+

RISE Ohio Task 5

Skillshed Analysis

November 2023

Elham Erfanian, Visiting Assistant Professor of Economics, Voinovich School of Leadership and Public Service, Ohio University

RISE Ohio Task 5. Skillshed Analysis

Final Report – November 2023

Contents

Executive Summary

In 2021, Ohio University's Voinovich School of Leadership and Public Service, in partnership with two Ohio Local Development Districts (LDDs)—Buckeye Hills Regional Council (BHRC) and the Ohio Mid-Eastern Governments Association (OMEGA)—was awarded funding by the U.S. Department of Commerce Economic Development Administration to provide technical assistance to communities in the 18-county region that have been impacted by the decline of the coal economy and to conduct a Skillshed Analysis on the workforce in the Ohio Southeast region. The project aims to identify the occupational skills of the region's coal-fired power plant and coal mining industries, as well as potential new job opportunities created by the petrochemical industry and other emerging occupations in the region. This research will help policymakers, economic development stakeholders, employers, job seekers, and their representatives to gain a better understanding of the characteristics, availability, and needs in the region's labor force. The report will provide a roadmap to facilitate career transitions in Ohio, allowing the state to minimize costs resulting from the decline of the coal economy.

A skillshed is the geographic area that serves as a resource for a region's workforce, education, and experience. The geographic definition should be meaningful to employers, employees, and regional economies. For this project, we consider Ohio Southeast as the skillshed.

The goals of a skillshed analysis are to:
1. Identify declining coal economy occupations in the existing workforce that can transition into emerging occupations with relative ease.
2. Determine the emerging occupations that will drive regional economic growth.

This skillshed analysis only includes occupations with available data on the U.S. Department of Labor's O*NET, as this is essential for determining how skills, knowledge, abilities, and education can help job seekers transition from one occupation to another. Declining occupations are those with employment projections below expected growth projections for Ohio or their respective JobsOhio region and with high employment in the region.

This skillshed analysis utilizes O*NET data to calculate dissimilarities between declining coal economy occupations and petrochemical and other emerging occupations. Similarity measures enable researchers to identify the ease of transitioning from a declining occupation to an emerging occupation. To simplify the illustration, these dissimilarity measurements are illustrated by color coded cells in each table. Cells with colors close to green are transitions with non-intensive reskilling, and cells with colors close to red are transitions with highly intensive reskilling.

The results from the coal fired power plant skillshed analysis show that the transition for "Chief Executives" is by far the most intense in terms of reskilling. Not only do these transitions need intensive reskilling, but the employees will also see a significant decline in their wage rates. On the other hand, transitioning from "Inspectors, Testers, Sorters, Samplers, and Weighers; Meter Readers, Utilities" or "Power Plant Operators" requires minimal reskilling. Transitioning from "Inspectors, Testers, Sorters, Samplers, and Weighers" to "Chemical Plant and System Operators" will generate a $12.51 increase in median hourly wages. Additionally, transitioning from "Meter Readers, Utilities" to "Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders" will increase median hourly wages by $9.69.

More than 39% and 28% of all the "Power Plant Operators", and "Power Distributors and Dispatchers" employees are working within the coal-fired power plant industry, respectively. For "Power Plant Operators", most of the transitions to emerging occupations will generate wage loss. There are only two transitions that lead to an increase in median hourly wage: transitions to "Chemical Engineers" and "General and Operations Managers". Compared to "Chemical Engineers", the transition to "General and Operations Managers" will require minimal to moderate reskilling and generate a higher wage increase ($12.77 vs. $7.26).

"Electrical and Electronics Repairers, Powerhouse, Substation, and Relay" and "Electrical Power-line Installers and Repairers" are two occupations with a high prevalence in the coal-fired power plant industry. Transitions to "Chemical Engineers", "General and Operations Managers", and "Material Scientists" are the only transitions that generate a higher wage. Compared to the other two transitions, the transition to "General and

2

Operations Managers" requires less reskilling while generating a higher increase in wage rates.

For coal mining occupations, the most intense reskilling occupation transition is from "Mining and Geological Engineers, Including Mining Safety Engineers", "Occupational Health and Safety Technicians", and "Surveyors" which tend to have a lower wage rate. However, less than 7%, 0.5%, and 0.2% of these occupations work in the coal mining industry, respectively. Occupations like "Inspectors, Testers, Sorters, Samplers, and Weighers" and "Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders" are two occupations with minimal to moderate reskilling needs. The transition for "Inspectors, Testers, Sorters, Samplers, and Weighers" and "Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders" to "General and Operations Managers" will generate an increase of $33.27 and $31.91, respectively, in wage rates.

The three paragraphs and the table below explain how to discuss and interpret the results of a skillshed analysis. We examine two transitions in the Ohio Southeast region: the highest and lowest reskilling transition for the "Power Plant Operators" occupation. Transitions from "Power Plant Operators" to "Clergy" and "Chemical Engineers" are examples of a highly intensive reskilling transition. The first transition generates a loss in wage rate while the second transition generates an increase in the transition. "Power Plant Operators" and "Clergy" both have similar skills and knowledge like "Critical Thinking", "Computers and Electronics", "Monitoring", "Complex Problem Solving", and "Time Management". "Philosophy and Theology", "Therapy and Counseling", "Psychology", "Speaking" and "Social Perceptiveness" are among the skills and knowledge where gaps occur. "Power Plant Operators" require a high school diploma or equivalent, while "Clergy" requires a bachelor's degree. This transition leads to a decrease of $17.87 in the median hourly wage.

"Power Plant Operators" and "Chemical Engineers" both have similar skills and knowledge like "Operations Monitoring", "Troubleshooting", "Monitoring", "Quality Control Analysis", and "Coordination". "Design", "Engineering and Technology", "Operations Analysis", "Chemistry" and "Science" are among the skills and knowledge where gaps occur. "Power Plant Operators" require a high school diploma or equivalent, while

3

"Chemical Engineers" require a bachelor's degree. This transition leads to an increase of $7.26 in the median hourly wage.

The second example is a transition with low reskilling needs: from "Power Plant Operators" to "Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers". "Operation and Control", "Operations Monitoring", and "Mechanical" are similar skills and knowledge, and there is a low/medium skill and knowledge gap in "Production and Processing". Both "Power Plant Operators" and "Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers" require a high school diploma or equivalent. This transition leads to a decrease of $23.63 in the median hourly wage.

Skillshed Analysis Results for Power Plant Operators Occupation, Ohio Southeast

	Power Plant Operators
Accountants and Auditors	(11.62)
Automotive Service Technicians and Mechanics	(22.67)
Bus Drivers, Transit and Intercity	(25.08)
Carpenters	(18.83)
Chemical Engineers	7.26
Chemical Equipment Operators and Tenders	(16.37)
Chemical Plant and System Operators	(7.99)
Chemical Technicians	(15.74)
Chemists	(5.75)
Clergy	(17.87)
Construction Laborers	(20.75)
Cooks, Institution and Cafeteria	(27.00)
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	(19.14)
Customer Service Representatives	(25.08)
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	(24.19)
Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	(23.63)

Values in colored cells are the change in median hourly wage in US dollars, while values in parentheses show occupational transitions with a decrease in the median hourly wage.

Based on the Skillshed analysis for coal fired power plant and coal mining industries in Ohio Southeast region, training or educational programs should focus on declining occupations that make up a high percentage of total occupations in these two industries. "Power Plant Operators", "Power Distributors and Dispatchers", "Electrical and Electronics Repairers, Powerhouse, Substation, and Relay", "Roof Bolters, Mining", "Loading Machine Operators, Underground Mining" and "Continuous Mining Machine Operators" are among the occupations with the highest percentage of employees working in coal related industries. Finding a job with comparable skills and knowledge for the workforce in these occupations is not easy. Another aspect that is critical in planning is focusing on the transitions that generate the highest wage rates. These transitions are usually accompanied by a higher salary, which, due to the indirect and induced economic impacts, might generate higher economic impacts within the region.

In addition to the declining trend in the coal economy, labor shortages have been experienced across Ohio, the US, and JobsOhio regions in recent years. This has had a negative impact on many sectors and industries. While reskilling and retraining the existing workforce require multidimensional strategies and planning, having a displaced workforce in the coal economy plays a vital role, as it has the potential to fill the workforce demand gap. The workforce involved in the coal economy has a long history of living in a region which is bound with well-established community engagement and societal interactions. Thus, retaining the workforce that already exists in the region will generate tremendous benefits to society and the economy.

The involvement of local economic development organizations is essential to assist and support the regional workforce experiencing a declining demand. In addition to help with retraining, skill improvement, or obtaining additional education, displaced workers might also require assistance with transportation or access to information. Access to information in this report, resources from the Department of Labor that aim to help in career transitions, or even job postings are often contingent on access to online sources and the ability to navigate the digital world.

Introduction

This report has been prepared by the Center for Economic Development and Community Resilience at Ohio University's Voinovich School of Leadership and Public Service in collaboration with OMEGA/Buckeye Hills. With a focus on the declining coal economy and its impact on Ohio residents, the objective of this report is to provide a comprehensive understanding of the skillshed analysis and map the occupational skills of coal economy workers and other displaced individuals to align with emerging occupations in the petrochemical and other emerging industries.

A skillshed analysis is a methodology used to assess the occupational skills within a workforce and inform decisions related to workforce training and curriculum development. This approach is particularly valuable for transitioning economies or those experiencing significant changes, such as plant closures or the establishment of new plants, which can disrupt the labor force.

A typical skillshed analysis involves three key steps. First, it identifies the occupations in which a particular region possesses a comparative advantage. Second, it examines whether these occupations have increasing or declining employment projections. Finally, it compares the current skillset of declining occupations with the skillset required for emerging occupations.

The significance of conducting a skillshed analysis lies in the fact that a shortage of skills can pose challenges for local governments, leading to structural unemployment and impeding regional growth. By conducting skillshed analyses, economic development officials can gain valuable insights to develop initiatives and policies that ensure the workforce is adequately prepared to support emerging occupations.

In summary, skillshed analyses play a vital role in assessing workforce skills, facilitating decision-making on training and curriculum development, and assisting economic development officials in addressing the challenges posed by transitioning or disrupted economies.

Coshocton County is one of the 25 counties located in the Southeast Ohio region. With a population of approximately 36,602[1] and a median household income of $43,251,[2] it is an important area to consider within the skillshed analysis conducted for the Ohio Southeast region. The skillshed analysis in this report has been conducted for the Ohio Southeast region, which includes majority of the counties located in Buckeye Hills and Ohio Mid-Eastern Governments Association (OMEGA) regions. Most of the counties within these regions are part of the broader Ohio Southeast region, and their inclusion ensures a comprehensive assessment of the workforce skills and occupational dynamics within the area.

By conducting this skillshed analysis at a regional level, the report aims to provide valuable insights and recommendations that can benefit the workforce, economic development officials, and policymakers in effectively addressing the challenges and opportunities related to transitioning economies and emerging industries within the Ohio Southeast region.

Project Description

Task five of the Voinovich School activities outlined in the project's scope of work comprises two sub-tasks that are integral to the analysis:

1. Conduct a skillshed analysis documenting declining occupations in the coal economy supply chain. This involves identifying the occupations that have been affected by decreasing demand in the coal economy across Southeast Ohio. The analysis focuses on understanding the specific skills associated with these declining occupations.

2. Map the skills required to work in declining occupations to emerging occupations in the identified industry clusters. This step involves translating the identified declining occupations into their corresponding skillsets. These skills are then compared to the skill requirements of emerging occupations within industry clusters.

---

[1] Available at https://www.coshoctoncounty.net/about-coshocton/

[2] Available at https://www.coshoctonportauthority.com/

Throughout the analysis, particular attention is given to the median wage associated with each occupation. The skillshed tables contain a matrix that shows the differences in median hourly wages between occupations. Additionally, a color-coded system is used to indicate the level of difficulty associated with transitioning from declining occupations to emerging occupations. This analysis provides valuable information that can assist displaced workers in making informed decisions, taking into account both the ease of transition and the wage differentials associated with various occupations.

Project Implementation

In this task, the team focused on identifying specific declining occupations within the coal-fired power plant and coal mining industries. Simultaneously, they also worked on identifying emerging occupations within the petrochemical industry and other emerging sectors.

The primary objective of this section was to establish a connection between declining occupations resulting from the closure of coal-fired power plant and coal mining operations and emerging occupations within the petrochemical industry and other emerging sectors. This connection is crucial for understanding potential skill transferability and facilitating workforce transitions.

Following the identification of declining and emerging occupations, the next steps involve conducting a skillshed analysis and a cluster analysis. These analyses aim to match declining occupations with emerging occupations, taking into account the required skills and characteristics of regional industries. This process helps identify skill gaps, potential areas for retraining or upskilling, and opportunities for workforce development.

By conducting these analyses, the team can provide valuable insights and recommendations to support the transition of workers from declining occupations to emerging occupations, enabling a smoother and more successful adaptation to changing economic dynamics in the region.

Project Methodology

In this section, the report begins with a review of relevant skillshed reports. This review serves as a foundation for understanding the existing literature and research on skillshed analyses, particularly in relation to transitioning economies and disrupted industries.

After the review, the report proceeds to discuss the declining occupations within the coal-fired power plant and coal mining industries. These occupations are identified and analyzed to determine their specific skill requirements, employment trends, and the impact of industry closures on the workforce.

Subsequently, the focus shifts to the emerging occupations within the petrochemical industry and other emerging sectors. The report identifies and examines these occupations, highlighting their skill requirements, projected growth, and their potential to absorb workers from declining occupations.

The methodology employed in conducting the skillshed analysis is then presented. This methodology outlines the approach used to identify, assess, and match the declining and emerging occupations. It may include data collection methods, analytical techniques, and any specific criteria or indicators used to evaluate skill compatibility and transition potential.

By discussing the relevant skillshed reports, examining declining and emerging occupations, and explaining the methodology, the report establishes a comprehensive framework for conducting the skillshed analysis and provides a solid basis for the subsequent analysis and recommendations.

Review of Relevant Skillshed Reports

The concept of skillshed analysis was first introduced by the Institute for Decision Making at the University of Northern Iowa in 1998 (Scott and Kotlyar, 2013). Its primary objective was to provide economic development groups with a better understanding of the labor force characteristics within a specific area.

The initial step in conducting a skillshed analysis involves defining the geographical boundaries of the skillshed. Various factors are taken into consideration when

establishing these boundaries, including population density, local geography including rivers, and transportation infrastructure such as roads and highways. These factors help delineate the area from which the analysis will draw its labor force data.

Once the skillshed is defined, data on the region's labor supply and demand is required. Reports examining skill gaps typically fall into two categories based on their data source: survey-based data or publicly available data. The majority of skillshed analyses utilize data from both workforce and employer surveys.

The workforce survey is used to assess the supply of available workers within the defined region. It captures information about the skillsets, work activities, and tasks performed by the workers. This survey provides valuable insights into the existing labor force's capabilities and skill profiles.

On the other hand, the employer survey focuses on measuring the demand for workers within the area. It gathers information regarding the specific education, training, and skills required by employers. This survey helps identify skills and qualifications that are in high demand, providing a comprehensive understanding of the labor market dynamics within the skillshed.

While survey data provides valuable insights at the skillshed level, it is important to acknowledge potential limitations, such as individual perceptions and the possibility that survey respondents lack direct knowledge of required skillsets. On the other hand, publicly available data can offer a cost-effective alternative to large-scale survey data collection and administration.

Regardless of the data source, the overarching goals of a skillshed analysis remain consistent. These goals include identifying the key occupations that will drive regional economic growth and determining the ease of workforce transition into these emerging occupations.

A skillshed analysis heavily relies on data-driven methodologies. It involves calculating dissimilarity measures among occupations and clustering them based on various criteria. To facilitate this analysis, several databases are utilized, such as Ohio employment projections and information from the Occupational Information Network (O*NET 27.1

Database). These databases provide valuable information on the knowledge, skills, work activities, and job zones associated with different occupations.

By comparing the attributes of the declining workforce in the coal economy to those of the emerging occupations, dissimilarity measures can be calculated. These measures serve as a guide for employees in declining occupations and economic development specialists, aiding in their decision-making process when transitioning into new careers. By effectively decreasing search costs, individuals can make more informed choices and increase their chances of successful workforce transition.

Declining Occupations in Ohio Southeast

In order to create a list of declining occupations specific to the Ohio Southeast region, the report utilizes the Bureau of Labor Statistics industry-occupation employment matrix and employment projection database.[3,4] Following the assumption that occupations with an above-average state growth rate projection are more likely to provide opportunities for workers to find new jobs with minimal search costs, the focus is primarily on occupations with a projected growth rate below the expected average. These occupations are considered declining, indicating low demand and a higher probability of displaced workers facing challenges in finding new employment.

Conversely, occupations with an above-average projected growth rate are not mapped, as it is presumed that employees in occupations already facing below-average growth rates would require additional assistance to recover from economic shocks.

Declining occupations that have entered the skillshed analysis are then filtered to include only those occupations for which corresponding O*NET data is available. This ensures that the analysis can be conducted with comprehensive information on the knowledge, skills, work activities, and job zones associated with each occupation.

---

[3] For more information see Industry-occupation matrix data, by industry : U.S. Bureau of Labor Statistics (bls.gov)

[4] For more information see https://ohiolmi.com/Home/Projections/ProjectionsHome

Coal Fired Power Plant Occupations

Table 1 contains the list of declining occupations within the coal-fired power plant industry that have been included in the analysis. The table includes the names of the declining occupations, the corresponding share of employees working in the industry, the industry employment growth rate projections, the median hourly wages, and the typical education associated with each occupation.

Coal Mining Occupations

Table 2 contains the list of declining occupations within the coal mining industry that have been included in the analysis. The table includes the names of the declining occupations, the corresponding share of employees working in the industry, the industry employment growth rate projections, the median hourly wages, and the typical education associated with each occupation.

Table 1. Declining Coal-Fired Power Plant Occupations in Ohio Southeast Region

Occupational Title	Share of Occupation	Share of Industry	Employment Projections 2021-2031	Median Hourly Wage	Typical Education
Power Plant Operators	39.3%	14.8%	-33.4%	$39.50	High school diploma or equivalent
Power Distributors and Dispatchers	28.8%	16.3%	-33.6%	$42.41*	High school diploma or equivalent
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	18.2%	5.4%	-33.4%	$33.48*	Postsecondary non-degree award
Electrical Power-Line Installers and Repairers	5.6%	9.2%	-33.4%	$33.79	High school diploma or equivalent
Control and Valve Installers and Repairers, Except Mechanical Door	3.8%	2.2%	-33.4%	$23.89	High school diploma or equivalent
Gas Plant Operators	2.5%	0.5%	-40.0%	$39.50**	High school diploma or equivalent
Electrical Engineers	2.2%	5.4%	-33.4%	$42.26	Bachelor's degree
Electrical and Electronics Drafters	1.7%	0.5%	-33.4%	$28.57*	Associate's degree
Stationary Engineers and Boiler Operators	1.3%	0.5%	-33.4%	$27.92	High school diploma or equivalent
Meter Readers, Utilities	1.0%	0.3%	-43.4%	$20.24	High school diploma or equivalent
Environmental Engineering Technicians	0.9%	0.2%	-33.4%	$24.06*	Associate's degree
Industrial Machinery Mechanics	0.6%	2.8%	-33.4%	$25.28	High school diploma or equivalent
First-line Supervisors of Production and Operating Workers	0.4%	3.4%	-33.4%	$27.12	High school diploma or equivalent
Industrial Production Managers	0.3%	0.7%	-33.4%	$51.18	Bachelor's degree
Computer System Analysts	0.2%	1.3%	-33.4%	$34.14	Bachelor's degree
Excavating and Loading Machine and Dragline Operators	0.2%	0.1%	-33.4%	$19.91	High school diploma or equivalent
Helpers--Installation, Maintenance, and Repair Workers	0.2%	0.2%	-33.4%	$14.24	High school diploma or equivalent
Production, Planning, and Expediting Clerks	0.2%	0.9%	-33.4%	$23.69	High school diploma or equivalent
Surveying and Mapping Technicians	0.2%	0.2%	-33.4%	$21.08*	High school diploma or equivalent
Buyers and Purchasing Agents	0.1%	0.8%	-40.0%	$30.51***	Bachelor's degree
Computer Programmers	0.1%	0.1%	-45.4%	$37.02*	Bachelor's degree
Executive Secretaries and Executive Administrative Assistants	0.1%	0.6%	-50.0%	$27.59*	High school diploma or equivalent
Electronics Engineers, Except Computer	0.1%	0.1%	-33.4%	$46.26*	Bachelor's degree
Human Resources Assistants, Except Payroll and Timekeeping	0.1%	0.1%	-40.0%	$17.62	Associate's degree
Machinists	0.1%	0.3%	-33.4%	$17.50	High school diploma or equivalent

Maintenance and Repair Workers, General	0.1%	1.1%	-33.4%	$18.71	High school diploma or equivalent
Mechanical Engineering Technologists and Technicians	0.1%	0.1%	-33.4%	$26.51**	Associate's degree
Bookkeeping, Accounting, and Auditing Clerks	0.0%	0.4%	-40.0%	$16.16	Some college, no degree
Chief Executives	0.0%	0.1%	-43.4%	$63.13	Bachelor's degree
Inspectors, Testers, Sorters, Samplers, and Weighers	0.0%	0.2%	-43.4%	$19.00	High school diploma or equivalent
Laborers and Freight, Stock, and Material Movers, Hand	0.0%	0.7%	-33.4%	$13.79	No formal education credential

* Wages at the state level are reported, as southeast regional level information is not available for these occupations.
** Wages for similar occupations are reported, as regional level information is not available for these occupations.
*** Wages at the national level are reported, as regional level information is not available for these occupations.

Table 2. Declining Coal Mining Occupations in Ohio Southeast Region

Occupational Title	Share of Occupation	Share of Industry	Employment Projections 2021-2031	Median Hourly Wage	Typical Education
Roof Bolters, Mining	81.9%	4.2%	-28.2%	$28.73***	High school diploma or equivalent
Loading Machine Operators, Underground Mining	64.9%	7.9%	-32.0%	$19.81**	No formal educational credential
Continuous Mining Machine Operators	22.4%	9.1%	-24.5%	$26.68*	No formal educational credential
Excavating and Loading Machine and Dragline Operators	8.5%	8.5%	-28.2%	$19.91	High school diploma or equivalent
Mining and Geological Engineers, Including Mining Safety Engineers	6.9%	1.4%	-28.2%	$40.18*	Bachelor's degree
Helpers--Extraction Workers	6.7%	1.1%	-24.5%	$18.50	High school diploma or equivalent
Hoist and Winch Operators	1.7%	0.1%	-24.5%	$25.14***	No formal educational credential
Explosives Workers, Ordnance Handling Experts, and Blasters	1.3%	0.2%	-24.5%	$25.50***	High school diploma or equivalent
Earth Drillers, Except Oil and Gas	1.0%	0.5%	-24.5%	$23.19***	High school diploma or equivalent
Operating Engineers and Other Construction Equipment Operators	0.9%	9.8%	-24.5%	$22.23	High school diploma or equivalent
Tank Car, Truck, and Ship Loaders	0.9%	0.3%	-24.5%	$23.74	No formal educational credential
Heavy Vehicle and Mobile Equipment Service Technicians and Mechanics	0.6%	3.6%	-24.5%	$24.18	—
Occupational Health and Safety Technicians	0.5%	0.3%	-24.5%	$34.74	High school diploma or equivalent
Conveyor Operators and Tenders	1.0%	0.9%	-24.5%	$19.60*	No formal educational credential
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	0.7%	0.7%	-28.2%	$20.36	High school diploma or equivalent
Pump Operators, Except Wellhead Pumpers	0.9%	0.3%	24.5%	$20.20	High school diploma or equivalent
Surveyors	0.2%	0.2%	-24.5%	$27.98*	Bachelor's degree
First-Line Supervisors of Production and Operating Workers	0.0%	0.5%	-24.5%	$27.12	High school diploma or equivalent
Industrial Production Managers	0.1%	0.4%	-24.5%	$51.18	Bachelor's degree
Inspectors, Testers, Sorters, Samplers, and Weighers	0.1%	1.3%	-35.8%	$19.00	High school diploma or equivalent
Bookkeeping, Accounting, and Auditing Clerks	0.0%	0.4%	-32.0%	$16.16	Some college, no degree
Buyers and Purchasing Agents	0.0%	0.3%	-32.0%	$30.51	Bachelor's degree

* Wages at the state level are reported, as southeast regional level information is not available for these occupations.
** Wages for similar occupations are reported, as regional level information is not available for these occupations.
*** Wages at the national level are reported, as regional level information is not available for these occupations.
— Data is unavailable for values denoted.

Petrochemical and Other Emerging Occupations

Table 3 contains a list of emerging occupations within the petrochemical industry and other emerging sectors that have been included in the skillshed analysis. Since the data provided in Table 3 comes from different sources, each column includes two values. For example, the first column includes either median hourly wage or the share of an occupation in the industry.

To compile this list, the report focuses on the Bureau of Labor Statistics industry-occupation employment matrix and utilizes information from the in-demand jobs list. These sources help to identify emerging occupations that are experiencing growth or increased demand within the specified industries.[5,6]

---

[5] For more information, see Industry-occupation matrix data, by industry : U.S. Bureau of Labor Statistics (bls.gov)

[6] For more information, see In-Demand Jobs List | Ohio's Top Jobs

Table 3. Emerging Occupations in Ohio Southeast Region

Occupational Title	Median Hourly Wage/ Share of Occupation	Growth/ Share of Industry	Employment/ Employment Projections 2021-2031	Openings/ Median Hourly Wage	Typical Education Required
Accountants and Auditors	$27.88	9	1,512	145	Bachelor's degree
Automotive Service Technicians and Mechanics	$16.83	3	2,049	192	Postsecondary non-degree award
Bus Drivers, School	$14.42	2	1,024	125	High school diploma or equivalent
Carpenters	$20.67	25	2,976	304	High school diploma or equivalent
Chemical Engineers	26.3	2.0%	20.2%	$46.76*	Bachelor's degree
Chemical Equipment Operators and Tenders	52.6	16.3%	-8.3%	$23.13	High school diploma or equivalent
Chemical Plant and System Operators	60.3	3.8%	-3.2%	$31.51	High school diploma or equivalent
Chemical Technicians	16.7	2.8%	1.9%	$23.76	Associate's degree
Chemists	9.4	2.2%	12.0%	$33.75	Bachelor's degree
Chemists and Materials Scientists	9.0	2.3%	11.6%	$38.34***	—
Clergy	$21.63	8	1,366	159	Bachelor's degree
Construction Laborers	$18.75	41	3,893	454	No formal educational credential
Cooks, Institution and Cafeteria	$12.50	2	1,757	246	No formal educational credential
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders+	0.7	0.7%	-28.2%	$20.36	High school diploma or equivalent
Customer Service Representatives	$14.42	8	3,465	450	High school diploma or equivalent
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	3.5	0.6%	-3.2%	$15.31	High school diploma or equivalent
Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers	2.8	0.5%	1.9%	$15.87	High school diploma or equivalent
First-Line Sup/Mgrs of Con. Trades/Extract. Work	$32.69	16	1,262	144	High school diploma or equivalent
First-Line Sup/Mgrs of Office & Admin. Support	$23.56	8	2,351	239	High school diploma or equivalent
First-Line Sup/Mgrs of Personal Serv. Workers	$16.83	21	4,020	451	High school diploma or equivalent
First-Line Sup/Mgrs of Food Prep. & Serving Workers	$13.46	2	2,139	303	High school diploma or equivalent
Food Batchmakers	$12.98	9	1,195	181	High school diploma or equivalent
General and Operations Managers	0.2	2.0%	1.9%	$52.27	Bachelor's degree

Occupation					Education
Heating, AC, & Refrigeration Mechanics/Installers	$20.67	18	1,085	129	Postsecondary non-degree award
Industrial Engineering Technologists and Technicians	3.2	0.6%	1.9%	$27.87**	Associate's degree
Landscaping and Groundskeeping Workers	$12.50	27	2,406	328	No formal educational credential
Licensed Practical and Licensed Vocational Nurses	$18.75	17	3,558	271	Postsecondary non-degree award
Medical Assistants	$14.42	32	1,530	210	Postsecondary non-degree award
Medical Secretaries	$14.42	44	2,450	328	High school diploma or equivalent
Mixing and Blending Machine Setters, Operators, and Tenders	12.0	3.7%	1.9%	$18.56	High school diploma or equivalent
Nursing Assistants	$12.50	2	6,103	682	Postsecondary non-degree award
Packaging and Filling Machine Operators and Tenders	2.3	2.4%	1.9%	$16.45	High school diploma or equivalent
Pharmacy Technicians	$12.98	21	1,485	143	High school diploma or equivalent
Plumbers, Pipefitters, and Steamfitters	$24.04	14	1,027	127	High school diploma or equivalent
Receptionists and Information Clerks	$12.50	5	1,383	187	High school diploma or equivalent
Registered Nurses	$29.81	98	8,157	534	Bachelor's degree
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	0.5	1.7%	1.9%	$30.79	High school diploma or equivalent
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	6.5	0.9%	-8.3%	$29.93*	High school diploma or equivalent
Social and Human Service Assistants	$14.90	22	1,226	177	High school diploma or equivalent
Truck Drivers, Heavy and Tractor-Trailer	$21.15	28	6,033	678	Postsecondary non-degree award
Truck Drivers, Light or Delivery Services	$15.87	18	2,789	321	High school diploma or equivalent
Welders, Cutters, Solderers, and Brazers	$18.75	5	1,162	129	High school diploma or equivalent

* Wages at the state level are reported, as southeast regional level information is not available for these occupations.
** Wages for similar occupations are reported, as regional level information is not available for these occupations.
*** Wages at the national level are reported, as regional level information is not available for these occupations.
+ Occupation listed emerging occupation in coal-fired power plant analysis.

Wage data is a crucial component for comparing wage gaps between emerging and declining occupations. To facilitate this comparison, the report utilizes median hourly wages specific to the Ohio Southeast region for each occupation. By incorporating Ohio Southeast median hourly wage data, the analysis can provide insights into the wage disparities between emerging and declining occupations within the region. This information allows for a better understanding of the potential economic impact and the attractiveness of transitioning from declining to emerging occupations.[7]

To create dissimilarity measures between emerging and declining occupations, several indicators of the Occupational Information Network (O*NET) were used. O*NET is a joint effort between the US Department of Labor and the North Carolina Employment Security Commission. It provides a database of standardized and occupation-specific job descriptions based on Standard Occupational Classification (SOC) codes that help to determine which factors are critical in the performance of an occupation. By utilizing the O*NET database, we can map occupations into skills to determine which skills overlap between emerging and declining occupations and which ones are lacking or need improving. The indicators considered in this analysis are capacities and knowledge required to perform a job, work activities, and job zones.[8]

O*NET data includes measures of 35 capability dimensions (from 0 to 7) associated with an occupation and the importance (from 1 to 5) of that capability within the occupation. These measures show basic and cross-functional skills like social perceptiveness and critical thinking. While the same skill can be important for a wide range of occupations, the role that skill plays in those occupations can vary dramatically. For example, the skill of "speaking" is important for both lawyers and paralegals. However, lawyers (who frequently argue cases before judges and juries) are required to be highly skilled speakers, while paralegals only need an average level.

---

[7] For more information see https://ohiolmi.com/Home/Projections/ProjectionsHome

[8] O*NET classifies occupational information into categories. We use information classified under four categories: skills (i.e., capacities), work activities, knowledge, and job zones. In the text, we refer to the O*NET skills category as capacities to avoid confusion with our broader definition of skills used throughout the report.

The knowledge category includes any skill obtained through formal education, such as computer and electronics, chemistry and biology, mathematics, or production and processing. Each of the 33 variables included in the category takes a value ranging from 0 to 7 indicating the level of proficiency in a skill that is needed for a given occupation. The value assigned to an occupation for each variable indicates the degree, along a continuum, to which a particular descriptor or variable is required to perform the occupation. A knowledge variable with a value equal to 5 implies that, for a given occupation, the individual needs knowledge equivalent to a bachelor's degree level for that skill.

Work activities, or skills obtained while working on the job, refer to 41 variables representing activities that are common across occupations. Examples of work activities are assisting and caring for others, handling and moving objects, and interpreting the meaning of information for others. For instance, the "Controlling Machines and Processes" variable has a value equal to 5.29 for the "Power Plant Operators" occupation, implying the need for using either control mechanisms or direct physical activity to operate machines or processes (not including computers or vehicles) in the job. Another important work activity for "Power Plant Operators" is "Inspecting Equipment, Structures, or Materials" (equal to 4.67), implying the need for inspecting equipment, structures, or materials to identify the cause of errors, defects, or other problems.

The report also considers the job zones classification provided by O*NET. Job zones categorize occupations based on the level of education, experience, and on-the-job training required to perform the job. Each job zone represents a different level of preparation needed for the occupation.

Job zones included in the analysis cover a broad range of occupations. Job Zone 1 includes occupations that require minimal preparation, while Job Zone 2 typically refers to occupations that require a high school diploma or some vocational training. Job Zone 3 indicates medium preparation is needed, while Job Zone 4 includes occupations that require considerable preparation. Job Zone 5 encompasses occupations that require the most specialized knowledge and typically demand higher levels of education and expertise.

While previous skillshed analyses have primarily focused on Job Zones 3, 4, and 5 due to their higher educational requirements and potential for driving innovation (Iowa Innovation Gateway, 2010; Nolan, Morrison, Kumar, Galloway, & Cordes, 2011), this analysis recognizes the importance of including all job zones. By considering all job zones, the analysis avoids excluding a significant portion of available occupations in Ohio, providing a more comprehensive understanding of the workforce within the region.

Methodology

In the skillshed analysis conducted for this report, the dissimilarity measure used is the squared Euclidean distance or L2 squared. This measure calculates the distance between two occupations, X and Y, in an n-dimensional space. Each dimension in this space represents one of the 110 variables which serve as proxies for skills.

By employing squared Euclidean distance, the analysis quantifies dissimilarities between two occupations based on their divergence in skill proficiency or variable levels across these dimensions. The distance between two occupations increases as their skill levels or variables deviate from each other.

The analysis utilizes 110 variables derived from O*NET data, describing various aspects of occupations such as work activities, required capacities, knowledge levels, and job zones. These variables serve as dimensions in multidimensional space, allowing for a comprehensive comparison between emerging and declining occupations.

To rank emerging occupations in relation to each declining occupation, the analysis calculates the distance from the multidimensional points representing the emerging occupations to those representing the declining occupations. This ranking enables the identification of emerging occupations that are closer or more similar to declining occupations in terms of skill profiles.

In this analysis, only the "level" values of the variables are considered, not the ones labeled as "importance." The decision to exclude "importance" values is based on the understanding that the level values provide more variation and are more informative to the analysis. Including the importance values would be redundant and would not contribute additional information.

Matching and Clustering

Once we calculate a dissimilarity measure, we use Ward's agglomerative method to cluster 31 declining coal-fired power plant occupations and 22 declining coal mining occupations as well as 42 emerging occupations into homogeneous groupings (Ward, 1963). Ward's method is a hierarchical clustering algorithm that groups observations with similar characteristics to identify patterns in the data. For the coal-fired power plant occupations, the clustering process results in the formation of three homogeneous clusters. Similarly, for the coal mining occupations, the clustering process results in the formation of four homogeneous clusters.[9]

The study includes:

- Three heat map tables corresponding to the coal-fired power plant skillshed analysis (Tables 4-6).
- Four heat map tables corresponding to the coal mining skillshed analysis (Tables 7-10).

Results for Coshocton County, BHRC, and OMEGA as part of Ohio Southeast Region

In the Coal Fired Power Plant analysis, three distinct groups or clusters have been identified based on the skill requirements of the occupations within each cluster. The following is a description of each group:

Group 1: This group includes occupations that require a high level of proficiency in the "Updating and Using Relevant Knowledge" skill (average rating of 4.9), the "Processing Information" skill (average rating of 4.7), and the "Organizing Planning and Prioritizing Work" skill (average rating of 4.7). Occupations within this cluster typically require training in vocational schools, related on-the-job experience, or an associate's degree. In some cases, they require a four-year bachelor's degree. The Job Zone for occupations in this group is 3.5, indicating a medium level of preparation needed.

---

[9] Examining CCC, the Pseudo-T-squared and Pseudo F, the choice of 4 clusters is reasonable.

Group 2: This group includes occupations that require a high level of proficiency in the "Customer and Personal Service" skill (average rating of 5.03), the "Handling and Moving Objects" skill (average rating of 4.9), and the "Controlling Machines and Processes" skill (average rating of 4.4). Occupations within this cluster typically require a high school diploma, but previous work-related skills, knowledge, or experience are usually needed as well. The Job Zone for occupations in this group is 2.2, indicating a lower level of preparation needed.

Group 3: This group includes occupations that require a high level of proficiency in the "Establishing and Maintaining Interpersonal Relationships" skill (average rating of 4.7), the "Organizing, Planning, and Prioritizing Work" skill (average rating of 4.7), and the "Updating and Using Relevant Knowledge" skill (average rating of 4.5). Occupations within this cluster typically require training in vocational schools, related on-the-job experience, or an associate's degree. The Job Zone for occupations in this group is 3.1, indicating a medium level of preparation needed.

For Coal Mining analysis, Group 1: This group includes occupations that require a high level of proficiency in the "Making Decisions and Solving Problems" skill (average rating of 4.9), the "Updating and Using Relevant Knowledge" skill (average rating of 4.9), and the "Organizing Planning and Prioritizing Work" skill (average rating of 4.9). Occupations within this cluster typically require training in vocational schools, related on-the-job experience, or an associate's degree. In some cases, they require a four-year bachelor's degree. The Job Zone for occupations in this group is 3.5, indicating a medium level of preparation needed.

Group 2: This group includes occupations that require a high level of proficiency in the "Establishing and Maintaining Interpersonal Relationships" skill (average rating of 4.7) and the "Customer and Personal Service" skill (average rating of 4.8). Occupations within this cluster typically require training in vocational schools, related on-the-job experience, or an associate's degree. The Job Zone for occupations in this group is 3.2, indicating a medium level of preparation needed.

Group 3: This group includes occupations that require a high level of proficiency in the "Handling and Moving Objects" skill (average rating of 4.9) and the "Controlling Machines

and Processes" skill (average rating of 4.1). Occupations within this cluster typically require a high school diploma and some previous work-related skills, knowledge, or experience, ranging, on average, from a few months to one year. The Job Zone for occupations in this group is 1.9, indicating a lower level of preparation needed.

Group 4: This group includes occupations that require a high level of proficiency in the "Controlling Machines and Processes" skill (average rating of 5.1) and the "Handling and Moving Objects" skill (average rating of 5.5). Occupations within this cluster typically require a high school diploma and some previous work-related skills, knowledge, or experience, ranging, on average, from a few months to one year. The Job Zone for occupations in this group is 2.2, indicating a lower level of preparation needed.

Individuals who are preparing to enter the labor force or considering a career change can benefit from focusing on occupational categories that are projected to experience high employment growth. By aligning their career plans with emerging occupations in growing industries such as the petrochemical sector, individuals can increase their chances of securing employment opportunities and adapting to the changing labor market.

The skillshed analysis conducted in the report compares the skill requirements of petrochemical and other emerging occupations with the occupational experience of the region's declining coal economy workforce. This comparison helps identify areas of overlap and highlights the need for improvements and targeted regional initiatives.

While specific occupations may become obsolete, the skills acquired by individuals in declining occupations can still be repurposed and utilized in emerging fields. In some cases, immediate skill repurposing may be possible, allowing individuals to transition smoothly into new roles. However, in other instances, additional training or education may be necessary to enhance existing skills or acquire new ones to match the requirements of emerging occupations.

Recognizing the value of skills and the potential for repurposing them, regional initiatives can be developed to provide targeted training programs, educational opportunities, and supportive policies. These initiatives can help the region's declining coal economy workforce to adapt and acquire the necessary skills to thrive in emerging industries.

By emphasizing the importance of skills and acknowledging that occupations may change over time, individuals and policymakers can take a proactive approach to career planning and workforce development. This mindset encourages continuous learning, skill enhancement, and the effective navigation of occupational transitions.

Mapping

We map the skillsets of declining coal economy occupations to the skillsets of petrochemical and other emerging occupations in Ohio Southeast using the methodology previously explained. Tables 4-10 show heat maps based on the occupational dissimilarity measure. The lowest dissimilarity measures are coded dark green and show the easiest occupational transitions while the largest dissimilarity measures are coded bright red. A large dissimilarity measure (an orange to red color) implies that additional human capital investments (i.e., substantial retraining) are needed in order to perform the tasks required by emerging occupations.

We also include median hourly wage differences inside the colored cells. Median hourly wage differentials are the difference between the median hourly wages in emerging and declining occupations. By examining the tables, one can make an informed career decision using both a color indicator describing the challenge associated with an occupational transition and the wage differential in dollars.

Coal Fired Power Plant Occupations

Table 4 includes the results of the skillshed analysis for cluster 1—transitioning from White Collar Occupations into Occupations Requiring Mechanical/Engineering/ Administration and Management Skills Cluster. Within this cluster, there are 11 declining occupations that could transition into seven emerging occupations.

The analysis examines the training intensity and wage differences associated with these transitions. The most intensive transition identified in this cluster is from the declining "Computer Systems Analysts" occupation to the emerging "Chemical Engineers" occupation, which requires significant retraining. However, it offers a substantial increase in hourly wage, amounting to $12.62.

On the other hand, the transition from "Mechanical Engineering Technologist" to "Industrial Engineering Technologist" requires the least retraining within this cluster, with a wage increase of $1.36 per hour. Transitioning from the declining occupation "Industrial Production Managers" to any of the seven emerging occupations in this cluster results in a decrease in hourly wage for those employees. Transitioning from "Surveying and Mapping Technicians" into "Materials Scientists" will generate the highest gain in hourly wages at $28.42. Transitioning from "Industrial Production Managers" into "Carpenters" will generate the highest loss in hourly wages at $30.51.

Table 5 shows the skillshed analysis for cluster 2—transitions from White Collar Occupations into Occupations Requiring Medical/Administration and Management Skills. The most intense transition identified is from the declining "Chief Executives" occupation to the emerging "Receptionists and Information Clerk" occupation. It results in a decrease of $50.63 in hourly wages for the employees.

The three transitions requiring the least retraining in this cluster are from the declining "Bookkeeping, Accounting, and Auditing Clerks" occupation to the emerging "Customer Service Representatives", "Medical Secretaries", or "Receptionists and Information Clerk" occupations. They require minimal retraining, but these transitions result in a loss in hourly wages, at $1.74, $1.74, and $3.66, respectively.

It's worth noting that transitioning from the declining "Chief Executives" occupation to any of the 17 emerging occupations in this cluster leads to a decrease in hourly wages for the employees. "Bookkeeping, Accounting, and Auditing Clerks" to "General and Operations Managers" transitions will generate the highest gain in hourly wages at $36.11. Transitioning from "Chief Executives" to "Cooks, Institution and Cafeteria", "Nursing Assistants," and "Receptionists and Information Clerk" will generate the highest loss in hourly wage at $50.63.

Table 6 includes the results of the skillshed analysis for cluster 3—transitioning from Blue-Collar Occupations into Occupations Requiring Mechanical Skills Cluster. Within this cluster, there are 14 declining occupations that can potentially transition to 18 emerging occupations.

The most intense transition identified in Cluster 3 is from the declining "Electrical and Electronics Repairer, Powerhouse, Substation, and Relay" occupation to the emerging "Landscaping and Groundskeeping Workers" occupation. This transition requires significant retraining effort, but it results in an hourly wage decrease of $17.77 for employees.

The transition with the least retraining effort identified in this cluster is from the declining "Meter Readers, Utilities" occupation to the emerging "Light Truck Drivers" occupation. While it requires minimal retraining, this transition results in an hourly wage loss of $4.37.

Transitions from "Laborers and Freight, Stock, and Material Movers, Hand" to "Chemical Plant and System Operators" will lead to the highest hourly wage increase at $17.72. Transitions from "Gas Plant Operators" and "Power Plant Operators" to "Landscaping and Groundskeeping Workers" will lead to the highest loss in hourly wages at $27.00.

Table 4. Transitions from 11 Declining Occupations into 7 Emerging Occupation, Ohio Southeast

CLUSTER 1: Transitions from White Collar Occupations into Occupations Requiring Mechanical/Engineering/ Administration and Management Skills	Computer Programmers	Computer Systems Analysts	Electrical Engineers	Electrical and Electronics Drafters	Electronics Engineers, Except Computer	Environmental Engineering Technicians	First-Line Supervisors of Production and Operating Workers	Industrial Production Managers	Mechanical Engineering Technologist	Power Distributors and Dispatchers	Surveying and Mapping Technicians
Carpenters	(16.35)	(13.47)	(21.59)	(7.90)	(25.59)	(3.39)	(6.45)	(30.51)	(5.84)	(21.74)	(0.41)
Chemical Engineers	9.74	12.62	4.50	18.19	0.50	22.7	19.64	(4.42)	20.25	4.35	25.68
Chemical Technicians	(13.26)	(10.38)	(18.5)	(4.81)	(22.5)	(0.30)	(3.36)	(27.42)	(2.75)	(18.65)	2.68
Chemists	(3.27)	(0.39)	(8.51)	5.18	(12.51)	9.69	6.63	(17.43)	7.24	(8.66)	12.67
First-Line Supervisors of Construction Trades and Extraction Workers	(4.33)	(1.45)	(9.57)	4.12	(13.57)	8.63	5.57	(18.49)	6.18	(9.72)	11.61
Industrial Engineering Technologist	(9.15)	(6.27)	(14.39)	(0.70)	(18.39)	3.81	0.75	(23.31)	1.36	(14.54)	6.79
Materials Scientists	12.48	15.36	7.24	20.93	3.24	25.44	22.38	(1.68)	22.99	7.09	28.42

Note: values in parentheses show occupational transitions with a decline in median hourly wages.

Table 5. Transitions from 6 Declining Occupations into 17 Emerging Occupations, Ohio Southeast

CLUSTER 2: Transitions from White Collar Occupations into Occupations Requiring Medical/Administration and Management Skills	Bookkeeping, Accounting, and Auditing Clerks	Buyers and Purchasing Agents	Chief Executives	Executive secretaries and Executive Administrative Assistants	Human Resources Assistants, Except Payroll and Timekeeping	Production, Planning, and Expediting Clerks
Accountants and Auditors	11.72	(2.63)	(35.25)	0.29	10.26	4.19
Clergy	5.47	(8.88)	(41.50)	(5.96)	4.01	(2.06)
Cooks, Institution and Cafeteria	(3.66)	(18.01)	(50.63)	(15.09)	(5.12)	(11.19)
Customer Service Representatives	(1.74)	(16.09)	(48.71)	(13.17)	(3.20)	(9.27)
First-Line Supervisors of Food Preparation and Serving Workers	(2.70)	(17.05)	(49.67)	(14.13)	(4.16)	(10.23)
First-Line Supervisors of Office and Administrative Support Workers	7.40	(6.95)	(39.57)	(4.03)	5.94	(0.13)
First-Line Supervisors of Personal Service Workers	0.67	(13.68)	(46.30)	(10.76)	(0.79)	(6.86)
General and Operations Managers	36.11	21.76	(10.86)	24.68	34.65	28.58
Licensed Practical and Licensed Vocational Nurses	2.59	(11.76)	(44.38)	(8.84)	1.13	(4.94)
Medical Assistants	(1.74)	(16.09)	(48.71)	(13.17)	(3.20)	(9.27)
Medical Secretaries	(1.74)	(16.09)	(48.71)	(13.17)	(3.20)	(9.27)
Nursing Assistants	(3.66)	(18.01)	(50.63)	(15.09)	(5.12)	(11.19)
Pharmacy Technicians	(3.18)	(17.53)	(50.15)	(14.61)	(4.64)	(10.71)
Receptionists and Information Clerk	(3.66)	(18.01)	(50.63)	(15.09)	(5.12)	(11.19)
Registered Nurses	13.65	(0.70)	(33.32)	2.22	12.19	6.12
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	14.63	0.28	(32.34)	3.20	13.17	7.10
Social and Human Service Assistants	(1.26)	(15.61)	(48.23)	(12.69)	(2.72)	(8.79)

Note: values in parentheses show occupational transitions with a decline in the median hourly wages.

Table 6. Transitions from 14 Declining Occupations into 18 Emerging Occupations, Ohio Southeast

CLUSTER 3: Transitions from Blue-Collar Occupations into Occupations Requiring Mechanical Skills	Control and Valve Installers and Repairers, Except Mechanical Door	Electrical Power-Line Installers and Repairers	Electrical and Electronics Repairer, Powerhouse, Substation, and Relay	Excavating and Loading Machine and Dragline Operators	Gas Plant Operators	Helpers--Installation, Maintenance, and Repair Workers	Industrial Machinery Mechanics	Inspectors, Testers, Sorters, Samplers, and Weighers	Laborers and Freight, Stock, and Material Movers, Hand	Machinists	Maintenance and Repair Workers, General	Meter Readers, Utilities	Power Plant Operators	Stationary Engineers and Boiler Operators
Automotive Service Technicians and Mechanics	(7.06)	(16.96)	(13.44)	(3.08)	(22.67)	2.59	(8.45)	(2.17)	3.04	(0.67)	(1.88)	(3.41)	(22.67)	(11.09)
Bus Drivers, Transit and Intercity	(9.47)	(19.37)	(15.85)	(5.49)	(25.08)	0.18	(10.86)	(4.58)	0.63	(3.08)	(4.29)	(5.82)	(25.08)	(13.50)
Chemical Equipment Operators and Tenders	(0.76)	(10.66)	(7.14)	(3.22)	(16.37)	8.89	(2.15)	4.13	9.34	5.63	4.42	2.89	(16.37)	(4.79)
Chemical Plant and System Operators	7.62	(2.28)	1.24	11.6	(7.99)	17.27	6.23	12.51	17.72	14.01	12.8	11.27	(7.99)	3.59
Construction Laborers	(5.14)	(15.04)	(11.52)	(1.16)	(20.75)	4.51	(6.53)	(0.25)	4.96	1.25	0.04	(1.49)	(20.75)	(9.17)
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	(5.55)	(15.45)	(11.93)	(1.57)	(21.16)	4.10	(6.94)	(0.66)	4.55	0.84	(0.37)	(1.90)	(21.16)	(9.58)
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	(8.58)	(18.48)	(14.96)	(4.60)	(24.19)	1.07	(9.97)	(3.69)	1.52	(2.19)	(3.40)	(4.93)	(24.19)	(12.61)
Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	(4.79)	(14.69)	(11.17)	(0.81)	(20.4)	4.86	(6.18)	0.10	5.31	1.60	0.39	(1.14)	(20.40)	(8.82)
Food Batchmakers	(10.91)	(20.81)	(17.29)	(6.93)	(26.52)	(1.26)	(12.30)	(6.02)	(0.81)	(4.52)	(5.73)	(7.26)	(26.52)	(14.94)
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	(3.22)	(13.12)	(9.60)	(0.76)	(18.83)	6.43	(4.61)	1.67	6.88	3.17	1.96	0.43	(18.83)	(7.25)
Heavy and Tractor-Trailer Truck Drivers	(2.74)	(12.64)	(9.12)	(1.24)	(18.35)	6.91	(4.13)	2.15	7.36	3.65	2.44	0.91	(18.35)	(6.77)
Landscaping and Groundskeeping Workers	(11.39)	(21.29)	(17.77)	(7.41)	(27.00)	(1.74)	(12.78)	(6.50)	(1.29)	(5.00)	(6.21)	(7.74)	(27.00)	(15.42)
Light Truck Drivers	(8.02)	(17.92)	(14.40)	(4.04)	(23.63)	1.63	(9.41)	(3.13)	2.08	(1.63)	(2.84)	(4.37)	(23.63)	(12.05)
Mixing and Blending Machine Setters, Operators, and Tenders	(5.33)	(15.23)	(11.71)	(1.35)	(20.94)	4.32	(6.72)	(0.44)	4.77	1.06	(0.15)	(1.68)	(20.94)	(9.36)
Packaging and Filling Machine Operators and Tenders	(7.44)	(17.34)	(13.82)	(3.46)	(23.05)	2.21	(8.83)	(2.55)	2.66	(1.05)	(2.26)	(3.79)	(23.05)	(11.47)
Plumbers, Pipefitters, and Steamfitters	0.15	(9.75)	(6.23)	4.13	(15.46)	9.80	(1.24)	5.04	10.25	6.54	5.33	3.80	(15.46)	(3.88)
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	6.04	(3.86)	(0.34)	10.02	(9.57)	15.69	4.65	10.93	16.14	12.43	11.22	9.69	(9.57)	2.01
Welders, Cutters, Solderers, and Brazers	(5.14)	(15.04)	(11.52)	(1.16)	(20.75)	4.51	(6.53)	(0.25)	4.96	1.25	0.04	(1.49)	(20.75)	(9.17)

Note: values in parentheses show occupational transitions with a decline in the median hourly wages.

Coal Mining Occupations

Table 7 shows the findings of the skillshed analysis for Cluster 1, which focuses on transitions from declining white-collar occupations into emerging occupations requiring mechanical/engineering/administration and management skills cluster.

The most intensive transition identified in this cluster is from the declining "Occupational Health and Safety Specialists" occupation to the emerging "Chemical Technicians" occupation. This transition requires significant retraining, but results in an hourly wage decrease of $10.98 in hourly wages.

On the other hand, the transition from "Explosives Workers, Ordnance Handling Experts, and Blasters" to "First-Line Supervisors of Construction Trades and Extraction Workers" is the least intensive transition, which requires minimal retraining. This transition leads to an increase of $7.19 in hourly wages for employees.

Two transitions, namely from "Explosives Workers, Ordnance Handling Experts, and Blasters" and "Surveyors" to "Materials Scientists" generate the highest gain in hourly wages, amounting to $24.00. Conversely, the transition from "Industrial Production Managers" to "Carpenters" results in the highest loss in hourly wages, with a decrease of $30.51.

Table 8 shows the skillshed analysis for cluster 2—transitions from White Collar Occupations into Occupations Requiring Medical/Administration and Management Skills Cluster. The most intensive transition identified in this cluster is from the declining "Bookkeeping, Accounting, and Auditing Clerks" occupation to the emerging "Clergy" occupation. This transition requires significant retraining effort and results in an increase of $5.47 in hourly wages for employees.

On the other hand, the transition from "Bookkeeping, Accounting, and Auditing Clerks" to "Customer Service Representatives" is the least intensive transition, but it leads to a loss of $1.74 in hourly wages for employees.

In general, transitioning to "General and Operations Managers" within this cluster results in the highest gain in hourly wage. For "Bookkeeping, Accounting, and Auditing Clerks", the gain is $36.11, and for "Buyers and Purchasing Agents", the gain is $21.76.

Conversely, transitions from "Buyers and Purchasing Agents" to "Cooks, Institution and Cafeteria," "Nursing Assistants," and "Receptionists and Information Clerk" result in the highest loss in hourly wages, amounting to $18.01.

Table 9 shows data related to cluster 3—transitions from Blue-Collar Occupations into Occupations Requiring Customer and Personal Service/Mechanical Skills Cluster. Transitioning from "Pump Operators, Except Wellhead Pumpers" to "Bus Drivers, Transit and Intercity" is the most intensive transition, and employees will lose $5.78 in their hourly wages.

Transitioning from "Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders" to "Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders" is the least intensive transition which leads to a gain of $9.57 in hourly wages.

Transitioning from "Inspectors, Testers, Sorters, Samplers, and Weighers" to "Chemical Plant and System Operators" will generate the highest gain in hourly wages at $12.51. Conversely, the transition from "Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders" to "Landscaping and Groundskeeping Work" results in the highest loss in hourly wages at $7.86.

Table 10 corresponds to cluster 4—transitions from Blue Collar Occupations into Occupations Requiring Mechanical Skill Cluster. The most intensive transition identified in this cluster is from the declining "Operating Engineers and Other Construction Equipment Operators" occupation to the emerging "Construction Laborers" occupation. This transition requires significant retraining effort and results in a decrease of $3.48 in hourly wages for employees.

Transitioning from "Mobile Heavy Equipment Mechanics, Engines" to "Automotive Service Technicians and Mechanics" is the least intensive transition but results in a loss of $7.45 in hourly wages. The transition from "Helpers-Extraction Workers" to "Plumbers, Pipefitters, and Steamfitters" generates the highest gain in hourly wage within this cluster, amounting to $5.54. Transitioning from "Roof Bolters, Mining" to "Automotive Service Technicians and Mechanics" will generate the highest loss in hourly wages at $11.90.

Table 7. Transitions from 6 Declining Occupations into 7 Emerging Occupations, Ohio Southeast

CLUSTER 1: Transitions from White Collar Occupations into Occupations Requiring Mechanical/Engineering/ Administration and Management Skills	Explosives Workers, ordnance handling experts, and blasters	First-Line Supervisors of Production and Operating Workers	Industrial Production Managers	Mining and Geological Engineers, Including Mining Safety Engineers	Occupational Health and Safety Specialists	Surveyors
Carpenters	(4.83)	(6.45)	(30.51)	(19.51)	(14.07)	(4.83)
Chemical Engineers	21.26	19.64	(4.42)	6.58	12.02	21.26
Chemical Technicians	(1.74)	(3.36)	(27.42)	(16.42)	(10.98)	(1.74)
Chemists	8.25	6.63	(17.43)	(6.43)	(0.99)	8.25
First-Line Supervisors of Construction Trades and Extraction Workers	7.19	5.57	(18.49)	(7.49)	(2.05)	7.19
Industrial Engineering Technologist	2.37	0.75	(23.31)	(12.31)	(6.87)	2.37
Materials Scientists	24.00	22.38	(1.68)	9.32	14.76	24.00

Note: values in parentheses show occupational transitions with a decline in median hourly wages.

Table 8. Transitions from 2 Declining Occupations into 17 Emerging Occupations, Ohio Southeast

CLUSTER 2: Transitions from White Collar Occupations into Occupations Requiring Medical/Administration and Management Skills	Bookkeeping, Accounting, and Auditing Clerks	Buyers and Purchasing Agents
Accountants and Auditors	11.72	(2.63)
Clergy	5.47	(8.88)
Cooks, Institution and Cafeteria	(3.66)	(18.01)
Customer Service Representatives	(1.74)	(16.09)
First-Line Supervisors of Food Preparation and Serving Workers	(2.70)	(17.05)
First-Line Supervisors of Office and Administrative Support Workers	7.40	(6.95)
First-Line Supervisors of Personal Service Workers	0.67	(13.68)
General and Operations Managers	36.11	21.76
Licensed Practical and Licensed Vocational Nurses	2.59	(11.76)
Medical Assistants	(1.74)	(16.09)
Medical Secretaries	(1.74)	(16.09)
Nursing Assistants	(3.66)	(18.01)
Pharmacy Technicians	(3.18)	(17.53)
Receptionists and Information Clerk	(3.66)	(18.01)
Registered Nurses	13.65	(0.70)
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	14.63	0.28
Social and Human Service Assistants	(1.26)	(15.61)

Note: values in parentheses show occupational transitions with a decline in median hourly wages.

Table 9. Transitions from 3 Declining Occupations into 13 Emerging Occupations, Ohio Southeast

CLUSTER 3: Transitions from Blue-Collar Occupations into Occupations Requiring Customer and Personal Service/Mechanical Skills	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	Inspectors, Testers, Sorters, Samplers, and Weighers	Pump Operators, Except Wellhead Pumpers
Bus Drivers, Transit and Intercity	(5.94)	(4.58)	(5.78)
Chemical Equipment Operators and Tenders	2.77	4.13	2.93
Chemical Plant and System Operators	11.15	12.51	11.31
Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	(5.05)	(3.69)	(4.89)
Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	(1.26)	0.10	(1.10)
Food Batchmakers	(7.38)	(6.02)	(7.22)
Heavy and Tractor-Trailer Truck Drivers	0.79	2.15	0.95
Landscaping and Groundskeeping Work	(7.86)	(6.50)	(7.70)
Light Truck Drivers	(4.49)	(3.13)	(4.33)
Mixing and Blending Machine Setters, Operators, and Tenders	(1.8)	(0.44)	(1.64)
Packaging and Filling Machine Operators and Tenders	(3.91)	(2.55)	(3.75)
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	9.57	10.93	9.73
Welders, Cutters, Solderers, and Brazers	(1.61)	(0.25)	(1.45)

Note: values in parentheses show occupational transitions with a decline in median hourly wages.

Table 10. Transitions from 11 Declining Occupations into 4 Emerging Occupations, Ohio Southeast

CLUSTER 4: Transitions from Blue Collar Occupations into Occupations Requiring Mechanical Skill	Continuous Mining Machine Operators	Conveyor Operators and Tenders	Earth Drillers, Except Oil and Gas	Excavating and Loading Machine and Dragline Operators	Helpers--Extraction Workers	Hoist and Winch Operators	Loading and Moving Machine Operator	Mobile Heavy Equipment Mechanics, Engines	Operating Engineers and Other Construction Equipment Operators	Roof Bolters, Mining	Tank Car, Truck, and Ship Loaders
Automotive Service Technicians and Mechanics	(9.85)	(2.77)	(6.36)	(3.08)	(1.67)	(8.31)	(2.98)	(7.45)	(5.40)	(11.90)	(6.91)
Construction Laborers	(7.93)	(0.85)	(4.44)	(1.16)	0.25	(6.39)	(1.06)	(5.53)	(3.48)	(9.98)	(4.99)
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	(6.01)	1.07	(2.52)	0.76	2.17	(4.47)	0.86	(3.61)	(1.56)	(8.06)	(3.07)
Plumbers, Pipefitters, and Steamfitters	(2.64)	4.44	0.85	4.13	5.54	(1.10)	4.23	(0.24)	1.81	(4.69)	0.30

Note: values in parentheses show occupational transitions with a decline in median hourly wages.

Discussion and Recommendations for Coshocton County

Skillshed analyses play an important role in understanding the impact of sectoral shifts on the economy and guiding communities through changing labor markets. By assessing the skills and occupations affected by negative economic shocks such as job losses in the energy sector, skillshed analyses provide insights into the workforce's needs and potential transitional pathways.

Integrating skillshed analyses into economic development planning enables communities to proactively respond to employers' demands of. By identifying the skills required for projected job openings, especially within targeted industry clusters, displaced workers can be trained and equipped with the necessary skills to meet those demands. This proactive approach helps minimize the impact of economic shocks, supports smoother transitions for workers, and positions communities to better meet the needs of current and prospective employers.

This analysis aims to provide valuable guidance to displaced workforce in the coal economy using heat maps to help employees navigate occupational changes. This visual representation helps individuals understand the potential challenges and opportunities that come with transitioning to different occupations outside of the coal industry, which has long been a source of good jobs and economic prosperity.

The heat map allows displaced workers to identify two potential paths. On one hand are smooth transitions: there may be occupations available that require little to no skill shifts, though it is important to note that these occupations may lead to a decrease in wages compared to those in the declining coal economy. On the other hand, there are transitions requiring significant investments of time and resources, made up of emerging occupations that offer better wages but have differing skillsets.

Using the provided heat maps, individuals can make more informed decisions about their career transitions. They can weigh the trade-offs between immediate employment opportunities with potentially lower wages and investments in new skills that may lead to higher-paying occupations in the long run. Ultimately, the heat maps serve as a tool to

assist displaced workers in navigating their career choices and understanding the potential outcomes associated with each option.

In cluster 1 of the skillshed analysis for the coal fired power plant industry, the results indicate that in most cases, transitions to "Chemical Engineers" and "Materials Scientists" are associated with higher median hourly wages. For instance, those who decide to transition from "Surveying and Mapping Technicians" to "Materials Scientists" will experience an increase of $28.42 in their hourly wages. These two occupations have similar needs like computers and electronics, instructing, mathematics, learning strategies skills and knowledge needs, while in chemistry and physics, they are very different. This transition also requires a bachelor's degree—a long-run investment in career path.

In cluster 2 of the skillshed analysis for the coal fired power plant industry, "Accountants and Auditors", "General and Operations Managers", "Registered Nurses", "Sales Representatives", and "Wholesale and Manufacturing, Except Technical and Scientific Products" are a few emerging occupations that, in most cases, lead to higher wages. For example, transitioning from "Buyers and Purchasing Agents" to "General and Operations Managers" will increase hourly wages by $21.76. They are similar in computers and electronics, administrative, mathematics, and economics and accounting skills and knowledge, but not in those reflecting personnel and human resources needs. Both occupations require a bachelor's degree.

In cluster 3 of the skillshed analysis for the coal fired power plant industry, most transitions to "Chemical Plant and System Operators" and "Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders" will lead to higher hourly wages. For instance, an employee transitioning from "Inspectors, Testers, Sorters, Samplers, and Weighers" to "Chemical Plant and System Operators" will see an hourly wage increase of $12.51. Quality Control Analysis, Mechanical, Critical Thinking, and Active Listening are similar skills and knowledge between the two occupations, while Operations Monitoring is a skill that is not. Both occupations need a high school diploma or equivalent.

In cluster 1 of the skillshed analysis for the coal mining industry, the results indicate that in most cases, transitions to "Chemical Engineers" and "Materials Scientists" result in a higher median hourly wage. Transitioning from "Mining and Geological Engineers, Including Mining Safety Engineers" to "Chemical Engineers" increases hourly wages by $6.58. Monitoring, Administration and Management are similar skills, while Chemistry and Physics are skills that are different between the two occupations. Both occupations require a bachelor's degree.

In cluster 2 of the skillshed analysis for the coal mining industry, transitioning to "General and Operations Managers" and "Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products" leads to an increase in hourly wages. Transitioning from "Bookkeeping, Accounting, and Auditing Clerks" to "General and Operations Managers" increases the hourly wage by $36.11. In Production and Processing and Administration and Management skills and knowledge, the two occupations are different. However, in Computers and Electronics, Active Listening, Reading Comprehension, and Active Learning skills, they are similar. This transition requires a bachelor's degree.

In cluster 3 of the skillshed analysis for the coal mining industry, transitions to "Chemical Equipment Operators and Tenders", "Chemical Plant and System Operators", "Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders" and "Heavy and Tractor-Trailer Truck Drivers" will lead to higher hourly wages. Transitioning from "Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders" to "Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders" increases hourly wages by $9.57. Both occupations need a high school diploma or equivalent.

In cluster 4 of the skillshed analysis for the coal mining industry, transitions to "Heating, Air Conditioning, and Refrigeration Mechanics and Installers" and "Plumbers, Pipefitters, and Steamfitters" typically led to higher hourly wages. Specifically, the transition from "Conveyor Operators" and "Tenders to Plumbers, Pipefitters, and Steamfitters" leads to an hourly wage of $4.44. Both occupations are similar in critical thinking skills and are different in building and construction and design. "Conveyor Operators and Tenders" do

not need any formal educational credentials, while "Plumbers, Pipefitters, and Steamfitters" need a high school diploma or equivalent.

Workforce training plays a crucial role in reintegrating individuals who have been displaced from the coal economy into the labor market, especially in emerging fields such as the petrochemical industry. To effectively implement workforce training programs, technical assistance and leadership from key regional partners and relevant economic development organizations are essential. These entities can provide valuable guidance, resources, and support to ensure that the positive economic shock resulting from the introduction of a growing industry maximizes its impact in the region.

One of the major challenges faced by displaced workers is access to information. Providing clear and comprehensive communication to displaced workers and their regional advocates about occupational opportunities is crucial. This information can empower individuals to make informed decisions about their career transitions while helping them understand available opportunities in emerging industries. By addressing this information gap, workforce development efforts can be better targeted and lead to improved regional economies and enhanced prosperity and living standards for all.

In summary, workforce training, technical assistance, and effective communication of the skillshed analysis results are vital in helping displaced workers transition into new fields such as the petrochemical industry. By leveraging the expertise of partners and economic development organizations, regions can maximize the positive impact of emerging industries and provide the necessary support to ensure the successful reintegration of displaced workers into the labor market.

Workforce training for individuals who have been displaced in the coal economy may be a necessary strategy to re-introduce workers into the labor market of other fields, especially the petrochemical industry. Technical assistance and leadership from key regional partners and relevant economic development organizations are vital to better the impact of positive economic shocks that result from introducing a new and growing industry to a region. Access to information serves as one of the main challenges that displaced workers face, meaning that communicating the results of the skillshed analysis with displaced workers and their regional advocates is a necessary step towards future

workforce development designed to improve regional economies and enhance prosperity and living standards for all.

References

Iowa Innovation Gateway (2010). Iowa innovation Gateway skillshed analysis: A study of occupational clusters, skills, & gap analysis in the Iowa innovation Gateway. *Des Moines: Iowa Innovation Gateway.*

Nolan, C., Morrison, E., Kumar, I., Galloway, H., & Cordes, S. (2011). Linking industry and occupation clusters in regional economic development. *Economic Development Quarterly*, *25*(1), 26-35.

Scott, H., & Kotlyar, I. (2013). A review of skillshed analysis practices and outcomes. *A report prepared for Social Sciences and Humanities Research Council (file# 412-2013-2006) under the Knowledge Synthesis Grants: Skills Development for Future Needs of the Canadian Labour Market competition.*

Ward Jr, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American statistical association*, *58*(301), 236-244.