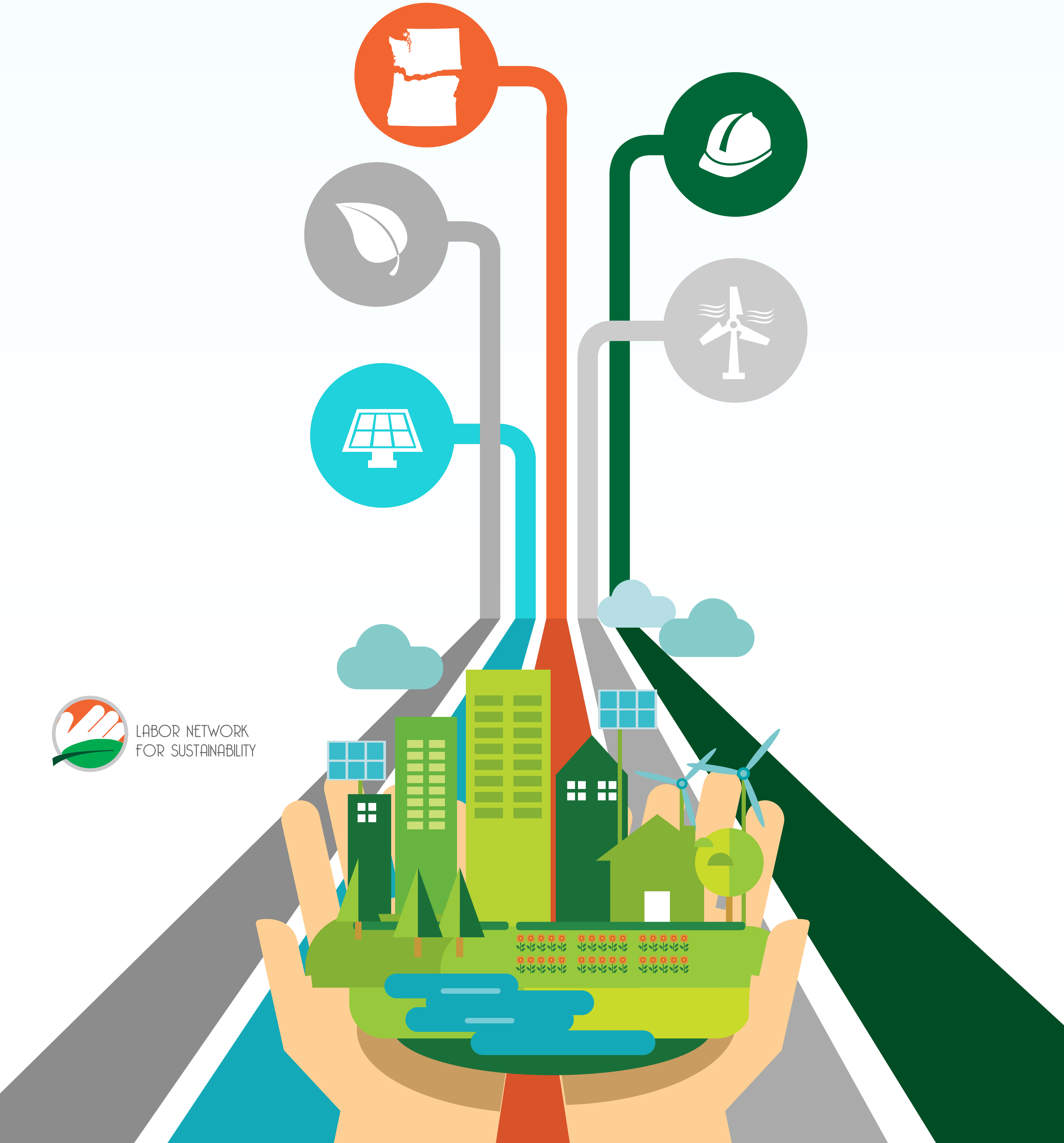
THE ECONOMIC IMPACT OF CLEAN ENERGY INVESTMENTS IN THE PACIFIC NORTHWEST: ALTERNATIVES TO FOSSIL FUEL EXPORTS



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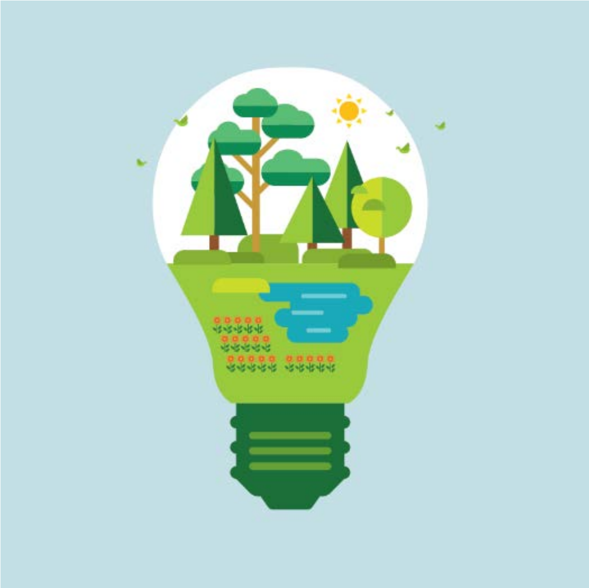
Introduction: Jobs for Hard-Hit Communities



In 2015, The Labor Network for Sustainability[1] released its "Clean Energy Future" report showing that the US could reduce its greenhouse gas emissions 80% by 2050 – and increase jobs and save money in the process.[2] It showed this will benefit the US economy, US workers, and US consumers. But throughout American there are communities, often devastated by deindustrialization and runaway employers, that face high levels of unemployment and poverty. Likewise there are skilled workers who would like to find work in their trades but instead face chronic unemployment. For such communities and workers, the possibility of jobs building and running coal, oil, and gas infrastructure often seems like a ray of hope. Those who seek to halt new fossil fuel infrastructure can easily appear as a threat to their future.

Grays Harbor County in western Washington is a case in point. Once a lumber processor and exporter, the largely rural county now suffers from high rates of poverty; a 9% unemployment rate; jobless lumber workers; and increasing numbers of workers who have simply given up even looking for work.[3] A consortium of three companies proposed to greatly expand the Grays Harbor Westway and Imperium crude oil storage and export terminal to ship oil brought by train from Utah to Asia. The project was estimated to create 231 construction jobs over the year or so it would take to build, and thereafter provide 148 operations jobs as long as it was open.

Yet despite the county's great need for jobs, in 2014 the city council of its principal city, Aberdeen, voted unanimously to oppose the transport of crude oil by rail through the city. They found that just in the first quarter of 2015 there had been "several explosions and fires of rail-borne tank cars carrying crude oil" and that the city has "very serious concerns about the safety of the public, public services, and public infrastructure," all of which would be "placed in serious jeopardy" by the addition of new petroleum storage and sales facilities. The city council decided that "the development of additional and expanded crude petroleum facilities is contrary to the health, safety, and welfare of its citizens and business community, the economy of the entire Grays Harbor estuary, and is inconsistent with the City's newly adopted planning goals of reconnecting its commercial, retail, and residential communities with the waterfront."[4] In the face of this and other opposition, in 2015 much of the proposal was withdrawn.

[1] The Labor Network for Sustainability (http://www.labor4sustainabilty.org) was founded in 2009 based on an understanding that long-term sustainability cannot be achieved without environmental protection, economic fairness, and social justice. LNS believes we all need to be able to make a living on a living planet.
[2] Labor Network for Sustainability, "The Clean Energy Future: Protecting the Climate, Creating Jobs, and Saving Money" http://www.labor4sustainability.org/wp-content/uploads/2015/10/cleanenergy_10212015_main.pdf
[3] https://fortress.wa.gov/esd/employmentdata/reports-publications/regional-reports/county-profiles/grays-Harbor-county-profile
[4] "A resolution adopting findings of fact in support of the six month moratorium imposed on crude oil facilities in the city of Aberdeen, Washington." Passed and approved on September 9, 2015. http://www.aberdeenwa.gov/wp-content/uploads/minutes-agendas-newsletters/Agenda_2015-09-09.pdf

Whenever there is opposition to a pipeline, power plant, oil well, or other fossil fuel project, it raises a legitimate question: Where are the people who would have built and operated them going to find jobs? The answer is often given that clean energy creates more jobs than the fossil fuel projects it replaces. This is true, but can it help the people of America's Grays Harbors?

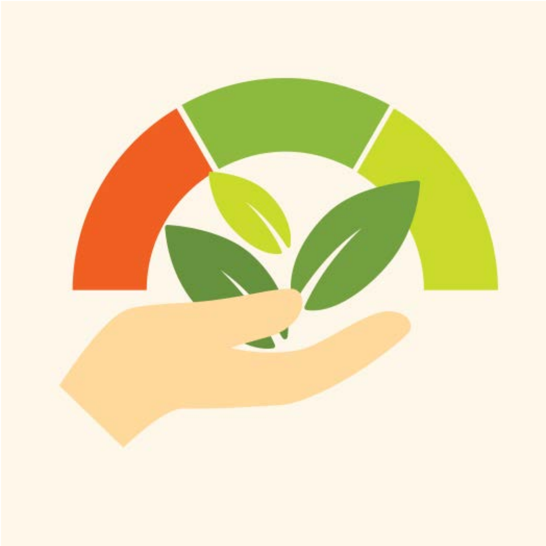
This report, "The Economic Impact of Clean Energy Investments in the Pacific Northwest: Alternatives to Fossil Fuel Exports," was prepared by Noah Enelow of Ecotrust Knowledge Systems,[5] with introduction and conclusion prepared by the Labor Network for Sustainability.

It shows how more jobs can be created through clean energy than through the proposed oil terminal and storage facility. It compares the proposed oil facility with two clean energy projects. The first is a 40 MW utility-scale solar photovoltaic array. The second is an energy efficiency program designed to reduce residential energy wastage and thereby reduce energy demand and consumer utility costs. These two projects would cost about as much as the proposed oil facility, *but would create far more jobs*.

We hope this report will be helpful for people in the affected communities of western Washington who want to ensure jobs and prosperity without the threat of a dangerous, polluting, climate-destroying oil export facility. We also hope it offers a model for constructing economic alternatives to fossil fuel infrastructure that can be drawn on by people in similar situations all around the region and the country to devise plans for their own communities. For both we hope it will show that there are alternatives to depending on fossil fuel expansion for jobs.

[5] The mission of Ecotrust (http://www.ecotrust.org) is to inspire fresh thinking that creates economic opportunity, social equity, and environmental wellbeing.

1. Background



With increasing global demand for fossil fuels from countries spanning the Pacific Rim, the Pacific Northwest is experiencing a dramatic rise in the demand for expansion of existing infrastructure, as well as new construction of terminals, storage tanks, pipelines, and rail and barge traffic.

The proposed fossil fuel transport and export projects in the Pacific Northwest have been supported in part in the expectation that they will create jobs and revitalize struggling economies up and down the Northwest coast. Are there alternative ways to do so?

In this study, we start by analyzing a sample fossil fuel infrastructure project. The particular project was chosen from the large array of proposed or planned projects in the Northwest because information about its costs and impacts is available from other studies. We will compare its projected job creation impact, using the results of studies developed by regional economic analysis firm ECONorthwest (Kitchen, Krebs and Whelan 2013), with the projected impact of a hypothetical renewable energy investment of comparable size in the same region, using the Jobs and Economic Development Impact (JEDI) model developed by the National Renewable Energy Laboratory (NREL). This thought experiment will allow us to answer the question of whether the proposed investments in fossil fuel export terminals are the best economic development option for the Pacific Northwest region.

This study demonstrates that investments in renewable energy and energy efficiency create more jobs per dollar of investment than fossil fuel infrastructure investments. Specifically, a portfolio of targeted investments in renewable energy such as solar and wind, complemented by energy efficiency upgrades for businesses and homes in the Pacific Northwest, can generate a greater number of jobs in construction, transportation, supply chains, and operations and maintenance (O&M) than a similar dollar investment in oil, coal, and natural gas infrastructure in this region.

2. Sample Fossil Fuel Project: Westway/Imperium

The Westway and Imperium crude oil storage and export terminal expansion projects in Grays Harbor County, Washington, is the fossil fuel project we have chosen to use as a benchmark comparison to a potential renewable energy investment of similar size. The project is a composite of two storage and export terminal expansions, Westway and Imperium. The original proposal also entailed the conversion of Imperium's storage facility, which formerly contained only biodiesel, to be able to contain crude oil.[6]

6 In a recent development, the company that owns a majority stake in Imperium Renewables, Renewable Energy Group, Inc. (Business Wire 2015), canceled its plans to ship crude oil through its terminal, though its plans for expanding its existing biodiesel storage capacity are still in effect (Gonzalez 2016).

We chose this project for three main reasons. First, it is a proposed project that is currently nearing the end of a lengthy and controversial permitting process. The project has been opposed legally by the Quinault Indian Nation, whose livelihoods would be negatively affected by the facilities' expansion (Resource Dimensions 2015, Powell and De Place 2015). In 2014, the city council of Aberdeen, WA, voted unanimously to oppose the transport of crude oil by rail through the city (Hart 2014). Second, the project involves multiple forms of fossil fuel infrastructure including storage tanks, rail spurs, pipelines, and marine port services, making it an apt representative project for the region. Third, an economic analysis of the projected impacts of the Westway-Imperium project exists (Kitchen, Krebs and Whelan 2013), whereas for most of the other proposed fossil fuel projects, no such study exists.

The construction of the Westway and Imperium oil export terminals is expected to cost $118.04 million, of which $68.63 million is expected to be spent within the state of Washington.[7] Table 1 below presents projected estimates of the number of jobs that Westway and Imperium are projected to create, based on the ECONorthwest economic impact analysis from 2013 (Kitchen, Krebs and Whelan 2013). The estimates are presented for each of the two phases of the project: construction and operations. The construction period is expected to last 9-16 months, while the operations phase continues indefinitely.

The operations of the Westway and Imperium oil export terminals, marine services, and rail services is expected to cost $107.92 million annually. These costs include all direct spending associated with the terminals and related marine and rail services. Likewise, the operations jobs reflect those created at the terminals, as well as the associated marine and rail services. All job estimates are counted in full-time person-years. While the construction jobs only last one year each, the operations jobs last as long as the terminals are in operation. We assume that the only operations spending occurring in-state consists of the payroll, utilities, services, and leasing data provided in the economic analysis (Kitchen, Krebs and Whelan 2013). Finally, the job creation estimates associated with these expenditures are associated with Grays Harbor County only.

Project Phrase	Total Cost	In-State Cost	Direct Jobs/Year	Total Jobs/Year	Total Construction Jobs/ $1 Million Invested Locally
Construction	$118,041,921	$68,629,373	231	758	11
Operations	$107,920,865	$107,920,865	148	303	3

Table 1. Projected Job Creation Impacts: Westway and Imperium Crude Oil Bulk Storage and Export Terminals

Three points are worth noting related to the results presented in Table 1. First, the table shows that the one-year construction phase of the project creates many more total jobs than the multi-year operations phase (758 vs. 303). Second, the study that generated these figures assumes that the project will operate at full capacity for its entire lifetime. The possibilities of increases in oil extraction costs, fluctuations in global demand for U.S. crude oil exports, and public policies that discourage oil consumption (such as a carbon tax or cap-and-trade), all entail that the terminals may operate at below full capacity in some years, reducing the number of operations jobs created or maintained at the terminals. In other words, it's likely that the predicted number of operations jobs will only be accurate in "good" years where global oil export demand is high; in "bad" years where demand is low, some of the workers at the terminal or related service

[7] All construction and operations data associated with the Westway-Imperium project, including in Table 1 below, are updated from 2013 USD to 2015 USD, using the Producer Price Index (PPI) for NAICS sector 4861, Pipeline Transportation of Crude Oil (BLS 2016).

industries will be laid off. The job creation figures for the operations phase of the project must thus be viewed as upper-bound, *best-case* scenario estimates.

Third, the results presented below also omit any jobs that may be *destroyed* by the expanded oil transport related to the building of the terminals. These jobs would exist in sectors negatively affected by oil train transport and the related dangers to natural resources and infrastructure due to explosions, derailments, and spills, as well as everyday increases in train traffic. The sectors that stand to lose out from the oil terminals include commercial and recreational fishing, tourism and hospitality, and local commerce and retail. The job creation figures for the project as a whole must thus be viewed as *gross* (as opposed to *net*) estimates, that fail to take into account the *opportunity cost* of the oil terminal expansion – the value of what must be given up in order to have the terminals.

What kinds of jobs will be created by the proposed Westway and Imperium terminals? Will they be predominantly administrative, managerial, and scientific; or will they also include significant numbers of construction, installation, transportation, and maintenance jobs? Table 2 below provides an estimate of the breakdown of *direct* jobs created, sorted by job category, during the construction phase of the Westway and Imperium terminals and pipeline.[8] We estimate job categories for the construction phase of the project from the Industry-Occupation matrix dataset (Bureau of Labor Statistics 2012), published every ten years by the Bureau of Labor Statistics (BLS). The best proxy for the construction phase of the Westway-Imperium project is the industry category labeled "Other Heavy and Civil Engineering Construction", which is given the six-digit code 237900 under the North American Industrial Classification System (NAICS).

From Table 2 below we can see, not surprisingly, that construction and extraction occupations are predicted to comprise a majority (59.4%) of the jobs generated by the construction phase of the Westway-Imperium project. We can also see that transportation and material moving occupations comprise 7.0% of total jobs; installation, maintenance and repair occupations comprise 5.0% of jobs; and production occupations comprise 2.6% of jobs.

Category	Percentage of Industry	Number of Direct Jobs
Construction and extraction occupations	59.4%	137
Installation, maintenance, and repair occupations	5.0%	12
Production occupations	2.6%	6
Transportation and material moving occupations	7.0%	16
All other job categories	26.0%	60
TOTAL	**100.0%**	**231**

Table 2. Direct Job Breakdown by Top Level Occupational Category, Construction Phase, Westway and Imperium
Source: Bureau of Labor Statistics (2012); Kitchen, Krebs, and Whelan (2013)

What kinds of jobs are expected to be created in the operations phase of the Westway-Imperium project? Table 3 below presents the corresponding direct job breakdown using three Industry-Occupation matrices. For the employment at the terminals, we use NAICS category 424710, Petroleum Bulk Stations and

[8] We do not have data on the industrial sectors in which the additional (indirect and induced) jobs will be created during the construction phase of the project; hence, we cannot identify the occupational categories for these jobs without replicating the original study.

Terminals. For related employment in marine services at the port, we use NAICS 488300, Support Activities for Water Transport. For rail-related services, we use NAICS 488200, Support Activities for Rail Transport. (Bureau of Labor Statistics 2012).

From Table 3 below we can see that the largest single occupational category is Transportation and Material Moving Occupations, comprising 85 of the 148 direct jobs. The other major industrial job categories create smaller numbers of jobs. The total number of direct permanent jobs created in the categories of installation, maintenance and repair, production, construction and extraction total only 24. The remainder of the jobs created directly by the operations phase of this project (41 direct jobs) include office-based administrative work, sales and related support, managerial, financial, and technical job categories.

	Terminals		**Marine Services**		**Rail Transport**		**Total**
Job Type	% Jobs	# Jobs	% Jobs	# Jobs	% Jobs	# Jobs	# Jobs
Transportation and material moving occupations	38.3%	17	70.9%	52	48.1%	14	83
Installation, maintenance, & repair occupations	5.8%	3	9.0%	7	26.0%	8	18
Production occupations	3.1%	1	2.6%	2	7.9%	2	5
Construction and extraction occupations	0.2%	0	0.6%	0	2.8%	1	1
All other occupations	52.6%	24	16.9%	12	15.2%	5	41
TOTAL	**100.0%**	**45**	**100.0%**	**73**	**100.0%**	**30**	**148**

Table 3. Direct Job Breakdown by Top Level Occupational Category, Operations Phase, Westway and Imperium

Table 4 presents a comparison of the job creation between the construction and operations phases of Westway and Imperium. If we sum the jobs created in the four top categories of occupations above, we see that whereas the construction phase creates 171 of these jobs for one year, the operations phase creates 107 long-term jobs, assuming the terminals are operating at full capacity. We can conclude that the Westway-Imperium project promises to create a relatively larger number of direct jobs in the construction phase than in the operations and maintenance phase. We will now compare these job figures to those of a hypothetical renewable energy project undertaken at similar scale.

Job Type	**Construction Phase**	**Operations Phase**
Transportation and material moving occupations	16	83
Installation, maintenance, and repair occupations	12	18
Production occupations	6	5
Construction and extraction occupations	137	1
All other occupations	60	41
TOTAL	**231**	**148**

Table 4. Comparison of Direct Job Breakdown by Occupational Category, Construction and Operations Phases, Westway and Imperium

3. Renewable Energy Scenario: Utility-Scale Solar PV

For our sample renewable energy project, we have chosen to model a utility-scale solar photovoltaic (PV) facility, located in the state of Washington. Solar energy is one of the fastest-growing energy sectors in the United States, in terms of both installed capacity and job creation. In 2015, solar and wind power accounted for 60 percent of new U.S. power capacity, and are expected to account for 70 percent in 2016 (Koch 2016). Prices for solar power have fallen by 60 percent since 2008. In a rare show of bipartisan cooperation, the United States Congress recently voted to extend the renewable energy production tax credits for another five years, which Bloomberg New Energy Finance (BNEF) expects will boost solar power capacity by an additional 20 gigawatts (GW) over the next five years (Randall 2015). Solar and wind power have surged even as fossil fuel prices have fallen, due to a combination of government incentives, strong consumer demand, and increasing cost competitiveness with fossil fuels. A recent Bloomberg article predicts, “By the time the new tax credits expire, solar and wind will be the cheapest forms of new electricity in many states across the U.S.” (Randall 2015).

We predict the job creation and economic development impact of a utility-scale solar PV array using the Jobs and Economic Development Impacts (JEDI) model developed by the National Renewable Energy Laboratory (NREL), a public research institute and think tank based in Golden, CO. The JEDI models are Excel-based economic impact models that use fixed production coefficients to predict the impacts of renewable and non-renewable energy projects in each of the 50 states (National Renewable Energy Laboratory 2015). Renewable energy projects include onshore and off-shore wind, solar photovoltaics (PV), and cellulosic biomass-based ethanol.

Unionized Utility-Scale Solar Jobs

The potential for high-quality, union jobs in utility-scale solar installations can be seen in California. According to a study by the UC Berkeley Labor Center,[a] in-state, utility-scale solar generated electricity has quadrupled in California between 2010 and 2014. The share of California’s electricity generated by renewable energy sources grew from 11% in 2008 to 19% in 2013. The study found:

Over the last five years, 10,200 well-paying construction jobs were created in California during the expansion of California’s solar-based, utility-scale electrical generating facilities. These jobs pay, on average, $78,000 per year and offer solid health and pension benefits. In addition, 136 permanent operations and maintenance jobs have been created and will last for the lifetime of these facilities. These operations and maintenance jobs pay an average of $69,000 per year, usually with solid benefits. In addition to the jobs created on the construction projects, about 1,600 jobs have been created to handle increased business up and down the supply chain and to perform other new business activities associated with these projects. These newly-created construction, maintenance, and business-related jobs have boosted consumer spending, which in turn has induced the creation of over 3,700 additional California jobs aimed at meeting increased consumer demand. In total, more than 15,000 new jobs have been created by the solar farm construction boom in California over the last five years.

Utility-scale solar construction in California over the last five years built 4,250 MW of renewable energy generating capacity in California. Because most of the construction was organized under collectively bargained contracts or project labor agreements, contractors have agreed to contribute training money for apprenticeship training based on each hour of work for every blue-collar worker on the site. This has provided $17.5 million in new money to help finance the training of construction apprentices and pre-apprentices. This infusion into California construction apprenticeship and pre-apprenticeship training includes $8.3 million into electrician training, $3.1 million into the training of construction craft laborers, $2.6 million into training ironworkers, $1.7 million to train carpenters and piledrivers, and $1.9 million to train operating engineers.

This new human capital formation will generate a stream of higher income over decades, reflecting the greater skill set and higher productivity of these trained California construction workers. For instance, over the lifetime of electrical apprentices, as they become journeyworkers, their income in today’s dollars will be higher by about $1 million compared to what their income would have been absent this training. In addition, these workers not only earn while they learn but they also participate in family-supportive health insurance programs, promoting family formation and stable child-rearing, and they begin building savings for their retirement. By the time these electrical apprentices retire as journeyworkers at age 65, they will have amassed a retirement nest egg of about $525,000 in defined contribution and defined benefit programs sponsored by their contractors and unions. This is substantially more than what the median single or married worker at age 65 today has for retirement.

[a] Peter Philips, “Environmental and Economic Benefits of Building Solar in California: Quality Careers – Cleaner Lives,” Donald Vial Center on the Green Economy, November 10, 2014.

We assume a utility scale, photovoltaic (PV) solar array of 40 MW nameplate capacity, which is approximately the average size of a utility-scale solar project in the United States as of 2014 (Bolinger and Seel 2015). We assume that the solar panels are made of crystalline silicon and arranged in a fixed mount pattern (National Renewable Energy Laboratory 2015). We assume that the mounting, the modules, and the electrical components are manufactured in-state, and the solar inverter is manufactured out of state. We assume that 50% of all materials and equipment by value are sourced through in-state suppliers; 100% of labor for installation, operations and maintenance is sourced in-state; and 50% of business overhead is spent in-state.

Table 5 below provides projections of the total cost, in-state spending, and direct and total annual jobs created by the solar array described above. Three results are worth noting. First, the total cost and in-state investment spending in the construction phase are both much larger than in the operations phase. Second, as in the case of the oil export terminal above, the direct and total jobs created by the construction phase are much larger than in the operations phase. Third, the operations phase creates a very small number of total jobs per $1 million of in-state spending. This result stems from the fact that the vast majority of spending during the operations phase of the project consists of debt service payments; the actual operational costs of the facility total $797,200, of which $733,424 is spent in-state. The number of direct and total jobs created per $1 million of in-state operational costs alone is quite large (9.5 direct jobs and *53.2 total jobs* per $1 million).

Project Phrase	Total Cost	In-State Spending	Direct Jobs/Year	Direct Jobs/ $1 Million In-State Spending	Total Jobs/Year	Total Construction Jobs/ $1 Million Invested Locally
Construction	$194,753,791	$109,920,707	478	4.3	1,114	10.1
Operations	$23,388,640	$23,324,864	7	0.3	39	1.67

Table 5. Projected Job Creation Impacts: Utility-Scale Solar Photovoltaic Array, 40 MW Nameplate Capacity, Washington State

Table 6 below provides the breakdown of construction jobs from the solar array. We find that 478 of these jobs are in construction or construction related services. These jobs comprise 43% of those created during the construction phase of the solar array. Indirect jobs created through sourcing and manufacturing of solar energy parts and components comprises an additional 409 jobs, or 37% of total jobs created. A large number of these indirect jobs will be created in manufacturing industries.

Impact Type	Jobs	Earnings ($ Million)	Output ($ Million)
Direct: Construction Labor	274	$17.75	-
Direct: Construction Related Services	204	$12.12	-
Subtotal: Direct	478	$29.86	$40.78
Indirect: Equipment and Supply Chain	409	$29.95	$122.17
Induced Impacts	226	$13.6	$54.89
Direct: Construction Labor	274	$17.75	-
Direct: Construction Related Services	204	$12.12	-

Table 6. Projected Job Breakdown, 40 MW Solar PV Array, Construction Phase

Table 7 below provides a comparison of the jobs breakdown of the construction phases of the proposed Westway/Imperium project and the hypothetical solar array. The results are clear: the solar array would create many more jobs, including many more construction jobs, than the oil terminals. The solar array would create 247 more construction or construction-related jobs, 147 more indirect, supply chain-related jobs, and 356 more total jobs, than the oil terminals.

Impact Type	Westway/Imperium	Solar PV Utility (JEDI)	Difference
Construction	137	274	137
Construction-related services	94	204	110
Subtotal: Direct	231	478	247
Indirect (Equipment / Supply Chain)	262	409	147
Induced Impacts	265	226	-39
Total: Direct, Indirect, and Induced	758	1,114	356

Table 7. Job Creation Comparisons, Construction Phase, Westway/Imperium vs. Solar Array

Table 8 below provides the results of the JEDI model for the operations phase of the solar array. These figures reveal a relatively small number of direct and total operations jobs. Every year the plant is in operation, assuming it is running at full capacity, it would create 39 total jobs, of which 7 would be direct jobs created on-site. The project would also create 17 indirect supply-chain related jobs.
Table 8. Projected Job Breakdown, Operations Phase, Solar Array

Impact Type	Westway/Imperium	Solar PV Utility (JEDI)	Difference
Direct: Onsite Operation Labor	7	$0.44	$0.44
Indirect: Local Revenue / Supply Chain	17	$1.13	$3.31
Induced Impacts	15	$0.89	$2.59
Total Impacts: Direct, Indirect, and Induced	39	$2.47	$6.36

Table 8. Projected Job Breakdown, Operations Phase, Solar Array

Table 9 below compares the operations jobs created by the solar array with those created by Westway/Imperium. Clearly the solar plant operations are insufficient to generate the number of jobs, year after year, that Westway/Imperium would create. This result suggests that investments in additional clean energy capacity must be ongoing, rather than one-time-only, to compete with investments in fossil fuel infrastructure. The following section of this study demonstrates that a complementary investment in energy efficiency upgrades can provide a larger number of jobs than those that would be created by a fossil fuel project such as Westway/Imperium.

Impact Type	Westway/Imperium	Solar PV Utility (JEDI)	Difference
Direct	148	7	-91
Indirect	87	17	-70
Induced	69	15	-54
Total Impacts (Direct, Indirect, Induced)	304	39	-265

Table 9. Job Creation Comparisons, Operations Phase, Westway/Imperium vs. Solar Array

Utility Scale Solar Photovoltaic—What Kind of Jobs?

This study has demonstrated that constructing a utility-scale solar photovoltaic power plant would create a larger number of jobs than a comparably scaled investment in fossil fuel export infrastructure. But what kinds of construction, installation, and manufacturing jobs would be created by this investment? This section provides a closer look at the occupations that such an investment could potentially generate in the Pacific Northwest.

Table *A* presents the assumptions behind the JEDI model analyzed in this study for the State of Washington. We assume that all electrical components and modules, except the solar inverter, are produced in Washington, though we assume that only 50% of these components (by value) are actually sourced locally. Under these assumptions, we derive an estimate of the local costs associated with the project, presented in the right-hand column of Table *A*.

Detailed PV Project Data Costs				
Installation Costs	**Total Cost**	**Purchased Locally (%)**	**Manufactured Locally (Y or N)**	**Local (In-State) Cost**
Materials, Equipment, and Labor				
Mounting (rails, clamps, fittings, etc.)	$7,102,239	50%	Y	$3,551,120
Modules	$78,000,000	50%	Y	$39,000,000
Electrical (wire, connectors, breakers, etc.)	$8,097,761	50%	Y	$4,048,880
Inverter	$11,600,000	50%	N	$0
Installation Labor	$17,745,612	100%		$17,745,612
Subtotal	$122,545,612			$64,345,612
Other Costs				
Permitting	$820,001	100%		$820,001
Other Costs	$18,122,018	100%		$18,122,018
Business Overhead	$53,266,160	50%		$26,633,080
Total	**$194,753,791**	-	-	**$109,920,711**

Table A. JEDI Model, Detailed Solar PV Project Data Costs by Category

Table *B* below presents the primary results from the JEDI model for the utility scale solar PV array, based on the assumptions detailed above. These results provide us with estimates of the number of jobs (measured in job-years), workers' earnings, and total output created by construction, construction related services, manufacturing, wholesale and retail trade, and other services and sectors. Induced impacts, which consist of the jobs, earnings, and output that these workers generate out of consumption spending, are counted separately in the second from the bottom line of the table.

	Jobs	Earnings ($000, 2015 USD)	Output ($000, 2015 USD)
Project Development and Onsite Labor Impacts			
Construction and Installation Labor	274	$17,745.6	N/A
Construction and Installation Related Services	204	$12,117.1	N/A
Subtotal	**478**	**$29,862.7**	**$40,779.2**
Module and Supply Chain Impacts			
Manufacturing	154	$12,754.3	$62,538.2
Trade (Wholesale and Retail)	63	$5,045.6	$13,523.0
Finance, Insurance and Real Estate	0	$0.0	$0.0
Professional Services	24	$1,583.4	$4,352.5
Other Services	60	$8,217.1	$21,897.7
Other Sectors	109	$2,345.8	$8,544.8
Subtotal	**409**	**$29,946.2**	**$110,856.3**
Induced Impacts	**226**	**$13,608.0**	**$39,380.4**
Total Impacts	**1,113**	**$73,416.9**	**$191,015.8**

Table B. JEDI Model Local Economic Impacts - Summary Results: Construction and Installation Period

What kinds of occupations will this investment create? To answer this question, we first examine the JEDI model's detailed output, which provides us with estimates of direct, indirect, and induced job creation by industrial category. These estimates are provided below in Table 3. Each of the categories is associated with a top-level job category listed in Table B above; Table C provides this mapping, which was derived from examining the broad and detailed results of the JEDI model.

JEDI Model		Job Creation			
Top Level Job Category	**Detailed Job Category**	**Direct**	**Indirect**	**Induced**	**Total**
Construction and Installation Labor	Construction/Installations - Non Residential	274	36	48	359
Construction and Installation Related Services/Professional Services	Office Services	199	23	59	281
Construction and Installation Related Services/Professional Services	Architectural and Engineering Services	5	1	2	9
Manufacturing	Semiconductor (solar cell/module) manufacturing	37	91	48	176
Manufacturing	Fabricated Metals	9	5	5	18
Manufacturing	Energy Wire Manufacturing	6	6	4	16
Trade (Wholesale and Retail)	Wholesale Trade	39	16	21	77
Trade (Wholesale and Retail)	Retail trade	7	1	1	9
Other Services/Other Sectors	TCPU (transportation, communication, and public utilities)	3	2	2	6
Other Services/Other Sectors	Other services	102	25	35	162
Other Services/Other Sectors	Government	1	0	0	2
TOTALS		**682**	**206**	**226**	**1,114**

Table C. JEDI Model: Job Creation by Industrial Category

We then match each category of job creation to an industry sector as defined by the North American Industrial Classification Scheme (NAICS). Table D below provides this conversion, which we conduct through a keyword search of the NAICS classification scheme. We use the six-digit code (most specific) when we are able to identify clearly a specific industrial sector associated with the expenditures outlined in the JEDI model, and the 4-, 3-, or 2-digit codes when the sector is less clearly identifiable through the keyword search.

JEDI Model - Job Category	NAICS Industrial Sector Name	NAICS Industrial Sector Code
Construction/Installations - Non Residential	Power and communication line and related structures construction	237130
Fabricated Metals	Conduits and fittings, electrical, manufacturing	335932
Energy Wire Manufacturing	Connectors and terminals for electrical devices manufacturing	335313
Wholesale Trade	Household appliances and electrical and electronic goods merchant wholesalers	423600
Retail trade	Miscellaneous store retail	453000
TCPU (transportation, communication, and public utilities)	Electric power generation, transmission, and distribution	221100
Office Services	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	541200
Architectural and Engineering Services	Engineering services	541330
Other services	Various	Various
Government	Licensing and permit issuance for business issuance, government	926150
Semiconductor (solar cell/module) manufacturing	Semiconductor and other electronic component manufacturing	334400

Table D. Industrial Categories: Mapping JEDI Model to NAICS Industry Sector

To estimate the job creation associated with each of these categories, following the JEDI model, we first strip out all "Induced" jobs from the estimates given above in Table 3, and count those jobs separately. We count these jobs separately because they comprise a very wide variety of sectors that form part of workers' consumption spending, and thus cannot be considered to be part of the original sector from which they were created.

Following the JEDI model, we count direct and indirect jobs for all manufacturing, trade, government, office, and utilities sectors to be part of the same sector; however, we count direct jobs only for construction and installation services to be within-sector, since the indirect impacts of construction and installation services tend to be generated outside those broad sectors. We combine indirect jobs for the latter two sectors under the category of "Other services."

Table E below presents estimates of the number of jobs created by sector for the construction of the solar photovoltaic utility plant. The top three sectors by number of jobs created are:

1. Power and communication line and related structures construction: **274 jobs**
2. Accounting, Tax Preparation, Bookkeeping, and Payroll Services: **222 jobs**
3. Semiconductor and other electronic component manufacturing: **128 jobs**

NAICS Industrial Sector Name	NAICS Industrial Sector Code	Job Creation
Power and communication line and related structures construction	237130	274
Accounting, Tax Preparation, Bookkeeping, and Payroll Services	541200	222
Semiconductor and other electronic component manufacturing	334400	128
Household appliances and electrical and electronic goods merchant wholesalers	423600	56
Conduits and fittings, electrical, manufacturing	335932	14
Connectors and terminals for electrical devices manufacturing	335313	12
Miscellaneous store retail	453000	7
Engineering services	541330	6
Utilities	220000	5
Licensing and permit issuance for business issuance, government	926150	1
Other Services	Various	163
Induced Impacts	Various	226
TOTAL		**1,114**

Table E. Solar PV, Job Creation by NAICS Industrial Sector

The next three tables provide estimates of the line-item occupational breakdown for the top three industrial sectors listed above. The industrial sector for which the largest single group of jobs is expected to be created is sector 237130, Power and communication line and related structures construction. The job creation breakdown, by line item occupation, associated with the construction of the solar PV array is given below in Table F. The top three occupations created by this sector, for this project, are expected to be as follows:

1. Construction laborers (BLS occupation code 47-2061): **50 jobs**
2. Electrical power-line installers and repairers (BLS occupation code 49-9051): **49 jobs**
3. Telecommunications line installers and repairers (BLS occupation code 49-9052): **27 jobs**

Occupation Title	BLS Occupation Code	# Jobs
Construction laborers	47-2061	50
Electrical power-line installers and repairers	49-9051	49
Telecommunications line installers and repairers	49-9052	27
Operating engineers and other construction equipment operators	47-2073	18
First-line supervisors of construction trades and extraction workers	47-1011	16
Electricians	47-2111	11
First-line supervisors of mechanics, installers, and repairers	49-1011	11
Construction managers	11-9021	8
General and operations managers	11-1021	6
Office clerks, general	43-9061	6
All Other Occupations		73
TOTAL		**274**

Table F. Job Creation, Top 10 Occupations: NAICS Sector 237130, Power and communication line and related structures construction

The industrial sector for which the second-largest single group of jobs is expected to be created is sector 541200, Accounting, Tax Preparation, Bookkeeping, and Payroll Services. The job creation breakdown, by line item occupation, associated with the construction of the solar PV array is given below in Table G. The top three occupations created by this sector, for this project, are expected to be as follows:

1. Accountants and auditors (BLS 13-2011): **81 jobs**
2. Bookkeeping, accounting, and auditing clerks (BLS 43-3031): **22 jobs**
3. Tax preparers (BLS 13-2082): **16 jobs**

Occupation Title	BLS Occupation Code	# Jobs
Accountants and auditors	13-2011	81
Bookkeeping, accounting, and auditing clerks	43-3031	22
Tax preparers	13-2082	16
Secretaries and administrative assistants, except legal, medical, and executive	43-6014	11
Office clerks, general	43-9061	10
Billing and posting clerks	43-3021	10
Financial managers	11-3031	6
Customer service representatives	43-4051	5
First-line supervisors of office and administrative support workers	43-1011	4
General and operations managers	11-1021	4
All Other Occupations		52
TOTAL		**222**

Table G. Job Creation, Top 10 Occupations, NAICS Sector 541200, Accounting, Tax Preparation, Bookkeeping, and Payroll Services

The industrial sector for which the third-largest single group of jobs is expected to be created is sector 334400, Semiconductor and other electronic component manufacturing. The job creation breakdown, by line item occupation, associated with the construction of the solar PV array is given below in Table H. The top three occupations created by this sector, for this project, are expected to be as follows:

1. Electrical and electronic equipment assemblers (BLS 51-2022):**14 jobs**
2. Semiconductor processors (BLS 51-9141): **7 jobs**
3. Electrical and electronics engineering technicians (BLS 17-3023): **6 jobs**

Occupation Title	BLS Occupation Code	# Jobs
Electrical and electronic equipment assemblers	51-2022	14
Semiconductor processors	51-9141	7
Electrical and electronics engineering technicians	17-3023	6
Team assemblers	51-2092	5
Inspectors, testers, sorters, samplers, and weighers	51-9061	5
Industrial engineers	17-2112	5
Electrical engineers	17-2071	4
Electronics engineers, except computer	17-2072	4
Computer hardware engineers	17-2061	4
Industrial engineering technicians	17-3026	4
All Other Occupations		68
TOTAL		**128**

Table H. Job Creation, Top 10 Occupations, NAICS Sector 334400, Semiconductor and other electronic component manufacturing

The next section presents a similar set of results for an energy efficiency investment of comparable scale to the operational costs of an oil export terminal proposed for the Pacific Northwest coast.

4. ENERGY EFFICIENCY: A COMPLEMENTARY INVESTMENT

As the previous section makes clear, the solar PV scenario presented in this study creates fewer operations jobs than the Westway/Imperium terminals. However, evidence from the Pacific Northwest and around the country suggests that a complementary annual investment in *energy efficiency*, at the scale of the operations cost of the Westway and Imperium terminals, would provide a greater number of total operations jobs than those created by the terminals. Energy efficiency measures and practices refer to actions taken to improve the energy performance of commercial and residential buildings, such as retrofitting less efficient equipment, installing better insulation, and improving maintenance practices, among many other options (Anderson, et al. 2014).

Energy efficiency measures create jobs in three different ways. First, investment spending on e nergy efficiency construction, retrofitting, installation, and maintenance creates jobs directly, which have a ripple effect throughout the economy. Second, energy efficiency measures lead to household utility cost savings, freeing up funds that can be spent on other sectors that tend to create more jobs, per unit of spending, than energy sectors. In other words, when households save money on lower utility bills, they spend that money on other goods and services (such as food, entertainment, and transportation). These goods and services tend to be more labor-intensive than energy or utilities sectors, which are relatively capital-intensive; consumer spending out of energy savings thus creates more jobs than spending on utility bills. Third, increasing the efficiency of energy resource use increases productivity growth, which leads to increases in

Workforce Standards

While clean energy programs clearly produce more jobs than fossil fuels, they too often are poor quality jobs and they are often unavailable to those who need them most. What standards for job quality and equity should clean energy programs meet?

In 2009, the City of Portland invited a diverse group of organizations that included local unions, environmental groups, minority contractors, and many others to craft standards to create jobs while providing high-quality employment and access for those who have been historically left out of new economic opportunities. The result was a Community Workforce Agreement on High Road goals and strategies. Its goal was to change the demographic makeup of the workers and businesses in the residential clean energy sector and increase pay and benefit standards. In 2011 the Oregon High Road Advisory Committee agreed on these key benchmarks for clean energy projects:

- 30% of all trade and technical hours worked by historically underrepresented and economically disadvantaged people, including people of color, women, low-income residents and veterans.
- 20% of total project dollars to diverse businesses – those owned by historically disadvantaged or underrepresented people.
- At least 80% of workers participating are residents of their own communities. Local is defined as within a 50-mile radius of the project, unless otherwise defined by the community.
- 180% of Oregon state minimum wage or Clean Energy Works' established wage minimum (250% for specialized work in the Metro area and 200% for specialized work in rural areas) paid to workers participating in our projects.
- 100% of workers receive either health insurance coverage or additional wages at no less than $2.50 per hour in lieu of coverage, which is allowed for up to 6 months, after which health care coverage should be provided.
- Resources for continuing education and certification are available for those coming into the home performance industry and to those ready for opportunities for promotion and upward mobility through career pathways and training in entrepreneurship.

Source: "Clean Energy Works High Road Outcomes: New Faces, Career Pathways and Increasing Influence," Clean Energy Works Oregon, September, 2012 overall economic prosperity over time, as measured by GDP as well as other indicators (Whelan, Krebs and Morgan 2013).

The economic impact of energy efficiency investments has been measured in a variety of geographical and policy contexts. These include (proposed) municipal financing programs such as Property Assessed Clean Energy (PACE) (Pozdena and Josephson 2011, Multnomah County 2015), statewide incentive programs including Energy Trust of Oregon (ETO) (Josephson 2014), total statewide investments in residential and commercial energy efficiency (Whelan, Krebs and Morgan 2013) and national-level estimates of aggregate investments in energy efficiency measures (Anderson, et al. 2014).

Examining the economic impact of energy efficiency investments using PACE financing, Pozdena and Josephson (2011) find that for each $1 million of investment, these programs create 5 to 8 jobs *within the municipality (town or city)* in which the programs are located, and a whopping *60 total jobs* within the United States as a whole. Importantly, these job creation impact estimates do not count the positive impacts of households' reallocation of spending due to savings on utility bills. A recent analysis from ECONorthwest (Whelan, Krebs and Morgan 2013) estimated that for each $1 million in cost savings from reduced utility bills in the State of Oregon due to energy efficiency, a total of *7.5 net jobs* were created in the state.

The above job figures suggest that a steady flow of investments in energy efficiency can provide consistent jobs in numbers that exceed those provided by fossil fuel export terminals. Consider a scenario that invests annually the amount spent within Grays Harbor County alone on the fossil fuel terminal project in Section II above ($107.92 million), on commercial energy efficiency retrofits within that county.

Table 10 below provides the estimated job creation impacts of an annual investment of $107.92 million into commercial energy efficiency retrofits in Grays Harbor County. Due to the high proportion of externally provided manufactured inputs – such as energy-efficient insulation, electronic building control systems, and state-of-the-art heating and air conditioning - only a portion of the total spending from the initial investment would be provided locally.

According to data provided by the IMPLAN model, given a scenario of $107.92 million invested in energy efficiency in Grays Harbor County, $30.55 million would be spent within the county. This smaller investment figure is still sufficient to generate significantly more within-county direct and total jobs than would be created by the Westway/Imperium fossil fuel export terminals. The initial within-county spending of $30.55 million would create 262 direct jobs and 362 total jobs, and gives rise to a total of $42.74 million in output.

	Output/Initial Spending ($ Million)	Gross Job Creation
Direct	$30.44	261
Indirect	$6.36	53
Induced	$5.83	47
Total	$42.74	362

Table 10. Job Creation Impact, Energy Efficiency Scenario
Source: IMPLAN (2012)

Table 11 below provides a comparison of the total jobs created through the operations phase of the Westway/Imperium fossil fuel terminal with those created by a comparably scaled investment in energy efficiency within Grays Harbor County. While solar PV operations alone are insufficient to create as many jobs as the terminal, the energy efficiency investment creates many more.

The energy efficiency investment creates 262 direct and 362 total jobs in Grays Harbor County alone. These figures exceed the job creation impact of Westway/Imperium by 114 direct jobs, and 62 total jobs. The vast majority of the direct jobs created by the energy efficiency investments will be in building maintenance and construction sectors.

Impact Type	(A) Westway/ Imperium	(B) Energy Efficiency	(C) Difference (B-A)
Direct	148	262	114
Indirect	87	53	-34
Induced	69	47	-22
Total	**304**	**362**	**62**

Table 11. Comparison of Total Jobs Created, Operations Phase, Westway/Imperium vs. Solar PV with Energy Efficiency Investment

What kinds of jobs will be created by the energy efficiency investment? The best proxy industrial category for which we have occupational data is NAICS 230000, the construction industry as a whole. Table 12 below presents a breakdown by top-level occupational category of the direct jobs created by the hypothetical energy efficiency investment. We see that 76% of the direct jobs (199 jobs) are expected to be created in occupations such as construction, maintenance and repair, production, and transportation.

Occupational Category	Percentage of Industry	# Direct Jobs
Construction and extraction occupations	62%	162
Installation, maintenance, and repair occupations	9%	24
Production occupations	2%	5
Transportation and material moving occupations	3%	8
All Other Occupations	24%	63
TOTAL	**100.0%**	**262**

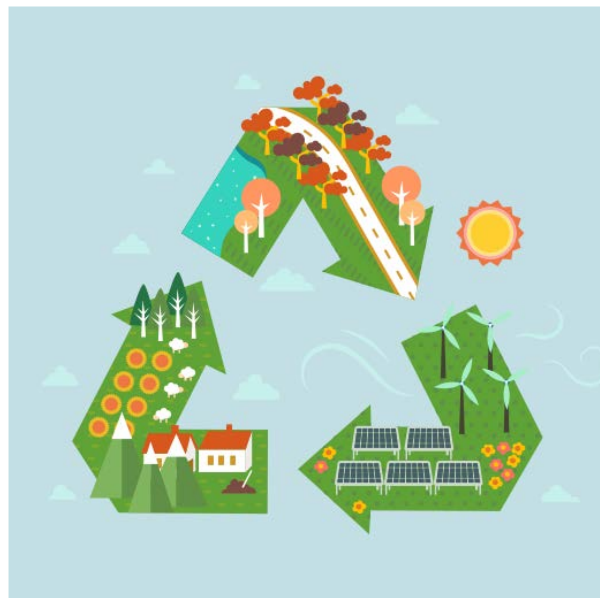
Table 12. Direct Job Breakdown by Top Level Occupational Category, Energy Efficiency Investment

Table 13 compares the expected job breakdown of the operations phase of Westway/Imperium with an energy efficiency investment of comparable size. We see that the number of occupations expected to be created directly by the energy efficiency investment is over half again the number expected to be created by the operations of the oil terminals and related marine and rail transport services (266 vs. 148). For construction related jobs, there is no contest: while the energy efficiency investments will create 162 direct jobs in the construction sector, the terminal operations create only one job.

Occupational Category	Westway/Imperium (Operations)	Energy Efficiency
Transportation and material moving occupations	83	8
Installation, maintenance, and repair occupations	18	24
Production occupations	5	5
Construction and extraction occupations	1	162
All other occupations	41	63
TOTAL	**148**	**262**

Table 13. Comparison of Direct Job Breakdown by Occupational Category, Westway and Imperium (Operations) vs. Energy Efficiency

In summary, we can conclude that an annual investment in energy efficiency upgrades for homes, businesses, and institutions in the Pacific Northwest (Oregon or Washington) can create many more direct and total jobs, and many more jobs in construction and related sectors, than can a comparably scaled investment in fossil fuel transport, storage, and export infrastructure. An economic development strategy focusing on the creation of jobs in construction and related sectors should thus prioritize investments in energy efficiency over fossil fuel infrastructure. As numerous economic studies demonstrate (Whelan, Krebs and Morgan 2013), energy efficiency investments have the potential to create jobs, save ratepayers money on lowered utility bills, and increase the overall efficiency and productivity of the economy – all while protecting the environment by reducing fossil fuel consumption.



Energy Efficiency—What Kind of Jobs?

This study has demonstrated that investments in commercial (and residential) energy efficiency can create more direct and total jobs as operating a fossil fuel export facility at a comparable scale. But what kinds of jobs would be created by the investment? This section provides a closer look at the occupations that investments in energy efficiency retrofits of existing commercial *buildings could potentially generate in the Pacific Northwest.*

Table I below presents an estimate of the sectoral breakdown of investments in commercial and energy efficiency retrofits. These estimates were developed by Garrett-Peltier (2011) in consultation with the U.S. Green Building Council, the New Buildings Institute, and other related authorities on energy efficiency. The right-hand column of the table provides an estimate of the dollar value of investment by sector under the scenario of a total $107.92 million investment in commercial energy efficiency.

Sector	% Investment	$ Investment (million USD)
Environmental Controls Manufacturing	18.2%	$19.64
Light Fixture Manufacturing	17.5%	$18.89
Environmental Controls Installation	7.8%	$8.42
Motor and Generator Manufacturing	7.7%	$8.31
Light Fixture Installation	7.5%	$8.09
HVAC Installation	6.0%	$6.48
Air Purification and Ventilation Equipment	4.8%	$5.18
Envelope Improvements Installation	4.8%	$5.18
Heating Equipment	4.6%	$4.96
Air Conditioning and Refrigeration Equipment	4.6%	$4.96
Motor and Generator Installation	3.3%	$3.56
Water Heating - Power Boilers	3.2%	$3.40
Water Heaters - Except Boilers	3.2%	$3.40
Water Heater Installation	2.7%	$2.91
Office Equipment Installation	1.1%	$1.20
Photocopying Equipment	0.8%	$0.91
Computer Equipment	0.8%	$0.91
Window Manufacturing	0.5%	$0.52
Insulation Manufacturing	0.5%	$0.52
Telephone Equipment	0.2%	$0.23
Roofing Materials Manufacturing	0.1%	$0.13
Painting and Coating Materials Manufacturing	0.1%	$0.13
TOTAL	**100.00%**	**$107.92**

Table I. Sectoral Breakdown of Investments in Commercial Energy Efficiency Retrofits (Garrett-Peltier 2011)
Source: Garrett-Peltier (2011), Table 3

Table J presents the results of an economic impact analysis of commercial energy efficiency retrofits in Grays Harbor County, following the investment scheme by sector as outlined in Table I above. The analysis was conducted using IMPLAN, an input-output economic model that computes direct, indirect and induced economic activity, job creation, labor income, and value added from an initial pattern of investment expenditures according to a 440-sector scheme. Crosswalks between the sector definitions given in Table I above, the IMPLAN 440-sector scheme, and the much larger six-digit industrial sector classification given by the North American Industrial Classification System (NAICS), are given in the Appendix in Tables N and O.

Table J presents estimates of the direct, indirect, and induced jobs created in Grays Harbor County through an investment in commercial energy efficiency retrofits. Due to the very small proportion of manufacturing jobs in Grays Harbor County, the vast majority of manufactured inputs to the production of energy efficiency retrofits were sourced from outside the county. Therefore, all of the direct jobs and the large majority of total jobs in energy efficiency created within Grays Harbor County fall under the general IMPLAN construction sector category "Maintenance and repair construction of nonresidential structures" (category 39). This sector category maps to a very large number of NAICS sectors, ranging from drywall contractors to roofing, electrical, plumbing, and other related sectors.

	Grays Harbor County: Job Creation			
IMPLAN Sector Name	**Direct**	**Indirect**	**Induced**	**Total**
Maintenance and repair construction of nonresidential structures	262	1	0	263
Architecture, engineering, and related services	0	16	0	16
Employment Services	0	1	0	1
Transport by truck	0	1	0	2
Services to buildings and dwellings	0	1	1	2
All Other Sectors	0	34	45	79
TOTAL	**262**	**53**	**47**	**362**

Table J. Energy Efficiency in Grays Harbor County: Job Creation by IMPLAN Sector
Source: IMPLAN.

The NAICS categories corresponding to the general IMPLAN construction sector (39) are given below in Table K, along with the magnitude of investment by sector from the energy efficiency retrofit scheme outlined above in Table I, following Garrett-Peltier (2011). These categories were used to compute the number of jobs created in each occupation by the energy efficiency retrofit investment, following the BLS's Industry-Occupation Matrix dataset (Bureau of Labor Statistics 2012). In some cases, occupation-by-industry data for the desired six-digit NAICS sector was unavailable; in this case, we used the most closely matched six-digit sector for which there was data. The codes for these sectors are given in Table K in parentheses below the original NAICS sector codes.

Sector Name	NAICS Sector Name	NAICS Code	$ (million USD)
Office Equipment Installation	Electrical contractors and other wiring installation contractors	238210	$1.20
Water Heater Installation	Plumbing, heating, and air-conditioning contractors	238220	$2.91
Motor and Generator Installation	Electrical contractors and other wiring installation contractors	238210	$3.56
Envelope Improvements Installation	Drywall and insulation contractors	238310	$2.07
Envelope Improvements Installation	Door and Window Installation (Building finishing contractors)	238350 (238300)	$2.07
Envelope Improvements Installation	Roofing contractors	238160	$0.52
Envelope Improvements Installation	Painting and wall covering contractors	238320	$0.52
HVAC Installation	Plumbing, heating, and air-conditioning contractors	238220	$6.48
Light Fixture Installation	Renovation general contractors, commercial and institutional building (Nonresidential construction)	236220 (236200)	$8.09
Environmental Controls Installation	Electrical contractors and other wiring installation contractors	238210	$8.42

Table K. NAICS Sector Names, Construction Sector Codes Only

Table L breaks down the direct jobs created by NAICS sector corresponding to those in Table K above, along with the name of each NAICS sector, its six-digit code, the total dollar value of investment in that sector in the energy efficiency scenario outlined above, and the percentage of total direct jobs created through that sector. The most important three sectors for direct job creation from investment in commercial energy efficiency in Grays Harbor County are:

1. Electrical contractors and other wiring installation contractors (238210): **96 jobs**, 37% of total
2. Plumbing, heating, and air-conditioning contractors (238220): **69 jobs**, 26% of total
3. Nonresidential construction (236200): **59 jobs**, 23% of total

NAICS Code	NAICS Sector Name	$ Investment (million USD)	# Direct Jobs Created	% Jobs Created
236200	Nonresidential construction	$8.09	59	23%
238160	Roofing contractors	$0.52	4	1%
238210	Electrical contractors and other wiring installation contractors	$13.18	96	37%
238220	Plumbing, heating, and air-conditioning contractors	$9.39	69	26%
238310	Drywall and insulation contractors	$2.07	15	6%
238320	Painting and wall covering contractors	$0.52	4	1%
238300	Building finishing contractors	$2.07	15	6%

Table L. Job Creation, Energy Efficiency, Grays Harbor County: Construction Jobs Created by NAICS Sector

Table M below provides estimates of the line-item occupational breakdown for the jobs created in the seven construction sectors listed above, by BLS-defined occupations. (For a complete breakdown of direct jobs created by construction sector, please see the Appendix, Table P.) The corresponding 6-digit BLS occupation code is listed in the second column of each table. The top three occupations created directly, within the county, by commercial energy efficiency retrofits in Grays Harbor County are as follows:

1. Electricians (47-2111): **49 jobs**
2. Plumbers, pipefitters, and steamfitters (47-2152): **21 jobs**
3. Heating, air conditioning, and refrigeration mechanics and installers (49-9021): **15 jobs**

In conclusion, we can infer that an investment in commercial energy efficiency retrofits comparably scaled to the proposed investment in the Westway-Imperium fossil fuel terminals would not only create more direct and total jobs than Westway-Imperium. It would also create significant numbers of jobs for skilled tradespeople such as electricians, plumbers, and HVAC mechanics and installers.

Occupation Name	BLS Occupation Code	TOTAL
Electricians	47-2111	49
Plumbers, pipefitters, and steamfitters	47-2152	21
Heating, air conditioning, and refrigeration mechanics and installers	49-9021	15
First-line supervisors of construction trades and extraction workers	47-1011	15
Carpenters	47-2031	14
Construction laborers	47-2061	13
Construction managers	11-9021	8
Office clerks, general	43-9061	8
Helpers--electricians	47-3013	8
Drywall and ceiling tile installers	47-2081	7
All Other Occupations		104
TOTAL		**262**

Table M. Job Creation, Energy Efficiency, Grays Harbor County: Top 10 Occupations, All Construction Sectors

Appendix: Additional Tables

Sector Name (Garrett-Peltier 2011)	NAICS Sector Name	NAICS Code
Environmental Controls Manufacturing	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use	334512
Light Fixture Manufacturing	Lighting fixtures, residential electric, manufacturing	335121
Environmental Controls Installation	Environmental control system installation	238210
Motor and Generator Manufacturing	Motors, electric; power generators manufacturing	335312
Light Fixture Installation	Addition, alteration and renovation general contractors, commercial and institutional building	236220
HVAC Installation	Central heating/cooling equipment and piping installation	238220
Air Purification and Ventilation Equipment	Air purification equipment, stationary, manufacturing	333411
Envelope Improvements Installation	Blown-in Insulation Installation; Door and Window Installation; Roofing contractors; Painting contractors	2383102 38350 238160 238320
Heating Equipment	Heating equipment manufacturing (various)	333414
Air Conditioning and Refrigeration Equipment	Air-conditioning equipment (except motor vehicle) manufacturing	333415
Motor and Generator Installation	Electric equipment and appliance installation	238210
Water Heating - Power Boilers	Power Boilers Manufacturing	332410
Water Heaters - Except Boilers	Water heaters (except boilers), commercial-type, manufacturing	333319
Water Heater Installation	Water heater installation	238220
Office Equipment Installation	Telecommunications equipment and wiring installation	238210
Photocopying Equipment	Photocopying machines manufacturing	333315
Computer Equipment	Computers manufacturing	334111
Window Manufacturing	Flat glass manufacturing	327211
Insulation Manufacturing	Insulation and cushioning, foam plastics (except polystrene), manufacturing	326150
Telephone Equipment	Telephone manufacturing	334210
Roofing Materials Manufacturing	Asphalt shingles made from purchased asphaltic materials	324122
Painting and Coating Materials Manufacturing	Architectural coatings (paint) manufacturing	325510

Table N. Energy Efficiency Investments: NAICS Sectors

NAICS Sector Name	NAICS Code	IMPLAN Sector Name	IMPLAN Code
Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use	334512	Automatic environmental control manufacturing	250
Lighting fixtures, residential electric, manufacturing	335121	Lighting fixture manufacturing	260
Environmental control system installation	238210	Construction of new nonresidential commercial and health care structures	39
Motors, electric; power generators manufacturing	335312	Motor and generator manufacturing	267
Addition, alteration and renovation general contractors, commercial and institutional building	236220	Construction of new nonresidential commercial and health care structures	39
Central heating/cooling equipment and piping installation	238220	Construction of new nonresidential commercial and health care structures	39
Air purification equipment, stationary, manufacturing	333411	Air Purification and Ventilation Equipment Manufacturing	214
Blown-in Insulation Installation; Door and Window Installation; Roofing contractors	238310 238350 238160	Construction of new nonresidential commercial and health care structures	39
Heating equipment manufacturing (various)	333414	Air Conditioning, Refrigeration, and Warm Air Heating Manufacturing	215
Air-conditioning equipment (except motor vehicle) manufacturing	333415	Air Conditioning, Refrigeration, and Warm Air Heating Manufacturing	216
Electric equipment and appliance installation	238210	Construction of new nonresidential commercial and health care structures	39
Power Boilers Manufacturing	332410	Power boiler and heat exchanger manufacturing	188
Water heaters (except boilers), commercial-type, manufacturing	333319	Other commercial and service industry machinery manufacturing	213
Water heater installation	238220	Construction of new nonresidential commercial and health care structures	39
Telecommunications equipment and wiring installation	238210	Construction of new nonresidential commercial and health care structures	39
Photocopying machines manufacturing	333315	Photographic and photocopying equipment manufacturing	212
Computers manufacturing	334111	Electronic computer manufacturing	234
Flat glass manufacturing	327211	Flat glass manufacturing	156
Insulation and cushioning, foam plastics (except polystrene), manufacturing	326150	Urethane and other foam product manufacturing	147
Telephone manufacturing	334210	Telephone apparatus manufacturing	237
Asphalt shingles made from purchased asphaltic materials	324122	Asphalt shingle and coating materials manufacturing	117
Architectural coatings (paint) manufacturing	325510	Paint and coating manufacturing	136

Table O. Energy Efficiency Investments: Crosswalk of NAICS Sectors to IMPLAN Sectors

	BLS Occupation Code	236200	238160	238210	238220	238310	238320	238300	TOTAL
Electricians	47-2111	0.8	0.0	48.0	0.6	0.0	0.0	0.0	49.4
Plumbers, pipefitters, and steamfitters	47-2152	1.2	0.0	0.6	19.7	0.0	0.0	0.0	21.5
Heating, air conditioning, and refrigeration mechanics and installers	49-9021	0.1	0.0	0.7	13.9	0.0	0.0	0.0	14.6
First-line supervisors of construction trades and extraction workers	47-1011	6.7	0.2	3.9	2.1	0.8	0.2	0.7	14.6
Carpenters	47-2031	9.6	0.0	0.1	0.1	2.1	0.0	2.1	14.1
Construction laborers	47-2061	9.0	0.1	1.7	1.0	0.8	0.0	0.7	13.4
Construction managers	11-9021	4.7	0.1	1.8	1.1	0.2	0.0	0.2	8.2
Office clerks, general	43-9061	1.5	0.1	2.7	2.8	0.3	0.1	0.5	8.0
Helpers--electricians	47-3013	0.2	0.0	7.3	0.1	0.0	0.0	0.0	7.5
Drywall and ceiling tile installers	47-2081	0.5	0.0	0.0	0.0	4.8	0.0	1.5	6.8

Table P. Energy Efficiency Investments, Grays Harbor County: Direct Job Creation by NAICS Sector

5. THE ECONOMIC IMPACT OF CLEAN ENERGY INVESTMENTS

This study has demonstrated that a program of renewable energy and energy efficiency investments in the Pacific Northwest can create more total jobs, and more jobs per unit of investment, than a comparably scaled investment in fossil fuel transport and export. However, a comprehensive renewable energy and energy efficiency strategy for the region remains to be developed. The specifics of this strategy must be tailored to the economic development priorities of the region. For instance, a clean-energy strategy encompassing the entire region would include a substantial role for land-based wind and solar energy, concentrated in the eastern half of Oregon and Washington. The ongoing development of wind and solar energy resources would create a large number of construction jobs, year after year, in different parts of the region. Construction laborers and related service providers would find themselves working in different sub-regions of the Pacific Northwest to build, install, and maintain new wind and solar power plants. While the number of permanent operations jobs for each of these plants would be relatively small, the ongoing regional transition away from fossil fuels and towards clean energy resources would entail that construction labor would be redeployed, year after year, to develop new projects.

By contrast, a clean-energy strategy targeting specific counties, such as Grays Harbor County, might focus instead on a combination of energy efficiency and residential and community solar. Use of locally abundant resources, such as making use of forest residue and thinning for commercial-scale cellulosic biomass production, may also be explored, though this option has proven difficult to commercialize, and controversial due to uncertain environmental impacts and related environmental risks.

This paper has not addressed the portfolio of policies and incentives required to make this clean-energy scenario a reality. Promising policy tools to promote the adoption of renewable energy and energy efficiency include:

- Clean Fuels Standard
- Renewable Portfolio Standard (RPS)
- Property Assessed Clean Energy (PACE)
- Feed-In Tariff
- Cap-and-Trade / Cap-and-Dividend
- Carbon Tax
- BETC/RETC
- Community Solar

Further research on clean energy in the Pacific Northwest can explore the potential job creation and economic development impact of these policy tools.

CONCLUSION: JOBS IN A CLEAN ENERGY FUTURE

The changing economics of fossil fuel, the rapid decline in the cost of clean energy, and the absolute necessity of radically reducing climate-destroying greenhouse gases mean that the Pacific Northwest, the US, and the world must and

Protecting Workers & Communities Through Climate Legislation

Oregon Senate Bill 1574, filed in the 2016 regular session, lays out a plan to meet the state's greenhouse gas emission reduction targets while providing specific plans to meet the needs of workers and low-income and minority communities. The bill declares:

Climate change policies can be designed to protect disadvantaged communities, rural communities and workers from economic costs and can provide co-benefits to and within these communities that include, but are not limited to, opportunities for job creation and training, investments in infrastructure, affordable housing investment, economic development, air quality improvements, energy savings and conservation and increased utilization of clean energy technologies.

Bill 1674 establishes a state cap-and-trade program designed to reduce GHG emissions at least 75% below 1990 levels. Funds collected from the sale of permits will be used entirely to support climate protection.

- Climate Investments Account of the State Highway Fund
- Electric and natural gas utilities exclusively for
  - Bill assistance for low-income residential customers;
  - Bill assistance for energy intensive industrial customers; or
  - Residential or small business climate credits.
- Oregon Climate Investments Fund
  - At least 40 percent distributed to projects that are geographically located in disadvantaged communities
  - At least 40 percent distributed to projects that are geographically located in economically distressed areas, with an emphasis placed on projects or programs that support job creation and job education and training opportunities
- Just Transition Fund to support economic diversification, job creation, job training and other employment and mental health services for workers and communities in this state that are adversely affected by climate change or climate change policies.

will transition to a new energy system. This report shows that Grays Harbor – and places like Grays Harbor – need not be left behind.

Nor need their workers be left behind. This report shows that investments in the Pacific Northwest in renewable energy and energy efficiency can generate more jobs in construction, transportation, supply chains, and operations and maintenance than a similar dollar investment in oil, coal, and natural gas infrastructure. The alternatives laid out for western Washington in this report can be an integral part of the great transition from fossil fuels to clean energy.

Pursuing that course toward a fossil free economy will provide many benefits. It will eliminate the health and safety threats created by exploding oil trains, coal pollution, and fracking contamination of water. It will help halt the drive to devastating climate change. It will provide communities a secure source of energy that does not depend on the gyrations of the global fossil fuel market. And it will provide a source of jobs that do not depend on the gyrations of the global economy.

This transition will not happen by itself, however. Because energy infrastructure is based on long-term investment and planning, it must be guided by economic strategies that are sustainable in the long term. The transition to worker- and community-friendly clean energy will require deliberate decisions at every level of government and economy to expand clean energy infrastructure rather than infrastructure based on fossil fuels.

There is not an automatic fit between workers who need jobs and the types and locations of jobs that any particular project will require. To make the energy transition both worker- and environment-friendly will require planning for an orderly, sustainable transition. For example, as the report points out, the ongoing development of solar energy resources throughout the Pacific Northwest would require building new plants throughout the region over many years. With proper planning, construction workers could find steady employment building these facilities one after another.

Similarly, a well-designed transition plan can consider the needs and harness the underutilized human and material resources of places like Grays Harbor. Its goal should be to ensure that no Grays Harbor is left behind in the transition to the clean energy future.

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