

Fossil Fuel Workforce Transition Study

Addendum

The fossil fuel transition study raises additional questions, which have been addressed below. Specifically:

- What is the impact of automation on the occupations under consideration in the fossil fuel transition study? What are the demographics of the workers in those workers?
- What are the baseline growth and projected growth of these occupations with the transition from fossil fuels? What is the current training strategy?
- Which jobs can workers from occupations most affected by the transition from fossil fuel most readily transition into, building on skills developed in the fossil fuel-dependent industries?

Impact of Automation

The target occupations are identified by the likelihood of those being impacted by automation in the table below. Automation is not likely to eliminate occupations wholesale. However, it does change the demand and the skills required to function in those jobs.¹⁻³ Automation is part of a larger phenomenon of the digitalization of the US workforce. These forces require that workers in affected occupations have or gain additional digital skills.⁴ Those workers most at risk of displacement are currently working in jobs that have a high likelihood of being impacted by automation, and that does not now require the regular use of digital skills. They are also likely to have the most difficulty transitioning to other occupations.

Two of the most at-risk occupations, Freight Laborers and Construction Laborers, have a large percentage of workers of color, particularly Latinx/Hispanic workers. However, most of the targeted occupations, particularly the "good jobs,"* are disproportionately white.

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* Jobs that require less than a four-year degree and where the median income is at least 80% of the MSA's median income.⁵

Table 1. Occupations by Likelihood of Being Impacted by Automation & Digitalization

Likelihood of Impact by Automation Digitalization in 2016		Occupation	2020 Jobs	Latinx/Hispanic	Asian	Black/African American	Native American	Native American/Alaska Native	Native Hawaiian/Pacific Islander	Two or More Races	White	Women
High	Low	Laborers and Freight, Stock, and Material Movers, Hand	30,912	12%	10%	11%	1%	2%	4%	60%	20%	
		Construction Laborers	12,988	23%	4%	4%	1%	1%	3%	63%	6%	
		Carpenters	12,061	18%	4%	3%	1%	1%	3%	70%	3%	
		Heavy and Tractor-Trailer Truck Drivers	11,668	12%	5%	9%	1%	2%	3%	68%	6%	
		Operating Engineers and Other Construction Equipment Operators	2,833	7%	1%	3%	3%	1%	3%	82%	3%	
		Welders, Cutters, Solderers, and Brazers	2,502	13%	8%	4%	1%	1%	3%	69%	7%	
		Pipelayers	365	11%	1%	3%	1%	1%	3%	78%	3%	
		Paving, Surfacing, and Tamping Equipment Operators	140	7%	4%	4%	4%	4%	4%	83%	4%	
	Mod	Crane and Tower Operators	571	8%	1%	6%	1%	2%	3%	78%	3%	
Mod	Mod	Office Clerks, General	29,695	10%	13%	6%	1%	1%	4%	67%	84%	
		First-Line Supervisors of Construction Trades and Extraction Workers	6,882	8%	2%	2%	1%	1%	2%	83%	6%	
		First-Line Supervisors of Production and Operating Workers	5,319	9%	11%	5%	1%	1%	3%	71%	21%	
		Automotive Service Technicians and Mechanics	4,317	14%	10%	4%	1%	1%	3%	68%	2%	
		Automotive Body and Related Repairers	794	14%	7%	3%	1%	1%	3%	72%	2%	
		Automotive and Watercraft Service Attendants	638	9%	12%	5%	2%	1%	5%	67%	13%	
		High	Customer Service Representatives	31,902	10%	13%	8%	1%	1%	4%	64%	64%
	Electrical Engineers	2,886	3%	28%	2%	0%	0%	3%	64%	10%		
Low	Mod	Project Management Specialists and Management Analysts	24,300	7%	18%	5%	1%	0%	4%	66%	57%	
		Management Analysts	16,677	4%	18%	3%	1%	0%	3%	71%	44%	
	High	Software Developers and Software Quality Assurance Analysts and Testers	66,734	3%	52%	1%	0%	0%	2%	41%	18%	
		General and Operations Managers	21,909	6%	11%	3%	0%	0%	3%	76%	31%	
		Construction Managers	4,803	5%	4%	1%	1%	0%	3%	85%	12%	

Growth and Training

The following table addresses the baseline growth projected in targeted occupations over the next five years and the additional projected growth with new clean energy infrastructure investments. The baseline growth level, computed from EMSI employment estimates for King County, represents the percentage change in the number of jobs between 2020 and 2024. The projected growth is calculated based on a report by the Economic Policy Institute estimating the economic impact of clean energy, infrastructure electrification, and energy efficiency investment by 2024 (preliminary numbers subject to change).⁷ Governor Inslee's Climate Commitment⁸ includes \$100 million investments in renewable energy, \$318 million in clean transportation investments, and \$141 million in energy efficiency investments between 2021 and 2023. These investments would contribute to job projection estimates.

Investment in clean energy produces the largest net growth in the electrical engineers and crane and tower operator occupations. It adds +1.62% and +1.41%, respectively, compared to growth projected without investing in clean energy and energy efficiency. Clean energy and energy efficiency investments are projected to produce moderate net growth among many manual and construction occupations such as laborers, freight workers, and paving equipment operators. However, there are only 140 workers in this occupation based on EMSI estimates for 2020. Other professional services occupations (software developers, business operations specialists, and general and operations managers) are also expected to grow moderately with green investments.

Table 2. Clean Energy Occupations Characteristics

Clean Energy Occupation & Pathway	Median Wage	Baseline Growth 2020-2024	Net Additional Growth with Clean Energy Infrastructure by 2024 ¹	Training Strategies
Construction Laborers	\$50,491	4.4%	0.33%	<ul style="list-style-type: none"> No formal educational credential and short-term on-the-job training through pre-apprenticeship or apprenticeship programs
Customer Service Representatives	\$41,881	10.7%	0.64%	<ul style="list-style-type: none"> Depending on employer's requirements: High school diploma to AS programs in community colleges 8-week training program available at Goodwill
Operating Engineers and Other Construction Equipment Operators	\$81,398	1.8%	0.40%	<ul style="list-style-type: none"> High school diploma or equivalent and Moderate-term on-the-job training through apprenticeship Fast forward to a journey-level worker if at least 2 years of previous experience in construction operations or repair.

Clean Energy Occupation & Pathway	Median Wage	Baseline Growth 2020-2024	Net Additional Growth with Clean Energy Infrastructure by 2024 ¹	Training Strategies
First-Line Supervisors of Construction Trades and Extraction Workers	\$96,868	3.2%	0.31%	<ul style="list-style-type: none"> • High school diploma or equivalent • 5 years of construction and leadership experience required
Business Operations Specialists, All Other	\$82,143	5%	0.70%	<ul style="list-style-type: none"> • Bachelor's degree • Sub-occupation: Sustainability specialists training: <ul style="list-style-type: none"> ◦ UW Certificate in Facility Management (3quarters) ◦ North Seattle College certificate in Sustainable and Conventional Energy & Control Technology (6 quarters)
Paving, Surfacing, and Tamping Equipment Operators	\$76,511	2.7%	0.52%	<ul style="list-style-type: none"> • High school diploma or equivalent and Moderate term on-the-job training • Short-term specialized training at West Coast Training, Bates Technical College
Crane and Tower Operators	\$82,867	-3.5%	1.41%	<ul style="list-style-type: none"> • High school diploma or equivalent and Moderate-term on-the-job training • Short-term specialized training at West Coast Training (4-8 weeks)
Carpenters	\$65,286	1.8%	0.32%	<ul style="list-style-type: none"> • High school diploma or equivalent • 4-year apprenticeship
Software Developers	\$139,787	12.3%	0.65%	<ul style="list-style-type: none"> • Sub-occupation 1: Software Developers <ul style="list-style-type: none"> ◦ Bachelor's degree in computer engineering • Sub-occupation 2: Software Quality Assurance Analysts and Testers <ul style="list-style-type: none"> ◦ Bachelor's degree in computer engineering ◦ AAS or certificate Information Technology
Laborers and Freight, Stock, and Material Movers, Hand	\$37,152	5.1%	1.04%	<ul style="list-style-type: none"> • No formal educational credential and Short-term on-the-job training • OSHA certification
Construction Managers	\$101,127	7.3%	0.33%	<ul style="list-style-type: none"> • Bachelor's degree in Construction Management and Moderate-term on-the-job training
General and Operations Managers	\$124,466	7.8%	0.82%	<ul style="list-style-type: none"> • AS to BA college degree (operations management, business, supply chain, etc.)

Clean Energy Occupation & Pathway	Median Wage	Baseline Growth 2020-2024	Net Additional Growth with Clean Energy Infrastructure by 2024 ¹	Training Strategies
Electrical Engineers	\$119,901	0.5%	1.62%	<ul style="list-style-type: none"> AS in Electrical and Electronics Engineering to Bachelor's degree
Management Analysts	\$103,676	7.2%	0.88%	<ul style="list-style-type: none"> 3-quarter AS in Business Analytics, Bachelor's degree in Business administration

Potential Occupations For Affected Workers

Table 3 below identifies the medium-low automation risk, in-demand occupations most similar to fossil fuel-dependent jobs to direct worker retraining. Workers dislocated from fossil fuel-dependent jobs can build on skills they already have and enter new, stable career paths.

For some occupations, workforce retraining is relatively straightforward. Workers can update their skills from fossil fuel work to clean energy work in the same industry. For example, construction laborers (a fossil fuel-dependent job) can eventually progress to supervisor positions when they complete their apprenticeship and after a few years of experience. Thanks to new regulations at the city and state level, energy-efficient construction is on the rise, requiring supervisors and workers to develop clean energy skills. However, construction laborers are at high risk of automation, while this is not the case for first-line supervisors. In the future, it might be hard for workers to find entry-level jobs in the construction industry. This can be remedied through short-term construction management courses that could help applicants reach for more senior-level positions.

Similarly, automotive service technicians currently rely mostly on fossil fuel-dependent skills. However, the substantial increase in electric vehicle sales in Washington State, permitted in part by legislative bills decreasing the final price of these vehicles to consumers and facilitating sales from manufacturers to consumers, could redefine their job responsibilities. Automotive service technicians should consider updating their skills thanks to short-term courses and certificates to serve electric vehicles.

Worker retraining will be harder for other occupations that do not have similar occupations in the same industry safe from automation. For example, the closest related job to plumbers, pipefitters, and steamers, which is not at high risk of automation, is Electrician. However, due to stringent regulations at the state level, workers must get certified after a lengthy apprenticeship program.

In addition to redirecting into entirely new occupations, the potential of existing occupations' work decoupling from fossil fuels offers other opportunities. Pipefitters are a prime example of this. While refinery and papermill work has declined in recent years, work connected to hydroponics has taken up much of that slack. Apprenticeship coordinators are confident about training apprentices for new lines of work within existing occupations. However, incumbent workers may need support and to update their skills updating to make the transition.

To facilitate the transition away from fossil fuel and lessen the impact on workers in fossil fuel-dependent industries, workforce development policies and programs must focus on supporting two categories of workers. The first is workers whose occupation can transition to clean energy or other green economy lines of work but require additional training. Collaborating with unions to reach and support these workers and maintain union representation in these occupations is central to this work.

The second category is supporting mid-career workers moving to new occupations. This is most readily accomplished with a mix of short-term courses and on-the-job training. Additionally, the only stackable degree at the state level is a certificate in Early Childhood Education. Students can accumulate credits from three short-term certificates (between 12 and 29 credits for each certificate) to earn full certification in Early Childhood Education. Policymakers and educational institutions could emulate this initiative and create stackable degrees for occupations with the largest projected growth (construction managers or information technology specialists (included in the Software Developers occupation)).

Table 3. Crosswalk Table Between Fossil Fuel to Other Occupations (Clean Energy and others)

Most Impacted (fossil fuel-dependent) Occupations	Crosswalked Occupations	Median Wage of Crosswalked Occupation	Baseline Growth of Crosswalked Occupation (2020-2024)	Net Additional Growth with Clean Energy Infrastructure by 2024	Training Strategies (focus on incumbent work/worker retraining)
Construction Laborers	First-Line Supervisors of Construction Trades and Extraction Workers (77% compatibility)	\$96,868	4.4%	0.33%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> • Trainee to journeyman • 2–4-year apprenticeship • Driver's license • Min 10th grade education <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> • Superintendent, foreman, etc. • 5 years of construction and leadership experience required <p>Retraining strategy</p> <ul style="list-style-type: none"> • Short-term: orient current trainees to work on clean energy construction sites • Long-term: entry-level jobs are at high risk of automation while more experienced positions are not -> encourage young people who want to work in construction to complete a college degree (certificate to BA) in construction management or certificate in Leadership in the Trades (Renton Technical College)

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Automotive Service Technicians and Mechanics	Electric Vehicles Service Technicians and Mechanics	\$50,942 (same SOC code as Automotive Service Technicians and Mechanics)	-2.1% [†]	0.28%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> • Certificate or 2-year AAS degree or 4-year hands-on training • Driver's license • Participants to Jiffy Lube training programs can receive 7 hours of college credit <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> • EV training: short-term TESLA certificates (12 weeks) at Shoreline Community College available for people with previous automotive experience <p>Retraining strategy</p> <ul style="list-style-type: none"> • Easiest: certificates or courses from online platforms (4-6 weeks) on hybrid/electric vehicles technology • College programs: possibility of transferring past college credits (South Seattle College AAS)
Plumbers, Pipe Fitters, and Steamfitters	Electricians (95% compatibility) or First-Line Supervisors of Construction Trades and Extraction Workers (92% compatibility)	Electricians: \$80,340 or First-Line Supervisors of Construction Trades and Extraction Workers: \$96,868	Electricians: 5.3% or First-Line Supervisors of Construction Trades and Extraction Workers: 3.2%	Electricians: 0.44% or First-Line Supervisors of Construction Trades and Extraction Workers: 0.31%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> • Plumbing requires a certification from L&I. • Plumber: <ul style="list-style-type: none"> o 2-4 years as a trainee (shortest: residential services plumber) o 1-year college program (Perry Tech) – Plumbing Technician • Pipefitter and Steamfitter: <ul style="list-style-type: none"> o 3-5 years as a trainee (union or college apprenticeship) <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> • Electricians require a certification from L&I, obtained after 4 years as a trainee. • First-Line Supervisors: 5 years of construction and leadership experience required <p>Retraining strategy</p> <ul style="list-style-type: none"> • First-Line Supervisors: certificates to AAS degrees at technical colleges (Construction Management or

[†] Due to limited data availability, Electric Vehicles Service Technicians and Mechanics share the same SOC code as the Automotive Service Technicians and Mechanics. -2.1% thus represents the expected growth rate for all Automotive Service Technicians and Mechanics. Additionally, employment projections for this occupation have been revised significantly by EMSI since December 2019 and current numbers may differ from past estimates.

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					<p>Leadership in the Trades). Short-term online courses on construction scheduling/finance/management also available.</p> <ul style="list-style-type: none"> Electricians: Online courses and State level policy change is needed: skilled trades training is relatively inflexible, and training program length is fixed → work with L&I and unions to make it more welcoming for mid-career changes.
Automotive Body and Related Repairers	Electrical Power-Line Installers and Repairers (93% compatibility)	\$91,832	12.2%	0.94%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> 2-year AAS program <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> Spokane Community College: 2-year AAS program 3-5-year lineworker apprenticeship program <p>Retraining strategy</p> <ul style="list-style-type: none"> College programs: possibility of transferring past college credit FF job has 2 out of 7 qualities (DOL data) required for the crosswalked job <ul style="list-style-type: none"> Missing: color vision, physical stamina, teamwork, technical and troubleshooting skills
Office Clerks, General	Customer Service Representatives (96% compatibility) (**** 55% probability of automation) Or Childcare Workers (92% compatibility)	Customer Service Representatives: \$41,881 Or Childcare Workers: \$33,248	Customer Service Representatives: 10.7% or Childcare Workers: 1.8%	Customer Service Representatives: 0.64% or Childcare Workers: 0.19%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> 1-3 year AAS degree in a technical college <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> Customer Service Rep: Depending on employer's requirements: high school diploma to 1-2 year AS degree in a community college Childcare Workers: <ul style="list-style-type: none"> Certificate to AAS degrees in community college Stackable credentials: ECE Initial Certificate 12 credits <p>Retraining strategy</p> <ul style="list-style-type: none"> College programs: possibility of transferring past college credits 8-week training program available at Goodwill
Operating Engineers and Other Construction	First-Line Supervisors of Construction Trades and	\$96,868	3.2%	0.31%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> 4-year apprenticeship <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> Superintendent, foreman, etc.

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Equipment Operators	Extraction Workers (81% compatibility)				<ul style="list-style-type: none"> • 5 years of construction and leadership experience required <p>Retraining strategy</p> <ul style="list-style-type: none"> • Short-term: orient current trainees to work on clean energy construction sites and advance to field supervisor positions • Long-term: entry-level jobs are at high risk of automation while more experienced positions are not -> encourage young people who want to work in construction to complete: <ul style="list-style-type: none"> ○ A college degree (certificate to BA) in construction management ○ Certificate in Leadership in the Trades (Renton Technical College) ○ Short-term online courses on construction scheduling/finance/management
Laborers and Freight, Stock, and Material Movers, Hand	Packers and Packagers, Hand (93% compatibility)	\$32,554	12.4%	0.88%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> • High school certification or GED • Hands-on training • OSHA certification <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> • High school certification or GED • Hands-on training • Optional: certificate <p>Retraining strategy</p> <ul style="list-style-type: none"> • Both occupations can be trained on the job or through a short-term training program in a technical or community college • Possibility of transferring past college credits • Short (1 day) forklift training available at different locations, including Evergreen Safety Council
Heavy and Tractor-Trailer Truck Drivers	Cleaners of Vehicles and Equipment/Auto detailer (86% compatibility)	\$44,156	1.5%	0.50%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> • 2-quarter college award + class A-C CDL <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> • Cleaners and Auto Detailers: High school diploma or GED <p>Retraining strategy</p> <ul style="list-style-type: none"> • Cleaners: Short-term training usually provided by employers

Most Impacted (fossil fuel-dependent) Occupations	Crosswalked Occupations	Median Wage of Crosswalked Occupation	Baseline Growth of Crosswalked Occupation (2020-2024)	Net Additional Growth with Clean Energy Infrastructure by 2024	Training Strategies (focus on incumbent work/worker retraining)
General and Operations Managers in fossil fuel sectors (carbon-fuel based production/ transportation/ manufacturing/ retail)	General and Operations Managers in clean energy sectors (manufacture energy-efficient products, energy-efficient buildings construction, and operations, retrofitting)	\$124,466	7.8%	0.82%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> AS to BA college degree (operations management, business, supply chain, etc.) <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> AS to BA college degree (operations management, business, supply chain, etc.) <p>Retraining strategy</p> <ul style="list-style-type: none"> Have the college credits, but some professionals might need to update their skills to enroll in clean energy industries with 3-quarter certificates in construction management, facility management, or sustainable transportation. Micro-credentials (6 weeks courses or longer certificates) on sustainable construction or sustainable management available on online platforms (EdX, Coursera)
First-Line Supervisors of Production and Operating Workers	Wind Energy Operations Managers (93% compatibility)	\$104,874 (data available only for the parent SOC code)	4.6% (data available only for the parent SOC code)	0.96% (data available only for the parent SOC code)	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> Certificate to BA in operations management and supervision <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> BA college degree in industrial mechanics and maintenance <p>Retraining strategy</p> <ul style="list-style-type: none"> Short-term programs available: 6-month program at NW-REI and certificates in industrial engineering Courses (36 hours) on wind energy available on Coursera
Welders, Cutters, Solderers, and Brazers	<i>Solderers and Brazers:</i> Cleaners of Vehicles and Equipment/Auto detailer (87-93% compatibility) or <i>Welders, Cutters, and Welder Fitters:</i> Electrical Power-Line Installers and	Cleaners: \$44,156 or Power-Line Installers and Repairers: \$91,832	Cleaners: 1.5% or Power-Line Installers and Repairers: 12.2%	Cleaners: 0.50% or Power-Line Installers and Repairers: 0.94%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> 2-year AAS + certification or 4-year apprenticeship <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> Cleaners and Detailers: High school diploma or GED Electrical power-line installers or repairers: Spokane Community College: 2-year AAS program <p>Retraining strategy</p> <ul style="list-style-type: none"> Cleaners: Short-term training usually provided by employers

Most Impacted (fossil fuel-dependent) Occupations	Crosswalked Occupations	Median Wage of Crosswalked Occupation	Baseline Growth of Crosswalked Occupation (2020-2024)	Net Additional Growth with Clean Energy Infrastructure by 2024	Training Strategies (focus on incumbent work/worker retraining)
	Repairers (91% compatibility)				<ul style="list-style-type: none"> Electrical power-line installers or repairers: College programs: possibility of transferring past college credits
Automotive and Watercraft Service Attendants	Cleaners of Vehicles and Equipment/Auto detailer (89% compatibility)	\$44,156	1.5%	0.50%	<p>Fossil fuel training and skills</p> <ul style="list-style-type: none"> High school diploma or GED <p>Crosswalked job training and skills</p> <ul style="list-style-type: none"> Cleaners and Auto Detailers: High school diploma or GED <p>Retraining strategy</p> <ul style="list-style-type: none"> Cleaners: Short-term training usually provided by employers

Note: Crosswalked occupations selected for this table have an automation probability of 50% or less and have enough capacity to absorb dislocated workers from the fossil fuel industry. If no occupation among the leading occupations in clean energy was similar to the fossil fuel-dependent occupation or did not provide a quick retraining pathway, the closest occupation allowing short-term worker training was selected. In that case, occupations with a potential green pathway were still preferred.

Acknowledgments

Special thanks to Robert Scott of the Economic Policy Institute and John Burbank of the Opportunity Institute for sharing their work and expertise with us.

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