THE DISPARATE LOCAL IMPACTS OF CLOSING FOSSIL-FUEL POWER PLANTS

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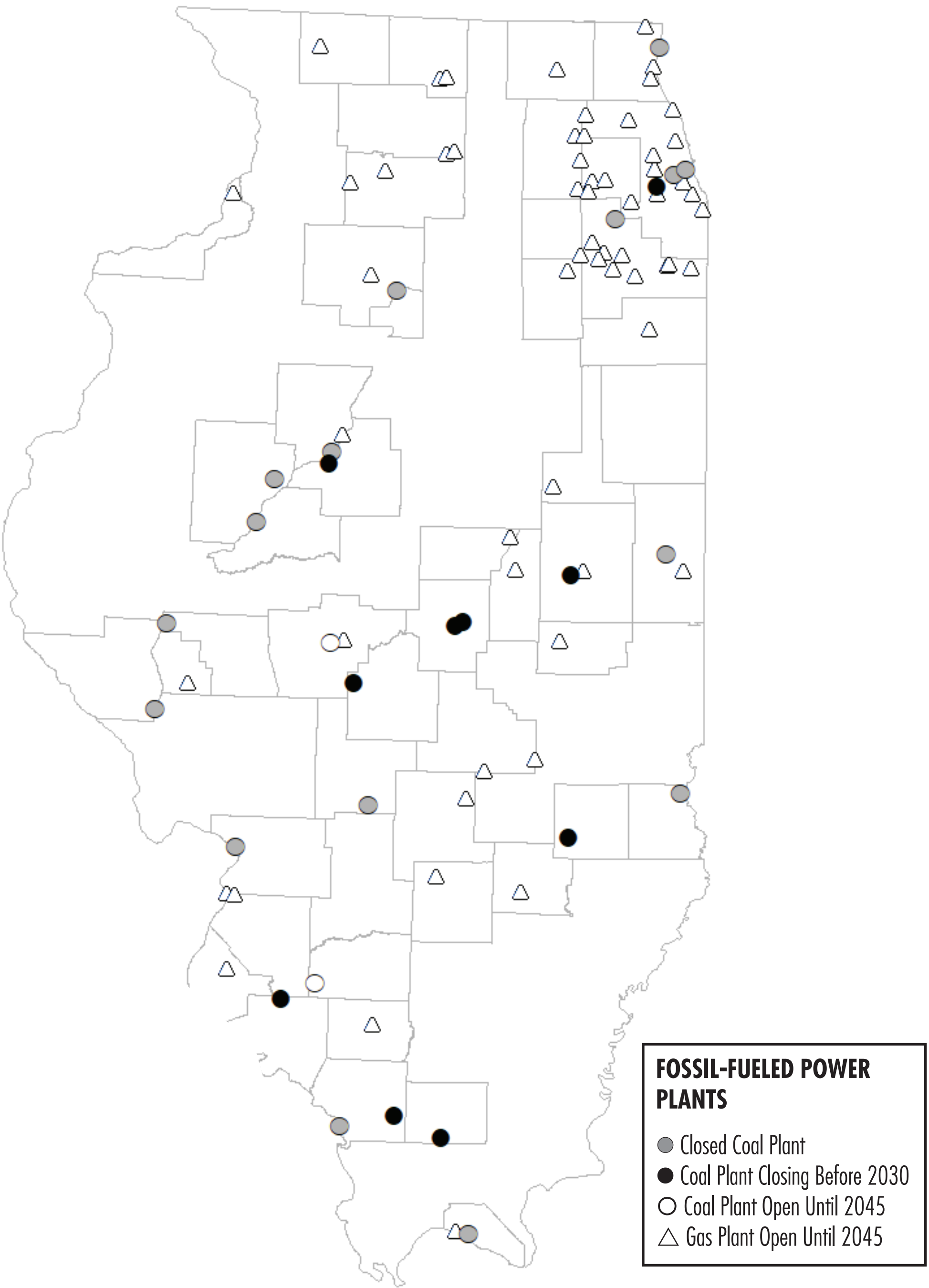
This paper illuminates the inequitable spatial distributions of local impacts from energy transition away from fossil-fuel dependency through a case study of the closing of 87 fossil-fuel power plants in Illinois. The Illinois Climate and Equitable Jobs Act signed into law by Governor JB Pritzker on September 15, 2021, promotes sizable global benefits from the reduction of greenhouse gases produced by fossil-fuel power plants in the state. Yet, the losses are borne entirely on a relatively small number of local governments, workers, and communities. The estimated impacts for the state's 102 counties include localized health gains from improved air quality, income gains attributed to new jobs that will be created as the energy grid is expanded within the state to serve wind-powered and solar-powered electricity-generation facilities, climate benefits from reduction of greenhouse gas emissions, local income losses in municipalities that experience closure of a fossil-fuel plant, and lost tax revenue in communities dependent on fossil-fuel energy production.

INTRODUCTION

Eighty-seven fossil-fuel power plants currently operate in the State of Illinois, including 14 that use coal for their primary fuel, 56 that use natural gas, and 17 that use oil. Their future operations are impacted by two chief phenomena. First, the availability of cheaper electric energy from renewable sources has resulted in decreasing dependence on fossil-fuel plants. Second, the enactment of the Illinois Climate and Equitable Jobs Act (CEJA) in 2021 assured cessation of operating as usual and their likely closure. Figure 1 identifies the location of the fossil-fuel plants in Illinois. The 14 coal-fired plants will most certainly close in the near future, with two exceptions. CEJA enabled the Dallman plant in Springfield (Sangamon County) and the Prairie State Energy Campus (PSEC) in Washington County to remain online until 2045, or beyond, if each plant can operate with zero carbon emissions by that year. Petroleum-fired plants are not shown in Figure 1 because they provide very small amounts of electricity capacity and generation; all 17 oil plants will close by 2030. Natural gas plants present the greatest uncertainty. CEJA mandates gas plants to close by 2045; however, production of electricity with natural gas has increased faster than any other fuel source in recent years, including solar and wind.

FIGURE 1


FOSSIL-FUELED POWER PLANTS
Closed Coal Plant
Coal Plant Closing Before 2030
Coal Plant Open Until 2045
Gas Plant Open Until 2045

The locations of a substantial number of fossil-fuel plants in sparsely populated counties are the source of geographic disparities. Most of the 25 coal-fired plants open in Illinois in 2010 are in small towns and rural regions. Since 2010, 11 coal plants have closed. Two of the closed plants were located in Chicago, while the other nine plants were located downstate, and eight were in small towns and rural regions. The impacts of closing the 14 coal plants still open in 2021 are included in this study. Eight private plants have been targeted for closure by their owners before the 2030 date mandated in CEJA, and only the Will County plant is located in an urban place. Among the six coal plants expected to close in the final year allowed by the legislation, three are located in small towns or rural regions.

Natural gas plants are much more likely to operate in densely-populated urban areas than coal-fired plants, which means that inequitable exposure to harmful substances and disparate health impacts has not lessened consistently with the decline in emissions overall. Low-income, Black, Brown, or Indigenous people are more concentrated in bigger cities, and, as also true in non-urban settings, they are more likely to reside near noxious facilities than higher income people.

CEJA incentivizes power generators and brokers in Illinois to adopt zero-emissions energy production by the year 2045, and it will likely cause the shuttering of all fossil-fuel power plants by that year. The new Illinois law provides financial incentives to produce renewable sources to generate 40% of the state's electricity production by 2030 and 50% by 2040. It also requires all private coal and oil electric generating units to reach zero emissions or close by January 1, 2030. Likewise, the state's two publicly-owned coal plants and all private and municipal gas units must reach zero emissions or close by 2045.

In this paper, the author estimates the economic impacts of transitioning from fossil fuels on fossil fuel-dependent counties. Local losses are compared to gains associated with improved health outcomes and reductions in greenhouse gas (GHG) emissions contributing to climate change. The approach stops short of a cost-benefit analysis in that it ignores opportunity costs and limits the analysis to a subset of impacts (Joseph et al., 2020). The author's estimation of impacts for 49 counties that have or will experience direct losses from closing plants, the State of Illinois, and the world, is another difference when compared with cost-benefit analysis. Cost-benefit analysis targets a single region within which one society is afforded standing (Mishan & Quah, 2021, p. 11). Hence, cost-benefit analysis is unable to illuminate potentially disparate spatial impacts. Instead, the economic impact approach is a common method for evaluating gains and losses from closing fossil-fuel plants across communities, with recent studies published for Pittsburgh (Russell et al., 2017), Texas (Strasert et al., 2019), the counties of 20 eastern states (Thomson et al., 2018), and Virginia (Virginia Climate Center, 2023).

The focus of the author's analysis is on the subset of impacts that includes gains to health from improved environmental quality and losses a community incurs when a plant closes. Table 1 reports the author's estimates of job losses and payroll losses by county. An estimated 2,865 workers annually receiving $425 million in payroll[1] (benefits included) would lose their jobs due to the combined closing of all remaining coal and gas plants and the reduction of demand for coal mined in the state. In addition to the estimated loss of 1,833 coal plant jobs and 394 gas plant jobs, an estimated 638 coal mine workers would no longer be needed. The analysis includes the losses in eight counties that have an active coal mine but no fossil-fuel plant in addition to the 41 counties with an operating fossil-fuel plant. These eight counties without a fossil-fuel plant are Clay, Franklin, Hamilton, Lawrence, Macoupin, Montgomery, Saline, and Wabash.

On top of lost income, fossil fuel-dependent communities will lose a substantial amount of tax revenues. Table 2 reports the author's estimates of county-wide property tax losses resulting from fossil-fuel plant closures. The author identified the taxable values of most plants from local assessors' information and multiplied them by the relevant tax rate to develop the estimates. Net generation data were used to estimate property tax losses for plants where taxable values could not be obtained, based on a relationship between generation and known taxable values. Annual property tax revenue losses exceed $2 million for the sum of the local governments in each of six counties (Jasper, Kendall, Lee, Randolph, Will, Williamson) and exceed $1 million in four additional counties (Cook, DuPage, Lake, Washington). Will County is the most impacted county with an estimated loss of nearly $5 million in property taxes to the overlapping jurisdictions with authority to tax the fossil-fuel plants in the county. For K-12 school districts with taxing jurisdiction over the plants, property tax revenue losses would be as high as $1.87 million. In coal-dependent school districts with small tax levies, coal plant tax revenue can constitute as high as 35% of property taxes the district has been receiving. Fossil-fuel plant host communities would lose $28.1 million in total estimated countywide property taxes, and 48.6% of the loss, or $13.7 million, would be incurred by school districts.

TABLE 1

CUMULATIVE JOB LOSSES AND ANNUAL PAYROLL LOSSES IN FOSSIL-FUEL SECTORS BY COUNTY THROUGH 2045 (IN MILLIONS)

COUNTY	COAL[a]	GAS	MINES[b]	PAYROLL[c]
Bureau	-	1	-	$ 0.156
Champaign	-	3	-	0.467
Christian	123	-	-	19.135
Clay*	-	3	-	0.467
Cook	-	20	-	3.111
DeWitt	-	1	-	0.156
Douglas	-	1	-	0.156
DuPage	-	16	-	2.489
Fayette	-	2	-	0.311
Ford	-	4	-	0.622
Franklin*	-	-	83	10.219
Grundy	-	10	-	1.556
Hamilton*	-	-	74	9.111
Jackson	1	-	1	0.279
Jasper	82	-	-	12.757
Kane	-	6	-	0.933
Kankakee	-	1	-	0.156
Kendall	-	118	-	18.357
Lake	100	12	-	17.424
Lawrence*	-	-	84	10.342
Lee	-	45	-	7.001
Logan	-	-	39	4.802
Macon	2	-	-	0.311
Macoupin*	-	-	2	0.246
Madison	-	3	-	0.467
Marion	-	2	-	0.311
Massac	121	2	-	19.135
McHenry	-	1	-	0.156

TABLE 1 *(continued)*

CUMULATIVE JOB LOSSES AND ANNUAL PAYROLL LOSSES IN FOSSIL-FUEL SECTORS BY COUNTY THROUGH 2045 (IN MILLIONS)

COUNTY	COAL[a]	GAS	MINES[b]	PAYROLL[c]
Monroe	-	1	-	$0.156
Montgomery*	-	-	46	$5.663
Ogle	-	1	-	$0.156
Peoria	73	1	83	$21.731
Perry	-	3	-	$0.467
Piatt	-	4	-	$0.622
Randolph	138	-	43	$26.763
Rock Island	-	32	-	$4.978
Saline*	-	-	2	$0.246
Sangamon	100	2	-	$15.868
Scott	-	2	-	$0.311
Shelby	-	37	-	$5.756
St Clair	-	1	-	$0.156
Stephenson	-	1	-	$0.156
Tazewell	205	-	-	$31.892
Vermilion	-	3	-	$0.467
Wabash*	-	-	4	$0.492
Washington	450	-	103	$82.687
Will	331	51	-	$59.428
Williamson	107	-	74	$25.757
Winnebago	-	4	-	$0.622
TOTAL	**1,833**	**394**	**638**	**$425.002**

Notes: Author's estimates. [a]Data on plant employment are triangulated from multiple sources including the plant owners, the National Establishment Time Series (Dun & Bradstreet), and Reference USA. [b]Data on employment in coal mining are from the 2020 Illinois Coal Annual Statistical Report prepared by the Illinois Department of Natural Resources Office of Mines and Minerals. The state is assumed to continue exporting about 75% of its mined coal to other states and countries beyond 2045 (see U.S. EIA, 2023[a]). [c]Estimates of payroll are based on 2022 Quarterly Census of Employment and Wages for Illinois in the Fossil-Fuel Electric Power Generation industry and the Coal Mining industry, and include benefits that are estimated as 40% of wages.

**Counties with only a coal mine, without a fossil-fuel plant.*

TABLE 2

BASELINE NET ELECTRICITY GENERATION (MEGAWATT HOUR) AND ESTIMATED ANNUAL PROPERTY TAX LOSSES THROUGH 2045

COUNTY	NET GENERATION	COUNTY-WIDE LOSS	COUNTY	NET GENERATION	COUNTY-WIDE LOSS
Bureau	1,357	$2,000	Massac	5,128,019	$816,000
Champaign	236,256	-	McHenry	5,584	10,000
Christian	3,933,111	447,000	Monroe	1,088	1,000
Clay	20,566	8,000	Ogle	4,369	7,000
Cook	901,532	1,148,000	Peoria	2,764,422	304,000
DeWitt	46	-	Perry	110,537	108,000
Douglas	28,665	59,000	Piatt	42,904	23,000
DuPage	895,662	1,346,000	Randolph	6,885,339	2,159,000
Fayette	1,695	1,000	Rock Island	2,230,323	270,000
Ford	153,845	308,000	Sangamon	1,226,176	-
Grundy	615,510	919,000	Scott	55,749	45,000
Jackson	7,259	3,000	Shelby	1,999,242	832,000
Jasper	3,254,366	2,006,000	St Clair	19,565	29,000
Kane	152,110	136,000	Stephenson	39,185	50,000
Kankakee	26,658	27,000	Tazewell	2,701,322	809,000
Kendall	5,966,561	2,418,000	Vermilion	145,954	167,000
Lake	2,758,403	1,444,000	Washington	12,685,744	1,460,000
Lee	2,563,866	2,018,000	Will	3,265,987	4,787,000
Macon	1,412,652	598,000	Williamson	669,385	2,886,000
Madison	106,894	98,000	Winnebago	432,118	320,000
Marion	17,656	24,000	**TOTAL**	**63,467,681**	**$28,093,000**

Notes: Author's estimates of local property tax losses are based on the assessed property values of power plants reported by local tax assessors and the property tax rates reported by district in the Illinois Department of Revenue's Table 28. Shaded counties have estimated annual property tax losses exceeding $1 million across all jurisdictions in the county.

Though the local losses are large, they are dwarfed by an estimated $27.6 billion in annual gains from improvements in health and reduced mortality coupled with reductions in GHG emissions. All 102 Illinois counties receive gains from the closing of the plants regardless of whether they house a plant expected to close, as does the entire world. Most of the estimated $10.8 billion in annual health gains would accrue to people living outside the host counties, and all but a miniscule portion of the $16.8 billion benefits in reduced GHG emissions would spill out from the counties with fossil-fuel plants. Small towns and rural communities that host a plant would incur all the estimated annual losses without government intervention. The imbalance between global gains and local losses requires a strategy to assure that coal-dependent communities will not be left behind in the transition to a clean-energy economy.

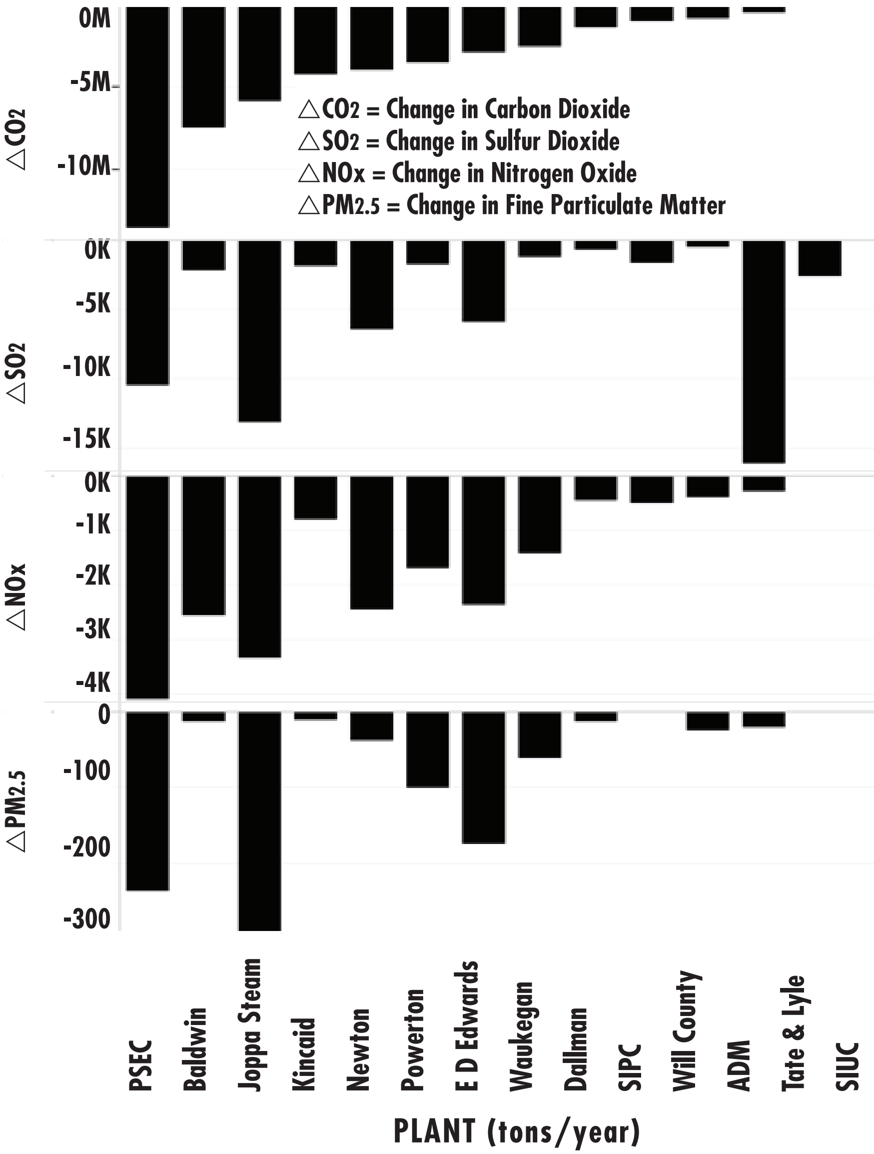
The author uses benefit transfers from the Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool available through the U.S. Environmental Protection Agency (USEPA) to estimate and monetize the health gains. Similarly, benefits from reduced GHG are estimated as the avoided social costs of carbon dioxide (SC CO_2). Benefit transfers is a technique that adapts methods and findings from existing research conducted in other settings to the area under study (Mishan & Quah, 2021, p. 213). The next section describes the approach and assumptions made in the process. Section 3 presents the findings, and Section 4 concludes the paper.

APPROACH TO THE ECONOMIC IMPACT ANALYSIS

The analysis uses USEPA's COBRA tool to estimate costs from adverse health outcomes from pollution by an operational plant. When a fossil-fuel plant closes, harmful emissions cease, and adverse health outcomes are avoided. The reduction of GHG emissions mitigates climate warming and reduces property damage that would otherwise occur as a result of the warming. The approach assumes fossil-fuel plants will close by the dates mandated by CEJA, eliminating their baseline emissions in the years following closure. The simulation accounts for the cumulative gains from plants that close after 2021, the baseline and last full year of emissions before CEJA became binding. Hence, it assumes ongoing gains in avoided health outcomes and reduced carbon. Figures 2 and 3 illustrate the changes in emissions from baseline for each plant (in the case of coal) and each county (for gas plants). The author uses the COBRA tool to estimate ambient fine particulate matter ($PM_{2.5}$) concentrations (both primary and secondary formation) from levels of primary $PM_{2.5}$, nitrogen oxides (NOx), and sulfur dioxide (SO_2) before and after the closure of plants. Carbon dioxide (CO_2) is not a criteria pollutant that contributes to $PM_{2.5}$ formation. Nor does CO_2 have direct adverse health outcomes. Hence, GHG emissions are considered separately in the analysis that follows.

FIGURE 2

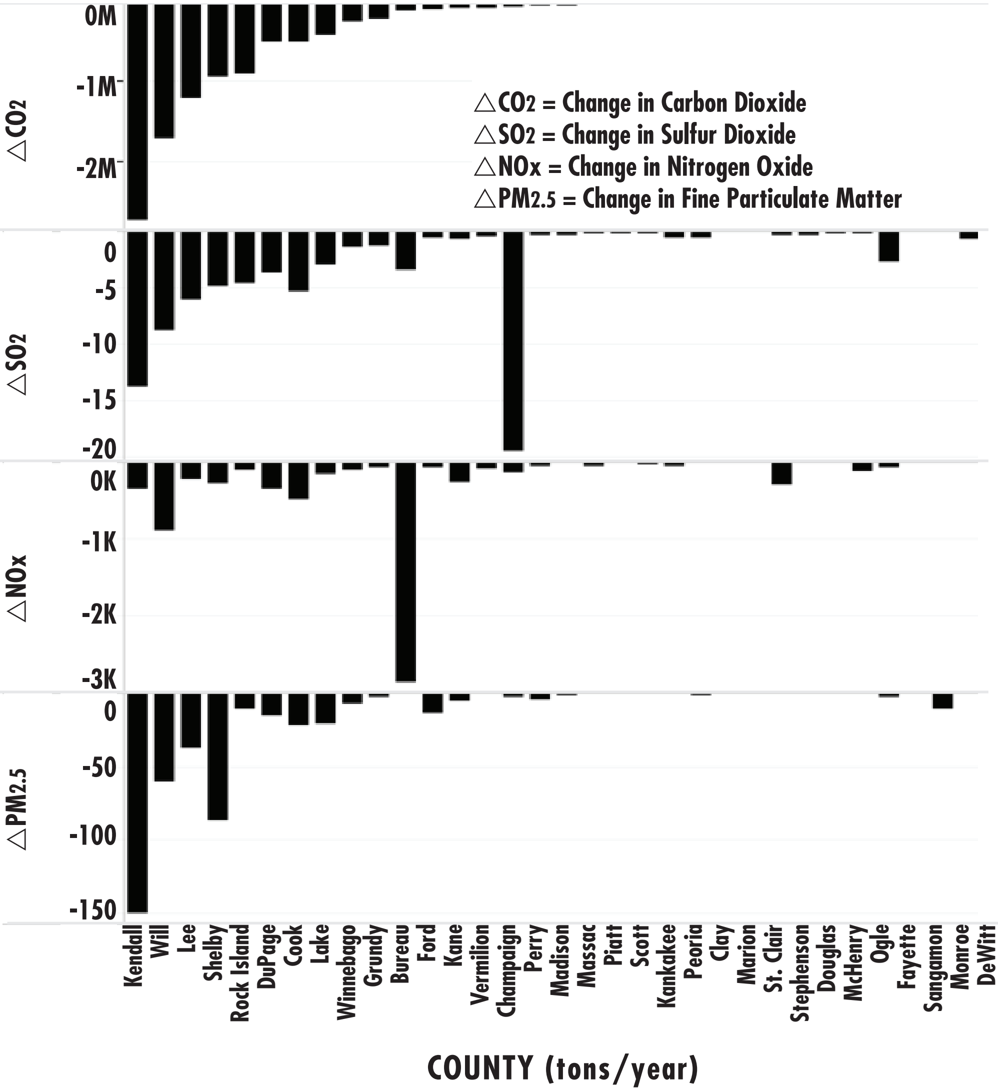
CHANGES IN ANNUAL EMISSIONS (IN TONS) OF CARBON DIOXIDE AND CRITERIA POLLUTANTS FROM BASELINE UPON CUMULATIVE COAL PLANT CLOSURES THROUGH 2030 (PLANT-LEVEL)



Source: USEPA Emissions & Generation Resource Integrated Database (eGRID)

FIGURE 3

CHANGES IN COUNTY ANNUAL EMISSIONS (IN TONS) OF CARBON DIOXIDE AND CRITERIA POLLUTANTS FROM BASELINE UPON CUMULATIVE GAS PLANT CLOSURES THROUGH 2045 (COUNTY-LEVEL)



Source: USEPA Emissions & Generation Resource Integrated Database (eGRID)

Though plants with the highest emissions confer the greatest gains from closure, the gains are not predominantly enjoyed by the host communities due to sparser populations that lower the incidence of avoided mortalities and morbidities. Washington County, the location of the Prairie State Energy Campus (PSEC), gains substantially less from the closure of its own plant than other host communities due to the plant's rural location. Figure 3 illustrates the emissions reductions from closing natural gas plants that would occur between 2030 and 2045 under CEJA. Natural gas plants emit less criteria pollutants than coal plants because natural gas burns cleaner; however, natural gas plants emit a lot of carbon. Natural gas plants also tend to be smaller than coal plants (the average natural gas plant generated 330 gigawatt hour (GWh) of electricity in Illinois in 2021, compared to 3,095 GWh for the average coal plant), and many gas plants are in densely populated cities near vulnerable populations.

The author estimates the gains of avoided health outcomes using USEPA's COBRA tool and the standard 4-step approach suggested by USEPA (U.S. EPA, 2018). The first step is to estimate and project baseline emissions scenarios; the author's baseline profile includes the emissions of all 87 fossil-fuel plants in 2021. The second step is to quantify the estimated reduction in emissions; the author assumes that emissions reduce from baseline to zero in the year after closure. Emissions are modeled to drop immediately, without gradual reduction, which is consistent with practices observed with previous closures. In recent closures, the asset's usage was maintained or increased up to the point of closure. This practice allows plant owners to capture the remaining value of the asset before it is idled. The third step is to estimate the air quality changes from the reductions, and the last step is to quantify the health effects and related economic impacts from the improvement in air quality (U.S. EPA, 2018). Steps 3 and 4 are carried out with the COBRA tool.

CO-BENEFITS RISK ASSESSMENT (COBRA) HEALTH IMPACTS SCREENING AND MAPPING TOOL

Benefit transfers in the analysis include both value transfers and function transfers (Mishan & Quah, 2021, pp. 213-19). The COBRA tool draws on USEPA's analysis of expert opinions from top epidemiologists in transferring the functions and monetary values included in the model from existing research findings (U.S. EPA, 2024). The functions are mathematical equations predicting the relationships between emissions, population, and various health impacts from pollution. Health impact functions translate estimated changes in ambient

$PM_{2.5}$ concentrations into estimated incidences of illness, impairment, or death (U.S. EPA, 2024). Health impact functions modeling 12 health outcomes are transferred in the COBRA tool including premature mortality, infant deaths, nonfatal heart attacks, cardiovascular hospital admissions, respiratory hospital admissions, respiratory emergency room visits, asthma onset, asthma symptoms, lung cancer, minor restricted activity days, work loss days, and hay fever/rhinitis (U.S. EPA, 2024).

Estimated values per incident of avoided health outcomes are likewise transferred in the COBRA tool from many of the same epidemiological studies. Table 3 presents the estimated values per incident of avoided health outcome, as adapted by the author for years 2025, 2030, and 2045. The values are adjusted into 2020 dollars using the process described in the technical appendix. The technical appendix also provides information on how each of the values for avoided premature mortality and avoided morbidities are determined, with references to resources where the reader can obtain additional information.

TABLE 3

ESTIMATED VALUES PER INCIDENT OF AVOIDED HEALTH OUTCOME

AVOIDED HEALTH OUTCOME	2025	2030	2045
Mortality (including infants)	$17,449,713	$18,034,516	$19,521,066
Nonfatal Heart Attacks	$101,086	$104,897	$114,624
Hospital Admits, All Respiratory[a]	$35,035	$36,356	$39,728
Hospital Admits, Cardiovascular	$32,082	$33,291	$36,378
Asthma Onset	$91,681	$95,137	$103,959
Asthma Symptoms	$1.21	$1.23	$1.27
Lung Cancer[a]	$53,719	$54,394	$56,075
Emergency Room Visits, Respiratory	$1,754	$1,776	$1,831
Minor Restricted Activity Days	$136	$137	$142
Work Loss Days	$342	$346	$356
Hay Fever/Rhinitis	$1,203	$1,219	$1,256

Notes: [a] weighted average of age-specific estimates. Please see technical appendix for information on how values are determined, with references to resources for additional information.

USING THE COBRA TOOL

The COBRA tool requires a user to identify a baseline scenario for ambient air quality and emissions of criteria pollutants, furnish an emissions scenario, choose a discount rate, and identify the regions where impacts will be examined. Estimated impacts can be examined for every county in the contiguous United States. The emissions scenarios specify the industry or sector where the change in emissions will occur, which is Fuel Combustion at Electric Utility for the current analysis. This analysis uses the 2021 data from USEPA's Emissions & Generation Resource Integrated Database (eGRID) to develop the baseline emissions of $PM_{2.5}$, SO_2, and NOx in each county where a closing plant is located, and then each emissions scenario eliminates a particular plant's baseline emissions according to the expected timeline of the closures. For the year 2025, five coal plants are expected to be closed (since the 2021 baseline year), and the emissions in each of five counties are modeled to be eliminated where the closing plants are located. For 2030, 12 coal plants in 11 counties are modeled as closed (including the coal plants closed in the 2025 scenario). For 2045, the closure of all 87 fossil-fuel plants in 41 counties is modeled in a high-benefit scenario, and only the closure of the 31 coal plants in 13 counties is modeled in a pessimistic low-benefit scenario considering effects that would occur if the state is unable to close natural gas plants.

COBRA translates the emissions scenario into predicted concentrations of pollution in each county, and then it predicts adverse health outcomes in each county based on the estimated changes in exposure to harmful concentrations of $PM_{2.5}$. The technical appendix describes how the COBRA tool translates emissions of $PM_{2.5}$, NOx, and SO_2 into estimates of mortality and morbidity attributed to air pollution. This analysis manually transferred and adjusted the monetary values per incident shown in Table 3 so that values are expressed in 2020 dollars and reflect growth in incomes for years 2025, 2030, and 2045.

USEPA's assumptions about the relevant discount rate for the future, values of human life and reduced quality of life, and the SC CO_2 have been refined since November 2023, taking into account recent research on the subjects and resulting in a substantially larger value of human life and cost of carbon. Recent changes in estimates of the values of reduced quality of life are mixed, with values of some health outcomes increasing and others decreasing.

The SC CO_2 is used for valuation of avoided GHG emissions and associated reduction in damage to property from climate change. GHG benefits rely on estimates of the SC CO_2 equal to $212 per metric ton in 2025, $230 per ton in 2030, and $287 per ton in 2045 using the new set of estimates published in USEPA's December 2023 Final Rulemaking (U.S. EPA 2023, p. 78).[2] All gains and losses are presented in present-value terms using a 2% annual discount rate, consistent with the Office of Management and Budget (OMB) Circular A-4 and the recent moving average of the 10-year Treasury Note (White House, 2024).

SOURCES OF DATA

COBRA software stores baseline emissions and populations data and incidence rate estimates for each health outcome by each year of age in addition to the health impact functions and monetary values and information on the relationships between emissions and concentrations of pollution for all U.S. counties. Table 4 presents descriptive statistics for baseline data for the 49 host counties in Illinois, along with the sources of data. Populations are summed over the 100 age categories due to space limitations. Incidence rates cannot be summed across age categories because they depend on populations in each age group and therefore are not included in the table.

The baseline and each scenario for the years 2025, 2030, and 2045 are developed from data on emissions, plant capacity, and net generation that come from eGRID data. The eGRID database is a comprehensive source of data on emissions, generation, and other attributes of electric power generated in the United States. It compiles plant-level data on CO_2, NOx, and SO_2 emissions reported by power plants. Separately, USEPA uses National Emissions Inventory (NEI) data to determine $PM_{2.5}$ emissions at power plants from annual emissions of the air pollutants reported to NEI.

The simulation mainly relies on the relationships between emissions and $PM_{2.5}$ concentrations and on the health impact functions stored in COBRA, but it also uses the population by age stored within the tool. The change (Δ) in $PM_{2.5}$ concentration values in Table 4 are summary statistics for the output estimates of pollution concentration to aid the reader in understanding how COBRA translates the author's inputs of baseline and changing emissions scenarios into changes in ambient $PM_{2.5}$ concentration. For example, the mean value of -0.0364 in 2025 reveals the improvement in ambient air quality for the average fossil fuel-dependent county from elimination of 2021 baseline emissions of PM2.5, SO2, and NOx in the counties with a plant closing by 2025. The change in ambient air quality is a key input for health-impact functions.

Data on plant jobs are collected from multiple sources including the plant owners, the National Establishment Time Series, Reference USA, and the Quarterly Census of Employment and Wages. Data on employment in coal mining are from the 2020 Illinois Coal Annual Statistical Report. The state is assumed to continue exporting about 75% of its mined coal to other states and countries beyond 2045 (see U.S. Energy Information Administration (EIA), 2023a).

ASSUMPTIONS OF THE ECONOMIC IMPACT ANALYSIS

All economic impact evaluations and projections of the future require simplifying assumptions. The author makes four important assumptions in this analysis that are informed by a review of research, practices, and documents as detailed in the technical appendix. The four assumptions are:

Assumption 1: Plant closures will occur by the incentivized dates (2025, 2030, and 2045) with an allowance that natural gas plants might not close by 2045.

Assumption 2: Population levels in counties remain static from 2023 through 2045.

Assumption 3: The locations of future job creation gains and infrastructure costs are not knowable.

Assumption 4: Recent changes to consequential estimates for impact evaluation are improvements.

Assumption 1 and Assumption 3 have the greatest potential for distorting the relative distributions of gains and losses that represent disparate impacts. The evidence for Assumption 1 provided in the technical appendix is compelling. The average costs of renewable energy sources have decreased considerably and so have the costs for natural gas plants, as they have become more efficient due to combined cycle turbines (PJM Learning Center, n.d.). A similar argument is included in the technical appendix for Assumption 3. Grid connections for electricity production from renewable sources come with enormous cost disincentives when compared to natural gas, which makes future project siting unpredictable. Though the number of new jobs required to construct extensions to the grid network is estimated to exceed job losses from plant closure, it is not possible to predict at this time the counties where those jobs will be predominantly located. A similar problem occurs with the costs of infrastructure, which would impose a loss. These gains and losses offset one another, making them irrelevant at the county level.

TABLE 4

SUMMARY STATISTICS FOR 49 COUNTIES WITH LOSSES

	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM	DATA SOURCE
Net Generation (2021)	1,109,603	2,127,612	0	11,308,063	eGRID (2021)
ΔNOx (2025)	-206	699	-3,341	0	eGRID (2021)[a]
ΔSO_2 (2025)	-473	2,075	-13,231	0	eGRID (2021)[a]
$\Delta PM_{2.5}$ (2025)	-12	49	-297	0	eGRID (2021)[a]
ΔCO_2 (2025)	-402,949	1,431,256	-7,449,410	0	eGRID (2021)[a]
ΔNOx (2030)	-318	797	-3,341	0	eGRID (2021)[a]
ΔSO_2 (2030)	-715	2,254	-13,231	0	eGRID (2021)[a]
$\Delta PM_{2.5}$ (2030)	-15	51	-297	0	eGRID (2021)[a]
ΔCO_2 (2030)	-667,082	1,663,002	-7,449,410	0	eGRID (2021)[a]
Low ΔNOx (2045)	-411	961	-4,122	0	eGRID (2021)[a]
Low ΔSO_2 (2045)	-944	2,649	-13,231	0	eGRID (2021)[a]
Low $\Delta PM_{2.5}$ (2045)	-20	60	-297	0	eGRID (2021)[a]
Low ΔCO_2 (2045)	-973,501	2,478,545	-13,591,665	0	eGRID (2021)[a]
High ΔNOx (2045)	-565	1,005	-4,122	0	eGRID (2021)[a]
High ΔSO_2 (2045)	-1,333	3,674	-18,827	0	eGRID (2021)[a]
High $\Delta PM_{2.5}$ (2045)	-30	63	-298	0	eGRID (2021)[a]
High ΔCO_2 (2045)	-1,197,795	2,466,106	-13,591,665	0	eGRID (2021)[a]
Population (2023)	242,061	764,697	5,040	5,266,680	COBRA v. 5.1 (June 2024)
$\Delta PM_{2.5}$ Concentration (2025)	-0.0364	0.0118	-0.0811	-0.0221	COBRA v. 5.1 (June 2024)[b]

	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM	DATA SOURCE
ΔPM2.5 Concentration (2030)	-0.0558	0.0147	-0.0949	-0.0319	COBRA v. 5.1 (June 2024)[b]
Low ΔPM2.5 Conc (2045)	-0.0777	0.0229	-0.1227	-0.0391	COBRA v. 5.1 (June 2024)[b]
High ΔPM2.5 Conc (2045)	-0.1113	0.0260	-0.1655	-0.0629	COBRA v. 5.1 (June 2024)[b]
Jobs in Coal Plants (2021)	37.41	88.72	0	450	Author's Estimates[c]
Jobs in Gas Plants (2021)	8.04	19.81	0	118	Author's Estimates[c]
Jobs in Coal Mines (2021)	13.02	28.72	0	103	Coal Annual Statistical Report[d]
Total Jobs (2021)	58.47	103.95	1	553	Author's Estimates[c,d]
Total Payroll (2021)	8,673,508	15,690,924	155,570	82,687,350	Author's Estimates[e]
Countywide Tax Loss (2021)	573,327	1,101,644	0	4,787,000	Author's Estimates[f]
School District Loss (2021)	278,694	510,976	0	1,870,000	Author's Estimates[f]
Property Tax Ext. (2021)	44,206,767	164,398,233	814,224	797,451,354	Illinois Department of Revenue Table 28
Tax % of Extension (2021)	5.77%	13.49%	0.00%	56.05%	Author's Estimates

Notes: [a]*Scenario eliminates eGRID (2021) emissions for plants scheduled to close by year indicated.*
[b]*COBRA output of Source-Receptor Matrix from change in PM2.5 concentration for scenario indicated.*
[c]*Based on information from plant owners and National Establishment Time Series and Reference USA.*
[d]*Prepared by the Illinois Department of Natural Resources Office of Mines and Minerals (Value is 75% of total).*
[e]*Based on data in the Quarterly Census of Employment and Wages.*
[f]*Based on assessed values of plants obtained from county assessors and tax rates reported in Illinois Department of Revenue Table 28.*

ANALYSIS AND INTERPRETATION

The author uses an estimated $147,000 in wages plus benefits (40% of wages) to arrive at new income gains of $220.5 million annually after 2025, $735 million after 2030, and $1.47 billion annually after 2045. Jobs in wind and solar electric power generation tend to pay less than jobs in fossil-fuel plants, $105,000 per year on average in 2022 compared to $126,000 for the average fossil-fuel energy worker (QCEW, 2022). Based on a fixed share of workers per terawatt hour (TWh), the author estimates 10,000 new jobs will be created to interconnect the needed network of renewable sources to an enhanced grid and to generate and transmit the additional 66 TWh of clean, renewable energy needed to replace supply from decommissioned fossil-fuel plants and to meet demand in a more-electrified economy. Thirty-five of those additional TWh are needed up front by 2030 to meet renewable portfolio standards, and 5,000 additional jobs are estimated to be created in the electric power generation, transmission and distribution industry by that date. Projects are underway or in the queue, and the author estimates 1,500 new jobs to be created by 2025. The payroll gains from the new law are estimated to be nearly 3.5 times the magnitude of payroll losses. These gains will be distributed throughout the state with very little benefit returning to the fossil-fuel host communities where losses occurred.

The author estimates $1.65 billion annually in new infrastructure costs based on a request by Ameren Illinois to increase customer rates $300 per year by 2027 to cover infrastructure costs of decarbonizing the grid (Ameren, 2024).[3] ComEd submitted a similar multi-year integrated grid plan that would increase the rates of its customers by an estimated $92 per year. Using the higher of the two costs and assuming that other utilities would follow suit in passing on costs to the state's 5.5 million household consumers, the estimate is calculated as $300 x 5.5 million households = $1.65 billion. The increased utility costs would likely be borne evenly across counties on a per household basis, which makes them irrelevant at the county level. Hence, they are not included in the county-level estimates. Similarly, jobs created to interconnect and maintain the new network cannot be reliably predicted by county. These additional gains are estimated statewide only.

DISPARITIES AMONG COUNTIES

Most of the gains from closing fossil-fuel power plants accrue outside the host communities where the losses are incurred. Table 5 provides an overview of the spatial incidence of gains for each year of the analysis. Estimated total annual gains (the sum of all health gains in the U.S. and benefits to the world from GHG reductions) increase from $5.8 billion ($1,583.6M + $4,185.8M) in 2025 to $12.8 billion ($5,314.9M + 7,518.0M) by 2030 and to $27.7 billion ($10,836.0M + $16,844.6M) by 2045 due to the closure of additional plants within each period. The share of estimated gains that accrues to host communities increases from 0.7% (= $42.1 / $5,769.4) in 2025 and 1.3% (= $169.9 / $12,832.9) in 2030 to 6.8% (= $1,881.5 / $27,680.6) in 2045 as natural gas plants close in large cities. Prior to 2045, closures will be limited to coal plants, which are near smaller towns and rural places, meaning there are fewer incidents of negative health outcomes to avoid after reduction of noxious emissions.

TABLE 5

SPATIAL INCIDENCE OF ANNUAL GAINS FROM CUMULATIVE CLOSING OF POWER PLANTS (IN MILLIONS)

	2025		2030		2045	
	LOW	HIGH	LOW	HIGH	LOW	HIGH
Host Communities	$42.1	$89.0	$ 80.6	$169.9	$125.9	$1,881.5
Illinois	$313.7	$668.8	$484.3	$1,033.6	$683.3	$2,295.8
United States	$1,583.6	$3,414.6	$2,466.2	$5,314.9	$3,474.2	$10,836.0
World (GHG)[a]	$ 4,185.8		$ 7,518.0		$13,690.3	$16,844.6

Notes: All estimates in 2020 dollars. [a]All benefits from GHG reductions assumed to accrue to world with miniscule share to host communities.

The benefits accruing to the world are driven by the reduction of GHG emissions as plants close. The author estimates a reduction of 19.7 million metric tons of CO_2 annually due to the closure of five coal plants between 2022 and 2025. Closure of additional fossil-fuel plants increases cumulative reductions in CO_2 to 32.7 million tons annually by 2030 and between 47.7 million and 58.7 million tons by 2045 depending on expectations about natural gas plants closing.

The range from low to high estimates in Table 5 for each year conveys the level of uncertainty we have for events in the future. The range is narrower for years 2025 and 2030 than for year 2045 because future closures of coal plants are more certain than the closures of gas plants. Coal plants started closing years before the enactment of the new law, while Illinois has recently increased its dependence on natural gas. Coal plants are dirtier than gas plants, have greater health co-benefits from closure, and are intensively targeted for closure for environmental equity reasons. Natural gas plants near vulnerable populations will likely close sooner than 2045 as provided for in CEJA. Yet, the Act also contains an offramp provision that could keep gas plants open beyond 2045 if targets are not met for expansion of clean, renewable energy sources that can maintain system load reliability. The other source of uncertainty in the estimates of health co-benefits is the range of estimates of avoided mortality and avoided nonfatal heart attacks, as depicted in Table 6.

Most of the avoided mortality and morbidity in Illinois from closing coal plants accrues outside the host communities. This imbalance occurs because the remaining coal plants are located in small towns and rural areas with fewer residents to be impacted by the pollutants. All but nine of the avoided deaths in 2030 would be avoided outside host communities in the scenario where all

TABLE 6

ESTIMATED AVOIDED HEALTH OUTCOMES FROM CUMULATIVE FOSSIL-FUEL PLANT CLOSURES

AVOIDED HEALTH OUTCOME	HOST COMMUNITIES		
	2025	2030	2045
Mortality	[2 – 5]	[4 – 9]	[6 – 95]
Infant Mortality	0	0	0
Nonfatal Heart Attacks	2	3	[4 – 31]
Hospital Admits, All Respiratory	0	0	[1 – 5]
Hospital Admits, Cardiovascular[a]	0	1	[1 – 7]
Asthma Onset	7	12	[17 – 125]
Asthma Symptoms	1,315	2,260	[3,157 – 23,054]
Lung Cancer	0	0	[0 – 3]
Emergency Room Visits, Respiratory	2	4	[5 – 38]
Minor Restricted Activity Days	2,054	3,527	[4,937 – 37,406]
Work Loss Days	345	593	[830 – 6,342]
Hay Fever/Rhinitis	45	78	[109 – 795]

Notes: [a]Excludes heart attacks. Range from low to high estimates in brackets.

nine coal plants close (See Table 6, Host Communities, 2030, Mortality [4 – 9]). Due to sparse populations, host communities likewise do not account for the one avoided infant death and account for only 3% to 5% of the reductions in most maladies, hospital admissions and visits, lost days at work, and restricted activity in 2030 (between 3/99 for Nonfatal Heart Attacks and 1/19 for Hospital Admits, Cardiovascular). Avoided incidents in host communities increase in 2045 because natural gas plants are located in densely populated cities where more harm is avoided, so these places begin being counted among the host communities after 2030. Hence, the 2045 estimates indicate that 17% to 21% of the reductions in premature mortality and other negative health outcomes would be borne on host communities following the closure of all fossil-fuel facilities including natural gas plants (between 31/184 for Nonfatal Heart Attacks and 38/179 for Emergency Room Visits, Respiratory).

While most of the benefits of closing fossil-fuel power plants escape the communities that host them, 100% of the losses from a plant closure are borne locally on the host community. Table 7 compares annual gains and losses in coal dependent counties by inflection year. The last column presents net gains

	ILLINOIS			**UNITED STATES**		
	2025	**2030**	**2045**	**2025**	**2030**	**2045**
	[17 – 38]	[26 – 56]	[34 – 116]	[88 – 192]	[132 – 290]	[172 – 546]
	0	0	0	1	1	2
	12	18	[24 – 38]	66	99	[128 – 184]
	2	3	[4 – 6]	10	15	[20 – 28]
	3	4	[5 – 8]	12	19	[24 – 35]
	47	70	[90 – 145]	221	333	[433 – 630]
	8,663	12,940	[16,629 – 26,731]	40,820	61,458	[79,906 – 116,346]
	1	2	[2 – 4]	6	9	[12 – 17]
	15	22	[28 – 45]	64	95	[124 – 179]
	14,067	21,008	[26,981 – 43,429]	64,825	97,651	[126,908 – 185,010]
	2,381	3,556	[4,566 – 7,353]	10,950	16,495	[21,436 – 31,255]
	299	446	[573 – 921]	1,408	2,119	[2,755 – 4,011]

in 2045. A negative net gain identifies a county that experiences net losses. To obtain net gains for 2025 and 2030, the reader can subtract losses from gains in the particular year. Ten of the 49 coal-dependent counties have estimated direct annual net losses by 2045. All but two (Kendall and Lee) of the 10 net-loss counties are downstate, and only Kendall County is part of a metropolitan area. Direct net losses range from $1.9 million each year in Lee County, the location of two combined-cycle natural gas plants with combined nameplate capacity of 1,319 megawatts (MW), to $78.9 million each year in Washington County, the location of PSEC, the largest fossil fuel plant in the state. As a set, the 49 fossil fuel-dependent counties collectively experience net gains of $1.5 billion. Six of the eight counties with coal mines but no plant have estimated net collective gains of $24.1 million. Hamilton and Lawrence counties have estimated net losses of $6 million in each county with a mine but no plant.

TABLE 7

ANNUAL GAINS AND LOSSES IN COAL DEPENDENT COUNTIES BY INFLECTION YEAR (IN THOUSANDS)

COUNTY	2025 GAINS	2025 LOSSES	2030 GAINS	2030 LOSSES	2045 GAINS	2045 LOSSES	2045 NET GAINS
Bureau	$ 2,843.0	$ 0	$ 4,207.0	$ 0	$ 8,330.0	$ 158.0	$8,172.0
Champaign	8,191.0	0	15,512.0	0	37,715.0	467.0	37,248.0
Christian	2,610.0	0	4,779.0	19,582.1	11,575.0	19,582.0	-8,007.0
Clay*	1,266.0	0	2,162.0	0	4,395.0	475.0	3,920.0
Cook	222,570.0	0	335,558.0	0	762,346.0	4,259.0	758,087.0
DeWitt	1,253.0	0	2,294.0	0	6,658.0	156.0	6,502.0
Douglas	1,279.0	0	2,577.0	0	6,024.0	215.0	5,809.0
Du Page	40,343.0	0	61,232.0	0	144,211.0	3,835.0	140,376.0
Fayette	1,455.0	0	2,508.0	0	6,252.0	312.0	5,940.0
Ford	1,219.0	0	2,146.0	0	5,049.0	930.0	4,119.0
Franklin*	5,272.0	0	7,709.0	0	14,496.0	10,219.0	4,277.0
Grundy	2,768.0	0	4,482.0	0	10,448.0	2,475.0	7,973.0
Hamilton*	1,222.0	0	1,741.0	0	2,992.0	9,111.0	-6,119.0
Jackson	3,918.0	0	5,404.0	0	10,610.0	282.0	10,328.0
Jasper	814.0	0	1,818.0	14,762.7	3,309.0	14,763.0	-11,454.0
Kane	19,381.0	0	29,827.0	0	69,421.0	1,069.0	68,352.0
Kankakee	6,524.0	0	10,755.0	0	24,501.0	183.0	24,318.0

COUNTY	2025 GAINS	2025 LOSSES	2030 GAINS	2030 LOSSES	2045 GAINS	2045 LOSSES	2045 NET GAINS
Kendall	$ 4,669.0	$ 0	$ 7,360.0	$ 0	$ 17,499.0	$20,775.0	$ -3,276.0
Lake	31,937.0	18,867.8	44,986.0	18,867.8	95,222.0	18,868.0	76,354.0
Lawrence*	1,287.0	0	2,381.0	0	4,331.0	10,342.0	-6,011.0
Lee	2,179.0	0	3,305.0	0	7,075.0	9,019.0	-1,944.0
Logan	2,198.0	0	3,908.0	0	9,356.0	4,802.0	4,554.0
McHenry	13,303.0	0	19,792.0	0	43,924.0	166.0	43,758.0
Macon	7,980.0	0	15,147.0	0	44,625.0	909.0	43,716.0
Macoupin*	3,226.0	0	5,195.0	0	11,762.0	246.0	11,516.0
Madison	18,589.0	0	28,117.0	0	63,575.0	565.0	63,010.0
Marion	3,720.0	0	5,984.0	0	14,910.0	335.0	14,575.0
Massac	3,267.0	19,951.1	3,948.0	19,951.1	5,695.0	19,951.0	-14,256.0
Monroe	2,168.0	0	3,073.0	0	6,219.0	157.0	6,062.0
Montgomery*	2,338.0	0	3,903.0	0	9,299.0	5,663.0	3,636.0
Ogle	2,801.0	0	4,229.0	0	9,179.0	163.0	9,016.0
Peoria	17,268.0	22,034.8	25,014.0	22,034.8	44,174.0	22,035.0	22,139.0
Perry	2,178.0	0	3,031.0	0	6,485.0	575.0	5,910.0
Piatt	1,263.0	0	2,358.0	0	7,048.0	645.0	6,403.0
Randolph	2,982.0	28,921.6	4,056.0	28,921.6	7,881.0	28,922.0	-21,041.0
Rock Island	7,122.0	0	10,764.0	0	22,311.0	5,248.0	17,063.0
St. Clair	17,691.0	0	25,247.0	0	54,773.0	185.0	54,588.0
Saline*	4,720.0	0	6,245.0	0	9,603.0	246.0	9,357.0
Sangamon	12,001.0	0	20,609.0	0	48,156.0	15,868.0	32,288.0
Scott	269.0	0	438.0	0	972.0	356.0	616.0
Shelby	1,669.0	0	3,175.0	0	7,796.0	6,588.0	1,208.0
Stephenson	2,397.0	0	3,575.0	0	7,632.0	206.0	7,426.0
Tazewell	12,065.0	0	20,523.0	32,700.8	40,086.0	32,701.0	7,385.0
Vermilion	5,431.0	0	10,523.0	0	22,982.0	634.0	22,348.0
Wabash*	1,124.0	0	1,869.0	0	3,379.0	492.0	2,887.0
Washington	1,411.0	0	2,019.0	0	5,222.0	84,147.0	-78,925.0
Will	33,590.0	64,214.7	52,882.0	64,214.7	123,058.0	64,215.0	58,843.0
Williamson	8,558.0	0	11,912.0	28,642.5	20,261.0	28,643.0	-8,382.0
Winnebago	$ 13,786.0	$ 0	$20,769.0	$ 0	$ 45,544.0	$ 942.0	$44,602.0

*Notes: *Counties with only a coal mine, without a fossil-fuel plant.*

The localized net losses are substantial for several communities that host a fossil-fuel plant. The author estimates imbalances between localized gains and losses for 10 counties. Washington (-$78.9 million annually), Randolph (-$21.0 million), Massac (-$14.3 million), Jasper (-$11.5 million), Williamson (-$8.4 million), Christian (-$8.0 million), Hamilton (-$6.1 million), Lawrence (-$6.0 million), Kendall (-$3.3 million), and Lee (-$1.9 million) counties have estimated localized losses exceeding gains, as displayed in the last column of Table 7. The 2045 net gains account for all cumulative impacts in the previous years, along with the anticipated closures in that year.

The conclusion one should draw from Table 7 is that there will be a stark imbalance between localized gains and localized losses unless the state carefully intervenes to address the issue. Most health co-benefits accrue in areas near and downwind the power plants that have large populations. Cook County enjoys the greatest health gains from the new law (estimated at $762.3 million annually) because it meets all the criteria and has suffered the most health consequences from plant emissions historically. Cook County is located near and downwind from several gas plants and has a large population to benefit. Yet, Cook County has only $4.3 million in estimated localized losses because the large generating and high-employment plants it once hosted closed long ago.

Conversely, the largest localized losses would be imposed on Washington County, where PSEC is located. Washington County has estimated localized losses of $84.1 million annually and only $5.2 million in localized gains. PSEC employs a lot of workers and has a lot of taxable value; however, Washington County has a small population so the incidence of negative health outcomes is small relative to the volume of pollution. Neighboring Madison and St. Clair counties benefit more for their substantially larger populations.

DISCUSSION AND CONCLUSION

This study quantifies the economic impacts that can be expected from the closure of fossil-fuel electric generation plants in the State of Illinois in accord with CEJA. In doing so, it illuminates regional disparities between localized gains and losses. Overall gains to the United States and the world vastly exceed losses even after considering extensive utility price increases passed onto consumers to finance needed infrastructure. Still, if left unaddressed, the differences in localized gains and losses will cause Illinois' lagging central and southern regions to lag further behind in the transition to a net-zero carbon emissions economy.

The estimated imbalances suggest that discretionary resources in annual allocations from the Energy Transition Assistance Fund are insufficient to compensate net localized losses. The largest imbalances among counties with near-term losses (Randolph and Massac) annually exceed the $40 million awarded annually as Energy Transition Community Grants. More worrisome is that little of the discretionary portions of the assistance will be directed to communities with the biggest losses for political reasons. Thirty-five percent ($14.1 million) of the $40 million in grants awarded in March 2023 were awarded to local governments with property tax jurisdiction containing the Zion Nuclear Power Plant, in Lake County, which was decommissioned 40 miles north of Chicago 25 years ago.

A number of factors will offset some of the disparities as the economy adjusts to energy transition. First among these is the mobility of the workforce in the fossil-fuel electricity generation industry. Coal plant workers, in particular, have proven themselves to be geographically mobile, often moving to plants in other counties after a plant closes. Such mobility might suggest the severity of the differences is overstated.

Though a county-level analysis such as this one can illuminate geographic disparities in health outcomes due to differences in ambient air quality, more precise air quality models are needed to avail of natural experiment opportunities presented by the closure of fossil-fuel plants. Although costly and difficult to employ statewide due to extensive data requirements, future work should develop fine-scale models to better account for local conditions such as stack height, quality of pollution controls, locally prevailing wind conditions, local topography, and the immediate proximity of population concentrations.

Impact estimates of the sort provided in this analysis are sensitive to the assumptions about the relevant discount rate for the future, values of human life and reduced quality of life, and the SC CO_2. Recent updates to best practices promoted by USEPA and transferred in the latest version of the COBRA v. 5.1 model (2% discount rate) result in estimated gains that are more than three times greater than similar estimates that would be generated before November 2023 from the earlier COBRA v. 4.1 model (3% discount rate) and estimates of the SC CO_2. This analysis uses the latest USEPA recommendations and version of COBRA.

Local governments in fossil fuel-dependent counties can anticipate revenue losses and sizable economic adjustment from lost jobs and incomes. Municipal and county governments can weather the shocks best by coordinating economic planning activities with state and national economic development and environmental management agencies and Illinois colleges and universities to retrain dislocated workers, incentivize new basic industries to replace fossil fuel-dependent sectors, and remediate the environmental hazards left behind by closing plants and mines. Fossil fuel-dependent communities need to engage in regional planning to develop strategies that assure they will not be left behind in the transition to a clean-energy economy.

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TECHNICAL APPENDIX

ADJUSTING VALUES IN TABLE 3 FOR INFLATION

The values are adjusted into 2020 dollars and account for projections of the rate of real per capita Gross Domestic Product (GDP) growth (Congressional Budget Office, 2023) and estimated income elasticity of willingness to pay for health risk reductions. Consistent with USEPA best practices, the income elasticity is assumed inelastic at 0.15 for a minor health impact, 0.45 for severe and chronic health effects, and 0.40 for premature mortality (U.S. EPA, 2024).

DETERMINING VALUES OF AVOIDED HEALTH OUTCOMES

The value for avoided premature mortality is based on the value of statistical life (U.S. EPA, 2024), the estimated amount society would pay in higher taxes to reduce risk so that death of one anonymous person could be avoided (Mishan & Quah, 2021, p. 243). The values for avoided morbidities are based on costs of illness calculations (U.S. EPA, 2024). Savings from avoided hospitalizations and emergency room visits are based on typical costs associated with hospitalization and the willingness to pay to avoid adverse outcomes that occur when hospitalized (Mishan & Quah, 2021, p. 274). Typical costs include hospital charges, post-hospitalization medical care, out-of-pocket expenses, lost earnings of individuals and their caregivers, lost recreation value, and lost household production. The value of avoided ailments that are less acute are based on willingness to pay (U.S. EPA, 2024) calculations from contingent valuation and similar revealed preference survey techniques (Mishan & Quah, 2021, p. 274).

HOW COBRA TRANSLATES AN EMISSIONS SCENARIO INTO PREDICTED HEALTH OUTCOMES

The tool multiplies fixed transfer coefficients from a Source-Receptor (S-R) Matrix to adjust each county's $PM_{2.5}$-concentration estimate for a hypothetical monitor at the center of the county for all the emissions changes entered at sources (U.S. EPA, 2024). The output is high and low estimates of the avoided health outcomes in each county based on the estimated change in ambient air quality and the health impact function(s) for the particular outcome. The high and low estimates account for differing assumptions about the sensitivity of the outcome to changes in ambient $PM_{2.5}$ levels reflected in the health impact functions transferred into the model from previous research (U.S. EPA, 2024).

Estimated monetary values for avoided health outcomes are also included in the output.

ASSUMPTIONS OF THE ECONOMIC IMPACT ANALYSIS

Assumption 1:
Plant closures will occur by the incentivized dates (2025, 2030, and 2045) or not.

CEJA includes strong incentives for natural gas plants to close by 2045, but there are countervailing market pressures for them to remain open. In nine out of 25 U.S. energy supply regions, renewable generation is more costly than combined cycle natural gas, including in downstate Illinois, which is supplied by the Midcontinent Independent System Operator (MISO, U.S. EIA, 2023b).[4] Hence, it is reasonable to assume that market conditions could continue to stymie closure of natural gas plants through 2045.

Assumption 2:
Population levels in counties remain static from 2023 through 2045.

This assumption is a modeling simplification that enables the estimates to reflect only changes in emissions, which is the topic of interest. Recently, most Illinois counties have been experiencing a loss of population. Hence, this assumption has the effect of underestimating the magnitude of benefit disparity in Illinois counties that host a closing power plant, yet it allows the isolation of the effect from the closure. Age-specific populations change according to the aging of cohorts and birth, death, and migration rates held constant over the period.

Assumption 3:
The locations of future job creation gains and infrastructure costs are not knowable.

Across the Midcontinent Independent System Operator (MISO) and Pennsylvania-New Jersey-Maryland Interconnection (PJM) grid operators combined, the share of renewable energy projects in the grid connection queue is 52% solar, 37% wind, and 11% storage (Rand et al., 2024). About 20% of projects and 14% of capacity in the queue between 2000 and 2018 became operational, which means that the remaining projects constitute backlog (Rand et al., 2024). MISO stopped accepting new requests for grid connections in 2023 and PJM will not review new requests until 2026 while it processes backlog (Rand et al., 2024). More important are the cost disincentives for connections to renewable sources when compared to natural gas, with potential interconnection and network costs of $24/kilowatt (kW) for new generators using natural gas, \$136/kW for onshore wind, \$253/kW for solar, \$335/kW for storage, and \$385/kW for offshore wind (Seel et al., 2023). The author assumes the additional transmission and network costs are passed forward onto ratepayers and average \$220/kW, which is the current mean cost for projects in the combined MISO and PJM queue. Illinois would need to deploy an additional 5 TWh of clean renewable sources per year to meet the 2030 CEJA target and a deployment rate of 3 TWh per year to meet 100% net zero emissions by 2045 (ICC, 2022).

Assumption 4:
Recent changes to consequential estimates for impact evaluation are improvements.

This paper uses the recently released version of COBRA updated in June 2024. It also uses the newly recommended discount rate of 2% and new estimates for valuing SC CO_2 recommended by USEPA (2023). Each of these changes results in substantial differences to the estimates in the simulation. COBRA v. 5.1 transfers and pools health impact functions and values from epidemiological studies that are more current than the previous version 4.1 released in 2021. The effect is that the newer version estimates greater incidence of mortality and fewer incidents of most morbidity endpoints. A bigger difference is the estimates of economic values presented in Table 3, which are greater in the recent epidemiological studies than those used in version 4.1. The value of mortality is 86% higher than in previous estimates. Part of the difference is due to a discount rate of 2%, which is lower than previous OMB recommendations of 3% or 7% in 2021. Values are now larger for SC CO_2, which are 2.5 times higher than recommended before November 2023. The new recommended estimates, however, are in response to criticisms from scholars who pointed to better projections, more accurate damage functions, and improved discounting methods that suggested previously estimated values of SC CO_2 were less than one-third the value they should be (Rennert et al., 2022).

ENDNOTES

[1] All dollar value present in this paper is in a constant value, based on year 2020 dollar value.

[2] An Excel workbook is available for download from https://www.epa.gov/environmental-economics/scghg to assist with estimating SC CO_2 in intercensal years not ending with a zero.

[3] The refiled grid plan would raise rates between \$200 and \$400 per year. A previous plan including a \$300 rate increase was rejected by the Illinois Commerce Commission in December 2023.

[4] Based on data provided with the Annual Energy Outlook 2023 (U.S. EIA, 2023b) available for download at https://www.eia.gov/outlooks/aeo/electricity_generation/.

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