Repairing the Damage

Cleaning Up Hazardous Coal Ash Can Create Jobs and Improve the Environment

Appendix B: Economic Impact Analysis of Closure Scenarios for Two Case Studies in the Ohio River Valley

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October 2021

Prepared by Downstream Strategies for the Union of Concerned Scientists and the Ohio River Valley Institute

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Overview

Repairing the Damage: Cleaning up Hazardous Coal Ash Can Create Jobs and Improve the Environment is Part 4 in a series of reports exploring issues and opportunities of cleaning up legacy pollution from fossil fuel extraction in Appalachia. The report explores the issue of coal ash pollution and cleanup in the Ohio River Valley states of Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. It provides detailed case study analyses of two current or former coal-fired power plants: Sebree Generating Station in Kentucky and J. M. Stuart Generating Station in Ohio. Appendix A provides a detailed description and engineering analysis of each coal ash complex as well as cost estimates and direct job creation at each of the two current and former coal plants for two cleanup scenarios—the owner's proposal as well as a more comprehensive "clean closure" plan developed by the engineering firm. This appendix provides a detailed description of the economic analysis of the two cleanup scenarios for each case study based on the results of the engineering analysis.

Methodology

The economic impact analysis of the two proposed clean up alternatives done at the J.M. Stuart Station in Ohio and the Sebree Station in Kentucky used the Impact Analysis for Planning (IMPLAN) Pro state-level models for the appropriate states.[1] IMPLAN models are recognized internationally for providing consistent estimates of economic impacts for a specified geography. Economic impact analyses provide estimates of the economic activity that would result from specified activity or ongoing activity within a defined geography (region).[2]

For the analysis in this report, WWC Engineering, Inc., developed a detailed set of cost and employment estimates by year and activity for both the owner's plan and a clean closure proposal for both the J. M. Stuart Generating Station in Ohio and Sebree Generating Station in Kentucky (see Appendix A).[3] This economic analysis is based on the results of the engineering analysis.

[1] See IMPLAN.com.

[2] This analysis assumes that both Ohio and Kentucky establish policies to require preferences for intra-state goods and services (including labor). While this may reflect practical political reality, this assumption also recognizes that the state IMPLAN models do not include information about the specific location of the generating facilities and coal ash impoundments within the state boundaries. It is possible that goods and services for the cleanup of both facilities (especially the J. M. Stuart plant located along the Ohio River) could receive cross-border goods, services, and labor.

[3] The costs provided by the engineers were in 2022 dollars. To appropriately adjust these dollars and report all results in current year (2021 dollars), the deflators within the IMPLAN were used. These deflators include inflation rates for each of the 544 industries as well as an overall rate for gross domestic product for final demand. The net result of this adjustment for inflation is to reduce the total value of the activity by about 1.25 percentage points. Because both industry-level and national inflation rates come into play in the adjustment, the specific change from 2022 dollars to 2021 dollars depends on the activity being specified. Employment levels are not affected by deflation in the IMPLAN model.

INDUSTRY SPECIFICATIONS

As noted in other studies[4] of the remediation of coal ash disposal sites that are discussed in the report, the IMPLAN model does not have an industry that is readily identified with the type of construction activity required for this type of remediation work. Our solution was to employ a relatively common approach called an "analysis-by-parts." This creates the opportunity to specify the commodities and services used in each of the activities for each year, lets the model identify the employment that would be associated with those activities for the indirect effects, and uses the employment levels and costs provided by the engineers to define the direct effects. Direct effects are the costs and jobs required by the actual projects, indirect effects are regional upstream activities (e.g., purchases of goods and services needed to conduct the projects), and induced effects are follow-on impacts on the regional economy (such as workers spending their wages and state and local governments spending the additional fees and tax revenues).

The distribution of the spending pattern used the hard costs built from the industry spending patterns for the IMPLAN industries "maintenance and repair construction of highways, streets, bridges, and tunnels" (IMPLAN industry 62) and "water, sewage, and other systems" (IMPAN industry 49). For both states these two industries had relatively similar spending patterns, but each had specific concentrations that were viewed as appropriate for handing water, moving large quantities of coal ash, and cleaning up the sites after relocating the waste. After discussions with environmental engineers familiar with the activities involved in closing coal ash impoundments, the allocations of ready-mix concrete and other cement-related commodities were reduced to better reflect the purchases of the commodities associated with the cleanup. Additionally, the local purchasing shares were increased for a few commodities such as "sand and gravel mining," "truck transportation," "landscape and horticultural services," and a few other commodities with relatively minor contributions in order to reflect the likely local sources for those goods and services. Spending on soft costs such as "architectural, engineering, and related services" and "environmental and other technical consulting services" were zeroed out in the hard costs component and modeled separately to allocate the share of the costs going into those activities.

LABOR AND EMPLOYMENT SPECIFICATIONS

The analysis-by-parts methodology estimates the effect on the state economies associated with the indirect and induced effects generated from the spending necessary to clean up the coal ash disposal sites. However, the on-site employment (direct employment) that was specified by the engineers in Appendix A and the income associated with that employment is not specified in the direct effects in the IMPLAN model's analysis-by-parts approach. To correctly account for this activity, the labor costs were estimated and removed prior to setting the costs distributed to the spending patterns as noted above. Thus, the spending patterns were defined only for the materials and services purchased for the activity, while labor costs were addressed in a separate modeling exercise. The full time equivelent employment levels provided by the

[4] See Evans and French (2018), French (2019), and NPRC and IBEW (2018) in the reference list for the main report.

enigineers were converted to full- and part-time employment, the definition used by the IMPLAN model, using an IMPLAN industry level conversion.[5] .

Labor costs were estimated by state using a labor income per employee for the appropriate IMPLAN industry sector with a 25 percent adjustment to reflect fair wage rates for the employees. The total labor income was distributed to both employee compensation and proprietor incomes based on ratios within the model. Although a 25 percent wage premium reflects the necessity of a fair wage in regions with low aggregate incomes, the premium still results in the aggregate labor income being constrained at a level below the model's default given the overall construction costs. This constraint reflects the employment levels specified by the engineers with the result that fewer construction workers were employed and lower direct regional incomes were required than without this constraint. Economically, these specifications reflect a scenario that required that the average construction workers be more highly skilled than what would be assumed by the defaults for the industries initially modeled.

As a final step, the distribution between employee compensation and proprietor income for each state was based on the distribution for the appropriate industry, and a labor income change activity was specified for each year and each type of hard or soft construction activity. A change in labor income activity results in estimates for only the induced effects since that labor income is spent across the regional economy. Because direct effects (economic activity and employment) were specified separately from the engineers' results, they were added to the IMPLAN secondary effects to calculate total jobs and economic activity.

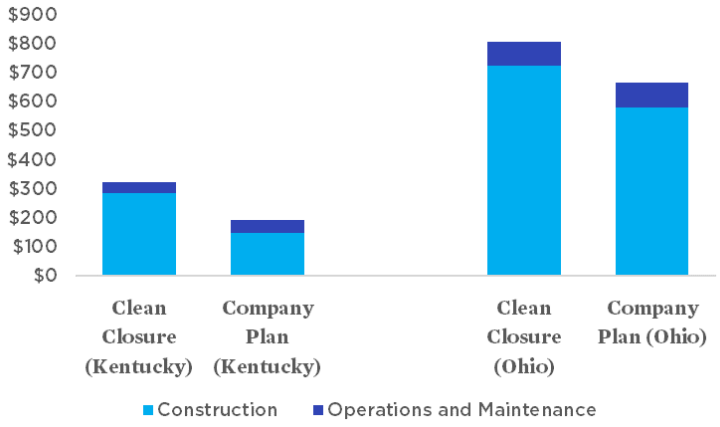
The net result for an aggregate activity for a given year thus includes estimates of the hard and soft costs for the secondary effects from the industry spending patterns, the secondary effects from the labor income changes, and the estimated direct effects on output, labor income, and employment.

Discussion

This section presents additional detail on the results of the IMPLAN analysis to accompany the main report. Figure B-1 shows the total statewide economic impact from the Sebree (Kentucky) and J. M. Stuart (Ohio) case studies, breaking out the impacts of the initial construction phase from those of the operations and maintenance activities. As noted in Figure B-1, the closure of the J. M. Stuart plant will create a larger economic impact because there are significantly larger cleanup needs. For both cleanup scenarios in both case studies, direct employment created by the cleanup activities is dominated by the initial construction phase when the coal ash waste is being removed and contained. See Figure B-2 for Sebree closure options and B-3 for J. M. Stuart closure options.

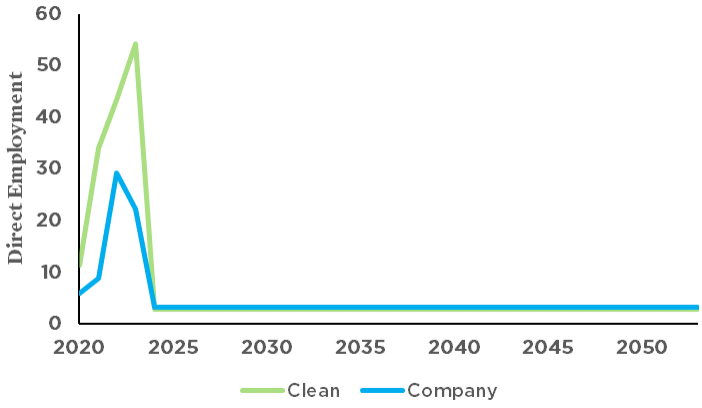
[5] An FTE is calculated using the total hours needed to complete the work, whereas our results represent total jobs, which includes both full- and part-time positions.

Figure B-1. Total Economic Output from Closure Scenarios in Kentucky and Ohio



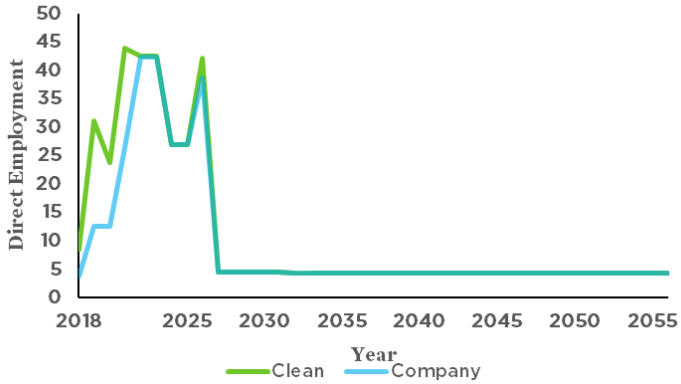
Our analysis found that the clean closure scenario leads to greater economic output than the company plan for both case studies. This chart shows the impacts from the construction phase (four years for Kentucky and nine years for Ohio) separately from the operations and maintenance phase (construction phase plus 30 years). The totals in Figures ES.1 in the executive summary and Figures 3 and 6 in the main report match the totals shown here but are split out by direct, indirect, and induced effects.

Figure B-2. Direct Employment per Year over Project Lifetime for Sebree Closure Options



Once the initial construction (excavation) phase is complete, ongoing operations and maintenance beginning in 2024 creates relatively few ongoing direct jobs when compared to the large impacts from the construction activity.

Figure B-3. Direct Employment per Year over Project Lifetime for J. M. Stuart Closure Options



Once the initial construction (excavation) phase is complete, ongoing operations and maintenance beginning in 2027 creates relatively few ongoing direct jobs when compared to the large impacts from the construction activity.

The following two tables compare details on the economic measures between the clean closures and the company closures by effect. The values for total economic output correspond to Figure B-1. Value added is a component of output, and labor income is a component of value added (see Figure B-4 for a graphical representation of the components of economic output). Results are shown for the direct, indirect, and induced effects. See Table B-1 for results for the Sebree closure options and Table B-2 for the results for the J. M. Stuart closure options. The tables explicitly show the difference between the closure options in each case. Details on definitions may be found in the "Overview of the IMPLAN Model" section below.

Table B-1. Total Economic Output and Selected Components of Output for Sebree Closure Options ($ millions)

	Total Output			Total Value Added			Total Labor Income		
	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference
Direct	$142.0	$85.9	$56.1	$23.9	$17.2	$6.7	$17.1	$12.5	$4.6
Indirect	$120.1	$70.0	$50.1	$62.1	$36.2	$25.9	$36.7	$22.0	$14.7
Induced	$62.0	$38.6	$23.3	$36.0	$22.4	$13.6	$21.8	$13.5	$8.3
Total	$324.1	$194.5	$129.5	$122.0	$75.8	$46.2	$75.7	$48.0	$27.7

This table breaks out the total economic impact (also called output) of both Sebree closure options by showing the direct, indirect, and induced effects (rows) and selected components of output (columns).

Table B-2. Total Economic Output and Selected Components of Output for J. M. Stuart Closure Options

	Total Output			Total Value Added			Total Labor Income		
	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference
Direct	$307.8	$254.1	$53.7	$45.6	$39.6	$6.0	$35.5	$30.8	$4.7
Indirect	$301.0	$246.8	$54.2	$163.1	$133.7	$29.3	$98.3	$80.8	$17.5
Induced	$200.1	$166.1	$34.0	$120.5	$100.0	$20.5	$71.2	$59.0	$12.2
Total	$809.0	$667.0	$141.9	$329.1	$273.3	$55.9	$205.0	$170.6	$34.4

This table breaks out the total economic impact (also called output) of both closure options for J. M. Stuart by showing the direct, indirect, and induced effects (rows) and selected components of output (columns).

Tables B-1 and B-2 show economic activity over the full project lifetime, to include both the initial construction (excavation) phase and 30 years of ongoing operations and maintenance. Annual employment estimates, however, are presented in Tables B-3 and B-4 separately for the two portions of each project: the short-term construction or excavation activity and the operations and maintenance activities that continue throughout the project. The bulk of the jobs created are in the construction phase, with only a few people needed to continue operating and maintaining the remediated site once the cleanup is complete, as shown in Figures B-2 and B-3. The initial construction phase is four years for Sebree cleanup and nine years for J. M. Stuart cleanup. The operations and maintenance activities include employment during the construction phase plus 30 years of monitoring required by federal regulations.

Table B-3. Annual Employment for Sebree Closure Options

	Total Annual Employment During Construction (4 years)			Total Annual Employment in Operations and Maintenance Activities (34 years)		
	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference
Direct	35.7	16.3	19.4	2.6	3.1	-0.4
Indirect	151.8	79.5	72.3	2.5	3.0	-0.4
Induced	94.3	48.3	46.0	2.2	2.5	-0.4
Total	281.8	144.1	137.7	7.3	8.6	-1.3

Table B-4. Annual Employment for J.M. Stuart Closure Options

	Total Annual Employment During Construction (4 years)			Total Annual Employment in Operations and Maintenance Activities (34 years)		
	Clean Closure	Company Closure	Difference	Clean Closure	Company Closure	Difference
Direct	31.8	25.6	6.2	3.4	3.4	0.0
Indirect	153.2	123.0	30.2	4.0	4.0	0.0
Induced	128.7	103.4	25.3	4.4	4.5	0.0
Total	313.7	252.1	61.6	11.8	11.8	0.0

Overview of the IMPLAN Model

The estimates of impacts from the IMPLAN model are specified by activities. The unique activity associated with coal ash impoundment closures analyzed in this report were best modeled using an industry spending pattern, which is different from an industry change specification approach, probably the most-used impact specification type. The six types of activity specifications in the IMPLAN model are:

- **Industry change:** This is probably the most-used impact specification, usually specifying an output or employment level.
- **Commodity change:** This activity specification takes into account that commodities in IMPLAN can be produced in multiple industries.
- **Labor income change:** A labor income change activity is generated by changes in employee compensation and/or proprietor income and only creates induced effects from changes in spending.
- **Household income change:** Household income changes can be specified for any one of the nine different household income levels. Appropriate tax rates and spending patterns are applied.
- **Industry spending pattern:** Industry spending patterns specify the shares of spending on any of the commodities within the model. The pattern includes a regional coefficient.
- **Institutional spending pattern:** Institutional spending patterns specify a change in commodities demanded as complete goods produced for consumption. The institutions can include households, state and local governments, the federal government, and enterprises.

DEFINITIONS OF IMPACT EFFECTS

Depending on the specifications used by the analyst, the IMPLAN model reports on up to three different impact effects: the direct effects, the indirect effects, and the induced effects. The model also provides an aggregate, "total effects"—the sum of those three. For a typical (industry change) analysis, the direct effects are specified by the costs of the activity (as was done for this analysis). These costs are adjusted for goods and services that are procured from outside the specified region (in this case, the two states).

- **Direct effects:** The direct effects reflect the costs (sales) and employment levels that are being specified to measure or represent a given level of production.
- **Indirect effects:** Indirect effects are the measure of the effect on the regional economy generated as firms and proprietors in the economy change production to meet the requirements of the change in output specified in the direct activity.
- **Induced effects:** Induced effects are the measure of the effect on the regional economy generated from the changes in household income that resulted from both the changes

in labor to meet the increase in production specified in the direct effects and by the estimated regional inputs required in the indirect effects.

- **Iterative solution:** Both the indirect and induced effects (together sometimes referred to as secondary effects) are based on iteratively solving the initial specified direct effect as it ripples across the region and generates additional economic activity. For the indirect effect this activity is related to the production requirements addressing the question of what other industries within the region will be able or required to increase their production given the specified direct effect. The induced effect is related to spending, as the initial increase in regional spending will generate more spending activity. The IMPLAN model built for this analysis has been structured to estimate these changes as they ripple out to the last dollar.[6]

- **Economic multipliers:** Economic impact analyses often refer to an economic multiplier, the ratio of one effect over another effect or set of effects. One commonly used multiplier is the total effect divided by the direct effect. Thus, an employment multiplier of 3.0 would indicate that for every 100 direct jobs needed for a given activity, 200 additional jobs would be generated in all regional industries and governments. In this example, an employment multiplier of 3.0 refers to the total 300 jobs associated with all activity (200 indirect and induced jobs plus the 100 direct jobs) divided by the initial 100 direct jobs.

DEFINITIONS OF ECONOMIC VARIABLES

Impact results are estimated by the IMPLAN model for six different general economic measures as well as up to 75 state and local government tax categories and potentially 35 federal government categories. These variables are estimated for each impact effects identified above. The six general economic measures include the following.

- **Output:** This is a broad summary measure of production that primarily measures the change in sales but also includes the changes in inventories that would be associated with the changes in production.

- **Employment:** The IMPLAN model uses full- and part-time employment counts from the federal government.[7] IMPLAN uses this measure as opposed to full-time equivalent employment to be consistent in source definitions with the measures of value added provided by the same federal agencies (primarily the BEA as noted above but also the Census Bureau's State, County and Zip Code business patterns program.)

- **Value added** includes four components in the IMPLAN model:

[6] A reduction in economic activity can be modeled the same way, and these effects will account for the reduced economic activity.

[7] Employment counts come from the Bureau of Labor Statistics and the Bureau of Economic Analysis.

- **Employee compensation:** This is a measure of employees' salaries and all benefits.
- **Proprietor income:** Proprietor income is a labor payment received by self-employed individuals and unincorporated business owners.
- **Other property type income**: Other property type income is gross operating surplus minus proprietor income, and includes consumption of fixed capital, corporate profits, and net business transfer payments.
- **Taxes on production and imports:** Indirect business taxes, or taxes on production and imports, include sales and excise taxes, customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments.

- **Labor income:** Labor income, the value that initiates the induced effects, is the aggregate of the two components of value added that accrue directly to the region's households: employee compensation and proprietor income.

Each of these economic variables is estimated for each industry within the specified region for each impact effect the model estimates. Figure B-4 shows graphically how the economic variables are interrelated.

Figure B-4. Graphical Representation of Components of Economic Output as Defined by the IMPLAN Model