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# Improving the Method for Coal Transportation Rate Escalation in the NEMS Coal Market Module

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# Introduction

Coal transportation represents a significant share of the delivered cost of coal to all coal demand sectors. Approximately 80% of all coal deliveries in the United States are for electric power consumption, and about 70% of coal deliveries to the electric power sector are delivered in whole or in part by rail.[1] The cost of coal transportation averaged about 41% of the delivered cost of coal to electric power consumers in 2017, based on survey Form EIA-923 data. [2, 3]

Coal-fired electric generating units in the United States are increasingly competing on the margin with natural gas-fired generating units in response to expanding supply of low-cost natural gas, growth in renewable electricity capacity, and low electric power demand growth. Consequently, the competitiveness of the existing fleet of coal-fired generating units has become more sensitive to the escalation of coal transportation rates over time. For example, long-term real escalation at a rate of 1% per year would result in approximately 35% higher coal transportation rates in 30 years, or about 14% higher real delivered coal costs of $2.35 per million British thermal units (MMBtu), assuming no changes in real commodity cost and an average delivered cost of $2.06/MMBtu in 2018.

The Domestic Coal Distribution Submodule (DCDS) in the Coal Market Module (CMM) of the National Energy Modeling System (NEMS) includes an approach for escalating real, constant-dollar coal transportation rates over time. Since 2008, annual coal production in the United States has declined by more than one-third, from 1,171.8 million short tons (MMst) to 755.5 MMst in 2018 (35.5%).[4] The change from serving a growing or even stagnant market to serving one in decline implies that transportation rates may not escalate as represented in the current econometric approach. To evaluate these impacts, the U.S. Energy Information Administration (EIA) requested an external review of our current approach for escalating transportation rates to determine if the pricing by railroads should be modified to better reflect the declining trend in coal transportation.

This paper describes the history and calculations associated with the current approach and lays out an alternative approach that EIA is considering. The alternative approach presented is adapted from findings by Hellerworx, Inc., which the company developed while under contract to EIA.[5] Illustrations of the approaches presented in this paper are based on data and projections from the *Annual Energy Outlook 2019* (AEO2019).

# Background on the Current Approach

## Calculation of Base Year Coal Transportation Rates

The CMM contains predefined transportation routes linking coal supply regions to coal demand regions by subsector. Base year domestic coal transportation rates for each route are estimated from EIA survey data without differentiation by transportation mode (rail, truck, barge, or conveyor). [6] The rates are

[1] U.S. Energy Information Administration, *Today in Energy*, U.S. coal shipments reach their lowest levels in years, Primary Contributor: Elias Johnson, August 3, 2018.

[2] U.S. Energy Information Administration, *Today in Energy*, Coal shipments to the U.S. power sector continue to fall, September 13, 2019.

[3] U.S. Energy Information Administration, Transportation Costs to Electric Power Sector, July 17, 2018.

[4] U.S. Energy Information Administration, Short-Term Energy Outlook Data Browser, as of November 29, 2019.

[5] Hellerworx, Inc., "DOE/EIA Coal Market Module: Coal Transportation Rate Methodology Assessment," September 29, 2017 (unpublished).

[6] U.S. Energy Information Administration, Assumptions to AEO2019: Coal Market Module, February 2019.

computed as the difference between the delivered price by sector for coal transported between each coal demand region and the average cost of coal for each coal type as reported by the survey commodity price or the average minemouth price for each supply curve. Delivered end-use price data are developed from Form EIA-3, *Quarterly Survey of Industrial, Commercial and Institutional Coal Users*; Form EIA-923, *Power Plant Operations Report*; and the U.S. Census Bureau, *Monthly Report EM-545*. Minemouth price data are calculated from Form EIA-7A, *Coal Production and Preparation Report*. Supply curves are delineated by geographic region, coal rank, mine type (surface or underground), and sulfur content. Coal demand regions are further delineated by sector and subsector and reflect how the coal is used, the power plant pollution control equipment configuration, or the coal export coast (eastern, western, or Gulf of Mexico).

The base year transportation rates are then adjusted to remove the estimated impact of railroad fuel surcharges before the real escalation factors are applied. The fuel surcharges are subsequently added back after the projected escalation rate indexes have been applied to the base rates. Major coal rail carriers have implemented fuel surcharge programs resulting in higher transportation fuel costs that are passed on to shippers. Although the programs vary in their design, the Surface Transportation Board (STB), the regulatory body with limited authority to oversee rate disputes, recommended that the railroads agree to develop some consistencies among their disparate programs and likewise recommended closely linking the charges to actual fuel use. The STB suggested a mileage-based program as one way to more closely estimate actual fuel expenses.

The fuel surcharges are estimated separately for eastern and western regions as follows:

- For shipments originating in eastern coal supply regions, the methodology is based on CSX Transportation's mileage-based program. The surcharge becomes effective when the projected nominal distillate price to the transportation sector exceeds $2.00 per gallon. For every $0.04 per gallon increase higher than $2.00, a $0.01 per carload-mile is charged.
- For shipments originating in western coal supply regions, the methodology is based on BNSF Railway Company's mileage-based program. The surcharge becomes effective when the projected nominal distillate price for the transportation sector exceeds $1.25 per gallon. For every $0.06 per gallon increase higher than $1.25, a $0.01 per carload-mile is charged.

The number of tons per carload and the number of miles vary with each supply and demand region combination and is a predetermined model input. For every projection year, 100% of all coal shipments are assumed to be subject to the surcharge program.

The CMM was built during a time when coal transportation was expanding and includes tier rate adders to adjust the base year rates to account for changing patterns of coal consumption. For the power sector only, second-tier transportation rates were created to capture the higher cost of expanded shipping distances to large demand regions. These rates were also created to capture the costs to modify coal-fired power plants to be able to burn subbituminous coal that were not originally designed to burn subbituminous coal. To this end, the CMM includes an incremental cost of $0.10 per million British thermal units (MMBtu) (2000 dollars) to upgrade a coal-fired unit to burn Powder River Basin (PRB) coal. This incremental cost reflects the incremental capital cost to add or modify coal pulverization and handling equipment, boilers, and exhaust gas controls and to account for additional unit operating costs from boiler slagging/fouling as well as overall unit heat rate impacts.

## Evolution of the EIA Coal Transportation Rate Escalation Approach[7, 8, 9]

Before 1997, EIA relied on a regression model to estimate real escalation rates based on the American Association of Railroads' Railroad Cost Recovery Index, with separate escalators for the eastern and western United States. In 1997, EIA adjusted its econometric approach to incorporate the effects of rail productivity improvements on rail costs to correct for the widening gap between the rail transportation input cost trends and trends in actual rail transportation rates. The approach modeled the real Producer Price Index (PPI) for coal transportation benchmarked to the base year as a function of the real wage cost index, the real price of distillate fuel, the real producer price index for transportation equipment, and a time trend to account for productivity. A parameter was also included that allowed the user to adjust the effects of the productivity trend variable over time to allow for analyst judgment.

In 2005, EIA incorporated differentiated East/West escalator indexes to account for longer shipping distances in the West, transformed the PPI for rail equipment (PPI-RE; Bureau of Labor Statistics WPS 144) into a User Cost of Capital (UCC) for the railroad equipment variable, and used ton-miles per employee to model productivity. Both eastern and western deliveries were modeled as functions of productivity and the UCC, but the function for eastern deliveries also included contract duration and western deliveries included a distance variable. A two-standard deviation adjustment for the productivity coefficient was assumed as a way to ensure that changes in productivity would have a lesser impact on the change in future transportation rates than in the past. The UCC represents the cost of capital tied up in rail as a function of the real AA utility bond rate, the cost of depreciation at a rate of 10%, and the change in the PPI-RE.

In 2009, the East index function was modified by substituting diesel fuel price for contract duration but with diesel fuel prices zeroed out in the econometric projection equation to avoid double-counting the effect of fuel surcharges. The West index function substituted gross capital investment by Class I railroads for UCC and substituted the western share of coal demand for distance. In addition, rail productivity is assumed to stay flat to reflect an assumption that changes in productivity would not be passed on to shippers. In calculating the UCC, three percentage points are added to the cost of borrowing to account for the possibility that a national-level program to regulate greenhouse gas emissions may be implemented in the future.

## Summary of the Current Coal Transportation Rate Escalation Approach

The current approach for escalating real coal transportation rates is illustrated in the left panel of Figure 1, and it can be described as a series of calculations based on the preceding discussion.

1. Calculate First-Tier Base Year Transportation Rates based on survey Form EIA-923 and Form EIA-7A data less estimated fuel surcharges.
2. Calculate Second-Tier Adjusted Base Year Transportation Rates by applying cost adjustments for shipping distances from coal demand regions or upgrading a plant for PRB coal consumption.
3. Calculate Escalated Transportation Rates for each year in the projection period by applying either an East or West escalation index, depending on the coal supply basin's location, with the indexes estimated econometrically as follows:

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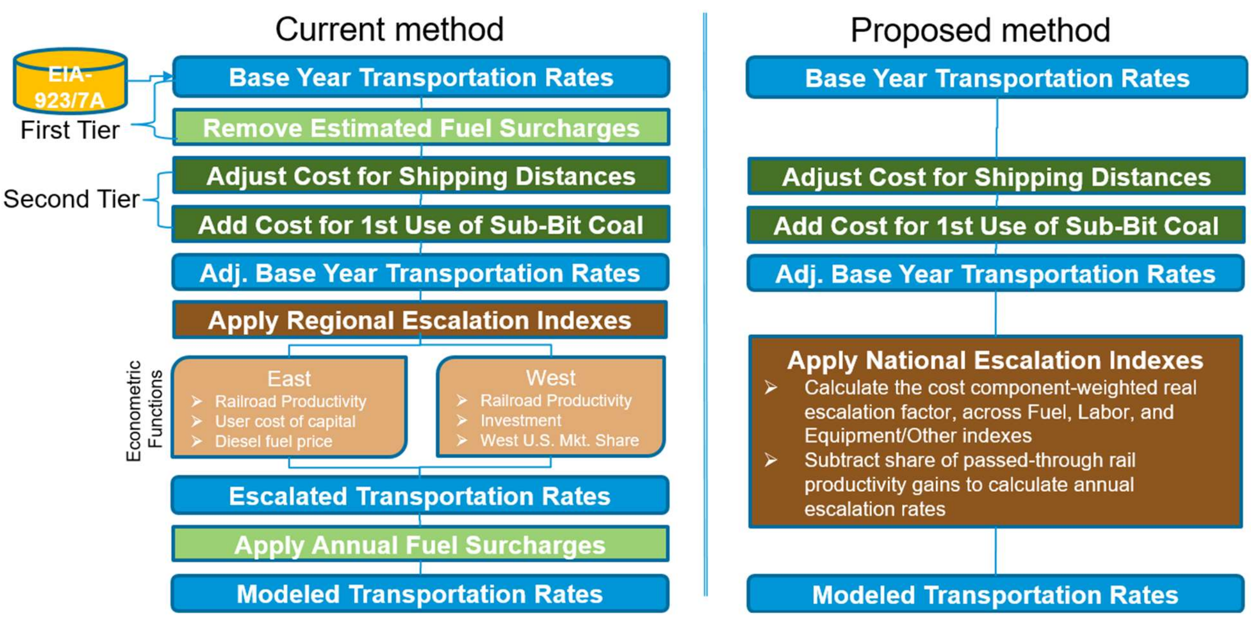
[7] Watkins, Jim, "Forecasting *Annual Energy Outlook* Coal Transportation Rates," Issues in Midterm Analysis and Forecasting 1997, DOE/EIA-0607(97), (Washington, DC, U.S. Energy Information Administration), July 1997, pp. 75–82.

[8] U.S. Energy Information Administration, Coal Market Module of the National Energy Modeling System: Model Documentation *2005* (April) and *2009* (June), Appendix D.

[9] U.S. Energy Information Administration, Assumptions to the *Annual Energy Outlook 2020*: Coal Market Module, January 29, 2020.

   a. East as a function of three factors
      i. Railroad Productivity, based on ton-mile per employee estimates and assumed to not change over time, assuming lower costs from improvements in productivity would not be passed along to shippers
      ii. User Cost of Capital (UCC), estimated as a function of the cost of capital tied up in rail as a function of the real AA utility bond rate premium plus any modeled risk premium, the cost of depreciation at a rate of 10%, and the change in the PPI-RE
      iii. Diesel Fuel Prices, which are zeroed out in the projection equation to avoid double-counting of fuel surcharges
   b. West as a function of three factors
      i. Railroad productivity
      ii. Investment, based on gross capital investment by Class 1 railroads
      iii. Western Share of U.S. Coal Demand
4. Calculate Modeled Transportation Rates for each year in the projection period by estimating fuel surcharges.

**Figure 1. Comparison of coal transportation rate escalation methods**




Source: U.S. Energy Information Administration

# Alternative Approach for Escalating Transportation Rates

## Recommendations from Expert Reviewer

Hellerworx, Inc., under contract with EIA, investigated the implications of declining coal markets on the escalation of coal transportation rates. Its investigation noted that average, delivered coal transportation rates based on data collected by survey Form EIA-923 include the effects of shifting patterns in coal shipments in addition to factors affecting escalating coal transportation rates. For example, if shippers in Georgia shift consumption from Central Appalachia to the Illinois Basin, average rates for the United States would reflect the effects of longer overall shipping distances. Hellerworx's assessment, therefore, focused on examining shipments of coal mine to coal-fired power plant pairings with consistent shipment volumes during the 2015–2016 time frame, when domestic U.S. coal consumption was rapidly declining.

The expert review resulted in several recommendations to EIA for improving its treatment of coal transportation rate escalation, as outlined in Hellerworx's report to EIA:

- *EIA should continue its current practice of using the escalators applicable to rail rates as a surrogate to escalate rates for all modes of coal transportation.*
- *EIA should modify its two-tier structure for modeling coal transportation rates so that the higher (or "Tier 2") transportation rates are used only when total production of a given coal type exceeds the 2008 level. In all other scenarios, future coal transportation rates should be modeled based solely on the escalation of the current (or "Tier 1") rates.*
- *EIA should discontinue the use of separate coal transportation rate escalation indices for the eastern and western regions of the United States, and instead use a single set of coal transportation rate escalation indices nationwide.*
- *EIA should replace its existing escalation indices for coal transportation rates (which include a total of five variables: the cost of capital for rail equipment, investment, the western share of coal production, fuel surcharges, and railroad productivity) with a single national cost escalation index that includes four cost-based variables (labor costs, fuel costs, equipment and other costs, and railroad productivity.)*
- *Half of the expected gains in railroad productivity should be passed through to coal shippers (rather than no productivity pass-through as in EIA's existing methodology.)*
- *EIA should treat fuel costs as one of several cost-related drivers of expected future coal transportation rates, rather than making a separate adjustment to reflect the fuel surcharge programs (as is done in EIA's existing methodology.)*

## Approach Suggested by Expert Reviewer

The alternative approach is centered on applying a structured, share-weighted national coal transportation rate index similar to the Surface Transportation Board's All-Inclusive Index. The approach, illustrated in the right panel of Figure 1, would model changes in diesel cost directly as an element of the share-weighted index instead of estimating fuel surcharges. Base Year Transportation Rates and adjustments for intra-regional shipping distances and upgrades to take subbituminous coal would still be calculated in the same way as the current approach. The Adjusted Base Year Transportation Rates would then be escalated based on a single National Coal Transportation Rate Escalation Index (NCTREI), rather than applying separate indexes for East and West to estimate the Modeled Transportation Rates.

Formulating the NCTREI, as specified by Hellerworx, happens in two steps. First, the cost component-weighted real escalation rates are calculated based on indexes for fuel, labor, and equipment/other. Next, the share of rail productivity gains passed through to shippers is subtracted to obtain the annual escalation rates.

The following example illustrates the approach proposed by Hellerworx. The component weights are based on the 2018 Rail Cost Indexes published by the Association of American Railroads (AAR) and average projected diesel fuel prices in EIA's *Annual Energy Outlook 2018* (AEO2018). The cost component weights for 2018 were 33.0% for labor, 15.9% for fuel, and 51.1% for equipment and other costs.[10]

These weights are adjusted in the Hellerworx approach to reflect historical and projected diesel fuel prices to the transportation sector (diesel prices) as follows (references to prices are assumed to be in the same constant-year, real dollars [2019$]):

- **Adjusted Fuel Weight** = AAR Fuel Weight (15.9%) x [Average AEO2019 projected diesel prices from 2018 to 2050 ($27.43/MMBtu) ÷ AEO2018 2017 diesel price ($19.59/MMBtu)] = 15.9% x 1.401 = **22.3%**
- **Allocation Amount** = Adjusted Fuel Weighting (22.3%) – AAR Fuel Weight (15.9%) = **6.4%**
- **Allocation Share for Labor** = AAR Labor Weight (33.0%) ÷ [AAR Labor Weight (33.0%)+ AAR Equipment and Other Costs Weight (51.1%)] = 33.0% / 84.1% = **39.2%**
- **Adjusted Labor Component Weight** = AAR Labor Weight (33.0%) – [Allocation Amount (6.4%) x Allocation Share for Labor (39.2%)] = 33.0% - 2.5% = **30.5%**
- **Adjusted Equipment/Other Component Weight** = 100% - Adjusted Fuel Weighting (22.3%) - Adjusted Labor Component Weight (30.5%) = **47.2%**

The indexes to which the weights are applied need to be projected and input into the CMM as independent model assumption parameters. Projected index values are normalized to the same base year as the Base Year Transportation Rates, with an assumed base year index value of 1.0. Based on the recommendation from Hellerworx,

- The index of diesel fuel price to the transportation sector would be projected endogenously based on historical and projected values for diesel fuel as projected by NEMS.
- The index value for labor costs would be projected based on the performance of the U.S. Bureau of Labor Statistics (BLS) Employment Cost Index during the most recent, 10-year period available.[11] Hellerworx analysis indicated that the BLS index increased at an average rate of 2.1% per year from fourth-quarter 2006 to fourth-quarter 2016, compared with the U.S. Bureau of Economic Analysis (BEA) gross domestic product implicit price deflator (GDP-IPD) average inflation rate of 1.6% during the same period, suggesting a 0.5% rate of real increase. Hellerworx recommended the BLS index instead of the AAR Labor Index because the AAR index showed a large discontinuity between pre- and post-recession periods compared with the BLS index. Hellerworx also suggested that the unionized rail transportation sector should be able to secure wage increases in line with the private sector on average over the long term.
- The equipment/other costs would be projected to increase at the general rate of inflation, that is, constant in real dollar terms.

Once the weighted-average, national cost index is calculated, the percentage change implied by the index from one year to the next would be adjusted for the estimated rate of productivity change passed along to shippers. The index for rail productivity would be based on the estimated, average productivity gains published by the Surface Transportation Board (STB) during the most recent, 10-year period

[10] Association of American Railroads (AAR), Rail Cost Indexes, RCAF Quarterly Filings & Decisions, STB RCAF 2019Q4 Decision 9-20-2019, Docket No. EP 290 (Sub-No. 5) (2019-4).

[11] BLS Series ID CIS2010000000000I, which tracks the cost of wages, salaries, and benefits for all private sector workers in the United States.

available. Hellerworx estimated an average annual productivity gain of 1.4% more than the 2006–2015 period. This gain was 0.8% from 2006 to 2010 and 2.0% from 2011 to 2015.

Hellerworx recommended that half of estimated rail productivity improvements should be passed to coal shippers under its proposed method (0.7% per year). This recommendation is based on Hellerworx's belief that railroads will be strongly pressured to pass along a portion of gains to customers to remain competitive in an environment of decreasing coal demand in a declining market for coal transportation.

## Discussion of Recommendations and Approach Made by the Expert Reviewer

EIA staff reviewed the alternative approach and conducted further research on the Surface Transportation Board's All-Inclusive Index, escalation parameters available within NEMS, and model functionality associated with the Tier 2 rate adders. EIA made the following findings based on this review:

- Applying a single rate of escalation based on trends in the rail sector remains a reasonable assumption because more than 75% of coal deliveries to the power sector, which account for approximately 90% of domestic coal deliveries, were delivered by rail or multiple modes including rail.[12]
- The second tier of coal transportation rate adders is applied to situations where either a shipper would need to incur additional costs to switch to using subbituminous coal from the Power River Basin (PRB) for the first time or account for the effect of additional shipments away from the centroid of a coal demand region that are higher than baseline levels. These factors mitigate the need to apply a base-year standard based on peak-year coal consumption for its application, provided the baseline levels are regularly updated.
- Applying a single escalator for the entire United States is reasonable.
    - The current approach for escalating eastern rail movements is based on projections that, in practice, rely on the user cost of capital estimate, adjusted for changes in fuel prices following rail surcharge formulations.
    - Similarly, western rail movements are escalated based on the share of coal shipped from the western United States each year, which lacks a clear causal relationship with rate escalation, and an exogenous projection of rail productivity adjusted for changes in fuel prices following rail surcharge formulations.
    - In both cases, the formulations appear to emulate the combination of variables used to formulate the Surface Transportation Board's All-Inclusive Index.
    - In practice, the East and West escalation formulations result in relatively narrow, minimal differences over time (less than 10%, primarily because of the East index's reliance on the user cost of capital) as illustrated by the AEO2019 rate multiplier projections in Table 1 and reported in the AEO2019 Assumptions document for the Coal Market Model.[13]
- Applying a rate escalation methodology that incorporates fuel cost changes as one of several variables affecting coal prices in a share-weighted approach is reasonable.
    - This approach would reduce issues with using fuel adjustment surcharge terms specified by the railroads, which vary by rail company and are specified using different

[12] U.S. Energy Information Administration, Coal shipments to the U.S. power sector continue to fall, September 13, 2019.
[13] U.S. Energy Information Administration, Assumptions to the *Annual Energy Outlook 2019*: Coal Market Module, February 2019.

combinations of diesel strike prices and accompanying rate adders. Also, coal transportation contracts evolve and may, over time, incorporate higher or lower fuel cost assumptions.

- However, any differences in fuel's share of total shipping costs as a result of differences in average shipping distances between those originating in the eastern and the western regions would not be explicitly accounted for under this approach.
    - As defined earlier, the fuel surcharges for the eastern and western regions vary within \$0.04 to \$0.12 per carload mile, or approximately \$0.35 to \$1.00 per ton assuming a thousand-mile haul and 120 tons per carload, depending on the price of diesel for the transportation sector.

**Table 1 AEO2019 coal transportation rate multipliers**

constant dollar index, 2017=1.0000

| Scenario | Region: | 2017 | 2020 | 2025 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|
| Reference | East | 1.0000 | 1.0807 | 1.0624 | 1.0604 | 1.0328 | 1.0147 |
| | West | 1.0000 | 1.0254 | 1.0122 | 1.0181 | 1.0119 | 1.0097 |
| Low Oil Price | East | 1.0000 | 1.0774 | 1.0613 | 1.0555 | 1.0387 | 1.0175 |
| | West | 1.0000 | 1.0264 | 1.0165 | 1.0161 | 1.0173 | 1.0134 |
| High Oil Price | East | 1.0000 | 1.0897 | 1.0738 | 1.0513 | 1.0189 | 1.0123 |
| | West | 1.0000 | 1.0261 | 1.0037 | 1.0050 | 1.0002 | 1.0070 |
| Low Economic Growth | East | 1.0000 | 1.0837 | 1.0708 | 1.0592 | 1.0238 | 1.0003 |
| | West | 1.0000 | 1.0271 | 1.0113 | 1.0142 | 1.0069 | 1.0038 |
| High Economic Growth | East | 1.0000 | 1.0838 | 1.0680 | 1.0620 | 1.0329 | 1.0129 |
| | West | 1.0000 | 1.0251 | 1.0121 | 1.0159 | 1.0176 | 1.0176 |
| High Resource | East | 1.0000 | 1.0831 | 1.0733 | 1.0566 | 1.0389 | 1.0235 |
| | West | 1.0000 | 1.0283 | 1.0084 | 0.9983 | 0.9916 | 0.9896 |

Source: Projections: U.S. Energy Information Administration, National Energy Modeling System runs REF2019.D111618A, LOWPRICE. D111618A, HIGHPRICE. D111618A, LOWMACRO. D1111618A, HIGHMACRO. D111618A, and HIGHRESOURCE. D111618A Based on methodology described in the Coal Market Module of the National Energy Modeling System 2018, DOE/EIA-M060 (2018) (Washington, DC, 2018)

- The Surface Transportation Board's (STB) All-Inclusive Index approach provides a useful framework for structuring a revised, national rail transportation rate escalation approach in the CMM.
    - The framework includes variables that could be endogenously escalated using price, wage, and interest rate escalator series projected in other modules within NEMS, and it incorporates fuel as one of several input variables. These variables eliminate the need for EIA staff to re-estimate or re-evaluate the underlying regression equations over time.
    - The only variables requiring exogenous specification under this approach are the latest base year cost share for each variable published by the STB and the outlook for rail productivity and assumptions for its pass-through to shippers, which can be projected by EIA analysts and can be reported explicitly in the AEO Assumptions documentation for transparency.

- The explicit accounting for rail productivity improvement over time is explicitly allowed for under the proposed approach, and using the most recent 10-year period to estimate an average is a reasonable method for estimating the base rate of change.
- The proposed approach of applying half the base rate of productivity improvement during periods of declining coal production may overstate the level to which shippers share in the benefits over time to the extent overall coal production stabilizes or increases.
  - Applying an annual percentage adder for rail productivity improvement could be linked to the trend in annual coal production in the CMM projections, that is, an elasticity corresponding to the rate of annual changes in coal production could be included that would dampen the application of changes in rail productivity gradually to zero as coal production stabilizes to zero and remain at zero if coal production volumes increase.
  - Rail productivity declines indicating upward pressure on rates should be assumed to pass through directly to shippers in full.

## Approach Based on the Surface Transportation Board's All-Inclusive Index

EIA staff compared the approach suggested by Hellerworx with the cost breakouts in the Surface Transportation Board's (STB) All-Inclusive Index. Table 2 lists the Rail Cost Adjustment Variables (RCAF) and the 2018 shares for each, along with the short-term basis for escalating each variable applied by the AAR. The last column in Table 2 lists the most closely related variables available within NEMS for each of the RCAF variables based on the AAR escalator basis.

The availability of relevant escalators in NEMS suggests that EIA could simply apply the RCAF methodology directly, rather than using the Hellerworx approach described above, except for adjustments for rail productivity. Shares for the Equipment Rentals, Depreciation, and Other categories could be combined because they rely on the same underlying index for escalation, but each share value would be entered separately in the model and then added together or projected separately to ensure accuracy and allow flexibility should more specific escalator bases be added to NEMS in the future.

Nominal escalator series from NEMS reported as price indexes would be normalized to the last historical data year in NEMS, which is the year 2017 in AEO2019, and then deflated relative to the GDP Chain-Type Price Index (2009=1.000), which would also be normalized to 2017. The escalator series for Indexed 10-year U.S. Treasury Bond Rate is reported as a nominal percentage-per-year change and must be converted to an index before the normalization and deflation calculations are executed. The escalator series for Diesel Fuel Prices to the Transportation Sector are reported in real dollars, and they would be converted into an index normalized to 2017.

The resulting real, normalized indexes are then used to project annual percentage changes as a multiplier to the previous year's value. These values are multiplied by their corresponding share-weighted multiplier in each year of the projection period. Under this approach, the 2018 shares for each RCAF variable would be applied to the rate of change in each of the corresponding escalators from 2018 to 2019. The applicable shares for the 2019–20 calculations would then be re-estimated based on the change in the escalated contribution for each RCAF variable from 2018 to 2019, and so on for each subsequent year.

**Table 2. Rail cost adjustment factor shares and escalator basis**

| RCAF variable | 2018 share | AAR short-term escalator basis | Possible NEMS long-term projections escalator basis |
|---|---|---|---|
| Labor | 33.0% | Sector analysis of subcomponents for rail sector | Employment Cost Index—Total Private Compensation (2005=1.00) |
| Fuel | 15.9% | Ultra-Low Sulfur Diesel Fuel referenced, but otherwise, based on a survey of rail purchasers and petroleum experts | Diesel Fuel Prices to the Transportation Sector (2018$ per million British thermal units) |
| Materials and supplies | 5.1% | Not clear, but references change in prices for Metal Products and Misc. Products | Wholesale Price Index–Metals and Metal Products (1982=1.00) |
| Equipment rentals | 5.3% | Price index for Industrial Commodities less Fuel and Related Products and Power (PPI-LF) | Wholesale Price Index–Industrial Commodities less Energy (1982=1.00) |
| Depreciation | 15.0% | Power Price Index for Railroad Equipment (PPI-RE) | Wholesale Price Index–Industrial Commodities less Energy (1982=1.00) |
| Interest | 2.1% | Interest rates for 10- and 30-year U.S. Treasury Bonds are referenced, but the latest historical value based on annual reports from railroads is carried forward | Indexed 10-year U.S. Treasury Bond Rate |
| Other | 23.6% | Price index for Industrial Commodities less Fuel and Related Products and Power (PPI-LF) | Wholesale Price Index – Industrial Commodities less Energy (1982=1.00) |

Sources: Association of American Railroads (AAR), Rail Cost Indexes, RCAF Quarterly Filings & Decisions, STB RCAF 2019Q4 Decision 9-20-2019, Docket No. EP 290 (Sub-No. 5) (2019-4); U.S. Energy Information Administration, National Energy Modeling System (NEMS)

For example, assume that a calculation had only two variables, labor and energy, and that they had shares of 75% and 25% in 2018, respectively. If labor costs increased 10% in 2019, and energy only 5%, the share-weighted multipliers would be 75%*1.10=0.825 for labor and 25%*1.05=0.2625 for energy, resulting in an aggregate 2019 real escalation multiplier of 0.825+0.2625=1.0875. Shares applicable to the 2020 calculation would be equal to 0.825/1.085=75.9% for labor, and 0.2625/1.085=24.1% for energy.

## Alternative Approach to Adjustments for Rail Productivity Change

The approach based on the STB All-Inclusive index must still accommodate changes in rail productivity over time for the rates to shippers. The approach of subtracting one-half of the average 10-year historical rate of change in rail productivity suggested by Hellerworx may apply during periods of declining coal shipments. However, such discounts are less likely to be passed along during periods of stable to increasing coal market conditions.

This potential outcome could be reflected by decreasing the share of rail productivity improvements passed along to shippers as market conditions improve, based on a functional relationship between the annual rates of change in the volume of coal production or ton-miles shipped. The average rate of market decline in the previous three years based on either of these measures could be used to represent the perception of market conditions going into the current model year. If the observed market conditions indicate a negative growth rate, an exponential function can be used to translate the rate into a share that applies to the assumed rate of rail productivity. The analyst would specify the threshold in the volumetric rate of decline when a specified maximum share of rail productivity improvement would apply, and the exponent determining the rate of decline in that share as the growth rate increases to zero would also be defined.

For example, assume that the volumetric rate of decline during the preceding three years is equal to -3% and that rates of decline less than or equal to -5% per year will get a maximum share of 50% of rail productivity improvement applied to the rail transportation index calculation. For rates of decline greater than -5% and less than 0%, a simple exponential function is applied to the ratio of the actual rate of decline (-3%) to the maximum (-5%), which in this case is 60%. If the exponent is set to 0.5, the share would be set to approximately 78% of the maximum share (50%), resulting in a rail productivity improvement adjustment of 0.54% in the modeled year, compared with 0.70% under the Hellerworx suggested approach. By comparison, the rail productivity adjustment would have been only 0.31% if the actual rate of decline had -1% in the modeled year, that is, the share approaches zero as the rate of decline also approaches zero.

## Comparison of Approaches

The current approach for East and West Transportation Rate indexes was compared with the approach recommended by Hellerworx and the approach based on the STB All-Inclusive index. The Hellerworx approach was further evaluated to determine the impact of allowing the shares to adjust over time, and both the Hellerworx and STB approaches were evaluated under the fixed and alternative approaches for adjusting the rate of change in the index for changes in rail productivity. The performance of each approach for escalating transportation rates is evaluated based on the results from the AEO2019 Reference case and each of the core AEO2019 side cases. The base year for the index values presented is 2017. The resulting index values for 2030 across the various alternatives is presented in Table 3.

### Table 3. Comparison of coal transportation rate escalation approaches by AEO2019 case in 2030

| 2030 | Reference | High Macro | Low Macro | High Price | Low Price | High Resource | Low Resource |
|---|---|---|---|---|---|---|---|
| **EIA Current Methodology** | | | | | | | |
| Average national index (no fuel surchages) | 1.037 | 1.036 | 1.034 | 1.026 | 1.033 | 1.026 | 1.037 |
| East | 1.060 | 1.062 | 1.059 | 1.051 | 1.056 | 1.057 | 1.050 |
| West | 1.018 | 1.016 | 1.014 | 1.005 | 1.016 | 0.998 | 1.026 |
| West share | 56% | 56% | 55% | 54% | 56% | 53% | 55% |
| Fuel surcharges ($/ton-mile) | | | | | | | |
| East | 0.0033 | 0.0033 | 0.0028 | 0.0058 | 0.0011 | 0.0029 | 0.0037 |
| West | 0.0025 | 0.0026 | 0.0022 | 0.0038 | 0.0014 | 0.0023 | 0.0028 |
| Combined index effect | 0.041 | 0.042 | 0.024 | 0.118 | (0.025) | 0.029 | 0.057 |
| Estiamted combined national index | 1.078 | 1.078 | 1.058 | 1.144 | 1.009 | 1.055 | 1.094 |
| **Hellerworx Recommmended Methodology** | | | | | | | |
| Constant factor weighting | | | | | | | |
| Unadjusted for rail productivity | 1.102 | 1.104 | 1.099 | 1.338 | 1.018 | 1.085 | 1.124 |
| 0.7% annual rail productivity | 1.007 | 1.008 | 1.004 | 1.224 | 0.929 | 0.991 | 1.026 |
| Adj. annual rail productivity | 1.061 | 1.058 | 1.051 | 1.273 | 0.976 | 1.025 | 1.094 |
| Adj. factor weighting | | | | | | | |
| Unadjusted for rail productivity | 1.082 | 1.088 | 1.143 | 1.401 | 0.963 | 1.069 | 1.094 |
| 0.7% annual rail productivity | 0.988 | 0.993 | 1.044 | 1.282 | 0.878 | 0.977 | 0.999 |
| Adj. annual rail productivity | 1.041 | 1.043 | 1.094 | 1.334 | 0.923 | 1.010 | 1.066 |
| **EIA Alternative Approach** | | | | | | | |
| Unadjusted for rail productivity | 1.079 | 1.090 | 1.146 | 1.280 | 0.975 | 1.071 | 1.084 |
| 0.7% annual rail productivity | 0.985 | 0.995 | 1.047 | 1.170 | 0.889 | 0.978 | 0.990 |
| Adj. annual rail productivity | 1.031 | 1.038 | 1.089 | 1.209 | 0.928 | 1.007 | 1.050 |
| **Key index variables (2017=1)** | | | | | | | |
| Employment cost index ($2017) | 1.135 | 1.182 | 1.099 | 1.108 | 1.145 | 1.141 | 1.126 |
| Diesel fuel cost index ($2017) | 1.398 | 1.402 | 1.382 | 2.150 | 0.954 | 1.323 | 1.486 |
| Wholesale price indexes ($2017) | | | | | | | |
| Metals and metal products | 0.886 | 0.877 | 1.012 | 1.033 | 0.825 | 0.892 | 0.876 |
| Industrial commodities excluding energy | 0.922 | 0.907 | 1.067 | 1.098 | 0.856 | 0.929 | 0.912 |
| AA utility bond rate | 1.517 | 1.618 | 2.048 | 1.795 | 1.292 | 1.498 | 1.482 |
| GDP chain-type price index | 1.355 | 1.349 | 1.545 | 1.645 | 1.256 | 1.367 | 1.333 |
| **Coal production (million short tons)** | 647.1 | 646.6 | 621.5 | 577.9 | 658.7 | 542.7 | 719.8 |

The base year 2017 values for the fuel surcharges are $0.0017 per ton-mile in the East and $.0020 per ton-mile in the West. Assuming a 1,000-mile haul distance, fuel surcharges in the Reference case are approximately $1.60 per ton higher for coal originating in the East by 2030, compared with an increase of $0.50 per ton for coal originating in the West. Based on the average transportation rates in 2017 for the Illinois Basin to Florida ($26.31 per ton) or the Power River Basin to Illinois ($20.63 per ton), each representing about 900- to 1,000-mile haul distances, the 2030 fuel surcharge increases would translate into approximate increases in the index values of 0.067 and 0.024, respectively.[14] This formulation was used to estimate the Estimated Combined National Index in Table 3.

The projected 2030 index values across the different alternatives indicates that adjusting the factor weightings over time results in a modest reduction in the index values before productivity changes are applied. This outcome is the result of applying a simple average of projected fuel prices and fixing the factor weightings during the projection period. Achieving the improved accuracy and refinement is a

[14] U.S. Energy Information Administration, Real and nominal average transportation costs, Delivered Costs by primary transport mode and supply region, as of August 20, 2019.

matter of straight forward, one-time programming in each of the alternatives, as well as incorporating additional indexes under the EIA alternative approach.

Applying a fixed rate of productivity sharing with shippers at the modest decline rate of 0.7% per year reduces the index value by 10% by 2030 across the approaches. The impact on the index is lower when the rate of productivity cost sharing by the rail companies is adjusted as the decline in annual coal production approaches zero. These adjustments reduce the index by approximately 4% to 6% in 2030. The actual reduction depends on the pattern of annual coal production in each of the AEO cases.

Projected rate escalation results are shown for three of the rate escalation alternatives in Table 4 to facilitate comparisons across AEO2019 cases and projection years. Table 4 presents the following three cases:

- The current EIA methodology
- The contractor-recommended methodology reflecting constant factor weighting with only the 0.7% annual rail productivity improvement included
- The EIA Alternative Approach inclusive of the annual rail productivity improvement adjusted for coal production trends

### Table 4. Comparison of selected rate escalation methodologies by AEO2019 side case and year

| | 2017 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|
| **Reference Case** | | | | | |
| EIA Current Methodology | 1.000 | 1.090 | 1.078 | 1.051 | 1.017 |
| Contractor-Recommended Methodology | 1.000 | 1.034 | 1.007 | 0.968 | 0.915 |
| EIA Alternative Approach | 1.000 | 1.045 | 1.031 | 1.021 | 0.998 |
| **High Macro** | | | | | |
| EIA Current Methodology | 1.000 | 1.092 | 1.078 | 1.054 | 1.025 |
| Contractor-Recommended Methodology | 1.000 | 1.035 | 1.008 | 0.969 | 0.921 |
| EIA Alternative Approach | 1.000 | 1.047 | 1.038 | 1.053 | 1.054 |
| **Low Macro** | | | | | |
| EIA Current Methodology | 1.000 | 1.091 | 1.058 | 1.015 | 0.980 |
| Contractor-Recommended Methodology | 1.000 | 1.033 | 1.004 | 0.963 | 0.913 |
| EIA Alternative Approach | 1.000 | 1.054 | 1.089 | 1.116 | 1.120 |
| **High Price** | | | | | |
| EIA Current Methodology | 1.000 | 1.183 | 1.144 | 1.112 | 1.096 |
| Contractor-Recommended Methodology | 1.000 | 1.189 | 1.224 | 1.188 | 1.142 |
| EIA Alternative Approach | 1.000 | 1.129 | 1.209 | 1.185 | 1.156 |
| **Low Price** | | | | | |
| EIA Current Methodology | 1.000 | 1.032 | 1.009 | 0.994 | 0.970 |
| Contractor-Recommended Methodology | 1.000 | 0.979 | 0.929 | 0.882 | 0.835 |
| EIA Alternative Approach | 1.000 | 0.994 | 0.928 | 0.916 | 0.913 |
| **High Resource** | | | | | |
| EIA Current Methodology | 1.000 | 1.088 | 1.055 | 1.030 | 0.997 |
| Contractor-Recommended Methodology | 1.000 | 1.026 | 0.991 | 0.950 | 0.894 |
| EIA Alternative Approach | 1.000 | 1.041 | 1.007 | 0.986 | 0.954 |
| **Low Resource** | | | | | |
| EIA Current Methodology | 1.000 | 1.094 | 1.094 | 1.077 | 1.040 |
| Contractor-Recommended Methodology | 1.000 | 1.041 | 1.026 | 0.993 | 0.937 |
| EIA Alternative Approach | 1.000 | 1.048 | 1.050 | 1.050 | 1.042 |

**Note**: The EIA Current Methodology results assume 1,000-mile rail hauls with base values of $26.31 per ton (East) and $20.62 per ton (West) weighted by the share of western coal production in total U.S. production each year to account for the impact of the regional fuel surcharges. The Contractor-Recommended Methodology reflects the constant factor weighting option with only the 0.7% annual rail productivity improvement included. The EIA Alternative Approach includes the annual rail productivity improvement adjusted for coal production trends.