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An Economic Analysis of the Appalachian Coal Industry Ecosystem: Summary Report

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An Economic Analysis of the Appalachian Coal Industry Ecosystem: Summary Report

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An Economic Analysis of the Appalachian Coal Industry Ecosystem: Summary Report

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January, 2018

Abstract

The decline in the demand for coal has led to significant negative impacts in a reas t throughout Appalachia. Consider the integrated effects across components of the coal industry ecosystem (CIE). As extraction activity is diminished, there are ripples through the industry supply chain that extends to a wide number of sectors, occupations, and county and multi-county regions of the Appalachian economy. As these suppliers are impacted, jobs are imperiled, and the fiscal health of communities is weakened. Displaced workers will need to seek alternative employment opportunities that may entail investments in formal education and training, and this takes both time and resources. As the economic base suffers, state and local governments will see their capacity to fund education weaken as well. The decline in natural gas prices and increasing environmental concerns, along with the age of the capital stock, has affected coal-fired power generation in the Appalachian Region. When capacity is replaced by natural gas, the demand for the Region's coal is further distressed. The shifting structure and spatial location of power generation creates additional impacts on the economic base, tax base, and employment prospects. A vibrant rail transportation infrastructure has developed to support coal-related commerce and this regional asset is now at risk. Retirement of portions of the railroad capital stock may translate into higher transportation costs and diminished opportunities for economic development tied to the movement of bulk commodities, inputs, and final products.

The original version of this report is available on the Appalachian Regional Commission website [Appalachian Regional Commission](https://www.arc.gov/wp-content/uploads/2018/01/CIESummary-AppalachianCoalIndustryEcosystemAnalysis.pdf) website.

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An Economic Analysis of the Appalachian Coal Industry Ecosystem

Summary
Report

West Virginia University
and
The University of Tennessee

Prepared for the
Appalachian Regional Commission
under contract # PW-18673-16
January 2018





AN ECONOMIC ANALYSIS OF THE APPALACHIAN COAL INDUSTRY ECOSYSTEM

Summary Report Submitted to the
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Washington, D.C. 20009-1068

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By West Virginia University
and
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An Economic Analysis of the Appalachian Coal Industry Ecosystem

Summary Report

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An Economic Analysis of the Appalachian Coal Industry Ecosystem

Report Overview

The decline in the demand for coal has led to significant negative impacts in areas throughout Appalachia. Consider the integrated effects across components of the coal industry ecosystem (CIE). As extraction activity is diminished, there are ripples through the industry supply chain that extends to a wide number of sectors, occupations, and county and multi-county regions of the Appalachian economy. As these suppliers are impacted, jobs are imperiled, and the fiscal health of communities is weakened. Displaced workers will need to seek alternative employment opportunities that may entail investments in formal education and training, and this takes both time and resources. As the economic base suffers, state and local governments will see their capacity to fund education weaken as well. The decline in natural gas prices and increasing environmental concerns, along with the age of the capital stock, has affected coal-fired power generation in the Appalachian Region. When capacity is replaced by natural gas, the demand for the Region's coal is further distressed. The shifting structure and spatial location of power generation creates additional impacts on the economic base, tax base, and employment prospects. A vibrant rail transportation infrastructure has developed to support coal-related commerce and this regional asset is now at risk. Retirement of portions of the railroad capital stock may translate into higher transportation costs and diminished opportunities for economic development tied to the movement of bulk commodities, inputs, and final products.

This project was designed to examine comprehensively the Appalachian CIE through in-depth quantitative analysis. Through project research we identify, quantify, synthesize, and map multiple ecosystem dimensions for Appalachian counties. The CIE is characterized by the relationship and interdependence among coal mining, its supply chain linkages, transportation services, coal-fired power plants, and human capital resources. These interrelated systems analyses are assessed to provide a deeper understanding of the CIE, its supply-chain interdependencies and supporting transportation infrastructures, and its impacts on social and economic welfare. We identify and assess the historical and anticipated impacts of trends in coal production, transportation, and coal-based power generation, as well as impacts on the supply-chain linked industry and human capital resources in Appalachia that affect the path of regional economic development and individual well-being.

This research project comprises several interrelated goals and objectives. First, we provide an overview of economic conditions in Appalachia with an emphasis on activities related to the coal industry ecosystem. Next, a supply-chain analysis of county-based CIEs provides a rich characterization of coal-impacted counties by defining and measuring three related dimensions: CIE dependence, impact, and risk. These dimensions are defined using Region-based and own-county industry structure and are used to identify distinct CIE classes. Third, we assess where, when, and to what extent CIE related transportation impact hardships will be felt in Appalachian communities. In the fourth research project component, given the dominant role of coal-fired

power plants in Appalachia, we have used econometric analysis to understand the way in which coal-fired power plant shutdowns affect county-level economic outcomes. Our research pays special attention to how shutdowns of varying sizes exert disparate economic effects across larger versus smaller counties. The final part of the overall research project addresses the impacts that coal mining activity will have on the displacement/reabsorption of worker occupations, as well as the implications for resources available to fund public education, a key to future development in Appalachia.

This report consists of a compilation of executive summaries for each of the five individual task reports submitted separately, available as self-contained reports that can be accessed from the Appalachian Regional Commission website.

Task 1. An Overview of the Coal Economy in Appalachia

Eric Bowen, Christiadi, John Deskins, and Brian Lego, West Virginia University

This task report details major trends in coal production in the Appalachian Region over roughly the past decade. Highlights of this research are as follows:

COAL PRODUCTION

- **Overall Coal Production Decline:** Coal production fell by nearly 45 percent overall in Appalachia between 2005 and 2015. This is more than double the rate of national decline in coal production of around 21 percent.
- **Drivers of National Drop in Coal Demand:** Losses in coal production stem from a perfect storm of three major national factors that have depressed demand for coal: significant reductions in the cost of natural gas—a competitor fuel to coal in the electric power industry—due to greatly enhanced productive capacity; a regulatory environment that has increased the cost of burning coal for electric power generators; and weak international demand in recent years.
- **Concentration of Coal Production Losses:** Losses in coal production are heavily concentrated in Central Appalachia, primarily in southern West Virginia and eastern Kentucky. This concentration of losses can be traced to low coal mine worker productivity in this region. After aggressive mining in Central Appalachia for more than a century, the remaining coal is more expensive to extract, compared to other coal-producing regions, because it tends to be deeper in the ground and/or seams tend to be thinner.

- **Coal Production Forecast:** Our forecast predicts a stabilization of coal output in Appalachia. This results largely from the expectation of higher natural gas prices in coming years as infrastructure enhancements broaden markets for natural gas, as well as from an expectation that there will be no major regulatory changes that increase the cost of burning coal in coming years. While production in Northern and Southern Appalachia will largely remain stable, we expect a modest recovery in Central Appalachia due to improvements in global demand for metallurgical coal. Overall, however, expected improvements will capture only a small fraction of the decline that has been observed over the past decade.

EMPLOYMENT and UNEMPLOYMENT

- **Coal Industry Employment and Employment Diversification:** Coal industry employment fell by around 27 percent between 2005 and 2015. These losses were heavily concentrated in Central Appalachia. Further, the counties with the highest dependence on the coal industry tended to be rural counties in Central Appalachia. Overall, many of the counties that had the greatest dependence on the coal industry suffered the greatest losses in coal production and employment.
- **Total Private Sector Employment:** Total private-sector employment in Appalachian coal-mining counties has been generally flat over the past few years. Further, total private-sector employment in the mining counties in Central Appalachia has fallen substantially in recent years. These facts provide evidence that the decline in coal, coupled with heavy reliance on coal in some counties, has led to broader negative spillover effects to regional economies.
- **Unemployment:** Coal mining counties in Central Appalachia have consistently posted relatively high unemployment rates in recent years.
- **County Snapshot—Central and Northern Appalachia:** We provide a close examination of two specific heavy coal-producing counties—Marshall County, West Virginia, in Northern Appalachia, and Boone County, West Virginia, in Central Appalachia. Here we see that these counties have exhibited vastly different outcomes in recent years in terms of the coal industry and in terms of broader economic outcomes. Our analysis highlights how economic conditions can vary widely across counties.

POPULATION, LABOR FORCE, and POPULATION AGE DISTRIBUTION

- **Population and Labor Force:** Total population has fallen by a small margin in the coal mining counties of Central Appalachia in recent years, perhaps partly as a result of the decline in the coal industry. Although the overall population loss has been relatively modest, the drop has been especially pronounced in the prime working-age population in the mining counties of Appalachia. The labor force has declined substantially in the coal mining counties of Central Appalachia.

- **Population Age Distribution:** Partially as a result of the loss in prime working-age residents, coal-mining counties in Appalachia have experienced noticeable increases in the share of individuals who are of retirement age.

INCOME and POVERTY

- **Wages and Salary Income:** Wages and salary income per job tends to be higher in the mining counties of Appalachia, compared to non-mining Appalachian counties. This is likely the result, in part, of high wages in the coal industry. Wage and salary incomes tend to be lower in the coal-mining counties of Central Appalachia, compared to Appalachia's other coal-producing regions.
- **Poverty:** While poverty has been higher in the mining counties of Appalachia compared to the non-mining counties for many years, poverty has risen substantially in both groups of counties in recent years. In the long-term, poverty has been substantially higher in the coal-mining counties of Central Appalachia compared to the other coal-producing regions of Appalachia.

EDUCATION and HEALTH

- **Education:** Although weak education outcomes represent a significant economic development challenge in Appalachia in general, the data do not reveal that the attainment of a bachelor's degree differs noticeably between the mining and non-mining counties of Appalachia. Rates of college attainment are by far the lowest in the mining counties of Central Appalachia, compared to the mining counties in the other Appalachian coal-producing regions.
- **Health:** Poor health outcomes represent another significant economic development challenge in Appalachia. The data reveal that overall mortality rates are significantly higher in the mining counties of Appalachia compared to other counties in the U.S. Further, mortality in the mining counties of Central Appalachia, which has increased noticeably in recent years, is highest compared to the mining counties in the other Appalachian coal-producing regions.

Task 2. County-level CIE Supply Chain Analysis

Randall Jackson and Péter Járosi, West Virginia University

The continuing decline in the U.S. coal industry has implications that differ from industry to industry and from region to region. These differences in industry implications arise because of the nature of the coal industry ecosystem (CIE), in which each industry occupies its unique position in the coal industry supply chain. There are industries that provide goods and services directly to the coal industry, and those that supply the coal industry indirectly via provision of goods and services to the first-level suppliers and to their suppliers throughout subsequent supply chain levels and linkages. Likewise, each region has a unique mix of industries, so as collections of industries, regional economies also vary in terms of their position in the CIE, and in terms of the extent to which they are aligned with the coal industry. These critical differences, in turn, give rise to impacts of coal decline that can vary substantially from region to region, from state to state, and from county to county.

In this task report, we describe an effort to provide for the Appalachian Region a clearer picture of the implications of long term declines in the coal industry, and the way in which these implications vary geographically. We develop and implement in this report three measures that reveal meaningful characteristics of the CIE at the county level, in terms of: industry and place-based CIE dependence, changes in CIE-dependent employment, and susceptibility to anticipated continued coal industry decline. We then combine these three measures—Dependence, Impact, and Risk—to form a typology that we apply to identify and focus on counties in three identifiable categories: Hardship counties, Vulnerable counties, and Depressed counties.

The 123 Hardship counties rank below the median of all counties on the Dependence and Risk dimensions, and above the median on the Impact dimension. These counties have experienced high levels of negative impacts, but because they have lost most of their CIE-dependent industry jobs, they are not at risk for further substantial coal decline-driven job loss. The 124 Vulnerable counties rank below the median score on the Impact dimension, but above median scores on the Dependence and Risk dimensions. These counties did not exhibit negative consequences of CIE decline between 2005 and 2015, but because they are CIE-dependent and at risk of further coal industry decline, they form a group of counties with higher potential for future coal decline-driven job loss. The 83 Depressed counties score above median on all three dimensions. They suffered CIE-dependent job losses between 2005 and 2015, they continue to host CIE-dependent industries, and they are at risk of further future coal decline job-loss.

Finally, we narrow focus on the Depressed counties that rank highest on all three CIE-dimensions. Specifically, there are nine Depressed counties that rank in the top 20 on all three CIE dimensions. These are Mingo and Boone Counties in West Virginia; Harlan, Leslie, Martin, Pike, and Perry Counties in Kentucky; and Buchanan and Dickenson in Virginia. Unemployment

rates in these counties range from a low of 8.9 percent to a high of 13.2 percent; job losses have been substantial, as high as 34 percent and averaging 21 percent. On average in these counties, roughly one in ten employees works in the coal industry itself, and their wages account for almost 23 percent of county totals. In two of these counties, coal-industry employment shares exceed 20 percent, and corresponding wage shares of total exceed 37 percent. These Depressed counties clearly warrant special attention and concern if current coal industry trends continue.

Task 3. Transportation Implications of Coal

Mark Burton, University of Tennessee

Recognizing the realities of a changing energy landscape, the Appalachian Regional Commission (ARC) has commissioned a series of research initiatives that explore various aspects of Appalachian Coal Industry Ecosystems (CIE). This task report describes the goals, execution, and findings of a CIE effort focused on rail freight access in the Appalachian Region.

For more than a century, railroads have played an important role in Appalachia's coal industry ecosystem. But that ecosystem is changing, and the long-run, downward trend in Appalachian coal production implies a large and lasting reduction in coal traffic for the Region's railroads. The recently encountered cyclical traffic lapse provided policymakers with a glimpse as to how rail carriers may adapt to more permanent traffic losses. Taken as a whole, this information suggests that preserving rail freight access in Appalachia's core may eventually become difficult.

Utilizing network modeling techniques developed at the University of Tennessee, the study team modeled railroad network flows under baseline (2011) traffic conditions and with the diminished coal flows predicted for 2036. Key findings include:

- Rather than unfolding evenly through time, the results suggest that the largest declines in railroad tonnage may have already been observed.
- Geographically, with only a few exceptions, any threats to rail access associated with reduced coal volumes seem to be constrained to Appalachia.
- While unwelcome, the magnitude of losses to rail access, either in the form of physical proximity or affordability, is not currently predicted to be catastrophic. However, this prediction depends pivotally on rail carriers' abilities to garner adequate revenues from remaining freight traffic.
- Continued access to eastern ports and the global connectivity they afford depends largely on Appalachian coal's competitiveness in international markets and the strength of those markets going forward.

The results suggest that, during 2015 and 2016, aggressive electric utility strategies (including accelerated plant retirements), combined with a pronounced cyclical downturn in coal demand, compressed more than a decade's worth of reduced coal consumption and transportation into a two-year span. Setting aside the broader effects of these events, the rapid reduction in coal-related railroad activity eliminated roughly 2,000 full-time railroad jobs and \$150 million in income from a region that can ill-afford such disruptions.

Still, for policymakers, there are two advantages in this outcome. First, beginning in late 2016 and continuing throughout 2017, coal production and transportation began to regain the more gradual, long-run path predicted by the West Virginia University forecasts. Barring any additional, unanticipated disruptions, this affords policymakers the opportunity to evaluate and

implement policies that help ensure the preservation of stable rail-freight access in the face of further declines in coal outputs.

As importantly, the temporal compression in reduced coal activity forced the Region's railroads to act with an immediacy that provides valuable information regarding future network adjustments. Specifically, while the railroads have acted with deliberate speed, they have also avoided responses that are irreversible. In adjusting to the 2015-16 collapse of coal demands, the railroads have not abandoned trackage, have not razed or sold terminal facilities, and have shed unsustainable lines through leases rather than line sales. In aggregate, these actions suggest a railroad industry that is hesitant to permanently relinquish freight capacity.

If one accepts the long-run reduction in eastern railroad coal traffic as probable, the next question is whether existing or foreseeable non-coal traffic will be drawn to Appalachian-inclusive rail corridors by capacity made available through the loss of coal volumes. The analysis reported here suggests that this will not happen. The rail routes in and through Appalachia were built to access the Region's coal and timber. The railroad trunk lines that first connected the American East with the nation's interior were built around Appalachia, much like the Interstate highways that came a century later.

The final question is—absent robust coal volumes and without a probable substitute—whether surviving Appalachian freight traffic will generate sufficient activity to sustain the Region's rail access. The answer, for the moment, is a somewhat tentative probably. However, the key to this assurance is coal volumes that do not permanently fall too far below those predicted in the above analysis. Without the residual forecasted coal traffic, a positive outcome would be impossible.

Task 4. Economic Impacts and Risks Associated with Electric Power Generation in Appalachia

Eric Bowen, Christiadi, and John Deskins, West Virginia University; Charles Sims, and Rebecca J. Davis, University of Tennessee

The electric power industry is a crucial part of the coal ecosystem, accounting for the large majority of the total coal production sold within the United States. This report provides a detailed examination of the economic impact of changes in electric power generation in Appalachia over the past decade. We begin in Chapter 1 with an overview of the industry, paying special attention to coal-fired power generation. In Chapter 2, we estimate the effect of a loss of a power plant on county economic outcomes. Last, in Chapter 3, we examine the risk factors for further power plant retirements. Highlights of this research are as follows:

THE ELECTRIC POWER INDUSTRY

- **Overall Electricity Generation:** Overall electric power generation changed little nationally over the years 2005 through 2015. However, generation from the Appalachian Region fell by more than 15 percent during that period, while generation outside the Region rose by nearly 3 percent.
- **Electric Power Generation Fuel Mix:** Coal has fallen substantially as a fuel for electric power generation in Appalachia. Coal represented around 53 percent of total generation in Appalachia in 2015, down from just over 74 percent 10 years prior. However, Appalachia remains much more reliant on coal for electric power generation compared with the rest of the nation, where coal represents around 35 percent of generation.
- **Electric Power Sector Employment:** Total electric power employment has fallen considerably over the period of analysis. However, employment declined to a greater degree in Appalachia, falling from just over 50,000 workers to about 48,500, a decline of more than 3 percent, compared with a decline of less than 1 percent in the rest of the United States.
- **Coal-Fired Power Plant Retirements:** Coal-fired generation capacity has fallen by around 18 percent since 2005, while natural gas-fired generation capacity has risen more gradually by around 4 percentage points per year on average over the decade of analysis. Appalachia contains less than 20 percent of the operating coal-fired generation capacity in the four NERC regions surrounding it. However, over 40 percent of the retired coal-fired capacity can be found in Appalachia.

THE REGIONAL ECONOMIC IMPACT OF ELECTRIC POWER PLANTS

We estimate the economic impact of electric power plants on regional economies using regression analysis with data from all counties in the 13 Appalachian states that contained any electric power generation capacity during any year between 2005 and 2015. In particular, we estimate wage and salary income in a county as a function of the coal-fired electric power generation capacity and the natural gas-fired electric power generation capacity in the county. Results are as follows:

- We are able to statistically identify a positive effect of coal-fired electric power generation capacity on wage and salary income in a county.
- We estimate that the effect of coal-fired electric power generation capacity on wage and salary income is relatively large for small population counties, but that the effect diminishes to zero for sufficiently large population counties.
- Our estimates of the magnitude of the effect of a coal-fired power plant shutdown range dramatically. For illustrative purposes, in the one extreme, we estimate that the shutdown of a large coal-fired power plant in a small county can lead to a loss of around two-thirds of the county's wage and salary income. In contrast, for a mid-size plant shutdown in a mid-size county, we estimate that the plant shutdown reduces wage and salary income by around 5 percent.
- We are not able to statistically identify an effect of natural-gas fired electric power generation capacity on county-level wage and salary income.

RISK FACTOR ANALYSIS FOR COAL-FIRED GENERATION RETIREMENTS AND REPOWERINGS

We use data on 57 coal-fired unit retirements in the Appalachian Region to inform a stochastic dynamic programming model to identify three primary and three secondary risk factors that shorten the economic lifetime of a coal-fired generating unit. Primary risk factors are those where a 5 percent change results in a greater than 5 percent decrease in the economic lifetime of the unit. Secondary risk factors are those where a 5 percent change results in a 1 to 5 percent decrease in the economic lifetime of the unit. We also identify factors that have very little influence on the economic lifetime of a coal-fired unit.

- Primary risk factors include a high fixed cost of generation, low cost of retiring the unit, and a low discount rate used by utilities in decision-making. These primary risk factors are influenced by a variety of drivers including construction costs, land values, macroeconomic factors, and whether the unit is in a regulated market.

- Secondary risk factors include low fuel efficiency, low generation responsiveness, and low/stable generation revenues. These secondary risk factors are influenced by a variety of drivers including age, capacity factor, ramp rate, and electricity markets.
- Coal prices have very little influence on the retirement decision due to the prevalence of long-term coal contracts in the electricity generation industry. The insensitivity of the retirement decision to coal prices suggests that there is little that the coal industry could do to delay the recent spate of coal-fired plant retirements. It also suggests that government intervention in the coal industry that lowers delivered coal prices or adds stability to the coal market would have little to no impact on retirement decisions.

Task 5. Human Capital and the CIE

Matthew N. Murray, University of Tennessee, and Péter V. Schaeffer, West Virginia University

Task 5 of the comprehensive report has two goals. The first is to examine occupations that might be affected by employment losses in the coal industry ecosystem (CIE). The primary focus is on direct production employment in the coal sector, but some references are also made to managerial support workers and indirect workers in the coal industry supply chain. Potentially-impacted occupations are identified, as are alternative occupational opportunities in other sectors of the economy where coal workers might be absorbed. We also discuss coal worker transition time from unemployment status to employment status and identify factors that both encourage and prevent timely transitions. This discussion is framed by an overview of broad labor market conditions throughout the Appalachian Region. The second goal is to assess the state and local elementary and secondary education funding implications of a declining CIE. Considered are state funding sources and mechanisms and local funding sources for education that rely on local tax capacity and effort to complement state resources in support of elementary and secondary education. Together these various components of the analysis enable an evaluation of future employment prospects for the current coal workforce along with the funding streams that will affect the quality of the workforce of the future through the support for K-12 education.

The analysis of potentially-affected coal miner occupations begins with an overview of labor market conditions with a spotlight on mining counties within the Appalachian Region, as defined by those counties with coal employment in 2010. These counties are referred to as coal-employment counties or simply coal counties in what follows. To frame the discussion of coal-employment communities, we make comparisons to the Appalachian Region, states that are represented in the Appalachian Region, and the national economy. The analysis shows that labor markets within coal communities and the Appalachian Region itself are generally depressed relative to the states and the United States. The characteristics of these labor markets suggests that there will be difficulties creating robust new employment opportunities in the Region.

There were 129 counties in the Appalachian Region that had coal employment in 2010. Seventy-eight of these counties saw coal employment contract between 2000 and 2015. In 2015, three counties were reliant on coal employment for more than 20 percent of their employment base and another 13 counties were reliant on coal for 10-20 percent of their local employment base. Of these 16 counties, only four have experienced employment growth since 2010.

Highly-paid coal miners generally have limited re-employment opportunities within their place of residence, especially in terms of similar occupations and pay scales. We evaluate alternative

employment opportunities for coal workers by isolating their occupational classifications and comparing these to equivalent occupational classifications for workers in the manufacturing, construction, and transportation sectors. This analysis is undertaken for two regional geographies: (i) an aggregation of Appalachian counties within a given state and (ii) entire state economies for Appalachian states that have coal communities. These broad regions are chosen since individual counties offer insufficient scale and diversity to absorb coal workers. One important implication is that coal miners may be required to engage in lengthy commutes or migrate from their current place of residence in pursuit of gainful employment opportunities outside of the coal industry. Commuting to jobs in another county is already a common occurrence in Appalachia. Outmigration may represent a potentially significant hurdle since the population of the Appalachian Region is characterized by relatively low mobility rates relative to the national population. Retraining and other assistance will likely be needed for many of those displaced by declining coal production.

The coal sectors in Alabama, Pennsylvania and Ohio have relatively small numbers of occupations that are equivalent to occupations in manufacturing, construction and transportation at the state and substate regional levels. These small numbers suggest that it will be relatively easy to find employment opportunities outside the coal sector. However, digging beneath the surface shows that in these same states there are several specific occupational categories in the coal sector that have no equivalent occupations in other sectors. In other instances, the number of equivalent occupations in other sectors is limited in supply. As is generally the case, individual counties may be at significant risk of hardship through coal industry transition, but this can be masked across multi-county areas.

In contrast, the coal sectors in Kentucky, Virginia and West Virginia each have relatively large numbers of occupations without equivalent occupations in the manufacturing, construction and transportation sectors. This means that it will be harder to absorb coal workers into other sectors of the economy. In Kentucky, six occupations in the coal industry representing 2,901 positions have no counterparts outside the coal sector; in Virginia, there are eight occupations with 6,048 positions that have no equivalent occupations in manufacturing, construction and transportation; and in West Virginia, there are 18 coal occupations with no counterpart occupations elsewhere in the state. For West Virginia, these occupations represent 6,580 positions and more than one-third of all occupations in the state's coal industry. Six occupations representing 4,722 positions in Kentucky have no counterparts in the state.

Funding elementary and secondary education is a core government function that helps promote economic development and individual and family wellbeing. Elementary and secondary education is funded by revenue from federal, state and local governments. Local revenue is especially important since it is so closely tied to the performance of the coal industry. Because incomes are below average in the Appalachian Region (i.e. the Region is characterized by low tax capacity), per capita local tax burdens are also below the national average. In 2014, nominal per capita local taxes among coal-employment counties totaled \$1,298 compared to a national average of \$1,875. West Virginia and Kentucky have especially low per capita burdens. However, when one accounts for differences in income, the evidence indicates that Appalachian

counties choose to impose relatively low burdens on themselves and are thus characterized by low tax effort. While per capita income in coal communities is 94.1 percent of the national average, revenues in coal communities are just 69.2 percent of the national average.

All the Appalachian states have state funding programs that contribute significantly to local support for K-12 education. In general, these complicated formulas account for low tax capacity jurisdictions and seek to both boost funding and narrow funding disparities through foundation aid and/or equalization programs targeted to local spending or the local tax base. Nominal per pupil state funding for K-12 education was \$6,639 in coal-employment Appalachian communities in 2014, which is higher than spending levels in other Appalachian counties, states in the Appalachian Region, and the United States. Per pupil spending was highest in West Virginia. Total state funding support in recent years has grown at rates that compare favorably to other regions. Total local per pupil revenue to support elementary and secondary education in coal communities has hovered near the national average. Between 2010 and 2014, local per pupil revenue growth was up 14.1 percent in coal communities versus 5.6 percent growth for localities across the country. Together these data do not reveal declining support for K-12 education in coal-employment communities in Appalachia.

Current education spending per pupil in coal communities was \$12,119 in 2014, well ahead of the \$11,307 national average and the \$10,798 Appalachian Region average. Coal communities have consistently spent more per pupil than the national average since 2000. However, current per pupil spending did decline between 2010 and 2014 in Kentucky, Virginia and West Virginia, as well as in a number of coal communities in Alabama, Ohio and Tennessee, despite growth in total state and local revenue per pupil. In addition, enrollments have declined in all coal-employment states other than Alabama, which has seen very small growth. Between 2000 and 2014, coal counties saw enrollment counts fall by 158,192. Enrollments fell most sharply in Mississippi (down 24.9 percent) and Maryland (down 18.5 percent).