FROM FOSSIL FUELS TO RENEWABLE ENERGY: NAVIGATING THE WORKFORCE TRANSITION IN THE U.S. ENERGY SECTOR

Senior Honor Thesis by Gu Wei Tian Xie (BSBA, 2024)
Under the direction of Prof. Jeff Mittelstadt

Abstract

The transition towards renewable energy sources in the United States represents a crucial shift in the pursuit of green energy, which carries large implications for the labor market within the energy sector for extraction workers. This study focuses on the transition of human capital from non-renewable to renewable energy sectors in the energy industry. Utilizing comprehensive data from the Occupational Information Network (O*NET), this study analyzes cognitive and non-cognitive worker requirements between extraction and renewable occupations. The results indicate that requirements for renewable energy occupations are more dissimilar from extraction occupations compared to Career Starters. While the path is not uniformly straightforward, specific extraction occupations are identified as very well aligned to renewable energy occupations with cognitive and non-cognitive requirements. These select pipelines suggest an opportunity for fostering a smooth transition to align workforce development with environmental and energy goals.

Introduction

The U.S. energy transition could displace 1.7 million fossil fuel workers, highlighting the need for Just Transition pathways to ensure equitable opportunities in the green job market (Lim et al., 2023). The 2015 Paris Agreement underscores the urgency of reducing fossil fuel reliance due to its environmental and socio-economic impacts, advocating for a shift to renewable energy. The clean energy initiative magnified the contrast between employment in the renewable and fossil fuels energy industry.

EXTRACTION JOB DECLINE

- Coal and nuclear power generation declined by 0.8% and 4.2%, respectively (U.S. Department of Energy, 2022).
- Coal mining jobs decreased from over 125,000 in 1990 to under 50,000 (Chetan, 2022).

RENEWABLE ENERGY JOB GROWTH

- Wind turbine service technicians are projected to see the highest employment increase of any job in the United States, exceeding 45% over the next decade (U.S. Bureau of Labor Statistics, 2023).
- Solar photovoltaic installers have anticipated growth rates of over 22% (U.S. Bureau of Labor Statistics, 2023).

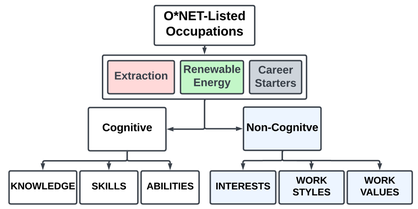
This shift necessitates investments in workforce transition strategies, echoing the vision of U.S. labor leader Tony Mazzocchi who coined the term 'Just Transition'(Pollin & Callaci, 2019). Current efforts include the Bipartisan Infrastructure Law and Inflation Reduction Act, focusing on developing clean energy technologies and workforce programs.

My study identifies key fossil fuel and renewable energy roles, leveraging O*NET's job classifications and cognitive and non-cognitive skills assessments to facilitate effective worker transitions. This study aims to contribute to the academic discourse and offer actionable intelligence for strategic labor market development. The research's outcomes are intended to inform policy, guide industry strategy, and ultimately support the workforce through this transition to a sustainable future.

Methodology

Utilizing quantitative pair-wise analysis, my study compared worker requirements between renewable energy and extraction occupations to calculate a transferability score, facilitating a Just Transition within the energy industry. Further details on data sources, occupation selection, calculation methods, and limitations are provided below.

The study leveraged the O*NET and the Bureau of Labor Statistics (BLS) for detailed occupational information. ONET's annual updates on worker attributes and BLS's SOC system enable a comprehensive evaluation of skills for transition potential. This research targeted specialized roles at risk due to industry greening, excluding roles with significant sector overlap. It investigates 23 essential extraction occupations and 32 key renewable energy roles based on Dierdorff et al.'s (2009) framework.



Career Starters were identified as roles similar to fossil fuel occupations but may need additional training or education. These positions are crucial for long-term job transitions. For the purpose of this analysis, each extraction occupation was paired with two Career Starter roles, adhering to the central limit theorem for statistical validity.

Skill similarities between job pairs were quantified using cosine similarity and Euclidean distance analyses. These metrics provided comparative insights into the degree of alignment or difference between the occupational characteristics of the energy sectors.

$$\text{Cosine Similarity} = \frac{A \cdot B}{\|A\|\|B\|} \qquad \textit{Euclidean Distance} = \sqrt{\sum_{i=1}^{n}(a_i - b_i)^2}$$

Energy Occupations

List of relevant energy occupations identified from research that focus on at-risk extraction and green renewable energy occupations.

32 Renewable Energy Occupations

Biofuels Processing Technicians	Industrial Ecologists
Biofuels Production Managers	Nuclear Fuel Enrichment and Processing Technicians
Biofuels Technology Development Managers	Nuclear Power Plant Process Control Workers
Biomass Plant Technicians	Power System Operators
Chief Sustainability Officers	Solar Energy Installation Managers
Climate Change Policy Analysts	Solar Energy Systems Engineers
Electrical Energy Storage or Distribution Technicians	Solar Operations Engineers
Energy Auditors	Solar Photovoltaic Installers
Energy Engineers, Except Wind and Solar	Solar Sales Representatives and Assessors
Environmental Economists	Solar Thermal Installers and Technicians
Geo-thermal Heat Pump Machinists	Sustainability Specialists
Geo-thermal Sheet Metal Workers	Weatherization Installers and Technicians
Geothermal Electrical Engineers	Wind Energy Development Managers
Geothermal Power Generation Mechanical Engineers	Wind Energy Engineers
Geothermal Technicians	Wind Energy Operations Managers
Hydroelectric Production Managers	Wind Turbine Service Technicians

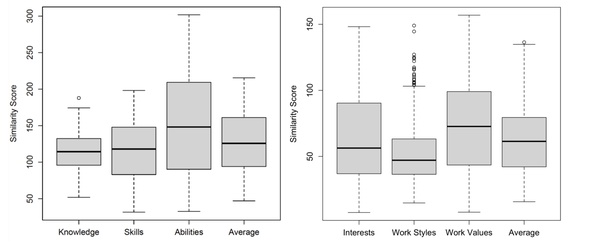
23 Extraction Occupations

Continuous Mining Machine Operators	Mining and Geological Engineers,
Wellhead Pumpers	Pump Operators, Except Wellhead Pumpers
Roof Bolters, Mining	Dredge Operators
Derrick Operators, Oil and Gas	Earth Drillers, Except Oil and Gas
Loading and Moving Machine Operators	Gas Compressor and Gas Pumping Station Operators
Rotary Drill Operators, Oil and Gas	Explosives Workers, Ordnance Handling Experts, and Blasters
Service Unit Operators, Oil and Gas	Machine Setters, Operators, and Tenders
Roustabouts, Oil and Gas	Geological Technicians, Except Hydrologic Technicians
Rock Splitters, Quarry	Geoscientists, Except Hydrologists and Geographers
Helpers--Extraction Workers	Petroleum Pump System Operators
Excavating and Loading Machine and Dragline Operators	Riggers
Petroleum Engineers	

Results

The Euclidean Distance findings between extraction workers and green jobs: Cognitive distances were generally higher, indicating more significant differences in job requirements. Non-cognitive distances were lower, suggesting closer alignment in softer job aspects.

Cognitive and Non-Cognitive Euclidean Distance Between Extraction and Renewable Energy Occupations



These results showcase a higher degree of variance between extraction occupations and renewable energy occupations in terms of their cognitive measures. The central tendency is similar among all cognitive metrics. The range of abilities is the highest among the three. The Non-Cognitive Euclidean Distance reveals that while work styles have the smallest spread and range, indicating generally more similar work styles between extraction and renewable energy workers, outliers suggest a few exceptional cases of high dissimilarity.

Renewable energy jobs are, on average, more distant in terms of skills from extraction jobs than career starter positions, with a statistically significant difference of 3.101 units. This gap highlights the specialized skills required in renewable energy, suggesting targeted training could facilitate the transition of workers from extraction to sustainable energy roles.

Descriptive Statistic Between the Transition to Renewable vs Career Starters	Value
Sample Size (N1)	46
Sample Size (N2)	36
Sample Mean (Renewable)	52.057
Sample Mean (Starter)	48.956
Sample Standard Deviation (s1)	6.053
Sample Standard Deviation (s2)	6.469
Standard Error for the Difference (SE)	1.4
Margin of Error (MOE)	2.79
Point Estimate	3.101
Lower Bound (95% CI)	0.316
Upper Bound (95% CI)	5.886

Two Sample Hypothesis Test:

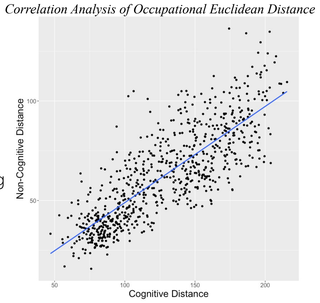
$$\text{Null Hypothesis } (H_0): \mu_1 <= \mu_2$$

$$\text{Alternative Hypothesis } (H_1): \mu_1 > \mu_2$$

With a p-value of 0.01492, I reject the null hypothesis in favor of the alternative hypothesis ($p < 0.05$), suggesting the average Euclidean distance from extraction to renewable energy is significantly greater than career starters.

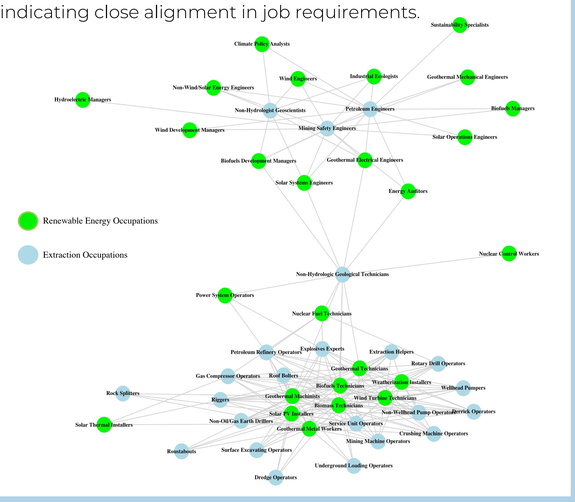
The correlation analysis shows a strong link between cognitive and non-cognitive traits in extraction and renewable energy sectors, with a Euclidean correlation coefficient of 0.812. This strong connection underscores the need to integrate both aspects in workforce training and development.

Correlation Analysis of Occupational Euclidean Distance



Network Plot

This maps the lowest 25% quartile Euclidean distances between extraction and renewable energy occupations, indicating close alignment in job requirements.



Discussion and Conclusions

To ensure a Just Transition, based on O*NET classifications and both cosine similarity scores and Euclidean Distance measures, my research highlights the skill set nuances critical for this transition.

Integrated Skill Development: The correlation between cognitive and non-cognitive skills emphasizes the need for comprehensive training programs that develop technical and soft skills essential for effective workforce integration.

Policy Implications: Focus on identifying renewable energy roles that align with the skills of extraction workers and develop targeted training programs illustrated through accessible transition pathways. With substantial investment, such as the proposed $600 million annually, targeted training can be tailored precisely to meet industry needs, reducing retraining failures and optimizing resource use.

Future Research: Future studies should consider geographic contexts and specific job requirements in the energy sector, including wage impacts on job transitions to better understand and facilitate worker re-skilling. These focused efforts will ensure that workforce development aligns with the evolving energy sector and contributes to sustainable economic growth.

Acknowledgements

Thank you to Prof. Jeffrey Mittelstadt, Dr. Sekou Bermiss, Dr. Jacob Zeng, Dr. Patricia Harms, and Dr. Michael Meredith. This Honors Thesis would not be possible without your collective support and contribution. This research is dedicated to those experiencing hardship in the energy transition.

UNC KENAN-FLAGLER BUSINESS SCHOOL