



American
Petroleum
Institute



Occupation Transferability Report

Understanding Transferability between the ONG and Clean Energy Industries

November 2021

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Executive Summary

Executive Summary | Background

1

The Biden Administration, through Executive Orders and legislative proposals, has repeatedly asserted it will be relatively easy for workers in the Oil and Natural Gas (ONG) industry to transition into jobs in the Clean Energy industry.* This assertion is foundational to the Administration's overall position on energy policy.

2

For example:

- On Jan. 27, 2021, President Biden signed the Executive Order on Tackling the Climate Crisis at Home and Abroad, which calls for “millions of construction, manufacturing, engineering, and skilled-trades workers to build a new American infrastructure and clean energy economy.”
- In a White House press briefing that same day, Secretary John Kerry asserted that “the same people [oil and gas workers] can do those [clean energy] jobs.”

3

It is now more important than ever to understand the kinds of jobs that exist in the ONG and Clean Energy industries, and whether America's ONG workers can realistically transition to Clean Energy given job requirements, quality, and availability. Such analysis is critical to evaluating the potential impact of the Biden Administration's policies on both industries and the large numbers of American workers they employ.

4

To this end, the American Petroleum Institute (API) and North America's Building Trades Unions (NABTU) commissioned a study by Cicero Group to understand the most prevalent occupations in ONG and Clean Energy, and to evaluate whether American ONG workers can realistically transition to the most in-demand Clean Energy occupations.

“What President Biden wants to do is make sure [oil and gas workers] have better choices...that they can be the people who go to work to make the solar panels.”

- John Kerry, Special Presidential Envoy for Climate

Executive Summary | Research Objectives and Methodology

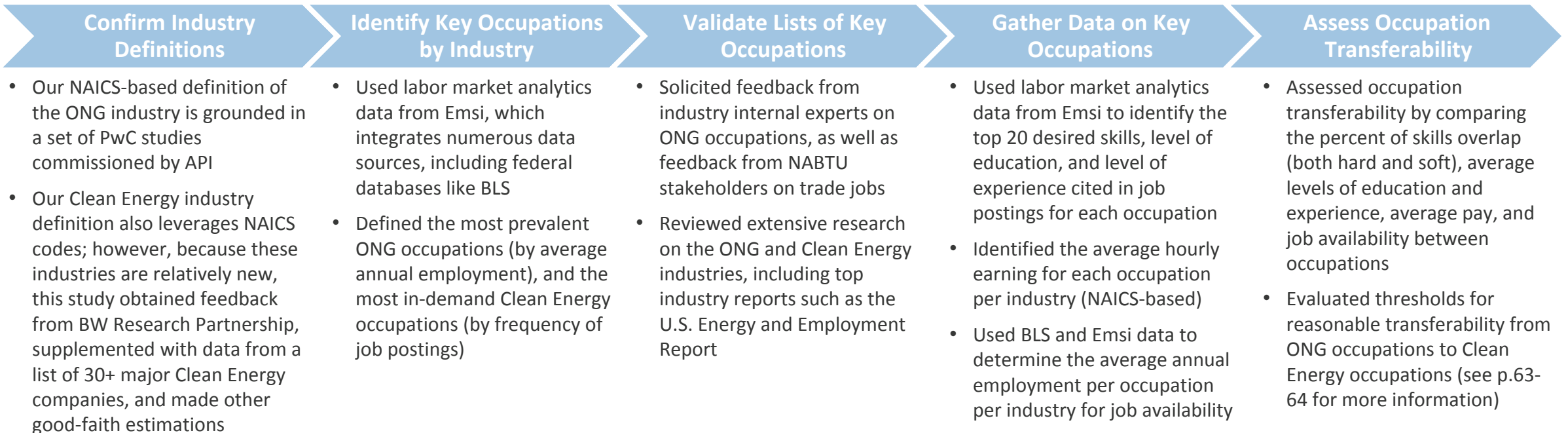
Research Objectives

This study answers three key questions about the potential for transferability from ONG to Clean Energy occupations:

- 1) What are the **most prevalent occupations** in the ONG industry, and the **most in-demand occupations** in the Clean Energy industry?
- 2) How **realistic** is it to expect that American ONG workers **can and will transition** into Clean Energy occupations?
- 3) What are the **policy implications** of these findings, particularly when it comes to supporting American workers and a vibrant national economy?

Methodology

A comprehensive overview of this study's methodology is included in Appendix B. At a high level, the analysis included research across five phases:



Executive Summary | Answers to Key Questions



Question #1

What are the **most prevalent occupations** in the ONG industry, and the **most in-demand occupations** in the Clean Energy industry?

The most prevalent occupations in ONG and the most in-demand occupations in Clean Energy can be categorized into three types: Technical-Trade, Management-Professional, and Sales.

- This study analyzes the 18 most *prevalent* occupations in ONG, and the 18 most *in-demand* occupations in Clean Energy. **Comparing prevalence vs. demand** is important to understanding whether and how the typical American ONG worker (in the most common ONG occupations) would realistically be able to transition their career to the Clean Energy industry.
- Technical-Trade occupations require specialized technical skills and often on-the-job training, whereas Management-Professional occupations typically require a 2- or 4-year degree. Sales occupations refer specifically to sales representatives. Most of the occupations analyzed in this report are Technical-Trade occupations.
- When considering whether to transition from ONG to Clean Energy, **workers are more likely to consider transitioning *within* the same occupation type** as opposed to *between* occupation types (which is inherently more difficult given varying job requirements).
- Identifying the list of occupations for analysis in this study required setting aside certain occupations:
 - Out-of-Scope Occupations: These are not directly related to the relevant industries and/or outside the bounds of the industry definitions used in this study.
 - Special-Category Occupations: These are, for various reasons, not as useful for conducting an in-depth analysis on occupation transferability. Instead, this report provides a high-level analysis of these occupations.

Executive Summary | Answers to Key Questions



Question #2

How **realistic** is it to expect that American ONG workers **can and will transition** into Clean Energy occupations?

Transferability is a function of job requirements, quality, and availability. Analyzing these factors shows that ONG workers face considerable challenges transferring from ONG occupations to Clean Energy occupations.

- Among **Technical-Trade occupations**, only 1 out of 14 ONG occupations demonstrates reasonable transferability to Clean Energy occupations based on job requirements, job quality, and location (Construction Laborers). Other occupations may be considered transferable based on some, but not all of these factors. Further, it may be very difficult for some to find a Clean Energy job due to the **ONG industry employing many more workers than are employed or in-demand in Clean Energy.**
- Among **Management-Professional occupations**, only 1 out of 3 ONG occupations demonstrates reasonable transferability to Clean Energy occupations (General and Operations Managers). However, **the ONG industry employs 5x the number of General and Operations Managers as the Clean Energy industry.**
- The sole **Sales occupation in ONG does not demonstrate reasonable transferability to Clean Energy** due to a mismatch in education requirements (see p.31).
- It is important to recognize that other, ONG occupations may be transferable from a skills perspective to similar occupations in Clean Energy. For example, many **union-based occupations that would fall in the Technical-Trade category provide broad cross-training** that would allow electricians, welders, and other workers to function successfully across industries. **The issue is job availability**—there are typically many more of these jobs available in the ONG industry than the Clean Energy industry—and job overlap, as **many of the trades that exist in the ONG industry are not prevalent in the Clean Energy industry** (see slide 35).
- In addition, some highly-prevalent ONG occupations (especially union-based occupations) would be considered transferable from a skills perspective to other, less in-demand Clean Energy occupations—but **job availability remains an issue**, with relatively few comparable jobs available in Clean Energy .

Executive Summary | Answers to Key Questions



Question #3

What are the **policy implications** of these findings, particularly when it comes to supporting American workers and a vibrant national economy?

These findings urge interpreting with caution any policy positions that frame transferability from ONG to Clean Energy as straight forward or easy. They also suggest a more data-driven, nuanced approach to policies that will impact occupation transferability so that American workers are not shortsightedly disadvantaged.

- API and NABTU recommend that federal and state officials **ground their policymaking in data about the potential (or lack thereof) for occupation transferability**—this will align policymaking with the daily realities of American workers, who ultimately must decide whether it is possible and reasonable to transition their careers and livelihoods to a different industry.
- We also recommend that policies designed to facilitate transferability into Clean Energy **focus first on occupations that already demonstrate reasonable pathways** for American workers. This is the most realistic starting-point for expanding career opportunities for workers and supporting a vibrant economy.
- Ultimately, government policies should avoid picking winners and losers and instead **allow the market to work** and produce the most sustainable results for American workers.



Question #1

What are the **most prevalent occupations** in the ONG industry, and the **most in-demand occupations** in the Clean Energy industry?

To understand occupation transferability from ONG to Clean Energy, this study gathered data on the most *prevalent* occupations in ONG and the most *in-demand* occupations in Clean Energy.

ONG Industry
Most Prevalent Occupations

- We define *prevalence* by an occupation’s total annual employment in the United States
- To measure prevalence, we gathered annual employment data for individual occupations over a 4-year average (2017-2020)
- This approach allowed us to understand which ONG occupations employ the most American workers

Clean Energy Industry
Most In-Demand Occupations

- We define *in-demand* by an occupation’s average annual job postings in the United States
- To measure demand, we gathered annual job postings data for individual occupations over the same 4-year average (2017-2020)
- This approach allowed us to understand which Clean Energy occupations are most in-demand



For both industries, the scope of this study considered jobs directly related to the discovery, generation, and immediate distribution of energy sources. For additional details about the methodology, see Appendix B.

To determine these lists of occupations by industry, we examined available data through three main filters. The first filter identified occupations considered out-of-scope for this study.

ONG and Clean Energy Occupations Data



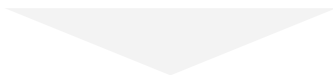
Removal of Out-of-Scope Occupations

First, a small number of occupations were removed from the dataset because they were clearly outside the scope of this study.



Preliminary Occupations List for High-Level Transferability Analysis

These occupations are not directly related to the relevant industries and/or outside of the upper and lower bounds of our industry definitions (upper bounds refer to activities that lead into an industry, such as supply chain or manufacturing; lower bounds refer to activities that lead out of an industry, such as installing electric power lines from power plants to homes). See p.12 for details.



Final Occupations List for Detailed Transferability Analysis

The below occupations were classified as out-of-scope for purposes of this study and removed from the analysis.

Out-of-Scope ONG Occupations	Avg. Annual Employment (2017-20)
1 Cashiers	623,493
2 First-Line Supervisors of Retail Sales Workers	92,233
3 Fast Food and Counter Workers	45,665
4 Retail Salespersons	23,706
5 Laborers and Freight, Stock, and Material Movers, Hand	22,414
6 Automotive and Watercraft Service Attendants	21,591
7 Stockers and Order Fillers	20,674
8 Automotive Service Technicians and Mechanics	16,267
9 Food Preparation Workers	14,558

Cashiers; First-Line Supervisors of Retail Sales Workers; Fast Food and Counter Workers; Retail Salespersons; and Food Preparation Workers were removed as out-of-scope occupations because they are gas station-related occupations, and this type of work is considered outside the lower bounds of the ONG industry. **Importantly, however, is the fact that over 750,000 jobs rely on this natural extension of the ONG industry, and these jobs (and their American workers) would be put at risk by policies that shrink the industry.** Clean Energy provides no workplace equivalent to the gas station, and therefore cannot realistically provide jobs to most of these gas station-related workers.

The other four occupations on this list were removed because they either correspond to some gas station-related positions (e.g., automotive service attendants and technicians/mechanics working at gas stations) or do not have a clear, direct connection to the ONG industry.

Out-of-Scope Clean Energy Occupations	Avg. Annual Employment (2017-20)*
1 Electrical Power-Line Installers and Repairers	49,840
2 Telecommunications Line Installers and Repairers	26,320
3 Security Guards	6,440
4 Personal Service Managers, All Other; Entertainment and Recreation Managers, Except Gambling; and Managers, All Other	2,240
5 Telecommunications Equipment Installers and Repairers, Except Line Installers	1,960

Electrical Power-Line Installers and Repairers; Telecommunications Line Installers and Repairers; and Telecommunications Equipment Installers and Repairers, Except Line Installers were removed as out-of-scope occupations because they are considered outside the lower bounds of the Clean Energy industry. Similarly, Security Guards and Personal Service Managers, All Other were removed as out-of-scope because this type of work does not have a clear, direct connection to the Clean Energy industry and it is unclear if these jobs fall outside the lower bounds of the industry (e.g., security for the broader power grid).

**These employment figures are broad, directional estimates based on the best available data for the industry. See Appendix B for details on how these estimates were calculated.*

The second filter identified occupations in a few special categories that warranted a high-level analysis of transferability.

ONG and Clean Energy Occupations Data



Removal of Out-of-Scope Occupations



High-Level Transferability Analysis of Special-Category Occupations

Then, another small batch of occupations were excluded from detailed analysis. Instead, a high-level analysis of transferability for these occupations is included on p.14.



Final Occupations List for Detailed Transferability Analysis

A high-level analysis of the special-category occupations mentioned previously demonstrates mixed potential for transferability from ONG to Clean Energy.

Special-Category Occupations in ONG		Avg. Annual Employment (2017-20)
1	Heavy and Tractor-Trailer Truck Drivers	54,476
2	Office Clerks, General	33,746
3	Customer Service Representatives	25,826
4	Bookkeeping, Accounting, And Auditing Clerks	19,688
5	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	19,375
6	Accountants and Auditors	18,370

Truck Driver Occupations were removed because their generalizable skills mean they are more likely to be transferable on job requirements. However, it is important to note that ONG truck drivers often need additional licensing because many drive fuel tankers, which require not only a Commercial Driver License (CDL), but typically also one or more specialized driver endorsements for transporting hazardous materials.* Job availability for Heavy and Tractor-Trailer Truck Drivers is an obstacle because there are nearly 55,000 ONG drivers and fewer than 4,000 Clean Energy drivers currently. In addition, job postings may over-estimate actual Clean Energy demand, as the persistent truck driver shortage in the U.S. may inflate the frequency of job postings.**

Generic Office-Based Occupations were removed because their generalizable skills categorize them as having high transferability on job requirements (e.g., an accountant or auditor most likely possesses the foundational skills to work in either the ONG or Clean Energy industries).

Tech-Based Occupations were removed because they require tech skills not aligned with the 18 most prevalent ONG occupations. This represents low transferability on job requirements. It is important to note that removing these occupations improves the likelihood of ONG transferability in our analysis. These same four occupations *are* present in ONG, and in fact are more prevalent (by about 8,000 jobs) compared to Clean Energy employment in these same four occupations. Note that 'Computer Occupations, All Other' is included in the final list of Clean Energy occupations (see p.16) because it shows relatively high job demand and allows us to evaluate transferability to a more general/broad tech-based occupation.

Nuclear Occupations were removed because a) they require an inherently specialized and different skillset (an instance of low transferability on job requirements), and b) they have considerably negative job outlooks according to BLS data (-13% for Nuclear Engineers; -19% for Nuclear Technicians; and -36% for Nuclear Power Reactor Operators).

Special-Category Occupations in Clean Energy		Avg. Annual Employment (2017-20)***
1	Nuclear Engineers	16,400
2	Office Clerks, General	7,280
3	Nuclear Technicians	6,700
4	Secretaries and Administrative Assistants	5,320
5	Nuclear Power Reactor Operators	5,300
6	Heavy and Tractor-Trailer Truck Drivers	3,920
7	Accountants and Auditors	2,380
8	First-Line Supervisors of Office and Admin. Support Workers	2,240
9	Software Developers and Software Quality Assurance Analysts and Testers	1,820
10	Customer Service Representatives	1,680
11	Computer Systems Analysts	1,400
12	Computer User Support Specialists	1,260
13	Management Analysts	1,260
14	Marketing Managers	700
15	Information Security Analysts	560
16	Light Truck Drivers	280



*See [Endorsements N, H, and X](#) from the Federal Motor Carrier Safety Administration.

**The [American Trucking Association](#) estimates an immediate national shortage of over 60,000 drivers, projected to grow to 160,000 drivers by 2028.

***These employment figures are estimates based on the best available data for the industry. See Appendix B for details on how these estimates were calculated.

The final filter identified the 18 most prevalent ONG occupations and the 18 most in-demand Clean Energy occupations for a detailed analysis of transferability.

ONG and Clean Energy Occupations Data



Removal of Out-of-Scope Occupations



Preliminary Occupations List for High-Level Transferability Analysis



Final Occupations List for Detailed Transferability Analysis

A final list of occupations was used to conduct the in-depth transferability analysis contained in the remainder of this study. This final list of occupations follows on p.16.

Our analysis yielded the below final lists of most prevalent occupations for the ONG industry, and the most in-demand occupations for the Clean Energy industry.

Most Prevalent Occupations in ONG		Avg. Annual Employment (2017-20)
1	General and Operations Managers	50,069
2	Construction Laborers	46,684
3	Roustabouts, Oil and Gas	44,763
4	Service Unit Operators, Oil and Gas	40,901
5	First-Line Supervisors of Construction Trades and Extraction Workers	38,975
6	Petroleum Pump System Operators, Refinery Operators, and Gaugers	34,259
7	Operating Engineers and Other Construction Equipment Operators	30,501
8	Industrial Machinery Mechanics	24,025
9	Sales Reps, Wholesale and Mfg., Except Technical and Scientific Products	21,108
10	Petroleum Engineers	19,636
11	Control and Valve Installers and Repairers, Except Mechanical Door	18,202
12	First-Line Supervisors of Production and Operating Workers	17,404
13	Rotary Drill Operators, Oil and Gas	16,295
14	Plumbers, Pipefitters, and Steamfitters	15,930
15	Power Plant Operators	15,484
16	First-Line Supervisors of Mechanics, Installers, and Repairers	14,629
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	14,627
18	Gas Plant Operators	13,375

Most In-Demand Occupations in Clean Energy*		Avg. Annual Job Postings (2017-20)	Avg. Annual Employment (2017-20)**
1	Electrical Engineers	5,320	10,700+
2	First-Line Supervisors of Mechanics, Installers, and Repairers	4,060	15,120
3	Computer Occupations, All Other	4,060	8,200+
4	Industrial Engineers	4,060	8,200+
5	Maintenance and Repair Workers, General	3,780	8,100+
6	Mechanical Engineers	3,780	8,100+
7	Sales Reps, Wholesale and Mfg., Technical and Scientific Products	2,800	10,000***
8	Solar Photovoltaic Installers	2,520	12,000****
9	Project Mgmt. Specialists and Business Ops. Specialists, All Other	2,240	5,180
10	First-Line Supervisors of Production and Operating Workers	2,100	4,060
11	First-Line Supvr. of Construction Trades and Extraction Workers	1,960	18,060
12	Wind Turbine Service Technicians	1,960	7,000****
13	Construction Managers	1,680	10,780
14	Electricians	1,540	13,300
15	General and Operations Managers	1,400	10,220
16	Construction Laborers	1,260	45,500
17	Power Plant Operators	560	5,740
18	Operating Engineers and Other Construction Equip. Operators	560	20,720

*To curate this list of Clean Energy occupations, we used multiple demand metrics. See Appendix B for details.

**These employment figures are based on a list of Clean Energy NAICS codes (see Appendix B), which are relatively new codes measuring a relatively young and growing industry. Therefore, we consider these employment figures to be estimates as opposed to precise counts, and so should be read to demonstrate general trends. Figures with a "+" sign are broadly estimated. See Appendix B for details.

***Because this specific employment metric is significantly underrepresented by Clean Energy NAICS codes, this figure is a high-level estimate based on data from the [National Solar Jobs Census 2020](#) (since we estimate that many if not most Clean Energy sales positions derive from the solar sector).

****Because Solar Photovoltaic Installers and Wind Turbine Service Technicians are employed strictly within the Clean Energy industry, these specific figures were pulled from the BLS 2019 employment statistics for a more accurate annual employment figure.

Each of these occupations can be categorized as a Technical-Trade Occupation, Management-Professional Occupation, or Sales Occupation.

Most Prevalent Occupations in ONG		Avg. Annual Employment (2017-20)
1	General and Operations Managers	50,069
2	Construction Laborers	46,684
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4	Service Unit Operators, Oil and Gas	40,901
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16	First-Line Supervisors of Mechanics, Installers, and Repairers	14,629
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	14,627
18	Gas Plant Operators	13,375

Most In-Demand Occupations in Clean Energy		Avg. Annual Job Postings (2017-20)	Avg. Annual Employment (2017-20)
1	Electrical Engineers	5,320	10,700+
2	First-Line Supervisors of Mechanics, Installers, and Repairers	4,060	15,120
3	Computer Occupations, All Other	4,060	8,200+
4	Industrial Engineers	4,060	8,200+
5	Maintenance and Repair Workers, General	3,780	8,100+
6	Mechanical Engineers	3,780	8,100+
7	Sales Reps, Wholesale and Mfg., Technical and Scientific Products	2,800	10,000
8	Solar Photovoltaic Installers	2,520	12,000
9	Project Mgmt. Specialists and Business Ops. Specialists, All Other	2,240	5,180
10	First-Line Supervisors of Production and Operating Workers	2,100	4,060
11	First-Line Supvr. of Construction Trades and Extraction Workers	1,960	18,060
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13	Construction Managers	1,680	10,780
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15	General and Operations Managers	1,400	10,220
16	Construction Laborers	1,260	45,500
17	Power Plant Operators	560	5,740
18	Operating Engineers and Other Construction Equip. Operators	560	20,720



Technical-Trade Occupations require specialized technical skills obtained either through on-the-job training or postsecondary credentials (certifications or degrees)



Management-Professional Occupations typically require a 2-year or 4-year degree



Sales Occupations refer specifically to sales representatives

Examining the occupations data through these filters provides some high-level takeaways and produces a final list of occupations for more detailed analysis in the remainder of this report.

ONG and Clean Energy Occupations Data

Removal of Out-of-Scope Occupations

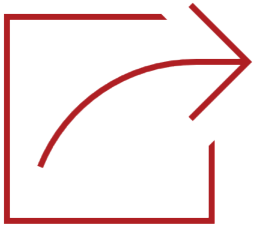
- Removing these occupations clarifies the scope of this study.
- Examining several gas station-related occupations shows that 750,000+ American jobs would be put at risk if the ONG industry were to shrink.

Preliminary Occupations List for High-Level Transferability Analysis

- Setting aside these occupations for a high-level analysis shows mixed potential for their transferability.
- While some occupations (i.e., truck drivers, generic office-based occupations, and tech-based occupations) may demonstrate transferability on job requirements, large job availability gaps highlight the barriers facing workers.

Final Occupations List for Detailed Transferability Analysis

- The remainder of this report focuses on an in-depth analysis of the transferability of the 18 most prevalent ONG occupations to the 18 most in-demand Clean Energy occupations (by occupation type, as outlined on p.20).
- Of note, these ONG occupations employ nearly 477,000 workers and the Clean Energy occupations employ 221,000 —highlighting a significant gap in job availability.



Question #2

How **realistic** is it to expect that American
ONG workers **can and will transition** into
Clean Energy occupations?

To assess occupation transferability, this study focuses on analysis within the three distinct occupation types identified previously, given inherent differences between each type.

Most Prevalent Occupations in ONG

Most In-Demand Occupations in Clean Energy

Transferability within occupation types is inherently more feasible

**Occupation Type #1:
Technical-Trade Occupations**

**Occupation Type #1:
Technical-Trade Occupations**

*Transferability between occupation types is inherently more difficult,
due to differences in job requirements (e.g., skills and education)*

**Occupation Type #2:
Management-Professional Occupations**

**Occupation Type #2:
Management-Professional Occupations**

**Occupation Type #3:
Sales Occupations**

**Occupation Type #3:
Sales Occupations**



Within each occupation type, transferability consists of three key factors: Job requirements, quality, and availability.

Job Requirements

Influence whether a worker can transition

Skills

Key Question: Does a given ONG occupation have at least 50% overlap in the top required skills for a Clean Energy occupation?*

Education

Key Question: Does a given ONG occupation require the same (or more) typical education as a Clean Energy occupation?*

Note: There are other measures of job requirements (e.g., years of experience, etc.) but these are not specifically addressed in this report due to data limitations.



Job Quality

Influences whether a worker will transition

Pay

Key Question: Does a given Clean Energy occupation offer similar pay (90% or more) as an ONG occupation?*

Note: See p.34-36 for additional analysis of job quality considerations like over-skilled workers.

There are other measures of job quality (e.g., benefits, workplace safety, etc.) but these are not specifically addressed in this report due to data limitations.



Job Availability

Influences whether workers have transition opportunities

Location

Key Question: Is there a sufficient concentration of Clean Energy jobs in the top regions of a given ONG occupation?*

Job Demand

Key Question: Are there enough Clean Energy jobs overall to realistically employ a significant number of transitioning ONG workers?*



Job Transferability

Key Question: Given all of these factors, is it reasonable to expect American workers in the most prevalent ONG occupations to transition to the most in-demand Clean Energy occupations?

From a **job demand** perspective, an industry-level analysis of data shows that the most prevalent ONG occupations employ 10x as many workers as there are average annual job postings for the most in-demand Clean Energy occupations.

Most Prevalent ONG Occupations



Most In-Demand Clean Energy Occupations



← The significant gap between the number of current ONG workers in these occupations compared to job postings in Clean Energy demonstrates the inherent constraints of job availability.

This gap is compounded by the transferability barriers highlighted previously, as well as the fact that not every Clean Energy job opening can or will be filled by current ONG workers.

Beyond job demand, this report analyzes the transferability of ONG occupations across the job requirement, quality, and availability factors. The table below is illustrative.

		ONG Occupation Type #1		
Occupation Transferability Criteria		ONG Occupation #1	ONG Occupation #2	ONG Occupation #3
<i>Clean Energy Occupations That Meet Transferability Criteria</i>				
Job Requirements	At Least 50% Overlap for Top Skills Required	<ul style="list-style-type: none"> Clean Energy Occupation #1 Clean Energy Occupation #2 Clean Energy Occupation #3 	<ul style="list-style-type: none"> Clean Energy Occupation #1 Clean Energy Occupation #2 	<ul style="list-style-type: none"> Clean Energy Occupation #1 Clean Energy Occupation #2
	Same Typical Education Required	<ul style="list-style-type: none"> Clean Energy Occupation #2 Clean Energy Occupation #3 	<ul style="list-style-type: none"> Clean Energy Occupation #2 	<i>No occupations meet this criteria</i>
Job Qual.	Similar (or Higher) Pay	<ul style="list-style-type: none"> Clean Energy Occupation #3 	<i>No occupations meet this criteria</i>	----
Job Avail.	Available in Same States	<ul style="list-style-type: none"> Clean Energy Occupation #3 	----	----
Reasonably Transferable Clean Energy Occupations		<ul style="list-style-type: none"> Clean Energy Occupation #3 	----	----

Job requirements, quality, and availability (by location) are analyzed in succession. Availability based on job demand is discussed on p.37.

In this example, ONG Occupation #1 corresponds to one Clean Energy occupation that meets all criteria for reasonable transferability.

ONG Occupation #2 does not correspond to any Clean Energy occupations that meet the criteria for pay, so the transferability analysis ends here.



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Technical-Trade ONG Occupations	
Occupation Transferability Criteria		Construction Laborers	Control and Valve Installers and Repairers
		<i>Clean Energy Occupations That Meet Transferability Criteria</i>	
Job Requirements	At Least 50% Overlap for Top Skills Required	<ul style="list-style-type: none"> Construction Laborers Operating Engineers and Other Construction Equipment Operators 	<ul style="list-style-type: none"> Maintenance and Repair Workers, General
	Same Typical Education Required	<ul style="list-style-type: none"> Construction Laborers 	<ul style="list-style-type: none"> Maintenance and Repair Workers, General
Job Qual.	Similar (or Higher) Pay	<ul style="list-style-type: none"> Construction Laborers 	<i>No occupations meet this criteria</i>
Job Avail.	Available in Same States	<ul style="list-style-type: none"> Construction Laborers 	-----
	Reasonably Transferable Clean Energy Occupations	<ul style="list-style-type: none"> Construction Laborers* 	-----

**Generally, the regions where ONG Construction Laborer jobs are in demand also have significant Clean Energy Construction Laborer jobs. However, laborers in some areas will experience a more difficult transition. For example, 9% of ONG Construction Laborer job demand is in Pennsylvania, but Pennsylvania accounts for only 2% of Clean Energy Construction Laborer job demand.*



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

Technical-Trade ONG Occupations

Occupation Transferability Criteria

First-Line Supervisors of Construction and Trades Workers*

Clean Energy Occupations That Meet Transferability Criteria

At Least 50% Overlap for Top Skills Required

- *First-Line Supervisors of Construction and Trades Workers*
- *First-Line Supervisors of Mechanics, Installers, and Repairers*
- *First-Line Supervisors of Production and Operating Workers*
- *Maintenance and Repair Workers*

Same Typical Education Required

- *First-Line Supervisors of Construction and Trades Workers*
- *First-Line Supervisors of Mechanics, Installers, and Repairers*
- *First-Line Supervisors of Production and Operating Workers*
- *Maintenance and Repair Workers*

Similar (or Higher) Pay

- *First-Line Supervisors of Construction Trades and Extraction Workers*
- *First-Line Supervisors of Mechanics, Installers, and Repairers*
- *First-Line Supervisors of Production and Operating Workers*

Available in Same States

No occupations meet this criteria

Reasonably Transferable Clean Energy Occupations

*While an analysis of top skills does not demonstrate transferability to the Clean Energy occupation of construction laborers (which is understandable, since supervisors in this line of work will naturally have a different set of top required skills), it is reasonable to think that these supervisors would have foundational construction skills. However, it is not reasonable to simply assume they would trade a supervisory job for a non-supervisory job.



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Technical-Trade ONG Occupations	
Occupation Transferability Criteria		First-Line Supervisors of Production and Operating Workers	First-Line Supervisors of Mechanics, Installers, and Repairers
		Clean Energy Occupations That Meet Transferability Criteria	
Job Requirements	At Least 50% Overlap for Top Skills Required	<ul style="list-style-type: none"> First-Line Supervisors of Construction and Trades Workers First-Line Supervisors of Mechanics, Installers, and Repairers First-Line Supervisors of Production and Operating Workers 	<ul style="list-style-type: none"> First-Line Supervisors of Construction and Trades Workers First-Line Supervisors of Mechanics, Installers, and Repairers First-Line Supervisors of Production and Operating Workers
	Same Typical Education Required	<ul style="list-style-type: none"> First-Line Supervisors of Construction and Trades Workers First-Line Supervisors of Mechanics, Installers, and Repairers First-Line Supervisors of Production and Operating Workers 	<ul style="list-style-type: none"> First-Line Supervisors of Construction and Trades Workers First-Line Supervisors of Mechanics, Installers, and Repairers First-Line Supervisors of Production and Operating Workers
Job Qual.	Similar (or Higher) Pay	<ul style="list-style-type: none"> First-Line Supervisors of Production and Operating Workers 	<ul style="list-style-type: none"> First-Line Supervisors of Construction and Trades Workers First-Line Supervisors of Mechanics, Installers, and Repairers First-Line Supervisors of Production and Operating Workers
Job Avail.	Available in Same States	No occupations meet this criteria	
Reasonably Transferable Clean Energy Occupations		-----	-----



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Technical-Trade ONG Occupations	
Occupation Transferability Criteria		Gas Plant Operators	Industrial Machinery Mechanics
		Clean Energy Occupations That Meet Transferability Criteria	
Job Requirements	At Least 50% Overlap for Top Skills Required	<i>No occupations meet this criteria</i>	
	Same Typical Education Required	-----	• <i>Maintenance and Repair Workers, General</i>
Job Qual.	Similar (or Higher) Pay	-----	<i>No occupations meet this criteria</i>
Job Avail.	Available in Same States	-----	-----
	Reasonably Transferable Clean Energy Occupations	-----	-----



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Technical-Trade ONG Occupations		
Occupation Transferability Criteria		Operating Engineers and Other Construction Equipment Operators	Petroleum Pump System Operators, Refinery Operators, and Gaugers	Plumbers, Pipefitters, and Steamers
		Clean Energy Occupations That Meet Transferability Criteria		
Job Requirements	At Least 50% Overlap for Top Skills Required	<ul style="list-style-type: none"> Construction Laborers Operating Engineers and Other, etc. 	No occupations meet this criteria	No occupations meet this criteria
	Same Typical Education Required	<ul style="list-style-type: none"> Construction Laborers Operating Engineers and Other, etc. 	----	----
Job Qual.	Similar (or Higher) Pay	<ul style="list-style-type: none"> Operating Engineers and Other, etc. 	----	----
Job Avail.	Available in Same States	No occupations meet this criteria	----	----
Reasonably Transferable Clean Energy Occupations		----	----	----



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

Technical-Trade ONG Occupations

Power Plant Operators

Clean Energy Occupations That Meet Transferability Criteria

Occupation Transferability Criteria

At Least 50% Overlap for Top Skills Required

- *Power Plant Operators*
- *Maintenance and Repair Workers, General*

Same Typical Education Required

- *Power Plant Operators*
- *Maintenance and Repair Workers, General*

Similar (or Higher) Pay

No occupations meet this criteria

Available in Same States

Reasonably Transferable Clean Energy Occupations

Job Requirements

Job Qual.

Job Avail.



Technical-Trade Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Technical-TradeONG Occupations		
Occupation Transferability Criteria		Rotary Drill Operators, Oil and Gas	Roustabouts, Oil and Gas	Service Unit Operators, Oil and Gas
		Clean Energy Occupations That Meet Transferability Criteria		
Job Requirements	At Least 50% Overlap for Top Skills Required	<i>No occupations meet this criteria</i>	<i>No occupations meet this criteria</i>	<ul style="list-style-type: none"> Maintenance and Repair Workers, General
	Same Typical Education Required	----	----	<i>No occupations meet this criteria</i>
Job Qual.	Similar (or Higher) Pay	----	----	----
Job Avail.	Available in Same States	----	----	----
Reasonably Transferable Clean Energy Occupations		----	----	----



Management-Professional Occupations | Transferability Analysis

Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.

		Management-Professional ONG Occupations	
Occupation Transferability Criteria		General and Operations Managers	Petroleum Engineers
		<i>Clean Energy Occupations That Meet Transferability Criteria</i>	
Job Requirements	At Least 50% Overlap for Top Skills Required	• <i>General and Operations Managers</i>	<i>No occupations meet this criteria</i>
	Same Typical Education Required	• <i>General and Operations Managers</i>	-----
Job Qual.	Similar (or Higher) Pay	• <i>General and Operations Managers</i>	-----
Job Avail.	Available in Same States	• <i>General and Operations Managers</i>	-----
	Reasonably Transferable Clean Energy Occupations	• <i>General and Operations Managers*</i>	-----

The average annual employment of General and Operations Managers in the ONG industry is roughly 5x the employment of managers in the Clean Energy industry (50,069 vs. 10,220). Thus, even though General and Operations Managers could reasonably transfer from the ONG industry to the Clean Energy industry, **only a portion would be able to transfer based on job availability. Additionally, while there is general overlap between regions, the transition would be more difficult in certain areas. For example, Florida has 9% of the job demand for General and Operations Managers in the ONG industry, compared to just 2% of the job demand for General and Operations Managers in the Clean Energy industry.*



Management-Professional Occupations | Transferability Analysis

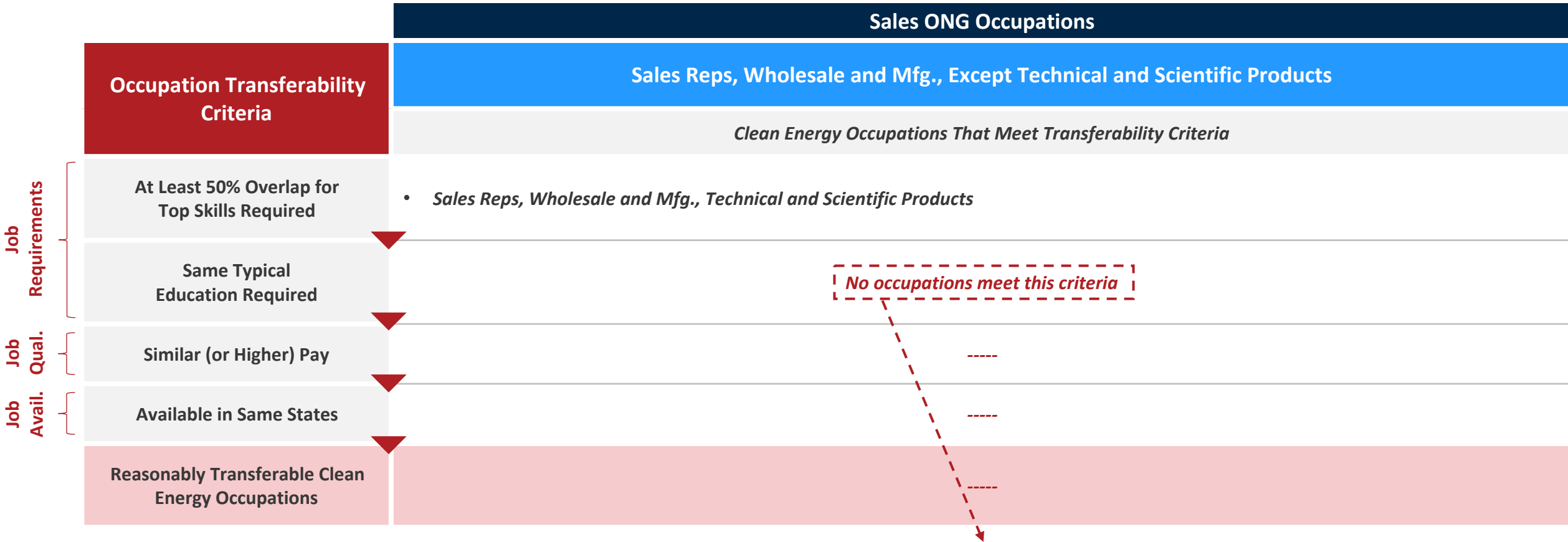
Note: ONG Occupations are listed in alphabetical order (by occupation type) for easy reference.



*The Mechanical Engineers occupation has a 55% overall skills match, but was removed from the transferability list because 2 of the top 10 required skills ("Mechanical Engineering" and "Professional Engineer") are clearly critical to the occupation, but are not top skills for the ONG occupation of Project Mgmt. Specialists and Business Operations Specialists, All Other. Similarly, the Industrial Engineers occupation was removed with a 65% overall skills match as critical, technical skills including "Electrical Engineering" are required.



Sales Occupations | Transferability Analysis



This transferability analysis ends at the comparison of required education levels. Our research identifies two interrelated reasons for this education mismatch:

- 1) The sales occupations in ONG and Clean Energy are inherently different in that the ONG occupation specifically excludes selling “technical and scientific products” whereas this is the primary focus of the Clean Energy occupation.*
- 2) As such, it is reasonable for the job requirements of the Clean Energy occupation to be more robust. For example, solar sales rep jobs, as the Interstate Renewable Energy Council notes, increasingly require a bachelor’s degree ¹ while ONG sales positions most commonly require only a high school diploma.*

Overall, ONG workers face significant challenges in transitioning to Clean Energy within a given occupation type, not to mention between occupation types (which presents its own challenges).

Most Prevalent Occupations in ONG		Avg. Annual Employment (2017-20)	Reasonably Transferable Clean Energy Occupations	Avg. Annual Job Postings (2017-2020)	Avg. Annual Employment (2017-2020)
1	General and Operations Managers	50,069	• General and Operations Managers	1,400	10,220
2	Construction Laborers	46,684	• Construction Laborers	1,260	45,500
3	Roustabouts, Oil and Gas	44,763	None; reasonable transferability ends with skills comparison	-----	-----
4	Service Unit Operators, Oil and Gas	40,901	None; reasonable transferability ends with education comparison	-----	-----
5	First-Line Supervisors of Construction Trades and Extraction Workers	38,975	None; reasonable transferability ends with location comparison	1,960 4,060 2,100	18,060 15,120 4,060
6	Petroleum Pump System Operators, Refinery Operators, and Gaugers	34,259	None; reasonable transferability ends with skills comparison	-----	-----
7	Operating Engineers and Other Construction Equipment Operators	30,501	None; reasonable transferability ends with location comparison	560	20,720
8	Industrial Machinery Mechanics	24,025	None; reasonable transferability ends with pay comparison	-----	-----
9	Sales Reps, Wholesale and Mfg., Except Technical and Scientific Products	21,108	None; reasonable transferability ends with education comparison	-----	-----
10	Petroleum Engineers	19,636	None; reasonable transferability ends with skills comparison	-----	-----
11	Control and Valve Installers and Repairers, Except Mechanical Door	18,202	None; reasonable transferability ends with skills comparison	-----	-----
12	First-Line Supervisors of Production and Operating Workers	17,404	None; reasonable transferability ends with location comparison	2,100	4,060
13	Rotary Drill Operators, Oil and Gas	16,295	None; reasonable transferability ends with skills comparison	-----	-----
14	Plumbers, Pipefitters, and Steamfitters	15,930	None; reasonable transferability ends with skills comparison	-----	-----
15	Power Plant Operators	15,484	None; reasonable transferability ends with pay comparison	560	5,740
16	First-Line Supervisors of Mechanics, Installers, and Repairers	14,629	None; reasonable transferability ends with location comparison	1,960 4,060 2,100	18,060 15,120 4,060
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	14,627	None; reasonable transferability ends with location comparison	1,400 4,060 2,240	10,220 8,200+ 5,180
18	Gas Plant Operators	13,375	None; reasonable transferability ends with skills comparison	-----	-----



Technical-Trade Occupations require specialized technical skills obtained either through on-the-job training or postsecondary credentials



Management-Professional Occupations typically require a 2-year or 4-year degree



Sales Occupations refer specifically to sales representatives

It is important to recognize that other, ONG occupations may be transferable from a skills perspective to similar occupations in Clean Energy. For example, many union-based occupations that would fall in the Technical-Trade category provide broad cross-training that would allow electricians, welders, and other workers to function successfully across industries. The issue is job availability—there are typically many more of these jobs available in the ONG industry than the Clean Energy industry—and job overlap, as many of the trades that exist in the ONG industry are not prevalent in the Clean Energy industry (see slide 35).

Additional, qualitative data gathered from numerous interviews with Technical-Trade workers sheds light on another aspect of **job quality**: the degree to which ONG workers may be over-skilled for work in certain Clean Energy sectors.

Oil

Oil requires large, diverse, and skilled teams for initial construction and significant ongoing maintenance. **Given the more complex work, there is a greater need for more experienced journey level workers.**



“If you had [gone] into a refinery, at any job that you're working on, a refinery is different every time you go in. You could be on a coker unit one day, you could be in the SR unit the other day, you could be in the crew unit, but it's all the same refinery. So even though you go to the same place, you're not doing the same job.”
- Electrician

“In refineries there's always new technology in production... And with those [changes] they have to do lots of upgrades to those units.”
- Electrician

Natural Gas

Natural gas also requires large, diverse, and skilled teams for initial construction and significant ongoing maintenance. **Given the more complex work, there is a greater need for more experienced journey level workers.**



“The installation of a natural gas plant puts union members to work for a number of years.”
- Plumber/Pipefitter

Solar

A solar farm is considered one of the lowest-skilled building projects in the energy sector. **Given the relatively less complex work, there is a tendency to use less skilled labor.**



“I would bet that there is no generation plant technology as simple as a solar plant... A wind plant is more complicated, coal fired plants are more complicated, gas plants are more complicated. [A solar farm] is driving posts in the ground, hanging panels on them, stringing together and making the connections and that's it.”
- Industry Expert, Solar Employer

Wind

Wind farms require a smaller workforce to complete a project, regardless of the project size. **Given the relatively less complex work, there is a tendency to use less skilled labor.**



“They'll use 40 guys to build a 200-tower wind farm and [do] maintenance with 6 guys... The maintenance part is very low skill-level based.”
- Electrician

“[Windmills] are pretty much a cookie cutter of each other. It can become repetitive.”
- Electrician

This **job quality** issue of over-skilled workers overlaps with **job availability** gaps that mean **ONG** workers are less likely to work on many Clean Energy projects.

Top 5 Technical-Trade workers that are most likely to work on ONG projects

Technical-Trade Worker Type	Wind	Solar	Oil	Natural Gas
Pipelayer, Plumber, Pipefitter, or Steamfitter (n=276)	14%	20%	74%	79%
Stationary Engineer (n=25)	28%	40%	64%	80%
Operating Engineer (n=156)	28%	46%	67%	72%
Construction Equipment Operator (n=246)	36%	47%	63%	73%
Boilermaker (n=33)	24%	36%	55%	76%


“If fossil fuels [went away], it would definitely impact trades... A lot of the work would dry up if there wasn't any gas or any coal or any oil. It would definitely impact the trade[s] big time.

[There would] be a lot less projects to look for. Solar and wind, they [don't] use very much pipe. So you could pretty much count solar and wind out as me finding a job at a solar or a wind plant where they're building one because they're not going to do much pipe fitting. It'd definitely be harder to find a job if there weren't any fossil fuel plants that were operating.”

- Pipefitter

Top 5 Technical-Trade workers that are most likely to work on Clean Energy projects

Technical-Trade Worker Type	Wind	Solar	Oil	Natural Gas
Solar Photovoltaic Installer (n=79)	34%	91%	29%	43%
Wireman (n=19)	47%	63%	32%	47%
Roofer (n=14)	43%	64%	36%	57%
Electrician (n=177)	33%	66%	47%	50%
Construction Laborer (n=218)	38%	56%	64%	66%

  = 50% or more of tradespeople reported having worked in this industry during their career

In general, wind and solar farms are more likely to require fewer skilled trades workers, from a narrower selection of trades, compared to oil and natural gas construction and maintenance projects.

“The two largest [trades on solar projects] are electricians and the iron workers. Iron workers put the racking up. They will also bolt panels down... [Building a solar farm] is a simple job... It doesn't require a high level of electrical skill and knowledge. Other things—we pour some concrete at the power conversion stations to set the inverters on. We'll have operators to build roads and to grade and to grub vegetation out where it's needed. But those are a lot fewer in number than the iron workers or the electrical workers.”

- Industry Expert, Solar Employer

While occupation transferability from ONG to Clean Energy faces significant barriers, it is also true that **job quality is impacted differently by market conditions in each industry.**

Key Market Conditions Impacting ONG Employment

As oil and gas prices vary, ONG employment tends to ebb and flow.

- For example, after a sustained period of hiring growth, the 2014-16 downturn in oil prices corresponded with approximately 200,000 industry layoffs.¹
- Researchers also point to the cyclical nature of ONG employment, which affects job availability.¹

Global events like the COVID-19 pandemic and geopolitical trends can have outsized impacts on ONG.

- In 2020, the economic impacts of COVID-19 spurred layoffs in the oil, gas, and chemicals industry, as well as widespread furloughs and pay cuts.¹
- Geopolitical actors (like Russia and OPEC+) still exert influence over the industry and global oil prices, though that influence diminishes greatly when the U.S. leads global production.²

International accords can increase demand for certain energy sources.

- Under the International Energy Agency (IEA) Sustainable Development Scenario (SDS), which outlines a major transformation of the global energy system and is fully aligned with the Paris Agreement objectives, oil and natural gas are projected to provide 46 percent of the world's energy by 2040.³

Key Market Conditions Impacting Clean Energy Employment

Renewable energy is the fastest-growing energy source in the United States, and employment trends reflect this growth.

- The Center for Climate and Energy Solutions estimates that renewable sources doubled in the U.S. from 2000 to 2018.⁴
- From 2017 to 2019, clean energy employment growth (6% overall) outpaced growth in the broader energy sector (4.4%).⁵

Clean energy is attracting increased investment and becoming more affordable, driving continued growth.

- The prices of top renewable energy sources have declined substantially over the past decade. For example, global cost declines just in 2018 included⁶:
 - Concentrated Solar Power: -26%
 - Bioenergy: -14%
 - Solar Photovoltaic: -13%
 - Onshore Wind: -13%
 - Hydropower: -12%

Clean Energy represents only a portion of U.S. energy consumption.

- In 2020, petroleum and natural gas accounted for 69% of U.S. energy consumption, whereas renewables and nuclear electric power accounted for 21%.⁷



Question #3

What are the **policy implications** of these findings, particularly when it comes to supporting American workers and a vibrant national economy?

The findings in this study suggest a data-driven, nuanced approach to policies that will impact occupation transferability so that American workers are not shortsightedly disadvantaged.

1

Policy positions that frame occupation transferability from ONG to Clean Energy as highly opportune or easy should be interpreted with caution. In fact, the findings in this study suggest the opposite—that reasonable transferability, at least from the most prevalent ONG occupations to the most in-demand Clean Energy occupations, faces real obstacles across most occupations.

2

Federal and state officials should ground their policymaking in data about the potential (or lack thereof) for occupation transferability. This will align policymaking with the daily realities of American workers, who ultimately must decide whether it is possible and reasonable to transition their careers and livelihoods to a different industry. Data should be evaluated at the state and local levels, as reasonable transferability within occupations can vary from state to state and region to region.

3

Policies designed to facilitate transferability into Clean Energy should focus first on occupations that already demonstrate reasonable pathways for American workers. This is the most realistic starting-point for expanding career opportunities for workers and supporting a vibrant economy. It will also help avoid policies grounded in unrealistic transferability expectations that would disadvantage workers in the ONG industry. Ultimately, policies should avoid picking winners and losers, and instead allow the market to work and produce sustainable results.

Appendix A: Occupation Summaries by Industry

ONG Occupation Descriptions

ONG Occupations		BLS Occupation Descriptions
1	General and Operations Managers	Plan, direct, or coordinate the operations of public or private sector organizations, overseeing multiple departments or locations.
2	Construction Laborers	Construction laborers and helpers perform many tasks that require physical labor on construction sites.
3	Roustabouts, Oil and Gas	Assemble or repair oil field equipment using hand and power tools. Perform other tasks as needed.
4	Service Unit Operators, Oil and Gas	Operate equipment to increase oil flow from producing wells or to remove stuck pipe, casing, tools, or other obstructions from drilling wells. Includes fishing-tool technicians.
5	First-Line Supervisors of Construction Trades and Extraction Workers	Directly supervise and coordinate activities of construction or extraction workers.
6	Petroleum Pump System Operators, Refinery Operators, and Gaugers	Operate or control petroleum refining or processing units. May specialize in controlling manifold and pumping systems, gauging or testing oil in storage tanks, or regulating the flow of oil into pipelines.
7	Operating Engineers and Other Construction Equipment Operators	Operate one or several types of power construction equipment, such as motor graders, bulldozers, scrapers, compressors, pumps, derricks, shovels, tractors, or front-end loaders to excavate, move, and grade earth, erect structures, or pour concrete or other hard surface pavement. May repair and maintain equipment in addition to other duties.
8	Industrial Machinery Mechanics	Repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems. May also install, dismantle, or move machinery and heavy equipment according to plans.
9	Sales Reps, Wholesale and Mfg., Except Technical and Scientific Products	Sell goods for wholesalers or manufacturers to businesses or groups of individuals. Work requires substantial knowledge of items sold.
10	Petroleum Engineers	Devise methods to improve oil and gas extraction and production and determine the need for new or modified tool designs. Oversee drilling and offer technical advice.
11	Control and Valve Installers and Repairers, Except Mechanical Door	Install, repair, and maintain mechanical regulating and controlling devices, such as electric meters, gas regulators, thermostats, safety and flow valves, and other mechanical governors.
12	First-Line Supervisors of Production and Operating Workers	Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators. Excludes team or work leaders.
13	Rotary Drill Operators, Oil and Gas	Set up or operate a variety of drills to remove underground oil and gas, or remove core samples for testing during oil and gas exploration.
14	Plumbers, Pipefitters, and Steamfitters	Plumbers, pipefitters, and steamfitters install and repair piping fixtures and systems.
15	Power Plant Operators	Control, operate, or maintain machinery to generate electric power. Includes auxiliary equipment operators.
16	First-Line Supervisors of Mechanics, Installers, and Repairers	Directly supervise and coordinate the activities of mechanics, installers, and repairers. Excludes team or work leaders.
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	This occupation includes the 2018 SOC occupations 13-1082 Project Management Specialists and 13-1199 Business Operations Specialists, All Other and the 2010 SOC occupation 13-1199 Business Operations Specialists, All Other.
18	Gas Plant Operators	Distribute or process gas for utility companies and others by controlling compressors to maintain specified pressures on main pipelines.

Summary of ONG Occupations (1/2)

	Occupation	Avg. Annual Employment (2017-20)	Typical Education Required	Mean Hourly Earnings	Top Regions By Job Demand Concentration
1	General and Operations Managers	50,069	Bachelor's degree	\$51.56	Midwest – 28%, Southeast – 28%, Southwest – 18%
2	Construction Laborers	46,684	No formal educational credential	\$21.28	Midwest – 31%, Southeast – 22%, Southwest – 19%
3	Roustabouts, Oil and Gas	44,763	No formal educational credential	No occupations were compared on this criteria	--
4	Service Unit Operators, Oil and Gas	40,901	No formal educational credential	No occupations were compared on this criteria	--
5	First-Line Supervisors of Construction Trades and Extraction Workers	38,975	High school diploma or equivalent	\$36.08	Southwest – 37%, Midwest – 19%, Southeast – 14%
6	Petroleum Pump System Operators, Refinery Operators, and Gaugers	34,259	High school diploma or equivalent	No occupations were compared on this criteria	--
7	Operating Engineers and Other Construction Equipment Operators	30,501	High school diploma or equivalent	\$27.92	Midwest – 33%, Southwest – 24%, Southeast – 15%
8	Industrial Machinery Mechanics	24,025	High school diploma or equivalent	\$31.25	No occupations were compared on this criteria
9	Sales Reps, Wholesale and Mfg., Except Technical and Scientific Products	21,108	High school diploma or equivalent	No occupations were compared on this criteria	--
10	Petroleum Engineers	19,636	High school diploma or equivalent	No occupations were compared on this criteria	--
11	Control and Valve Installers and Repairers, Except Mechanical Door	18,202	High school diploma or equivalent	\$28.79	--
12	First-Line Supervisors of Production and Operating Workers	17,404	High school diploma or equivalent	\$43.05	Southwest – 32%, Midwest – 24%, Southeast – 16%

Summary of ONG Occupations (1/2)

Occupation		Avg. Annual Employment (2017-20)	Typical Education Required	Mean Hourly Earnings	Top Regions By Job Demand Concentration
13	Rotary Drill Operators, Oil and Gas	16,295	No formal educational credential	No occupations were compared on this criteria	--
14	Plumbers, Pipefitters, and Steamfitters	15,930	High school diploma or equivalent	No occupations were compared on this criteria	--
15	Power Plant Operators	15,484	High school diploma or equivalent	\$49.87	No occupations were compared on this criteria
16	First-Line Supervisors of Mechanics, Installers, and Repairers	14,629	High school diploma or equivalent	\$39.14	Midwest – 31%, Southwest – 25%, Southeast – 18%
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	14,627	Bachelor's degree	\$43.05	Southwest – 39%, Midwest – 22%, Southeast – 11%
18	Gas Plant Operators	13,375	High school diploma or equivalent	No occupations were compared on this criteria	--

Summary of Top Skills Required by ONG Occupation (1/2)

Occupation		Top Skills
1	General and Operations Managers	Operations, Sales, Management ,Customer Service Leadership, Training And Development, Communications, Profit And Loss (P&L) Management Valid Driver's, License, Food Services, Accounting, Retail Sales, Computer Literacy Microsoft Outlook, Merchandising, Presentations, Restaurant Operation, Microsoft Excel, Operations Management, Safety Training
2	Construction Laborers	Valid Driver's License, Construction, Commercial Driver's License (CDL), Excavation, Communications, Loading And Unloading, Good Driving Record, Coordinating, CDL Class B License, Cured-In-Place Pipe, Rehabilitation, Heavy Equipment, Power Tool Operation, Management, Stormwater, Customer Service, Trenching, Leadership, Safety Training, Willingness To Learn
3	Roustabouts, Oil and Gas	Oil And Gas, Operations, Pumps, Drilling Rig, Hydrogen Sulfide (H2S) Training, Personal Protective Equipment, Oil Fields, Hydraulics, Problem Solving, Organizational Skills, Good Driving Record, Valid Driver's License, Mental Concentration, Communications, Heavy Equipment, Drilling, Pipe (Fluid Conveyance), Mud Systems, Diesel Engines, Solvent
4	Service Unit Operators, Oil and Gas	Operations, Basic Math, Communications, Valid Driver's License, Environment Health And Safety, Oil And Gas, Commercial Driver's License (CDL), Computer Literacy, Good Driving Record, Production Equipment, Oil Fields, Quality Improvement, Personal Protective Equipment, Management, Well Control, Troubleshooting (Problem Solving), Pumps, Valves (Piping), Hydrogen Sulfide (H2S) Training, Mental Concentration
5	First-Line Supervisors of Construction Trades and Extraction Workers	Valid Driver's License, Operations, Communications, Construction, Leadership, Management, Good Driving Record, Coordinating, Planning, Computer Literacy, Detail Oriented, Commercial Driver's License (CDL), Personal Protective Equipment, Occupational Safety and Health Administration (OSHA), Scheduling, Interpersonal Communications, Basic Math, Problem Solving, Subcontracting, Customer Service
6	Petroleum Pump System Operators, Refinery Operators, and Gaugers	Refinery, Operations, Valid Driver's License, Personal Protective Equipment, Communications, Troubleshooting (Problem Solving), Oil And Gas, Basic Math, Valves (Piping), Transportation Worker Identification Credential (TWIC) Card, Computer Literacy, Refining, Firefighting, Petrochemical, Scheduling, Problem Solving, Punctuality, Teamwork, Breathing Apparatuses, Occupational Safety and Health Administration (OSHA)
7	Operating Engineers and Other Construction Equipment Operators	Valid Driver's License, Commercial Driver's License (CDL), Good Driving Record, Heavy Equipment, Excavation, Construction, Loading And Unloading, Coordinating, Dozer, Operations, Leadership, Skid Steer Loaders, Communications, Sawing, Tanker Endorsement, Personal Protective Equipment, Trenching, Grading (Landscape), Management, Natural Gas Pipelines
8	Industrial Machinery Mechanics	Troubleshooting (Problem Solving), Mechanics, Valid Driver's License, Operations, Pumps, Communications, Computer Literacy, Oil And Gas, Hydraulics, Valves (Piping), Basic Math, Personal Protective Equipment, Good Driving Record, Field Service Management, Mechanical Aptitude, Preventive Maintenance, Refinery, Customer Service, Management, Welding
9	Sales Reps, Wholesale and Mfg., Except Technical and Scientific Products	Sales, Communications, Customer Service, Management, Self-Motivation, Selling Techniques, Customer Relationship Management, Presentations, Valid Driver's License, Business To Business, Sales Territory, Interpersonal Communications, Cold Calling, Microsoft Office, Operations, Detail Oriented, Business Development, Time Management, Microsoft Excel, Verbal Communication Skills
10	Petroleum Engineers	Operations, Oil And Gas, Management, Communications, Planning, Good Driving Record, Troubleshooting (Problem Solving), Geology, Reservoir Engineering, Drilling, Industrial Engineering, Petroleum Engineering, Valid Driver's License, Accounting, Oil Rig, Problem Solving, Scheduling, Mechanical Engineering, Microsoft Office, Sales

Summary of Top Skills Required by ONG Occupation (2/2)

Occupation		Top Skills
11	Control and Valve Installers and Repairers, Except Mechanical Door	Valid Driver's License, Gas Meter Systems, Communications, Troubleshooting (Problem Solving), Computer Literacy, Operations, Mechanical Aptitude, Electronics, Valves (Piping), Customer Service, Microsoft Excel, Self-Motivation, Control Valves, Microsoft Office, Application Programming Interface (API), Compressor Station, Computer Networks, Mechanics, Plumbing, Basic Math
12	First-Line Supervisors of Production and Operating Workers	Operations, Communications, Management, Leadership, Valid Driver's License, Planning, Coordinating, Customer Service, Scheduling, Auditing, Microsoft Office, Microsoft Excel, Oil And Gas, Interpersonal Communications, Personal Protective Equipment, Problem Solving, Computer Literacy, Troubleshooting (Problem Solving), Quality Control, Written Communication
13	Rotary Drill Operators, Oil and Gas	Operations, Oil And Gas, Personal Protective Equipment, Drilling Rig, Problem Solving, Pumps, Organizational Skills, Power Tool Operation, Written Communication, Hydraulics, Oil Fields, Spooling, Hydrogen Sulfide (H2S) Training, Good Driving Record, Mental Concentration, Service Industries, Commercial Driver's License (CDL), Communications, Valid Driver's License, Drilling
14	Plumbers, Pipefitters, and Steamfitters	Plumbing, Valid Driver's License, Communications, Detail Oriented, Customer Service, Water Distribution, Good Driving Record, HVAC, Pipe (Fluid Conveyance), Valves (Piping), Pumps, Troubleshooting (Problem Solving), Heating Systems, Infrastructure, Interpersonal Communications, Sales, Construction, Wastewater, Coordinating, Sanitation
15	Power Plant Operators	Operations, Valid Driver's License, Communications, Turbines, Troubleshooting (Problem Solving), Oil And Gas, Control Systems, Written Communication, Computer Literacy, Pumps, Valves (Piping), High Voltage, Management, Mechanics, Electrical Equipment, Mechanical Aptitude, Leadership, Problem Solving, Self-Motivation, Corrective And Preventive Action (CAPA)
16	First-Line Supervisors of Mechanics, Installers, and Repairers	Management, Operations, Customer Service, Oil and Gas, Leadership, Valid Driver's License, Communications, Sales, Troubleshooting (Problem Solving), Basic Math, Planning, Verbal Communication Skills, Environment Health and Safety, Scheduling, Microsoft Excel, Computer Literacy, Mechanics, Coordinating, HVAC, Microsoft Outlook
17	Project Mgmt. Specialists and Business Operations Specialists, All Other	Operations, Communications, Management, Sales, Microsoft Office, Microsoft Excel, Leadership, Detail Oriented, Presentations, Planning, Interpersonal Communications, Customer Service, Negotiation, Problem Solving, Auditing, Accounting, Coordinating, Microsoft- PowerPoint , Research, Written Communication
18	Gas Plant Operators	Operations, Supervisory Control And Data Acquisition (SCADA), Pumps, Valid Driver's License, Fractionation, Valves (Piping), Microsoft Excel, Amine Gas Treating, Communications, Mechanical Aptitude, Microsoft Outlook, Personal Protective Equipment, Stress Management, Emergency Shutdown, Lock Out / Tag Out, Construction, Energy Isolation, Verbal Communication Skills, Quality Assurance, Organizational Skills

Clean Energy Occupation Descriptions

Clean Energy Occupations	BLS Occupation Descriptions
1 Electrical Engineers	Research, design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use. Excludes "Computer Hardware Engineers" (17-2061).
2 First-Line Supervisors of Mechanics, Installers, and Repairers	Directly supervise and coordinate the activities of mechanics, installers, and repairers.
3 Computer Occupations, All Other	All computer occupations not listed separately. Excludes "Computer and Information Systems Managers" (11-3021), "Computer Hardware Engineers" (17-2061), "Electrical and Electronics Engineers" (17-2070), "Computer Science Teachers, Postsecondary" (25-1021), "Multimedia Artists and Animators" (27-1014), "Graphic Designers" (27-1024), "Computer Operators" (43-9011), and "Computer, Automated Teller, and Office Machine Repairs" (49-2011).
4 Industrial Engineers	Industrial engineers devise efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service.
5 Maintenance and Repair Workers, General	Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of a building in repair. Duties may involve pipe fitting; HVAC maintenance; insulating; welding; machining; carpentry; repairing electrical or mechanical equipment; installing, aligning, and balancing new equipment; and repairing buildings, floors, or stairs.
6 Mechanical Engineers	Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices.
7 Sales Reps, Wholesale and Mfg., Technical and Scientific Products	Sell goods for wholesalers or manufacturers where technical or scientific knowledge is required in such areas as biology, engineering, chemistry, and electronics, normally obtained from at least 2 years of postsecondary education.
8 Solar Photovoltaic Installers	Solar photovoltaic (PV) installers assemble, set up, and maintain rooftop or other systems that convert sunlight into energy.
9 Project Mgmt. Specialists and Business Ops. Specialists, All Other	This occupation includes the 2018 SOC occupations 13-1082 Project Management Specialists and 13-1199 Business Operations Specialists, All Other and the 2010 SOC occupation 13-1199 Business Operations Specialists, All Other.
10 First-Line Supervisors of Production and Operating Workers	Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators.
11 First-Line Supvr. of Construction Trades and Extraction Workers	Directly supervise and coordinate activities of construction or extraction workers.
12 Wind Turbine Service Technicians	Wind turbine service technicians install, maintain, and repair wind turbines.
13 Construction Managers	Construction managers plan, coordinate, budget, and supervise construction projects from start to finish.
14 Electricians	Electricians install, maintain, and repair electrical power, communications, lighting, and control systems.
15 General and Operations Managers	Plan, direct, or coordinate the operations of public or private sector organizations, overseeing multiple departments or locations.
16 Construction Laborers	Construction laborers and helpers perform many tasks that require physical labor on construction sites.
17 Power Plant Operators	Control, operate, or maintain machinery to generate electric power. Includes auxiliary equipment operators.
18 Operating Engineers and Other Construction Equip. Operators	Operate one or several types of power construction equipment, such as motor graders, bulldozers, scrapers, compressors, pumps, derricks, shovels, tractors, or front-end loaders to excavate, move, and grade earth, erect structures, or pour concrete or other hard surface pavement. May repair and maintain equipment in addition to other duties.

Summary of Clean Energy Occupations (1/3)

State Totals represent the full sum whereas state percentages shown are truncated figures

	Occupation	Avg. Annual Job Postings (2017-20)	Avg. Annual Employment (2017-20)	Typical Education Required	Mean Hourly Earnings	Concentration of Job Demand in Top 3 Regions for a Given ONG Occupation
1	Electrical Engineers	5,320	11,400+	Bachelor's degree	No occupations were compared on this criteria	--
2	First-Line Supervisors of Mechanics, Installers, and Repairers	4,060	15,120	High school diploma or equivalent	\$37.52	Southwest – 9%, Midwest – 24%, Southeast – 21%*
2	First-Line Supervisors of Mechanics, Installers, and Repairers	4,060	15,120	High school diploma or equivalent	\$37.52	Southwest – 9%, Midwest – 24%, Southeast – 21%**
2	First-Line Supervisors of Mechanics, Installers, and Repairers	4,060	15,120	High school diploma or equivalent	\$37.52	Midwest – 24%, Southwest – 9%, Southeast – 21%***
3	Computer Occupations, All Other	4,060	8,700+	Bachelor's degree	No occupations were compared on this criteria	--
4	Industrial Engineers	4,060	8,700+	No occupations were compared on this criteria	--	--
5	Maintenance and Repair Workers, General	3,780	8,100+	High school diploma or equivalent	--	--
6	Mechanical Engineers	3,780	8,100+	Bachelor's degree	No occupations were compared on this criteria	--
7	Sales Reps, Wholesale and Mfg., Technical and Scientific Products	2,800	10,000	Bachelor's degree	No occupations were compared on this criteria	--
8	Solar Photovoltaic Installers	2,520	12,000	High school diploma or equivalent	No occupations were compared on this criteria	--
9	Project Mgmt. Specialists and Business Ops. Specialists, All Other	2,240	5,180	Bachelor's degree	\$41.48	Southwest – 10%, Midwest – 24%, Southeast – 15%
10	First-Line Supervisors of Production and Operating Workers	2,100	4,060	High school diploma or equivalent	\$50.11	Southwest – 9%, Midwest – 27%, Southeast – 25%*
11	First-Line Supvr. of Construction Trades and Extraction Workers	1,960	18,060	High school diploma or equivalent	\$37.53	Southwest – 12%, Midwest – 23%, Southeast – 26%*
11	First-Line Supvr. of Construction Trades and Extraction Workers	1,960	18,060	High school diploma or equivalent	\$37.53	Southwest – 12%, Midwest – 23%, Southeast – 26%**
11	First-Line Supvr. of Construction Trades and Extraction Workers	1,960	18,060	High school diploma or equivalent	\$37.53	Midwest – 23%, Southwest – 12%, Southeast – 26%***

Summary of Clean Energy Occupations (3/3)

State Totals represent the full sum whereas state percentages shown are truncated figures

	Occupation	Avg. Annual Job Postings (2017-20)	Avg. Annual Employment (2017-20)	Typical Education Required	Mean Hourly Earnings	Concentration of Job Demand in Top 3 Regions for a Given ONG Occupation
12	Wind Turbine Service Technicians	1,960	7,000	Postsecondary nondegree award	No occupations were compared on this criteria	--
13	Construction Managers	1,680	10,780	Bachelor's degree	No occupations were compared on this criteria	--
14	Electricians	1,540	13,300	High school diploma or equivalent	No occupations were compared on this criteria	--
15	General and Operations Managers	1,400	10,220	Bachelor's degree	\$60.77	Midwest – 25%, Southeast – 15%, Southwest – 14%*
15	General and Operations Managers	1,400	10,220	Bachelor's degree	\$60.77	Southwest – 14%, Midwest – 22%, Southeast – 11%**
16	Construction Laborers	1,260	45,500	No formal educational credential	\$20.36	Midwest – 23%, Southeast – 32%, Southwest – 13%
17	Power Plant Operators	560	5,740	High school diploma or equivalent	\$38.04	No occupations were compared on this criteria
18	Operating Engineers and Other Construction Equip. Operators	560	20,720	High school diploma or equivalent	\$28.10	Midwest – 15%, Southwest – 13%, Southeast – 34%

Summary of Top Skills Required by Clean Energy Occupation (1/2)

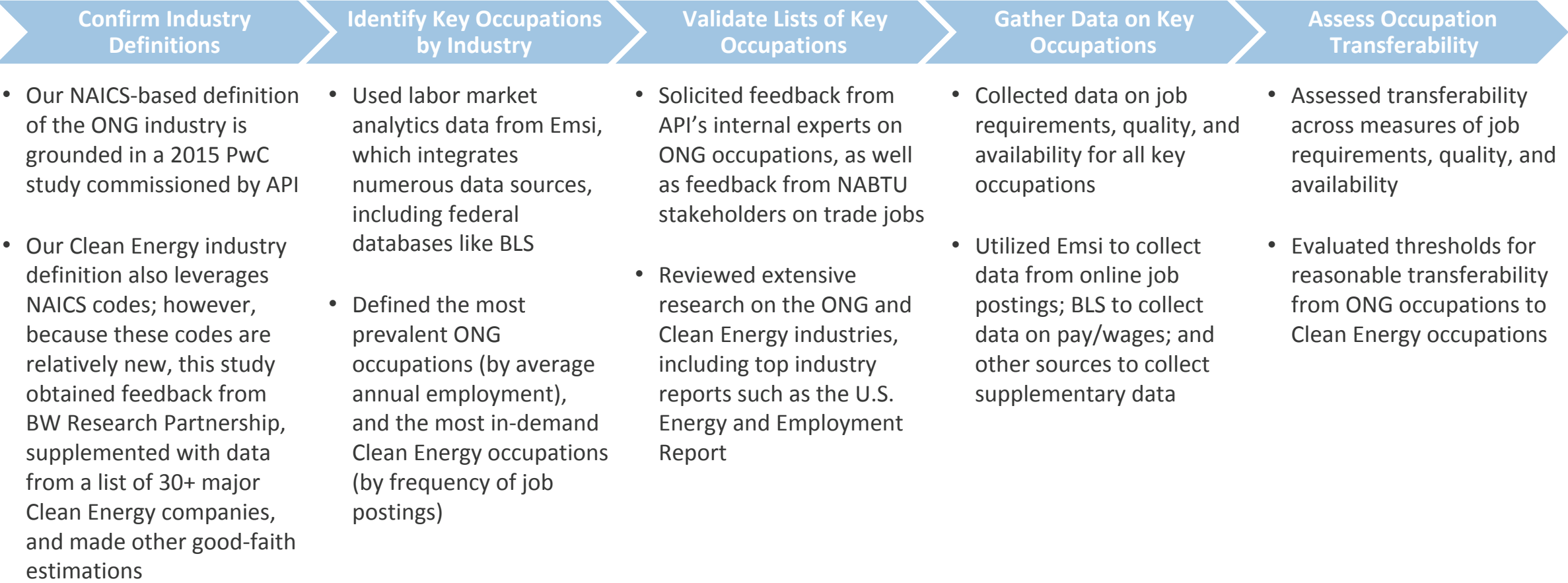
Occupation	Top Skills
1 Electrical Engineers	Electrical Engineering, Planning, Operations, Communications, Management, Leadership, Problem Solving, Electric Power Systems, Coordinating, Interpersonal Communications, Project Management, Valid Driver's License, Verbal Communication Skills, Teamwork, Electric Power Distribution, Licensed Professional Engineer, Professional Engineer, Innovation, Microsoft Office, Engineering Design Process
2 First-Line Supervisors of Mechanics, Installers, and Repairers	Troubleshooting (Problem Solving), Valid Driver's License, Transformers (Electrical), Communications, Electrical Equipment, Operations, Electrical Wiring, Personal Protective Equipment, Customer Service, Circuit Switches, Electrical Substation, High Voltage, Electrical Systems, Voltage, Relays, Circuit Breakers, Wiring Diagram, Construction, Planning, Power Tool Operation
3 Computer Occupations, All Other	Management, Communications, Leadership, Project Management, Planning, Operations, Computer Science, Presentations, Infrastructure, Agile Methodology, Project Management Professional Certification, Innovation, Information Technology, Budgeting, Problem Solving, Governance, Coordinating, Teamwork, Integration, Written Communication
4 Industrial Engineers	Operations, Communications, Management, Planning, Problem Solving, Leadership, Auditing, Microsoft Office, Troubleshooting (Problem Solving), Written Communication, Reliability, Interpersonal Communications, Project Management, Electrical Engineering, Investigation, Presentations, Corrective And Preventive Action (CAPA), Quality Control, Microsoft Excel, Valid Driver's License
5 Maintenance and Repair Workers, General	Valid Driver's License, Operations, Troubleshooting (Problem Solving), Mechanics, Communications, Personal Protective Equipment, Management, Power Tool Operation, Construction, Commercial Driver's License (CDL), Computer Literacy, Plumbing, Pumps, Basic Math, Preventive Maintenance, Valves (Piping), Mechanical Aptitude, HVAC, Turbines, Carpentry
6 Mechanical Engineers	Operations, Communications, Planning, Management, Problem Solving, Mechanical Engineering, Leadership, Professional Engineer, Troubleshooting (Problem Solving), Coordinating, Valid Driver's License, Project Management, Presentations, Interpersonal Communications, Verbal Communication Skills, Microsoft Excel, Licensed Professional Engineer, Mechanical Systems, Written Communication, Reliability
7 Sales Reps, Wholesale and Mfg., Technical and Scientific Products	Sales, Communications, Customer Service, Management, Self-Motivation, Selling Techniques, Customer Relationship Management, Presentations, Valid Driver's License, Business To Business, Sales Territory, Interpersonal Communications, Cold Calling, Microsoft Office, Operations, Detail Oriented, Business Development, Time Management, Microsoft Excel, Verbal Communication Skills
8 Solar Photovoltaic Installers	Communications, Roofing, Construction, Valid Driver's License, Operations, Electrical Wiring, Power Tool Operation, Electrical Equipment, Management, Troubleshooting (Problem Solving), Customer Experience, Lumber, Roofing Materials, Carpentry, Teamwork, Customer Service, Problem Solving, Detail Oriented, Solar Systems, Verbal Communication Skills
9 Project Mgmt. Specialists and Business Ops. Specialists, All Other	Communications, Management, Operations, Leadership, Planning, Microsoft Excel, Problem Solving, Coordinating, Customer Service, Presentations, Written Communication, Project Management, Microsoft PowerPoint, Research, Auditing, Innovation, Construction, Valid Driver's License, Influencing Skills, Negotiation
10 First-Line Supervisors of Production and Operating Workers	Operations, Leadership, Communications, Management, Planning, Valid Driver's License, Coordinating, Scheduling, Problem Solving, Customer Service, Construction, Microsoft Excel, Troubleshooting (Problem Solving), Microsoft Office, Written Communication, Distributed Computing, Computer Literacy, Corrective And Preventive Action (CAPA), Teamwork, Decision Making

Summary of Top Skills Required by Clean Energy Occupation (2/2)

Occupation		Top Skills
11	First-Line Supvr. of Construction Trades and Extraction Workers	Communications, Construction, Valid Driver's License, Operations, Planning, Leadership, Management, Coordinating, Telecommunications, Scheduling, Customer Service, Commercial Driver's License (CDL), Troubleshooting (Problem Solving), Teamwork, Problem Solving, Good Driving Record, Microsoft Office, Occupational Safety and Health Administration (OSHA), Subcontracting, Construction Management- H Electric Power Distribution
12	Wind Turbine Service Technicians	Turbines, Valid Driver's License, Wind Turbine, Troubleshooting (Problem Solving), Operations, Torque (Physics), Power Tool Operation, Lock Out / Tag Out, Voltage, High Voltage, Wind Farming, Management, Personal Protective Equipment, Communications, Hydraulics, Commercial Driver's License (CDL), Written Communication, Environment Health And Safety, Oscilloscope, Microsoft Office
13	Construction Managers	Construction, Management, Communications, Construction Management, Leadership, Operations, Project Management, Coordinating, Planning, Scheduling, Subcontracting, Microsoft Office, Project Schedules, Contract Management, Procurement, Interpersonal Communications, Microsoft Excel, Budgeting, Infrastructure, Valid Driver's License
14	Electricians	Troubleshooting (Problem Solving), Valid Driver's License, Transformers (Electrical), Communications, Electrical Equipment, Operations, Electrical Wiring, Personal Protective Equipment, Customer Service, Circuit Switches, Electrical Substation, High Voltage, Electrical Systems, Voltage, Relays, Circuit Breakers, Wiring Diagram, Construction, Planning, Power Tool Operation
15	General and Operations Managers	Operations, Management, Leadership, Communications, Planning, Customer Service, Operations Management, Budgeting, Sales, Problem Solving, Innovation, Influencing Skills, Coordinating, Presentations, Accounting, Strategic Planning, Microsoft Excel, Negotiation, Scheduling, Customer Satisfaction
16	Construction Laborers	Construction, Valid Driver's License, Commercial Driver's License (CDL), Loading And Unloading, Heavy Equipment, Communications, Telecommunications, Excavation, Coordinating, Power Tool Operation, Good Driving Record, Balancing (Ledger/Billing), Management, Detail Oriented, Mechanical Tools, Operations, Physical Stamina, Trenching, Incident Reporting, Requirements Management,
17	Power Plant Operators	Operations, Turbines, Valid Driver's License, Troubleshooting (Problem Solving), Boilers, Communications, Pumps, Valves (Piping), Management, Electrical Equipment, Combustion Turbines, Computer Literacy, Written Communication, Water Chemistry Analysis, Corrective And Preventive Action (CAPA), Control Systems, Instrumentation, Chemistry, High Voltage, Steam Turbine
18	Operating Engineers and Other Construction Equip. Operators	Valid Driver's License, Commercial Driver's License (CDL), Good Driving Record, Heavy Equipment, Excavation, Construction, Loading And Unloading, Coordinating, Dozer, Operations, Leadership, Skid Steer Loaders, Communications, Sawing, Tanker Endorsement, Personal Protective Equipment, Trenching, Grading (Landscape), Management, Natural Gas Pipelines

Appendix B: Research Methodology

The methodology for this study spanned five phases. Each of these phases is explained in more detail on subsequent slides.



This study was commissioned by the [American Petroleum Institute](#) (API) and [North America Building Trades Unions](#) (NABTU). API and NABTU engaged [Cicero Group](#), a research and management consulting firm, to conduct the study using data from [Emsi](#), a leading labor analytics firm, and other labor data sources.

Definition of the Oil and Natural Gas (ONG) Industry

In order to obtain occupations data from Emsi and other sources, this study utilized API's standard NAICS-based definition of the ONG industry (see Figure 1). These NAICS codes encompass the upstream, midstream, and downstream sectors of the ONG industry. In addition to this standard definition, we also incorporated NAICS code 221112 which captures occupations related to "Fossil Fuel Electric Power Generation." And we manually removed occupations corresponding to gas station-related occupations in order to adhere more strictly to the downstream bounds of the industry (and because Clean Energy has no distribution channel analogous to gas stations).

Definition of the Clean Energy Industry

Because today's Clean Energy industry is comparatively young and a standard NAICS-based industry definition is more difficult to pinpoint, this study utilized the following set of NAICS codes to encompass the key sectors of the industry:

- 221111: Hydroelectric Power Generation
- 221113: Nuclear Electric Power Generation
- 221114: Solar Electric Power Generation
- 221115: Wind Power Generation
- 221116: Geothermal Power Generation
- 221117: Biomass Power Generation
- 221118: Other Electric Power Generation (which focuses on [tidal energy](#))
- 237130: Power and Communication Line and Related Structures Construction (which includes [alternative energy structure construction for key sectors](#))
- 238210: Electrical Contractors and Other Wiring Installation Contractors (which includes [solar installers](#))

The US natural gas and oil industry encompasses multiple activities that span separate industry classifications in government economic data. Oil and natural gas exploration and production is included in the mining sector; oil refining is part of the manufacturing sector; pipeline operations are included in the transportation sector; natural gas distribution is in the utilities sector; and oil marketing is considered part of the wholesale and retail trade sector. For this study, PwC has defined the natural gas and oil industry to include all of these activities.

Table 1, below, shows the composition of the industry as defined by PwC, followed by detailed descriptions based on the *North American Industry Classification System* ("NAICS").

Table 1.- Composition of the US Natural Gas and Oil Industry

NAICS	IMPLAN Sector	Description
211**	20	Oil and gas extraction (including NGL extraction)
213111**	35	Drilling oil and gas wells
213112**	36	Support activities for oil and gas operations
2212	48, 528*	Natural gas distribution (private and public)
23712	56*	Oil and gas pipeline and related structures construction
32411	154	Petroleum refineries
32412	155, 156	Asphalt paving, roofing and saturated materials manufacturing
324191	157	Petroleum lubricating oil and grease manufacturing
4247	399	Petroleum and petroleum products merchant wholesalers
44711, 44719	408	Gasoline stations
45431	413*	Fuel dealers
486	419	Pipeline transportation

* IMPLAN sectors 56, 413 and 528 include additional NAICS activities outside the US natural gas and oil industry. Modeling of the economic impacts includes only the portion of these sectors that include the natural gas and oil industry's NAICS segments.

** Indicates the upstream subsector of the natural gas and oil industry.

Figure 1: NAICS-based industry definition for ONG used by API (from its report on 'Impacts of the Oil and Natural Gas Industry on the US Economy in 2015')

Definition of the Clean Energy Industry (Cont'd)

See below for rationale on utilizing certain NAICS codes to define the Clean Energy industry:

- 221113: Nuclear Electric Power Generation
 - While industry experts and researchers may debate the inclusion of nuclear energy under the 'Clean Energy' industry umbrella, nuclear is widely recognized as a zero-carbon energy source. And from a policy perspective, the Biden Administration American Jobs Plan makes several references to nuclear power. As such, we consider nuclear energy to be within the scope of this study.
- 237130: Power and Communication Line and Related Structures Construction (which includes [alternative energy structure construction for key sectors](#))
 - Knowing this code could introduce non-Clean Energy jobs into our analysis, we first gathered data from Emsi on the top occupations (by annual employment) for this code by itself. From that data pull, we identified occupations that were not relevant to Clean Energy and removed them as out-of-scope occupations. One important exception was Construction Laborers—although some portion of this occupation may derive from power and communication line construction instead of alternative energy structure construction, there is no reliable way to differentiate these two types of work and so we opted to include all instances of Construction Laborers from this code.
- 238210: Electrical Contractors and Other Wiring Installation Contractors (which includes [solar panel installers](#))
 - An important occupation from this code relevant to Clean Energy is Solar Photovoltaic Installers (which is included in the final list of Clean Energy occupations analyzed in this study). To gather data on this occupation, we included code 238210 in our industry definition and captured the total number of solar photovoltaic installers within the industry. No other occupations from this code were included in our final list of occupations for Clean Energy.
- Also note that we intentionally did not include NAICS code 333611 (Turbine and Turbine Generator Set Units Manufacturing) because manufacturing is a separate industry unto itself.

Methodology for Identifying Key Occupations by Industry

We first gathered high-level occupations data for the ONG and Clean Energy industries using the following steps:

- 1) Using the NAICS-based industry definitions mentioned previously, we worked with Emsi to identify the 50 most prevalent occupations (by employment) for both ONG and Clean Energy. Emsi provided employment data for these occupations over a 4-year period (2017 through 2020).
- 2) For each occupation, we calculated a 4-year average annual employment figure, allowing us to rank-order the occupations by prevalence in each industry.
- 3) From these rank-ordered lists, we then removed occupations considered out-of-scope for the purposes of this study (i.e., understanding occupation transferability from ONG to Clean Energy). These included occupations not directly related to the relevant industries and/or outside of the upper and lower bounds of our industry definitions (upper bounds refer to activities that lead into an industry, such as supply chain or manufacturing; lower bounds refer to activities that lead out of an industry, such as installing electric power lines from power plants to homes). A list of these jobs and a high-level analysis of transferability implications is contained on p.11-12.
- 4) We also categorized another set of occupations as “special-category” that were technically in-scope for this study, but for various reasons were not as useful for conducting an in-depth analysis on transferability. These occupations are discussed on p.13-14.

Then, in order to narrow down further to a final set of key occupations for analysis, we used the following approaches by industry:

- For the ONG industry, we narrowed the list of occupations to those with the highest average annual employment. This allowed our analysis to focus on occupations that employ the most significant numbers of American workers. We originally intended to evaluate only the top 10 most prevalent occupations, but in evaluating the list of ONG occupations felt it would be considerably more useful to analyze an additional eight occupations.
- For the Clean Energy industry, we narrowed the list of occupations to those with the highest average job demand. This allowed our analysis to understand the potential transferability pathways for American workers from the most prevalent ONG occupations to the most in-demand Clean Energy occupations. We had originally intended to evaluate only the top 10 most in-demand occupations, but expanded our analysis alongside the list of ONG occupations.
- Additional details on how we finalized the list of the most in-demand Clean Energy occupations are contained on p.57-60.

Methodology for Identifying Key Occupations by Industry (Cont'd)

To finalize the list of the most in-demand Clean Energy occupations, we evaluated occupations using three main criteria:

- **Job Demand:** Using Emsi's Job Posting Analytics (JPA) database, we gathered data on occupations based on job postings from numerous online sources over a 4-year span (2017 through 2020). These data tracked the total number of unique (de-duplicated) online job postings for a given occupation in a given month. For each occupation, we calculated the average monthly number of unique job postings (which provides a measure of average monthly job demand). We also calculated the total number of monthly job postings for each occupation—while this measure did not allow us to de-duplicate across months (e.g., a job posting could be counted more than once if it was active for more than one month), we used it as a directional, relative measure of demand across occupations. Both of these measures helped us arrive at a rank-ordered list of Clean Energy occupations based on job demand, which we used to help narrow to a final list of occupations. To supplement these measures, we also gathered job demand data based on a sample of 30+ major Clean Energy companies (see Figure 2 on p.59), which allowed us to further pressure-test our list of occupations on a company basis rather than solely a NAICS code basis.
 - Also of note—after the list of occupations was finalized, we were able to gather data on the number of average *annual* unique job postings using Emsi's database. These numbers are used in the body of the report. They differ slightly in nature from our other measures of job demand because they are de-duplicated within a given year and are based on a slightly different measure of when job postings are considered active. However, they provide an accurate and more intuitive measure of job demand across Clean Energy occupations. And, because highly accurate measures of occupation-related data are still emerging in the Clean Energy industry, we made good-faith efforts to refine our job demand estimates. Specifically, we increased our absolute estimates of average *annual* job postings (for the final list of occupations) by using a “job postings multiplier” derived from comparing average monthly job postings based on NAICS codes to average monthly job postings based on our sample of major Clean Energy companies. In cases where the company-based average was higher than the NAICS-based average, we calculated the multiplier and applied it to the number of average *annual* job postings for a given occupation. For all occupations, we discounted this multiplier by 50% to account for some degree of statistical noise from companies that would also employ those occupations in work outside the scope of this study (e.g., Tesla might employ Electrical Engineers not just in its solar power division but in other divisions as well). In essence, this multiplier provided a reasonable proxy for refining our absolute estimates of job demand. (We also used it to refine our estimates of average monthly job postings across all occupations.) To be conservative, we then rounded up to the nearest hundred, and used a second “industry multiplier” to account for an estimated industry-wide gap between demand measures and actual measures. More detail on this industry multiplier is contained on p.58.

Methodology for Identifying Key Occupations by Industry (Cont'd)

- **Employment:** Because job postings data contain the inherent limitations of over- or under-estimating exact job demand (e.g., companies in urgent need of talent may post more frequently than usual, or some occupations are less likely to be posted online), we also considered average annual employment over the same 4-year period (2017-20). Instances of relatively high job postings but relatively low employment suggest the potential for some degree of over-estimation, and instances of relatively low job postings but relatively high employment suggest the potential for some degree of under-estimation. Comparing these measures of demand and employment allowed us to prioritize (or de-prioritize) which occupations were most reasonable to include in the final list of the most in-demand Clean Energy occupations.
 - Also of note—after the list of occupations was finalized, we increased our absolute estimates of average annual employment (for the final list of occupations) by using the same “job postings multiplier” described on p.57. In essence, this multiplier provided a reasonable proxy for refining our absolute estimates of employment. To be conservative, we then rounded up to the nearest hundred, and used a second, “industry multiplier” to further refine the average annual employment figures. This industry multiplier was derived from comparing industry-wide employment totals from the Clean Jobs America 2021 report (produced by E2 with analysis based on data from BW Research Partnership for the 2021 U.S. Energy and Employment Report, or USEER). Specifically, the report finds total employment in the Renewable Energy and Clean Fuels sectors (the sectors relevant to the scope of this study) to be 436,055 in 2020. Note that this figure excludes manufacturing and utilities, which are outside the scope of this report. Comparing this figure to the adjusted average annual employment (incorporating the “job postings multiplier”) for the top 100 Clean Energy occupations in our data (which make up the bulk of Clean Energy employment in our data) shows a difference of about 1.32x between our total estimated employment (329,200) and the E2 figure. To compensate for this estimated industry-level gap, we used a conservative “industry multiplier” of 1.4x (rounded up to be consistent with our conservative estimation methodology). Several occupations in our analysis did not use this industry multiplier for various reasons:
 - Clean Energy Occupations 1 and 2-5: The average annual employment figure was manually increased to twice the average annual job postings figure as a directional estimate, since raw employment was significantly lower than job postings (signaling a likely gap in data leading to significant under-counting).
 - Clean Energy Occupation 7: The average annual employment figure was estimated from data from the National Solar Jobs Census 2020.
 - Clean Energy Occupations 8 and 12: The average annual employment figure was pulled from BLS 2019 data, since this occupation is specific to the Clean Energy industry. (Also note: Average annual job postings figure was informed by annualizing BLS's 2019-2029 job outlook growth and multiplying by 3 (assuming 3 job postings for every 1 hire).)
 - (Also note that average annual employment figures for Special-Category nuclear occupations were pulled from BLS data.)

Methodology for Identifying Key Occupations by Industry (Cont'd)

- **Job Outlook:** In a few instances, we also strongly considered an occupation's BLS-projected job outlook (from 2019 to 2029) to determine whether to include it in the final list. For example, certain occupations in nuclear energy have materially negative job outlook percentages, suggesting they should be deprioritized (not to mention the inherent skills gap for ONG workers to transition into occupations like Nuclear Engineer). Other occupations have materially positive job outlook percentages, suggesting the importance of including them in an analysis of occupation transferability.

Figure 2: Major Clean Energy companies used to gather supplementary job demand data

Suniva, Inc.	Ormat Technologies, Inc.	Invenergy LLC	Fse Inc
First Solar, Inc.	Berkshire Hathaway Energy Company	Avangrid, Inc	Taylor Corporation
Nextera Energy, Inc.	Terra-Gen Operating Company, LLC*	Enel Green Power North America, Inc.	Bureau of Reclamation
Solaredge Technologies, Inc.	General Electric Company	Exelon Corporation	Bonneville Power Administration
Real Goods Solar, Inc.	Vestas	Duke Energy Corporation	National Renewable Energy Corporation
Sunrun Inc.	Siemens AG*	Entergy Corporation	Veolia Environmental Services North America Corp.
Tesla, Inc.*	Nordex Usa, Inc.	Firstenergy Corp.	DTE Energy Company
Invenergy LLC	EDP Renewables North America LLC	American Electric Power Company, Inc.	
Calpine Corporation	Pattern Energy*	Covanta Energy Group, Inc	

This list represents a robust sample of major clean energy companies in the United States. It was compiled to a) confirm that our NAICS-based data captured an appropriately thorough list of Clean Energy occupations, and b) help refine job demand comparisons between occupations on a company basis (recognizing that NAICS-based measurement is still somewhat emerging in the Clean Energy industry). Due to the nature of the Clean Energy industry, some of the companies on this list span a diverse spectrum of energy types and even include activities outside of Clean Energy. To account for this potential statistical noise in the company-based data, we discounted our “job postings multiplier” by 50% (see p.57).

Methodology for Validating Key Occupations

To validate the final lists of occupations for ONG and Clean Energy, we consulted additional sources of expertise:

- **Industry Experts:** Given API's leading expertise on the ONG industry, internal stakeholders reviewed the occupations data to ensure the final list aligned with general industry knowledge and prior API research. NABTU stakeholders also provided feedback on occupations, given their expertise in trade occupations relevant to the ONG industry. In addition, the research team is appreciative of high-level feedback provided by Philip Jordan, Vice President and Principal Researcher who specializes in energy at BW Research Partnership.
- **Industry Reports:** The research team also conducted extensive secondary research into energy industry reports and information sources. Among these various sources, we leveraged several leading reports to compare and pressure-test the occupations analyzed in this study. For example, we relied heavily on the following reports:
 - 2020 U.S. Energy and Employment Report
 - Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy and Employment Report
 - Minority and Female Employment in the Oil & Gas and Petrochemical Industries (API)

Methodology for Gathering Data on Key Occupations

In order to analyze the potential for transferability from the most prevalent ONG occupations to the most in-demand Clean Energy occupations, we gathered data using Emsi's proprietary Job Posting Analytics (JPA) database and BLS. For each occupation we aggregated data across numerous job postings (often in the thousands or tens of thousands) on the following:

- Job Requirements
 - Skills
 - Education
- Job Quality
 - Pay (as measured by median hourly earnings)
- Job Availability
 - Location (by state and region)
 - Job Demand (as measured by the number of job postings)

Methodology for Assessing Occupation Transferability from ONG to Clean Energy

Using the data identified previously, we analyzed the potential for transferability from the most prevalent ONG occupations to the most in-demand Clean Energy occupations using the following criteria:

- Job Requirements
 - Skills
 - Because individual occupations aggregate data across numerous job postings, they typically yielded hundreds of required skills. Emsi's data aggregation process identifies a list of largely unique skills for each occupation (and the research team reviewed these lists to ensure we captured unique skills), which allowed us to analyze a highly-salient subset of skills. For each occupation, we identified the top 20 most in-demand skills (based on the most up-to-date job postings data, from January 2020 through May 2021) and verified that this mix included both hard and soft skills. Then, we compared the top skills for a given ONG occupation (within a given occupation type, as discussed on p.20) to the top skills for a given Clean Energy occupation. Our threshold for "reasonable transferability" on skills was at least 50% overlap of these top 20 skills.
 - Education
 - For each occupation, we identified the most common level of education cited in job postings (and in cases where multiple levels were cited, deferring to the lowest level). Our threshold for "reasonable transferability" on education was a given ONG occupation having the same typical level of education required (or a more advanced level) as a given Clean Energy occupation.
- Job Quality
 - Pay (as measured by median hourly earnings)
 - For each occupation, we identified the average hourly earnings (based on BLS data from its May 2020 Occupational Employment and Wage Statistics) per industry-related NAICS code (as previously defined) and calculated a weighted average of those NAICS-based earnings based on employment per NAICS code. Our threshold for "reasonable transferability" on pay was a given Clean Energy occupation offering at least 90% of the pay compared with a given ONG occupation.



Methodology for Assessing Occupation Transferability from ONG to Clean Energy (Cont'd)

- Job Availability
 - Location (by state region)
 - For each occupation, we used job postings data to identify where job demand exists by state and at what levels. We then categorized the states into regions.* Our threshold for “reasonable transferability” on location was twofold:
 - We identified the top three regions where a given ONG occupation’s job demand was located. This set of regions represented the bulk of job demand for the ONG occupation.
 - Then, for a given Clean Energy occupation, we measured how much of its job demand was located in those same regions. For each of the top three regions, the concentration of Clean Energy jobs had to be at least 50% of the level of concentration of ONG jobs. For example, if 30% of job demand for a given ONG occupation existed in the Southwest, at least 15% of job demand for a given Clean Energy occupation had to exist in the Southwest. If that threshold was not met for one of the three regions, the occupation was not transferable.
 - It is important to note that using this standard of 50% of demand among an entire region is optimistic about the reasonableness of transfer. If a job is deemed not transferable due to location, that means that the likelihood of a given worker finding a Clean Energy job in the same region (same state or nearby states) is very low.
 - Job Demand (as measured by the number of job postings)
 - For all Clean Energy occupations, we aggregated the total number of average annual unique job postings (from 2017 through 2020) in order to compare job demand with total ONG employment (see p.37 for this comparison).

**The states included in each region are as follows:*

WEST	MOUNTAINS	SOUTHWEST	MIDWEST	SOUTHEAST	NORTHEAST	ALASKA	PACIFIC ISLANDS
WA	ID	AZ	ND	AK	NY	AK	HI
OR	MT	NM	SD	LA	PA		
CA	UT	TX	NE	MS	MD		
	WY	OK	KS	AL	NJ		
	CO		MN	KY	DE		
	NV		IA	TN	VT		
			MO	FL	NH		
			WI	GA	MA		
			IL	SC	CT		
			IN	NC	RI		
			MI	VA	ME		
			OH	WV	DC		