

Unions for Jobs & Environmental Progress

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Potential Energy Job Losses and Transition Assistance Needs With 2035 Electric Generation Decarbonization Target

Executive Summary

Some current climate change proposals call for the elimination of carbon dioxide emissions from fossil-based electric generation by 2035. This accelerated phase-out - 15 years in advance of the targets set by the Paris Agreement - would eliminate 800 Gigawatts of coal and natural gas-fueled capacity, representing 67% of total U.S. electric generating capacity. Some 1.4 million job losses likely would result from the closures of generating plants, coal mines, and natural gas production facilities. Railroad jobs would be lost with the elimination of coal transportation to electric utilities. All of the impacted industry sectors are heavily unionized, with relatively high wages and benefits.

This paper offers estimates of the potential loss of direct and indirect jobs and wages at four major industries: 1) fossil-fueled electric generation facilities; 2) coal mining; 3) natural gas extraction and transportation; and 4) coal-dependent railroads. Estimates of potential transition assistance for workers and communities are based on replacement of wages at 67%, 75%, and 100% for a three year period. Jobs are assumed to be lost in five equal phases commencing in 2022.

UJEP is an independent ad hoc association of labor unions involved in energy production and use, transportation, engineering, and construction. Our members are: International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers Union; International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers; International Brotherhood of Electrical Workers; International Brotherhood of Teamsters; SMART Transportation Division; Transportation • Communications International Union, IAM; United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada, and United Mine Workers of America. For more information about us, visit <http://www.ujep4jobs.org>.

The political discussion about near-term elimination of fossil-based electricity needs to consider the impacts of direct and indirect job losses on families and communities. Many power plants, coal mines and other fossil energy facilities are located in rural areas, and often are the largest employers and sources of tax revenues for local communities. Indirect jobs in the community are supported through the relatively high wages paid to fossil energy workers, and by the large supply chains needed to support energy facility operations and maintenance. Power plant workers, coal miners, and coal-dependent railroad employees typically are 50 to 60 years old, with few prospects for reemployment at comparable wages.

Transition assistance to workers in communities directly impacted by plant closures is a highly effective means to avoid severe community disruptions such as large-scale closures of businesses, destruction of housing values, and loss of police, fire, and other essential services. Funds received during the transition period would recirculate throughout communities, much as COVID-19 state and federal assistance helped many communities to avoid even more devastating losses to businesses and consumer-dependent sectors. Such assistance could be provided through a trust fund administered by the U.S. Department of Labor, with block grants to state labor departments for managing transition assistance programs. State programs in turn would be responsible for qualification determinations and disbursements.

The combined economic value of the wages paid to 1.4 million direct and indirect workers covered by this assessment is \$84 billion annually. The costs of providing transition assistance for three-year benefit periods ranges from \$12.3 to \$18.0 billion annually, as shown in the table below. Providing assistance to displaced workers at this level would represent just 0.06% to 0.09% of U.S. GDP in 2019.

**Estimates of Energy Jobs at Risk with 2035 Utility Decarbonization
and Direct and Indirect Transition Assistance Needs
at Alternative Levels of Wage Replacement**

Sector	Direct Jobs*	Indirect Jobs*	Direct Jobs Avg. Wage*	Transition Assistance @67% (Bil. \$2019/Yr.)	Transition Assistance @75% (Bil. \$2019/Yr.)	Transition Assistance @100% (Bil. \$2019/Yr.)
Fossil Elec. Gen.	89,600	504,000	\$85,468	\$4.6	\$5.1	\$6.5
Coal Mining	50,770	254,000	\$89,180	\$2.4	\$2.7	\$3.6
Nat Gas Prod. & Trans.	103,400	302,300	\$90,300	\$4.5	\$5.0	\$6.7
Railroads	29,900	78,250	\$67,240	\$0.8	\$0.9	\$1.2
Totals/Avg	273,670	1,138,550	\$85,990	\$12.3	\$13.7	\$18.0

*Direct jobs and average wage from U.S. Bureau of Labor Statistics; indirect jobs average wage assumed at U.S. average wage of \$53,490 (BLS, 2019).

These estimates do not consider the potential loss of benefits such as retirement and health care, or the programs and policies that may be appropriate to address benefit-related issues. These and other transition assistance needs such as retraining, community economic development, educational assistance, and incentives for industrial development in adversely impacted areas are being considered by other entities. The wage replacement program described in this paper addresses the need to provide an economic lifeline for nearly one and a half million workers and their families and communities when faced with the sudden loss of secure, high-wage jobs.

Background

Some current climate change proposals call for the elimination of carbon and other greenhouse gas emissions from fossil-based electric generation by 2035. The phase-out of fossil-based generation would eliminate thousands of coal and natural gas generating units across the nation. These units have a combined nameplate generating capacity of 801 Gigawatts, representing 67% of total U.S. electric generating capacity.¹ The other principal energy sectors at risk of large-scale job losses with a 2035 decarbonization target are coal mining, natural gas production and distribution, and rail transportation.

Many power plants, coal mines and other fossil energy facilities are located in rural areas, and often are the largest employers and sources of tax revenues for local communities. Indirect jobs in the community are supported through the relatively high wages paid to fossil energy workers, through the expenditures of wages, and by the large supply chains needed to support operations and maintenance of power plants, natural gas extraction, railroads and coal mines. Power plant workers, coal miners, and coal-dependent railroad employees typically are 50 to 60 years old, with few prospects for reemployment at comparable wages.

A 2035 target for phase-out of carbon emissions from the electric generation sector would confront utilities and independent power producers with severe difficulties in financing any new fossil generating capacity due to the shortened period for cost recovery. Utilization of CCS technologies for carbon storage - a potential source of hundreds of thousands of skilled, high-wage jobs - also may be extremely limited given the lengthy periods required for design, engineering, financing, construction, and securing necessary state and federal regulatory approvals for their construction.

A. Fossil-Fueled Electric Generation

Table A1 itemizes the BLS job classifications typically found at fossil generation facilities. Administration, engineering, electrical, operations and maintenance are represented. Several unions are engaged in these activities, including the IBEW, Boilermakers, Iron Workers, Machinists, Plumbers and Pipe Fitters, and others.

¹ DOE/EIA, Electric Power Annual 2018 (November 2019), Table 4.3.

Table A2 shows BLS state-level employment and wage data for fossil-fueled generation plants in 37 states, including virtually all of the states with multiple major generating facilities. Some 90% of total U.S. fossil generation is represented by these 37 states. After adjusting the jobs data upward on a pro rata basis (10%), an estimated total of nearly 90,000 direct U.S. jobs are represented, with an average direct wage of \$85,468 per worker. Total direct wages at U.S. fossil generating plants were \$7.6 billion in 2019. These estimates do not include any employment associated with transmission and distribution of the power generated by fossil plants.

Some 504,000 total indirect jobs are associated with fossil generation plants, based on the 2019 EPI jobs multiplier for power generation, with estimated income of nearly \$27 billion using the U.S. average wage for all occupations in 2019 (\$53,490). The overall economic impact of direct and indirect jobs at fossil-based power generation plants amounts to \$34.6 billion annually, with 594,000 total direct and indirect jobs.

Potential Transition Assistance

Assuming enactment of a 2035 decarbonization program, the loss of direct and indirect jobs at fossil electric plants would likely occur in phases between 2022 and 2035. Transition assistance for displaced workers and communities would be essential for avoiding large-scale economic disruption in hundreds of communities across the nation, and for providing a pathway toward alternative employment. Such assistance could be provided through a trust fund administered by the U.S. Department of Labor, with block grants to state labor departments for managing transition assistance programs.

Tables A3 (direct jobs) and A4 (indirect jobs) estimate potential transition assistance needed for workers and communities impacted by electric generation plant closures. Plants are assumed to be retired in five equal phases between 2022 and 2035. Compensation is assumed at alternative rates of 67%, 75%, and 100% of wages for a period of three years. The average compensation for direct jobs would amount to \$57,000 per worker for three years at the lowest 67% rate, while the average for indirect workers would be \$35,700 at this rate. Replacement benefits such as health care and pensions are not included in any of these estimates.

Transition assistance for direct jobs lost would amount to an estimated \$1.0 to \$1.4 billion annually (\$2019) within the assumed compensation range of 67% to 100%, or \$15.3 to \$21.5 billion over the 2022-2035 period. Transition assistance for indirect jobs would amount to \$3.6 to \$5.1 billion (\$2019) annually, or \$54 to \$76 billion over this period. The total estimated annual assistance to direct and indirect workers, \$4.6 to \$6.5 billion, would represent just 0.02% to 0.03% of current U.S. GDP of \$20 trillion. Some congressional proposals call for 2% of U.S. GDP to be devoted to climate change programs.

Transition assistance to workers in communities directly impacted by plant closures may be a highly effective means to avoid severe community disruptions such as large-scale closures of

businesses, destruction of housing values, and loss of police, fire, and other essential services. Funds received during the transition period would recirculate throughout communities, much as COVID-19 state and federal assistance helped many communities to avoid even more devastating losses to businesses and other consumer-dependent sectors.

B. Coal Mining

Coal mining and rail transportation of coal also would suffer major job dislocations with a 2035 decarbonization program. The coal industry stands to be virtually eliminated by a 2035 decarbonization mandate, because electric utilities are the predominant source of coal demand. It is doubtful that the supply industries needed to sustain coal production (mining equipment, etc.) could remain viable if left only with a small export market and domestic steel market. Other nations likely would step up to meet these demands.

Coal use by electric utilities has declined sharply over the past decade with the advent of lower-cost natural gas. In 2014, coal-fueled power plants generated 1,569 billion kWh of electricity, or 40% of total U.S. generation.² By 2019, coal generation had declined to 960 billion kWh, or 24% of total generation.

The Bureau of Labor Statistics reports that coal mining in 2019 accounted for 50,770 direct jobs. The average unionized mining wage is \$89,180, including overtime (see Table B1.) These direct wages generated \$4.5 billion in income for coal miners and their families. Total indirect income for suppliers and communities added another \$13.6 billion, for a total annual impact of \$18.1 billion.

Potential Transition Assistance

Estimates of total compensation needs for direct (Table B1) and indirect jobs (Table B2) lost in the coal mining industry are based upon the same assumptions used for the fossil-based electric generation sector - five equal phases of 20% reduction of jobs over the 2022-2036 period, with compensation paid over a three year period at alternative rates of 67%, 75%, and 100% of wages. For indirect jobs, the 2019 U.S. average wage of \$53,490 is used, with the same percentage rates.

Total transition assistance needs for the loss of direct jobs ranges from \$604 million to \$906 million (\$2019) annually, amounting to total assistance of \$9.1 billion to \$13.6 billion (2019\$) over the 2022-2036 period.

The coal mining sector has a relatively high indirect job multiplier of 5.0, reflecting its impacts on local communities and its long supply chains for mining equipment, operations and

² U.S. DOE/EIA, Short-Term Energy Outlook, September 2020.

maintenance.³ Table B2 shows the estimates for transition assistance needs for the loss of some 50,880 indirect job-years annually from 2022 to 2036. Annual assistance needs range from \$1.8 billion to \$2.7 billion (2019\$), for total indirect job assistance over this period of \$27.2 to \$40.8 billion (2019\$). The total annual assistance needs for both direct and indirect jobs are estimated at \$2.4 billion to \$3.6 billion using the range of 67%-100% for wage replacement. This equates to 0.01% to 0.02% of current U.S. GDP.

C. Natural Gas Extraction and Distribution

Natural gas is the largest single fossil fuel input to electric generation. In 2019, electric generators in the U.S. consumed 31 billion cubic feet per day (BCFD) of natural gas, or 37% of total U.S. gas consumption of 85 BCFD, and 34% of total U.S. dry gas production of 92.2 BCFD.⁴

Current estimates of direct jobs associated with natural gas extraction are on the order of 165,600,⁵ with 109,000 direct jobs in natural gas distribution.⁶ An additional 29,800 workers are engaged in gas pipeline transmission. Average 2019 wages for natural gas extraction are \$96,600, gas distribution wages are \$85,010, and pipeline transmission jobs receive an average of \$74,650.⁷ The weighted average annual wage for these three natural gas industry segments is \$90,300, with a total payroll of \$27.5 billion.

Assuming that 34% of these direct jobs can be attributed to the electric generation sector, based on its share of 2019 total U.S. dry gas production, natural gas extraction accounts for some 56,300 direct jobs, gas distribution accounts for 37,000 direct jobs, and gas pipeline transmission adds 10,100 workers. Together, natural gas extraction, distribution and transportation for electric generation represent an estimated 103,400 direct jobs, with combined direct wages of \$9.3 billion annually.

Indirect jobs associated with gas extraction for electric utility use are estimated at 302,300 jobs, while indirect jobs for utility-related gas distribution are estimated at 117,300 jobs, with another 32,000 indirect jobs for gas transmission.⁸ The combined estimated economic impact of these 451,600 indirect jobs is \$24.2 billion based on the 2019 U.S. average wage of \$53,490. Overall, direct and indirect jobs associated with gas extraction, transmission and distribution for utility use generate some \$33.6 billion of annual income for workers and communities.

³ Economic Policy Institute, Updated employment multipliers for the U.S. economy (January 23, 2019).

⁴ U.S. DOE/EIA, Short Term Energy Outlook, September 2020, Table 5a.

⁵ Gas extraction jobs are from Energy Futures Initiative and National Association of State Energy Officials, 2020 U.S. Energy and Employment Report (2020).

⁶ U.S. Bureau of Labor Statistics, May 2019 National Industry-Specific Occupational Employment and Wage Estimates (2020).

⁷ Id.

⁸ Economic Policy Institute, Updated employment multipliers for the U.S. economy (January 23, 2019).

Potential Transition Assistance

Tables C3 (direct jobs) and C4 (indirect jobs) estimate potential transition assistance needed for workers and communities impacted by the closures of natural gas extraction, transmission and distribution facilities. With the closure of natural gas electric generation, gas-based supply jobs are assumed to be retired in five equal phases between 2022 and 2035. Transition assistance is assumed at alternative rates of 67%, 75%, and 100% of wages for a period of three years. The average compensation for direct jobs would amount to \$60,230 per worker for three years at the lowest 67% rate, while the average for indirect workers would be \$35,677 at this rate. Replacement benefits such as health care and pensions are not included in any of these estimates.

Transition assistance for direct jobs lost would amount to an estimated \$1.2 to \$1.9 billion annually (\$2019) within the assumed compensation range of 67% to 100%, or \$18.7 to \$28.0 billion over the 2022-2035 period. Transition assistance for indirect jobs would amount to \$3.2 to \$4.8 billion (\$2019) annually, or \$48 to \$72 billion over this period. The total estimated annual assistance to direct and indirect workers, \$4.5 to \$6.5 billion, would represent 0.02% to 0.03% of current U.S GDP of \$20 trillion.

Transition assistance to workers in communities directly impacted by natural gas extraction, distribution and transmission closures may be an effective means to provide transitional income support for workers in both rural and urban locations, where a large amount of utility gas peaking capacity is located. Natural gas job losses likely will be concentrated in west Texas, the Gulf Coast, and other major gas supply regions such as Pennsylvania - typically in rural areas with few other job options. Funds received during the transition period would recirculate throughout communities, much as COVID-19 state and federal assistance helped many families and communities to avoid even more devastating losses.

D. Railroads

Coal historically has been the largest single commodity moved by U.S. railroads, serving utility, industrial and export markets. Bulk commodities such as coal and grain represent 52% of all U.S. railroad freight car loads.⁹ Consisting of almost 140,000 route miles, the nearly \$80-billion freight rail industry is operated by seven Class I railroads (railroads with operating revenues of \$490 million or more) and 22 regional and 584 local/short line railroads. Overall, the U.S. rail industry employs 233,830 workers at an average wage of \$68,240.¹⁰

Among railroad jobs, those most vulnerable to unemployment with a 2035 decarbonization mandate are 110,750 jobs associated with transportation and material moving, including 36,120

⁹ U.S. Department of Transportation, Freight Rail Overview, available at <https://railroads.dot.gov/rail-network-development/freight-rail-overview>.

¹⁰ U.S. Bureau of Labor Statistics, May 2019 National Industry-Specific Occupational Employment and Wage Estimates - NAICS 482100 (2020).

locomotive engineers and operators. BLS indicates that the average wage for rail transportation and material moving workers was \$67,240 in 2019.

An estimated 29,900 rail jobs are at risk of unemployment due to utility decarbonization. This estimate represents 90% (utility share) of the 30% share of tonnage represented by coal shipments, or 27% of 110,750 transportation and materials moving railroad jobs. The Association of American Railroads notes that:

Although coal shipments have declined in recent years, coal is still an important part of the nation's industrial economy. Well over 90% of U.S. coal consumption is used for electricity generation while some coal is used to produce coke and for other industrial purposes.

Just five states account for nearly 70% of U.S. coal production, but coal is consumed all over the country —a feat made possible by freight railroads. Rail coal volumes have fallen in recent years, but coal is still a crucial commodity for U.S. freight railroads and the larger economy. In 2019, U.S. railroads moved 4.04 million carloads of coal, with each rail car carrying enough coal to power 19 homes for a year. Coal accounted for 30.1% of originated tonnage for U.S railroads, far more than any other commodity.¹¹

Potential Transition Assistance

Tables D3 (direct jobs) and D4 (indirect jobs) estimate potential transition assistance needed for workers and communities impacted by reduced railroad shipments of coal. With the closure of all coal-based electric generation plants, 29,900 direct railroad jobs are assumed to be retired in five equal phases between 2022 and 2035. An additional 78,250 indirect jobs may be lost based on the EPI job multiplier for the railroad industry.¹²

Transition assistance is assumed at alternative rates of 67%, 75%, and 100% of wages for a period of three years. The average compensation for direct jobs would amount to \$44,849 per rail worker for three years at the lowest 67% rate, while the average for indirect workers would be \$35,677 at this rate. Replacement benefits such as health care and pensions are not included in these estimates.

Transition assistance for direct railroad jobs lost would amount to an estimated \$268 to \$402 million annually (\$2019) within the assumed compensation range of 67% to 100%, or \$4.0 to \$6.0 billion over the 2022-2035 period. Transition assistance for indirect jobs would amount to \$558 to \$837 million (\$2019) annually, or \$8.4 to \$12.6 billion over this period. The total estimated annual assistance to direct and indirect workers, \$826 million to \$1.2 billion, would represent less than 0.01% of current U.S GDP of \$20 trillion.

¹¹ Association of American Railroads, 2020 Coal Fact Sheet, available at <https://www.aar.org/wp-content/uploads/2020/07/AAR-Coal-Fact-Sheet.pdf>.

¹² Economic Policy Institute, Updated employment multipliers for the U.S. economy (January 23, 2019).

Table A1.

Example BLS Occupational Job Categories for Fossil Electric Generation - Direct Jobs

State	Ind. Code			Jobs
Texas	221112	Fossil Fuel Electric Power Generation	All Occupations	5,670
Texas	221112	Fossil Fuel Electric Power Generation 11-0000	Management Occupations major	490
Texas	221112	Fossil Fuel Electric Power Generation 11-1021	General and Operations Managers detailed	170
Texas	221112	Fossil Fuel Electric Power Generation 11-3010	Administrative Services and Facility detailed	50
Texas	221112	Fossil Fuel Electric Power Generation 11-3051	Industrial Production Managers detailed	70
Texas	221112	Fossil Fuel Electric Power Generation 11-9021	Construction Managers detailed	40
Texas	221112	Fossil Fuel Electric Power Generation 11-9198	Personal Service Managers, All Other detailed	40
Texas	221112	Fossil Fuel Electric Power Generation 13-0000	Business and Financial Operations major	740
Texas	221112	Fossil Fuel Electric Power Generation 13-1198	Project Management Specialists and detailed	280
Texas	221112	Fossil Fuel Electric Power Generation 13-2011	Accountants and Auditors detailed	50
Texas	221112	Fossil Fuel Electric Power Generation 13-2098	Financial and Investment Analysts, detailed	270
Texas	221112	Fossil Fuel Electric Power Generation 15-0000	Computer and Mathematical Occupations major	200
Texas	221112	Fossil Fuel Electric Power Generation 17-0000	Architecture and Engineering Occupations major	380
Texas	221112	Fossil Fuel Electric Power Generation 17-2071	Electrical Engineers detailed	80
Texas	221112	Fossil Fuel Electric Power Generation 17-3023	Electrical and Electronic Engineers detailed	90
Texas	221112	Fossil Fuel Electric Power Generation 19-0000	Life, Physical, and Social Science Occupations major	80
Texas	221112	Fossil Fuel Electric Power Generation 41-0000	Sales and Related Occupations major	50
Texas	221112	Fossil Fuel Electric Power Generation 43-0000	Office and Administrative Support major	300
Texas	221112	Fossil Fuel Electric Power Generation 43-1011	First-Line Supervisors of Office and related detailed	40
Texas	221112	Fossil Fuel Electric Power Generation 43-4051	Customer Service Representatives detailed	**
Texas	221112	Fossil Fuel Electric Power Generation 43-5061	Production, Planning, and Expediting Occupations detailed	**
Texas	221112	Fossil Fuel Electric Power Generation 43-6014	Secretaries and Administrative Assistants detailed	100
Texas	221112	Fossil Fuel Electric Power Generation 43-9061	Office Clerks, General detailed	30
Texas	221112	Fossil Fuel Electric Power Generation 47-0000	Construction and Extraction Occupations major	210
Texas	221112	Fossil Fuel Electric Power Generation 47-2111	Electricians detailed	100
Texas	221112	Fossil Fuel Electric Power Generation 49-0000	Installation, Maintenance, and Repair Occupations major	1,560
Texas	221112	Fossil Fuel Electric Power Generation 49-1011	First-Line Supervisors of Mechanics detailed	210
Texas	221112	Fossil Fuel Electric Power Generation 49-2095	Electrical and Electronics Repairers detailed	310
Texas	221112	Fossil Fuel Electric Power Generation 49-9041	Industrial Machinery Mechanics detailed	250
Texas	221112	Fossil Fuel Electric Power Generation 49-9051	Electrical Power-Line Installers and detailed	220
Texas	221112	Fossil Fuel Electric Power Generation 49-9071	Maintenance and Repair Workers, detailed	210

Texas	221112	Fossil Fuel Electric Power Generation	49-9098	Helpers--Installation, Maintenance and Repair Workers, Except Electrical Power Line Installers	detailed	50
Texas	221112	Fossil Fuel Electric Power Generation	51-0000	Production Occupations	major	1,440
Texas	221112	Fossil Fuel Electric Power Generation	51-1011	First-Line Supervisors of Production Workers	detailed	180
Texas	221112	Fossil Fuel Electric Power Generation	51-4041	Machinists	detailed	30
Texas	221112	Fossil Fuel Electric Power Generation	51-8013	Power Plant Operators	detailed	1,100
Texas	221112	Fossil Fuel Electric Power Generation	53-0000	Transportation and Material Moving Occupations	major	70
Texas	221112	Fossil Fuel Electric Power Generation	53-7065	Stockers and Order Fillers	detailed	50

Table A2.

State	Fossil Elec Generation Jobs	Direct Wages	Total Direct Wages (\$Mil.)	Est. Indirect Jobs	Est. Indirect Income @ \$53,490* (\$Mil.)	Total Direct & Indirect	
						Jobs	Income (\$Mil.)
AL	2,390	\$84,790	\$203	13,487	\$721	15,877	\$924
AK	410	\$74,390	\$30	2,314	\$124	2,724	\$154
AR	NA						
AZ	NA						
CA	7,770	\$115,790	\$900	43,846	\$2,345	51,616	\$3,245
CO	540	\$94,300	\$51	3,047	\$163	3,587	\$214
CT	390	\$87,910	\$34	2,201	\$118	2,591	\$152
DE	NA						
FL	9,210	\$66,320	\$611	51,972	\$2,780	61,182	\$3,391
GA	370	\$81,510	\$30	2,088	\$112	2,458	\$142
HI	2,070	\$97,840	\$203	11,681	\$625	13,751	\$827
ID	NA						
IL	2,670	\$75,580	\$202	15,067	\$806	17,737	\$1,008
IN	4,440	\$75,780	\$336	25,055	\$1,340	29,495	\$1,677
IA	1,490	\$89,280	\$133	8,408	\$450	9,898	\$583
KS	1,100	\$82,310	\$91	6,207	\$332	7,307	\$423
KY	1,390	\$70,670	\$98	7,844	\$420	9,234	\$518
LA	1,140	\$75,660	\$86	6,433	\$344	7,573	\$430
ME	NA						
MD	2,010	\$96,240	\$193	11,342	\$607	13,352	\$800
MA	3,890	\$78,970	\$307	21,951	\$1,174	25,841	\$1,481
MI	6,200	\$90,170	\$559	34,987	\$1,871	41,187	\$2,430
MN	1,820	\$88,930	\$162	10,270	\$549	12,090	\$711
MS	860	\$75,620	\$65	4,853	\$260	5,713	\$325
MO	1,890	\$81,230	\$154	10,665	\$570	12,555	\$724
MT	NA						
NE	NA						
NV	550	\$97,420	\$54	3,104	\$166	3,654	\$220

NH	NA						
NJ	990	\$91,250	\$90	5,587	\$299	6,577	\$389
NM	640	\$93,850	\$60	3,612	\$193	4,252	\$253
NY	1,800	\$101,170	\$182	10,157	\$543	11,957	\$725
NC	1,010	\$92,680	\$94	5,699	\$305	6,709	\$398
ND	990	\$96,140	\$95	5,587	\$299	6,577	\$394
OH	2,960	\$85,310	\$253	16,703	\$893	19,663	\$1,146
OK	2,190	\$83,490	\$183	12,358	\$661	14,548	\$844
OR	270	\$98,230	\$27	1,524	\$81	1,794	\$108
PA	2,650	\$77,250	\$205	14,954	\$800	17,604	\$1,005
RI	NA						
SC	1610	\$83,680	\$135	9,085	\$486	10,695	\$621
SD	NA						
TN	NA						
TX	5,670	\$78,490	\$445	31,996	\$1,711	37,666	\$2,156
UT	1,060	\$91,210	\$97	5,982	\$320	7,042	\$417
VT	NA						
VA	960	\$86,660	\$83	5,417	\$290	6,377	\$373
WA	NA						
WV	2,700	\$79,040	\$213	15,236	\$815	17,936	\$1,028
WI	3,030	\$89,340	\$271	17,098	\$915	20,128	\$1,185
WY	150	\$91,370	\$14	846	\$45	996	\$59
37-States	81,280	\$85,468	\$6,947	458,663	\$24,534	539,943	\$31,481
US Total*	89,628	\$85,468	\$7,642	504,529	\$26,987	594,157	\$34,629

*US total reflects 10% pro rata upward adjustment of 37 state data based on generation from states with missing data.

Note: Does not include jobs in coal mining and transportation or natural gas production and distribution.

Source: Direct jobs and wages are from Bureau of Labor Statistics, Occupational Employment Statistics, May 2019

Available at:

https://www.bls.gov/oes/current/oes_research_estimates.htm

Indirect jobs multiplier for electric generation is from Economic Policy Institute, Updated employment multipliers for the U.S. economy (January 23, 2019). Appendix Table A1.

*Average U.S. wage all occupations 2019 from U.S Bureau of Labor Statistics, May 2019

Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/oes_nat.htm

Table A3.

Estimates of Direct Job Loss Compensation for Lost Fossil Electric Power Generation Wages, 2022-2036

Direct Jobs Lost Only - Assume 3-Year Period of 67%, 75% and 100% Compensation for Lost Wages
and Phased Job Losses at 17,881 Job-Years Lost Every Three Years (Total Jobs Lost 89,628)

Year	Job-Years Lost	Avg. Wage \$/yr \$2019	Total Compensation at Alternative Rates (Bil. 2019\$)		
			@67% Wages	@75% Wages	@100% Wages
2022	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2023	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2024	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2025	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2026	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2027	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2028	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2029	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2030	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2031	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2032	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2033	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2034	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2035	17,881	\$85,468	\$1.0	\$1.1	\$1.4
2036	17,881	\$85,468	\$1.0	\$1.1	\$1.4
Sum	268,215		\$15.3	\$17.2	\$21.5

First round of job loss

Second round of job loss

Third round of job loss

Fourth round of job loss

Fifth round of job loss

Table A4.

Estimates of Indirect Fossil Electric Generation Job Losses and Compensation for Lost Wages, 2022-2036

Indirect Jobs Lost Only - Assume 3-Year Period of 67%, 75% and 100% Compensation for Lost Wages

at 100,905 Job-Years Lost Every Three Years (Total Indirect Jobs Lost 504,529)

Year	Job-Years Lost*	Avg. Wage \$/yr**	Total Compensation at Alternative Rates (Bil. 2019\$)		
			@67% Wages	@75% Wages	@100% Wages
2022	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2023	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2024	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2025	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2026	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2027	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2028	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2029	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2030	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2031	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2032	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2033	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2034	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2035	100,905	\$53,490	\$3.6	\$4.0	\$5.1
2036	100,905	\$53,490	\$3.6	\$4.0	\$5.1
Sum	1,513,575		\$54.0	\$60.7	\$75.9

First round of job loss

Second round of job loss

Third round of job loss

Fourth round of job loss

Fifth round of job loss

*Indirect job losses estimated with 5.6 electric generation job multiplier from Economic Policy Institute,

Updated Employment Multipliers for the US Economy (January 2019), available at

<https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/>

** Average U.S. wage all occupations 2019 from U.S Bureau of Labor Statistics, May 2019

Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/oes_nat.htm

Table B1

Illustrative Estimates of Direct Job Losses and Compensation for Lost Coal Mining Wages, 2022-2036

Direct Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 10,154 Job-Years Lost Every Three Years (Total Jobs Lost 50,770)

Year	Job-Years Lost	Avg. Wage \$/yr \$2019	Total Compensation at Alternative Rates (Mil. \$2019)			First round of job loss
			@67% Wages	@75% Wages	@100% Wages	
2022	10,154	\$89,180	\$604	\$679	\$906	
2023	10,154	\$89,180	\$604	\$679	\$906	
2024	10,154	\$89,180	\$604	\$679	\$906	
2025	10,154	\$89,180	\$604	\$679	\$906	Second round of job loss
2026	10,154	\$89,180	\$604	\$679	\$906	
2027	10,154	\$89,180	\$604	\$679	\$906	
2028	10,154	\$89,180	\$604	\$679	\$906	Third round of job loss
2029	10,154	\$89,180	\$604	\$679	\$906	
2030	10,154	\$89,180	\$604	\$679	\$906	
2031	10,154	\$89,180	\$604	\$679	\$906	Fourth round of job loss
2032	10,154	\$89,180	\$604	\$679	\$906	
2033	10,154	\$89,180	\$604	\$679	\$906	
2034	10,154	\$89,180	\$604	\$679	\$906	Fifth round of job loss
2035	10,154	\$89,180	\$604	\$679	\$906	
2036	10,154	\$89,180	\$604	\$679	\$906	
Sum	152,310	\$89,180	\$9,060	\$10,187	\$13,583	

Coal mining direct jobs are from U.S. Bureau of Labor Statistics, May 2019

National Industry-Specific Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/naics4_212100.htm

Average wage from United Mine Workers of America, includes overtime.

Table B2

Illustrative Estimates of Indirect Coal-Related Job Losses and Compensation for Lost Wages, 2022-2036

Indirect Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 50,810 Job-Years Lost Every Three Years (Total Indirect Jobs Lost 254,053)

Year	Job-Years Lost*	Avg. Wage \$/yr**	Total Compensation at Alternative Rates (Mil. \$2019)		
			@67% Wages	@75% Wages	@100% Wages
2022	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2023	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2024	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2025	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2026	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2027	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2028	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2029	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2030	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2031	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2032	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2033	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2034	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2035	50,810	\$53,490	\$1,813	\$2,038	\$2,718
2036	50,810	\$53,490	\$1,813	\$2,038	\$2,718
Sum	762,150		\$27,192	\$30,576	\$40,767

*Indirect job losses estimated with 5.004 coal mining job multiplier from Economic Policy Institute,

Updated Employment Multipliers for the US Economy (January 2019), available at

<https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/>

** Average U.S. wage all occupations 2019 from U.S Bureau of Labor Statistics, May 2019

Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/oes_nat.htm

Table C1

Illustrative Estimates of Direct Job Losses and Compensation for Lost Natural Gas-Related Wages, 2022-2036

Direct Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 20,680 Job-Years Lost Every Three Years (Total Jobs Lost 103,400)

Covers Natural Gas Extraction, Distribution and Pipeline Transmission Only

Year	Job-Years Lost	Avg. Wage \$/yr \$2019	Total Compensation at Alternative Rates (Mil. \$2019)			Notes
			@67% Wages	@75% Wages	@100% Wages	
2022	20,680	\$90,300	\$1,246	\$1,401	\$1,867	First round of job loss
2023	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2024	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2025	20,680	\$90,300	\$1,246	\$1,401	\$1,867	Second round of job loss
2026	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2027	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2028	20,680	\$90,300	\$1,246	\$1,401	\$1,867	Third round of job loss
2029	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2030	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2031	20,680	\$90,300	\$1,246	\$1,401	\$1,867	Fourth round of job loss
2032	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2033	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2034	20,680	\$90,300	\$1,246	\$1,401	\$1,867	Fifth round of job loss
2035	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
2036	20,680	\$90,300	\$1,246	\$1,401	\$1,867	
Sum	310,200	\$90,300	\$18,683	\$21,008	\$28,011	

Direct jobs and average wages are from U.S. Bureau of Labor Statistics, May 2019

National Industry-Specific Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/naics4_212100.htm

Table C2

Illustrative Estimates of Indirect Job Losses and Compensation for Lost Natural Gas-Related Wages, 2022-2036

Indirect Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 90,320 Job-Years Lost Every Three Years (Total Indirect Jobs Lost 451,600)

Covers Natural Gas Extraction, Distribution and Pipeline Transmission Only

Year	Job-Years Lost*	Avg. Wage \$/yr**	Total Compensation at Alternative Rates (Mil. \$2019)			Notes
			@67% Wages	@75% Wages	@100% Wages	
2022	90,320	\$53,490	\$3,222	\$3,623	\$4,831	First round of job loss
2023	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2024	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2025	90,320	\$53,490	\$3,222	\$3,623	\$4,831	Second round of job loss
2026	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2027	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2028	90,320	\$53,490	\$3,222	\$3,623	\$4,831	Third round of job loss
2029	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2030	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2031	90,320	\$53,490	\$3,222	\$3,623	\$4,831	Fourth round of job loss
2032	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2033	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2034	90,320	\$53,490	\$3,222	\$3,623	\$4,831	Fifth round of job loss
2035	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
2036	90,320	\$53,490	\$3,222	\$3,623	\$4,831	
Sum	1,354,800		\$48,336	\$54,351	\$72,468	

*Indirect job losses estimated with natural gas sectoral job multipliers from Economic Policy Institute,

Updated Employment Multipliers for the US Economy (January 2019), available at

<https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/>

** Average U.S. wage all occupations 2019 from U.S Bureau of Labor Statistics, May 2019

Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/oes_nat.htm

Table D1

Illustrative Estimates of Direct Job Losses and Compensation for Lost Railroad Wages, 2022-2036

Direct Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 5,980 Job-Years Lost Every Three Years (Total Jobs Lost 29,900)

Year	Job-Years Lost	Avg. Wage \$/yr \$2019	Total Compensation at Alternative Rates (Mil. \$2019)			Notes
			@67% Wages	@75% Wages	@100% Wages	
2022	5,980	\$67,240	\$268	\$302	\$402	First round of job loss
2023	5,980	\$67,240	\$268	\$302	\$402	
2024	5,980	\$67,240	\$268	\$302	\$402	
2025	5,980	\$67,240	\$268	\$302	\$402	Second round of job loss
2026	5,980	\$67,240	\$268	\$302	\$402	
2027	5,980	\$67,240	\$268	\$302	\$402	
2028	5,980	\$67,240	\$268	\$302	\$402	Third round of job loss
2029	5,980	\$67,240	\$268	\$302	\$402	
2030	5,980	\$67,240	\$268	\$302	\$402	
2031	5,980	\$67,240	\$268	\$302	\$402	Fourth round of job loss
2032	5,980	\$67,240	\$268	\$302	\$402	
2033	5,980	\$67,240	\$268	\$302	\$402	
2034	5,980	\$67,240	\$268	\$302	\$402	Fifth round of job loss
2035	5,980	\$67,240	\$268	\$302	\$402	
2036	5,980	\$67,240	\$268	\$302	\$402	
Sum	89,700	\$67,240	\$4,023	\$4,524	\$6,031	

Direct jobs and average wages are from U.S. Bureau of Labor Statistics, May 2019

National Industry-Specific Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/naics4_482100.htm

Table D2

Illustrative Estimates of Indirect Job Losses and Compensation for Lost Railroad Wages, 2022-2036

Indirect Jobs Lost Only - Assume Five 3-Year Periods of 67%, 75%, and 100% Compensation for Lost Wages and Phased Job Losses at 15,650 Job-Years Lost Every Three Years (Total Indirect Jobs Lost 78,250)

Year	Job-Years Lost*	Avg. Wage \$/yr**	Total Compensation at Alternative Rates (Mil. \$2019)				Notes
			@67% Wages	@75% Wages	@100% Wages		
2022	15,650	\$53,490	\$558	\$628	\$837		First round of job loss
2023	15,650	\$53,490	\$558	\$628	\$837		
2024	15,650	\$53,490	\$558	\$628	\$837		
2025	15,650	\$53,490	\$558	\$628	\$837		Second round of job loss
2026	15,650	\$53,490	\$558	\$628	\$837		
2027	15,650	\$53,490	\$558	\$628	\$837		
2028	15,650	\$53,490	\$558	\$628	\$837		Third round of job loss
2029	15,650	\$53,490	\$558	\$628	\$837		
2030	15,650	\$53,490	\$558	\$628	\$837		
2031	15,650	\$53,490	\$558	\$628	\$837		Fourth round of job loss
2032	15,650	\$53,490	\$558	\$628	\$837		
2033	15,650	\$53,490	\$558	\$628	\$837		
2034	15,650	\$53,490	\$558	\$628	\$837		Fifth round of job loss
2035	15,650	\$53,490	\$558	\$628	\$837		
2036	15,650	\$53,490	\$558	\$628	\$837		
Sum	234,750		\$8,375	\$9,418	\$12,557		

*Indirect job losses estimated with natural gas sectoral job multipliers from Economic Policy Institute,

Updated Employment Multipliers for the US Economy (January 2019), available at

<https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/>

** Average U.S. wage all occupations 2019 from U.S Bureau of Labor Statistics, May 2019

Occupational Employment and Wage Estimates, available at

https://www.bls.gov/oes/current/oes_nat.htm