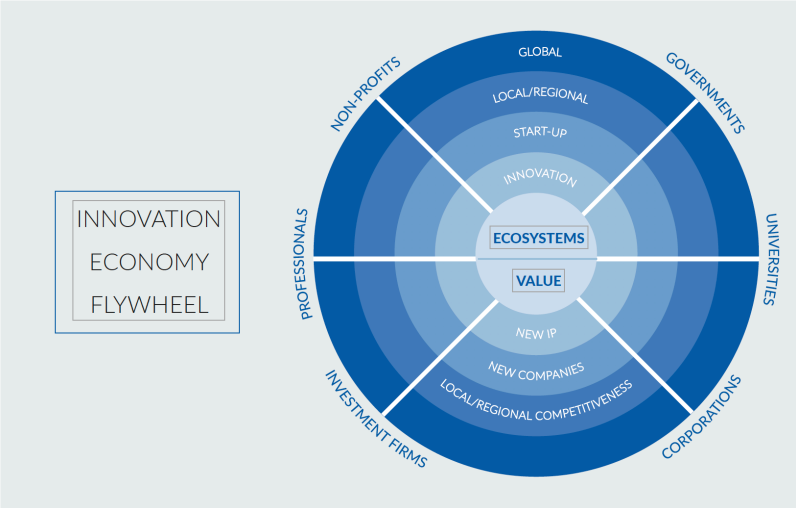
Figure 6. Percentage of Companies with Targets by Division of the Fortune 500

	Power Forward 3.0	Power Forward 2.0
Division	Companies with Targets # (%)	Companies with Targets # (%)
All Fortune 500	240 (48%)	215 (43%)
Fortune 250	142 (57%)	139 (56%)
Fortune 251-500	98 (39%)	76 (30%)
By Quintile		
Fortune 100	63 (63%)	60 (60%)
Fortune 101-200	57 (57%)	54 (54%)
Fortune 201-300	44 (44%)	44 (44%)
Fortune 301-400	32 (32%)	32 (32%)
Fortune 401-500	44 (44%)	25 (25%)

Source: Ceres 2017

- Closer to home, with new carbon and clean building policies in the state of Washington, there is likely to be increasing market crossover and innovation potential between existing energy providers, large global companies who are big users of energy, and clean technologies. The region boasts a maturing and seasoned innovation sector that will benefit clean tech innovation and entrepreneurs (innovation flywheel concept, see Figure 7)
- Recognize that the utility industry is continuing to evolve as it adapts to new trends, including greater use/requirement of distributed energy resources, flattening energy sales, a need for emissions reductions, increasing penetration of plug-in electric vehicles, and growing attention to transmission and distribution constraints and grid resilience. In an era of utility transformation, innovations in energy efficiency will play an important role as a low-cost utility resource that can help lower costs, reduce emissions, and improve reliability.

Figure 7. Innovation Economy Flywheel Concept (2019)



Source: 2018 Greater Seattle Innovation Ecosystem Report

- Existing energy and water infrastructure are aging and need replacement
- Seize on developing/supporting policies that are vital to educating consumers and customers about current and upcoming energy alternatives and facilitating access to a wide array of new clean technologies – also to invest in R&D

- Recognize that the public sector can create markets (NYC example of regulatory approaches that encourage multi-tenant building owners to "go green.")
- Recognize that energy providers are moving towards open system innovation to support ongoing software solutions (like Avista's and Duke Energy's OpenDSP project)
- Understand how the federal Tax Cuts and Jobs Act (TCJA) will likely help to incentivize corporations to increase business investment (estimates of up to $1.5 trillion in incremental new investment), some of which could be targeted into clean energy innovation and commercialization. Attracting these funds into clean energy innovation will depend on success in aligning various elements of the innovation ecosystem and encouraging a robust pipeline of research, creation of markets for clean energy applications, and collaborative private-public projects/entities that facilitate commercialization of innovations (test beds, incubators, accelerators)
- Appreciate how clean energy adoption in the construction and real estate sectors is being driven by energy code mandates – demand will continue to accelerate "smart building" technologies, such as predictive analytics, load controls, peak load management, energy loss management, advanced lighting and climate controls, demand/response, etc.
- Support efforts like the Northwest Energy Innovation Alliance (NEIA) that is dedicated to a stronger, more effective regional innovation network that will build a global energy innovation hub in three distinct areas: energy storage, grid control systems, and catalysts. The NEIA is specifically focused on bridging the so-called "valley of death" and leveraging public investments by improving the track record of transitioning research prototypes to commercialized products that specifically address market trends and needs
- Review, assess and evaluate proposals and recommendations emanating from the *Growing the Green Economy in Washington State: Exploring an Eco-nomic Center* (2019. Association of Washington Cities Center for Quality Communities.) This includes developing (1) A Eco-Nomic Center to serve as clearinghouse for green economy activities, (2) Investing in educational R&D and workforce training, (3) Creating a Water Innovation Center, (4) Creating a Clean Energy Center, (5) Integrating ICT capabilities across designated business sector, (6) Encouraging smart grid technologies, (7) Expanding focus on cross-laminated timber, (8) Expand R&D in agriculture and food supply, and (9) Develop economic models for assessing risk, managing assets, and financing infrastructure
- Recognize that state of Washington policies supporting reductions of carbon in power and transportation sectors will open more opportunities for innovation in electrification
- Consider more active engagement and communication of efforts like Urbanova, Forterra, and other local efforts across the state that bring together multiple elements of the cleantech sectors – energy, water, building, and transportation
- Build stronger relationships with investor firms interested in hardware funding and have established a relationship with the UW Clean Energy Test Beds (UWCT), or interested in building relationship with participating innovators:

    - E8 (Seattle) https://www.e8angels.com/
    - Phoenix Venture Partners (Bay Area, Seattle) http://www.phoenix-vp.com/
    - Enel (Italy, global utility with venture-like innovation activity, bought Spokane-based Demand Energy)https://startup.enel.com/
    - Breakthrough Energy Ventures (Seattle, Bay Area) http://www.b-t.energy/ventures/
    - Prime Coalition (Boston) https://primecoalition.org/

    Other "pro-hardware" investors that we have had multiple conversations with:
    - Energy Foundry (Chicago) http://www.energyfoundry.com/
    - BCI Technical Investments (Pittsburgh) https://bci-ti.com/
    - Clean Energy Trust (Chicago) http://cleanenergytrust.org/

    Recent "pro-hardware" investor introductions emanating from 2019 NREL Industry Growth Forum:
    - Clean Energy Venture Group (NY, Boston) https://cevg.com/
    - Cottonwood Technology Fund (Santa Fe, NM) https://www.cottonwood.vc/
    - Mitsubishi Business Incubation Unit (Tokyo) https://www.linkedin.com/in/yusuke-tsuji-7639ba53
    - BASF Venture Capital America (Bay Area) https://www.basf.com/global/en/who-we-are/organization/locations/europe/german-companies/BASF_Venture-Capital.html
    - RMI Ventures (Boulder, CO) https://rmi.org/
- Analyze and evaluate successful cleantech companies based on the following criteria: (a) sales metrics (b) customer metrics (c) financial management metrics, (d) gross margins, among other key metrics appropriate for startup businesses. To date, the following companies have generally been recognized as successful cleantech startups based on suggested metrics:
    - Tesla - https://www.tesla.com
    - Nest (now merged with Google and Google Nest will serve as the blanket branding for all of Google's home products - https://nest.com
    - First Solar - http://www.firstsolar.com/Careers
    - Impossible Food, Inc. - https://impossiblefoods.com
    - TPI Composites (largest domestic manufacturer of composite wind blades) - http://www.tpicomposites.com/English/home/default.aspx
    - Katerra - https://www.katerra.com

Resources

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