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Investing in Clean Energy Jobs: A Literature Review

Clean Energy Transition Institute

About the Clean Energy Transition Institute

The Clean Energy Transition Institute is a Seattle-based nonprofit organization whose mission is to accelerate an equitable clean energy transition in the Northwest (Idaho, Montana, Oregon, and Washington). We provide unbiased decarbonization research and analytics and convene decision-makers to evaluate low-carbon strategies and steer limited resources toward solutions that will best reduce energy sector emissions.

About this Report

The Clean Energy Transition Institute commissioned Research Fellow Claire Buysse to perform a literature review of clean energy job studies in the fall of 2020 through February 2021, the result of which is ***Investing in Clean Energy Jobs: A Literature Review.***

About the Author

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Executive Summary

After more than a decade of public investment in clean energy in the United States, largely initiated by the 2009 American Recovery and Reinvestment Act, a wealth of retrospective studies makes clear that funding clean energy drives broad economic development and job creation.

As the country recovers from the economic fallout of the COVID-19 pandemic, there are important choices to make about how stimulus dollars are spent, and whether these investments will build a sustainable and economically resilient future that also accelerates the transition to clean energy.

Investing in Clean Energy: A Literature Review examines the economic benefits of investing in clean energy, emphasizing a just transition for workers and communities, and makes a strong case for clean energy as an economic stimulus in Washington state. The discussion is organized into four parts, with the following key takeaways:

Part 1: Job Creation in the Clean Energy Economy

- Washington has fewer fossil fuels jobs to lose than other parts of the country, but these jobs still may not be easily replaced by clean energy work.
- Clean energy—particularly energy efficiency and solar—drives more job creation than the fossil fuel industry, but jobs in fossil fuels tend to have higher wages, better benefits, and less turnover.
- There are trade-offs between job creation and electricity generation capacity for wind and solar, with wind likely to power more of Washington's clean energy future but provide fewer jobs.

Part 2: Workforce Transition and Development

- Pre-existing programs, such as registered apprenticeships, are an effective, time-tested, and industry-backed way to build a clean energy workforce.
- Broad skills training and local-hire provisions build economic resilience for workers and communities, and economic outcomes should be targeted and tracked for disadvantaged groups.
- Collaboration with industry can inform the need for labor and decrease the cost of transitioning workers, while labor unions can provide a unified, cross-company network to organize and support workers through job transitions.

Part 3: Distribution of Costs and Benefits

- Low-income groups and marginalized communities face multiple barriers to accessing the benefits of a clean energy transition, which require careful attention and local engagement.
- Rural areas in Washington have ample clean energy resources in wind and solar, as well as potential for economic benefits from electric vehicles.
- A just transition must consider community-wide investments in all impacted industries, as well as support for fossil fuel workers.

Part 4: The Impact of Public Policy

- Reliable, long-term investments and incentives provide stability for clean energy businesses, workers, and their customers.
- Making public investments accessible to all—through thoughtful policy design, clear communication, and timely administration—is key for achieving equitable clean energy development and sustainable economic benefits from clean energy.
- Policies that encourage private sector investment alongside public spending, such green banks, can both accelerate and sustain a clean energy economy.

Introduction

This review of clean energy jobs investment literature summarizes 76 studies and reports to inform Northwest policymakers about the best practices for both developing clean energy jobs as well as transitioning existing fossil fuel jobs. The research was current as of February 2021.

During the first three months of the COVID-19 pandemic, 21,242 clean energy jobs were lost in Washington state.[1,a] While the labor market slowly recovered in the months that followed, more than 60% of those job losses remained at the end of 2020.[2] Devastating economic impacts across industries underscore the need for public investment in local economies. Clean energy investment has successfully stimulated the economy in the past, creating many new, high-quality jobs and making it an attractive target for recovery spending.[3–5,b]

A pandemic-era economic stimulus is also an opportunity to target investments to historically marginalized groups. Hispanic and Latino workers in the United States have seen disproportionately large jobs losses in clean energy and the broader energy industry.[2,6] A focus on equity in responding to the pandemic-induced economic crisis is critically important to getting Washingtonians back to work.

Amid economic uncertainty, effective public policy must be timely, flexible, and designed with long-term benefits in mind.[7] This report aims to shed light on strategies for investing in the clean energy economy in Washington state. It reflects the key findings of a literature synthesis that are organized around four central themes: (1) job creation, (2) workforce transition and development, (3) distribution of costs and benefits, and (4) public policy.

1. Job Creation in the Clean Energy Economy

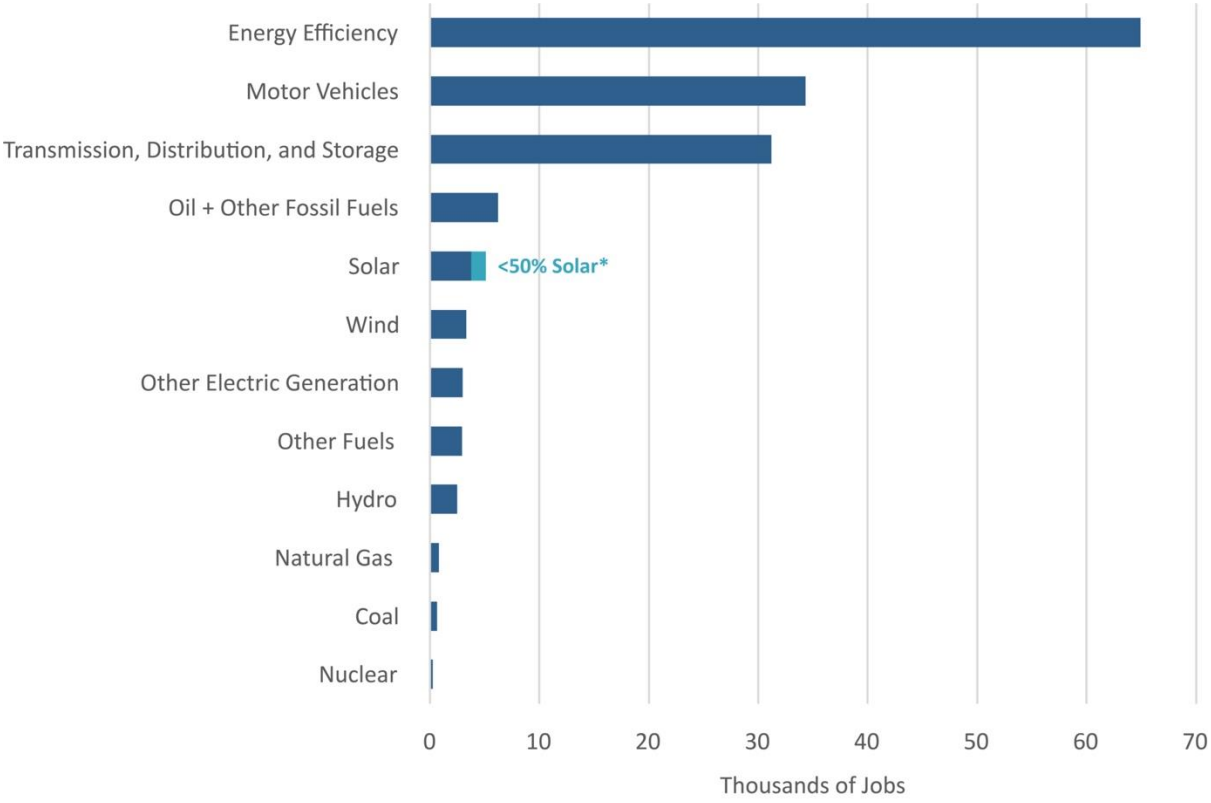
Job creation is a well-studied and oft-touted economic benefit of the transition to clean energy. Over the past decade, there has been considerable growth in the clean energy economy and, importantly, this growth has become increasingly decoupled from energy consumption.[8] This section outlines major findings on the clean energy industry's job creation potential.

Energy efficiency is an engine of job creation

There is a wealth of literature that confirms the fact that energy efficiency is one of the most cost-effective[9] and labor-intensive clean energy investments[8]—and it gets immediate, local results.[9,10] Across the United States, jobs in energy efficiency and motor vehicles—those primarily focused on reducing energy consumption—are growing faster than traditional energy sector jobs.[8] What's more, these emissions-reducing jobs are inherently local and primarily found in small businesses.[11]

Energy efficiency has created the most energy jobs in Washington, as shown in Figure 1, and throughout the West Coast.[12–14] While Washington has been consistently recognized for its progress in energy efficiency,[13,15,16] there is room for improvement. Several states have made significant investments in energy efficiency and provide useful models for Washington state policy.[15,c] In particular, California has seen massive job growth in energy efficiency[13] and tops the most recent list for building energy efficiency policies.[15]

Figure 1: Washington state energy jobs by sector (2019)



Data from US Energy and Employment Report (2020). *Indicates jobs that spend less than 50% of their time on solar-related work.[14]

Clean energy potential for local job creation

While the state is a crude-oil refining center for the Pacific Northwest,[d] fossil fuel energy is not local to Washington. With no natural gas production in the state, Canadian imports support Washington state's natural gas economy. Washington is home to a single, soon-to-retire coal-fired power plant.

During a clean energy transition, the fossil fuel industry is expected to shed about 140 jobs per year in Washington state.[17] Prior to the COVID-19 pandemic, researchers estimated that these job losses could primarily be handled through retirement attrition;[17] however, retirement-eligible workers left at a lower rate than anticipated during the 2008 recession,[18] and this effect may be repeated in the current pandemic.

> The majority of Washington's fossil fuels jobs are in oil and other petroleum industries.

Given the greater likelihood of displacement over retirement for fossil fuels workers, and that labor market turbulence triggered by displacement can lead to additional wage losses,[19,e] protections for fossil fuels workers, like wage compensation insurance[20,21] and pension guarantees[22], are extremely important for a just energy transition.

As fossil fuel jobs decline, jobs in clean energy can continue to grow while providing new opportunities to previously unemployed and underemployed workers.[5] However, clean energy jobs in Washington state are not

currently growing as quickly as they are for its Pacific Coast neighbors.[13] These neighbors—California, Oregon, and British Columbia—provide Washington with important models for low carbon fuels, distributed solar initiatives, portfolio diversification, clean technology clusters, industry collaborations, bipartisan policy, and more.

Solar currently providing more clean energy jobs than wind

Researchers estimated that an annual $6.6 billion invested in clean energy projects in Washington state would generate around 41,400 jobs per year: over six jobs per $1 million invested.[17] This number is higher for energy efficiency investments, which are more labor-intensive, and slightly lower for investments in renewables. It also does not include those jobs created from the recirculation of employee wages into the local economy, which adds an additional two to three jobs per $1 million.

Compare these figures to other options for state spending (not including jobs created from wage recirculation):

- $1 million investment in fossil fuels generates only 3.1 jobs[17]
- $1 million household tax cut generates only 4.7 jobs[17]
- $1 million in Boeing subsidies generates less than 5 jobs[3]

Clean energy is a clear jobs winner, but job creation varies by technology. Wind generation currently supplies significantly more electricity to Washington than solar,[23] but solar supports more jobs (see Figure 1), and researchers estimated that investments in wind in Washington would create 1.7 fewer jobs per $1 million than solar.[4,17]

> Wind supplied over 3,000 MW of power to Washington in 2018, while solar supplied only 20 MW.

However, wind energy is likely to play a big role in meeting the state's renewable energy targets for electricity generation,[24] with the potential to meet 48% of the power load in 2050.[25,26] Solar is anticipated to meet only 15% of the power load.[25]

Not all jobs are created equal

While job growth is a powerful incentive for policy action on clean energy,[27] the quality of jobs—and their potential to meet the needs of transitioning fossil fuel workers and underserved communities—are important considerations. A few key indicators of job quality include wages, health insurance coverage, retirement plans, and unionization rates.[f]

Average Washington wages in renewable industries are much lower than in the fossil fuel industry,[17] although solar jobs consistently pay above the median wage in Washington and across the United States.[3,28,29] Health insurance coverage and unionization rates also fall short for clean energy as Table 1 shows.[17] (Compare, for example, an average natural gas distribution worker to two clean energy workers in Washington state.)

Table 1: Comparison of employment characteristics for energy-related jobs

	Natural Gas Dist.	Building Retrofits	Wind
Average total compensation	$123,000	$67,400	$71,900
Health insurance coverage	95.6%	55.1%	66.6%
Union membership	48.7%	19.8%	12.3%
Retirement plan coverage	not available[g]	43.9%	55.4%
High school degree or less	25.2%	46.2%	38.5%
Number of workers in WA	1,164	14,112	7,524

Data reproduced from Pollin et al. (2017) based on survey data from 2010-2015. Wages are shown in 2015 dollars.[17]

To improve job quality, Clean Energy Works (now Enhabit), a federally-funded program in Oregon, set workforce standards and provided incentives for healthcare coverage for clean energy contractors. The outcomes and challenges of this program can inform Washington state policy, such as the importance of having a range of options for meeting health insurance requirements.[30,31] In addition, job quality is strongly related to the size and bargaining power of labor unions,[32,33] which underscores their important role in creating good jobs.[h]

> The construction industry dominates Washington's energy jobs, supporting the most jobs per sector in energy efficiency (42,807), transmission distribution and storage (13,672), and electric power generation (5,746) in 2019.

As with wages, the educational credentials required for clean energy jobs are significantly lower than for fossil fuel jobs, with a large proportion of jobs requiring a high school degree or less. While this mismatch creates a gap in transitioning fossil fuel workers, the sheer number of anticipated clean energy jobs ensures plenty of jobs with the appropriate education credentials.[5,17,20] It may also be an opportunity to provide employment for state residents who are not otherwise positioned to meet Washington's growing need for high-credentialed workers.[34,35,i]

The location and stability of new clean energy jobs are also important for transitioning workers and supporting communities. A poll of solar industry employees showed that roughly 59% work in their own region/metropolitan area, but the remaining employees work away from home, sometimes from out of state.[28]

The construction industry, which fills a large portion of clean energy jobs, is prone to high separation and unemployment rates, and these jobs may disappear upon completion of a project.[4] However, a complementary investment in energy efficiency or environmental remediation, which are highly place-based activities, can help to keep these jobs local, especially for those workers nearing retirement.[5,21,36]

2. Workforce Transition and Development

Developing a clean energy workforce, and transitioning fossil fuel workers to new jobs, is an essential component of a successful clean energy transition. This section outlines major findings on the development of a clean energy workforce.

Don't reinvent the [training] wheel

Existing workforce development systems are the fastest and most effective way to prepare a clean energy workforce.[9] Building green skills into a broad, occupational skills training system that *already exists* is better preparation for workers than highly specific "green jobs" training, and it gives them more options in a turbulent labor market.[9,33,j] With so many clean energy jobs in construction, the industry's well-developed registered apprenticeship model is a useful pre-existing pathway.[33]

> Existing workforce development systems are the fastest and most effective way to prepare a clean energy workforce.

A review of retraining programs in the United States and a clean-energy focused program in Oregon provides valuable insight for future workforce development in Washington state, including the importance of setting up programs before worker displacement, establishing clear eligibility requirements, offering sufficient income replacement for the full training period, and aligning curriculum with national standards.[21,30] In addition, an on-the-job training subsidy can be an important incentive for integrating new, entry-level workers into clean energy projects.[31]

Collaboration and adaptability can align labor supply and demand

It is impossible to train your way out of a jobs crisis,[33] which makes it essential to align worker training to demand timelines.[30,33] Since employers can help determine where, when, and what jobs are needed, strong relationships with employers (business councils and mediated industry partnerships) improve job placement prospects for workers.[33,37] This role is especially important during company restructuring, when jobs are not necessarily replaced one-to-one, which is likely in a clean energy transition.[37,k] Coordination with labor unions can further strengthen organization and serve as an important link between retraining programs and dislocated workers across multiple employers.[37]

Workforce training programs, which influence the supply of workers, must also be forward-looking and adaptable. These programs should be scalable to fluctuating labor demand[38] with curriculum development driven by data on training and skills gaps in the clean energy labor market.[9,l] Even with a strong demand for labor, workforce shortages can slow a clean energy transition.[39]

Workforce training an opportunity to target investments to specific groups

Thoughtfully-designed workforce development programs can improve outcomes for the most vulnerable groups during a clean energy transition.[33] Market transitions disproportionately affect workers who are younger and have fewer educational credentials or skills.[19] They also highlight the vulnerability of economically-disadvantaged populations and others who may feel the ripple effects of lost fossil fuel jobs.

By locating projects in transitioning or underserved communities, and prioritizing local hire, a clean energy transition can invest in these vulnerable populations and in the local economy.[21] There are various policy tools to achieve this,[m] and several groups have called for the implementation or expansion of local hire provisions in Washington state.[40,41]

The availability of jobs is not the only issue for underrepresented workers: research suggests a lack of access to these jobs is actually more pressing.[40,42] While many new jobs will be in construction and manufacturing, which typically employ a higher proportion of people of color,[32] progress should also be measured with diversity benchmarks. A recent clean energy program in Oregon set a 30% benchmark for trade/technical hours worked by underrepresented groups and a 20% benchmark for project dollars directed to diverse businesses.[31,n]

> Thoughtfully designed workforce development programs can improve outcomes for the most vulnerable groups during a clean energy transition.

A smart workforce transition can be an inexpensive one

Washington state's current program for dislocated workers cost $3,274 per participant in 2018.[43] This initial investment came with real returns for participating workers, taxpayers, and the local economy.[44] Despite the return on investment, the upfront cost may be a financial or political barrier and minimizing this cost may prove important in securing an investment. Recent research suggests that retraining Washington's youngest fossil fuel workers first would be more cost effective than retraining those closer to retirement.[17]

The public sector does not need to foot the whole bill, either. In California, the construction industry has been the primary funder of its apprenticeship training system; in addition, a portion of employer and employee contributions are reinvested in the program.[4] Attracting private sector investment and securing sustainable funding sources[4,45] are important considerations for workforce program design.

3. Distribution of Costs and Benefits

Both workers and their local communities are impacted by a transition to clean energy. Notably, the cost of a clean energy transition may fall disproportionately on fossil fuel workers, marginalized communities, and low-income groups. This section outlines major findings on the equitable distribution of costs and opportunities to create tangible benefits for these groups.

Fossil fuel communities require broad, tangible economic development

Fossil fuel jobs support various communities in Washington, including Centralia, Anacortes, Ferndale, and Tacoma. Research tied to the Green New Deal recommended channeling 10% of clean energy investments into these impacted communities.[17,o] Energy is not the only impacted industry, however, with a carbon price forecasted to impact iron and steel milling, aluminum production, cement manufacturing, commercial transportation, and more .[46,47]

These cross-industry impacts emphasize the value of a multi-faceted, community-wide economic development plan during a clean energy transition. There are several models to draw on, such as the retirement of Washington's own Centralia coal plant, which included the creation of a community transition council to steer multi-year investments in weatherization, energy technology, and worker retraining.[46,48,p]

Rural areas benefit from electrifying transportation, wind, and solar

It is all too easy for clean energy development to cater to an elite urban class, but rural communities have a significant stake in the transition. For example, rural areas in Washington are likely to host large-scale wind

and solar projects;[25] wind in particular has the potential to drive economic development in urban and rural areas alike.[9,q]

Additionally, rural areas outside the reach of mass transit systems will require electric vehicle (EV) options to achieve low-carbon transportation.[32] In Washington state, rural EV drivers are expected to save up to twice as much on fuel as urban drivers.[49] EVs also have lower maintenance costs[49] and are relatively insulated from global oil price swings.[50] However, the currently high upfront cost of EVs makes these benefits harder to access and means that savings take longer to accrue.[32]

Rural areas also have exposure to the costs of a clean energy transition. One example of this is the inclusion of black liquor and poultry litter in renewable portfolio standards, since the associated facilities (i.e., paper mills and industrial-scale chicken farms) are often located in rural areas and have negative impacts on air and water quality.[51]

Low-income communities face multiple barriers

An argument against the clean energy transition is the need to increase ratepayer costs to cover stranded fossil fuel assets alongside new investments in clean energy resources. This argument has been consistently exploited in support of the fossil fuel industry.[52] Advocates also raise concerns about the burden of clean energy costs on low-income groups, calling for strong consumer protections[53] and a more equitable distribution of costs amongst stakeholders.[54,55,r]

In the long term, spending on clean energy is expected to reduce ratepayer costs. This is because energy efficiency measures lower household energy use[s] and the cost of new renewable energy eventually falls below the cost of installing pollution controls at fossil fuel plants.[11,32,56]

While Washington already has some of the lowest energy costs in the country,[57] higher short-term costs can still be prohibitive, especially for low-income groups.[21,40,51] One proposed solution is a three-tiered consumer assistance program for the bottom 60% of income earners, which acknowledges the incremental energy burden also carried by middle-income groups.[21,t]

Because of the multiple barriers facing low-income groups, attention must be focused on addressing gaps in financing, internal capacity, and policy incentives for the benefits of clean energy technology to reach low-income communities

In addition to increasing energy rates, low-income groups face other barriers to accessing the benefits of a clean energy transition,[51] including high upfront costs, creditworthiness requirements, and split-incentives in landlord-tenant relationships.[9,58,59] They also include health and safety barriers, such as asbestos and mold,[58] and the risk of resident displacement to make way for clean energy projects.[40]

Similar to rural areas, the approval of certain energy sources as renewables, such as waste-to-energy incinerators, also threatens air and water quality in disadvantaged communities.[51] Because of the multiple barriers facing low-income groups, attention should also be focused on addressing gaps in financing, internal capacity, and policy incentives for the benefits of clean energy technology to reach low-income communities.[60,u]

Marginalized communities value local leadership and collective ownership

While the clean energy transition is an incredible opportunity to invest in marginalized communities and advance energy equity, it also has the potential to be invasive and unwelcome. To avoid this, local participation and local leadership are required. There are continued calls from community groups, environmental organizations, and academics for clean energy projects to include the participation of local residents, business leaders, educators, and environmental justice groups.[21,53,59]

Community organizations in particular can play a key role in outreach and project development, and by serving as intermediaries between residents and government agencies, utilities, or energy efficiency contractors.[58] In Washington state, tribal lands have considerable renewable resources,[16] but an equitable development of clean energy capacity on this land must be led and facilitated by its Indigenous residents.

> An equitable development of clean energy must be led and facilitated by local community and/or tribal members.

Outside of community-based projects, clean energy policies can support marginalized communities by requiring a percentage of investments go to businesses that are minority-owned and operated, an increasingly common practice.[61,v] One group also recommends "iterative and adaptive" equity screening for climate and energy policies to ensure that they are fair, inclusive, and effective at reducing current and future disparities.[51]

4. The Impact of Public Policy

Public policy has historically been a driving force for clean energy development and can be a major determinant of a successful transition. This section discusses how policy design can impact the clean energy transition.

Uncertainty and administrative bottlenecks stifle job creation and workforce transition

Uncertainty about the implementation and longevity of clean energy policies severely limits commercial development, with potential investors concerned about the reliability of their returns. The solar industry is a good example of this: recent federal[28,w] and state[62,63,x] policy shifts have negatively impacted U.S. solar installations, and employers reported policy challenges as the most significant difficulty in growing a profitable business.[28]

> Policy uncertainty and administrative red tape can limit the pace of the clean energy transition.

In the case of energy efficiency, Washington's own clean energy leadership report[12] acknowledges that the state's regulatory incentives did not include adequate cost recovery.[y] With feedback on policy changes likely to be quick,[63] policy should be designed with enough flexibility to allow for swift adaptation to better meet commercial needs.

Administrative bottlenecks similarly limit a clean energy transition. For example, direct incentives are a common practice, but rebates and grants are prone to administrative complexity when scaled up; state green banks and green bonds offer an avenue to avoid these challenges.[45,z] Timely review, permitting, and inspection may also be a barrier,[10,12,25,45,64–67] as well as utility interconnection.[16,62,66] Some of these burdens may be alleviated by state-standardized codes, fee structures, and filing procedures, as well as streamlined documents and training.[25,30,68]

The history of U.S. workforce development programs is also rich with administrative challenges, including communication and benefit delays and a lack of clarity around eligibility.[21] Thoughtful construction of these programs, as noted in the Part 2: Workforce Transition and Development section, can resolve many of these issues.

Structure of clean energy incentives determines users

Public policy largely determines who can access the benefits of a clean energy transition, and who ultimately receives public investment dollars. Issues of access are also covered in the Part 3: Distribution of Costs and Benefits section, but important links to public policy are emphasized here.

For example, it is difficult for nonprofits, government entities, and low-income individuals to take advantage of the federal investment tax credit for solar.[64,aa] Administrative requirements for low carbon fuel standards, among other things, may also be prohibitive for small businesses and transit agencies.[69] In Washington state, community institutions face competing priorities, like bill pay assistance and demand reduction programs, as well as financial barriers, like access to grants and loans.[60,64,70,bb]

> Clean energy investment policies are often regressive, benefiting corporations that sell energy efficiency products and wealthy households that can afford upgrades.

The distribution of public investment dollars is closely related to access. Clean energy investment policies are often regressive, benefiting corporations that sell energy efficiency products and wealthy households that can afford upgrades. Instead, household rebates are a promising progressive policy[55,cc] and several interventions have been proposed to meet the challenges low-income groups face.[60] A coalition of climate justice advocates and clean energy researchers specifically recommend that state governments provide strong consumer protections and monitoring of progress across population.[64]

Public policy influences private sector investments

The private sector may have greater access to capital than the government, making it ripe for the upscaling of clean energy investments. Again, Washington's own clean energy leadership report[12] identifies the importance of private funding in sustaining clean energy job growth and highlights the opportunity for Washington companies to differentiate themselves in the clean energy market.[dd]

As mentioned in Part 2: Workforce Transition and Development section, private sector investment can support a large portion of workforce training costs and more. State policies can encourage business involvement, e.g., by removing barriers for on-site solar or wind installation and providing more options for adopting renewable energy through utilities or third parties.[27]

The use of green banks has also been widely recognized for its ability to leverage private dollars: through the Connecticut Green Bank, public investments in clean energy were matched 6:1 by private investments, which had previously been matched just 1:1.[71] The combination of public and private dollars makes it easier to build financial capacity for clean energy investments, which may be traditionally viewed as risky, unproven technology.[45]

Conclusion

This synthesis report draws on the body of literature published through February 2021, which does not cover clean energy issues equally, leaving research gaps that must be addressed. There are numerous studies focusing on residential and community solar in Washington and the United States, often including an equity lens, as well as energy efficiency.

At the same time, much less has been reported on jobs and equity in wind, geothermal energy, grid modernization, and biofuels. Battery storage is often coupled with solar in the literature but lacks standalone information. There is also a solid foundation of literature on workforce transitions, yet many of these studies focus on the U.S. coal industry.

Further work would be welcome on transitioning the workforce away from natural gas infrastructure and petroleum exports, which are more relevant in Washington state. Finally, the differentiation of urban and rural impacts and opportunities is a significant research gap, and a closer look at these differences in Washington will be key to ensuring an equitable clean energy transition.

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[a] 35,376 Washington jobs were lost in the energy industry as a whole from March to May 2020.[72]

[b] Job quality indicators include wages, healthcare, unionization, retirement benefits, and the opportunity for advancement.

[c] Areas for growth include utility and public benefit policies (e.g., energy efficiency resource standards and programs for income-qualified customers) as well as transportation (e.g., zero-emission vehicle programs and transit funding).

[d] Out of Washington's 5,411 fossil fuel jobs (as of 2014), petroleum refining and petroleum bulk stations/terminals accounted for 1,918 and 738 jobs, respectively, representing 49% of Washington's fossil fuel jobs. Natural gas distribution and oil and gas pipeline construction/transportation account for the bulk of the remaining jobs (1,164 and 1,137 jobs respectively).[17]

[e] Based on other market transitions around the globe, researchers suggest that involuntary layoffs are essential during the transition but that these layoffs are small relative to voluntary separations. Both contribute to labor market turbulence.[19]

[f] The opportunity for job advancement is another important consideration. Clean energy investments do create many low-credentialed jobs (e.g., requiring a high school degree or less) with opportunity for advancement.[5] However, researchers have also found that solar

installers in California have significantly less opportunity for wage growth than union electricians.[4] This solar gap is also found in U.S. manufacturing[29] and highlights the role of labor unions in supporting clean energy workers.

[g] Retirement data for fossil fuel workers was not published in the report and could not be provided by the authors upon request.

[h] The majority of large-scale renewable projects in California from 2002-2015 were built under labor agreements ensuring union pay, health insurance, and pension programs.[4]

[i] Washington has strong demand for workers with a postsecondary education in the next five years (e.g, ~70% of projected job openings requiring at least some education beyond high school) and has historically relied on workers trained out-of-state to meet many of these high-credentialed workforce needs.[35]

[j] Green jobs training programs for women under the American Recovery and Reinvestment Act were woefully unsuccessful in this aspect, with a heavy focus on "weatherization" rather than core trade skills. Other issues with this program were gender discrimination and the mistiming of labor supply with demand.[73]

[k] A recent survey of Washington employers revealed that the state's workforce training services were misaligned with employer needs.[74]

[l] Panels to identify skills gaps in Washington state have historically targeted the energy sector, but there has not been a specific focus on clean energy.[9]

[m] The NAACP recommends renewable energy credits for in-state investments as well as local hire quotas and bidding preferences.[61]

[n] The program also guaranteed 180% of Oregon state minimum wage and healthcare coverage/healthcare pay for all workers.

[o] Locating clean energy projects in disproportionately distressed areas has the potential to increase visibility and public support across the political spectrum.[20] This tactic has been used many times before, including by Roosevelt's New Deal.

[p] Importantly, this broad economic development can have multiple priorities, including building energy efficiency, transportation infrastructure, and community solar.

[q] The same report notes wind's capacity for job creation in manufacturing, installation, and operations, finding component manufacturing to "hold particular promise."[9]

[r] These stakeholders include utility shareholders as well as current and future ratepayers of varying incomes and energy utilities (gas and electric).

[s] One source notes that "[r]esidents of states with the weakest energy efficiency policies saw their monthly energy bills go up twice as much as people in the most efficient states".[11,56]

[t] The NAACP has additional recommendations for Washington state, including establishing temperature-based consumer protections and removing reconnection fees.[41]

[u] The Center for Labor Research and Education recommends subsidies for low-income households as well as decoupling low-carbon goods and services from the ownership of assets likes homes or vehicles.[59]

[v] The NAACP uses the term "Minority Business Enterprise", or MBE, defined as a business that is at least 51% owner-operated and controlled on a daily basis by people who identify with specific ethnic minority classifications.

[w] The impact of Section 201 tariffs, while noticeable in 2018, has been "largely mitigated by lower global prices on these components." Potential impacts from phasing out the federal solar investment tax credit are still uncertain.[28]

[x] Non-residential solar installations declined in 2019, driven by "regulatory cliffs and policy reforms" in California, Massachusetts, and Minnesota. These major policy shifts included a transition to new time-of-use rates (California) and interconnection delays (Massachusetts).[62]

[y] A federal report has also noted information bottlenecks in advanced manufacturing that limited their upscaling, which again highlights the value of industry collaboration and information flow between the public and private sector.[75]

[z] The financing of clean energy projects is also challenging, since projects are relatively small scale and financers have a limited understanding of performance risk.[45]

[aa] A report from Lawrence Berkeley National Lab found that 40% of tax-exempt solar customers used third-party ownership arrangements in 2018, allowing them to take advantage of federal income tax credits.[76]

[bb] Front and Centered provides two case studies on issues of access to solar incentives in Washington state.[70] A recent Washington State University report also mentions that community solar projects, whether led by utilities or nonprofits, don't have momentum that will last beyond current incentives.[68]

[cc] Common uses of public revenue and their socioeconomic distribution are outlined in Table 1 and Figure 9 of a World Resources Institute issue brief.[55]

[dd] According to the report, Washington has "inherent competitive advantages" in the clean energy areas of energy efficiency, renewable energy integration, and bioenergy.[12]